AUSTRALIA

EXECUTIVE SUMMARY

The Australian objective is to develop plans for the integrated management of the nation's natural resources on a catchment basis. In detail, this can be summarised as :

- specify outcomes across water, land, other environmental resources and cultural heritage, consistent with the principles of ecologically sustainable development;
- implement the philosophy of integrated catchment management by specifying the roles of communities and of governments under a 'catchment co-ordinating' structure; and
- provide co-ordination and financial support for measures to improve the sustainability of natural resources management practices, including communication, education, on-ground works and evaluation.

1. NATURAL RESOURCE MANAGEMENT STRATEGY

Major priority areas include :

- Riverine Environment Management;
- Irrigation Regions Management;
- Dryland Regions Management; and
- Basin-wide Initiatives.

1.1 RIVERINE ENVIRONMENT MANAGEMENT

The aim of Riverine Environment Management is to achieve ecologically sustainable management of the Basin's riverine environment.

Improving water quality

The objective is 'to improve the quality of water resources for environmental, consumptive and recreational uses'.

- *Salinity and Drainage Strategy*

  Rising salinity levels and increasing land salinisation in irrigation areas are major issues. Completion of the Strategy marked the first occasion on which state governments had agreed to tackle a specific environmental problem through common effort across their borders.

- *Algal Management Strategy*

  The Algal Management Strategy aims to reduce nutrient inputs to the river system, improve streamflow regimes and increase our understanding of the nature of blue-green algae.

Balancing flow regimes

The objective is 'to establish river flow regimes that provide a balanced and fair distribution of water between human and environmental uses'.

- *The Cap*

  An audit of water use in the Murray-Darling Basin completed in 1995 indicated that increasing diversions were reducing the security of supply to all users and exacerbating river health problems. Following further studies and an independent review, the Ministerial Council confirmed a Cap on water diversions, limiting them to the volume of water that would have been diverted under 1993-94 levels of development. Procedures have been put in place for monitoring and reporting on compliance with the Cap.

- *Environmental Flows Decision Support Program*

  The aim of the Environmental Flows Decision Support Program is to support a strategic long-term approach to rehabilitating the Basin's rivers through the development of science-based products that will help to predict the likely effects of a wide range of actions and policies on riverine environments.

Managing for nature conservation

Its objective is 'to enhance bio-diversity and maintain ecological communities throughout their range within floodplain, wetland, riparian and in-stream ecosystems'.

- *Fish Management Plan*

  The prime aim of the Fish Management Plan is to sustain native fish populations in perpetuity.

- *Floodplain Wetlands Management Strategy*

  The goal of the Floodplain Wetlands Management Strategy is to maintain and, where possible, enhance floodplain wetland ecosystems for the benefit of present and future generations.

1.2 IRRIGATION REGIONS MANAGEMENT

The aim of Irrigation Regions Management is to achieve ecologically sustainable development of the irrigated regions.

- *Irrigation Management Strategy*

  The aim of the Irrigation Management Strategy is to achieve an economically and environmentally sustainable and self-sufficient irrigation industry by the year 2010.

- *Regional Economic Development Policy*

  The goal of the policy is to encourage strong, growing and diversified regional economies, based on competitive rural industries and self reliant communities and ecologically sustainable management of natural resources.

1.3 DRYLAND REGIONS MANAGEMENT

Dryland Regions Management fosters community and government partnerships to address serious problems of land, water and vegetation degradation in the dryland farming and grazing regions of the Basin.

1.4 BASIN WIDE INITIATIVES

- *Communication Program*

  Central to the community-government partnership is the development of a comprehensive communication program.

1.5 CATCHMENT MANAGEMENT REGIONS

In addition to the programs and strategies indicated above, much work is being undertaken at the regional level. Within the framework of the Natural Resources Management Strategy, a number of catchment-based regions have been established to co-ordinate natural resources management through their *Regional Action Plans and Projects*.

2. PRESENT STATUS OF IRRIGATION IN AUSTRALIA AND A VISION FOR THE FUTURE OF IRRIGATION

2.1 INTRODUCTION

Australia irrigates 2 million hectares of land for cotton, rice, fruit crops, grapevines, pastures and vegetables. The annual farm gate value of produce from irrigation farms is about $12.0 billion Australian, or more than 25% of the total agricultural production of the nation.

The major irrigation areas are in inland Australia, especially in the Murray-Darling Basin (South Australia, New South Wales, Queensland and Victoria). Water required for irrigation is stored in reservoirs in the upper reaches of the main streams and rivers and is released on demand to down stream irrigators. Legal agreements between the States determines the relative share of water resources. Groundwater resources are utilised in some regions.

In New South Wales, 500,000 ha of pastures, and 200,000 ha of rice and cotton are flood irrigated. Extensive earth and concrete lined channel supply systems divert waters from storages and waterways to irrigation districts. Many of these systems have been in use for 50-80 years.

In Victoria, 500,000 ha of pastures are flood irrigated. Major channel systems divert water from the river systems to the irrigation districts.

In South Australia, Victoria and New South Wales, over 100,000 ha of high value horticultural crops (citrus, grapes, stonefruit, almonds, vegetables) are sprinkler or drip irrigated. In horticultural irrigation districts water is often distributed in low pressure pipelines, which have often replaced the older channel systems. South Australia also irrigated 60,000 ha of pastures.

In other states, a similar range of crops are produced. Queensland also irrigates 140,000 ha of sugarcane. Many inland areas of Australia have been developed only through the irrigation industry.

Access to irrigation water is controlled by the government with the amount available to any irrigator, or the area that may be irrigated, regulated. Significant private irrigators do exist but most regional water supply infrastructure is owned, constructed, maintained and operated by government agencies. Some policy changes over recent years will result in increasing privatisation or corporatisation of the ownership and operation of infrastructure. Historically, supply of water was subsidised to encourage development but there is now increasing cost recovery, at least for operating and maintenance costs. Governments are also developing policies to allow greater trade in water to permit more transfer within and between districts to provide water for new industries.

In most States, local area management is controlled by elected management boards who make decisions on all aspects of irrigation management for all farmers in the district.

About 20% of land irrigated is supplied from underground sources. This is generally managed by the States.

In Summary

- The value of Australia's irrigated agriculture is $12 billion per year.
- Greater than 25% of total agricultural production comes from irrigation.
- 70% of agricultural product is further processed. Activities outside the farm gate multiply the return perhaps four-fold, generating jobs and investment.
- Irrigation uses 73% of the nation's water resources.
- Production of most fruit, vegetables, dairy products, wine, cotton and rice depends on irrigation.

The end result is that irrigation

- has improved farm productivity;
- has enhanced the quality of agricultural products and helped to ensure that quality standards required by consumers can be consistently achieved;
- has allowed agriculture to develop new crops suitable for international market niches;
- has provided the basis for a large food processing industry in regional Australia;
- is the foundation of many associated industries and, in particular, tourism and related services; and
- provides agriculture with the reliability that is the key to accessing many South East Asian markets.

2.2 VISION FOR IRRIGATION

Australian irrigated agriculture has a bright and ecologically sustainable future.

Such an expectation can be arrived at by looking at the irrigation industry from a number of perspectives.

Irrigated Food Exports

- *A stable supplier of high value fresh food exports*

  A key to the revitalisation of irrigated agriculture will be the rapidly expanding demand in South East Asia for reliable supplies of high quality horticultural crops and other food products.

  These markets demand stability of supply and irrigation guarantees stability of production.

- *Exports of traditional products enhanced by GATT negotiations*

  Other products of irrigated agriculture will gradually benefit from the realignments of international trade that have been established through GATT negotiations.

- *Value adding and service opportunities*

  There is a great potential for value adding (processing and packaging) of irrigated agricultural products which means that the Australian economy will receive a major long term boost.

  Major beneficial flow-on effects will be experienced through all the sectors of the economy that service irrigated agriculture.

- *A strong and viable irrigation equipment industry*

  Australia has a strong and innovative irrigation equipment manufacturing industry. This part of the industry is a major exporter of irrigation technology in its own right and also services the expanding non-farm and urban irrigation requirements.

The Management of Irrigation

- *On farm management*

  A key change at the farm level will be that farmers will have the money to invest in new irrigation technologies. Instead of bearing the cost of tariff protection provided to other parts of the economy, farmers will have the capital to invest in their own properties.

  Farmers will use new irrigation technologies. This will include matching the supply of water to that actually needed by the crops, using water stress to manipulate the growth, yield and quality of plants and the innovative use of waste water. This will result in the more efficient use of less water and will maximise the use of rainfall and reduce drainage - both surface and sub-surface. More efficient irrigation practices will be adopted and sprinkler and drip irrigation techniques will be further refined.

  Farmers will be better trained and ready to adopt new farm management practices as productivity and viability improves, the spread between average performance and best management practice will be significantly reduced.

  Irrigators will fully participate in national research and development programs.

- Supply agencies

  The driving force of the new era of sustainable irrigation techniques will come from farmers, whose returns have increased, working closely with the irrigation service providers. Governments will, however, have an important role in the management and allocation of water resources. This has been highlighted in the Council of Australian Governments' Water Resources Policy. Some of these changes include :

- Privatisation or corporatisation of the ownership and operation of irrigation infrastructure.
- The management of irrigation systems by regional bodies.
- Greater trade in water and transfer of water within and between districts. This will provide water for new industries.
- Governments will promote and support industry or regional restructuring to help the move towards higher valued use of water and more effective irrigation practices.

Irrigators will form strong customer groups to deal directly with the agencies and companies involved in the storage and delivery of water. In some cases the irrigators, through their customer groups, will operate and maintain parts of the system.

Tariffs and the Price of Water

In order to minimise price rises, irrigators will be looking for cost savings in the delivery of water and maintenance and renovation of assets. These will be achieved by new management arrangements and innovative practices developed through research. Irrigators will be looking for international best practice in the delivery of water.

The industry will avoid the distortions that can be created as a consequence of artificially low or subsidised water prices. The distortions can include damage to the environment, creation of artificial values and the encouragement of inefficient practices.

In the short term, supply agencies will proceed with proposals to set water prices at levels which will provide for the operation, maintenance and replacement of the irrigation system.

The sophistication of water pricing will increase. Water prices will eventually consist of several components related to factors such as volumes and timing. The components will be manipulated to influence the utilisation of water and ensure that costs are kept to a minimum.

Importantly, the savings generated by farmers adopting more efficient irrigation techniques will provide extra capital for these farmers to invest.

Supporting Industries

Industries supporting the revitalised irrigation industry will improve their operations to facilitate and benefit from exports of irrigated agriculture.

The international marketing of irrigated agricultural products will be enhanced progressively through the initiatives of private industry and marketing groups.

Environmental Issues

The rivers which carry the water for irrigation must be healthy in their own right. For some rivers, flows throughout the system will be better managed to guarantee this health.

Irrigators, communities along river, and the managers of water storages will understand and care for the needs of the environment. Environmental water flows will be provided to maintain key elements of the ecology of streams, and will recognise the need for periodic floods of specified dimension and timing. Streams and wetlands will be managed with knowledge of the needs of native wildlife such as water birds and fish.

Farmers, being in the long term business of primary production, will work to ensure that the irrigation system is environmentally sustainable.

Irrigation service providers, in conjunction with farmers, are developing better management practices for nutrient control both on farm and within irrigation drainage networks.

The new era of revitalised irrigated agriculture and transferable water rights may result in land that is badly affected by rising watertables and salinity being withdrawn from irrigation. This will be achieved through the market place. The environment can purchase this water in the market place.
In the past, conservation groups have highlighted the worst examples of salinity to raise public awareness about the problems and to gain support for costly remedial action. Since then the farming community, the Government, the irrigation service providers and conservation groups have been working together to determine the most appropriate strategy for the future.

2.3 STRATEGIC GOALS/MAJOR OUTCOMES

Should relate to matters such as :

- Financial Framework with Governments.
- Water Resource Management.
- Environmental Management.

3. FUTURE CHALLENGES AND AIMS FOR NATURAL RESOURCE MANAGEMENT

Australia has identified the need to take an integrated catchment management approach to natural resource management to ensure future long term sustainability of irrigation, dryland farming and the environment.

The major aims of the Natural Resources Management Strategy are :

- prevent further resource degradation;
- restore degraded resources;
- promote sustainable user practices;
- ensure appropriate resource use planning and management;
- ensure a viable long-term economic future for Basin dependents;
- minimise adverse effects of resource use;
- ensure community and government co-operation;
- ensure self-maintaining populations of native species;
- preserve cultural heritage;
- conserve recreation values.

Future Water for Agriculture Initiatives should involve :

- maximising private sector investment opportunities;
- identifying land that can be sustainably irrigated without compromising salinity, water quality, and other environmental goals;
- improving efficiency of the irrigation industry to get the most out of our treasured water resources;
- ensuring water markets operate effectively to move water from low to higher value use.

AUSTRIA

1. Geography and Geology

Austria is situated on the south-eastern fringe of Central Europe and covers a total area of some 83,850 km^2. Austria is a mountainous country and its landscape is characterised by the prevailing geological and tectonic features. The Alps comprise 65 per cent of the federal territory; two-fifths of the total area are situated higher than 1,000 m above sea level. The high Alpine mountain regions with altitudes of 3,000 to 3,800 m above the Adriatic Sea are partly covered with glaciers. North of the high Alps lie the sub-alpine mountains and the Bohemian chain (maximum height a little over 1,000 m). Between these two chains and towards the east extend the plains of the Tertiary basins, through which the Danube flows.

2. Climate and Rainfall

Austria lies in a transition zone between the maritime north-west and the continental east of Europe, with hot, wet summers and cold, dry winters. The average annual temperatures in the valleys range between 7°C and 10°C; in the mountains they may drop to -6°C or lower. The highest average monthly temperatures usually occur in July (17°C to 21°C in the valleys); the lowest average monthly temperatures are to be found in January (-1°C to -7°C in the valleys). In the winter months the country is covered with snow for a period of 30 to 90 days in the valleys, and the whole period in the higher regions of the mountains where the snow sometimes does not melt before the first summer months.

The average annual precipitation in Austria is 1,170 mm but it varies in the different parts of the country. In some mountain regions the average annual rainfall may rise to a maximum of 3,000 mm, while in some parts of the eastern plains it amounts to only 500 mm. Generally, it may be assumed that the quantity of rainfall decreases from West to East and that the intensity of rainfall increases with the altitude of the region. In the mountains, however, certain arid regions are formed due to the rain shadow effect of the surrounding mountain ranges.

3. Population and Land Use

The population of Austria is 8.1 million, the average population density amounts to appr. 96 inhabitants/km^2. This density is relatively low, due to a large extent of alpine area.

Austrian landscapes are characterised by forests and grassland. According to current statistical data, nearly half of Austria's territory is covered by forests. Forests and grassland are dominating the alpine regions (western parts of Austria, central and southern Alps) and the northern highlands. Most of the arable land can be found within a broad belt along the Danube, the north eastern hilly region (Weinviertel), the eastern parts along the Slovakian and Hungarian borders and the basins in south-eastern Styria and in Carinthia.

Cattle farming and dairy produce constitute the most important lines of agriculture, total animal production accounting for two thirds of agricultural final production in Austria. On the other hand, forests are an important economic factor and an additional source of income for farm foresters.

Table: Land use in Austria

Land use	*Area in 1000 ha*
arable land	1397
gardens, fruit plantations	27
vineyards	54
meadows	945
pastures	148
alpine grassland	851
total agricultural area	3422
forests (with yield)	3274
other areas	845
total area in use	7541
total area	8386

Austria's agriculture is marked by small- and medium-sized farms, the average farm size amounting about 15 ha of utilisable agricultural area. Of a total of 250,000 farms, holdings of a size up to 5 ha account for 34 per cent, farms of 5 ha up to 100 ha for 63 per cent and farms of 100 ha and over for only 3 per cent.

4. Water balance

The quantity and quality of water have to be maintained for a wide variety of uses. Thus the water balance constitutes an important basis for the management of water resources in Austria.

The annual average for precipitation amounts to 1170 mm, the annual average for run-off is 654 mm, thus annual evaporation amounts to 516 mm. Since about 340 mm per year are flowing in from neighbouring countries, the resulting total run-off level from Austria amounts to about 1000 mm per year.

There are considerable regional differences: The average annual precipitation in the Rhine basin in western-most Austria amounts to 1950 mm, in the Northeast of Austria it goes down to 600 mm and below. The run-off values vary accordingly between 1470 mm and 120 mm per year.

5. Water resources and uses

Austria is rich in water, the annual water amount available averages 84 billion m^3 with groundwater adding up to about one third of the total amount. Corresponding to the amount of 2.6 billion m^3 of water required, 3 percent of the total water supplies and 6 percent of groundwater reserves are used for economic purposes. 99 percent of Austrian drinking water comes from ground and spring water.

Per capita water withdrawal, at 326 cubic metres per year, has remained fairly constant since 1980. 3.2 million households use about 27 per cent, industry 66 per cent and agriculture 7 per cent. About 99 per cent of all drinking water is derived from groundwater (half from spring water and the other half from gravel aquifers). Industry meets almost all its water needs with its own withdrawals; only 3.3 per cent of enterprises obtain their water from the public supply, of which these enterprises account for about 11 per cent. Industry uses about twice as much spring water as does the public drinking water supply. Of the total water use agriculture accounts for appr. 0.2 billion m³ (78 000 ha of irrigated area, 80 % of which in the east of Austria).

In Austria irrigation is primarily used as supplemental irrigation to compensate for a lack of rainfall during the vegetation period. The main irrigation regions are in the north-eastern lowlands (Marchfeld, Weinviertel, Parndorfer Platte, Seewinkel, Südliches Wiener Becken, Tullner Feld, Wachau), where natural precipitation reaches 450 - 700 mm per year (300 - 450 mm in the vegetation period). Other irrigation areas in southern and western parts of Austria are of minor importance.

6. Water management

Austria's huge water resources determined a user oriented water-management. Due to the lack of water scarcity problems (only 3 per cent of the renewable water resources were used) preservation of resources was not of great interest in the past. But water quality decreased as economic prosperity increased. Industrial production led to a steadily increasing input of nutrients and pollutants. As a consequence water protection and preservation became additional basic principles of Austria's water policy four decades ago.

The Austrian Water Act has enshrined the following principles of water policy:

- ❖ An overall and comprehensive protection of surface and groundwater throughout the country
- ❖ precautionary principle for all surface and ground waters, with special emphasis on the protection against dangerous substances
- ❖ combined approach based on
- \- firstly the control of pollution at source together with the reduction of the emissions due to the state-of-the-art
- \- and secondly by setting water quality objectives with the obligation of taking measures in case of failing standards.

The two main objectives were (i) to preserve the sustainable use of surface water resources by protection and/or upgrading water quality to the level of nearly pristine quality and (ii) to protect groundwater aquifers in order to use them for drinking water supply. Measures to achieve these objectives were financed by governmental institutions with subsidies for water supply and waste water treatment (Wasserwirtschaftsfonds) and environmental subsidies, the so called 'Umweltförderung'. All efforts together amount to annual expenses of 2% of the Austrian gross national product. Today:

- ❖ Austrian lakes have an excellent bathing water quality - and consequently drinking water quality
- ❖ most large Austrian rivers show water quality class II of the saprobic system
- ❖ 99 % of drinking water derives from groundwater resources mostly without any technical removal of pollutants
- ❖ quantity and quality of irrigation water is sufficient in most regions.

But Austrian water policy does not rest on its laurels. New challenges are lying ahead:

- ❖ Protection of ground and surface waters in rural areas with special regards to impacts due to diffuse sources (e.g. agricultural use)
- ❖ Search for resource friendly waste treatment, disposal and recycling (e.g. sludge)
- ❖ Remediation measures for old landfills (contaminated sites)

Since years Austria has been keen on establishing elements of the national water policy in international contracts. Beside bi- and multilateral treaties with its neighbouring countries Austria initiated and supported the Convention on Co-operation for the Protection and Sustainable use of the Danube in the early nineties. This step highlighted the efforts to design further water management activities within an international river basin. The convention came into force on the 22nd October 1998, being a milestone for the protection and the sustainable use of the River Danube and setting uniform quality objectives for all riparian countries. In context with the activities to protect the Black Sea the next urgent step will be to convene the level and extent of reduction of emissions. Today Austria sees these tasks as a great, positive challenge to international co-operation.

7. Water quality

To safeguard water quality, the uniform monitoring of groundwater and running waters in the framework of the Water Quality Monitoring Ordinance (WGEV) has been regulated since 1991.

Since this time the quality of Austrian ground and running waters has been examined on the basis of uniform criteria: a stringent quality safeguarding system guarantees optimum data safety. In the period of 1995-1997 a total of 1,822 sampling stations in pore ground water bodies and 227 in karstic and crack ground water bodies, i.e. a total of 2,049 ground water sampling stations, were monitored usually 4 times per year. Thus, 150 large, interconnected pore ground water bodies, seven regions with smaller supplies of pore groundwater and also the major karstic lime-alpine water bodies were monitored.

Rivers and streams

Since 1996 the monitoring network has been fully developed and comprises 244 running water sampling stations. 81 percent of the running waters on the water quality map of 1998 are biologically classified Quality Class II or better (in a four-class rating sabrobic system. I = not or nearly not polluted; II = moderately polluted; III = strongly polluted; IV = extremely strongly polluted). A comparison of the quality data of 1966/71, 1988 and 1995 clearly shows improvements mainly due to accelerated and concerted extension of the water treatment plant network. However, the Quality Class II will be difficult to reach where settlements and waste water discharging plants are located near waters with a low flow regime, even if the waste water discharged is treated in an appropriate manner.

The limit values of the EU Fishing Waters Directive have been taken as a basis for the evaluation of the water quality of running waters. Analyses have shown that most of the sampling stations fall below these values. This result is especially satisfactory, since the WGEV-monitoring network was particularly designed for the detection of supraregional water contamination.

Groundwater

Since 1996 the monitoring network has been fully developed and comprises about 2,000 groundwater sampling stations. Analysis of the examination results of groundwater quality on the basis of the criteria of the groundwater Threshold Value Ordinance shows that the majority of the about 90 chemical parameters clearly falls below the limit values set in the Threshold Value Ordinance.

Groundwater polluting parameters in pore groundwater bodies are mainly nitrates, pesticides (atrazine, desethylatrazine) and to a minor share also chlorinated hydrocarbons.

In the period of 1995 - 97, 81 percent of all nitrate values measured in Austria fell below the threshold value of 45 mg NO_3/l. Compared to the data gathered in 1992, the threshold value of 45 mg NO_3/l was only exceeded to a minor degree even up to the middle of 1998 and showed neither particularly positive nor negative tendencies.

The major loads are largely limited to regions intensively used by agriculture in the south-east and the east of the federal territory. These areas are also often polluted by pesticides - this tendency, however, is declining. In the western provinces and in alpine valleys and basins the nitrate situation usually ranges from satisfying to very good.

The results of pesticide investigations have shown the clear 'pole position' of atrazine and desethylatrazine among the pesticides found in groundwater. On the other hand results have shown that the trend in atrazine and desethylatrazine is declining since 1993. 15 percent of the atrazine values and 24 percent of the desethylatrazine values of the 12,000 measured data of the period between 1995-1997 exceeded the threshold value of 0.1 µg/l tolerated in the Drinking Water Pesticides Ordinance.

Bentazone exceeds the threshold value much more often than atrazine and desethylatrazine, but by not more than 2 percent, which is relatively unproblematic.

Since 1993 a clear backward trend has been observed in the atrazine and desethylatrazine load in all the pore groundwater bodies, which is due to the banning of atrazine.

Chlorinated hydrocarbons generally increase in densely populated or industrial areas and in the vicinity of contaminated sites. Contamination of the entire territory according to the parameters of the Groundwater Threshold Value Ordinance is not observed. Elevated heavy metal values are rare and only occur sporadically. This set of parameters does not constitute a quality problem throughout Austria.

Lakes and wetlands

The Austrian lakes - about 6,000 natural lakes, including 26 larger than 1 km^2 - are an essential element in the qualitative and quantitative water regime and, as an important natural potential, also play a central role in tourism and recreation. Their protection is therefore a central task in Austrian water management both from an ecological and economical view.

In general, Austria's lakes are in very good limnological and bacteriological condition. This is an important asset for tourism. Phosphorus levels have fallen in recent years, and the transparency of the water has increased considerably since the early 1970s; in a few lakes it is now comparable to the situation in the early 1930s. Acidification is not a serious problem as the limestone hydro-geology creates sufficient buffer capacity, except for in the crystalline high mountain regions. Concentrations of sodium and chlorine, although still low, have been rising since the early 1970s as a result of increasing use of salt on roads during winter.

More than 90 per cent of 43 lakes studied in Carinthia in 1993 showed very good bathing water quality in terms of clarity, nutrients and bacteriological conditions. The phosphorus content of Lake Constance (Bodensee) has been reduced from around 85 mg/m^3 in the late 1970s and early 1980s to 29 mg/m^3 slightly below the preliminary target value of 30 mg/m^3. More recently, the lake has also shown a reduction in of bio-mass of algae and a consequent improvement in the oxygen content of the water.

8. Bio-diversity of wetlands

Austria is one of the signatory states of the Convention on Biological Diversity and has thus committed itself to the conservation of bio-diversity and the sustainable use of its components. Rivers, lakes and other wetland areas are the most important habitats for almost 1000 endangered species in Austria.

The increased environmental awareness of the past few years has led to the protection of waters not only for their useful function for human beings, but also for their quality as ecosystems. The 1990 Amendment of the Water Law already provides for the protection of water bodies including the preservation and improvement of the ecological efficiency, which can be threatened both by water pollution and interference with the run-off regime and the water bodies morphology.

Rivers and Streams

A study identifying river sections that are still in a pristine status was carried out for all the Austrian rivers with a catchment area of at least 500 km^2 (a total length of 5,000 km). 21 percent of the river stretches examined were identified and documented as reference locations showing characteristic elements of the original river type. The results of this study show that river regulation and hydro-power plants have contributed over the past decades to a loss of the ecological quality of our rivers.

These results are particularly important for modern, environmentally friendly flood protection. Measures which increase flows will be avoided, while natural retention areas are preserved and restored, leaving flood areas undeveloped to reduce natural hazards. In accordance with the ecological model that is established in the frame of an interdisciplinary concept, a so-called 'water care concept', specific activities for improving the ecological efficiency of water bodies are implemented.

In order to give new impetus to the preservation and restoration of ecologically intact, near-natural river ecosystems, a campaign entitled “Living Rivers” was launched in 1988 with three goals to be achieved by the year 2000: (1) (legally binding) preservation of important river stretches; (2) significant improvement of ecologically degraded stretches and (3) increasing the (public) awareness and understanding of river ecosystems. Targets were set up (i) to revitalise 500 km of rivers; (ii) to create 500 ha of new flooding area; (iii) to initiate 500 ha of new riparian forests and (iv) to plant 500 ha of buffer strips along river banks.

Lakes and wetlands

The situation of wetlands has deteriorated significantly since 1945. Since this time, more than 190 000 hectares have been artificially drained for the purpose of agricultural land use. Nowadays, all wetlands in Austria should be considered deficient habitats for the plant and animal species living in them.

Austria is a member of the Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar-Convention) since 1983. Seven sites with a total area of 102,000 hectares have been established as Ramsar wetlands; the most important are the Danube-Morawa-Dye-Wetlands (Donau-March-Thaya-Auen) with 38,000 hectares and Lake Neusiedl with 60,000 hectares, both situated in the eastern-most part of Austria, along the borders to Slovak and Czech Republic and to Hungary respectively.

9. Conclusions and outlook

Austria's water management is characterised by its geographical position being situated in and around the Alps. As a large part of the national territory consists of alpine regions, average population density (96 inhabitants/km^2) and land use of 48% forest area reflect this situation. Hydrological conditions profit from an average precipitation of 1170 mm/a. Nevertheless, bearing in mind that precipitation is spread throughout Austria unequally, special measures for management of water resources had and have to be taken. On the one hand there is the aim for protection of human settlements against the devastating forces of water, such as floods, landslides or avalanches. On the other hand power generation could benefit from the excellent water resources and the orographic conditions. Nowadays hydro-power plants generate approximately two third of electricity used in Austria. The other side of the coin shows that these activities also lead to morphological and hydrological impacts on most of Austria's rivers.

Precipitation, leaching, soil degradation and erosion may cause a high pollutant input into the aquatic system. Agriculture and water management should harmonise their activities to decrease the impacts of diffuse pollution sources. In the eastern parts of Austria, where the agricultural land use is high and the precipitation rate is low, groundwater aquifers are under pressure by nitrate and pesticides. In other cases surface waters can be affected by impacts due to soil erosion.

Scientific progress lead to new targets for water management. At present water authorities have to take into account the ecological functioning of surface waters. Bearing in mind the existing heavy modifications of rivers and streams, a close co-operation of institutions will be necessary, especially in the field of hydraulic engineering, flood protection, hydroelectric power stations and ecology to develop viable solutions for our surface waters.

In this context the Water Framework Directive will be the key instrument for water management in the European Community for the future. The Framework Directive requires that future water management must be river basin oriented with special regard to the conditions and needs of the individual European river basin. The directive's environmental objectives require that surface as well as ground water should achieve good status. Good status relates to good quantitative, chemical and in particular ecological status of a water body. Austria has the big chance to contribute its experience to a more holistic approach of water management in international activities, especially within the River Danube Basin.

Consequently Austria’s future water policy will be characterised by:

❖ sustainable use of water resources, harmonising the needs of the different types of water use with the potential of renewable water resources and the demands for ecological functioning of water bodies
❖ overall and comprehensive protection of surface and groundwater throughout the country using the so called combined approach based on
- the control of pollution at source
- and water quality objectives
❖ preservation and restoration of near pristine conditions of water bodies
❖ protection of settlements against the hazards of water by environmentally-friendly flood-control measures

Key elements for implementing the principles mentioned above are:

- Obligatory licensing for all kinds of water uses and discharges
- compliance monitoring with internal and external control
- control of water quality via the national network for monitoring of water quality and quantity (water quality network)
- obligatory remedial measures in case of not meeting quality objectives and emission limit values
- obligatory adaptation of present water uses and discharges to the state-of-the-art
- significant improvement of the ecological status of surface waters
- periodical assessment of achievements in surface and ground water protection in Austria by the triennial “Water Quality Report” to the Austrian parliament
- further activities in the Convention on Co-operation for the Protection and Sustainable use of the Danube, especially in context with the protection of the Black Sea

BANGLADESH

SUMMARY

Bangladesh is inhabited by about 126 million people in an area of about 147,000 square kilometers and is located within the flood plains of three great rivers, the Ganges, the Brahmaputra and the Meghna. About 93% of the catchments of the country's river system lie outside in the upper region of Bangladesh, but drain the system over it's flood plains to the Bay of Bengal. Because of this unique geographic location, the country receives excess inflows in the monsoon months (July - September) causing recurrent floods and suffers due to shortage of water in the dry season (December - April). The current population density of about 850 per square kilometer is already the highest of any nation in the world. It is predominantly an agricultural country and her economy is heavily dependent on agricultural production. During the decade between 1984-85 and 1994-95, the share of agriculture to GDP declined from 41.8 to 32.8%. The projection of employment up to 2020 shows that until then agriculture will continue to be the major source of employment by absorbing over 40% of the labour force.

Bangladesh is very rich in water resources and is blessed with one of the most fertile lands. The country receives a normal annual rainfall from 1200 mm in the extreme west to as high as 5800 mm in the northeast. The average annual rainfall is about 2300 mm. About 81% of this rainfall occurs in the four humid summer months from June to September. Localized rainfall of long duration in the monsoon season often generates localized floods due to inadequate drainage. However, such floods may be catastrophic when combined with runoff carried by the three major rivers from transboundary catchment areas in India, Nepal and Bhutan. Although there is an abundance of available water there is a wide seasonal variation in the quantity of water. The total annual flow of the river systems in Bangladesh is about 1,511,000 million cubic meters of which 1,360,000 million cubic meters (90%) originates outside Bangladesh.

The Bangladesh National Water Policy (BNW) has adopted the approach of basin planning which provides the most rational basis for development of water resources. International river basins, such as the Ganges basin, the Brahmaputra basin and the Meghna basin present special problems to Bangladesh. Due to its location as the lowest riparian, Bangladesh has no control over the rivers entering through its borders. The adverse effects of this are the floods and water scarcity which occur frequently. As a long-term measure, therefore, it is the policy of the government to undertake essential steps for realizing basin-wide planning with other co-riparian countries for management of the water of the rivers entering is borders. Thus the transboundary water management issue is vital for the development of water resource projects in Bangladesh. Although the 1996 Treaty on sharing the dry flows of the Ganges water with India is expected to bring some relief to the drought prone area of the southwest of Bangladesh, the water shortage problem during the dry season will continue to be aggravated in the Ganges and other basins with rising demands of an increasing population.

Water management in the dry season will have to be primarily concerned with the proper exploitation and allocation of water resources. Easily available water has been the sustaining regime of intensive cultivation in Bangladesh. A key development issue is the extent to which this strong growth can be maintained. Overall growth in surface water irrigation has been slow due to a reduced flow in the major rivers. In the case of groundwater, its availability and the future costs of abstraction are uncertain. More groundwater can be made available through the adoption of measures to abstract from greater and greater depths using shallow tube-well technology and finally force-mode tube-wells. Each technology makes more water available, but at increasing cost. Potential linkage, between arsenic and heavy metal abstractions from groundwater, if established, would radically alter the country's, high dependence on groundwater. Among various minor irrigation equipment, Shallow Tube-wells (STWS) covered 2 million ha or about 60% of the total area under irrigation, Low Lift Pumps (LLPS) irrigated 0.57 million ha, or 17% and Deep Tube-wells (DTWS) irrigated 0.54 million ha or 16% of the total area. Non-mechanized irrigation covered 0.28 million ha or 7% of the total irrigated area. The economics of irrigation in Bangladesh indicates that LLP is the most cost effective of all minor irrigation technologies in the country. For LLPs used by farmers, profits were found to be extremely high, STW comes next in terms of rate of return. DTWS, on the other hand are not found to be economically viable, although there are many DTWs in use both in the private and public sectors.

Major irrigation schemes, which account for less than 10% of irrigated land in the country, appear to be least viable among all modes of irrigation. The World Bank estimates show that the ERR (economic rate of return) of such projects ranges between 11% and 12%. They are heavily subsidized and claim about 50% of development expenditure in the agricultural sector. Water charges for major irrigation is very modest compared to minor irrigation and only a fraction is actually realized. Major irrigation schemes, however, have multiple objectives, such as flood control, water drainage, environmental protection and fisheries development, which are often difficult to measure quantitatively as well as qualitatively. But the evidence is clear that the actual cost of irrigation by major irrigation projects is much higher than tube-well irrigation. Furthermore, the chances of cost recovery from large projects is very limited. Fisheries and wild life are integral aspects of economic development in Bangladesh and strongly linked to the advancement of target groups, poverty alleviation, nutrition and employment generation. Availability of water for fisheries is thus important from the point of view of sustenance as well as commercial ventures. This issue needs an integrated management approach.

The population of Bangladesh will be about 180 million by the year 2025. The long term water vision for Bangladesh is to attain food self-sufficiency by then. This will need an unhindered flow in the 57 border rivers during dry seasons. Bangladesh is dependent on agriculture farm level water resources development and management is key to it is rural development. Rural infrastructure includes communication, water supply, health and sanitation needs. The vision is that all these facilities will be available to rural people.

INTRODUCTION

Most of Bangladesh is located within the flood plains of the three great rivers - the Ganges, the

Brahmaputra and the Meghna, along with their tributaries and distributaries. The three rivers drain a total catchment area of about 1.72 million ha of which only 7% lies within Bangladesh. The remaining area lies in India, Nepal, China and Bhutan. Bangladesh is interlaced by a network of about 230 rivers and innumerable canals and water bodies. Of these, 57 are transboundary rivers.

Bangladesh is blessed with the most fertile land in the world and is very rich in water resources. It receives a normal rainfall from 1200 mm in the extreme west to as high as 5800 mm in the north-east. The average annual rainfall is about 2300 mm. About 81 percent of rainfall occurs in the humid summer months between May and October. Lengthy localized rainfall in the monsoon season often generates localized floods due to poor drainage. However, such floods may reach catastrophic proportion when the upstream runoff carried by the three major rivers is combined.

In contrast to the wet season, rainfall during the dry season is low, unreliable and amounts to one-third of the potential evapotranspiration. Farming was traditionally confined to the wet season but demand for grain has risen and outstripped its production capacity. Crops need to be grown throughout the year and supplementary irrigation was introduced in the 1960s for pre- and post-monsoon crops, followed by the development of full irrigation in the 1970s for dry season crops.

Bangladesh is prone to periodic natural disasters like floods, droughts and cyclones. Besides the annual event of normal flooding inundating about 27% of the country's arable area, periodic severe flooding is also common. Over the 1954-1998 period, flooding covered 37% of the land in every tenth year. The record was in 1998 when almost 60% of the country was inundated and the floods stayed for more than two months (Government of Bangladesh, Ministry of Water Resources, 1998).

The country is also periodically affected by cyclonic storms in the coastal districts. The country has over 700 km of coastline on the mainland and several offshore islands in the Bay of Bengal. During the last 125 years, over 42 cyclones have hit the coastal belt; 14 occurred during the last 25 years. Cyclones often take a heavy toll of human life, livestock, crops, property and the physical infrastructure. (World Bank, Coastal Embankment Rehabilitation Project, 1995).

Bangladesh is a deltaic country inhabited by 120 million people over an area of about 1,47,000 square km. The current population density of 813 per square km is already the highest of any nation other than the tiny city-states. With a per capita income of about US$240, Bangladesh remains one of the poor nations of the World. Progression of a few key social development indicators over a 20 year period gives some idea of the social development status of the country.

Bangladesh is predominantly an agricultural country and her economy is still heavily dependent on her agriculture. Between 1984-85 and 1994-95, the share of agriculture to the GDP declined from 41.8% to 32.8% while the share of the manufacturing and services sectors went up. Despite this, agriculture continues to be the largest provider of jobs as is evident from the Table below.

Table 1. Key Social Development Indicators

Indicators	1975	1995
Population (Million)	80.1	120.3
Population density (person/sq. km)	543	813
Population growth rate (%)	2.57	1.83
Infant mortality rate (per 1000 live births)	140	78
Life expectancy (years) Urban population	46	58
(as % of total population)	8.8	22
Growth rate of urban population	4.25	6.09
Access to safe water (%) of population	56	76
Persons per hospital bed	5110	3450
Persons per physician	11350	4870
Adult literacy % (national)	25.8	47.3

Source : Government of Bangladesh, Ministry of Planning March 1998.

Table 2. Structural Change and Employment 1984-1995

Sector	Composition of GDP (percent)		Employment (million)
	1984-85	1994-95	1994-95
Agriculture	41.77	32.77	30
Industry	9.86	11.36	7
Electricity, Gas & Natural Resources	0.58	1.86	-
Construction	5.53	6.33	-
Transport and Communication	11.22	12.17	-
Trade & other services	19.82	22.98	10
Housing Services	7.97	7.45	-
Public Services	3.25	5.08	-
Education	-	-	2

Source : Government of Bangladesh. Ministry of Planning, March 1998 and World Bank and Bangladesh Center for Advanced Studies 1998.

Bangladesh has an estimated 25,000 km of river channels. Half a century ago, all these were navigable year round. During 1956-88, it is estimated that the annual average sediment load entering Bangladesh and conveyed to the Bay of Bengal via the main rivers is about 1.1 billion tons with a range of 0.75-2.2 billion tons. A part of this sediment load is deposited on the flood plains during the flood season, gradually changing its topography and drainage conditions. The inland waterway networks have thus been reduced during the dry season to only 3,800 km. Similarly the two seaports suffer from draft problems requiring lighterage to carry cargo to jetties. (Government of Bangladesh, Ministry of Planning, 1998).

The scope of inland water transport has further been reduced by a vigorous program of rural road construction. It is estimated that by June 1997, there were about 3,000 km of national highways, 2,000 km of regional highways, 11,500 km of Feeder A, 14,400 km of Feeder B and 87,000 km of other rural roads. Of these, the length of paved roads is about 21,000 km. Apart from these road networks, there are about 12,000 km of paved roads in metropolitan and other cities. Embankments and rural roads were not, in most cases, designed carefully to ensure a free and unobstructed flow of water and to meet the needs of drainage, navigation and fisheries.

LAND AND WATER

Land and water are the two most important resources for the overall development of Bangladesh. Land is indeed a very scarce resource in a country with a population density of 813 per sq.km. By 2020, even with a steady decline in fertility, the population is due to reach 170 million and density will increase to 1200 people per sq.km. Dhaka, the capital city, with over 125,000 people per sq.km. already ranks as the third densest urban center in the world after Hong Kong and Lagos.

Agricultural land is becoming scarcer each year. There is a need for a sound classification system of land on the basis of its productivity. Nationwide land classification data could then be used by planners for zoning purposes. In the absence of such policy prime agricultural land in Bangladesh in many cases has been used for setting up cantonments, industrial estates and other non-agricultural uses. In these cases the opportunity costs of alternative uses were never examined.

Of the total land area of 14.7 million ha, arable land in Bangladesh amounts to around 9.0 million ha, about 61 percent of the total land area. During the past decade, through expansion of irrigation and the use of other modern inputs, Bangladesh has been able to achieve a cropping intensity of nearly 180%. Of the total cultivable land, 7.56 million ha are suitable for irrigation, but so far only 3.83 million ha have been brought under irrigation. Similarly, Bangladesh farmers use less fertilizer than recommended. Thus wide gaps exist between potential and realized yields for all crops. (World Bank and Bangladesh Center for Advanced Studies, 1998).

Available data on broad categories of land during 1974 to 1996 show (Table 3) that in the past 25 years land under "not available for cultivation" has increased from 19% in 1974 to 27% in 1996. It can be safely presumed that most of this land has been used for non-agricultural purposes such as urban development and construction of various infrastructure.

Table 3. Land Use in Bangladesh 1974-1996

Nature of Land Use	Area in '000 ha			Percentage of Total		
	1974	1990	1996	1974	1990	1996
Cultivated Crop Land	8,489	8,827	7,802	59%	58%	53%
Currently Fallow	627	288	392	4%	2%	3%
Cultivable Idle Land	272	267	531	2%	2%	4%
Forests	2,229	1,858	2,151	16%	12%	14%
Not Available of Cultivation	2,661	3,934	3,961	19%	26%	27%
Total	14,278	15,184	14,839	100%	100%	100%

Source : Ibrahim Khalil, 1991 and Bangladesh Bureau of Statistics, 1998

River-bank erosion, migration of river-banks and meandering river channels are causing loss of land. Recent satellite image studies of the Ganges-Brahmaputra-Meghna rivers under the Flood Action Plan show that while over the period 1982-92, 106,300 ha were lost to erosion, only 19,300 ha were accreted. Thus there has been 87,000 ha lost to erosion, equivalent to an annual erosion rate of 8700 ha per annum, most of it agricultural land (World Bank, River Bank Protection Project, 1995a).

Under such scarce conditions, the need for planning based on a sound land use policy cannot be ignored any more. The increasing population will need additional rice and wheat by 2025. The days of planning for agricultural production only without taking into account the growing need of other competing sectors are over. Crop production will have to relinquish land in favour of emerging other sectors.

CROP PRODUCTION AND URBANIZATION

From a base of 24 million people in 1996, Bangladesh's urban population is expected to reach 30 million at century's end, about 50 million by 2010 and nearly 80 million in 2020. Probable loss of cultivable land to such alternative use as housing and other infrastructure to support urbanization would be enormous.

CROP PRODUCTION AND WATER-RELATED INFRASTRUCTURE

Flood control, drainage and irrigation projects require huge quantity of land for construction of embankments, irrigation/drainage channels and other infrastructure. So far only the Bangladesh Water Development Board (BWNDB), the principal water sector agency, has acquired 75,000 ha of land for such purposes. Railways and roads have used five times the quantity of land used by the BWDB.

CROP PRODUCTION AND FISHERIES

There are many examples where rich wetland and inland water bodies have been turned into single cropped land. The reverse conditions exist in the coastal area where shrimp farming areas have been created by destroying paddy fields. Conversion of land to shrimp-farming is a non-reversible process and constitute a permanent loss to crop production.

CROP PRODUCTION AND FORESTS

Forest cover in Bangladesh is about $60^{o}/_{o}$ now, which is much below the recommended cover. The forest cover has doubled over the past 25 years. It is further estimated that 76,000 ha of land is under encroachment as of 1993. There is a possibility that part of it will meet the need of human settlements and part will be used for agriculture and other purposes. The forest cover is expected to increase in the next 25 years due to afforestation.

WATER RESOURCES

The notion of an abundance of water in Bangladesh is somewhat misleading. There is a wide seasonal and regional variation in the quantity of water available. During the wet season (June to October), there is plenty of water, the rate of flow depending on the amount of snow-melt in the Himalayas and rainfall in the entire catchment area of the rivers (Bangladesh-Nepal Joint Study Team, 1989). Statistics reveal that major flooding occurs in one out of ten years. The opposite happens in the dry season (November to May. In nearly half the years the average rainfall is so low and the flow of rivers so reduced that in certain areas of Bangladesh this situation seriously disrupts economic life. The southwestern region of Bangladesh which is solely dependent on the Ganges waters for its sustenance and has been facing major environmental hazards since the operation of the Farakka barrage in 1975 upstream. However, the environmental hazards are in the process of elimination after the Ganges Treaty of 1996 through guaranteed flows and restoration of the Gorai.

Groundwater related quality issues especially the arsenic problem, are gradually becoming important. Many of these problems are less evident to the general population than the more visible quantity-related issues. The preservation of water quality has direct implication for water supply as water quality determines effective water availability. A minimum quantity of water is required to maintain the assimilative capacity of a water body to receive effluents and to guard against contamination.

Water is polluted in Bangladesh in several ways as discussed below. Until recently, there has been no regular program of water quality monitoring. A baseline survey came out recently and several public agencies are now undertaking detailed surveys of tube-wells. (Government of Bangladesh, Ministry of Water Resources, 1998a). It is expected that a strong database on the quality parameters of surface and groundwater, will be available in due course. However a fairly good database and an assessment have been made for water resources of Bangladesh under Flood Plan Action.

TOWARDS A WATER VISION

In Bangladesh, the strategy of water resources development has so far pivoted around flood control and irrigation expansion to promote food grain production. Not denying the importance of food production and food security it is now widely recognized that conflicts among alternative and competitive uses of water are becoming sharper as population and demand for limited supplies of water are increasing. It is, therefore, necessary to formulate a long-term vision for integrated water resource management (IVA) to address the demands of all water-using sectors and maintain a sustainable environment. Hence, the water vision should reflect, in a holistic manner, a clear perspective of the management of the water ecosystem in the country by taking into account seasonal variations in availability, alternative uses and demands, mechanisms of water supply and demand management strategies, and the guidelines of the National Water Policy. A National Water Management Plan (NWNV) is underway in light of the policy.

It is assumed that by 2025 most of the actions/schemes under the NWW will have been implemented or in the process of implementation. Based on this premise and the need to balance population growth, water demand for food, rural development and the strategic components of a long-term vision are briefly presented below.

a. Integrated flood mitigation

Since flood is a recurrent phenomenon in Bangladesh and with two-thirds of the country being vulnerable to flooding, a balanced and rational approach to flood management is essential. The approach should consist of a combination of structural and non-structural methods to mitigate flood damages and at the same time, retain the beneficial effects of inundation. However, flood mitigation measures must not be considered in isolation of other components of water resource development. These should be part of an integrated water management plan, along with food production, environment, fisheries, drainage, navigation and household supply.

Flood mitigation measures should also be addressed in the regional context. Bangladesh, being the lowest riparian in the Ganges, the Brahmaputra and the Meghna systems, faces the fury of floods - although all other countries in the region also suffer from flooding of different levels of severity. Hence, there is a need for active cooperation amongst the countries of the GBM region for flood management. A comprehensive scheme of collection, transmission and exchange of real time relevant data among the GBM countries will promote efficiency in flood forecasting and disaster preparedness in Bangladesh.

b Supply augmentation

There is no suitable site for a reservoir within Bangladesh. Hence, storage potential for dry season augmentation or any other purpose is nil. However, the Ganges Water Treaty with India signed in December 1996 has provisions for Bangladesh to receive an agreed quantity of water in the dry season (Jan-May) for a 30-year period. Taking advantage of this Treaty, the issue of constructing a barrage across the Ganges for harnessing the available waters needs to be addressed on an urgent basis. Earlier studies have indicated that a Ganges Barrage would increase irrigation potential, increase food production, rejuvenate the Gorai and other streams, push the salinity front southward, and help in the conservation of the Sundarbans. Augmenting of supplies of surface water through sub-regional cooperation in water sector developments may be initiated. The scope of augmenting the Ganges flows through the construction of reservoir in Nepal and Bhutan should be examined to bring significant benefits to Bangladesh in terms of flow augmentation. Bangladesh can collaborate with Nepal, India and Bhutan in the construction of dams for mutual benefit.

c Sharing of Common rivers

Of the 57 transboundary rivers, Bangladesh has an agreement for water sharing with the upper riparian, i.e., with India in the case of the Ganges only. Efforts to reach an agreement for sharing waters of other common rivers should form part of the national water vision so that the country is assured of an adequate supply during lean seasons.

d Irrigation expansion

Future increases in food grain demand could be met from an increase in per acre yield; and an expansion of the irrigated area would form a part of the strategy to augment land productivity. Some 71 percent of irrigation water is now sourced from groundwater, which is likely to continue to be the major source of irrigation water for dry seasons and pre-monsoon cropping. But fears are expressed about unregulated ground water exploitation or water mining being responsible for the lowering of the water table in many instances leading to the advocacy of a switch from suction mode STW to force mode DTW. Recent estimates by the National Minor Irrigation Development Project (NMMP) suggested that by setting STWs at progressively greater depths, this technology could continue to expand. On the basis of the NNVND estimates of groundwater quantity and quality, a strategy has to be defined for the next 25 years in deciding on the main mode and rate for irrigation expansion.

Table 4 shows the growth of irrigation areas since 1982 in Bangladesh. The technology used for irrigation is those of canal, LLP, Traditional, Manual, DTW and STW.

Table 4. Growth of irrigation area since 1982

Irrigation Season	Irrigated area (million ha)	% by water source	
		Ground Water	Surface Water
1982-83	1.52	40.8	59.2
1983-84	1.61	47.2	52.8
1984-85	1.77	50.2	48.8
1985-86	1.74	52.1	47.9
1986-87	1084	52.9	47.1
1987-88	2.06	54.0	46.0
1988-89	2.38	56.2	43.8
1989-90	2.58	55.8	44.2
1990-91	2.79	55.3	44.7
1991-92	2.75	63.0	37.0
1992-93	2.96	65.1	34.9
1993-94	2.94	64.8	35.2
1994-95	3.31	69.3	30.7
1995-96	3.73	69.1	30.9
1996-97	3.79	71.0	29.0
1997-98	3.83	70.7	29.3

Source: National Minor Irrigation Census 1997/98 BWDB estimates

URBAN DEVELOPMENT

Rapid urbanization will continue to be a dominant phenomenon in Bangladesh over the next 25 years. In the absence of a coherent strategy, a chaotic situation could develop in terms of services and governance. Currently the urban population accounts for about 20 per cent of the total national population- and it is growing at an average annual rate of about six per cent. Even with an assumption of slightly decreasing rate of growth in the next decade, the proportion of the urban population will reach 33 per cent in 2010, 47 per cent in 2020.

RURAL DEVELOPMENT

The Government's rural development program, which had its origin in the early 1960's, was conceptualized essentially as an instrument for providing support for increasing agricultural production. The rural development model emphasized the formation of co-operatives and the integration of support services provided by government departments. The model had four major elements:

- Two-tier Co-operative-Krishak Samabaya Samity (KSS) and the Thana Central Co-operative Association (KCCA)
- Rural Works Program (RWP)
- Thana Irrigation Program (TIP)
- Thana Training and Development Centers (TTDC)

Strategy for Rural Development Projects

The Government of Bangladesh (GOB) formulated and adopted the Strategy for Rural Development (RD) Projects in 1984. The strategy includes, among others, that the RD Projects will have a combination of three components:

- Development of physical infrastructure including roads, storage and markets
- Irrigated agriculture, minor drainage and flood control works
- Production and employment for the rural poor (rural poor will be the land less and those having land up to 0.50 acres)

Agencies responsible for the implementation of the three components of RD projects

- For development of physical infrastructure: Local Government Bodies with technical assistance from the Local Government Engineering Department (LGED) o For development of irrigated agriculture etc: The Local Government Engineering Department and the Ministry of Agriculture in association with the Thana/Upazila Parishad.
- For production and employment programs: The Bangladesh Rural Development Board (BRDB) in collaboration with the Thana/Upazilia Parishad and other concerned agencies will work for creating employment opportunities. The Non- Government Organizations (NGO's) will also take up activities in areas not covered by BRDB.

The above strategy has been followed during the Third and the Fourth Five Year Plan (FFYP 1990-95) of Bangladesh.

Performance During Fourth Five Year Plan (1990-95) are shown in Tabular from in Table 5.

The allocation for RDI sector during FFYP was Tk. 25,622.20 million against which an amount of Tk.21,823.5 million was utilized.

PERFORMANCE DURING 1995/96 AND 1996/97

All the three major components, i.e., production and employment program, infrastructure development program and irrigation related infrastructure were under implementation during 1995/96 and 1996/97. Under the production and employment programs, employment for 0.39 million persons was created. These were mostly self-employed members of the various formal and informal groups. Under the infrastructure construction program, 2.856 km of metalled roads were constructed in addition to 20,800 metres of bridges and culverts. Apart from these, 163 Growth Centers were developed by constructing sheds, internal roads and lanes in the hats and bazars. An amount of Tk. 17689 million was provided in the ADPs for 1995/96 and 1996/97.

Table 5. Targets and Achievements of Major Programs for Rural Development and institutions During Fourth Plan (1990-95)

Program	Unit	Targets	Achievements
A. PRODUCTION AND EMPLOYMENT PROGRAM (PEP)			
Formation of primary societies/group	Number	23,581	16,882
Enrolment of members	Number	529,621	777,660
Skill training	Number	166,695	616,800
Shares/saving	Million taka	159.6	449.33
Credit	Million taka	330.3	3,019.15
Realization of Credit	Million taka	-	2,559.15
B. SMALL FARMERS DEVELOPMENT PROGRAM (SEDP)			
Formation of groups	Number	1,982	5,625
Enrolment of members	Number	12,145	35,597
Share/Savings	Million taka	7.3	30.4
Disbursement of Credit	Million taka	60.7	166.4
Development of Physical Infrastructure			
Development of Growth Center	Number	316	277
Development of Feeder Road Type-B	Km	2,399	3,709
Construction of Bridge and Culverts	Metre	15,039	41,987
Rehabilitation of flood/cyclone	Metre	15,059	
Rehabilitation of flood/cyclone damaged pucca roads	Km	2,929	2,574
C. IRRIGATED AGRICULTURE AND IRRIGATION MANAGEMENT PROGRAM (IMP)			
IMP coverage (DTW)	Number	1,556	1,499
IMP coverage (LLP)	Number	207	156
IMP training	Persons	8,555	6,215
D. EMPLOYMENT GENERATION			
Infrastructure Program	M person-days	133.1	112.0
Self-employment under PEP	Million persons	0.53	9.78

FIFTH FIVE YEAR PLAN (1997-2002)

The following are the objectives of the Fifth Five Year Plan for the RDI Sector:

a. reduction of poverty in the rural areas;
b. productive employment generation in the rural areas;
c. self-employment creation for the rural poor;
d. Development of rural infrastructure; and
e. Development of small and landless farmers.

STRATEGIES

The elements of the strategy for achievement of the above objectives will include, among others, the following :

a. provision of skill training mostly for self-employment in non-farm sectors;
b. formal and informal group formation and group development for co-operative activities;
c. resource mobilization through individual/group savings;
d. creation of enabling environment for availing of credit facilities;
e. social mobilization for awareness creation on various aspects of rural life;
f. development of small and landless farmers;
g. development of rural infrastructure such as growth centers, and roads, bridges and culverts connecting such centers;
h. provision of small irrigation and flood control related infrastructure;
i. preventing destitution through rural maintenance program; and
j. covering at least one full administrative district under any project with one or more of the program components of productive employment, rural infrastructure and small-scale irrigation and flood control infrastructure to find out the replicability.

Projections for RDI sector during the Fifth Five-Year Plan are shown in Table 6

Table 6. Projection for development of RDI in Public Sector During Fifth Plan

Program	Unit	Projection
Productive employment generation	Million person	1.3
Employment under infrastructure program	Million person-days	175
Growth center development	Number	600
Feeder Road Category-B	Kilometre	7,000
Rural Road	Kilometre	15,000
Bridges and Culverts	Metre	100,000
Small Scale Water Management Related Infra.	Kilometre	1,000
- Embankment	Kilometre	4,000
- Khal/Canal	Kilometre	350
Water Control Structure		
Maintenance of Physical Infrastructure	Kilometre	10,000

FINANCIAL OUTLAY DURING FIFTH PLAN

An amount of Tk. 87,002 million has been projected for the development of RDI in the Public Sector. The program-wise break up of the outlay is shown in Table 7.

Table 7. Public Sector Financial Outlay for Development of RDI During Fifth Plan

Program	Financial Outlay
Production and Employment Program (PEP)	20,000.00
Infra. Dev. Program (including irrigation related infrastructure)	56,000.00
Other Programs (including special programs and action research)	11,002.48
Total	87,002.48

ROLE OF NGOs AT A GRASS ROOT LEVEL DEVELOPMENT

During the FFYP, the number of non-government organizations (NGOs) also increased throughout the country. The process was helped by easy availability of donor funds for NGOs. The donors supported the NGOs to supplement the government's delivery system to reach the poor, and to play a more creative role to make - them conscious. This argument created an indirect pressure on the government to make its delivery system to be more efficient. The resultant competition between the GOs and NGOs to reach the poor brought the questions of cost-effectiveness, transparency and accountability of using public fund under sharper focus.

STRATEGIES FOR PARTICIPATORY PLANNING DURING FIFTH PLAN

Alleviation of poverty and employment generation is the central objectives of the Fifth Plan. Given the market failure, the public sector must play the role of a catalyst in associating the vast segment of the populace who are under privileged and often are left out of the development process. Local level participatory planning, therefore, will start with building a mechanism where people, at large, especially in the vast expanse of the rural areas, will provide inputs to the planning process of the country. People at the grass root level, through conscience building, consultation and participation, will get the scope of determine the local needs and priorities and integrate them into an overall planning exercise of the country through their elected local bodies.

WOMEN IN DEVELOPMENT

Women constitute about 49 percent of the population. Various indicators reveal that the status of women is much lower than that of men. According to a 1995/96 survey, of the 56 million labour force, only 21.3 million are female. Women are generally pushed into the unskilled labour force.

The shared responsibility for women's equality and development is strongly emphasized in the Beijing Platform for Action, which was endorsed by the Government of Bangladesh in September, 1995. The Fifth Five-Year Plan of Bangladesh will be people centered. The main aim of the Plan is to integrate women's development into the macro framework and to reduce gender disparity in all sectors through integration of women into the main stream development efforts. A major thrust of the Plan will be on developing skills of women with the aim to yield a sustainable increase in productivity of the existing women labour force and opening up new windows of opportunities for future entrants into the labour force.

BHUTAN

SUMMARY

The paper, Water for Food and Rural Development: Under Bhutan's Resource Base consist of two parts. The first part gives the background information on the status of the resource base used for food production. Under the Bhutanese food production system, forest resources play an important role besides water and land. The existing conditions of these resources with their potential and constraints are described, culminating to proposals for formulation of interventions to manage the resource base.

The second part describes some of the policies, long term as well as short term, that are felt necessary to sustain food production without eroding the resource base. The long term interventions are proposed based on the existing policies and to fill the gaps in them.

The second part also describes some of the strengths of our existing policies that will deliver us into the first quarter of the next century.

1. BACKGROUND

1.1 PHYSICAL FEATURES AND CLIMATE

Bhutan is a landlocked country which lies in the Eastern Himalayas sandwiched between China and India. The country stretches from the foothills (below 150 m) in the south to the towering heights of the Himalayas (more than 7500 m) in the north. Physiographically, the country is divided into three regions, in ascending altitudes- the southern foothills, the central river valleys and the northern snow covered alpine regions. The corresponding climates are characterized by

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wet subtropical foothills, wet to dry temperate central river valleys and cold alpine conditions of the high mountains. Due to the mountainous setting, micro climates varying from the general conditions can occur (Jamtsho, 1996).

1.2 RAINFALL PATTERN

Bhutan has predominantly a unipolar rainfall pattern brought by the South- West monsoon. The monsoon reaches its peak by late June to early July and recedes by end of September. More than 70% of the precipitation is concentrated between June to October. The North-East monsoon comes in December-January. It is limited to a few rainfall events in the lower regions while the higher reaches get snows which replenish the glacier fields. The glacier fields feed and sustain the perennial streams that form the major rivers that drain the country.

The southern foothills get the maximum rainfall of 4000-5000 mm per annum. The rain shadow areas of some of the central river valleys get as low as 500 mm per annum. There is a steady increase in rainfall as the elevation rises from 1000 m to 2500 m followed by decrease in precipitation after 3500 m (Jamtsho, 1996).

1.3 WATER RESOURCES

Fair spatial distribution of good annual precipitation has promoted rich natural vegetation cover. With its geographical location in the Himalayas, Bhutan is endowed by nature with abundant water resources. The four major rivers, all flowing in the North-South direction drain the country. They are Dangmechhu (Manas), Punatsangchhu (Sankosh) Wangchhu (Raidak) and Amochhu. There are numerous tributaries which drains into the four river systems and constitute the water resources potential of the country. The estimated theoretical hydropower potential of the country is estimated at 20,000 megawatt (Power Master Plan, 1992). More than 50% of the potential is from the four rivers and their main tributaries. As of 1996 only 2% of the total estimated potential had been harnessed which accounted for one-third of Bhutan's foreign revenue. The hydropower generation is a clean source of energy, and on top of earning foreign revenue will reduce the pressure on the forest for fuelwood. But hydropower generation is subject to proper management of the watersheds to arrest degradation because of logging, agricultural and rangeland encroachment and human settlements.

Water demand for agriculture is met from secondary and tertiary level tributaries in small watersheds. The main rivers are not used for agriculture except in few flat areas. This is because of the need for pumping due to elevation difference between the river level and the terraced fields. The water resources in small watersheds are seasonal and highly vulnerable to changes in land use and climate. Under such a scenario, water scarcity and equitable distribution are the major issues of concern. The traditional water rights and rigid sharing systems that have evolved over a long period of time make interventions difficult. The conflicts between upstream versus the downstream and first versus the last users impedes the efficient use of the resource.

The drinking water is taped from small streams and springs within the watersheds. The demand for urban water supply is also met from such watersheds. The competitive demand for water from different sectors are increasing and will increase in the future.

Inspite of the so many constraints faced by water resources, a well defined watershed management strategy is absent in the national policies. The need for watershed management is felt by all the sectors but how it will be done is still vague.

The sustained and efficient use of water resources can only be achieved through a concerted and complementary efforts from all sectors supported by meaningful research interventions.

1.4 LAND USE

Bhutan is fortunate to enter the next millennium with a pristine environment. Our natural resource base is largely intact with 72.5% (LUPP[1], 1997) forest cover. With the strong government policy on conservation, Bhutan is the only country in the world where forest area has increased in the last few decades. The Forest and Nature Conservation Act of Bhutan stipulates that all forest harvesting or logging operations should be strictly based on approved management plans and sound ecological considerations to ensure sustainability. The forest policy states that revenue generation is secondary to conservation and protection.

Arable land at 7.8% (LUPP, 1997) of the total area has limited scope for expansion. The pressure on land is mounting due to increased food demand brought by population growth. With change towards market economy, cash crops are competing for agricultural land. The area under horticulture is expanding. Apples predominate in high altitude areas while citrus and cardamom are the main cash crops in low altitude regions.

Land under natural pasture is 3.9%. Since livestock rearing is an important activity, pasture is another land use category. Pasture is mostly located in high altitude areas where rearing of yaks is the sole occupation of the pastoral farmers.

The remaining land area of 15.7% is under snow/glaciers, rock outcrops, landslips/erosion and waterspreads.

1.5 IRRIGATION DEVELOPMENT

Indigenous irrigation system has been practised in Bhutan from time immemorial. Farmers have constructed small irrigation schemes with the use of local materials, mainly stones, earth and timber. Government assistance in irrigation development started in the seventies. Irrigation schemes were constructed based on demand and not seriously considering the real need and the economic feasibility. This approach made the users more dependent on the government assistance and eroded their sense of communal ownership of the schemes. The operation and maintenance of the schemes suffered and more frequent scheme failures occurred. As a result, investment from the government increased without bringing the corresponding benefits to the beneficiaries. This led to the realignment of the development approach which resulted in adoption of the National Irrigation Policy (NIP) in 1992.

The NIP covers the whole process of irrigation development and is founded on three basic principles: encouraging effective farmers' participation, multi- disciplinary feasibility study and institutional support to water users' groups. Now government assistance is provided in the form of technical support and construction materials. Farmers are involved in all stages of scheme development light from appraisal to commissioning and subsequent operation and maintenance. Free labor for the construction work is provided by the beneficiaries. The beneficiaries' share in terms of free labor account for 20- 55% of the total cost of scheme development. Irrigation sector provides institutional support to the Water Users' Associations by providing training on operation and maintenance of irrigation schemes. The emphasis on the three basic principles is bringing improvement in the management of irrigation schemes.

The main problems related to irrigation development are the small command areas, the steep and fragile mountain topography and a monsoonal climate. The small irrigation schemes with water brought from long distances through contour canals require high investment per unit area of command area. The canals are susceptible to failures during the monsoon. Command areas under rainfed secondary and tertiary level sources face water shortage during transplanting season of rice. It is due to the phase difference between the rainfall pattern and the transplanting season. Peak rainfall season lags behind peak transplanting season by a month. The rigid mountain climate does not favour delayed transplanting. The mismatch between the rainfall pattern and the cropping calendar reduces the potential yield of rice.

Traditionally, crops other than rice are not irrigated. Promoting irrigation of other crops by providing technical information through research and dissemination by extension is required. The benefits of irrigation to other crops, especially horticultural crops has to be demonstrated to the farmers. As reflected by crop water requirement determined from climatic data, irrigation of horticultural crops will lead to better quality produce, more efficient use of water and generate cash income.

Water management research is integrated into the national research system to address the need for a sustained effort to study the impacts and benefits of water and soil management practises on crop production. Its objectives are to raise the productivity of the existing rice-based irrigated agriculture through durable improvements in water delivery, to increase rural incomes by diversifying the range of irrigated crops on wetland as well as on dry land and to rationalise the irrigation assistance program with a view to increase the role of water users. Within these objectives, the mandates are to assess the performance of alternative irrigation systems and water management practises for a range of food and horticultural crops to broaden the production base to increase the returns to land and labor in harmony with the environment.

The ongoing research focuses on generating time series data of soil moisture balance for major horticultural crops, improving water use efficiency of rice irrigation and exploring suitable water harvesting technologies.

1.6 AGRICULTURE

Agriculture is characterized by an integrated production system with forest as the resource base. Most farmers produce cereals and dairy products for household consumption with the use of forest resources. The nutrient for crop production is largely organic based with leaf lifter as the major component of the farm yard manure. The forest is the source for fodder, fuel, timber and non-forest products. Forest is also used for free range grazing system by livestock.

Arable agriculture is mainly confined to the southern foothills and the central river valleys. Irrigated rice cultivation is done on terraced sloping hills and valley bottoms. In the southern belt with assured irrigation, two crops of rice is grown while in the higher altitudes one crop of monsoon rice is followed by wheat, mustard or vegetables.

Cultivation of horticultural crops is gaining prominence. It is being promoted due to As comparative advantages as well as to broaden the production base. The produce earns cash income which strengthens the household economy and the export earnings pay for food import. In the past, irrigation infrastructures were developed for rice irrigation. Diversifying irrigation programs to cover horticultural crops is a policy objective of the 8 Five Year Plan (1997-2002). Drip and sprinkler irrigation systems for orchards are under trial in demonstration farms.

In higher altitude areas, above 3000 m, reading of yaks is the sole occupation of the pastoral farmers. The farmers depend on the animal products for sustenance. In the past the animal products were bartered for food items with the people in the lower regions. Now with the monetised economy, the dairy products are sold in local markets and basic necessities are purchased from the cash generated.

The current level of food self-sufficiency is about 65% (NES[2], 1998). The government policy objective is to achieve 70% food self-sufficiency by the end of the 8th Five Year Plan (1997-2002). Therefore, increase in food production to achieve the self-sufficiency goal has to come largely from intensification of the cropping systems. The intensification of the cropping systems has impacts on the forest, soil and water.

Agriculture is the single largest contributor to the GDP. Although the agriculture sector grew by only 3.1 percent in 1997 its contribution to the GDP remained the highest at 36.4 percent (Kuensel, May 15, 1999, p-4). More than 80 percent of the population depend on agriculture directly for their livelihood

2. CREATION OF ENABLING ENVIRONMENT

Sustainable food production and rural development are dependent on efficient use of the natural resources. The natural resources have established interdependence relationship among themselves. In the Bhutanese context, the interdependence is even stronger and much more well defined due to our mixed production system. The status of water and soil resources are determined by the forest cover and its quality. The forest cover and its quality are in turn depends on the level of exploitation of the resources by the farming communities for food production. The resource use dynamics is strongly influenced by the population growth and their activities. The institutions that are involved in regulating and managing the resources have the responsibility to create the enabling environment for better management of the resources. Creating the enabling environment is a process that requires interaction and consultations at various levels among all the stakeholders.

The need for fresh policy formulation and strengthening the existing policy are highlighted in view of the high population growth rate (3.1%), the food self- sufficiency objective and the policy on forest conservation.

2.1 NATIONAL WATER POLICY

Bhutan is yet to formulate a comprehensive national policy on water resources and its utilisation. A policy on water which will rank the water use by national priority will reduce the competition for water from different sectors. A broad national level water policy supported by legal frameworks on sharing water at national, regional and watershed or local levels will result in equitable and efficient use of water. Such a policy is required in view of the expanding water demand from other sectors as well as the increase in agricultural water demand due to intensification. Intensification of agriculture has to take place to feed the growing population.

2.2 WATERSHED MANAGEMENT

Located in the Eastern Himalayas, on the highest and most active mountain ranges, the topography is characterized by steep slopes that descend to narrow river valleys. With relatively heavy monsoon rains generating high runoff rates, the land is vulnerable to soil erosion. Judging by the sediment carried by the rivers during the monsoon, soil erosion is substantial. Soil erosion if not controlled has great implication on the sustainable agriculture production and hydropower generation.

Watershed management is not done at the national level in terms of coverage. Attempts are made to manage the watershed in some regions, like the Wang Watershed Project covering the Wangchu basin. Irrigation Sector is initiating protection of critical watersheds in collaboration with Forestry Services Division. Community-based Natural Resources Management Research is being conducted in Lingmuteychhu Watershed by the Renewable Natural Resources Research Centre, Bajothang where all issues and constraints raised by the communities revolve on water. Soil and water conservation activities are reflected in the annual work plans of the districts, but nothing much in terms of tangible outputs are forthcoming.

Hydropower development is one of the three avenues of sustainable development identified by the government. The other two are agricultural and industrial development. Hydropower development will have great influence on the development of the other two avenues. This reflects how important watershed management is to the national objectives. And hydropower generation depends on sustained yield of silt-free water which is the outcome of proper watershed management. Hydropower development is possible only if the present integrity of Bhutan's watersheds can be maintained , which means maintaining the integrity of the country's forests (NES, 1998). Therefore, a coordinated national program on watershed management is definitely the need of the hour and this need will be felt much more in the future. An immediate start should be made with critical and small watersheds where water for agriculture is scarce and unstable. As a starting point, all the sectors that use water should begin mutually reinforcing watershed conservation programs decided through consultations.

Bhutan has been institutionalising decentralised decision making for development activities from the early eighties. This process of encouraging active participation from the users' groups in the management of the local resources is a good foundation to build on in the future. Active community participation and Organisation in managing the resources leads to vibrant and responsive institutions at the grassroots level. Water Users' Associations for operation and maintenance of irrigation schemes is being strengthened with institutional support from Irrigation Sector. Rural Water Supply Schemes are also promoting the users' groups for the same function. Management of community forests on degraded state lands is turned over to the communities on pilot basis.

2.3 RESEARCH

Organised agricultural research system was started from the early eighties. After its establishment much has been achieved within this short time and much needs to be done. The research was crop-fc>cused, mainly looking at crop husbandry aspects and varietal improvement. Research on issues related to soil and water for crop production is integrated into the national research system since 1997. It is getting assimilated into the system with some activities under implementation. Strengthening the integrated research system will ensure generation of valuable information required to fill the information gap.

A coordinated national research agenda needs to be set up to address issues related to water. It should be well focused and responsive to the needs of the farming communities. Research agendas must fit the needs of the local people, and findings must be disseminated quickly and applied effectively (NES, 1998).

Networking of research institutes both from inside and outside the country will lead to flow of information. Networking has the potential of benefiting the research communities in many ways. As a small country with only the foundations of its own academic and informal groups in place, it should not hesitate to draw upon the information resources of its regional neighbors and the international community (NES, 1998)

2.4 EMERGING BHUTAN: ITS STRENGTHS

By virtue of its self-imposed isolation, Bhutan is entering the next millennium with extensive forest cover and largely intact natural resource base. This has also afforded us the privilege of hindsight, learning from the mistakes of other developing countries. Lessons learnt have cautioned us and strengthened our national policies. Bhutan has adopted the 'middle path" as its development strategy whereby a balanced approach to development will be pursued. Bhutan will tread the development path of raising the socioeconomic conditions of its people without compromising its resource base. The key is to find a development path that will allow the country to meet the pressing needs of the people, particularly in terms of food, health care and education, without undermining the resource base of the economy (NES, 1998).

Forest is the main resource base. The three avenues of development entirely rests on the success of protecting the forest from a range of development activities, including agricultural extensification, rangeland encroachment and logging operations. To that end, the government has committed itself to maintaining a national forest cover of atleast 60% (NFP[3], 1974). Adhering to this commitment, the government has banned export of timber from January, 1999.

High population growth rate is a serious concern to the government. With the current growth rate of 3.1%, our population will double in twenty years. The growth will put even greater pressure on the country's resource base and the fragile mountain ecosystems. Recognising the threat from unabated high population growth rate, the government has formulated several demographic objectives for the Eighth Five Year Plan. The government aims to reduce the growth rate from 3.1% in 1996 to 2.48% in 2002 (NHS[4], 1996). The long term goal is to settle for a stable population with each couple having a family of two children. A multi-pronged population control program is underway.

The government has adopted the decentralisation policy since early eighties. Dzongkhag Yargay Tshogchungs (DYT), or district development committees were established in 1981 to encourage people's participation in national planning and decision-making processes. Geog Yargay Tshogchungs (GYT), or block development committees were established in 1991 to take the processes further down to the grassroots level. The government has realised the importance and need for people's participation in natural resource management.

Even the best of policies do not work unless the highest authorities in the land are committed to the cause of national development. Policies remain on paper short of being materilaised into effective programs to raise the living standard of the people. Government is strongly committed to the welfare of its people. This commitment is amply reflected in the policies and developmental activities currently being pursued. The one prerequisite upon which any truly effective development strategy depends - political will - is clearly there (NES, 1998).

BOSNIA AND HERZEGOVINA

SUMMARY

IDENTIFICATION OF THE MOST SIGNIFICANT NATIONAL PROBLEMS

- Development of utilities and social infrastructure in rural areas
- Increase in food production, in order to cover the shortage amounting to 50% of own needs
- Water management oriented toward the needs of agricultural development, namely:
- protection of hilly-mountainous regions (83.5% of the territory) from water erosion and introduction of soil and water conservation measures
  - preferential flatlands flood control
  - basic land drainage and field (pipe) drainage of a part of flatlands - irrigation of a part of flatlands
  - reclamation and land improvement in major part of flatlands and hilly- mountainous regions
- Protection of high quality soil from non-agricultural use and introduction of legal regulations governing the water and soil management
- Creation of conditions for capacity building

INTRODUCTION

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Bosnia and Herzegovina (BH) is geographically situated in southeast Europe on Balkan Peninsula. By the Dayton Accords of 1995 two entities were created in BH: The Federation of Bosnia and Herzegovina and the Republic of Srpska. Until 1992, BH was one of the six republics of former Yugoslavia. BH is situated in the northern warm strip, at equal distance from the Equator and the North Pole, therefore the climate is not dominated by only one type of weather. There are neither dry seasons nor harsh and long winters. In terms of climate it can be divided into three divergent regions.

The climatic conditions in the country offer wide possibilities for the agricultural production.

The waters hydrographically belong to the Black Sea Basin (3.9 mill ha or 75.7% of total BH surface area) and to the Adriatic Sea Basin (1.2 mill ha or 24.3%). The Sava river is a recipient of waterstreams from northern part of BH which belong to -the Black Sea Basin, while the Neretva river is the only direct tributary of the Adriatic Basin.

Water impounding reservoirs in BH were immediately after the Second World War built primarily for the purpose of utilising the power potentials of water. In the course of time, they more and more assumed the nature of multi purpose impounding reservoirs. These reservoirs, as well as those built in later periods, are used for flood control, breaking of flood tidal waves, fish breeding (cage breeding), tourism and recreation, irrigation, and also for the electric power production. Until 1992 there were built 26 impounding reservoirs with total volume of 3.8 billion m3 and average annual production of 5,248 GWh, accounting for 38% of the total annual production of electric power in BH in 1991. 38 more multipurpose impounding reservoirs are likely to be taken up in future.

Explosive development of industry and urban agglomerations in the period 1950-1990 caused an increase in pollution of watercourses, especially in Sarajevo-Zenica and Tuzla regions, where the development was most intensive. The Laws on Quality and Protection of Water were passed, which compelled the polluters to introduce treatment plants and to modernize the technological processes.

During the 1992-1995 war, the quality of water in watercourses improved because the main industrial polluters either reduced their production and pollution or stopped working. However, after the end of the war, the rehabilitation of industrial plants is again going to lead to pollution, as such it will be necessary to undertake further actions on water protection and preservation of quality. It is estimated that 20% of the pre-war pollution came from the Bosnia River Basin, 17% from the Neretva River Basin, 15% from Una River basin, 10% from Vrbas River Basin and 38% from other basins.

2. FOOD AND SOIL-WATER RESOURCES - THE PRESENT STATUS

2.1 Structure of the utilisation of land and productivity in BH

The total population according to 1991 census was 4.5 millions. The total land surface area is of the order of 5.1 mill. ha. Out of which 50.3% was agricultural land, 48.3% constitute the balance forest lands and the water surfaces. The major part of agricultural land are arable lands and gardens (42.2%), followed by natural meadows (16.8%), orchards (3.3%) and vineyards (0.2%). The remaining 37.5% are pasture grounds.

Amongst foodgrains, a dominant place is taken by corn, followed by wheat, barley, oats etc.

The yield of land farming, fruit-growing and vine-growing crop is at the low level in private sector of production due to the use of obsolete agricultural technology. On the state-owned farms, where modem technology is implemented, the yields are much higher, but this sector owns only a small percentage of the land, and furthermore, it is also undergoing the privatisation processes during the transition.

Bosnia and Herzegovina was not able to satisfy the needs in food through its own production even before the 1992-1995 war.

During the war, rural areas were subjected to a disastrous degradation and destruction, which led to further decrease in production and - increase in deficit in food, which had to be compensated through imports.

The war activities caused the degradation of soil through movement of combat forces and war machines, especially when these activities were taking place on moist land. This resulted in compaction of soil, damages to its composition, decrease in water permeability and creation of trapped water pools in plowlands and grasslands as well as in intensification of the processes of erosion and jeopardising the ground water resources. Large destruction of soil was caused by construction of trenches, dykes, fortifications, provisional roads, settlements, graveyards and deforestation.

2.2 Agricultural zoning of BH

The agricultural production in BH is divided into four production zones as follows: 1) flatland or lowland area (11%); 2) hilly area (26%); 3) mountainous area (57%); and 4) Mediterranean zone (6%). These zones, depending on type production and other characteristics are also named as: 1) grain-growing zone, 2) fruit-growing and livestock zone, 3) livestock-pasture- management zone and zone of southern crop-growing or Mediterranean zone:

Thus the country is mainly hilly and mountainous. Until now, little has been done to improve water and soil conditions in the upland territory while many things have been done which degrade and destroy the soil. By excessive forest cutting, plowing of grass lands and uncontrolled cultivation of sloped terrains the status of land is further deteriorating. The large sums invested into the protection of flat areas (river training, embankments, outfall drains, pumping stations) shall remain ineffective if soil and water conservation measures, both of agricultural engineering and technical nature, are not undertaken in the hilly-mountainous upland. Such measures would contribute to revitalising the mountainous area and better protection of the flat lowland areas.

2.3 The agenda of land reclamation

2.3.1 The preferential land resources of flatlands

In order to procure high and stable production of food in these highest quality regions, it is necessary to ensure the following in this chronological order :

- flood control (including soil land water conservation measures in the basin upland);
- land drainage, including the basic network of canals, and pumping, stations where needed;
- field drainage systems (pipe system);
- irrigation, covering about 200,000 ha;
- regrouping of land property (reallocation of holdings, land consolidation, field roads, windbreaks;
- agromelioration (calcification, fertilisation, humisation, recultivation).

2.3.2 Hilly-mountain land resources

These encompass mainly the grass-lands and forest lands, favorable for development livestock, which take about 83.5% of the territory. In these areas excessive runoff and floods cause heavy danger to the valley areas. Therefore the primary task here is to stop the erosion and decrease the runoff, which is to be achieved by the following measures:

- technical measures, including: giving preference to grasslands, afforestation, contouring strip cropping, no tillage, mulching,. improvements of physical. chemical and biological characteristics of the soil;

- technical engineering measures, which include: bench terraces, broadbase terraces gardens and hilly micro-reservoirs.

The introduction of hilly water micro-reservoirs is of special importance because BH has geomorphologically suitable for construction of such facilities and they can serve a multi purpose function not only in irrigation but in water supply, fish-breeding, fire protection, flood control and development of tourism as well.

2.4 Agro-hydrological balance in BH as an indicator of opportunities for development and sustainability of agriculture

2.4.1 Precipitation (P)

Precipitation represents the greatest water resource of BH. The yearly average of precipitation is about 1200 mm, which in terms of volume amount to 61.6 billion m3 . However, the precipitation is the most varying hydrological parameter in terms of space and time, the fact which is drastically obvious in the territory of BH.

The southern parts of BH have average yearly precipitation of about 2,000 mm, central parts receive about 1,000 mm and northern parts about 800 mm. These quantities are considerably higher in rainy years and considerably lower in the drought years. The seasonal variability is characterised by unfavourable distribution of precipitation over the year. This unfavourable distribution is from the point of view of agriculture particularly experienced in the southern parts of BH, where the major part of precipitation comes in the colder season, when the consumption through evapotranspiration is reduced. While the lesser part appears in summer season when the need for evapotranspiration is increased. This is characteristic of ~~mediterranian~~ precipitation regime. In central and northern parts of BH the distribution of precipitation over the year is far more favorable of agriculture. bearing the characteristics of a continental regime.

2.4.2 Potential evapotranspiration (PET)

Potential evapotranspiration (PET) is far more balanced and stable parameter than precipitation. The average yearly PET of BH is 725 mm and is lower than the average yearly precipitation by 475 mm. which can be considered as very favorable for agriculture. because the major part of demands of plants for water can be provided by precipitation. In southern parts PET is considerably higher (900 mm) while it is lower in central (650 mm) and northern parts (700 mm). The basic characteristic of seasonal distribution of PET over the year is that it is in ~~descrepancy~~ with the precipitation, this ~~descrepancy~~ being considerably higher in southern than in central and northern areas.

2.4.3 Water shortage or demands for irrigation water

The average yearly shortages or demands for water for irrigation in BH amount to 125 mm. They are the greatest in southern areas where in average they amount to 3OO mm. considerably lower in northern (100 mm). and lowest in the central parts. However. the demands in water which might arise once in every ten years or in very dry years are considerably higher. Because of that, the average yearly demands should be multiplied by the coefficient of 10 year needs, which is, depending on the area. 1.67 in southern parts, 4.0 in central, and 3.O in northern parts, the BH average being 2.75. Having this in mind, the 10 year demands in water would amount to 350 mm for BH, 500 mm for southern parts, 300 mm for northern parts and 200 mm for central parts. These quantities should be ensured for cases of droughts, which can appear once every 10 years, which means that they should not be spent during the normal years.

If sometime in future all the flat-lands of BH, amounting to 400,000 ha (Posavina, river valleys and karst fields) were to be irrigated then overall 10 year demands for water would amount to 1.4 billion m3 or 4.5% of the total average yearly outflowing potential of BH. However, even in the super-optimistic 25-year prospects it could not be assumed that an area greater than 200,000 ha could be irrigated, this representing 0.7 billion m3 or 2.2% of the total average yearly outflowing potential of BH. This all speaks in favour of the fact that from the point of view of water supply there should be no problems as concerning the future irrigation projects in BH, especially so if the planned water impounding reservoirs be built.

2.4.4 Water surplus or potential outflow

The average yearly water surplus in BH amounts to about 600 mm. These surplus quantities are greatest in the southern parts where they amount to ca 1400 mm, while in the central parts they are about 400 mm, and 200 mm in northern ones.

It is characteristic for the southern parts that they have the greatest yearly surplus which is in average 3.5 times greater than in central and 7 times greater than in northern parts.

There is similar situation with shortages. They are in southern parts in average 6 times greater than in central and 3 times greater than in northern parts. This shows that in the southern parts of BH the uneven distribution of water regime is most strongly expressed and therefore the need for balancing the waters is greatest there. Due to that, the application of irrigation is on one hand sine qua non of stable and intensive production while on the other hand the water erosion is strongest here and the water and soil conservation measures are most called for here, while the drainage and flood control are necessary in the major part of the flatlands of these parts. The water management is most complex in the southern parts, with disproportions being most strongly manifest, which does not mean that the same problems do not exist in central and northern parts of BH, although they are less strongly expressed there.

2.5.5 Droughts

The effects of droughts are most strongly expressed in southern parts less in northern, and least in central parts from which we can derive conclusion that in forming priorities for future irrigation we should put the southern parts on the top of the list of priorities as regarding the irrigation.

2.5.6 Conclusion regarding agrohydrological balance

If we take that the hydrologists deem those countries where the yearly mass of available water per capita is less than 1000 m3 as water-stressed countries, than BH would be highly ranking because in average it has per capita outflow potential amounting to 7500 m3 and about 15000 m3 of precipitation potential. However, what is important to emphasize regarding the BH from the point of view of water resources is that it has to manage the variations and to balance the waters to ensure better distribution of water in terms of time and space, i.e. to control and manage the waters in more rational way.

The BH agriculture meets 83% of its needs in water through the rainfall (rainfed system). This percentage could be increased through better choice of crops which would use the natural distribution of precipitation in a more rational manner. In our parts, we rarely have a deficit of water in soil from October to May. By giving preference to "cool season crops", which would use the winter precipitation moisture we could avoid the need to irrigate the land in certain areas.

3. THE RURAL DEVELOPMENT IN BOSNIA AND HERZEGOVINA - PRESENT STATE

3.1 Conditions up to the II World War

Up to the II World War, Bosnia and Herzegovina was primarily an underdeveloped rural country in which 3/4 of population thrived on agriculture. The agricultural population made 70% of total population, while the national income per capita was about 150 US$, with illiteracy level being 45%. The basic branches of agriculture were agricultural land farming, livestock and fruit-growing, while there were no agricultural food processing capacities and industrial tradition was very very modest.

3.2 Conditions after the II World War

After the II World War, in the heat of the post-war reconstruction of the country, came an accelerated industrialisation, with changes in employment structure of the population, development in education, rise in living standard, great migration of rural population from villages to urban areas, and seasonal and permanent migration of workers towards the European countries, so that in the 80s the agricultural population constituted only 18% of the total population. The migratory trend, from villages to cities, was strongly supported by the state policy, because in the socialist system it was easier to control the proletarian, industrial workers than the peasant population, which resisted the collectivisation and socialist cooperatives. The collectivisation of agriculture in BH however did not have any impact in terms of the ownership of private agricultural property, because about 94% of agricultural lands remained in private ownership, although the private property was limited to the maximum of 10 ha or to somewhat greater maximum surface area in the high mountain regions. Out of total number of privately owned lands, the number of those which exceeded 10 ha was very small.

The land property structure in BH is very unfavorable. The major part of small farms are technically poorly equipped, with low level of application of modem agricultural engineering, mineral fertilisers and plant protection means. The peasants are producing primarily for their own needs, but they can not even satisfy their own needs through their production. The agricultural activities represent more a way of life than professional occupation. Small farms are one of the main obstacles to modernisation and promotion of agricultural production.

Besides, the scattered nature of land property which is divided in patches situated far away from each other, is a further obstacle to modernisation. There were attempts to resolve this problem in certain areas either through the classical or functional land consolidation, which however yielded no significant results. The farms are still small in size, and there is even a tendency of further parcelling, due to unresolved issue of legal regulations dealing with inhabitants. The property is frequently re-allocated even after the land consolidation. There is no tradition in land leasing, exchange or sale of lands, in spite of the fact that the agricultural population has in relatively short period of time, from 50s to 80s, been drastically reduced. It was precisely at that period that the world agriculture achieved a revolutionary break through, thanks to the use of agricultural chemicals (fertilisers and pesticides), machinery, selection and genetic methods applied to plant and cattle production. This has not been satisfactorily reflected in the agriculture of BH, because the private sector, although possessing 94% of the land, was not preferentially treated on the part of the state through benefits, favorable loans or advisory services, the way the social sector was. The state policy regarding the agriculture concentrated only upon that 6% of agricultural land which was in a social ownership. However, the peasants managed to survive, refusing to cut the links with their villages or give away their lands even after moving to towns. They were not using their landed property, but were at the same time not willing to sell it.

The new industrial capacities were being concentrated in urban centers and their neighbourhoods, while the rural areas remained out of the reach of social intervention, for getting improved and modernised. The rural areas mainly remained without the appropriate infrastructure without modern roads, water supply, sanitation, electric power, telecommunications, health care institutions, educational institutions and commercial centers. Even the most primitive forms of industrial processing of agricultural products were not located in the rural areas, but were rather given to urban environments. Because of that, the agriculture lost the possibility to develop the vertical division of labour in rural areas. The rural areas have kept only the primary agricultural production.

The location of natural resources conditioned the uneven distribution of industrial capacities in terms of space. The process led to large economic and demographic concentration around the big cities (Sarajevo, Zenica, Tuzla, Banja Luka, Mostar, etc.) on one hand and to the depletion of rural spaces on the other hand. The cities were incapable of offering their new inhabitants the urban ways of life, this creating very complex urban problems like unlawful housing construction, lack of utilities and water supply, rise in unemployment, social problems, and other, while the rural areas were continuously being emptied of their population.

4. FUTURE SCENARIO AND GOALS

The rural area of BH has throughout the history been neglected in comparison to urban areas, while during the recent war disaster this space underwent a catastrophic destruction and exodus. Therefore, the process of reconstruction will need a lot of time to complete and a wide array of interventions aiming at its revival and reconstruction is needed.

The aim of any country is to ensure stable production of food for its population, because experience has shown that the complex nature of commercial, economic, transportation and interstate relationships usually presents serious obstacles to transfer of food from one country to another. As BH is presently providing only 50% of its needs in food, it is undoubtedly interested in increasing the agricultural production for the purpose of satisfying its overall needs, or even to ensure the export in certain branches of economy and certain products (cattle breeding, fruits).

Therefore BH must develop a modern agricultural production, but in order to achieve that it must draw up long-term plan of development of rural area, by which to provide civilised conditions of living to its rural population. These conditions must be attractive not only for rural but for urban population as well. All until the moment that the peasant-farmer is not provided within his village or in the vicinity of his village all the benefits which belong to modern civilisation and which the cities possess, the processes of de-agrarisation and devastation of villages and rural areas will continue. The rural areas will in such case be left without human resources. The newly created social changes that go along with the transition will only serve to speed up these processes. Development of rural areas must encompass the following: communal infrastructure; modern road communications; power supply; water supply; sanitation; telecommunications; health services; social infrastructure; schools; social homes; religious facilities; modern intervillage commercial, cultural and entertainment centers.

4.1 Modernisation and promotion of agricultural production

The increase in food production can in principle be achieved in two ways: 1) by developing new cultivable lands through deforestation and 2) by increasing per unit yield from the existing agricultural areas. The first method should not be employed if we have in mind the physical geography of the terrain and dangers of erosion which might be triggered by the deforestation. Therefore, the second method remains, which consists of increasing the yield per unit area. It is possible to achieve that by applying modern technology, but on the other hand it is impossible to implement the modem technology on unreclaimed land. Therefore the reclamation of land is the key element in the increase of food production, because unreclaimed lands (exposed to floods and droughts, undrained, unlinked by roads, dispersed and scattered in small patches) were up to now also one of the important brakes to the faster development of agriculture.

4.2 The contents of land reclamation, and soil water management improvement

The development and modernisation of agriculture should begin from land reclamation and control of waters, as fundamental factors of agricultural production and they should comprise the following contents :

- protection of preferential valley areas from flood should encompass not only about 200,000 of present defended ha but also the new remaining 200,000 ha (conservation measures in basin upland, impounding reservoirs, river regulation, embankments, channels, pumping stations, basic drainage channel network).
- detail drainage should encompass about 200,000 ha of mainly heavy soils.
- about 50% of lowlands or 200,000 ha should be encompassed by the irrigation
- other regulating measures (levelling, land consolidation, field road network. wind-break strip, agromelioration upon about 50% of lowlands or 200,000 ha.

4.3 Research and development

For the realisation of the above mentioned goals, the state should have well developed scientific, design and operative institutions and organisations as well as developed network of state agricultural extension services. Until the 1992-95 war, BH had inadequately developed network of such institutions which were poor in manpower and equipment and which were mainly relied upon the state, universities and huge economy systems. The war destroyed all those things which existed. Many institutions were liquidated, while the others are surviving with difficulties without modem equipment and without new generation. Capable, educated young manpower is going abroad because they can not promote themselves under such conditions. Even the state funds for scientific work which had been used by the institutions before the war, were liquidated. Therefore, new permanent resources (funds) for scientific-research work in the field of agriculture and water resources should be established. These two fields in almost all the world have benefited through state interventions only.

5. CHALLENGES FOR THE FUTURE

Water and soil are the fundamental natural resources for production of food.

BH is rich with water, however, utilisation of water for agricultural production for irrigation and watersupply of rural areas are insufficient. Only 6% of rural population is provided with public water supply. As water supply and sanitation are the key assumption of civilised living, Therefore it is necessary to include overall rural area in the local and regional water supply systems. Even prevention from harmful effects of water caused by the soil erosion, floods, currents, sediments, soil water logging is not adequate. Briefly, the water resources in which BH is rich are not adequately used and also not properly managed. So far the utilisation of water resources was primarily directed to production of energy. In future, utilisation and water managing should be for food production as well.

As BH is poor in high quality soil in its valley areas, which are rapidly vanishing reducing the good basis for existence of agricultural production, the following steps would be necessary for proper soil management:

5.1 To identify the land, water and rural problems at all the levels from local to state.

5.2 To increase the awareness on importance and need of rational water and land resources management directed to increase of food production and development of rural areas.

5.2 To organise Governmental and non-governmental bodies in order to bring the joint strategic visions of integrated water and land resources management and to

promote the implementation of sustainable development, especially in the rural areas.

5.3 To train new generation and modernise scientific-research organisations working in the field of water resources and agriculture, providing them with sophisticated equipment and to ensure permanent sources of financing for their work.

5.4 To improve the international cooperation through including the institutions and scientific organisations into the international network of organisations.

5.5 To organise, through the Society, seminars, workshops in the field of land and water, including in such meetings and discussions not only professional experts but farmers as well.

5.6 To print and distribute popular publications about rational utilisation of water and lands.

BRAZIL[1]

Ricardo A. L. Brito[2]

1. Introduction

Water occupies three quarters of Earth. About 97.2 percent of that are salty waters in the oceans and seas. Of the 2.5 percent left, 69 percent are ice in polar latitudes. The 31 percent left are liquid fresh water, however, nearly 30 percent are deep underground water, unavailable under presently known technology. Therefore, only about 0.3 percent of the total global water are available for men, in rivers, lakes and reservoirs (Cabral, 1998; Rebouças, 1999).

Worldwide, agriculture is the most significant user of fresh water, responsible for 70 percent of its use, compared to industrial (23%) and domestic (7%) use. Approximately half of the food supply in the world for the last 30 years has come from irrigated agriculture, and it is estimated that, in the near future, one half to two thirds of food production increment will come from irrigated agriculture. The global irrigated area, of 260 Mha in 1997, corresponds to 17 percent of the agricultural area and is responsible for 40 percent of total food production (Santos, 1998).

The cultivated area per inhabitant in the world, in 1984, was 2,970 in 2 and in 1995 it was 2;550 m2l. A decrease of 420M2/inh (16.5%) in 11 years caused by degradation, erosion, salinity, water shortage and urban expansion. In the case of irrigated agriculture, the global area was 221 Mha in 1984, which was

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equivalent to 464 m2/inh, and it raised to 255.4 Mha in 1995, corresponding to 449 m2/inh. While the total irrigated area increased 15.6 percent, the per capita value decreased 3.2 percent (Christofidis, 1998).

At the World Food Conference promoted by FAO in 1974, it was predicted that hunger would be eradicated in 10 years. At the next World Food Conference, in 1996, 22 years later, it was estimated that 840 M people were starving, which was equivalent to 14.5 percent of the global population, of 5.8 G inhabitants in that year. Despite these figures, steps were proposed to reduce by 50 percent the number of undernourished people by 2015. Predictions are that world population will stagnate at 12 G by 2050 (Christofidis, 1998).

According to Kennedy (1993),.the production of cereals, the most important food crop, did not follow the population growth. Production of cereal increased at a rate of 1.0 percent a year and the population grew 1.7 percent a year. Studies carried by Population Action International (cited by Christofidis, 1998) estimated that there will be 2.5 G starving people by 2025, and that 36 countries will reach that year with only 700 in 2 per capita of arable land, considered to be the minimum required to feed a person consuming 2400 kcal/day. That consumption is equivalent to 1.0 kg of maize. FAO informed (Christofidis, 1998) that, in the last 25 years, food consumption increased by IO percent more than food production in some I 00 developing countries.

Such a scenario may raise the question: is Malthus becoming fashionable again ?

The world per capita consumption of grains (cereals) in 1990 was 330 kg/inhabitant-year. In that same year, Canada consumed an average of 974 kg/inh, the US 860 kg/day, Mexico 309 kg/inh, Brazil 277 kg/inh and Haiti 100 kg/inh. Considering that 1.0 kg of grain (maize) contains 2,400 kcal, that is equivalent to 2,160 kcal/day. 1.0 kg of grain requires roughly 1,000 L of water to be produced.

2. Brazil: General Characteristics

Brazil has a territory of roughly 8.5 Mkm2, with a population of 162 million in 1998 and a total volume of available water estimated in between 5,327 and 5,610 km3/year, which is equivalent to a per capita value of 32,870 to 35,730 in 3/inh. Estimates indicate from 197,500 to 257,800 in 3/S of water flow in its rivers, representing around 18 percent of the world potential. Of that total, about 90 percent are in the Amazonian region (North and Central West regions) where only 15 percent of the population live. The other 10 percent of the volume are found in the other three regions (Northeast, South and Southeast) that concentrate 85 percent of the population and represent 91 percent of the demand for water. Agriculture (and livestock) consume 61 percent of the water, industry uses 18 percent and municipal and domestic use come to 21 percent (Christofidis, 1999; Rebouças, 1999).

Considering the present daily per capita demand for multiple uses of 1, 1 34 L/inh, that would require only 0.83 percent of the potential volume existing in the Brazilian rivers. However, that demand is still below the minimum standards considered as a healthy diet, of 1,535 L/inh. And the world average for a healthy diet is in the order of 2,736 L/inh (Christofidis, 1999). From the 54 largest darns built in the world, with capacities varying from 205 to 21 Gm3, 6 are located in Brazil; and in none of the Brazilian states the per capita availability of water reaches the "water stress" level of less than 1,000 in , considered by the United Nations as e reference value (Rebouças, 1999).

As it can be observed from the above figures, although the total volume may give an impression of abundance, the uneven distribution creates an equity problem that has already become critical in terms of water shortage, especially in the case of the semi-arid regions (parts of the Northeast and Southeast). Christofidis (1998) informed that water conflicts have already emerged in the watersheds of Guaíra (São Paulo state), Verde Grande river (Minas Gerais state),
Paraíba do Sul (São Paulo, Rio de Janeiro and Minas Gerais states), Bom Jardim (Goiás state) and several smaller river basins in the Northeast and Southeast.

Scarcity of water is becoming gradually more frequent and the competition for its use is severely growing in many parts of the world. *Agroanalysis*, a journal of the Getúlio Vargas Foundation (Brazilian Institute of

Economics) dedicated to studies on agricultural economics, edited a special issue, in 1998, on water resources and irrigation. The slogan adopted for that issue said "Water: the commodity of the turn of the century". That expression illustrates the importance that water is consistently taking in the world scenario. As a consequence, society is being forced to recognize such importance and to demand a more carefull use of water resources from planners and decision makers.

According to Lopes & Silva (1998), the population annual growth rate in Brazil was 1.23 percent in 1997 and it is estimated to be 0.92 percent by 2015. If the average value is taken (1.07%) and considering the above 'mentioned population in 1998, an estimate would be that, by 2015, the Brazilian population will be in the order of 194 million in 2015, and 212 million by 2025, an increment of 30 percent in the number of stomachs to be fed. By 2015, still according to the same authors, there will be a deficit between consumption and production of roughly 2,27 Mt of rice and 1.11 Mt of beans, although a superavit of 9.22 Mt of com is expected. They predict a need to produce 65 Mt of grains by 201 S.

Agriculture in Brazil is a very important activity. Total agricultural area is around 50 Mha, with a potential to cultivate another 60 Mha potentially usable for rainfed agriculture. Its importance is not only related to food production, but it is also economic, having been responsible for 30.7 percent of Brazilian exports in 1997, involving a amount of US$ 16.2 billion. The annual commercial trade of the agricultural sector generated a positive balance of US$ 8.7 billion in the same year. It is also quite relevant in terms of job opportunities. In 1996, the agricultural sector employed 16.6 million people, out of a total labor force of 68 million, representing 24.5 percent, as compared to services (22%) and the industry (20%). Brazil holds 32 percent of the world exports of soybean meal; 17 percent of soybean oil; 14 percent of grain soybean; 16 percent of coffee beans; 14 percent of tobacco; and 8.5 percent of sugar (Christofidis, 1999).

Another important aspect to be mentioned is the fact that agricultural (including livestock) production, per se, represents roughly 10 percent of the National Gross Product (GNP), equivalent to approximately US$ 81 billion. However, if the agribusiness (including the "off farm gate" operations) is considered, the sector's importance will jump to 40 percent of the GNP, or US$ 321 billion, a major change in its significance.

Irrigated agriculture in Brazil has expanded from 60 kha in 1950 to 2.87 Mha in 1998, of which 960 kha (33%) are the low flat lands in the South, mostly used for flood irrigation. It represents approximately 6 percent of the total national area planted and it is responsible for, 1.4 million direct jobs and 2.8 million indirect. Presently, the vast majority of irrigated areas are private, with only 4.2 percent of public irrigation schemes, comprising about 120 kha. The potential for irrigated agriculture is estimated in 49 Mha, of which 33 Mha are. low flat lands for flood irrigation ("várzeas") and 16 Mha in upper lands (Christofidis, 1999) and an expansion of some 500 kha is expected by the end of 2000 according to the National Plan for Irrigation and Drainage

According to Santos (1998), the irrigated area in Brazil represents about 5 percent of the total planted area, but it is responsible for 16 percent of the total agricultural production and for 35 percent of the value of this production. Irrigated agriculture represents one of the most cost- effective ways to generate employment. the author presented some figures on the cost of job generation in different sectors of the economy (in US$/job):

Chemistry & Petro-Chemistry	220,000
Iron industry	145,000
Livestock	100,000
Capital goods	98,000
Automobile industry	91,000
Industry in general	83,000
Telecommunications	78,000
Intermediate goods	70,000
Tourism	66,000
Agriculture in general	31,000
Irrigated agriculture (horticulture)	13,000

Although it is evident that agriculture is the most significant means of utilizing water for food production and that irrigated agriculture is comparatively more efficient in utilizing water, it is still important to mention that irrigation worldwide has been, in a general way, quite inefficient, as compared to potential levels of efficiency that could be achieved. Christofidis (I 999) presented average values of 45 percent for irrigation efficiency worldwide and 62 percent for Brazil. An unavoidable trend will be for other sectors, such as industrial, urban, environmental and domestic, to make use of water that is presently being used by agriculture.

A very important issue related to the low efficiency observed in many of the irrigation schemes, especially in developing countries, is the absence of a well defined methodology for assessing the performance of the schemes with a global approach, that would encompass technical, economical and social factors, all involved in a systematic procedure to assess irrigation performance. For that to become feasible, it is necessary, in the first place, to select adequate performance indicators that fulfill the requirements of rationality, technical feasibility and cost-effectiveness. Second, these indicators will need to be included in a methodological procedure that could be widely used in the majority of the schemes, as a "common language" to be adopted. If that is achieved, it will represent a major contribution for the improvement in the use of water in agricultural production.

The International Commission on Irrigation and Drainage (ICID) created a Working Group on Irrigation and Drainage Performance (WG-PERF), composed by representatives of some 12 countries and the International Water Management Institute (IWMI), whose major objective is to develop a methodology for performance assessment of irrigation schemes. As -a result of the creation of the WG-PERF, a program was outlined, called Research Program on Irrigation Performance (RPIP).

In line with RPIP, the Brazilian Agency for Agricultural Research (EMBRAPA), in association with the National Secretariat of Water Resources and the Inter-American Institute for Agricultural Cooperation (IICA) started the project RPIP-Brazil, in 1997, that has the objective of developing a methodology for assessing irrigation performance based on field data being collected in three major irrigation schemes in the country. The work is being carried out in connection with RPIP and keeping contact with the WG-PERF, as a forum for discussion.

Concerning the rational and equitable use of water in Brazil, an important step has been taken with the approval of Law 9433, the " Law of Water Resources Policy", sanctioned in 1997. The law is still to be regulated, before it can become completely effective, but it was the result of many years of discussions among politicians and the different sectors that represent the major uses of water in the country. The main features of the law are:

(i) adoption of the watershed (basin) as the planning unit for water use;
(ii) introduction of the multi-use concept: all users will have equal access to water use, with priority given to population domestic use;
(iii) recognition of water as a limited, finite and vulnerable good;
(iv) recognition of the economic value of water and therefore entitled to be charged for (principle of the "user payer" and the "polluter payer");
(v) proposal for a descentralized and participatory management, in which individual users, civil society and other social organizations will be able to influence on the decision making process;

The law also creates some important new figures, such as:

(i) a national policy of water resources;
(ii) a national council of water resources;
(iii) concession of rights for water use;
(iv) water charges;

From the data and situations described, it is possible to observe that the Brazilian potential, in terms of water and food production, is impressive. On the other hand, there are problems to be resolved that are proportional to the continental size of the territory. However, some of the actions that are being taken offer alternatives and ways to face the problems, and look for solutions so that the country will be able to cope with the changes to come and therefore to prevent any eventual water or food crisis in the future.

CANADA

1 WATER PARTNERS IN CANADA

Who has the responsibility of managing water in Canada? The Canadian Constitution gives the provinces the responsibility of managing the majority of all the natural resources, including water. The municipalities share the responsibility of supplying water and waster water treatment. As for the Federal Government, its assumes the global responsibility of navigation and fisheries as well as cross-boundary water or waters located on First Nations lands and in the northern territories.

The policies adopted by the federal and provincial governments are aimed at a sustainable management of water resources.

The federal and provincial governments have created a partnership for water management that is called the Canadian Council of Ministers of the Environment that is composed of federal, provincial and territorial ministers responsible for the environment.

2 BACKGROUND ON IRRIGATION AND DRAINAGE IN CANADA

2.1 IRRIGATION

Canada is extraordinarily rich in water resources. Almost 25 percent of all surface fresh water in the world is in Canada. We have more water per capita than any other large country.

The world's 260 million irrigated hectares of land (which is one sixth of the world's cropped land) now produces greater than one third of the world's food supply (Wolter & Kandiah, 1997). Of Canada's 33.5 million hectares of arable land, only 842,000 ha. are irrigated (Table 1). Yet, irrigation is important to Canada. In the province with the most irrigated land, Alberta, 40 percent of the agricultural output comes from 4 percent of the province's arable land: that which is irrigated. Many of Canada's major crops are also irrigated crops, such as cereals, oilseeds, alfalfa, non-cereal forage, sugar beets and potatoes. In those provinces that depend on irrigation only as a supplement to rainfed cropping, it has been shown to be economically rewarding. As the price of land continues to rise, producers are looking to increase crop yields per unit area of land. Irrigation is often the tool used to meet this objective.

Table 1. Lands irrigated in Canada

Province	Area irrigated, ha	Percent of total
Maritimes	4,800	0.6
Quebec	33,000	4.6
Ontario	65,000	8.0
Manitoba	21,900	3.0
Saskatchewan	92,200	11.0
Alberta	510,600	61.0
British Columbia	114,000	13.5
Total	841,700	19 % increase since 1991

Water in agriculture is withdrawn mainly for irrigation (85%) and livestock watering (15%). The Eastern Irrigation District of Alberta estimates an overall irrigation water use efficiency of 75 percent. This is likely typical for irrigated agriculture in western Canada.

Cropping patterns and irrigation needs differ among the various regions of Canada. Some areas such as southern Alberta have a relatively large portion of land under irrigation. Other regions such as Quebec have a very small portion of the arable land under irrigation. Irrigation is needed mainly in the drier parts of Canada, such as the southern regions of Alberta, British Columbia, and Saskatchewan (accounting for 84.5% of all irrigation in Canada). In British Columbia most irrigation is for fruit and vegetable production with micro-irrigation systems or with permanent-set standing sprinklers for hay production. The southern regions of Alberta and Saskatchewan receive less than 350 mm of precipitation per year. In general, without irrigation, a summer fallow rotation must be practiced. Most irrigation in these regions is by use of center-pivots, side wheel-role systems or flood irrigation for grains, oilseeds, forage crops and sugar beets. Manitoba is not as dry as the other two prairie provinces. Yet, in recent years, center-pivot irrigation of potatoes has become important to this province. The major agricultural areas of Ontario and Quebec receive on average 900 mm of precipitation per year. Even in these regions, for higher valued crops such as potatoes, and for vegetables grown on organic soils, supplemental irrigation is economically rewarding. On the organic soils, hand move laterals or large guns attached to a reel are used and for potato production, center-pivots are used. Of special mention for these two provinces, is the use of controlled drainage and/or subsurface irrigation. It has become common for farmlands that have artificial subsurface drainage systems, to use these buried pipelines to deliver water to the root zone. In the Maritimes, hand move systems are used primarily for supplemental irrigation and for frost control on berries.

2.2 DRAINAGE

There are approximately 8 million ha of drained land in Canada. Most of that land area is under surface drainage. More than 2.5 million ha are subsurface drained, mostly in Ontario and Quebec. These two provinces have very intensive cereal, grain, forage and vegetable crop production where the soils with have very low hydraulic conductivities. In addition, the cropland is very flat and the region (eastern Canada) experiences high amounts of precipitation that occurs mostly during the spring snowmelt period and the fall. Since the soils are very heavy, mainly clays and clay loams, with some fine sands and silts, and with the conditions described above, artificial subsurface drainage is necessary.

Surface drainage consists mainly of open field ditches, main drains, land levelling or smoothing, bedded lands, ridge and furrow cropping. There is some dyking for flood control in Quebec, Ontario, Manitoba, and British Columbia.

Subsurface drainage consists of mostly corrugated plastic pipe systems installed to an average depth of about 1.2 m below the soil surface. Generally, 75 or 100mm diameter pipes are used for lateral drains, and the collectors are 100 mm in diameter and increase as the area drained increases. Most collector outlets are 250-300 mm diameter. In cases where there is good hydraulic gradient to the rivers, then gravity outlets are used. Pumped outlets are used in regions where the land level is below that of the receiving water bodies.

Licensed drainage contractors undertake subsurface drainage installations. They would normally use trenchless drainlaying plows with laser grade control systems. Some trenchers are used for drain installation. Farmers generally undertake surface drainage works themselves, using leased or owned equipment.

The subsurface drainage industry in Canada has grown significantly and the expertise is recognized internationally. There are well established factories manufacturing pipes, pipe products and envelope materials. There are also a few companies that manufacture drainlaying equipment. Envelopes or geotextiles are required for wrapping around the perforated pipes that are laid on the fine sandy and silty soils. This prevents the entry of soil particles in the pipes.

As mentioned in the previous section, there is growing interest in the use of subsurface drainage systems for subsurface irrigation. This is especially the case on the very flat lands in eastern Canada, on soils with higher hydraulic conductivities. A water source is required to supply water to the sub-irrigation system. One significant advantage of combined subsurface drainage and irrigation is that nitrate pollution can be reduced. The higher water table during the growing season enhances denitrification, thereby reducing nitrate leaching. In addition to the environmental benefits, there are also benefits due to increased crop yields and reduced nitrogen fertilizer inputs. This represents cost savings to the farmers and increased income.

While most drainage is undertaken in the humid regions of the country, it should be noted that there is potential for subsurface drainage in the arid and semi-arid parts of western Canada, where irrigation is extensively practised. There is some subsurface drainage in western Canada, however more could be installed to combat salinity and waterlogging of the irrigated lands.

3. WATER CHALLENGES AND ISSUES

3.1 OVER THE NEXT 25 YEARS

Irrigation sustainability

The long-term environmental effects of irrigation must be understood if its potential negative impacts on soil and water are to be prevented and if irrigation is to continue its contribution to a diversified agriculture.

Land classification for irrigation is the first step in identifying areas that are sustainable for irrigated agriculture. Water quality for irrigation affects the sustainability of irrigated soils. Soil salinity/waterlogging affects between 4 and 25 % of Alberta’s irrigation districts (Hecker 1997). Of this area, 70 to 80% of the salinity within the irrigation districts of Alberta is attributed to canal seepage.

Although Canadian irrigated agriculture uses only 8 percent of the total national water withdrawal, 77 percent of this amount is consumed through evaporation and lost to other uses (Environment Canada 1987). Further expansion of irrigation should be considered only in the light of present and future requirements.

Water sources

The way we use water is important because some users borrow or take water from the natural cycle for longer periods that others, and some users may have a greater impact on downstream water than others (Vandierendonck and Mitchell 1997). For example, a farmer who irrigates may affect a region's groundwater supply since most of the irrigation applied is lost in evapotranspiration and may not be contributing to surface and ground water recharge. But whether the water is withdrawn from the surface or ground water sources, it is important to all sectors that rely on water, namely, industrial, municipal, agricultural and rural domestic. Table 2 summarizes water withdrawal and consumption from 1981 to 1991.

Table 2. Water withdrawal*, by use, and consumption, in millions of cubic metres.

	1981	1986	1991
Agriculture	3,125	3,559	3,991
Mining	648	593	363
Manufacturing	9,937	7,984	7,282
Thermal power	19,281	25,364	28,357
Municipal	4,263	4,717	5,102
Total Withdrawal	37,254	42,217	45,095
Water Consumption	3,892	4,279	5,357

**Source: Environment Canada, Water and Habitat Branch, as posted on the Statistics Canada web site.*

The demand for water is highly variable and is seasonally related, with the residential and agricultural sectors accounting for most of the variation (Vandierendonck and Mitchell 1997). In 1991, for an estimated Canadian population of 28 million and a total water consumption of 5,357 million cubic metres, each Canadian consumed 191.3 cubic metres of water per year or about 0.52 cubic metres per person per day. Of the total water withdrawn in 1991, agriculture accounted for 8.8 percent and this proportion has remained fairly constant since 1981.

Agricultural water use data in Canada are not collected or maintained in a systematic basis (Vandierendonck and Mitchell 1997). They mention that, in Ontario, although total amounts of water withdrawn by the agricultural sector have been estimated, actual documentation of the source of the water or its spatial context in a watershed has not been done adequately.

Regional water withdrawals in Canada are largely dependent on its use and climatic conditions. Table 3 shows total water withdrawals for the different regions of Canada. The prairie region has the highest water use per person in Canada and the second highest total water withdrawal. The necessity of irrigation water to produce food for domestic consumption and for export explains the higher needs of the prairies provinces.

Table 3. Summary of water withdrawals across Canada (Source: Symposium sur la gestion de l'eau au Québec, Document de référence, automne 1997, gouvernement du Québec)

Region	Total withdrawal* (millions of m^3)	Percent use of Canada	Water use per person (litre/day)
Atlantic Provinces	1,049	6%	1,209
Quebec	3,493	21%	1,352
Ontario	5,390	32%	1,410
Prairie Provinces	4,196	25%	4,226
British Columbia	2,610	16%	2,415
Canada	16,739	100%	1,596

**Excludes thermal power water use*

3.2 ENVIRONMENTAL AND ECOLOGICAL CONCERNS

The environmental challenges related to water uses in agriculture cover a wide range. As stated in the Environment Strategy for Agriculture and Agri-Food, the water resources challenge is to minimize the negative effect of agriculture and agri-food sector on the water quality and increase water use efficiency.

Water quality issues

Improper agricultural practices can result in nutrient and pesticide concentrations, in surface and ground water that exceed recommended levels. High concentrations of phosphorus and nitrogen can lead to eutrophication and deoxygenation of surface water. Increased pesticide use may cause ground water contamination for the percolation of chemicals through the soil profile.

Irrigation may lead to water quality problems. Improper irrigation practices may degrade the soil structure and quality (soil salinity problems), thus compounding many of the water quality issues associated with agriculture.

3.3 CANADIAN WATER LAWS AND POLICY

A Canadian federal water policy was formulated in the mid-eighties. The objectives were to provide a framework within which all water-related decisions of the federal government would be made by every department and agency as well. Its two main goals are to protect and enhance water quality and to promote wise and sound management of water resources.

As mentioned above, ownership of natural resources rests with the provinces. Consequently, the provinces are charged with managing these resources.

Western Canada

The Federal Irrigation Act is the original water law in Western Canada (Percy 1997) and it has undergone many changes over the past few years or, in some provinces, will undergo some transition.

Ontario

Two main environmental statutes, the Ontario Water Resources and the Environmental Protection Acts, both have restrictions pertaining to water and the environment, respectively.

Specific legislation in Ontario regulates pesticides under the Pesticide Act, which contains a general prohibition affecting nonpoint source pollution.

Quebec

Quebec is currently preparing a new water management policy that is taking an holistic view towards water resources management in the province. The elements of the policy are now being discussed in public hearings. There is a section in the policy that looks at how Quebec can market its services and expertise internationally, given its significant expertise in hydropower generation.

Quebec has set some general objectives for water management (full text can be found at the web site *www.mfe.gouv.qc.ca*) that include the following:

- Guaranteeing protection of public health,
- Seeking the sustainability of the water resources,
- Developing the water resource at the social and economic levels
- Reconciling the uses with a view to satisfying legitimate needs.

3.4 INTERNATIONAL JOINT COMMISSION

Many rivers and lakes are found along the border of Canada and the United States. The International Joint Commission originated back in 1906 when a treaty on lake water was signed. This treaty requires that both countries must collaborate in the management of these waters and protect these waters for the benefit of future generations.

In the 1960's, eutrophication, caused mainly by phosphorus loading, threatened to destroy the Great Lakes aquatic ecosystem. The Governments requested the IJC to investigate the problem and to formulate recommendations. As a result, Lake Erie, one of the most affected by this situation, has improved considerably.

3.5 CLIMATE CHANGE AFFECT ON WATER AND FOOD PRODUCTION IN CANADA

In the development of sustainable water resources policies in Canada, water managers and planners can no longer assume the climate will remain constant. Different scenarios based on studies have suggested that the long-term availability and quality of water in Canada and the frequency, duration and severity of such hydrological events as droughts, storms and floods are likely to change. Research is currently being conducted to determine the consequences of climate change impacts on Canadian water resources.

Climate change includes increasing soil temperatures, increasing growing season length, increasing hot spells, decreasing cold spells, decreasing snow cover area, retreating glaciers and permafrost, extreme droughts and wet spells, increase risk of soil erosion by wind and water, increasing demands for water, increasing conflicts over water, decrease river flows and reservoir levels, northward expansion of the range of weeds, insects and diseases and decrease in water quality.

The development of water resources policies and water management strategies in Canada should consider the impact of climate change. Because hydrological processes are so intimately related to atmospheric processes, any change in climate will have a profound effect on water supply of and demand for water.

Research needs include the following topics :

- Frost and drought tolerant crops
- Heat stress

- Water management
- Irrigation
- Fall seeded crops
- Climatic effects on livestock
- Application of short and long term climatic information
- Relationship among climate and agricultural production and practices
- Modeling of climate and production management relations
- Nutrient management
- Management scheduling
- Soil conservation research and practices

Agriculture in the Canadian prairies is already quite adaptable and innovative. Adaptation strategies if developed soon are likely to be beneficial to today's climate and likely tom offer more protection for future climates (Wheaton 1994).

3.6 INTEGRATED WATERSHED MANAGEMENT OR INTEGRATED WATER MANAGEMENT

Practising sustainable water management

Ten themes are being considered in this approach and include: sustainability, stewardship, ecosystem approach, enhancing effectiveness and efficiency, information and understanding, partnerships and stakeholders, impact assessment, adaptive management, anticipation and prevention, and alternative dispute resolution (Shrubsole and Mitchell 1997).

Several provinces including Quebec and Ontario are undertaking integrated watershed management projects. The objective is to conserve and protect the watershed and its land and water resources. Efforts are being made to reduce soil and ditchbank erosion, and to protect water quality. The landowners, agricultural producers and water users on the basin are regarded as the primary stakeholders. They are encouraged to form associations and to undertake conservation measures as a group. Best management practices which are being promoted include conservation tillage, vegetated buffer strips along ditchbanks, grassed waterways, contour cropping, strip cropping, drainage, manure storage, improved and more efficient manure and fertilizer applications, and improved pesticide management.

Agricultural producers are being encouraged to develop and implement farm conservation plans. Some provinces now require fertilizer management plans.

3.7 WATER USE CONFLICTS

Although Canada may appear to have a favourable water supply-demand balance, in reality the situation is disguised by wide variations. More than 60 percent of river flow goes north where only 10 percent of the Canadian population lives (Environment Canada 1987). Factors such as snow accumulation, spring snowmelt, water pollution, drought and climate change are contributing to water use conflicts.

Some uses to consider include, hydropower generation, wetland preservation, flood control, water reservoirs, irrigation requirements, recreational water and water supply for urban areas.

3.8 FISH PRODUCTION

Fresh water fisheries and aquaculture make important use of fresh water in Canada. In 1995, fresh water fisheries caught more than 38,000 tonnes for a value of $76.6 million. In the aquacultural industry, 4,800 tonnes of fish were produced for a value of $19 million.

3.9 MANAGEMENT OF WATER BY SUPPLY OR DEMAND

An increasing number of users are fighting over the existing water reserves to satisfy the basic needs of people, to maintain economic development, to support the natural environment and to be able to keep water for recreational purposes. It is necessary to reconcile these diverging needs and to promote a utilization that recognizes the social, economic and environmental advantages linked to the water resource. Governments, the private sector, NGOs and citizens, all have a major role to play in this regard.

4 CONCLUDING REMARKS

- The Canadian Constitution gives the provinces the responsibility of managing the majority of all the natural resources, including water. The municipalities share the responsibility of supplying water and waster water treatment. As for the Federal Government, its assumes the global responsibility of navigation and fisheries as well as cross-boundary water or waters located on First Nations lands and in the northern territories.
- Canada is extraordinarily rich in water resources. Almost 25 percent of all surface fresh water in the world is in Canada.
- Although Canada may appear to have a favourable water supply-demand balance, in reality the situation is disguised by wide variations. More than 60 percent of river flow goes north where only 10 percent of the Canadian population lives.
- Of Canada’s 33.5 million hectares of arable land, only 842,000 ha. are irrigated. Yet, irrigation is important to Canada, especially in the province of Alberta.

CHINA

PREFACE

With its social and economic development, China will become a modern, wealthy, civilized country in the 21st century. It is predicted that the population of China will reach a peak in about 2030 and the total population will probably exceed 1.6×10^9. In light of the cereal consumption at that time, the total cereal consumption for 1.6×10^9 people in 2025 will be 640×10^6 tons. However, the total cereal production at present is only about 500×10^6 tons, therefore, cereal production in China must be increased by 140×10^6 tons in the coming quarter century, namely 28% of the current cereal production in order to meet the demand for the increase in population and standard of living.

Water and soil are the most important resources for cereal production. In China, the cereal yield of irrigated farmland is 1 to 2 times more than that of rainfed farmland, approximately 92% of cereal is produced on irrigated farmland and 8% of cereal is produced on rainfed farmland. The average cultivated area per capita in China is only 0.08 ha, less than one third of the world average, however, the irrigated area is 21% of the world's irrigated area. The average irrigated area per capita is 0.04 ha and approximately the same as the world average. Thus it can be seen that the future agricultural development in China will depend, to a great extent, on the extension of the irrigated area and on an increase per unit area of yield. Food security is closely related to the use of water and soil resources.

1. OVERVIEW OF NATIONAL POLICIES AND DEVELOPMENT PLANS

Overall National Vision And Macro Economic Policies

Gao Zhanyi and Mu Jianxin, Chinese National Committee on Irrigation and Drainage (CNCID)

Chinese premier Zhu Rongji pointed out in his report of March1999 that China will continually carry out positive financial policies and realize a faster economic development on the basis of expanding domestic demand, optimizing structure, improving quality and increasing income. She will promote a comprehensive agricultural and rural economic development, earnestly implement the rural basic policies of the Party, regulate and optimize the agricultural structure and facilitate the combination between town and township enterprises and agricultural industrialization in addition to several other measures.

Policies For Agriculture And Rural Development

Since the Fourteenth National Congress of the Communist Party of China, the Central Committee had regarded safeguarding the farmer's legitimate rights and interests and mobilizing the farmer's initiatives as the starting point and foothold for agricultural and rural economic development and issued a series of significant policies and measures.

Policies For Agricultural And Rural Water Development

China will tighten its fundamental agricultural construction based on water conservancy, reinforce the embankments in some key sections of the Yangtz and the Yellow Rivers and correct some defective reservoirs on the basis of controlling catastrophic flood and resisting catastrophic drought. She will construct irrigation and drainage projects with the participation of the masses and encourage collectives and farmers to construct and manage small-sized water installations in various ways. In addition, China attaches importance to planed water use and water saving and therefore will devote a major effort to develop water saving agriculture and popularize various types of water saving techniques. Finally China will prevent pollution and conserve water resources.

2. PRESENT STATUS OF WATER

Water Resources

The water resources in China have the characteristics of an abundant total water volume, less in per capita holding and an extremely uneven distribution in both space and time. The mean annual water resource in China is about $2812x10^9$ m^3 which ranks sixth in the world, of which the mean annual river runoff is about $2700x10^9$, the recharge of groundwater is about $828.8x10^9m^3$, the duplicative part of the river runoff and the recharge of groundwater has been deducted from the total water volume. However, the per capita holding of water resources is only 2300 m^3 for large populations and approximately one-fourth of the world average. According to the water resources statistics for 153 countries and regions in 1997 undertaken by the Sustainable Development Commission of the United Nations, the average water resources volume per capita in China was 121st and designated as one of the 13 water short countries.

Rivers

There are numerous rivers in China, of which over 1500 have catchment areas of more than 100 km^2, seven of which are large rivers (shown in Table 1). Most run into seas in the east and the south and are called external rivers. There are also many internal rivers in north and west China, the longest being the Talimu River in Xinjiang vigir autonomous region with a length of 2179 km. The longest canal in the world, the Grand Canal, rises in Hangzhou in the south and reaches Beijing in the north It is a great water conservation work of ancient times and has a total length of 794 km.

Precipitation

Most districts of China have a monsoon climate with an uneven precipitation which decreases gradually from southeast to northwest. The precipitation in the southeast coastal areas is more than 1,600 mm, 400 to 800 mm in north and northeast China and less than 250 mm in the widespread areas of northwest China. It changes dramatically both seasonally and annually, especially in the arid areas. In some northern districts, the precipitation from June to September reaches 80% of the mean annual precipitation, and in some places during summer from July to August, it will reach 50 to 60% of the annual precipitation. However, it is less than 5% during the winter from December to February. The ratio of the maximum to the minimum annual precipitation differs greatly over the country. it will be two to three times in south China, three to four times in northeast China, four to six time in north China and as high as eight times in northwest China. Continuous high-flow years and drought years occur frequently and the unevenly space-temporal distribution of precipitation is the main reason for the frequent occurrence of flood and drought disasters.

Storage Capacity

Since the foundation of the People's Republic of China, large-scale water conservancy works have been constructed. The numbers of reservoirs have been increased from 20 to 804 and the total storage capacity is more than 460×10^9 m^3.

Water Consumption

Water consumption has increased by approximately 100×10^9 m^3 each ten years from 1949 to the 1990s. Agricultural water consumption gradually increased before 1980 and has been unchanged or even decreased a little since 1980. The proportion of agricultural water consumed in relation to total water consumption has reduced over time from 97% in 1949 to 73% in 1993. On the contrary, the industrial and municipal water consumption has increased from 3×10^9 m^3 in 1949 to 140×10^9 m^3 in 1993 and its proportion has increased from 2.91% in 1949 to 26.67% in 1993. The per capita water consumption increased by 8.16 m^3 each year before 1970 and has remained unchanged since 1980. Details of water consumption are provided in Table 1.

Table 1. Conditions on water consumption in each year

Year	Water consume per capita	Total water consu-med	Out of which			Municipal water consu-med	Sum of industr. & municipal water consumed	Ratio to the water consu-med
			Agri. water consu-med	Ratio to the total water consumed	Industr. water consu-med			
	(m^3)	(10^8 m^3)	(10^8 m^3)	%	(10^8 m^3)	(10^8 m^3)	(10^8 m^3)	%
1949	187	1031	1001	97.06	24	6	30	2.91
1957	316	2048	1938	94.63	96	14	110	5.37
1965	378	2744	2545	92.75	181	18	199	7.25
1980	450	4437	3912	88.17	457	68	525	11.83
1993	451	5250	3850	73.33	1150	250	1400	26.67

SALINITY INGRESS

There is 22.4×10^6 ha of low-lying and waterlogged land and 7.7×10^6 ha of saline land which are mainly in north China. There are also 7.688×10^6 ha of waterlogged farmlands in south China. After allowing for the duplicate areas, there are approximately 33.3×10^6 ha of waterlogged and saline and waterlogged farmlands in China. Even though most of the farmlands have been improved to a certain extent, they are still at the middle to low yield level but have great potential for further development.

Water Shortage

The development and utilization of water resources in China is very low and cannot meet the demand for the national economic development. The difference between supply and demand for fresh water is being aggravated day by day. In medium arid years, the annual water shortage throughout the whole country is $30x10^9$ m^3. Three hundred cities are short of water, of which, 108 cities are seriously short. The annual water shortage is $5.8x10^9$ m^3.

Groundwater Overdraft

Because there is not sufficient surface water in the north plain of China, groundwater has been extracted to a great extent and resulted in a serious overdraft. The groundwater level has been reduced by over one metre each year. A total of $1450m^2$ have been ingressed by salt water in the Bohai Sea districts because of the reduction of the groundwater level. The yield of water from wells has been reduced and will be continuously reduced with no recharge.

Irrigated Area

At present, there are $50.4x10^6$ ha nominally irrigated in China. However, the real annual irrigated area is only $43.2x10^6$ ha. It is predicted that the cereal yield will be reduced by at least $35.40x10^9$ kg each year because of a shortage of water.

The Yellow River Dry

The Yellow River (YR) is the second largest river in China and the main source of water for the northwest and north China. The Yellow River Basin (YRB) is an important agricultural area. It has $130x10^6$ people (10% of the country's total), $16x10^6$ ha of cultivated land (16% of the country's total), but only $58x10^9$ m^3/year of available water, corresponding to 2% of the country water resources.

However, the Yellow River has frequently been dry during the past ten years due to a water shortage and unreasonable water diversions. This phenomenon has not occurred before and its duration and involved river sections are becoming longer and longer.

3. ECOSYSTEM PRESERVATION

Because economic development largely depends upon the input of resources and frequently results in an excessive exploitation of resources, serious pollution and deterioration of the natural environment has resulted in some areas. At present, the management system is dispersed which has resulted in the lack of effective and coordinated management of resources.

The policies of "preserving, saving and rationally utilizing resources", "exploiting, utilizing and increasing its value" should have equal importance and "who exploits and who will preserve, who destroys and who will recover, who will utilize and who will compensate" are carried out in China based on these issues. The objectives are to depend on the results of science and technology to exploit the potentials of the agricultural resources, increase its efficiency, reduce its occupation and consumption, improve and preserve it is self-recovering capacity, and increase the value of the natural resources within the ecological system.

4. PRESENT STATUS OF FOOD

The total cultivated area has not changed much since the foundation of the Peoples Republic of China. Although it increased a little along with the extensive reclamation of wastelands in the first decade, it has decreased gradually since 1980 to or a little below that in1949. However, cereal production has increased gradually and steadily from $113.2x10^6$ tons in 1949 to $494.2x10^6$ tons in 1997 due to the development of irrigation and the improvement of agricultural science and technology. It has increased approximately to 3.25 times that of 1949. There are many factors that resulted in the increase of cereal yield, out of which, the most important is the development of irrigation. The second is the increase in per unit area yield, and this increase is closely related to the proper use of irrigation water, reasonable fertilization and scientific on-farm management.

5. LAND RESOURCES

China is an agricultural country with a large population and a small per capita area of cultivated land. This results in a contradiction between the demand and supply of agricultural product. Cereals, in particular, will be short for a long period. The cultivated area per capita is only 0.08 ha, about one third of the average of the world. In the recent half century, irrigation has been developed quickly in China. The irrigated area in China in 1949 was only 16×10^6 ha, which was about 16 % of the total cultivated area. In addition, yields were very low and cereal consumption was only 209 kilograms per capita. However, the irrigated area of the whole country was about 53.3×10^6 ha in 1998, about 53% of the total cultivated area. The increased irrigated area during the past 50 years has resulted in doubling that of 1949 and cereal consumption has reached 400 kg per capita.

Table 2. Conditions of irrigation development and cereal yield

Year	Irrig. area (100 (million mu)	Total agril. acreage (10^8 mu)	Ratio irrig. area to agril. acreage (%)	Total cereal yield (10^8 kg)	Total irrign. water consu. (10^8 m^3)	Ratio of irrign. water consu. to total water consu. (%)	Popu-lation (100 million)	Average irrigated area per capita (mu)	Average area of culti. land per capita (mu)
1949	2.40	14.68	16.35	1132	956	92.0	5.40	0.44	2.72
1965	4.81	15.54	30.95	1945	2350	85.0	7.25	0.66	2.15
1980	7.33	14.90	49.19	3206	3580	80.5	9.87	0.74	1.51
1993	7.46	14.26	52.31	4565	3440	66.5	11.85	0.63	1.20
1997	7.84	14.20	55.21	4942	3598	65.0	12.36	0.63	1.15

6. WATER FOR FOOD

With an increase of the irrigated area, the consumption of irrigation water for the whole country has also increased from 100×10^9 m^3 in 1949 to 358×10^9 m^3 in 1980. The total consumption of irrigation water has been unchanged since. However, the proportion of irrigation water to the total water consumption has decreased year by year with the increased demand by industry and municipalities. The effective use, efficiency and productivity of irrigation water has been increased gradually in the past decades, especially since 1980. Calculated as the real irrigated area, the average irrigation water consumption per ha for the whole country has decreased from 8745 m^3 in 1980 to 7800 m^3 in 1995 due to adopting various water-saving measures. Cereal yield per cubic metre of water has increased from 0.4 kg in 1980 to 1.0 kg in 1997.

7. AGRICULTURAL DEVELOPMENT

The total cereal yield of China in 1996 was 504×10^6 tons, an increase of 69.25×10^6 tons since 1991, 3.0% annually, 1.9% more than the increased rate of population in the same period. Rice, wheat and maize are the three major cereals, the yield of the three cereals in 1996 had set an historic record, of which the yield of rice was 195.1×10^6 tons, increased by 11.29×10^6 tons over that of 1991 amounting to 6.1%; the yield of wheat was 110.57×10^6 tons, increased by 14.62 tons more than that in 1991 and amounted to15.2%; and the yield of maize was 127.47×10^6 tons, increased by 28.7×10^6 tons over that in 1991 and amounted to 29.1%. The proportion of the yield of rice, wheat and maize to the total cereal yield was 38.7%, 21.9% and 25.3% respectively, the proportion of the yield of rice and wheat to the total cereal yield has decreased by 3.5% and is 0.1% less than that of 1991 and the proportion of the yield of maize had increased by 2.6%, which played an important role in realizing the balance between cereal supply and demand and promoting the development of aquiculture.

The comprehensive production capability of livestock products in China has been increased remarkably. The outputs of meat and eggs in China in recent years has always ranked first in the world and the output of meat makes up one-third of that of the world, an increase of 10 % in the last five years. The output of aquatic products have doubled and reached 28.13×10^6 tons in 1996, increased by 14.62×10^6 tons over that of 1991, increased by 108% and has ranked first for the world for seven years.

The mechanization of agriculture has improved notably and the work undertaken by agro-machinery has resulted in an increase of more than 40% in agricultural production.

8. WATER FEES

At present, the water fees in China are very low. Therefore, the present management systems of irrigated areas should be reformed, people's water-saving consciousness should be improved and water fees should be charged according the of the volume of water used.

9. PRESENT STATUS OF RURAL DEVELOPMENT

Land

The People's Republic of China has a large area of land. However, the farmland resources are relatively small, the cultivated area per capita being only one mu (0.08 ha), about one-third of the world level. The reserved resources of farmland that can be reclaimed is only a little more than 100×10^6 mu (8×10^6 ha) being very limited for the more than 1×10^9 people.

Land Contracted Responsibility System

The land contracted responsibility system is one where the farmlands of collective farms are contracted by farmers. It is the basic system in China's countryside. It has three major patterns for contracting :

1. contracting by population, i.e. all farmlands for contracting are averaged by population at first and then allocated to farmers according to the number in each household.

2. contracting by labour force where there are also three kinds of contracting patterns, i.e.

    a. all farmlands to be contracted are averaged by natural labour forces and then allocated to farmers according to the labour force in each household; or,

    b. farmlands prepared for contracting are averaged by the labour force intensity and then allocated to farmers according to the quantity of labour force converted from the marking results;

    c. contracting is by the ratio of population and labour force, i.e. some of the farmlands prepared to be contracted are contracted by populations and some are contracted by labour force.

3. the third is contracting by the ratio of the population to labour force, i.e. some of the farmlands prepared for contracting are contracted by populations and some are

contracted by labour force. The responsibility farmlands where commodity grains and other crops are planted are contracted by the labour force.

The common characteristics of the above three contracting patterns are that the former production teams have been replaced with family organizations which are the decisive sectors for agricultural production and management; the contracting structure of turning over enough to the state, reserving enough for the collective and the surplus is the farmer's, has been carried out on the whole; that the collective ownership of lands should be unchanged is stressed during contracting the lands of the collectives to each peasant household. The Central Committee stipulated in November 1993 that the contracted period of farmlands will be prolonged to 30 years on the basis of the original contracted period in order to stabilize the contracting relations of farmlands, encourage farmers to increase input and improve the productivity of farmlands.

Populations

China is the most populous country in the world. According to the State Statistical Bureau, the population had reached $1.22x10^9$ by the end of 1996 (not including Tibet, Hongkong and Macaw), out of which, males were 50.8% and females 49.2%. The municipal and town populations made up 29.4% and the farm populations consisted of 70.6%. The birth rate was 16.98%, death rate was 6.56%. The average population density of the whole country is 126 persons per km^2. Distribution of the population is uneven. It is at a minimum in northwest China which is one-sixth of the country's average; the maximum is in the southeast coastal area which is five times that of the country's average; the second is in north China which is 3.5 times of the average.

More and more water is demanded with population growth. Cereal yields at the end of this century will be $500x10^6$ tons and the irrigated area will be $53.4x10^6$ ha. It is predicted that the cereal yield will be increased to $567x10^6$ tons, the irrigated area is estimated to be $60x10^6$ ha and the water demand will also increase correspondingly.

Flood and Drought Disasters

China has a vast territory with complicated and various climates. There is no summer annually in the north of Heilongjiang Province, there is no winter annually in Hainandao, the four seasons are evident in the Huaihe River Basin, snow accumulates annually on the Qingzang Plateau. The four seasons are like spring in the south of the Yungui Plateau and the day and night temperatures differ notably in northwest China. Divided on the 400 mm isohyet line running through the continent from north west to south east, southwest of the line are arid and semi-arid areas which are 45% of the national area, the climate is dry and the precipitation is low. Precipitation increases gradually from northwest to southeast and changes remarkably southeast of the line. The maximum mean annual precipitation in four months is from June to September in the north and from April to July or from May to August in the south. The proportion of the maximum continuous precipitation of four months in the annual precipitation is 60% in the south, two to three times in the north, four to six times in north China, three to four times in northeast China and exceeds eight times in northwest China. Continuous flood or drought, day and night disasters, occur frequently.

As a result of the complicated topography, changeable climate and seriously uneven temporal and spatial distribution of precipitation, water and land resources lead to frequent flood and drought disasters. The stricken area of the agricultural disaster in 1997 was $30.31x10^6$ ha and the area without any harvest was $6.43x10^6$ ha. The drought area of crops of the whole country was $33.51x10^6$ ha and the lost cereals from drought disasters are 75% of that of the total disaster area. An exceptionally catastrophic flood disaster occurred in 1998 in the Yangtz, Nenjiang and Songhuajiang River Basins the direct economic loss of which exceeded $200x10^9$ RMB yuan and resulted in a great loss in rural and agricultural production.

Rural Economic Structure

Viewed from the rural industrial structure, the proportion of agriculture is decreasing and the proportion of non-agriculture activity is increasing.

Viewed from the agricultural economic structure, the proportion of plantation and forestry decreased and the proportion of husbandry and fishery increased. The agricultural output value in 1996 was 1,354.7x10^9 yuan calculated at current prices, which was 1.6 times that of 1991. The output of forestry was 77.9x110^9 yuan, which was 1.1 times that of 1991. The output of husbandry was 708.3x10^9 yuan, which was 2.3 times of that of 1991. The output of fishery was 202.0x10^9 yuan, which was 3.2 times of that of 1991. The proportions of the output value of agriculture, forestry, husbandry and fishery in 1996 to the total output value were 57.8%, 3.3%, 30.3% and 8.6% respectively. Compared with the output in 1991, the proportions of the output of agriculture and forestry decreased by 5.3% and 1.2% respectively while husbandry and fishery increased by 3.8% and 2.7% respectively.

Viewed from the productive structure of plantations, the proportion of cereals and cash crops decreased and the proportion of other crops increased.

Viewed from rural employment structure, the proportion of people engaging in agriculture decreased and those engaged in the non agricultural sector increased.

Rural citizen's food structure has changed remarkably. Farmer's cereal consumption was by and large stable from 1992 to 1997 and non-staple food consumption increased, of which the consumption of oil increased by 7.4%, meat by 6.2%, eggs by 15.2%, aquatic products by 66.5% and fruits and melons increased by 130%. With the increase of food consumption and the improvement in food quality, the consumption of other commodities increased markedly.

Rural poor populations have decreased gradually year by year. The size of the poor population in China at the end of 1996 had decreased to 58x10^6, which was 22x10^6 less than in1993. The average annual elimination of poverty has been 7x10^6 persons per year. The ratio of the poor population to the total population has decreased from 6.28% in 1992 to 4.7% in 1996.

In general, the farmer's standard of living and quality of consumption has improved after many years of development. However, the farmer's level of consumption is still very low and their income is the key factor that constrains an improvement.

Rural Urban Migration

At present, the population in China exceeds 1.2x10^9 including 920x10^6 in the rural areas, which are the majority. The rural labour force is about 450x10^6. However, presently agriculture can only use 150x10^6 labourers and therefore 300x10^6 labourers are surplus. There were 24.53x10^6 town and township enterprises at the end of 1993 which absorbed 123x10^6 rural labourers; moreover, there are still 70x10^6 rural labourers who go out to work or for business. Therefore, there are still 110x10^6 surplus rural labourers in China.

Agricultural Mechanization

The mechanization of agriculture in China is developing rapidly with the introduction of motor power. Hence the service industry for machinery is also developing at the same rate.

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Fundamental Construction of Irrigation and Drainage

The State Council issued "Policies for the Water Industry" in October 1997. This policy clarified the importance of China’s water resources, its infrastructure and associated industries. It outlined the scope and policies for the construction and development of water resources.

The total investment for the major construction of water resources in 1997 was $37x10^9$ RMB yuan. This provided for the completion of $11.2x10^9$ m^3 of earth and rock work, an increase of 6.3% and 7.7% respectively over the previous year. As a result, 857.1 $x10^3$ ha of irrigated land was added bringing the total to $4.249x10^6$ ha of irrigated land consisting of :

- $1.395x10^6$ ha of newly constructed water-saving irrigated areas,
- $1.144x10^6$ ha of newly constructed and improved water-logged controlled areas,
- $1.851x10^6$ ha of improved middle and low yielding fields and
- $2.40x10^6$ ha of improved soil and water in lost areas.

It also:

- provided $15.85x10^6$ people with drinking water,
- rehabilitated $348x10^3$ water-destroyed works,
- constructed, maintained and reinforced $13x10^3$ reservoirs and $280x10^3$ km of embankments and canals,
- constructed 1584 new water supply works in township which increased the daily water supply by 235 tons, and
- increased the capacity of small hydroelectric power plants by $650x10^3$ kilowatts.

1. FUTURE SCENARIOS AND AIMS

Increasing the Efficiency and Productivity of Irrigation Water

China is a large agricultural country and the use of irrigation water (including the use of on-farm irrigation water and rural domestic water) is 81% of China's total water consumption. The current efficiency of irrigation is only 0.3 to 0.4, which differs greatly from the 0.7 to 0.9 efficiency in developed countries. This is due to a backward technical and management level of old irrigation facilities which have been in disrepair for a long time. The water productivity of crops is only 0.87 kg/m^3. If we adopt scientific agricultural water-saving measures, increase the efficiency of irrigation water to 0.6 to 0.7 and increase the water productivity by 0.3, $120x10^9$ m^3 water will be saved based upon the present consumption of $400x10^9$ m^3. If two-thirds of the saved water is used for cereal production then the $80x10^9$ m^3 of saved water will increase the production of cereals by $112x10^6$ tons, calculated using productivity at 1.4 kg/m^3. Therefore, the saving of water and improvement of its efficient use are important ways to ensure China's food security during the next century.

Developing an Agricultural Water-saving Technology System

The efficiency and productivity of water use cannot be determined by using only one or a few engineering measures, but by establishing a comprehensive technological system combining rational water use, water saving irrigation engineering and management and agronomic measures. It is possible to greatly increase irrigation efficiency and productivity and thus increase grain production to ensure food security by improving these three factors.

Using rainfall water fully to develop a high efficiency dryland agriculture.

The area of cultivated land in China is $94.7x10^6$ ha, of which $53.3x10^6$ ha (56%) is irrigated and the balance, 44%, is dry land agriculture. There is a long history and plenty of experience in increasing the yield of dryland agriculture. Also experimental data and results on developing dryland agriculture in different areas are available and farmers have created various forms of storing rain water to combat drought. If these measures were applied to an area of $280x10^6$ ha (70% of the total dryland area), an extra $21x10^9$ kg of cereal grain could be produced resulting in an increased yield of 750 kg/ha. This would make a great contribution to food security in China in the next century.

Developing irrigation in dryland (rainfed) areas to further increase food security

Restoring water, maintaining soil moisture and establishing a soil water reservoir to increase the soil capacity for drought resistance and water supply are needed to develop irrigation on dryland. In addition, applying fertilizers to increase soil fertility, using soil water efficiently and retaining rainfall are significant methods of reducing the effects of drought and increasing yields.

Inter-basin water diversion in some areas of north China

In north China there is a lot of farmland with little water and in south China there is less farmland with lots of water. In the long term, from the agricultural and industrial development points of view, it is necessary to construct the South to North Water Diversion Project which will be an inter-basin water diversion. Preparation work for this project should be carried out actively and steadily and construction should start at the proper time. The aims of the East Line Plan and the Middle Line Plan are to supply water to the cities and industries. With the high cost of diversion the price of this water may be too great for farmers to use for irrigation. However, with the increase in the availability of water for industries and domestic use in the cities, it may be possible for agriculture to regain some water which was previously available but taken by industries and cities. The effluent from industries and cities will be increased and this may also be used for agriculture. This development will help to solve the water shortage problem in some areas of north China which are closely linked with food security. Water consumption in the Huang-Huai-Hai Rivers plain has exceeded its limit. However when the South to North Water Diversion Project is completed water use efficiency in north China is expected to increase and alleviate the water shortage situation in this area. If $42x10^9$ m^3 of water is diverted from the Yangtze River each year, it cannot only recover the ecological balance in this region (including the benefit of solving the Yellow River shortage problem), but can also meet the demand of further economic development of this region. Furthermore, the irrigated area can be increased by $3.33x10^6$ ha resulting in an increased production of $14x10^6$ tones, which is important for food security.

A further benefit will come by applying new biotechnology methods to modify the properties of crops biochemically and breeding new varieties for drought-resistance, high-quality and high-yield, so as to increase food production. One of the important ways to increase crop production on a large scale is to breed new varieties with drought-enduring, lodging-resistance and cold-enduring properties together with high yield and quality. With progress in biological science, studies should be conducted to understand crop biochemical mechanisms. By changing crop genetics, the physiological properties of water-loving and drought-resistant crops may be turned from "water-loving" to "drought-enduring". However, yield and quality must both remain excellent.

11. FUTURE OUTLOOK

Water Development

The pattern of water consumption up to 2025 for different sectors is indicated in Table 3.

Table 3 Prediction on increase of water consumption in China over the years

Item	Agricultural water consumption		Industrial water consumption			Domestic water consumption		Total water	% of total
Year	Irrigated area (10^6 ha)	Water consu. (10^8 m^3)	Output value (10^8 yuan)	Cnsu. index ($m^3/10^4$ yuan)	Water consu. (10^8 m^3)	Consu. index (L/capita day)	Water consu. (10^8 m^3)	consu. (10^8 m^3)	water resor. volume
1990	48	4400	23851	210	500	25	100	5000	17.86
2000	53.9	4750	69900	165	1153	35	167	6070	21.80
2025	60.3	5232	531460	90	4783	70	365	10380	36.10

Food Production and Demand

In the light of international experience, domestic cereal production that meets 90% of cereal demand is considered to be a high rate of self-sufficient. If China can become 90% self-sufficient, she will make an enormous contribution to the world and humanity. Theoretically, the scale of China's cereal import should be approximately 10% of her total demand.

The experience in China is that there is no need for cereal imports to exceed 5 % of the total demand. Thus, with China being 95% self-sufficient she stands in the fore-front of the world. Considering various adverse factors, the import scale can be extended from 6 to10%. The total cereal demand will be $640x10^6$ tons in 2025 on the basis of a population of 1.60 $x10^9$ and 400 kg cereal consumption per capita. If the cereal production in 2025 reaches $620x10^6$ tons, there is only $20x10^6$ tons difference between cereal demand and production, which can be solved from cereal import. This would be less than 5% of the total cereal production. Therefore, the cereal import scale of China in 2025 will not exert any threat to cereal supply in the international market.

To sum up, the proportion of cereal importation amounting to 6 to10% is within the scope of security. Therefore, the estimated scale of China's cereal importation still takes unforeseen circumstances into account.

Irrigation Development and Potentials for Yield Increase

The potentials for yield increase have a close relation with the development of irrigation in the 21^{st} century. Under current conditions, there are no alternatives but to depend on developing irrigation, improving the conditions for agricultural production, giving full play to the function of agricultural science and technology and increasing the per unit area yield of crops. The potentials for yield increase in the 21^{st} century mainly depend on the following three aspects.

1. It is predicted that the irrigated area in China will be increased by $9.9x10^6$ ha by 2025, to $64.9x10^6$ha. If 65 % of this increase is planted with cereals, the yield increase per ha will be 6000 kg, with about 38.6 $x10^9$ kg of yield increase.

2. Improving the constructed irrigated area and realizing conveyance and modernization. Improving $13.3x10^6$ ha of middle and low yielding fields, carrying out modernized irrigation in another $15x10^6$ ha of cereal farmlands and, in association with advanced agricultural techniques, the yield will be increased by 2700 kg/ha and 1500 kg/ha respectively with $36x10^9$ kg and $30x10^9$ kg yield increase respectively with a total increase in yield of $66x10^9$ kg

3. The yield of more than $40x10^6$ha of rainfed land will be increased through drought-resistance techniques and rainfed agricultural techniques.
If 70 % of rainfed land, i.e. $28x10^6$ ha, is planted to cereals, the potential yield increase will be $21x10^9$ kg calculated with 750 kg yield increase per ha.

The total potential yield increase of the above three aspects will be10^9 kg.

Prediction of Cereal Production and Irrigation Water Consumption

As stated above, the total irrigated area in China had reached $51x10^6$ ha on the basis of $95x10^6$ ha of the total cultivated area in 1997, the total cereal production was $494.2x10^6$ tons and the per capita holding of cereals had reached 400 kg with a populations of $1.23x10^9$, which ensured basic food security (details are provided in table 4). The total cultivated area will be increased from $95x10^6$ ha in 2000 to $100x10^6$ ha in 2025 and the irrigated area will be increased step by step from $51.9x10^6$ ha in 2000 to $60.3x10^6$ ha in 2025 due to adopting various effective measures and intensified policies. It is predicted that the cereal yield will be increased from $494.2x10^6$ tons in

1997 to 620x10^6 tons in 2025, increased by 125.6x10^6 tons after adopting various effective water-saving measures and agricultural techniques.

Table 4. Prediction on cereal production and irrigation water consumption in the 21st century

Scheme Year	Agrl. acreage (10^6 ha)	Irrigated area (10^6 ha)	Total yield (10^8 ton)	Average yield based on culti. land (kg/ha)	Irrigation water consump. (10^8 m^3)	Average (m^3 / ha)	Increased irrigation consump. (10^8 m^3)	Total popu-lation (10^8)	cereals per capita (kg)
1997	95	51.0	4.942	3937	3530	6922		12.36	400
2000	95	51.9	5.000	4116	3540	6820	0	13.00	385
2025	100	60.3	6.20	5670	3660	6070	750	16.00	388

It can be seen from the table above that it is possible to expand the irrigated area under the current stable cultivated area, reduce the per unit area of irrigation water consumption and increase the per unit area yield and the total cereal yield through planting and seeding appropriate cereal crops and adopting various water-saving and yield-increasing measures. It is also possible to obtain 620x10^6 tons of cereals from the irrigated area, which makes up 60% of the total cultivated area and from the rainfed area, which is 40% of the total cultivated area. The average cereal holding per capita will be 388 kg, which is nearly 400 kg. The population of 1.60x10^9 will need 640x10^6 t of cereals if 400 kg per capita is selected as the food security limit, the difference being only 20x10^6 tons, consisting of 3.2% of the total cereal production, which can be solved by importing cereals from the international market. The irrigation water consumption will be increased by only 75x10^9 m^3 from that in 2000, making up 12.3% of the total irrigation water consumed. This can be solved through expanding water sources or properly exploiting shallow groundwater.

12. RURAL DEVELOPMENT

Overall National Vision

China is the most populous developing country of the world. Agriculture is the basis of the national economy and social development. Since the foundation of P. R. China, agriculture in China had not only met the demand for agricultural product by residents from cities and towns, but also provided a guaranty for basic life, welfare and employment for more than 70% of the rural population and provided a basic guaranty and capital accumulation for the development of industry and other undertakings. The increased value of its agricultural output in 1997 was 139.69x10^6 RMB yuan which accounted for 18.7% of the total domestic output. This is an important component of the national economy.

The tasks for agricultural and rural development are very arduous for the 21st century. It should continuously produce sufficient food to ensure security and support the 1.60x10^9 population. It should develop a rural economy and ensure the stable increase of farmer's income. It should create opportunities to migrate the massive rural surplus labour force and it should lay foundations for the whole national economy and social development. The agriculture action plan for China's agenda for the 21st century was worked out based on the issues of more population, insufficient resources and backward techniques as listed below :

- Implementation of sustainable development strategy to promote agricultural modernization.
- Development of agricultural production for food security.
- Realization of sustainable development of township enterprises and state farms.
- Proper readjustment of rural economic structure to satisfy social and market demands.

- Input increase and improvement to enhance production capacity of agricultural resources.
- Conservation and rational use of agricultural resources and improvement of agro-ecological environment.
- Promotion of coordinated regional development and elimination of rural poverty.
- Stronger research and education for sustainable agricultural development.
- Promotion of a legal system, public participation and international cooperation for sustainable agricultural development.

Constraints

The agriculture and rural legal system is still faced with many serious problems which are :

- A large population vs. limited arable land and other agricultural resources. Per capita availability of arable land has shrunk year by year. In past decades, it has dropped from 0.09 ha to 0.08 ha.
- Rural economy is underdeveloped and farmer's per capita income remains low with limited increases over the years; rural population is growing fast, creating a huge surplus labour force with a poor educational level.
- Poor agricultural infrastructure, low productivity, poor disaster resistance and a huge fluctuation in production.
- Irrational structure of rural economy, inefficient agricultural inputs, low use and efficiency of chemical fertilizer and irrigation water, rapid increases of agricultural production costs.
- Pollution of the agricultural environment is getting more and more serious, affecting nearly 20×10^6 ha of arable land, about one-fifth of our total arable land. Soil degradation is also getting more serious. Agriculture is affected by more frequent natural calamities.

High-tech Farming Techniques

Efforts shall be made to develop new high-yield and high-quality varieties and breeds of crops, livestock and aquatic products, develop and propagate genetic resources with famous, special and high-quality traits by the use of techniques like tissue culture, cell fusion, hybridization and monoclonal antibodies and development of new varieties resistant to pests, saline-alkaline soil, low temperature, drought, infertile soil, wind, flood or poor environmental conditions. In the meanwhile, efforts will be made to develop precision farming with geographic information system (GIS), global positioning system (GPS) and remote sensing (RS) as its key technologies.

Aquaculture

It is predicted that by the year 2010, we will increase our total animal product output in farming areas by 50% and maintain sustainable and stable development of animal husbandry in pasture areas. Fish farming will be developed rationally with focus on the development of sea and freshwater fish farming so that fishery output from aquaculture will reach 60% of the total meat production.

Eco-system

It is predicted that by year 2010, the total number of ecological counties at both the national and provincial levels will amount to 350 and their project achievements and technologies will be popularized in all counties.

CROATIA

EXECUTIVE SUMMARY

The issue of food and rural development in Croatia may be best summarized using a part of the speech of the Croatian Prime Minister at the World Food Summit in Rome, 1996.

Croatia belongs to the group of new members of the world community, but it is a country with rich experience and tradition in agricultural development, both as regards the scientific and research work and education, and practical food production. Although concerned with solving of the heavy effects of war, as well as numerous problems related to transition from planning to market economy, the Croatian Government focuses particular attention on providing food to the entire population and supplying of the market with adequate contingents of good quality products. Therefore the Republic of Croatia is ready to accept all ideas regarding the Summit dedicated to the security of nutrition, and shall give full support to its organization.

As a responsible member of the International community, the Republic of Croatia is concerned about slow solving of global problems related to security of nutrition and will persist on their solution at all levels. The seriousness of the situation is illustrated by the fact that permanent reduction of arable land areas has already become a global trend, and the expected growth of the population on Earth requires doubling of food production by 2025.

Keeping this in mind, we are sure that adequate quantities of good quality food may be provided only through increasing of production per unit of area. At the same time, this increase must be achieved by applying ecologically balanced technologies, in order to preserve the natural resources, and in the environment of 'healthy competition" and social justice, in order to secure availability of food for all who need it. The key role in achieving of these high goals will belong to scientific research and education activities in agriculture and related disciplines, but also to development of democracy in all segments of social life.

1. OVERVIEW OF NATIONAL POLICIES AND DEVELOPMENT PLANS

Recognizing the role of the agricultural sector in the national economy of Croatia, the Ministry of Agriculture and Forestry decided, with the assistance of UN Food and Agriculture Organization (FAO) to formulate the strategy of sustainable agricultural development, in accordance with the provisions of the Constitution of the Republic of Croatia regarding the development of economy on market principles. The fundamental goal of the strategy is:

Encouraging of more efficient production and marketing of agricultural products in a way enhancing the welfare of farmers and consumers, contributing to the development of Croatian national economy, protecting the natural resources of the Republic of Croatia and ensuring competitiveness of Croatian agriculture on the world market. In achieving this goal, particular emphasis should be given to family farms, which are the basis of Croatian agriculture.

Thus, the Strategy represents the concept of sustainable development of Croatian agriculture as an integrated approach to national development, with its goals: efficiency, righteousness and sustainability being carefully integrated into a coherent and operational framework.

2. PRESENT STATUS OF WATER

2.1 GENERAL CHARACTE RISTICS

The Republic of Croatia, established after disintegration of former Yugoslavia in 1991, comprises the territory of 56,538 sq.km. which is about 22 percent of the former country, and its population is 4,784,265 (1991). It consists of two arms, the continental one stretching from Zagreb eastward, and the coastal one stretching along the Adriatic Sea.

With respect to the orographic, climatic and vegetation characteristics, the whole territory may be divided into the following geomorphologic units :

• the Panonian Plain	31,000	sq.km	-	54.8%
• the mountain area	7,540	sq.km	-	13.3%
• the Adriatic zone	18,000	sq.km	-	31.9%
	56,540	sq.km	-	100.0%

The basic characteristics of the physical environment lead to the conclusion that the long-term development of the country should be based on agriculture and tourism. The climate, high rainfall (average 1,088 mm per annum), large areas of good quality farm land (about 56 percent) both in the Pannonian and in the coastal region, provide a sound basis for long-term development of highly efficient ecological agriculture. On the other hand, the Adriatic zone, although only 520 km long in a straight line, has, due to a large number of islands (total 1,180 islands and rocks) and highly indented coast, the total length of 5,790 km. Adding to this the low population density (less than I million), well afforested coast, a large number of clean gravel beaches, clear sea with large forests and karst vegetation in the immediate vicinity, strong future development of tourism seems to be beyond any doubt.

2.2 FLOOD CONTROL AND EROSION PROTECTION

• The Sava River Basin (Zageb)	24,283	sq.km
• The Drava and Danube Basin (Osijek)	9,657	sq.km
• The Istrian & Littoral Water Basin (Rijeka)	9,840	sq.km
• The Dalmatian Water Basin (Split)	12,548	sq.km
	56,538	sq.km

Out of the total area of lowland parts of the country (about 1.79 million hectares), flood protection systems are required on 486 thousand ha; so far, the completely protected area comprises about 276 thousand ha, while on the remaining area the flood control systems have to be built or rebuilt. The largest still unprotected or partly protected individual areas are situated in the Gatchment areas of the Sava, Drava, and Danube rivers. The prevailing flood protection method is construction of dikes, and recently also relief canals and flood storage' have been used as well. In future, larger participation of flood storages and non-structural measures in solving these problems may be expected.

2.3 AVAILABLE WATER RESOURCES AND FUTURE NEEDS

Generally speaking, the Republic of Croatia is very rich in water, and in this respect it belongs to the very top among the European countries. The average annual rainfall varies, depending on the area, from 650 to 3,500 mm, with a general average for the whole country of 1,088 mm per annum.

The annual amount of rainfall water in Croatia is 61.55 cu.km. which is 12,860 ou.m. per capita. Out of this, the total runoff is 41.80 cu.km, which results in the average specific runoff of 23.4 l/s/sq.km.

The situation in the water basins is, as follows (in cu.km. per annum)

Water basin	Surface water	Ground water
Sava River Basin	24.22	10.70
Drava & Danube River Basin	7.53	0.56
Istrian - Liftoral Water Basin	2.96	7.57
Dalmatian Water Basin	7.09	11.42
	41.80	30.25

As already mentioned, the Republic of Croatia is very rich in water by European standards, both per unit of area and per capita.

Water consumption for the population, municipal services and industry between 1980 and 1990 was at the level of about 800 million cu.m. per annum. Water consumption for irrigation, with respect to a very small percentage of irrigated area (about 0.3 percent) is practically negligible.

Total water consumption for the population, municipal services and industry was (in million cu.m.):

1985	1990	1991	1992	1993	1994	1995	1996
887	779	600	678	666	661	651	639

The drop of water consumption was the result of reduced normal activities (production) caused by war circumstances and by the transition process.

Waste water from larger urban settlements and industrial plants is disposed into the rivers and the sea, following a treatment process. Minor problems of pollution of the receiving water bodies close to larger cities and industrial centres are still present, but large efforts are made to improve the situation.

The water requirements for long-term development resulting from the existing long-term development plans are shown in Tables (a) and (b):

(a) Water requirements for irrigation (million cu.m)

Region	2025		2050	
	ha	million cu.m	ha	million cu.m
Sava	50,000	151.69	170,000	510.75
Drava & Danube	87,000	274.94	280,000	885.81
Istra-Littoral	8,400	32.37	28,000	107.93
Dalmatia	13,650	57.61	36,000	158.38
Total	159,050	516.91	514,000	1,662.87

(b) Total water requirements (million cu.m)

User	2025		2050	
	Million cu.m.	% of runoff*	Million cu.m.	%of runoff*
Domestic	1,000	–	1,525	–
Irrigation	517	–	1,663	–
Total	1,517	3,6	3,188	7,8

* Includes only local runoff (41.80 cu.km.), without transit and ground water

2.4 IRRIGATION AND DRAINAGE SYSTEMS

Construction of drainage amelioration networks in river valleys started in the early years of the century, applying mainly open (surface) drains. The works were, in most cases, carried out parallel with flood protection works or immediately afterwards. Until the early sixties, only open drainage networks were constructed, and after that, almost exclusively only subsoil drainage networks. In the period up to 1985, a large number of earlier surface drainage networks was remodelled into subsoil drainage networks.

The drainage systems constructed until 1990 include :

- completely constructed surface drainage systems on 600,054 ha
- partly constructed surface drainage systems on 518,830 ha
- Subsoil drainage systems on 161,530 ha

In the next planning period it will be necessary to take the measures to complete both the flood protection systems and the systems of internal drainage. Also, efforts should be taken to remodel as many surface drainage systems into subsurface systems as possible, subsoil drainage being the method of the future.

3. PRESENT STATUS OF FOOD

AGRICULTURAL AREA AND LAND USE

The total area of the mainland part of Croatia is 5,653,800 ha, out of which 1,978,000 are forests. The total agricultural area is estimated (1991) to about 3,208,000 ha, out of which arable land is 2,202,000 ha, pastures 1,155,000 ha, and marshes and reeds 33,00 ha. Out of the arable land, ploughland and gardens are 1,466,000 ha, orchards 70,000 ha, vineyards 71,000, and meadows 413,000 ha. For a long period, the statistics in Croatia has recorded a constant reduction of agricultural areas, probably due to construction of infrastructure and abandoning of agriculture.

In the period from 1992 to 1995 the total sown area in Croatia was on the level of about 933,000 ha, which is 28 percent less than in 1991. The reason was occupation of a part of the territory.

The cropping pattern, as a result of food requirements, land tenure and also tradition, is characterized by a high percentage of cereals. In 1995, cereals were sown on 639,000 ha, which is 67.5 percent of the total arable land. Undeveloped livestock farming, reduced number of livestock, in particular during the war, poor breed selection and poor forage technology are the reasons for small percentage of land under forage crops (in 1995, 12.2 percent or about II 5,000 ha). The lowest percentage is that of industrial crops (75,000 ha in 1995).

Large areas in Croatia are uncultivated, in 1995 about 170,000 ha, which is even 15.2 percent of the total ploughland area. Before the war the percentage of uncultivated land was also rather high, although considerably less than at present (on average 9.2 percent in the 1981/91 period).

Agricultural land is divided into state property and private property (family farms). Thus, in 1991, out of the total agricultural land, 2,014,000 ha were private property, with 534,266 farms. The farms are small, which is the basic obstacle for rational use of production potentials. Thus, 201,332 farms are smaller than I ha. The average farm size is 2.94 ha. The average size of state-owned farms is 2,960 ha.

DEVELOPMENT OF AGRICULTURAL LAND

Presentation and description of agroecological zones - agricultural regions in Croatia - shows a high diversity of agricultural soils. In all regions there are considerable areas where the basic constraint for achieving high and stable crop yields is the unfavourable water-air regime, which is reflected as constant of temporary water surplus or shortage. On the other hand, the data on the small size of farms undoubtedly indicate the need to enlarge the farm size. Thus, land development and targeted enlargement of farm size are the key measures in achieving stable agricultural production and food supply.

HYDROTECHNICAL AMELIORATION

Status of land development

The areas belonging to former social farms - combinates - were gathered on one or a few locations, with larger plots, and were mostly drained. However, the areas of family farms are mostly divided into smaller parcels, dislocated and undeveloped. Modern crop farming requires enlargement of parcels and of farms in general.

STATUS OF DRAINAGE OF HYDROMORPHIC SOILS

According to the available data, the area of hydromorphic soils where the fundamental constraint is excessive humidity, which has to be solved by detailed drainage works, is 1,789,070 ha. Until 1990, basic drainage by open drains was carried out on 600,054 ha, or 33.5 percent. On the area of 518,830 ha, or 29 percent, the systems are partly constructed, while on 670,186 ha or 37.5 percent of excessively humid soils there are no drainage systems. It must be mentioned that the situation regarding amelioration works has been deteriorating since 1990. Namely, war operations, former temporary occupation by the enemy (27 percent of the area), uncertainty of land tenure changes and shortage of financial resources are the reasons of stalling of amelioration works.

Detailed subsoil drainage by pipe drains has been carried out only on 161,530 ha, or 19.6 percent, although the analysis of climatic and hydropedological indicates the need for detailed drainage by subsoil pipe drains on the total area of 822,350 ha. So far, pipe drainage was installed on 160,550 ha, or 99.4 percent on the areas belonging to former combinates, and only on 980 ha or 0.6 percent on private family farms. This means that in former combinates out of the total area sown 49.9 percent were drained, while on private farms the drained portion was only 0.1 percent of the total area sown. Since 1991, only 970 ha have been drained in Croatia, which is understandable with regard to the war circumstances.

In Croatia, irrigation systems have been built only on 5,790 ha, which is 0.28 percent of the arable area, or 0.44 percent of the area sown in 1990. In this respect, Croatia is at the very bottom of the European list. Most land is irrigated in the Neretva river valley (2,815 ha), then in the area of Zadar and Biograd (1,845 ha). In Slavonia and Baranja, the irrigated area is 830 ha, in Podravina and Posavina together 240 ha, and in Istria about 60 ha. However, in Croatia there are numerous reasons calling for larger application of irrigation. In Slavonia and Baranja recently even 60 percent of the years were dry. Therefore, conventional crop farming is facing a crisis and has to look for the solution through irrigation. Besides, constant increase of the population (70 - 100 more each day), comparatively low availability of land (only 0.45 ha of arable land per capita) and constant loss of areas due to urban development (daily about 4 ha) are also calling for further development of irrigation to compensate the above problems by increasing the yields. This is in accordance with the ideas in developed countries and statements of international experts: the future of agriculture belongs to genetics and irrigation.

Out of the total of 1,628,000 of ploughland and other cultures in Croatia there are hydropedological, topographic and hydrographic conditions for irrigation on 680,000 ha.

As regards the availability of adequate water for irrigation there are numerous watercourses, local sources with small intakes, as well as existing and potential smaller and large storage reservoirs, as well as ground water. As regards the availability of ground water, attention must be paid to problems of its possible pollution.

AGRICULTURAL PRODUCTION

Agricultural production has been considerably reduced since 1991 as a result of several adverse conditions: (a) reduction of agricultural productive resources caused by war, (b) devastation of the former social sector which, by its capacities and output was an essential part of Croatian agriculture, (c) reduced extent of self-financing (generally poor economic status of agriculture, as well as problems of delayed payment for sales), (d) low level of government support to agriculture, (e) unregulated regime of foreign trade with the neighbouring countries, and (o considerable migrations of agricultural population in the recent years, which reduced the available space for agriculture.

AGRICULTURAL REGIONS AND THEIR PRODUCTION

Croatia is a heterogeneous country with respect to the climatic and pedological characteristics, which is important from the standpoint of management of agricultural resources and enforcing of selective agricultural policy.

The Republic of Croatia is divided into three regions: the Pannonian, the mountain and the Mediterranean region. With regard to the resources and to agricultural production, the most important is the Pannonian region, while the other two regions are important in such types of production which are possible in these regions because of their climatic and pedological properties. In the Mediterranean region, important production is growing of early vegetables and vegetables and flowers in enclosed spaces (greenhouses).

Out of the total agricultural area in Croatia, the largest portion is in the Pannonian region (46.3 percent), a smaller one in the Mediterranean region (34.1 percent), and the smallest in the mountain region (19.6 percent). Climatic conditions determine considerable differences between regions for other categories of agricultural land.

CONSUMPTION OF MINERAL FERTILIZERS AND PROTECTIVE CHEMICALS

The consumption of mineral feritilizers in Croatia has constantly decreased since 1988. namely, in 1988 the consumption of active substance in mineral fertilizers was 172,6 kg/ha, which in 1995 dropped to 93.1 kg/ha.

The law determines that in Croatia protective chemicals cannot be sold nor used without the permission of the Ministry of Agriculture and Forestry based on the analysis of the chemical, physical and biological properties and the approval by the Ministry of Health.

Although nowadays agriculture is mentioned as a potential source of pollution of surface and ground water, due to low consumption of mineral fertilizers and chemicals, in particular on private farms, surface and ground water in Croatia is not seriously loaded from this source. Integrated protection measures and controlled fertilizing may even improve the situation, granting good quality water to the population for a long period in future.

CONSUMPTION OF AGRICULTURAL AND FOOD PRODUCTS

Summary consumption of agricultural and food products on the local market largely determines the level of requirements the requirements for primary products and processed products on the national level.

Self-sufficiency is a relative measure showing to what percentage the production of agricultural products covers the consumption. The war and its consequences, liberalization of the local market of agricultural products and transition from planning to market economy have resulted in the decrease of local production of almost all agricultural products, increasing of imports and of the negative balance of the Croatian foreign trade of agricultural products. The self-sufficiency of the majority of agricultural products has been severely reduced, and Croatia is at present to a certain extent dependent on the imports of large quantities of these products.

The degree of self-sufficiency or covering of consumption by the local production is higher than 100 only for wheat, maize, wines and poultry. On the basis of natural and technological conditions, generally speaking, Croatian agriculture has the possibility to achieve production of strategic product to the level of self-sufficiency and even more than that. Changing of the structure of resource utilization with improvement of the technological level, as well as stimulation measures of the agricultural policy, will make achieving of this goal possible on a longer run.

4. PRESENT STATUS OF RURAL DEVELOPMENT

The economic and social life in the rural areas is very complex, and agriculture is only one segment, although very important, in the development of rural areas. The traditional concept of rural development was used most frequently in connection with the development of agriculture in a broader sense. Recently, the concept of rural development includes also other dimensions of development, which are the prerequisite of improvement of overall quality of life in rural areas.

The rural areas, due to the migration into towns and industrial centers (in the country and abroad) were deprived of the young and most vital part of the population. For almost twenty years the natural population increase of the rural areas is negative, and their age and sex structure is disturbed.

The process of modernization of agricultural production was not followed by adequate development of industrial capacities, crafts, service workshops and other services in the rural areas. The priority was given to industrial development in urban zones, and therefore the villages and agriculture were subject to a strong exodus of labour and population into industry and urban areas. Both the number of farmers and the rural population dropped rapidly, and since the early sixties the number of farms has decreased as well.

Education promotes personal development of the individual, stimulating him to develop fully his intellectual, physical, emotional and spiritual talents. Free education gives everybody on equal chance to develop these talents.

Although the level of education in Croatia has risen considerably since World War 11, both as regards the rural and agricultural population, the differences in comparison with the urban and non-agricultural population have increased. These differences show that so far the development policy has created the educated town and the uneducated village. The educational pattern of rural population has constantly deteriorated, particularly regarding the percentage of persons with secondary school, high school and university education.

FOOD IMPORTS

The potentials and tradition in nutrition of the population of Croatia are the factors economically and culturally influencing the changes of foreign trade of food during the last two decades. Global analysis of commodity and food trade in Croatia going two decades backwards from 1995 (to 1975) shows hat the commodity trade was growing more slowly (increased by 4 times) than food trade (7 times). The average annual portion of food trade in the overall commodity trade in Croatia during the last two decades was 8.4 percent.

In the foreign trade of the Republic of Croatia the importance of food import has grown particularly during the last decade, when the country was exposed to essential changes related to Croatian independence and changed scope of registration of foreign trade, liberalization of the import regime, growth of the private trade network, etc.

The most distinctive change in the structure of food import was import of fruit and vegetables. Its portion was increased to 25 percent of the total import, and its value is USD 129 million.

FOOD SUPPLIERS TO THE CROATIAN MARKET

The two most important groups of countries supplying food to the Croatian market are the countries of the European Union (47.1 percent) and the countries of the former Yugoslavia - Slovenia, Macedonia and Bosnia and Herzegovina (together 14.5 percent). It should be mentioned that from among the other European countries Hungary is an important supplier of food to Croatia (10 percent of the total food import).

Participation of major countries in food import in 1995

No.	Country	Amount, mil.USD	Participation %
1	Italy	71	14.3
2	Slovenia	65	13.1
3	Germany	57	11.5

4	Hungary	50	10.0
5	Austria	39	7.8
6	The Netherlands	25	5.0

The average annual consumption of food products per family member was changed from 1970 to 1990 in Croatia, by reduction of consumption of cereals vegetables and products thereof and increased consumption of meat, fish and products thereof. At the same time, the consumption of milk was reduced as well. Such changes call for serious consideration, not only with regard to changes in the structure of nutrition, but also to the effects on the food market.

Along with stimulation and protection of the local production it is also important to develop the system of consumer protection, so that commercial import and privileged import (government commodity reserves), are not motivated only by the ratio of local standards regarding the quality of food of foreign origin.

FOOD EXPORT IN THE RECENT PERIOD AND ECONOMIC TREND

The total export of the Republic of Croatia and the food export from 1990 to 1996 (January to May) has a variable trend. However, up to 1992, a growing trend of export is noted, and from 1992 to 1994 the trend is failing, as a result of the war. Food export shows minor changes. The participation of food export in the overall export of Croatia from 1980 to May 1996 ranges between 7.5 and 10.4 percent.

Food export from the Republic of Croatia will be strongly influenced by forming of the free customs zone between the Republic of Croatia and the Federation of Bosnia and Herzegovina, normalization of political and economic relations with Serbia, accession of the Republic of Croatia to the CEFTA Association, signing of trade agreements with the European Union, growth of international tourist traffic in the country, and by structural of agriculture under the influence of the world market.

In any case, Croatia will develop as a country open to market relations with all countries of its direct and broader European geographic environment, ready, of course, also for cooperation with the countries of the ‘third world”, with which the exchange of goods is at a very low level, and which should and can be bilaterally improved.

5. FUTURE SCENARIOS AND AIMS

Although the share of agriculture in the domestic product until 2000 will continue to decrease slowly, agriculture in the rural areas will remain the major activity and the backbone of development. It will not be significant only as the place of employment, but also as a source of raw material for small processing plants, tourism, services and manufacturing crafts, intellectual services,etc. which will result in a versatile production structure that will allow full employment of the population, higher income and higher standard of living.

This would actually be the way to transform the present plans for development of underdeveloped areas on the entire territory of the country.

Depending on the incentive policy, at the end of the planning period and maybe even somewhat earlier gradual growth of population in the rural areas should be expected.

In the youth population, transfer in the non agricultural activities will generally stagnate, and in some parts of the country even uncertain increase of the number of the young farmers may be expected (Central Croatia and Slavonia). The measures of land policy should direct the development of agriculture towards highly productive farming. Recent investigations of standpoints and opinions of the rural youth indicate not only an increased interests in living in the village, but also a more positive attitude towards the farmers profession and reputation.

Starting from the socio-demographic trends in the village and agriculture and above assumptions, the share of agricultural population in the total population will continue to decrease.

The share of agricultural in the total population was 10.3 percent. The natural growth of agricultural population in the coming period will be negative.

The basic principle in the strategy of rural development should start from optimum and rational use of the potentials.

Planing of development in rural areas cannot be oriented towards returning to the traditional village, because it has changed, and it's stability, autonomy, social structures and institutions have been disturbed. It is necessary to establish special purpose funds at the national level and pass adequate laws which will ensure implementation of development of the village.

It is necessary to accelerate investments in municipal and tourist infrastructure, in particular in telecommunication and informatics, in order to make the economic and technical information available and to establish the connections between the rural areas and centres of economic and cultural life.

It is a notorious fact that in many rural areas there is not a sufficient number of schools, and the education programs are not suited to their requirements either. Therefore with regard to the importance of education and professional training in development of rural areas, educational activities should be suited to the specific needs, and educational infrastructure should be established which will allow implementation of the set objectives.

Problems of the village must be paid a greater attention in the general policy, in order to provide support to the development of rural areas, and in general, revitalizing of the village.

6. CHALLENGES FOR THE FUTURE SUSTAINABLE AGRICULTURE

As the world population is constantly growing, it is estimated that the present generation will face the task to produce, in the next fifty years, he quantity of food equal that produced in the past 8000 years of human history.

There can be no illusion that this task is possible to fulfil without serious increase of production per unit of area, because the possibilities of increasing productive areas are very limited.

At it's historical crossroad, the economic recovery and development in Croatia intends to be based on the modern concept of sustainable development, founded on agriculture and tourism as the economic activities relying on renewable natural resources. Such "pro ecological" orientation requires some changes and adjustment, in particular changes aiming at protection of natural resources of great importance to agriculture, first of all soil and water, and a certain kind of 'alliance" of the practised methods and the nature. In other words, increasing of yields per units of area, or production per unit of capacity, requires as a precondition the application of modern, corrected solution in crop farming.

IMPORTANCE OF BIOTECHNOLOGY

The requirements for traditional food from primary production and growth of ecological awareness of the population in our country lead, beyond any doubt, to the conclusion that the issue of biotechnological procedures which have already been developed to a considerable degree in the world, will require a strategic decision of the Croatian Government on the development of technology in general, and in particular, of biotechnology of land as permanent and inalienable national resource.

IMPORTANCE OF IRRIGATION

In the country, considerably larger investments in irrigation than at resent are justified. For more rapid development of irrigation, it is first necessary to change the present attitude. In past the still prevailing opinion about irrigation, it is first necessary to change the present attitude. In pact, the still prevailing opinion about irrigation in the country is that irrigation is means to fight the drought. As in the past drought used to occur periodically, and mostly rather rarely (on average every 3 to 4 years), this had influenced the belief and opinion which resulted in constant postponing of beginning of major investments in irrigation. Besides, in former production a rather narrow crop rotation and cropping pattern was applied, including only several basic crops. Thus there was, and there still is, the conventional “dry farming” agriculture with one sowing of crops which may mainly do without irrigation. This phenomenon is described as “psychological barrier’.

Earlier crop production on former state farms was loaded by large quantities of mineral fertilizers, pesticides, and heavy machinery. The effects of such technology are smaller humus content in soil, deteriorated texture, compacted soil, pollution and degradation of biological and productive properties of soil. Thus the soil and the environment were neglected.

In such circumstances and in accordance with the processes in the world, our country also adopts the idea of organic biological production and development of sustainable agriculture, n which context irrigation gets it’s proper place.

In irrigation conditions the farms will apply mixed crop-livestock-vegetable farming. A wider cropping pattern will be applied with plant crops, forage, industrial and vegetable crops in regular and stubble sowing. Two harvests on our fields are the dream of every farmer. However, this is possible to achieve only with irrigation and proper use of water and soil. Modern technology-irrigated agriculture uses water very rationally to intensify the production, and takes care of all natural resources of the environment and of the social surroundings. Accordingly, this gives more opportunity to livestock farming which provides manure and helps to maintain favourable physical, chemical and biological soil properties and allows the irrigation potentials to reach their full scale. Thus unlike the former agricultural practice in our country where crop production was separated from livestock farming (on former state farms-family farms were mainly small and unable to change anything),on future farms with mixed production there will be a close connection(symbiosis) of crop and livestock farming which will allow proper land use and rational application of irrigation and other agrotechnical measures.

At present, our crop farmers are more interested in growing of crops requiring more modern technologies and irrigation. New production of vegetables, fruits and ploughland crops are starting, with irrigation, towards production of ecologically clean food.

AGRICULTURE, TOURISM AND FAMILY FARMS

Determination of Croatia to found the development of agriculture on village family farms is a qualitatively different approach and departure from the former practice, which lasted for several decades. However to achieve this, t is necessary to provide the conditions allowing the village family farm to take over the role that is meant for it. It is necessary to make the diagnosis of the status of family farms in separate regions in order to find the permanent motive for agriculture. It is important to investigate the life cycle of the family farm, because the existence of the critical mass in various stages of life is essential for development of agriculture.

The family farm must be trained to operate in accordance with the criteria and requirements of the world market. the agricultural system based on family farms must be dynamic, flexible, innovative with constant tendency to improve the competitiveness, with rational use of space, protection of the environment, autochthonous natural, cultural and historical values, and reducing status and material differences between the agricultural and other populations in Croatia.

In the vicinity of tourists areas family farms should be stimulated to develop as mixed households according to the sources of income. Combining the work and employment of family members in tourism and agriculture will make them more flexible as economic units and allow them to gain maximum benefits. Orientation towards family farms also helps the development of various forms of tourism: agrotourism, rural, health, nautical, and others.

This approach to development will be maintained by the population in a given area, with better solving of social and other problems.

CZECH REPUBLIC

SUMMARY

The Czech republic is an economically and culturally developed state in central Europe (48° to 51° N, 12° to 19° E) with a thousand-year-lasting cultural tradition of which an indispensable component are attitudes towards the environment. The country has 10.3 million inhabitants and extends over 7.887 million hectares of total area. From this, forest covers 2.630 million hectares and agricultural land 4.281 million hectares (of which 3.143 million hectares is ploughed land). Czech agriculture is capable of feeding the country and its water sources are sufficient to provide water for agriculture.

Czech economy has been undergoing, since 1990, an essential transformation towards market economy. This process affects both the agriculture and the water management. Some serious economic and legal problems of these two sectors still remain unsolved. One of such problems is the persisting division of competences, related to these sectors, among two, three or even more different ministries, in particular, the Ministry of Agriculture, the Ministry of Environment and the Ministry for Regional Development. While the Ministry of Agriculture oversees the agricultural and forest production and the exploitation of land and water resources, the Ministry of Environment administers the protection of land, water and forest resources and the Ministry for Regional Development cares for the rural development.

There exist, at the moment, several outlines of future agricultural and water management policies of the country, differing mainly in how they treat the role of the state and how they solve the trade off between social, environmental and market aspects. A factor which is assumed to eventually decide is the expected full accession of the country to the European Union after 2005.

1. OVERVIEW

The Czech Republic is a democratic state based on market economy. Basic macroeconomic data are given in Table 1. The principles of country's macroeconomic policy are normally established in Government's programs and consequently specified by the annual state budgets which are enforced as laws. Sectorial balances, prognoses of development and policy concepts in agriculture (including food industry), water management, environment and rural development are prepared regularly (usually every year). These are then applied in specific projects. Specific policies and scenarios are discussed in greater detail in para 5.

Table 1. Basic macroeconomic data about the Czech Republic in 1997

Characteristic	Value	Unit
Population	10.3	million
Gross domestic product in current prices	1649.5	billion CZK
Per capita GDP	about 5000	USD/year
Share of investments in GDP	30.7	%
Contribution of agriculture to GDP	2.1	%
Contribution of agriculture and food industry to GDP	7.0	%
State budget expenses	524.7	billion CZK
Balance of foreign trade	-140.8	billion CZK
Annual rate of inflation related to the previous year	8,5	%
Unemployment	5.2	%
Exchange rate of CZK to DEM	18.3	CZK/DEM

2. PRESENT SITUATION IN WATER MANAGEMENT

The Czech Republic is an important water divide between basins of three large European rivers (Elbe, Oder and Danube) flowing to three different seas (North, Baltic and Black). The country has 15.3 thousand km of water streams which are categorised as significant for water management. An overview of water resources of the country is given in Table 2. The water resources of the country are mainly recharged by atmospheric precipitation (the long-term annual average is 693 mm) and are therefore regarded as relatively uncertain. Exploitable resources make 30 to 50% of the total resources. The annual precipitation moderately exceeds the annual evapotranspiration (the long-term annual average is 500 mm). The averal annual inflow of water from other countries is only 9 mm while the average annual outflow to other countries is 203 mm.

Table 2. Overview of water balance the Czech Republic

Water balance item	Average annual value (mm)
Precipitation	693 mm
Evapotranspiration	499 mm
Outflow	203 mm
Inflow	9 mm

On an average, the reliable sources of surface water amount to 4796 million m^3/year while the exploitable groundwater sources can give 1339 m^3/year. After the increase of prices and the restructuring of industrial and agricultural production between 1990 and 1997 there was a significant decrease of water consumption. The specific water consumption of households is now by about 10% below, the average of EU. The sectorial breakdown of water consumption in 1997 is given in Table 4. It follows from it that the water consumption in agriculture (including irrigation) only represents about 1% of the total water consumption.

Table 3. Overview of water resources of the Czech Republic

Internally renewable water resources:		194 mm/year
Potentially utilisable water resources:		about 89 mm/year
		i.e. 7 billion m^3/year
		or 680 m^3/capita/year
From this :	developed:	3.4 billion m^3/year
		330 m^3/capita/year
	potentially developable:	3.6 billion m^3/year
		350 m^3/capita/year

Table 4. Sectorial breakdown of water consumption in the Czech Republic in 1997

Sector	Surface water consumption		Groundwater consumption	
	thousand m^3	%	thousand m^3	%
Public water supplies	500 860.9	26.3	414 609.3	88.9
Power plants	854 361.8	44.8	1742.7	0.4
Industry	532 103.3	27.9	38 168.8	8.2
Agriculture	13 548.6	0.7	5 920.8	1.2
Other	5 189.7	0.3	6 035.0	1.3
Total	1 906 064.3	100.0	466 476.6	100.0

Therefore, there is no overall shortage of water for agriculture. However, water for agriculture, especially for irrigation, may be in short supply in some locations during prolonged drought spells which come quite irregularly during the growing season. Then a supplementary irrigation is needed (but is not always economical). The growing season in most climatic regions of the country extends from April to October. Except for some intensive vegetable-growing regions, only one main crop can be grown over a one-year period, while the rest of the season is frequently used for growing catch crops (mainly green fodder crops).

The main mission of the water management sector in the Czech Republic is the sustainable use of water resources and the prevention of damages which could be caused by water surplus or shortage. This means, in particular :

- general care of surface water and groundwater resources and maintenance of water streams,
- protection of the sources of drinking water supply,
- mitigation of impact of floods and droughts,
- protection of natural water ecosystems,
- control and improvement of the soil water regime (e.g. through irrigation and drainage).

Central responsibilities within the water management sector are with the Ministry of Agriculture (which is a central authority for water management) and the Ministry of Environment (which is a central authority for water resources protection). Since 1990, several transformation steps took place, aiming at the change of the previous water management system and taking into account the actual prices of goods and services, actual ownership rights and new legislation. In 1998, a partial amendment of the existing Water Act, dealing with the protection zones and measures against water pollution, was adopted. What remains is mainly to pass the new Water Act and the Water Supply and Sanitation Act and to improve the water protection legislation. A special institution must be created to co-ordinate various uses of water and to provide services for management of the catchments. An efficient system of compensations for the “production of public goods” (i.e., the maintenance of the environment - including the hydrosphere - and the landscape) must also be elaborated. Both the Ministry of Agriculture and the Ministry of Environment submitted their own proposals for new legislation.

Water administrators, designated by law, administer at present 93% of the total river network. There are 7 river administrators in the country, namely five River Board companies (for the basins of Labe = Elbe, Vltava = Moldau, Ohre = Eger, Morava and Odra = Oder), the State Land Reclamation Authority and the Forests of the Czech Republic (a state entreprise). In a brief overview, water and water structures in the Czech Republic are owned as follows :

- small streams, groundwater storage, main drainage structures and some main irrigation structures are owned by the state
- large and medium streams, boundary streams and water structures in streams are owned by the River Boards, which are, at present, joint-stock companies of which 100% of shares is held by the state
- water supply schemes, sewerage schemes and communal wastewater treatments plants are owned by communities (towns, villages), either directly or indirectly through joint-stock companies
- water management structures and networks situated in or attached to manufacturing plants are private property; the same applies to fishponds, small and pumped-storage hydropower plants and many irrigation schemes and structures.

The problems of ownership of some other items, like, e.g.:

- water in the natural environment
- streambeds
- some irrigation schemes and most drainage schemes
- remain unresolved. New legislation is being prepared to solve these problems and to improve the system of overall water management administration. The Land Fund of the Czech Republic has already privatised 2/3 of the total number of main irrigation systems. Transformation of ownership of main drainage facilities is also envisaged.

There are 91 large reservoirs in the country, with the total manageable volume of over 1 million m^3 (not including large fishponds). During the 1997 floods, the water reservoirs reduced maximum flows by 10 to 25%. Practically all towns above 5000 inhabitants have been provided with wastewater treatment plants. The percentage of treated wastewater, out of the total wastewater collected by public sewerage systems, is 90.9%. Water quality in streams has improved (in comparison with 1991). Ever since 1990 the release of liquid wastes into streams has been decreasing and the number of wastewater treatment plants has been increasing. The problem of eutrophication of surface water bodies due to diffuse sources persists. The main pollutants are mineral oil substances and industrial chemicals. The quality of water in fishponds and other small surface reservoirs remains unsatisfactory. The quality of groundwater from shallow aquifers is, often, also unsatisfactory due to high contents of nitrite, nitrate, ammonia, sulphate and total oxidisable matter.

The care of the water regime in the landscape was not satisfactory over past decades. The maintenance of fishponds and other small reservoirs was neglected, while some streambed fortifications made in this period were ecologically inappropriate. The water retention capacity of the landscape and its biodiversity were impaired. Therefore, a programme of revitalisation of rivers systems was launched, aiming at restoration of the natural character of the landscape.

3. PRESENT SITUATION IN FOOD PRODUCTION

In 1996, the Czech Republic had 4.281 million hectares of agricultural lands and 2.630 million hectares of forest land. The agricultural lands consisted (in 1996) of 3.143 million hectares of ploughed lands, 0.902 million hectares of perennial grasslands (meadows and pastures) and 0.236 million hectares of gardens, vineyards, hop gardens and orchards. 0.026 million hectares of land has been devastated, mainly due to open-cast coal mining, and is gradually being reclaimed. 0.159 million hectares are open water bodies. Per capita, the Czech Republic has 0.76 hectare of total land (of this, 0.42 hectare of agricultural land, of which 0.31 hectare is ploughed land) and 0.25 ha of forest land. The share of ploughed land in agricultural land (73.4%) is one of the highest in Europe. The existing supplementary irrigation system can provide water to 0.153 million hectares (3.6% of the total agricultural land), while the extent of drainage is 1.087 million hectares (25.4% of the total agricultural land). The drainage systems have been mainly built as underground tile or plastic drains discharged into surface drainage canals or large-diameter underground pipes. Once built, these drainage systems act spontaneously due to gravity. Their maintenance was largely neglected over the last decade. On the other hand, the exploitation of irrigation systems, which in the Czech Republic have been almost exclusively built as pressurised underground pipelines supplying water to sprinklers (travelling guns, centre pivot or linear move systems), require additional effort and expenditures. At present, only about 15 to 30% (varying according to actual weather) of the capacity of existing irrigation schemes is being exploited. Practically 100% of water for irrigation is taken from surface sources. Groundwater is only used for irrigation of small gardens and orchards. Microirrigation is used on about 0.8% of the potentially irrigable area, while gravity irrigation only covers about 0.5% of this area. The rest is under sprinkler irrigation. The global irrigation efficiency is estimated as 80%. Virtually no land in the country is affected by salinity or alkalinity. About 50% of agricultural land is exposed to a significant erosion risk.

The agricultural land of the country has been categorised according to the prevailing agricultural crops grown as follows :

- grain-growing region (41% of the total agricultural land)
- sugar-beet-growing region (24%)
- potato-growing region (18%)
- fodder-growing region (10%)
- maize-growing region (7%)

The main agricultural crops grown in the country are :

GRAINS

Main cereals grown are wheat, barley, oats, rye and maize. The structure of production in 1997 was as follows: winter wheat 46%, spring wheat 4%, spring barley 29%, winter barley 9%, oats 5%, rye 4%, maize 2%, other 1%. The average yield of cereals in 1997 was 4.14 $t.ha^{-1}$. The Czech Republic is capable of covering its consumption of all basic crop products, while the export and import of these products are, on the long-term scale, balanced. However, the production of grains may be further reduced in future if the export of grains encounters more obstacles than now. This may lead to a further overall reduction of agricultural production and, as a consequence, to the necessity of alternative use of agricultural land.

As for future development of the food production sector, one expects a higher support to the production of oil crops and to local fruit and vegetable growers, an improvement of the quality of potatoes and the enlargement of capacities for processing sugar beet. The increase of domestic consumption (e.g. of dairy products) would assist in stabilising the market. The way out for beef production lies in specialised breeds and in the increase of productivity. The pork production depends to some extent on the increase of export. The poultry production is expected to rise in accordance with world trends.

4. PRESENT SITUATION IN RURAL DEVELOPMENT

The countryside is an essential component of the living space for most people in the Czech Republic. Even the inhabitants of towns and cities spend a part of their lives in the country. The Czech countryside arose as a synthesis of natural factors with man’s effort, exerted over centuries, to cultivate the landscape. It is intimately associated with agriculture, forestry and water management and, therefore, its present state reflects the problems which these sectors have to face. The overall reduction of agricultural production and its (very common) unprofitability resulted in deterioration of socio-economic conditions of rural population. The present recession, experienced by all sectors of country’s economy, contributed to the decline in extent and quality of infrastructure. This altogether leads to poorer accessibility of basic services, public transport, health care and culture for inhabitants of the countryside and to a general decrease of their living standard in comparison with the period before 1990. It is more difficult for inhabitants of villages to find jobs than for town dwellers, which results in gradual migration of educated and skilled people from villages into towns and cities.

It is the policy of the government to compensate for these unfavourable processes and to take care of the regional development of which the development of countryside is an indispensable part. Since 1996, this policy is implemented and guaranteed by a separate ministry, the Ministry for Regional Development, which, in addition to launching and executing its own development programmes, also co-ordinates regional activities of other ministries and other subjects. Among the development programmes, on must mention the “Countryside Renewal Programme” which is focused on restoration of social, cultural and economic life of the countryside as well as on the protection of the nature and the landscape. Preferential support has been given, within this programme, to small village communities below 2000 inhabitants (94.4% of the total expenditures).

The rural development is also directly or indirectly supported by “The care of the Landscape” programme, subsidised by the Ministry of Environment, the “Programme of Revitalisation of Streams” (under Ministry of Agriculture), and a programme of air quality improvement, of which an important component is providing natural gas supply to small towns and villages.

The agriculture continues to play an essential role in the life of the countryside. Agricultural enterprises in the Czech Republic have recently undergone a differentiation, generated by different natural conditions. According to the criteria which are in accordance with those adopted by EU, 19 districts were identified as those in which agriculture has serious problems. Even in these and similar districts the agriculture is deemed to be an unreplaceable agent of landscape maintenance. The agricultural policy of the state, bearing this fact in mind, tries to support this function of agriculture by legislation as well as by economic tools.

However, it is particularly in the sector of water management that the existing legislation reveals gaps and deficits. The country still expects its new Water Act which is hoped to reflect in a holistic manner the changes having occurred after 1989. A positive news is that the corresponding bill has already been elaborated and submitted for approval. The division of competences among various ministries and other authorities is, however, ambiguous and unstable.

Comprehensive land use planning and land consolidation projects, after several years of theorising are now being put in practice and are expected to become a good tool for creation, protection and conservation of the landscape. Among other effects, these projects are seen as ways of gradual implementation of the (already elaborated but not yet put in practice) studies on the Local Systems of Ecological Stability.

5. FUTURE SCENARIOS AND OBJECTIVES

In future, the basic character and parameters of the present Czech agricultural policy are deemed to remain in force. The existing system of socially and environmentally motivated subsidies is assumed to expand further. In principle. However, the future Czech agricultural policy depends on the results of further negotiations about country's accession to EU. Four model scenarios, described below, have been formulated as a framework within which the actual future policy can oscillate:

SCENARIO A – SURPLUS PRODUCTION

The available sources are fully exploited for production. The plant production is intensive everywhere. The surplus production is exported. The prices are subsidised (to support the production and on social grounds). This scenario portrays a situation similar to the actual state in recent years and bears a risk that the surplus production will become unmarketable. The integration into EU will be difficult.

SCENARIO B – AGRICULTURE CAPABLE OF COMPETITION

The efficiency of production is improved. The agricultural land is differentiated according to its productivity. Some land is set aside as unproductive or the land use is changed towards a less intensive type (e.g., the ploughed land is converted into grassland or afforested). The state does not interfere in market processes but offers alternative programmes for regions in which the intensive agriculture is not feasible but the environment and the landscape have to be cared for. The risk lies in abandoning and neglecting less productive lands, social difficulties and insufficient landscape maintenance.

SCENARIO C – LANDSCAPE AND COUNTRYSIDE

The domestic demand for agricultural produce is fully saturated. The disadvantaged regions focus on "ecological" agricultural production or on maintenance of the environment and the landscape. The state offers an extensive "safety net" for producers of various commodities and provides funding for the landscape and environment maintenance. The traditional appearance of the countryside has been preserved or restored. This scenario resembles the present actual state. An optimum re-allocation of agricultural production is difficult to achieve and overproduction can easily occur.

SCENARIO D – WATER

The main objective of agricultural activities is the production of clean water for domestic and foreign users and the retention of water in the landscape. Good quality of water on the Czech territory has a favourable effect on the water quality in neighbouring countries. The country is better prepared to face the expected global climate change. The effects, i.e., the clean water and the water retained in the landscape, are treated as goods which must be paid for. This is mainly achieved through extensification programmes, enjoined regimes of farming and investments into enhancement of the landscape retention capacity, all applied on a large scale. This scenario requires that the agricultural policy is carefully co-ordinated with the water management policy. There is a risk of food underproduction and/or insufficient food safety of the country in potential crisis situations.

For future, several alternative scenarios of water management can be considered. They are all market-economy based but a certain level of state's authority over water as a natural resource and as a component of the environment is preserved in all of them. The extent of the participation of the state and, on the other hand, the extent to which the responsibility for water resources and for the environment is to be imposed on private owners, are the points in which the particular scenarios differ.

The most realistic scenario seems to be the one assuming a medium extent of state participation which should ensure that public interests are observed, while some responsibility and initiative is left with the private sector. The development of individual regions is, in this scenario, co-ordinated centrally. Permanent effort will be required to harmonise partial interests and to overcome the unwillingness of private owners to carry the burden imposed on them. One can also formulate a separate soil policy. The problems not yet fully resolved are the adequate land evaluation, the rational exploitation of the soil, its protection, the optimum land use in less fertile regions and the defence of public interests whenever the land is handled with. The long-term policy objective is to conserve and protect the soil as a natural resource, as a basic factor for food production and as a component of the environment which fulfils several ecological functions. The most realistic soil policy for future is probably the one based on a compromise between the liberal and the conservationist approaches such that some state control of the land is preserved. This scenario also implies that about 80% of the agricultural land is used for intensive agriculture (while on about one half of this area the farmers are compensated for the limitation imposed on them for the sake of protection of natural resources), 12 to 13% are exploited extensively and the remaining 7 to 8% are set aside. It is also assumed that land owners are compensated for the loss they incur in a public interest.

As for future scenarios of rural development, they are to a high degree predetermined by the corresponding agricultural policy scenarios but additional social and regional aspects must also be considered.

The environmental module of the future agricultural policy will apparently be based on the requirement that a sustainable development (in the sector of agriculture) is reached within 5 to 15 years.

6. CHALLENGES OF FUTURE

In the very near future, the development of Czech agriculture, food industry, water management and other related sectors will be marked by intensive preparations for the accession of the country to EU. The agriculture and food belong in this respect to most difficult sectors, particularly because of the Common Agricultural Policy of EU which creates a preferential environment for farmers in member countries. On a long-term horizon, the Czech agricultural policy (and other related policies) will apparently develop within the framework of the EU common policies and is therefore difficult to predict on the national level. Nevertheless, some elements of the scenarios listed above will almost certainly be included, taking into account Czech traditions and the opinions presently prevailing in the Czech society. Having formulated future policies as alternative scenarios renders more options to future decision makers.

The end vision is a stable agrarian sector which fulfils all its productive and non-productive functions and is at the same time capable of competition on the EU market. The comparative advantages, arisen historically or following from the country's geographic position and social structure, will be fully used and the state of the environment will be gradually improving. The market will be liberal but a "safety net" will be established according to EU rules. This will be, in principle, a continuation of the already existing agricultural policy, except that the (reformed) Common Agricultural Policy of EU will be put into force. The sectors of water management, soil management, forestry, environment and regional and rural development will be strongly influenced by the agricultural policy, but non-production functions and public interests will be more accentuated in them than in the agricultural policy itself. The geographic location of the country will make it possible to influence positively the water supply and water quality in neighbouring countries.

DOMINICAN REPUBLIC

The Water and Irrigation Sector

1. Agriculture and Socio – Economic Factors

1.1 Economy

The economy of Dominica is shifting from an agriculturally based one to a diversified one where services and tourism have a wide role. The contribution of agriculture to the gross domestic product (GDP) has been declining since 1962 when it represented 32% of our production, to only 12.66% in 1995. The total value of agriculture in 1997 was 12.36 %. Of this, 43.92 % was for livestock, fisheries and forestry, the remainder for crop production which, in 1997, was 6.93 % of the total GDP and had a monetary value of U.S. \$1,196x10^9 at current prices. Other sectors are increasing their share in the GDP (commerce and tourism,19.87 %; manufacturing,17 %; services 20.13 %) reflecting a declining proportional contribution of farming to the economy. The decrease in agricultural production can be attributed to a relative increase of other sectors and the policies and incentives to motivate growth in those sectors.

The growth rate of production in agriculture (3.4 % in 1997) is not considered to be sufficient to cope with Dominica's population growth. Agriculture, however, maintains an important role in our exports and labor. Irrigated agriculture contributes to this with nearly half of the total production. There is a record increase of production on irrigated land, but it is related more to an expansion in area rather than to a marked rise in productivity.

1.2 Social aspects

The population of Dominica is approximately 8x10^6 with a density varying from 21 people/km^2 in one of the most remote provinces to 1.4x10^3 people/km^2 in the densely populated province (8.2x10^3 people/km^2

in the capital city). The average national population density is 165 people/km^2. The rural population has decreased to 40 % from the total. Poverty is reported as 52% of families and the literacy rate is reported to be 82.1 %.

1.3 Food Demand

Demand for calories and protein in our diet is valued as 2,323 cal/day. The total national requirement for food is $3.55x10^6$ tons/year. Actual production is only $1.82x10^6$ tons/year which represents 51.26 % of our present requirements. We are clearly unable to produce all we need to eat, thus we need to import food to satisfy an unmet demand. Projections for the year 2015 are that our food requirement will increase to $4.8x10^6$ tons/year.

2 Physical Factors

2.1 Soils and Vegetation

Of the total land area, 13 % of our soils have been classified as Class I to III ($6.3042x10^5$ ha). To this can be added 7 % for marginal land where agriculture can be practiced with limitations. Thus the total land fit for cultivation is $6.48x10^5$ ha. The land area adapted for forests has been estimated as 52.7%. Land for the support of wild life is estimated at 2.5 % and fragile ecosystems occupy 0.50% of the total land area.

Regarding land use, the extent of our land covered by forests is 14%. Dry forest lands at 16.68 % of the land area is a good indication of the significant portion of our dry area. Pastures (grazing lands) have 28.44 % of the total, while agriculture occupies 26.7% ($1.2883x10^7$ ha). Rainfed agriculture accounts for 80.28 % of this while irrigation is practised on $2.54x10^6$ ha (19.72 %). There are use conflicts and deforestation is estimated to be progressing at the rate of $4x10^4$ ha/year.

The rate of erosion is creating concern in the upper basins. Values as high as 507 tons/ha have been measured in some critical areas. Other problems encountered with soils are related to salinisation and waterlogging due to over irrigation. Degradation of agricultural land is growing at a rate of 300 ha/year.

3 Water Resources

Mean annual precipitation for the country is about $1.5x10^2$ mm; with more arid zones receiving as little as $5x10^2$ mm/year, and more humid areas an average of $2.5x10^3$ mm/year. Evapotranspiration is over $2x10^3$ mm/year. Total runoff has been estimated in the order of $2.1x10^9$ m^3/year. Some areas are showing signs of a future water deficit and may shortly be under stress. Our largest basin has a catchment area of $6.8944x10^3$ km^2 (Yaque del Norte River) and we share a basin with Haiti (Artibonito) larger than $8x10^3$ k^2 with $2.3138x10^3$ k^2 on the Dominican side.

Ground water has a potential of $1.5x10^9$ m^3/year, but less than a third of this is being extracted. Water for irrigation is supplied partly (13 %) by underground sources.

Water demand for irrigation is $7.34041x10^9$ m^3/year which is 82 % of the total demand ($8.89145x10^9$ m^3/year). Water demand for municipalities is $9.1188x10^8$ m^3/year (10.45 % of the total used). Reuse of water for agriculture is reported to be about $1.49x10^8$ m^3/year.

Water supply systems serve 62 % of the population, while sewage systems cover only 30 % of our residents. Hydropower generation is about 16.7 % of the total annual energy generation in the country (1997).

3.1 Irrigation

A total area of $2.66427x10^5$ ha is served by our irrigation systems, almost completely by gravity for surface irrigation. This is about half the land adaptable for irrigation ($5.5x10^5$ ha). The existing infrastructure is composed of $1.836x10^3$ km of main canals, $1.773x10^3$ km of secondary canals, $1.2x10^3$

km of drainage canals and 14 major dams (of more than $1x10^6$ m^3 storage capacity) for the regulation of river flows and with a domain over 55 % of the irrigated area. The total storage capacity is $1.5x10^8$ m^3. Actual delivery is approximately $4.6x10^9$ m^3. Presently there are 76,072 farmers using water.

The annual investment in the irrigation subsector is in the order of U.S. \$$1.9x10^8$. As much as 80 % of the budget is spent on projects. Many are not really new infrastructures but the rebuilding of deteriorated systems. The Institute National de Recursos Hidraulicos (INDRHI) is the government agency responsible for the planning, design and operation of irrigation systems and the authority on water resources. It is the leading institution in the water sector and has the chair of the National Water Commission.

3.2 Retrospective Evaluation

The development of irrigation may be analyzed in three distinct stages. The first stage is the construction of irrigation schemes (canals). The Irrigation Service was established within the Ministry of Agriculture in 1932 and this was the starting date for this stage, although some canals existed before 1900.

The second stage is the era of dam construction. In the period 1970 to 2000, 18 dams have been built, one new dam will be commissioned soon (its irrigation area is $1.875x10^4$ ha) and further identified sites and studies will add about 20 more projects. Finding new suitable sites and financing new projects is becoming more difficult.

The third stage is organizing water users. This process started in 1986. To date, 10 main Irrigation Boards (IB), have been formed. They are composed of many water user associations (WUA), with a membership of about $3x10^4$ users. INDRHI is releasing responsibility in the management, maintenance and operation of irrigation systems. A gradual decentralizing policy of government responsibilities is transferring authority to the IBs to collect fees and to operate and maintain the irrigation systems. Their development shows real signs of growth and impressive results in the quality of their organization and the services they offer to members. Among the many advantages and happy results of this process are: reduced conflicts between the authority and water users, better service, minimum flow gate delinquency; and a higher collection of fee (an increase from 20% of total charges, when managed by INDRHI, to almost 80 % on their own). They also have a better attitude to adjustments in the water tariff.

3.3 Present Needs and Problems

Needs in the irrigation subsector are related to improving efficiency, productivity and organizational aspects of irrigation systems. Solutions are sought in the use of better technology, efficient operation and adequate means of financial support. Poor maintenance of existing infrastructures and the irrational use of water are causes for the low (overall) irrigation efficiency (25 %). Specific areas of concern can be pinpointed as follows :

a. Budgetary constrains : Annual fees for irrigation services are low (varies from U.S. \$4.75/ha in some regions to U.S. \$24/ha for farmers with less than 10 ha who are not cultivating rice). Water costs for a farmer only represent 0.21 to 0.58 % of total his production costs. Operation and Maintenance expenditure in INDRHI's Irrigation Districts for 1997 was U.S. \$$6.24x10^6$ (average U.S. \$35/ha) while returns (income from water fees) was only 13.8 % of this vamount. Water fees are obviously too low to meet maintenance and operation requirements.

b. Poor maintenance programs resulting from budgetary constraints and other organizational factors.

c. Use of inadequate agricultural technology.

d. Low efficiency at the farm level.

e. Lack of water control and measuring structures in canals.

f. Poor irrigation programming resulting in the waste of water: Supply of water is not based on actual crop needs and there is a permanent, total flow operation for main canals and laterals. Large volumes of water are lost to drains at night.

g. Design and construction of incomplete systems, giving little attention to minor distribution and on-farm development.

h. Poorly developed agricultural plans and crop patterns which are not based on an analysis of crop demand and water availability or market opportunities.

i. Insufficient drainage infrastructure. Only $9.6x10^4$ ha, 36 % of the irrigated area, have an adequate drainage system.

j. Lack of reliable data.

k. Weak research and extension services

l. Low cropping intensity and productivity.

m. Reduced financial options for farmers: A state owned agricultural development bank (Banco Agricola) provides credit for farming, but is not performing well (low loan recovery). The private commercial banks have gained space in the financial market with a bit more than half the loans to the sector, but at higher interest rates. In 1998 Banco Agricola loaned U.S. $\$1.52x10^8$ to 76,418 farmers working on $1.31x10^5$ ha. "In spite of this, the total credit rendered to farming decreased from 12 % of the total loans from the financial system in 1990, to 8.4 % in 1996. This situation is not proportional to the contribution the sector makes to the GDP."[i]

n. Land tenure: small scale farmers have great difficulty in proving clear legal title to their land. Occupancy without clear title is quite common. This is a limitation to the development of irrigation because farmers are not able to exercise all the rights over the land and are not take loans from banks. Small land holdings are another problem which restrict efficient and/or economic exploitation of land resources.

o. Commercialization problems: Farmers a have limited ability and little knowledge of market mechanisms and price fluctuations to guarantee sales

3.4 Present Policy and programs

The government is reducing its presence and role as provider of services and consequently reducing its fiscal load to run the low return and non-profitable services. The energy sector has been recently opened to private capital and the same is expected to take place with other services (water supply) and "public" utilities. INDRHI is implementing and reducing its management functions in the water sector. State policy calls for transferring its responsibility and power to WUA. This will allow INDRHI to become more efficient in managing the systems at the basin level rather than handling small systems. The main aspects of this policy is being implemented by INDRHI and is oriented towards the following:

a. Improve water resource management by the Irrigation Boards and the irrigation districts.

b. Training field staff in the techniques of modern management and operation.

c. Increase irrigation efficiency.

d. Institutional analysis and revision of the legal framework in the irrigation sector.

e. Disaster preparedness.

f. Users participation.

g. Community education campaigns on Water Conservation.

Some of the projects being executed are :

Project	Area (ha)	Beneficiaries	Activities	Financing
Moncion Dam	18,750	>4,500 farmers. 500,000 (energy)	Construction of a dam for irrigation and energy (140 G.w-hr.).	Go. D.R. (100%) U.S.$150 million
PROMASIR (Transfer to users and	80,000	20,000	Rehabilitation of existing infrastructure, Transferring management of irrigation	I.D.B.(80%) Go. D.R.(20%)

[i] Project documents for the Small scale Farmers Support Project in the Southeast (Dominican Republic). International Fund for agricultural development (IFAD – FAO)/ 1997.

Management programme)			systems to users, loans to water users association, institutional support	U.S.$53.5 million
PROMATREC (Irrigated land and watershed management programme)			Modernization of irrigation and drainage canal systems, Watershed management, Institutional capacity building, agricultural development (credit, transfer of technology), land titling.	W.B.(64.8%) Go. D.R. (33.1%). Beneficiaries (2.08%) U.S.$43.20 million
PRODAS (San Juan Province Development project)	123,600		Modernization of irrigation and drainage canal systems, research, extension services, development of existing organization (users and others), saline soils recovery, Community infrastructure, environmental protection.	I.D.B.(80%) I.F.A.D. (10%) Go. D.R. (10%) U.S.$60 million
AGLIPO II (Aguacate, Limon, El Pozo project).	7,353	1,900 farmers	Construction of irrigation and drainage canals.	O.E.C.F. (75%) (Japan) Gov. D.R. (25%) U.S.$90 million
Water Culture			Awareness campaign, Volunteers services for water quality monitoring in rivers.	
Hydrologic Disaster Prevention). (About to start)			Flood and Drought Studies, Flood control works, hidrometerological and telecommunication equipment, National Alert system.	I.D.B. W.B. Go. D.R. U.S.$24 million
Los Toros			Construction and equipment for a Small hydropower generation plant. 9.14 MW / Annual generation 57.27 G.w-hr.	E.D.F. (95.38%) Go. D.R. (4.62%) U.S.$16.7 million

Go. D. R. = Government of the Dominican Republic.
I.F.A.D. = International Fund for Agricultural Development (U.N.)
W.B. = World Bank.
E.D.F. = European Development Fund (LOME IV agreement).
I.D.B. = International Development Bank
O.E.C.F. = Overseas Economic Cooperation Fund (Japan).

4. Future Perspectives

"Prospects of expanding cultivation by developing new lands are limited, but considerable opportunities exist for the intensification of irrigated agriculture and, in particular, for the better use of existing irrigation infrastructures."[ii] However, the challenge that lays ahead cannot be faced with the existing policies and institutional settings. Therefore, deep institutional reform and changes in policy are considered to be the most pressing need. The government is trying to reorient the role of the state and reduce its financial burden as much as it wishes to move out of its paternalistic role.

A Fourth stage of development is needed in irrigation and it will demand several answers. Urgent action is needed to satisfy the food demand, the low rate of agricultural growth, the low efficiency in the use of water, the low productivity even with irrigation and the possible critical water shortages for the future in some areas and, in fact, actual loss of water. The concrete problem to tackle is the poor management of existing resources reflected by the low overall efficiency of 25%. To close the gap in food production we need to recover systems presently out of service, achieve new irrigated land and increase productivity. Characteristics of this forth stage should be shaped with the following objectives :

a. Demand that management increase its efficiency, and conserve water and other resources.
b. Modernize the irrigation systems and move towards pressure systems.
c. Design a proper credit system. Savings cooperatives and lending by NGOs is showing an acceptable rate of success. Loan recovery rates and resource allocation are both good. At present domestic lending institutions consider agricultural credit to be a high risk.
d. Consolidate existing Irrigation Boards presently in operation, improve their management and achieve financial maturity. Continue with the transfer programmes creating more irrigation boards.
e. Institutional reform in this sector thus improving the role and management of INDRHI and WUA.
f. Improve basin planning and project formulation.

[ii]. Irrigated Land and Watershed Management Project (Dominican Republic). World Bank – FAO / 1993.

g. Increase farmer participation, both in decision making at all levels of projects and with their own share of funding to develop their farm lands. The right to manage and operate an irrigation system has to be accompanied by some involvement by the framers in the investment and cost of O & M activities. Sustainability and ownership issues need to be satisfactorily answered through real empowerment, personal investment and responsibility to maintain an efficient operation of their systems.

h. Increased storage capacity. Dams have definitely played a great role and about $1x10^9$ m^3 of storage can be added to satisfy potential projects. The use of small reservoirs at the head of distribution systems is a complementary alternative.

i. Create an effective training and extension services.

ECUADOR

1. INTRODUCTION

Water and watershed management is a crucial part of the concept of water for food. This paper will focus on Ecuador, a country having Andean watersheds, one which drains to the Pacific Ocean and one which drains into the Amazon River Basin and into the Atlantic Ocean. Water and watershed management is important in both Andean watersheds, but due to the size of the basin and the water carried by the Amazon River to the Atlantic, the consequences of inappropriate management in the Andean watersheds in the upper western ring of the Amazon Basin are much greater. Furthermore, the issues and problems of water and watershed management in the Amazon/Atlantic-destined watersheds in Ecuador are shared similarly by other countries in this upper western ring of the Amazon Basin: Colombia, Peru, and Bolivia. While each of these countries is different in many ways, there is much that will be said here about Ecuador that applies to these other countries as well. A primary concern is the growing population in this upper western ring; this population growth places great pressure on water resources and increases the potential for damage to water quality, and consequently to humans, wildlife, land, and crops. This paper, therefore, will have two purposes. First of all, it is hoped that it will increase awareness of the problem, and of the potentially catastrophic consequences on water resources for food, of the population growth that is taking place in the upper western ring of the Amazon Basin. It is urgent to act now to prevent or abort the damage that the growing population and development can cause to water resources necessary for the next century. Secondly, this paper aims to solicit regional and global cooperation to set up programs and organizations of a scientific nature, not political, to assess, diagnose, study, and monitor the effects of ongoing policies of water and watershed management, to develop the human capital of the region, and to define policies to protect, before it is too late, the water resources of the region.

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2. THE ANDEAN WATERSHEDS

In order to address the issue of water for the future in the Andean region, one must first address the concerns of water management and watershed management in that region, especially for tributaries to the Amazon Basin. This focus is important because of the impact on health and ecology that appropriate or inappropriate management of water resources and the watersheds will have, not only on the Amazon Basin itself, but also, because of ocean currents, on the eastern coasts of the Americas as far north as Canada. Seemingly small decisions made in the upper western ring of the Amazon Basin that concern water and watershed management can have important effects on the Amazon Basin and the eastern coasts of the Americas.

It is true that water and watershed management in watersheds draining to the Pacific is also critical. However, focus will be placed in this paper on the need for appropriate water and watershed management in the upper western ring of the Amazon Basin because of the great size of land territory affected, and because of the large quantity of water generated on the Amazon side flowing to the Atlantic and entering Atlantic currents.

3. CAUSE FOR CONCERN

What is the cause for worry? Why is it necessary to blow a whistle and wake up the neighbors? What has been observed in the Ecuadorian Andean highlands to generate such concern?

The Amazon Basin covers a huge portion of the South American continent. From the upper western ring, many rivers flow from Ecuador, Colombia, Peru, and Bolivia into the Amazon Basin. Water and watershed management in these Andean areas affects the quality and quantity of water entering the Amazon. Thus situations visible now in water and watershed management in the Ecuadorian Andes will, if not already do, occur similarly along the Andean corridor in other countries with watersheds draining toward the Amazon. Consequently, the problems seen in Ecuador and the resulting potential for damage to water, land, and human resources in the Amazon Basin can be multiplied along the Andean watersheds of these other countries.

The most crucial problem observed in the Ecuadorian highlands and *ceja de selva*—"eyebrow of the jungle," or upper part of the Andean watersheds draining to the Amazon—is the rapidly growing population. This population growth, with increasing division of land tenure and its high poverty level, is producing a great pressure on existing water resources, with consequent water quality degradation, at the beginning of the Amazon watershed. Furthermore, as more people use water, water scarcity and diminishing water quality will likely be important factors in development of the area in the next century. Indeed, the rate of growth and tremendous development in this area that can be expected in the next century can lead to catastrophic problems for water in terms of quality and availability, and then there may not be enough time to plan and act effectively. Therefore, now is a good time—*the* time—to start assessing and monitoring water and watershed management, to put into practice appropriate policies, and to prevent and limit damage to water resources in the Andes, Amazon Basin, and, by extension, to the eastern coasts of the Americas.

Furthermore, as stated, it is primarily people of low income that are increasing in population in the highlands and in the "eyebrow of the jungle." Generally, then, it is people who are less prepared in terms of technology, education, and environmental awareness, who are and who will increasingly be those who most use and affect the beginning of the Amazon watershed—water resources which later on in their course through the Amazon Basin affect a large part of Latin America.

Additionally, the high degree of poverty in the highlands, coupled with the general lack of education of these people, creates a breeding ground for many types of social and economic, as well as environmental problems. As has been mentioned, damage to the Amazon waters, because of the Atlantic currents into which they flow, affect the whole eastern side of the Americas. Therefore our focus here is on water and watershed management in the Ecuadorian

Andean highlands and *ceja de selva*, the Andean region from which rivers drain into the Amazon River.

This paper focuses on the birth in the Andes of water for the Amazon Basin and notes water degradation at this point in the upper western ring of the Amazon Basin. However, it must be stated that water resources are also being seriously damaged further down in the Amazon watershed and Basin by oil exploitation[2] and by cutting down of Amazon forests.

Because of the common lack of education, the people in this upper western ring of the Amazon Basin generally cannot realize the damage they are doing to the water and land resources around them and further down the watershed. Therefore, the irrigation management transfer process, by focusing on the nonstructural aspects of irrigation through improved water resource management, offers an opportunity to increase their awareness and help save the Amazon in the short and long term. However, Ecuador and most of the other countries of the upper western ring do not have sufficient capital to create and fund programs to develop the human capital in the highlands and in the *ceja de selva*. Thus there is the need for international programs to work with these people and to develop policies to protect these precious water resources.

As mentioned, the countries of Colombia, Peru, and Bolivia form, with Ecuador, the upper western ring around the Amazon Basin and, because of similar phenomena of Andean population growth, could be involved in this global problem. However, this paper aims to present the situation of Ecuador concerning water for food, it will note current observations and experiences in Ecuador, particularly in the irrigated subsector of agriculture in the Andean corridor.

4. SOME GENERAL STATISTICS ON ECUADOR AND OTHER COUNTRIES OF THE UPPER WESTERN ANDEAN RING

Ecuador's population is close to 12 million. The population density is approximately 46 inhabitants per square kilometer, a greater density than that of any of the other countries in the upper western ring of the Amazon Basin. By comparison, the population density of Colombia is 31.7 inhabitants per square km; Peru, 19; Bolivia, 7.1; Venezuela, 25. Ecuador also has the highest population growth rate of countries in this upper western ring of the Amazon Basin, but the lowest Gross National Product (GNP).

Ecuador's GNP as of 1998 is US$ 18,000,000,000. In comparison, Colombia's is US$ 54,000.000.000; Peru's is US$ 41,000,000,000.

The national economy depends primarily on the agricultural sector output. The agricultural sector provides 17.5% of Ecuador's GNP, and is the most important sector in the country's economy, involving approximately 30% of the economically active population of the country (1997 data). There is stagnation of the per capita GNP in the agricultural sector. Nontraditional agricultural production contributes 32% of the agricultural production output; the irrigated subsector is a major contributor to this nontraditional agricultural production. The agricultural contribution to the positive balance of trade for Ecuador is 51%.

The agricultural sector, when agroindustry is included, contributes to more than one-quarter of the GNP and provides jobs for more than 30% of the economically active population of the country. The irrigated area in Ecuador accounted for the 75 % of the agricultural production of the country in 1995.

In land use, the arable land in Ecuador represents 9% of its total area. This compares to 5.1% of land as arable in Colombia; 2.9% for Peru; 3.1% for Bolivia.

Of the total area of Ecuador (26,000,000 ha), agriculture for diverse uses employs 31%. The irrigated area under command is 533,000 ha. Privately-irrigated land makes up 2/3 of these hectares, and government-run irrigated area constitutes the remainder. Only 10% of the available water in the country is used, and of this, 97 % is used for irrigation and 3% for domestic and industrial purposes. The demand for irrigation water is high and increasing yearly, especially in the Andes region and in the arid coastal plains. Significant losses of surface soil occur throughout the country because of deforestation, overuse and poor management practices. These losses are very significant in the Andes region.

Poverty is a serious problem in Ecuador. Information for 1995 indicated that close to 40% of the overall population lives below the food poverty level. In the highlands, this figure is regionally 60%; in the downstream Andean fringe and jungle, 57% live below the poverty level. These poverty figures for the Andean highlands, fringe, and jungle, indicate a critical situation for the population in terms of survivability. These data are important when considering population growth in these areas and their management of water and watershed resources.

5. THE PROBLEM CONCERNING WATER FOR FOOD

The irrigated subsector of agriculture in the upper western ring of the Amazon Basin has always had as its purpose the increased supply of water to lands to increase food production. How is the irrigated subsector related to this increased population and the degradation of water resources?

5.1 A BRIEF HISTORY OF IRRIGATION

First of all, it may be noted that, while the primary purpose of constructing any irrigation projects has been the obvious one of supplying water for food production, there are often other purposes for which irrigation projects are built. An important reason, in many developing countries, has been to meet a socioeconomic objective—to improve the lives of the rural poor, to keep the farmer on his land, and to stem the flight of rural poor to the big cities. This was true in Ecuador, when during the age of oil abundance and easier government money, increased construction of irrigation systems took place to improve food production and to meet the social need for farmers to produce a sufficient income to stay on the land.

However, in Ecuador, as in many developing countries, the rush in an irrigation project was to build an irrigation system that would be maintained by a government irrigation agency. It was primarily a structural approach to irrigation. Little attention or planning was given to the nonstructural aspect of management. But then it happened, in Ecuador and in other developing countries, that national economies suffered a downturn, and use of government monies became much more restricted. Privatization of formerly government-run enterprises, such as irrigation management, became not only a good idea, but also a necessity. In fact, irrigation management transfer has become such a necessity in some countries such as Ecuador that it became a priority, a top-down decision, sometimes a sudden transfer. Such a sudden transfer is being mandated in Ecuador through the technical assistance projects in which Utah State University and other agencies are involved.

This irrigation system management transfer is being made to farmers who have had little to no experience in managing irrigation, in working with fellow farmers to solve common irrigation system problems and to join in overall management, and in employing the necessary accounting, business, and marketing practices to make their systems economically productive. Training of farmers in technological (on-farm water management and systems operation and maintenance), crop production, diversification and marketing issues, institutional and organizational strengthening (democratic, and managerial practices) is, therefore, an important part of the irrigation system management transfer process.

The problem is compounded by the fact that back when the irrigation systems were built, an incomplete and inadequate technological approach to irrigation was used. Not enough attention had been paid at the beginning to the nonstructural aspect of management of these systems. Thus, even when irrigation management had been in the hands of government agencies, little attention was paid to how the irrigation system worked at the farm level, whether water effectively reached all farmers, and whether proper maintenance was given. Now, as government funds are needed desperately elsewhere and privatization is increasing, with transfer of responsibility for the irrigation systems being made quickly to the farmers/users, it is evident that problems resulting from this incomplete and inadequate approach are mounting. Government agencies that were not effective in the nonstructural, management aspects of irrigation have not been able to transfer the nonstructural aspects, nor do they have funds to do so. However, international technical assistance projects, working with the government of Ecuador, have enabled farmers and regional government agencies, called corporations, to be trained in irrigation management. The situation is similar in the other Andean countries, and indeed, in many Third World nations worldwide.

5.2 INCREASING POPULATION

Along the Andes, irrigation is used to improve water supply. In Ecuador, where rains are more frequent and abundant than in some other Andean nations, there are few reservoirs in the Andes, and irrigation depends more precariously, without reservoir backup, on rainfall to supply the rivers from which irrigation water is taken.

As population increases in the Andean region, pollution from human use, fertilizers, and pesticides increases. Groundwater and irrigation/drainage water runoff ends up in the rivers, which flow to either the Pacific or to the Atlantic. Again, the focus in this paper is on the watersheds draining to the Amazon, because the potential for damage to water resources and the consequences of this damage is greater due to the extensive land area involved in the Amazon Basin. Fertilizers, pesticides, untreated sewage, and other pollutants flow down these rivers, increasing the potential for human and wildlife disease and for deleterious effects on flora and crops. The downstream populations, in turn, add their pollutants to the water system, and the effects on humans, wildlife, forests, plants, and crops multiply. Added to this are the effects of oil and mineral ore exploitation and cutting of the Amazon forests. The polluted water ends up in the Amazon River, and finally, is carried by Atlantic currents around the eastern coasts of the Americas.

Furthermore, as a large green area and the largest ecosystem of the world, the Amazon forests have been called one of “the lungs” of our earth. Damage to the flora of the Amazon forests can result from the mismanagement of the Andean watershed resources, as well as from cutting of the forests. As an important oxygen-producing “organ” of the earth, damage to the Amazon will affect not only South America but also the rest of the planet. This consideration makes water and watershed management and protection of water resources in the upper western ring of the Amazon Basin an issue not just for the Latin American region, but the world.

5.3 SUGGESTED ACTIONS

Certain actions can be suggested to help to mitigate the pressure on water resources for food caused by increasing population and development in the upper western ring of the Amazon Basin. These actions could be classified as (1) programs to monitor effects of policies of water and watershed management of the region; (2) programs to increase awareness, at the local, government, regional, and global levels; (3) programs to help develop the human capital of the region, enabling them to take an active part in the preservation of their environment; (4) policy formulation, at government and regional levels, to help protect the water resources of the region; and (5) formation of a water resource authority, on a regional level if possible, to oversee actions 1 through 4. Such a water resource authority might take form as an entity similar to the Tennessee Valley Authority (TVA) formed in the United States earlier in this century.

These actions are institutional actions. However, because countries of this region, already economically stretched as they are, cannot produce the capital to fund such programs, it is important for the international community, through a combined effort of nations, to mitigate the effect of the current somber prognosis for the quality of water for food, not only for Ecuador, but also for countries in and affected by water and watershed management policies in the upper western ring of the Amazon Basin.

Conferences and roundtable discussions such as these can increase awareness by governments of the problem before it is too late, and international agencies can help fund programs and promote the formation of a regional water authority agency.

A plan of action must be made and implemented to integrate the resources of countries affecting and affected by water and watershed management in the upper western ring of the Amazon Basin. A regional confederation—scientific, not political, in nature—of these countries could work to prevent damage to precious water resources and to seek solutions to issues foreseen for the next century. International help from beyond the region will be necessary to fund and stimulate this cooperation and search for solutions.

Programs to work directly with the growing population in the upper western ring are essential. The inhabitants using the water resources must be made aware of how important it is to protect their water resources, not only for themselves and their descendants, but also for other inhabitants downstream. But, as Maslow's pyramid of needs suggests,[14] where there is hunger and subsistence living, it is difficult to produce altruistic, nonphysical, nonimmediate concern. Thus economic incentives are essential, and these can come through efforts to decrease poverty by improving the income and lifestyle of these people. Appropriate agricultural measures and programs, including irrigation system management transfer, can increase crop production and family income.

Indeed, at a more immediate level, irrigation system management transfer programs can help solve or at least mitigate the problem by working with the farmers/water users to increase their awareness about their environment and by teaching them management techniques which not only improve water management, but also increase their crop production and family income. Cutting-edge, but appropriate, usable technology should be offered, applied, and taught. To maximize income from improved crop production, transfer programs should also be involved in training farmers in accounting, management and organizational skills, and marketing. Then, with these economic incentives, farmers can be more open to encouragement, offered by the transfer programs through their water users associations, to implement policies that preserve their water resources, not only for their own future generations, but for their neighbors downstream as well.

6. CONCLUSION

As stated, the purpose of this paper is twofold. First of all, this paper has pointed out that there is a great need for increased awareness of the problem of a rapidly increasing Andean population in the upper western ring of the Amazon Basin, and a great need for consideration of the potentially catastrophic consequences of this population growth on water resources for food. Secondly, it points out the tremendous necessity of regional and global cooperation to set up programs and organizations of a scientific nature, not political, to assess, diagnose, study, and monitor the effects of policies of water and watershed management, to develop the human capital of the region, and to define policies to protect, before it is too late, the water resources of this important region of the world.

EGYPT

ABSTRACT

Egypt is one of the countries facing great challenges due to its limited water resources represented mainly by its fixed share of the Nile water and its aridity as a general characteristic.

Formulation of Egypt's water resources policy for the 21st century requires a major shift from the classical paradigm used in water resource planning and management to a new innovative paradigm. Dynamic interrelationships among water resource system components impose the integrated approach on policy makers.

Egypt prepared its first water policy after the construction of the Aswan High Dam in 1975. Since then, several water policies were formulated to accommodate the dynamics of the water resources and the changes in the objectives and priorities. The most recent policy was drafted in 1993. It included several strategies to ensure satisfying the demands of all water users and expanding the existing agricultural area of 7.8×10^6 feddans (1 feddan = 1.04 acre) by an additional 1.4×10^6 feddans. As the next century approaches, new strategies have to be adopted.

This paper provides information about Egyptian water resource development, and its determinant factors, evolution of the previous water policies, the future vision to face the enormous development challenges and the means to achieve such policies.

1. INTRODUCTION

Egypt is an arid country, which covers an area of about 1,000,000 km^2 of which only 4% is occupied by its population. According to the 1996 census, the population has reached 62×10^6

inhabitants of whom about 99% are concentrated in the Nile Valley and Delta. One of the important issues in the future is to redistribute the population over a larger area. To reach this objective, it is essential to reclaim new lands, create new industrial regions, build new cities, hospitals, schools, etc. in order to create new jobs and provide the required food for the new communities. The agricultu
exceeding 80% of the total demand for water. In view of the expected increase in water demand from other sectors, such as municipal and industrial water supply, the development of Egypt's economy strongly depends on its ability to conserve and manage its water resources.

Two main land reclamation projects have been launched to form the base for population redistribution and further economic development. The first is the El-Salam canal west of the Suez Canal and El-Sheikh Jaber east of the Suez Canal to reclaim about 620,000 feddans (1 feddan = 1.04 acre). The second project is the El-Sheikh Zaied Canal, which will reclaim some 500,000 feddans in the south of the New Valley. These two projects require huge investments but they do have major social, economic and institutional benefits. The main constraint to implement these projects is the amount of water available. It is well known that the water resources in Egypt are limited to the 55.5 BCM ($x10^9$ m^3) share of Egypt in the flow of the river Nile (55.5 BCM), the deep groundwater in the deserts (mostly non-renewable), and a small amount of rainfall in the northern coastal area and Sinai. Meanwhile, water demand is continually increasing due to population growth, industrial development, and the increase of living standards. Because of population growth, the per capita share of water has dropped dramatically to less than1000 m^3/capita, which, by international standards, is considered the "Water poverty limit". The value may even decrease to 500 m^3/capita in the year 2025.

The Ministry of Public Works and Water Resources (MPWWR) is formulating the national water policy for the 21st century to face the challenges of water scarcity. The policy's overall objective is to utilize the available conventional and non-conventional water resources to meet the socio-economic and environmental needs of the country. The formulated policy focuses on the following :

- Shift the management from the supply-oriented approach to the integrated approach that considers both supply and demand sides of the equation.
- Demand management that requires improving water use efficiencies.
- Developing new water resources through increasing Egypt's share in the Nile water through water conservation projects in the Upper Nile, harvesting rainfall, and desalinating brackish groundwater of 3000-12000ppm salinity.
- Environmental protection of water resources.

2. POPULATION GROWTH

The first determinant for water resources development is the population growth where the population has tripled during the last 50 years from $19x10^6$ in 1947 to about $62x10^6$ in 1996 and it is expected to be about $95x10^6$ by the year 2025.

3. LAND RESOURCES

The total area of Egypt is 1,001,450 km^2 the majority of which is desert lands. Most cultivated lands are located close to the Nile banks, its main branches and canals. Currently, the inhabited area is about $12.5x10^6$ feddans and the cultivated agricultural land is about $7.85x10^6$ feddans.

The per capita cultivated land declined from about 0.23 feddans in 1960 to about 0.13 feddans in 1996. The per capita crop area declined from 0.4 feddans in 1960 to about 0.2 feddans in 1996. The sharp decline of the per capita of both cultivated land and crop area resulted in the decrease of the per capita crop production. This affects directly the food security at the individual, family, community and country levels.

3.1 Land Tenure System

The current system of land tenure resulted from the limited growth rate of arable lands along with the high growth rate of population. The average holding size of lands dropped to about 1.5 feddans in 1995 with a large number of holders and tiny farms to irrigate.

The Ministry of Public Works and Water Resources has adapted the project of irrigation improvement to increase the efficiency of irrigation and alleviate the waste of water during the operation of irrigation systems. It is quite clear that, under the trend of rapid population growth and the limited land resources along with the inheritance laws, the number and percentage of tinny and fragmented farms will gradually increase. Hence, there is a need to closely observe the trends of fragmentation and amalgamation.

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4. STATUS OF WATER RESOURCES

4.1 Status of Water Supply

Water resources in Egypt are limited to the following resources:

- Nile River,
- Rainfall and flash floods,
- Groundwater in the deserts and Sinai and
- Possible desalination of sea water.

Each resource has its limitation on use, whether these limitations are related to quantity, quality, space, time, or use cost. The following is a description of each of these resources.

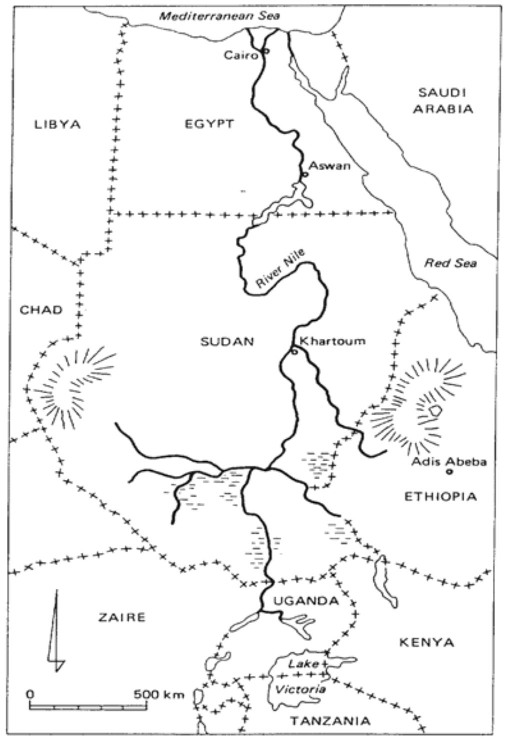
Nile River Water

Egypt's main and almost exclusive resource of fresh water is the Nile River. The Nile River inside Egypt is completely controlled by the dams at Aswan in addition to a series of seven barrages between Aswan and the Mediterranean Sea. Egypt relies on the available water storage of Lake Nasser to sustain its annual share of water that is fixed at 55.5 BCM annually by agreement with Sudan in 1959. The agreement allocated 18.5 BCM to Sudan annually assuming 10 BCM as evaporation losses from Lake Nasser each year based on an average annual inflow of 84 BCM/year. This average was estimated as the annual average river inflow during the period 1900 till 1959.

Rainfall and Flash Floods

- Rainfall

Rainfall on the Mediterranean coastal strip decreases eastward from 200 mm/year at Alexandria to 75 mm/year at Port Said. It also declines inland to about 25 mm/year near Cairo. Rainfall occurs only in the winter season in the form of scattered showers. Therefore, it can not be considered a dependable source of water.



Map of the Nile Basin

- Flash Floods

Flash floods due to short-period heavy storms are considered a source of environmental damage especially in the Red Sea area and southern Sinai. Many studies have been made to determine possible measures to avoid hazards caused by flash floods. Mechanisms have also been developed to harvest flash floods water. This water could be directly used to meet part of the water requirements or it could be used to recharge the shallow groundwater aquifers. It is estimated that about 1 BCM of water on average can be utilized annually by harvesting flash floods.

Groundwater in the Western Desert and Sinai

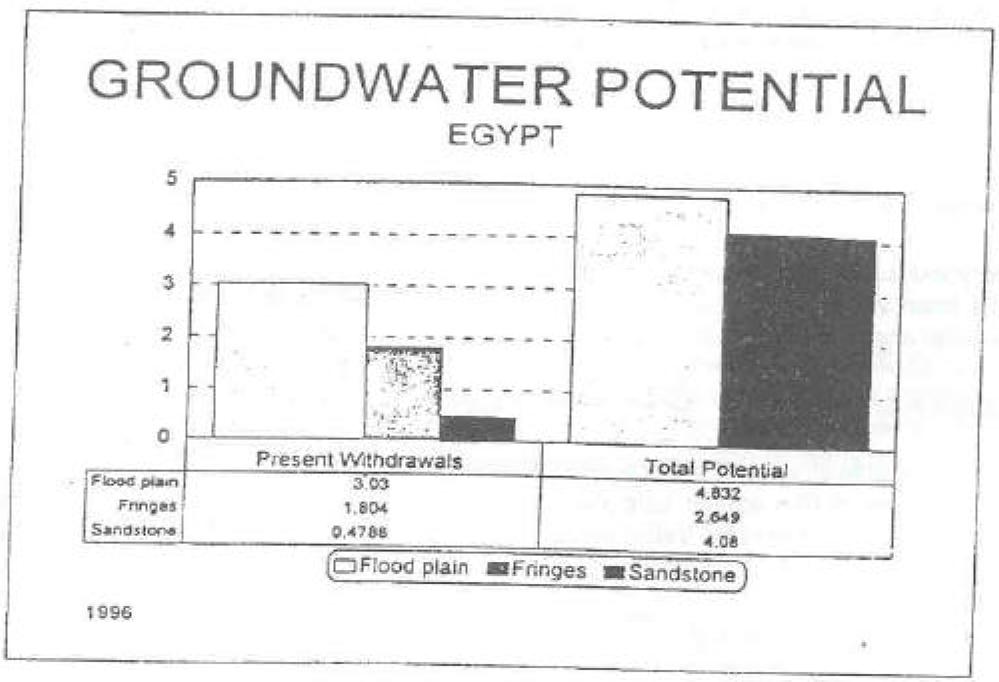
- Groundwater occurs in the western desert in the Nubian sandstone aquifer that extends below the vast area of the New Valley governorate and the region east of Owaynat. It has been estimated that about 200,000 BCM of fresh water are stored in this aquifer. However, groundwater occurs at great depths and the aquifer is generally non-renewable. Therefore, the
- utilization of such water depends on pumping costs and its depletion rate versus the potential economic return on the long run.

- Groundwater in Sinai is mainly encountered in three different water-bearing formations; the shallow aquifers in northern Sinai, the valley aquifers; and the deep aquifers. The shallow aquifers in the northern part of Sinai are composed of sand dunes that hold the seasonal rainfall, which helps to fix these dunes. The aquifers in the coastal area are subject to salt-water intrusion. The total dissolved solids in this water range from 2,000 to 9,000 ppm which can be treated to reach a suitable salinity level for use to irrigate certain crops.

- The groundwater aquifers in the valleys of Sinai are recharged from rainfall and especially from heavy storms. The annual rainfall on Sinai varies from 40 mm to 200 mm/year. Most of the rainfall water recharges the shallow groundwater aquifers in northern Sinai such as the delta of Wadi El-Arish and El-Beqaa flood-plain, while such aquifers are absent in southern Sinai. Although most of the shallow aquifers are renewable, only 10 to 20% of the deep aquifers are renewable by rainfall and flash floods.

- The total groundwater abstraction in the western desert in 1995/96 was estimated to be about 0.48 BCM while it is only 0.09 BCM/year in Sinai.

Groundwater Potential : Ground water development has started in the early sixties and is continuing. Figure below illustrates the present ground water use (1996) and future potential in the major ground water systems of the country. From this it is observed that the present use is concentrated in the Nile aquifer system, followed by the desert fringes and the Nubian sandstone. Other aquifer systems are still underdeveloped. Moreover, within the developed systems, only part of the potential is utilized mainly where ground water is fresh.



Groundwater Use and Potential in Egypt (1996)

Desalination of Sea Water

- Desalination of seawater in Egypt has been given low priority as a source of water. That is because the cost of treating seawater is high compared with other sources, even the unconventional sources such as drainage reuse. The average cost of desalination of one cubic metre of seawater ranges between 3 to 7 L.E (Egyptian pound). In spite of this, sometimes it is feasible to use this method to provide domestic water especially in remote areas where the cost of constructing pipelines to transfer Nile water is relatively high.

- Egypt has about 2,400 km of shorelines on both the Red Sea and the Mediterranean Sea. Therefore, desalination can be used as a sustainable water resource for domestic use in many locations. This is actually practised in the Red Sea coastal area to supply tourism villages and resorts with adequate domestic water where the economic value of a unit of water is high enough to cover the costs of desalination.

- The future use of such resource for other purposes (agriculture and industry) will largely depend on the rate of improvement in the technologies used for desalination and the cost of needed power. If solar and wind energy can be utilized as the source of power, desalination can become economic for other uses. It may be crucial to use such resource in the future if the growth of the demand for water exceeds all other available water resources. Nevertheless, brackish groundwater having a salinity of about 10,000 ppm can be desalinated at a reasonable cost providing a possible potential for desalinated water in agriculture.

- The amount of desalinated water in Egypt now is in the order of 0.03 BCM/year.

4.2 Non-conventional Water Resources

There exist other sources of water that can be used to meet part of the water requirements. These sources are called non-conventional sources, which include :

- The renewable groundwater aquifer in the Nile basin and Delta
- The reuse of agricultural drainage water
- The reuse of treated sewage water

These recycled water sources cannot be considered independent resources and cannot be added to Egypt's fresh water resources. They sources need to be managed with care and their environmental impacts evaluated to avoid any deterioration in either water or soil quality.

- The renewable Groundwater Aquifer in the Nile Valley and Delta

The total available storage of the Nile aquifer was estimated at about 500 BCM but the maximum renewable amount (the aquifer safe yield) was estimated to be only 7.5 BCM. The existing rate of groundwater abstraction in the Valley and Delta regions is about 4.5 BCM/year, which is still below the potential safe yield of the aquifer.

- Reuse of Agricultural Drainage

The amount of water that returns to drains from irrigated lands is relatively high (about 25 to 30%). This drainage flow comes from three sources; tail end and seepage losses from canals; surface runoff from irrigated fields; and deep percolation from irrigated fields (partially required for leaching salt). None of these sources is independent of the Nile River. The first two sources of drainage water are considered to be fresh water with relatively good quality.

The agricultural drainage of the southern part of Egypt returns directly to the Nile Rive where it is mixed automatically with Nile fresh water which can be used for different purpose downstream. The total amount of such direct reuse is estimated to be about 4.07 BCM/year in 1995/96. In addition, it is estimated that 0.65 BCM/year of drainage water is pumped to the El-Ibrahimia and Bahr Youssef canals for further reuse. Another 0.235 BCM/year of drainage water is reused in Fayoum while about 0.65 BCM/year of Fayoum is drained to Lake Qarun. Moreover, drainage pumping stations lift about 0.60 BCM/year of Giza drainage from drains to the Rossita Branch just downstream of the delta barrages for further downstream reuse.

Drainage water in the Delta region is then emptied to the sea and the northern lakes via drainage pump stations. The amount of drainage water pumped to the sea was estimated to be 12.41 BCM in 1995/96. This decreased and will continue to decrease in the future according to the development of the reuse of agricultural drainage water.

Reuse of Treated Waste Water

One way of augmenting the irrigation water resources is to reuse treated domestic wastewater for irrigation with or without blending with fresh water. The increasing demands for domestic water due to population growth, improvement in living standards and the growing use of water in the industrial sector due to the future expansion of industry will increase the total amount of wastewater available for reuse.

Wastewater treatment could become an important source of water and should be considered in any new water resource development policy. However proper attention must be paid to the associated issues with such reuse. The major issues include public health and environmental hazards as well as technical, institutional, socio-cultural and sustainability aspects.

4.3 STATUS OF WATER DEMANDS

Demands for water can be categorized in four main classes.

a. Crop Consumptive Use

The average annual consumptive use for 1995/96 was estimated to be 40.82 BCM. In that year about $7.8x10^6$ feddans were irrigated with an average water consumptive use per feddan of about 5100 m^3/year. This amount represents only the crop evapotranspiration and does not include conveyance losses in the irrigation network or seepage and deep percolation loses at the farm level.

b. Municipal Water Requirements

The total municipal water use was estimated to be 4.54 BCM in 1995/96. A portion of that water is actually consumed and the rest returns to the system, either through the sewage collection system or by seepage to the groundwater. There are regions like Alexandria, the Suez Canal, and desert areas where the discharge cannot be recovered.

c. Industrial Water Requirements

The estimated water requirement for the industrial sector during the year of 1995/96 was in the order of 7.5 BCM/year. A small portion of the diverted water for industrial requirement is consumed through evaporation during industrial processes while most of the water returns to the system.

d. Navigational Requirements

The river Nile main stream and part of the irrigation network are used for navigation. Water demand specifically for navigation occurs only during the winter closure period (about 3 weeks in January and February), when discharges to meet agriculture demands are too low to provide the minimum draft required by ships.

4.4 Summary of Water Resources Balance

In summary the actual resources currently available for use are 55.5 BCM/year, whereas water demands for all the sectors are in the order of 65 BCM/year. Recycling and better management nearly overcomes this gap between water needs and demands. Currently groundwater abstraction is about 4.8 BCM/year. An amount of 4.3 BCM/year of drainage water is now re-used. Another 0.4 BCM/year of treated wastewater is re-used for irrigation at present which still leaves a small deficit of demand over supply.

4.5 Water Quality Status

In general, the water quality of Lake Nasser is considered good. However, some threats can be identified if the settlements around the lake and in the upstream catchment area increase without taking the proper provisions to abate water pollution.

The quality of water released from Lake Nasser affects the quality of the Nile River downstream of the High Aswan Dam. The change in water quality of the river along its way own to the Delta is illustrated by the longitudinal profiles. Comparing the profile for 1976-1978 and 1991, it can be concluded that no significant changes have occurred so far on salt content or dissolved oxygen (DO), but a broader view of quality parameters shows some deterioration in the quality.

On the contrary, drainage canals, which are basically designed to collect the drainage of agricultural areas, receive increasing quantities of untreated or partially treated industrial wastewater, sludge and even solid wastes.

5. FUTURE POLICIES FOR THE DEVELOPMENT OF WATER RESOURCES

The main elements of future policy are:

5.1 Optimal Use of Available Resources

The optimum use of all available water resources can be achieved through an integrated plan at both national and local levels translating the overall policy targets into long term programs after reviewing and examining their impact on socio-economic development.

The following is a set of proposed strategies to achieve optimum use of all the available water resources.

Minimize Water Losses by:

a. using pipelines to transfer water in the new lands especially where there are highly permeable soils;
b. gradual expansion of groundwater wells for use as a secondary source of water at the farm level to decrease conveyance losses in third order canals;
c. replacement of level-based water distribution systems to flow-based water distribution systems through calibration of control;
d. introduce new technologies for canal maintenance and weed control; and
e. improve the Nile River navigation channel and facilities to reduce, or eliminate, the amount of water released for that purpose during the winter period.

Irrigation Improvement Projects include:

a. rehabilitating and renewing water structures,
b. using pipeline and raised mesqas,
c. the use of one-point collective pumping from branch canals into mesqas, and

d. land leveling using modem techniques.

The improvement projects also include the redesign of field irrigation systems and, most importantly, the formulation of water user associations that express the new vision for the water distribution management process.

Cost Recovery

Setting up a cost recovery system in which water users pay for the services of water distribution and network maintenance.

This program will initiate public awareness on cost allocation and cost recovery programs It will inform the media of the importance of water and encourage the implementation of water user's association groups. These groups will be supervised by water association supervisors who will facilitate and coordinate between farmers to ensure that they work as one team towards achieving the MPWWR strategies. It will also be a good way to transfer and exchange knowledge between different users and promote transparency and accountability. It should secure public support and commitment to water policies and programs.

Shifts in Cropping Patterns

Encouraging policies to reduce the consumption of agriculture water by:

- Gradually replacing sugarcane with sugar beets especially in Upper Egypt taking into account the lifetime of current sugar factories, which were designed to process sugarcane.
- Reducing the cultivated rice area to about $9x10^5$ or $1x10^6$ feddans which will be sufficient to satisfy national demand, provide some potential for export, and prevent soil salinization and seawater intrusion.
- Replacing currently used varieties of rice with the new shorter-life rice varieties which have a higher productivity and lower water requirement due to their shorter lifetime.
- Using genetic engineering develop new crop varieties that have higher productivity and consume less water.
- Narrow the gap between net revenues of similar seasonal crops to enable the MPWWR to encourage lower water consumptive crops.
- Design an indicative cropping pattern for each region based on climatological conditions, soil characteristics and available water resource in terms of quantity and quality. Farmers should be advised to follow the indicative cropping pattern or pay for excess water if they deviate.

5.2 Develop Groundwater Strategies

The future strategy for groundwater development would aim to encourage agricultural development of desert areas. These areas would involve initiating new communities that can absorb part of the highly concentrated population in the Nile valley and Delta. Such approach will increase the future demands for groundwater, which consequently will need continuous monitoring and evaluation of the groundwater aquifers to avoid any possible deterioration in these aquifers due to misuse.

The Renewable Aquifer Underlying the Nile Valley and Delta

The strategy for groundwater envisages the conjunctive use of Nile surface and groundwater through:

- Using the aquifer as a storage reservoir to supplement surface water supply during peak periods and recharging during the minimum demand periods.
- Use of modern irrigation methods (sprinkler or trickle) in the new lands that uses groundwater as the source of water to prevent water logging and keep the groundwater table far from the root zone.
- Use a vertical well drainage system in Upper Egypt to prevent the groundwater table from reaching the root zone thus avoiding water logging and increasing productivity.
- Groundwater could be used as a source of water for artificial fish ponds as it has a consistent and steady temperature and good quality.
- Augment the canal water supply by pumping groundwater from low capacity private wells at tail ends of long mesgas where water shortage is experienced.

Groundwater Aquifers in the Western Desert and Sinai

Groundwater occurs at great depths and needs a large investment to be profitable. Therefore future strategies to use groundwater in the Western desert and Sinai include:

- the use of the modern technologies to determine the main characteristics of each aquifer, its maximum capacity and safe yield. These data should be the basic criteria for selecting the most suitable projects that can use such aquifers as a sustainable source of water.
- New small communities ($2x10^3$ to $5x10^3$ feddans) in the desert areas designed to use all available natural resources through integrated planning.
- Use non-conventional sources of energy such as solar and wind to minimize the costs of pumping.
- Use the new technologies for farm irrigation in desert areas to minimize field losses especially deep percolation due to the high porosity of such soils.

5.3 Reuse of Agricultural Drainage Water

The strategies for drainage water reuse include the following measures:

- Increasing the reuse of drainage water from about 4.5 BCW/year to 7.0 BCM/year by year 2000 and to 9.0 BCW/year by year 2017 with average salinity of 1170 ppm. This could be achieved through implementing several projects to expand the reuse capacity at different areas. Main future projects include the El-Salam canal project, the El-Omoom and El-Batts drainage project;.
- Improving the quality of drainage water especially in the main drains;
- Separating sewage and industrial wastewater collection systems from the drainage system;
- Draining 50% of the total generated drainage water in the delta into the sea to prevent seawater intrusion, and to maintain the salt balance of the system;
- Implement an integrated information system for water quality monitoring in drains using the existing data collection network after updating and upgrading; and
- Continuous monitoring and evaluation of the environmental impacts due to the implementation of a drainage water reuse policy especially on soil characteristics, cultivated crops, and health conditions.
- Reuse of Sewage Water
- The future policy for using sewage water can be summarized as follows:
- Increase the amount of secondarily treated wastewater use from 0.26 BCM/year to 2.8 BCM/year by 2001 and to 4.5 BCM/year by 2017;
- Limit the use of treated wastewater to cultivated non-food crops such as cotton, flax, and trees;
- Separate industrial wastewater from domestic sewage, so that it would be easier to treat domestic sewage with minor costs and avoid the intensive chemical treatment needed for industrial wastewater.

5.5 Development of Surface Water Resources

In addition to achieving better utilization of the available water resources, the future policy also aims at investigating the possibilities of developing new water resources or increasing the availability of existing resources in order to meet future increasing demands. In that regard, the future water policy for Egypt includes the following strategies.

(i) Increasing Egypt's Share of the Nile Water through Cooperation with the Nile Basin Countries

85% of the Nile water originates from the Ethiopian highlands through the Sobat River, the Blue Nile River, and the Attbara River. Egypt's share of the Nile's water was fixed at 55.5 BCM/year by the Nile water treaty. Studies show that a large portion of the Nile water is lost before it reaches Aswan, therefore, there is a modest potential to decrease these losses through implementing joint projects with other countries in the Nile basin.

(ii) Desalination of Brackish Water

The Government is examining the possibility of using the low salinity brackish groundwater to irrigate certain seasonal crops. This water is available at shallow depths in the Western and Eastern Deserts and at the borders of the Nile valley. The average salinity of such water varies from 3000 to12000 ppm.

Non-conventional sources of energy, e.g. solar and wind energies, would be used in the treatment process to minimize the cost and increase its economic value.

This source will supplement rainfall to Increase land productivity by cultivating two crops per year instead of one.

(iii) Harvesting Rainfall and Flash Flood Water

The future strategies for flash flood risk assessment and utilization involves the use of:

a. Modern technologies such as remote sensing and GIS to study the basic characteristics of stream networks that contribute to flash floods,
b. adjusting daily releases from the High Aswan Dam to their occurrence, and
c. avoiding hazards from flash floods by implementing risk zone maps for major bottlenecks on the basin streamlines and identifying areas that lie in risk zones to take proper precautions to avoid any possible hazards.

5.6 Water Quality Management

One of the major issues facing Egypt is the accelerated decline of water quality. Water quality has a direct effect on the quantity available for a specific use. As the quality of water degenerates the areas of use narrows, thereby, reducing supplies and intensifying shortages.

Future policy aims to implement a long-term strategy to prevent the different sources of pollutants from discharging to the Nile River and other water bodies.

6. MEANS FOR POLICY ACHIEVEMENT AND SUCCESS

6.1 Public Awareness

The Govt. has launched a public awareness program aiming at :

- Informing the public, through media, the major achievements in water management.

- Explaining the significance of water saving in irrigation and domestic uses by demonstrating water saving consequences to people.
- Demonstrating, through the media and in the parliament, a simplified version of the water resources policies and its associated strategies and future plans to execute these policies.
- Achieving public participation and commitment to water policies and programs.
- Increasing the knowledge of people about new technologies in farm irrigation, and domestic uses to conserve water for future development.
- Increasing the awareness of the environmental issues related to water resources utilization.

6.2 Continuos Monitoring and Evaluation

Policy making is a dynamic and continuous process in which the formulated policy should be checked and updated according to changes in the social or the economical conditions. The policy should be monitored through a set of well-defined criteria measuring the overall performance of the policy and the results of the implementation of the selected strategies. The evaluation process should be done on a regular basis to enable strategic adjustments needed to correct deviations from the original objectives.

Realizing the need for intensive monitoring to collect the required data about water resources (quantity, quality, and level of use) and an integrated information system to store, and analyze these data to help in the decision making process of adjusting the existing water policies, the Government. has launched several monitoring programs such as the Water Quality Monitoring Program, the Drainage Water Quality Monitoring Program, and the Groundwater Quality Monitoring Program.

6.3 Improvement of Water Resources Management Systems

Integrated Water Resources Management

Water resources management is a complex process that requires a multi-disciplinary team in order to take all its facets into consideration.

The integrated water resources management approach combines these different aspects under one system that manages demand and quality of water resources as it manages supply. The Government has taken several initiatives towards applying this approach and all its principles such as user involvement and participation, organizational restructure, etc. as given below.

Users Participation in Water Management

The MPWWR bears the responsibility of coordination between the different parties and the promotion of their participation in the decision making process through establishing joint committees representing the different water users by hosting seminars and workshops to demonstrate and propagate water policies and its associated strategies.

The Irrigation Improvement Project is currently establishing Water Users Associations (WUA) that promotes farmers' involvement and participation in water management at the Mesqa level. The role of these associations will be extended to manage secondary canals by forming high level associations. This effort is one step on a long way to change from central management of water resources to participatory management of water resources. This will need the government to study privatization of some water resource activities in order to strengthen the capacity of the important water sector and to improve private sector participation it water resource management.

Institutional Strengthening

It is planned to review and update all the institutional and administrative procedures needed to enhance water resources management to reflect the integrated approach of water management and the new trends of privatization where part of the activities may be transferred to the private sector such as operation and maintenance of some parts of the network.

Human resources development would be a major aspect of institutional strengthening.

The future policy will include an intensive training program to improve the technical and management skills of the staff and to ensure the preparation of new generations that can carry the responsibility in the future. This effort will be continuous, in a flexible way that reflects modern and state-of-the-art technologies in all the ministry's activities.

Coordination between Ministries

This coordination framework is sought to strengthened through the following measures:

- Clear definition of the responsibilities of each party in the water resources management process avoiding redundancy or overlap in responsibilities.
- Clear definition of the responsibilities of joint committees making sure that committees do not replicate what other committees or authorities are presumed to do.
- Enhance the data exchange process between different authorities.
- Exchange knowledge, experiences, and technical expertise in the different fields of water resources between different authorities.

6.4 Laws and Decrees

A detailed review for all existing water resources laws and decrees should be done classifying these laws and decrees into categories according to their relation to water management aspects to ensure that the most recent version of these laws reflect the long-term objectives and the government's overall policy.

6.5 INTERNATIONAL COOPERATION

The Nile River is an international River as its water runs though ten different African countries. These countries have established good coordination links amongst them selves and issued some agreements between different parties to ensure the proper utilization of this shared resource for the benefit of all countries. This coordination must be continued and future discussions should be concentrated on the sustainable development of the water resources in the ckountries of the Nile River basin.

6.6 Use of Modern Technologies in Water Resource Management

- Future policy considers the utilization of new technologies in water resource management especially in the following areas:
- The use of satellite images and remote sensing techniques to build a geographic information system for the Upper Nile basin comprising hydro-meteorological data.
- The use of mathematical models to simulate the hydrological cycle over the whole Nile River basin to follow water movement from its sources till it reaches the High Aswan Dam.
- The use of Information Systems and Decision Support Systems in an integrated way to satisfy all the ministry's needs for information and indicators related to water resource management.

6.7 Research and Development

The policy formulation process is based on a soil foundation of applied research findings and comprehensive planning studies. Research as a dynamic process is considered the key action of the policies success. The National Water Research Center with its twelve institutes is the responsible Agency for doing research.

State of the art technology, in various aspects of water resource planning and management, adopted and utilized for the planning and formulation of Egypt's water resources policies for the 21st Century.

7. SUMMARY AND CONCLUSION

Water scarcity is a growing global problem challenging sustainable development and expansion of cultivated areas to meet increasing food requirements. Egypt is one of the countries facing great challenges, due to its limited water resources represented mainly by its fixed share of the Nile water, and its aridity is the general characteristics of the country.

The agriculture sector is the largest user of water in Egypt with its share exceeding 80% of the total demand for water. In view of the expected increase in water demand from other sectors, such as municipal and industrial water supply, the development of Egypt's economy strongly depends on its ability to conserve and manage its water resources.

Efficient and effective use of all water resources in Egypt requires the formulation and implementation of an appropriate water sector policy. The Ministry of Public Works and Water Resources (MPWWR) is formulating a national water policy for the 21st Century to face the challenges of water scarcity. The policy's overall objective is to utilize the available conventional and non-conventional water resources to meet the socio-economic and environmental needs of the country.

An assessment of water resources has been made. As a result of this analysis, a preliminary setting for various policies has been determined. The formulated policy focuses on three major aspects: demand management, resources development, and environmental protections Strategy options to be considered are :

- Conservation projects in the upper waters of the Nile Basin
- Recycling Nile aquifer water
- Recycling drainage water
- Recycling wastewater after treatment
- Utilization of desert groundwater
- Cost recovery based on cultivated area and type of crop
- Harvesting of rainfall
- Improvement of water quality
- Limitation of the rate of land reclamation
- Raising public awareness of the water problem.

These options should be integrated into the generally accepted National Water Policy for Egypt. The means that such policy achievements and successes must be presented through the following programs:

- Public awareness,
- Continuous monitoring and evaluation,
- Improvement of water resource management,
- Enforcement of laws and decrees,
- International cooperation and

- Use of modern technologies in water resource management research and development.

FRANCE

This vision aims to generate at local, national and global level, an awareness of the importance of a sustainable management of water resources.

France has always shown a strong interest in water policy, through its public and private bodies. The 1964 Water Law defined the legal framework within which France has organised water management at basin level with a high effective participation of the civil society as stakes holders. The new 1992 Water Law, implies that « Water is Everybody's Business », which is the ultimate goal of the Vision exercise promoted by the WCE.

The French vision is an integrated water management vision, with main emphasis on a sustainable and planned use of water resources, within a balanced natural eco-systems.

This vision contemplates a harmonious balance between the rural and urban worlds and is based on a sustainable management of the landscape. French agriculture aims to both sustain a balanced rural development and food production.

1. WATER, FOOD AND LAND MANAGEMENT

In France, supplying the food needs of the population has been a long-term target for the development of new infrastructure for water resources mobilisation and distribution. Throughout history, water projects have been the prime influence in the development of agricultural and rural areas, from the Galo-Roman era down to modern times. For example, the Watteringues in the North in 1169 (Dunkerque-polders), the Canal de Durance by Adam de Craponne in 1555, the Roussillon projects and the Canal de la Neste in the last century.

More recently, technical progress and modernisation of farming systems have allowed France to become a net exporter in agricultural products. The agricultural activity has thus become an important component of the economical national development and of the policy in rural development.

In recent decades, sociological and economical changes have been rapid and profound. The development policy carried out in France has allowed a more harmonious development than one that would have resulted purely from economical driving forces.

An economical focus would have tended to concentrate the French population in a few main centres, particularly Paris, whereas the population density distribution has remained largely stable. Voluntary actions have been carried out with the double objective of avoiding the desertification of the rural zones and avoiding too much urban concentration.

It is clear, everywhere in the world, that the uncontrolled development of "mega cities" generates acute social, economical and political problems. The desertification of rural areas, and the abandonment of farming may generate some risks of soil and landscape degradation, of increased naturals hazards (fire, erosion, …) and jeopardise the entire rural economies within these areas.

A balanced development, within rural areas, preserving the natural system, is also beneficial for leisure activities. It helps to avoid a harmful and costly hyperconcentration of visitors along the seacoasts by offering alternative and attractive venues elsewhere and thereby spreading the tourist load throughout the country.

Despite some failures and the fact that there has been a slight decline of rural zones compare with urban zones, this policy has generated the development of regional metropolis and middle range towns. Thereby it has helped to contain the growth of the megalopolis PARIS.

Actions have been launched to create and maintain sufficient employment (agricultural, industrial, services) in small cities and in rural areas. In this endeavour it is clear that water is an important challenge, especially in dry zones, for example the Mediterranean regions. Water is needed for agriculture (irrigation), for cities and for the development of some industries (food processing), for tourism (to support the quality of natural systems, bathing, domestic supply to tourist areas,…). But to make sure that all these actions are appropriate and efficient, it is required to consider "water" and all accompanying actions, not sector per sector but in terms of integrated development.

Thus for example, recognising the impact of landuse on the water cycle is essential. Protecting water resources and more generally encouraging a sustainable development implies taking into account territory management and land use. In upstream sections of the watershed, the impact of forestation on soil and water conservation is well known. A harmonious combination of forest, livestock and agriculture is the best solution to prevent fires, to maintain terraces and reduce erosion; and as a consequence, to reduce flood peaks and increase groundwater recharge.

Human activities have a tremendous impact on water quality and on aquatic natural systems. Carefully planned location of activities along with an efficient control of withdrawals and spills and the development of fair agricultural practices, strengthens the protection policy of the ecosystems, wetlands and natural systems. All these are indispensable for protection, and sometimes rehabilitation of the water quality.

Acquisition of lands along the sea-coast (Conservatoire National du Littoral et des Rivages Lacustres) are made to create buffers, protected zones and National Parks (totally protected). Moreover, Natural Regional Parks have been established where a concern for protecting the environment is the driving force for the economical development. All these measures are important as they create sanctuaries and pilot areas, which can serve as examples for good practices in land use management.

At the international level, issues may be quite different from France. In particular the demographic growth does, in some developing countries, increase the risks of overdeveloping agricultural and over grazing inappropriate and fragile soils, resulting in the threat of a massive rural migration towards the cities. This can be dramatic, particularly if there are insufficient jobs. Water is a paramount factor for both domestic water supply in cities, and for food supply (irrigation) and employment in rural zones. However, despite some difference in the degree of the crisis, the basic principles are similar, and the main issue is a balanced development of the national territory for which comprehensive thinking is required.

2. AGRICULTURAL WATER: CONTROLLING THE DEMAND

Agricultural water to support lively rural areas

The control of water in agriculture favours a stable activity by reducing the variability of water inherent in climatic sources. It allows a balanced land use and maintains an economical activity in the area. This factor has proven to be crucial in France in the maintenance of sufficient activity in rural areas and the control of migratory fluxes.

The water projects undertaken during recent decades have been instrumental in maintaining economical equilibrium in rural areas. French agriculture is today extremely dynamic and efficient. In particular, in the South regions of France, water infrastructure has been able to compensate for climatic insufficiency and has allowed producers to cope with permanent changes in the food market.

Thus France has been able to maintain a well spread high performance agricultural activity throughout the country. This has made the country a net exporter in the European market. Out of the 35 Mtons of wheat produced each year, France exports 15 to 20 Mtons. Missions and objectives assigned to the agricultural sector have evolved considerably with time, and are still evolving today as the result of a continuously changing economical environment. Among the significant changes, one finds an increasing requirement for quality and reliability linked to the food processing industry, the increasing integration of Europe and an increased concern for environmental protection.

With a 6 %share of the national product, the agricultural sector, along with forestry and the food processing industry, supports and maintains the economical rural activity which covers some 85 % of the national territory, including the mountains. This development has been made possible by the improvement of farming system techniques, among which is the control of water to the soil and plants.

Irrigation a regularity factor in production

Agricultural land under Irrigation has increased constantly in recent decades. It reached 1.9 Millions Ha in 1997, which constitutes 6% of the agricultural domain and covers one out of seven farms. In terms of area the dominant crop is corn, with 43 %. "Indispensable irrigation" was first developed in the south part of France. However more recent development in irrigation has covered the west, central and the north part of France, as supplemental irrigation. In France, irrigation is also valued by farmers as a resource to aid in providing for a continually changing economical context, resulting from permanent market fluctuations and of European and international law modifications. Irrigation improves the capacity of farms to adjust their cropping patterns.

For farmers, the motivation to increase yields and net income has given way to production diversification, yield regularity, and reliability of product quality. Today the cash crops grown under contracts with food processing companies are only possible if access to irrigation is guaranteed.

Irrigation as an employment factor

Irrigation plays a key role in controlling jobs in the agricultural and food processing sectors. Farms where there is irrigation, have a lower average cultivated area than those running under rainfed conditions; and they have a higher density of employment. They are globally more dynamic and are a key asset of the rural development. Recent studies show that areas where irrigation has been introduced (partially not totally at farm level) have experienced a lower agricultural decline and have more jobs available than in others. It is estimated that approximately 5 jobs per 100Ha are generated when cereal farming land is switching from rainfed to irrigational supply. In orchard production, the increase in jobs is much more (1 job direct or indirect per hectare).

Irrigation and Water Resources

Annual consumption in irrigation is about one third of the total consumption in France, i.e. 2.4 out of 8 km3. These volumes represent a very limited part of the total precipitation volume for France (480 km3) as well as of the fraction of the latter that can be mobilised (150 km3). However the abundance of water shown by these figures is misleading, and local and temporal water scarcity does exist. Recent summer droughts have generated conflicts and tensions among the water users, including the support to natural systems during low periods. This imbalance between limited water resources and a growing demand for water is becoming socially unacceptable. The growing scarcity of water that can be mobilised at a low cost, along with a higher concern for the environmental impacts of major hydraulic structures, and a decrease of investment from the state, has led water professionals to change their policies. Today policies promote solutions that aim for a better control of the water demand along with an economically sound development of new resource. This is the aim for instance, in the collective management of individual irrigation systems.

The effect of water withdrawals for irrigation on the natural system is negative, from a strictly quantitative point of view. On the other hand, irrigation has some advantages with respect to water quality, when compared with rainfed farming. Due to the regulating effects of irrigation on yield, and because irrigation allows a better control of the other practices such as the application of fertilisers and treatment against diseases, it minimises the risks of excess chemicals being carried away from the field and contaminating other water resources. When irrigation is well controlled, it is less harmful to the environment than a similar rainfed farming situation.

Controlling the uses and the demand for water

In an atmosphere of growing competition for water and financial resources, it is now clear that the focus in France is in controlling the demand and the uses of water. There are still situations and specific cases for which rural development and regional re-equilibrium will require the mobilisation of new water, including water for agriculture. However these situations will be limited. In general the water supply will not see any increase and if there are changes they be moderated in a prioritised way, to satisfy other uses than agriculture.

The challenge for agriculture today is to manage the demand for water, in the most equitable manner within the farms, to increase the efficiency of the water use, to improve agricultural practices and to minimise the impacts on the natural environment.

3. A RESTRUCTURED LEGAL FRAMEWORK

The French legal framework for water management

Water management in France is characterised by a clear demarcation of the roles of the State (regulation, control and policy), Basin Committees (general trends for future management), Water

Agencies (solidarity among share holders and financial incentives for activities in line with the recommendation of the Basin Committee), and local management companies.

It is noteworthy to recall that the regulating and legal role of the State has been strengthened during recent times. Its role in investment is nowadays more limited than it was, while the role of local and regional political bodies is on the increase at decision level and to a lower extent on the financial side. Public investment is fully integrated in a comprehensive policy of development for each regional territory. Investments are restricted, today, to those aiming to ease the access to water resources and to correct certain regional natural handicaps.

In France, two major laws have recently modernised the legal framework; one is on water, the other on agriculture.

The 1992 water law modified and complemented the 1964 water law. The combination of the two laws creates a framework for water management in France. The 1964 law stated the unity of water resources (groundwater, surface water and coastal sea-water) and established its management through basin units; the 1992 law put forward the objective of a balanced management of water resources considered as a national asset. This latter is based on two major principles:

The first principle is that water belongs to the commons (common asset) of the nation and therefore, a comprehensive and balanced management must be undertaken to reconcile the user's needs and the protection of the environment {natural systems}.

The second is the principle of subsidarity, which specifies that water management must be decentralised, negotiated and collected at the most appropriate level.

These two principles are meant to enrich and reinforce the existing approaches having the following main features:

The unity of water resources and the interdependency among uses of water leads to an integrated approach where the natural domain of the basin is put forward in place of the traditional administrative bodies (region, department).

The protection of natural systems is considered as a use of water similar to others.

The decentralisation goes along with the recognition of the importance of the local debate and negotiation.

The implementation of appropriate evaluation and measurements means is compulsory.

It must be noted that this legal framework will soon be modified by the coming water European directive, scheduled for 2000. This directive will be most likely to strengthen the above principles.

A decentralised and participatory management of water and landuse

Basin institutional bodies, basin committees and water agencies, established by the 1964 water law in France, have improved and adapted with the times, and particularly as a result of the 1992 law. Currently there is a new law under preparation, which will aim to strengthen the solidarity principle within these bodies.

Decisions concerning water policy within the six French basins are taken on an agreement basis for all the users represented in the Basin Committee (politicians, farmers, industrials, environmental associations, and consumers associations, State). The committee expresses the agreement in the general interest of the basin by voting with financial means. These are fed by taxes on withdrawals and on pollution from all users. These financial means allow support of the local managers in improving water quality and water resource.

Furthermore, the 1992 law favours, all users, in a decentralised manner, at small basin and watershed levels. The involvement and responsibility of users at a local level is in line with the recommendations made at the Rio de Janeiro Conference June 1992 and further reinforced during the Paris Conference on water and sustainable development in March 1998.

The agricultural policy framework

The Common Agricultural Policy (CAP) is a pillar of the construction of the European Union. This policy constrains the development of national agricultural of each member of the union as well as the demand for irrigation water. Initially the policy was aimed at generating a significant production growth. It has allowed security in farmer's incomes during the sixties and the seventies.

The inflexion in this policy came in the eighties, when the success generated huge agricultural surpluses. Controlling the surpluses then became the first priority. At the end of the eighties, the French agricultural department made its policy more explicit in its concerns about the environment. This has led to evaluation of the impacts of agricultural activities on natural systems, especially on aquatic systems. The agricultural sector was then asked to value quality more than in the past. Quality in this case refers to high quality products grown with respect to the environment. Maximising production is no longer the only goal for farming and the social demands of society must be considered. Water is no longer considered as an unlimited resource.

This trend has been strengthened during the nineties, and sustainable management became the central concept of agricultural policy. Water resource conservation requires a balanced and sustainable management. Agricultural development must be made with a long-term view and must combine economical efficiency, social equity and environmental protection.

The trends within the common agricultural policy (CAP), which avoid targeting growth yields and aim rather to control the quantity produced, have not led so far to a decrease in the irrigation demand.

A new mission for agriculture: landuse management

The new agricultural law of 8 July 1999, redefined the legal framework for agricultural activities, and extended the missions of farmers to that of landuse, environment and territory management. A contract CTE (Contrat Territorial d'Exploitation - Contract for Landscape Management) will, in the future, link the farmer and the State for a four to five year period. This contract will consider both the creation of economic value and protective landscape management. This contract modernises the job status in the agricultural sector, especially the status of a Farmer's partner, which is usually a women. It specifically defines and remunerates missions aimed at protecting the environment. For instance, it specifies, for the farmers who irrigate, a special commitment for reasonable irrigation practices.

4. DIVERSIFIED IRRIGATION MANAGEMENT MODES

There are three main modes of management of irrigation infrastructure in France. The choice between them results from specific climatic features but is also linked to the historical development of the country. The three modes are: Associative Management, Regional Development Companies (Sociétés d'Aménagement Régional SAR) and individual irrigation schemes.

The Associative Management

For very old developments in the south of France, in the 19th century and even before, one found mainly associative structures for management. These grouped landowners and users of shared equipment in an ASA (Association Syndicale Autorisée - Water User Association). These associations have been created to undertake collective works, as well as to manage the equipment and maintain the structures once in operation. .

This management mode has been successful for a long time and in France, today, one finds about 1800 associations with collectively 134 000 members and covering an irrigated area of 450 000 ha. This gives an average of 75 members and 250 ha per association. Their legal status allows them to act on behalf of the general interests to equip irrigation schemes, build structures and to raise fees among their members.

The success met by this type of management (1/3 of the total irrigated areas in France) is due to the strong link between the membership of the association and the landownership, and to the reliability of the fees collected; this is because they are ensured through the general tax collection system. Associative management structures have lasted for many years which is a sign of their success. They reach a fair level of solvency - the price of water covers at least the operating and usually the maintenance costs, and in some cases even part of the initial investment.

As a result of their status, the function of the associations is decentralised and farmers are responsible for the collective decisions of the association. However the size of the association seems to make a difference in this respect. In small associations (lower than 10 members), collegiality and responsibility of each member are high. The large associations are usually well structured, in a professional way, and generally efficient. However the middle sized association have more difficulty in combining collegiality and professionalism.

The overall success of this type of management does not hide some weaknesses that are the result of two main causes. The first is that farmers are usually more inclined to manage with a short term perspective rather than considering the long term, and therefore they usually do not plan for sufficient maintenance and renewal of the main equipment. The second is that the status based on landholding is inflexible. It does not allow for adjustment of landuse (e.g. in the fringes of the cities) or of farming systems. This lack of flexibility is also a problem when social demand evolves and leads to conflicts between urban and rural and between young and old farmers, which jeopardises the whole system.

Maintenance used to be regularly carried out in the past, often through collective {co-operative} works involving each associate. Today, maintenance faces technical and financial difficulties that will require some associations to be fully modernised.

This associative mode can function effectively together with the other modes. It is not rare to have associations within the large domain supplied by a regional development company (SAR). In fact some SARs carry out parts of the missions of the association beyond water supply (e.g. maintenance).

The Regional Development Company (SAR)

Most modern development since World War II, has been undertaken by regional developing agencies (Sociétés d'Aménagement Régional -SAR). The Agricultural Department created SARs between 1956 and 1964, with the goal of developing the South of France. There are 5 regional companies in France, 3 of them directly manage equipment for irrigation totalling 275 000 ha within their own concession, and another 90 000 ha for which distribution is the responsibility of others (support supply to associations and to individual irrigating farmers).

The SARs have been involved in the development of new resources and/or in projects aiming to better use existing resources. They have acted as the arm of a strong political move, aiming to eliminate the lag of development found in the south of France, where the structural effect of water is fundamental. Although agricultural water is very important for development, domestic and industrial uses are equally important for some SARs. . For these SARs, water demand development provides a perfect illustration of balanced regional development between the rural and urban worlds.

The initial development investment is partially subsidised, to a level depending on the water use. Loan reimbursement (for the non-subsidised part of the initial investment), the operating costs, maintenance costs and the cost for renewing the equipment are totally covered by the charges for water, without subsidies. The system is operated under the following principles: equity (for all users), high quality of service (guaranteed by a contract with customers), continuity and sustainability (perennial maintenance and adaptation of the structures), transparency and responsibility. Farmers are represented on the board of the SAR.

Generally the infrastructure is well developed and the management efficient, compared with other regions in France :

- There are rarely conflicts between users of water within the SAR Concessions.
- The sustainability of the equipment is ensured thanks to an original mechanism for renewing the structures.
- Users pay for the operating costs, whilst maintenance is partially funded through the initial investment.
- Nowadays the accounts of the operators are usually balanced.

The long-term missions of the SARs have not been fundamentally modified since their initiation; but they have been regularly updated, focussed and adjusted through successive mission letters. However the internal functioning of the companies has radically changed. Beyond the regional development of irrigated agriculture, each SAR has been asked to fulfil other missions including water resource management, supply to non-agricultural users (Urban industrial), and the development of engineering capacity (consultant company).

Initially SARs were a direct creation of the state, mainly governed and supported by the state. They have now evolved, with reduced state influence, towards a function aimed at the benefits of the local territorial political bodies and water users. They therefore provide an original example of a "semi private or semi public" function in which the companies, while assuming some public or collective mission, are run under the private company principle with the necessity of balancing the accounts.

Collective management of individual irrigation schemes

An important part of the recent development of irrigation is based on individual initiatives. These may be the creation of new resources using a farm reservoir or more often the withdrawal from shallow groundwater or direct offtakes from rivers. In terms of cultivated area, this type of irrigation is in the majority with1.2 million Ha. The collective management of these individual irrigation initiatives is an important challenge for the integrated management of multiple uses of water. In summer the crop demand for water is at its highest, whilst inversely the surface natural streams are at their lowest levels. Maintaining an acceptable water quality in these streams requires that nearby shallow groundwater withdrawals and direct river offtakes are planned and controlled. The collective management of individual irrigation schemes therefore became a very important challenge by the end of the eighties, particularly in those areas presenting high quantitative deficits, for example in the South West of France (Gascogne, Charente,…). The solution of acute conflicts arising in these basins required the development of a new approach to integrate management as well as the implementation of specially adapted economical tools (quotas and tariffs).

The importance of the regulating role of the State

The State has largely withdrawn from the management and operation of water infrastructures, however it remains the only safeguard (warranty) for a good long-term management of resources and infrastructure. In this perspective the role of the State, or of any other public body, should not be diminished. Large irrigation systems represent huge investments, paid by the community as a whole, and it is completely legitimate and important that their management and maintenance be controlled by a public body and not by the users of the systems alone. The total withdrawal of the influence of the State would be dangerous. An appropriate maintenance[1] supposed a long term management policy which can contradicts with the usual profitability criteria of private business. The consequences of inadequate maintenance are not immediately obvious, but may emerge many years later when it is either too late, or the situation is such that the public authority is forced to fund costly rehabilitation works. The users themselves are price sensitive and may not understand the long-term economic benefits of an appropriate and sustainable maintenance programme. These potential conflicts of interests are important and must be taken into account.

The necessity of modifying the water management modes implies the Development of new methods of management, new decision making tools and new economical tools. Pilot schemes are needed to test these new ideas in the field, with local operators and partners, with the goal of documenting results and useful information and making these available to the entire profession. In this regard the State has a key role to play to instigate and co-ordinate a consistent policy of Research and development into management, with particular emphasis on regional factors useful to local partners.

French actors in the field of water have agreed to underline the importance of the role of the state and to reinvest in new missions for the sustainable management of water resources and infrastructure alongside local operators.

5. THE VALUE OF WATER AND MANAGEMENT TOOLS

Irrigation management can be split into two subsets: management of the resource and of the uses, and the management of transport and distribution infrastructure. The two are linked and complementary when, for example, the irrigation system is downstream of a reservoir, or dissociated for instance when individual pumping equipment shares a common source (examples: Charente, Beauce).

Through management tools irrigation aims to either ensure a reliable response to the demand for water, using the resource available, and/or to balance the accounts of the operators in charge of transport and distribution of water to users.

Tariffs and quotas have been thoroughly investigated to evaluate their effectiveness.

Professionals are currently collaborating to instigate many investigations with research centres focused on the value, the cost and the price of water. The water law of 1992 specifies that water is a common property of the nation. It therefore gives a special status to water of being both an "economical good" and a "social good", the management of which cannot be left to market forces alone.

The value of water

The economical value of water, necessary for comparison of different uses of water within the same category or between regions, is one, but not the only determinant of management decision making. In irrigated agriculture, the economical value is :

- a strategic value linked to the decision about the proposed cropping pattern at the start of the season. It is equal to the ratio of the differential of added value between irrigated crops and non-irrigated crops to the volume of water required for irrigation (in \$/m3).

- a tactical value during the irrigation season which is equal to the marginal gain of added value per unit of water volume.

The cost of water services

The notion of cost is very variable depending on the components incorporated in the computation. The full cost includes the initial investment, the operating and maintenance costs, the renewal of the investment and the cost linked to the withdrawals from the natural system (value of water at the withdrawal). The sustainable cost is equal to the full cost minus the financial cost of the initial investment. It therefore includes the operating and maintenance costs, the renewal of the investment and the cost of withdrawals from the natural system. The sustainable cost does not allow for the creation of new investment but is designed to cover the long-term operation and equipment maintenance without the use of additional public money.

In the main French systems, managed by the SARs, water price is higher than the sustainable cost, and is nearing the full cost (initial investment partially subsidised by the state); the average price for agricultural water is about 1F/m3 (0.15 Euro or $ per m3).

In France today professionals are aiming at the realistic objective of the recovery of the sustainable costs for the main infrastructure for water storage and transport. This position is justified as these components are usually multipurpose structures and they are part of a comprehensive regional development. For irrigation distribution systems the objective is to generalise a tariff policy allowing recovery of an intermediate between the sustainable and the full costs. In the case of multipurpose structures, all users of water must contribute equitably to cover the costs.

Metering water withdrawals

The 1992 water law requires the implementation of evaluation and measurement of all the uses of water. Generally collective systems are equipped with meters. However there is a significant trend to equip individual irrigation schemes as well, particularly in the basins where co-operative management is proving difficult. This trend is the result of an equity concern among the farmers, as well as a concern of communication with other water users. Metering devices enable negotiation with real, reliable and incontestable figures. Thus the density of meters in the Charente Maritime departement, where the pressure on the resource is very high, is also very high reaching 81%.

Tariff and quotas

The analyses of the value and cost of water feed into a comprehensive investigation of a 'fair' tariff policy. This policy must be efficient enough to enable a balance of the accounts of the local operators without being unduly cumbersome, and should also allow the regulation of water allocations in regions where water is limited. Answers are site specific and depend on the type of management (ASA-SAR-Individual).

All users of water in France must pay a fee to the water agency, based on their consumption. For irrigation, the recovery of the fees is generally achieved in the collective systems of ASAs and SARs but is less successful for individual irrigation schemes.

6. TECHNICAL PROGRESS

During the era of high growth of irrigated areas, the trend has been to classify a hierarchy of irrigation techniques according to their assumed level of performance. Thus localised (or drip) irrigation has been assumed to perform more efficiently than sprinkler irrigation, and the latter more efficient than surface irrigation. After years of practical experience in the use of all these techniques, it is now recognised that this hierarchy is not so clear. There is no perfect technique for irrigation, and what is important is the appropriate adaptation of the equipment to the site constraints, the nature of soil the crop, etc.. In some cases, sprinkler irrigation can be more efficient than localised irrigation. The main factor contributing to the performance lies in controlling the supply to the crop whilst using other water resource inputs effectively and in conjunction with irrigation. Irrigation control is now recognised as a major factor in the performance.

Thus at the field level, the area of expected technical progress is in the irrigation techniques, but particularly in the techniques for controlling the water supply to the crop; and in this way helping the users to increase their irrigation efficiency.

For main system management (storage, transport and distribution infrastructure), important progress has been recorded during the last forty years or so, in methods of regulation and in the automatic control of structures (Dynamic regulation, remote control, and telemetry). These methods have proved their effectiveness in improving the management of water supply in situations with fluctuating demand. They have also enabled management to minimise water losses. These modern and efficient operation and management methods were developed by the SARs and are today widely used by them on basins with important irrigation schemes in the south of France. These methods should be extended to the basins of the central and western parts of France.

7. FLOOD CONTROL

Recent massive floods (November 1999) in the South of France (Aude, Tarn and Pyrénées Orientales) have reminded us, in a cruel way, how floods can have devastating material and human consequences, particularly flash floods.

A full protection against flooding is impossible {or prohibitively expensive}. We know that this kind of events will occur from time to time and we can even estimate, on average, how often they will occur. However we are not in a position to anticipate them as they come without warning. Whatever the techniques used, the economic resources employed and the human will, no physical infrastructure[2] will guarantee complete protection from flooding and be universally acceptable. In addition the size of flood alleviation schemes required to capture the biggest (and therefore most infrequent).

If we cannot completely avoid damage then the goal should be to minimise it, with a high priority on actions that aim to suppress or decrease the loss of human lives; damage that cannot be rehabilitated.

Two types of complementary actions, must be contemplated :

- Structural actions: dikes, reservoirs, and river rehabilitation schemes…. These are costly but in some cases there appears no alternative.
- Non-structural actions: a better understanding and knowledge about the phenomenon, risk identification, information, landuse rules, warning and alert system, crisis management,…. These are often less costly and still can be very efficient; particularly in minimising human loss.

Full protection must be limited to areas of absolute priority, and these are the major urban areas. This is because full protection is very costly and it is necessary to have large undeveloped expansion areas where the flood can spread and be attenuated. Whatever we do, extremely high floods represent huge volumes of water that cannot be drained instantly, and there is a need to provide storage areas to minimise damage. Limited zones with high priority must be protected and for the remaining areas special crisis management must take place.

Choosing between the two options is not an easy task as there are conflicting interests (which zones will be flooded to allow others to be protected, with what frequency, intensity, duration etc.) and still one has to be realistic in terms of financial commitment.

The decisions are mostly political. They required a high level of negotiation and discussion among the interested parties, in order to reach a consensus sufficiently high for implementation.

8. WATER FOR FOOD AND RURAL DEVELOPMENT IN 2025 IN FRANCE

The objective: reinforcement of already engaged set of actions

French actors in the agricultural water sector do not anticipate any radical changes in policy for the future. France is not facing a water sector crisis, which does not mean to say that water quality is not a major concern in some cases.

Agriculture as part of an integrated management of both water and territory.

The modern goal is to consolidate landuse practices (avoiding desertification) using modern agricultural methods, which respect and are sympathetic to the environment. The follow up of improvements already implemented with regards to the reduction of non point source pollution will require tremendous effort to ameliorate current agricultural practices. The considerable efforts used to promote reasonable irrigation and fertiliser application (program Irimieux and Fertimieux) will have to continue. However, the new initiative will be the complete integration of agricultural practices with collective water management and the implementation of the environmental missions assigned to agriculture by the recent agricultural law (CTE).

A balanced management of development

Through the development of dialogue and negotiation, the objective will be to reconcile "project developers" and "ecologists", to favour reasonable decisions and to implement collectively agreed actions in the development of infrastructure and in the rehabilitation of natural aquatic systems.

The use of modern economic tools for management

Efforts towards the use of modern means of management (meters, tariff) must continue and be generalised to each and every water withdrawal scheme. The integration of each water use in the integrated financial system (taxes and supports from water agencies) must be completed. Lastly there is a need to balance the finances of the infrastructure management leading to target at least the recovery of the sustainable cost, for which maintenance and renewal of the equipment is paid by the users.

The use of modern techniques for basin management

Modern techniques for main system management (automation, remote control technique) have been mainly developed successfully in the South of France. They will be generalised to basin of the central and western parts of France. The goal is to improve the performance of the water resource system in responding to the variable needs of multiple users (agriculture, municipal and industrial supply, environmental needs).

Improving management structures

In the past the Regional Companies (SAR) have shown a great capacity for adaptation to new constraints and requirements from their customers, and from their supporting bodies. This capacity will certainly be further stimulated in the future, although no one knows today in which direction. As far as the Associations are concerned, their situation is quite variable. Many of them will have to modernise their status to allow better adjustment to landuse changes, and to better cope with maintenance requirements. Lastly the collective management of individual irrigation schemes, which proved to be successful in some French regions, will have to be generalised and incorporated into the integrated water management of all water uses.

Agricultural Landuse management and flood control

The goal here will be to control the risks of flooding by strengthening the flood prevention policy for upstream watersheds, and moreover using real time flood forecasting and management. In this context, it is clear that the agricultural domain will be highly encroached upon for flood alleviation expansion.

GERMANY

1. Land Use

Germany is situated in the centre of Europe and covers an area of 3.5697×10^5 km^2. With a population of about 8.2×10^7, the average population density is about 230 inhabitants/km^2. In spite of the dense population and the high level of industrialisation, 54.1 % of the German territory is farmland and 29.4 % woodland. 11.3 % of the area is used for settlement and transportation systems.

2. Landscapes

A rough subdivision of Germany by landscapes shows three basic forms: the North German Plain, the uplands and the Alpine region. The North German Plain consists of hilly geest and moraine landscapes with many lakes as well as lowlands and glacial meltwater channels. Areas of moorland and heath are especially found in the north-west. The hills of the central uplands separate North Germany from South Germany. The uplands are morphologically subdivided into mountainous regions and valleys, the mountains reach altitudes from 700 to 1,500 m. The Alpine region is subdivided into the South German Alpine Foreland and the Bavarian High Alps in the south with the highest German mountain, the Zugspitze, reaching a height of 2,962 m above mean sea level (msl).

3. Climate

The climate of Germany is governed by the humid temperate climatic zone. The mean annual precipitation is about 770 mm, varying from the lowest mean of 500 mm p.a. and the highest in the Alps of about. 2,500 mm p.a.. In general, precipitation decreases from west to east.

4. Surface waters

The surface waters include six river systems, i.e. the Rhine, Ems, Weser and Elb draining into the North Sea, the Odra draining into the Baltic Sea and the Danube discharging into the Black Sea. The rivers are connected by various canals. All rivers carry water throughout the year with varying discharges depending upon precipitation, season and groundwater level.

Natural lakes are mainly found in the North German Plain and in the Alpine Foreland. They cover a total area of 1.213×10^3 km^2. Twenty six of the natural lakes have a surface area of 10 km^2 each. The largest lake is the Bodensee (Lake Constance). Additionally, there are numerous artificial reservoirs in Germany with a total capacity of 2.985×10^9 m^3 of water.

In Germany monitoring of water resources is undertaken to secure existing and possilbe future drinking water supplies and to protect aquatic ecosystems. Although both biological and chemical monitoring is undertaken to provide an indication of overall water quality, water classification is based solely on a saprobic (bilogical) index system. The eight quality classes are defined as:

- Quality Class I : No or very little pollution
- Quality Class I to II : Little pollution
- Quality Class II : Moderate pollution
- Quality Class II to III : Critical pollution
- Quality Class III : Heavy pollution
- Quality Class III to IV : Very heavy pollution
- Quality Class IV : Excessively polluted
- Quality Class V : Ecologically destroyed

Monitoring for the purpose of national classification is carried out by the Lõnder at 146 sites throughout Germany.

The long-term objective in Germany is to ensure that all waters attain at least Class II status. To a large extent this has been achieved in the west of the country, however, in the east there are still extensive problems in particular that are due to inadequate treatment of sewage, a legacy of the previous regime.

5. Groundwater

The groundwater has important ecological functions. Its natural quality must be preserved and protected throughout the country. The goals of groundwater quality must be oriented on the quality of natural groundwater- pollution must be eliminated. Polluted groundwater mean long-term damage, which can be eliminated only over a long period and with considerable technical and financial effort. For this reason, groundwater must be protected against harmful inputs of substances by means of preventive measures. To achieve this goal the soil must also be sufficiently protected with the objective of minimising the input of problem substances in terms of quantity and quality from industry, trade, transport, agriculture and households.

The quality of groundwater resources is also monitored in Germany. There is significant concern in the country about deterioration of groundwater resources, not least because of their importance as a source of drinking water.

6. Water demand satisfied by surface waters and groundwater

The annual volume of water used in Germany (data of 1995) is 4.52×10^{10} m^3, the greatest share of which (approx. 2.78×10^{10} $m^{3)}$ was used as cooling water by thermal power stations supplying the public. The industrial sector consumed roughly 1×10^{10} m^3, and approx. 5.8×10^6 m^3 was used for public water supplies. Mainly groundwater and spring water (72.7 %) is used for public water supplies, followed by surface water (22 %) and bank-filtered water (5.3 %). Roughly 1×10^9 m^3 per year were used by the agricultural sector. In total, there are 1.61×10^{11} m^3 of water p.a. available on average. Nevertheless, in the south-west and the central eastern parts of Germany, long distance water transfer networks are required to supply population centres in these areas.

Germany has succeeded since the 1970s to uncouple water consumption from general economic development. Between 1970 and 1990 water taken by industry from public supplies decreased by about one third. The water productivity of the economy as a whole has thus increased. This is also true for the per capita consumption of households, small businesses and the agricultural sector.

Two components can be discerned: first, the prevention of pollution by way of advanced water treatment; and second, the multiple use and reuse of (protected or treated) water within industrial plants. The "minimisation approach" trend will continue to be promoted as shown by the laws already in force and by current policy initiatives. In addition, there is an identifiable shift in industrial water use from groundwater to surface water.

A further trend concerns the sealing of the ground which reduces groundwater recharge and increases the risk of flooding. Increasingly, municipalities are beginning to finance the treatment of rainwater run-off through a charge based on the area of sealed surfaces. This creates an incentive to cover suitable surfaces with porous stones or to infiltrate the flow from sealed surfaces rather than feed it into sewers.

7. Agriculture

The overall task of German agricultural activities today is :

- sufficient food production at reasonable prices;
- public supply with excellent food quality for the consumer's health; and
- safeguarding a sustainable and resilient environment as well as preserving the cultural landscapes.

The objective of agricultural irrigation in the humid climate sector, to which Germany belongs, is to compensate individual cases of precipitation deficits during the vegetation period with artificial water supplies in order not to improve but to save crops and their quality. In Germany, irrigation is applied to areas of intensive agricultural and horticultural activities with annual precipitation rates of less than 700 mm. It is estimated that about 5.31×10^5 ha of land, i.e. 3 % of the agricultural acreage, are irrigated. The irrigation methods employed are mainly sprinkler systems, for which generally groundwater is extracted.

In the future, the irrigated area will not steadily increase. Sprinkling will mainly be applied to special crops including vegetables and potatoes, because it guarantees great irrigation economy.

8. Legal structure

The political constitution of Germany is ruled by a federal system, i.e. public functions are partly assumed by the Federal Government and partly by the 16 Lõnder. According to the Basic Law, i.e. the constitution of the Federal Republic of Germany, the communities (towns, districts and municipalities) are part of the respective Land. However, in dealing with local matters, the communities can act to a certain extent on their own responsibility (right of self-government) under constitutional law. Federalism and the application of the subsidiarity principle are the most prominent features of water management institutions in Germany. The overall framework for water resource protection, planning, and management is therefore characterised by the fact that there are three primary levels of competence in addition to the European Union: Federal Republic, Lõnder, and municipalities. Since 1960 the Federal Government provides a legal framework for all Lõnder with the Federal Water Act. The Lõnder themselves have complemented the Act by issuing specific Lõnder Water Laws, which are legally binding upon all water users.

The principles of federalism are thus applied to water management in a flexible way, allowing decisions to be taken by water users themselves or at the municipal, local or Lõnder level, in the various professional communities, in the private or in the public sector, whichever is most appropriate. The principle of subsidiarity is thus applied throughout the structures of state government, municipal affairs and the allocation of tasks to the public and private sector, e.g. agriculture.

9. Associations

In addition, water management associations can be formed by land owners, private enterprises, municipalities and public corporations for a wide variety of functions. Corresponding to local and regional needs, these associations can be small neighbourhood schemes in rural areas or cover a large territory. They are based on the principle of user participation and local autonomy. The Lõnder have established the legal framework for associations to operate irrespective of any territorial boundaries that might otherwise hinder water management according to hydrological criteria. The Federal Government therefore has enacted the Water and Soil Act for the organisational structure of such associations. These operators of water infrastructure systems are not involved in the manufacturing or service sectors associated with the "water industry" (this term is not used in Germany).

10. Technical-scientific associations

The following technical-scientific associations are concerned with the objectives of water resources management :

- The German Association for the Water Environment, ATV;
- The German Institute of Standardisation, represented by the Technical Committee on Water Management, DIN/NAW;
- The German Gas and Water Association, DVGW and
- The German Association for Water Resources and Land Improvement, DVWK.

The ICID National Committee of Germany is organisationally connected to the DVWK.

11. Water management in Germany

Long-term objectives of the German water resources policy is based on the principles of:

- priority of prevention;
- cooperation of all parties concerned;
- allocation of costs on the basis of the polluter-pays principle and full coverage of costs with tasks performed on the basis of subsidiarity and decentralisation.

These objectives are supported by a lot of tools. One tool is water management planning. It serves to secure social and economic development in the long term. It applies to water management as well as to water resource protection which is a necessary precondition for sustainable development. The instruments for general water management planning are water management framework plans and water management plans. Water management plans aim at the protection of surface water bodies rather than quantitative water management. For water resource protection the following instruments are used: effluent disposal plans, effluent load plans, surface water protection regulations and water protection zones; in addition, flood areas can be designated.

On the basis of comprehensive water resource protection Germany has developed a zoning approach which is increasingly being recognized as a model solution. The Federal Water Act provides for the establishment of water protection zones in order to :

- Protect water bodies from harmful effects in the interst of public water supply,
- Recharge underground acquifers, and
- Prevent pollution from run-off containing soil components, fertilisers and biocides.

Water protection zones must be identified in water management registers. Activities may be restricted or even banned in water protection zones and property owners are obliged to tolerate measures connected with water protection, such as monitoring. These restrictions can be applied seasonally or year-around. Specific land uses can be imposed according to provisions in Land Water legislation. The precise restrictions are laid down for each protection zone through Lõnder legislation in the form of ordinances.

Another main tool is the requirement for a permit or licence for nearly all water uses. None has the right to a permit or licence but anyone can expect, by right, a proper decision on application. A permit can be granted temporarily, and it can be withdrawn at any point if this is justified on the grounds of water resource protection and management. A licence establishes the right to a specific water use which cannot normally be withdrawn. When issuing a licence, competent authorities have to take the rights and interests of other water users into account (in addition to the public interest). Established water quality requirements, often reflecting the need to maintain quality for specific uses, can justify denying a permit or licence.

A third economic instrument should be mentioned. In Germany, economic instruments are used to reduce the "implementation deficit" in environmental policy using direct regulations. Direct regulations and economic instruments (effluent charges and water resources taxes) are linked since the charges and taxes are levied, as a rule, only where an abstraction permit or licence is required and often not on the amount of water actually abstracted or pollution load discharge but rather on the quantity for which a permit has been granted. Finally, the taxes are usually set by the same public agencies that are also responsible for the granting of abstraction or discharge permits. From the administrative point of view, direct regulation and economic instruments are designed to work in tandem.

12. Water pollution due to agriculture

As further progress is made in waste water treatment, the main share of the pollutant load in water bodies in many cases is shifting to agriculture. Presently, approximately 50 - 55 % of all nitrogen and 40 - 45 % of all phosphorus inputs into German water bodies originate from farmland. There are no precise input data available on plant protection substances (pps), but global surveys show that only a few pps are detected throughout the year (e.g. atrazine, which has been banned since 1991).

Water pollution through farming is mainly caused by:

- erosion and rainwash of soil particles contaminating surface waters with phosphates and pps,
- leaching of nitrate as a result of the use of mineral fertilisers and farm manure of animal origin, and leaching of some pps into groundwater above detection limits, and
- direct discharges of fertilisers, semi-liquid and liquid manure, and residual liquors containing pps (which is not permitted).

The use of mineral fertilisers in intensive farming, which showed an increase until the late eighties, the large number of cattle involving a high amount of liquid manure and the increased application of pesticides over the past few decades have led to a greater pollution of waters, and groundwater in particular. A change of contamination has very often not been observed until today because of the long time lag between application and detection in the groundwater layers.

13. Environmentally sound agricultural practice

Counteracting this development requires that farming be adapted to an ecologically and socially sound structure. Already enacted are the Federal Water Act, the Fertilisers Act, and the Plant Protection Act as well as the EC Directive concerning the Approval and Application of Pesticides and the EC Directive concerning the Protection of Waters against Pollution through Nitrate from Agricultural Sources ("Nitrate Directive") being important legal provisions for an environmentally compatible agriculture.

Land use by agriculture, according to the rules of good professional practice, has to be introduced to minimise as much as possible the nutrient inputs into waters. Pesticides, if properly applied according to the provisions, must not have any harmful effect on ground and surface waters.

The farming community itself has long acknowledged the requirement of water protection and has recognized the considerable potential of practical improvements. The DVWK and other associations therefore have published a "Position Paper on the necessary political Initiative for Agriculture and Water Protection", and have presented this paper to the Federal Government for a reorientation of the Common Agricultural Policy and to establish a harmonised agricultural and environmental policy. The European Water Framework Directive, presently submitted to the Council of the European Union for negotiation and decision-making, will substantially influence water protection and practised land management.

14. Flood protection

Comprehensive inland flood protection measures, i.e. mainly the construction of dykes, but also retention basins and reservoirs, have considerably reduced the danger of flood damages in Germany.

The reduction of flood plains through dyke construction, the acceleration of flood waves as a result of river training, barrages and coincidences with the flood waves of the similarly developed tributaries have caused a substantial rise in flood peaks in large rivers. A reduction in the water retention capacity of the countryside, brought about by the expansion of settled areas, intensive farming, damage to forests in mountain regions and the training of small rivers has also contribute to intensified flood events. Severe flood damages of recent events appeared in late 1993 and early 1994 and in January/February 1995 on the river Rhine and in the summer 1997 in the Odra basin.

Existing protection systems must be maintained and developed in accordance with the state of the art. The stability of flood protection facilities (reservoirs, retention basins, dyke systems, flood spillways) must be maintained, and if necessary improved through continuous inspection.

Future measures will put emphasis on the conservation and reconstruction of natural flood plains (e.g. riparian forests) and on the conservation or restoration of rivers and lakes. Flood plains have to be allocated, where structural changes and any kind of use with adverse effects will be prohibited.

In addition, a great variety of measures of minor importance must be implemented to support the retention, infiltration and retardation of precipitation run-off from developed areas and farmland. Also needed are measures which, in combination, can mitigate floods in smaller rivers. Such measures include, for example, soil-conserving practices in agriculture and forestry, unsealing of land surfaces and stormwater retention measures. Flood protection on the coast is also a major task in the five "coastal" Lõnder, in order to protect 1.1×10^5 ha of agricultural lowland which can be flooded through storm surges if no precautionary measures are applied.

15. Rural Development

The overall societal framework conditions for rural areas are changing rapidly at national and international levels. Among the highlights are the reunification of Germany, the EU enlargement to include Eastern European countries, the globalisation of world markets, the continuing development of the EU's structural policy, a continuing change in agricultural structures as well as the establishment of the sustainability principle for regional development. Against this backdrop, rural development must face up to great challenges. These include:

- supporting agriculture and forestry,
- promoting regional and community development, and
- securing durable conservation of natural life-support systems.

Buttressing the economic strength of rural areas and securing and creating jobs are the decisive factors for the development of rural areas. This requires:

- efficient and competitive, market-oriented and environmentally sound agriculture and forestry sectors,
- job alternatives outside the agriculture and forestry sectors,
- an efficient and demand-driven infrastructure (transport, supply and disposal, telecommunications,

education, cultural and social affairs),
- an attractive living environment, and
- a healthy environment, leisure activities and a high cultural standard.

It is becoming increasingly clear that those regions can best face up to transformed framework conditions, which develop self-sustaining economic and financial cycles. They are particularly important for agriculture and forestry, as they play a vital role in coping with changing agricultural structures.

Agriculture and forestry still are important sectors of the economy in rural areas. As they fulfil manifold area-related tasks they are of fundamental importance for the whole of society. Agriculture and forestry are the only economic sectors securing the management, preservation and development of the cultural landscape as a whole. Aiming at promoting competitiveness of agricultural and forestry enterprises and advancing their active and smooth integration into a sustainable regional and community development, rural development instruments are to be used as follows :

- A foresighted land and soil management must prevent conflicts in land use, which increasingly interfere with agricultural and forestry purposes. Existing land use conflicts must be settled.
- The development of holdings in the new Laender must be effectively accompanied by the determination and reorganisation of the location of property areas.
- Cultivated areas must be adapted to the economic requirements resulting from the continuing structural change in agriculture according to their location, form and size and must be developed by a suitable network of roads and water bodies. The participation of farmers and foresters in area-related promotion programmes must be supported in the restructuring process.
- Gains in productivity and time can free resources for non-agricultural activities and income alternatives. In addition to direct marketing, tourism and management measures in the framework of nature and landscape conservation, the provision of new services in the framework of village renewals must be facilitated. This can be done by converting the use of agricultural buildings, in particular for the purposes of living, commerce, trade, cultural activities or public and community life.

In order to improve site qualities and living conditions in rural areas the implementation of the following goals is a priority:

- High priority must be given to the protection of land ownership. Settling competing claims for using and determining the location of property means creating legal certainty, using private capital and thus promoting public and private investment.
- Providing land for infrastructure projects and building sites at attractive locations facilitates the establishment of service, craft and trade industries.
- Support must be given to the design of a rural infrastructure which is tailored to needs.
- A sustainable housing development with little land consumption must be promoted, for instance, by preserving characteristic village buildings through converting their use and renovating them.
- Community spirit, community life and village culture can be revitalised, for instance, by preserving or establishing community centres, village inns and village stores as well as by supporting social and cultural initiatives.
- Provision of areas for water retention and reducing the risk of erosion.
- Support of the protection of land and water and preserve drinking water reserves.
- Compensation and substitution measures at suitable locations in accordance with nature conservation legislation should be carried out.
- Special environmental protection programmes, for instance programmes concerning wetland meadows, riverbanks, statutory nature conservation and extension should be supported.
- Ecological assets to villages, for instance by designating green belts, planting greenery, unsealing surfaces and restoring water bodies should be added.
- Land management is one of the core competences of rural development. In the interest of a future-oriented rural development strategy it can be helpful in the following situations :

- in difficult, problematic cases of land reorganisation; planning and implementation are to be offered "as one". For instance in the case of big infrastructure projects, recultivation of landscapes characterised by open-cast mining, conversion projects and cross-community projects,

- land use conflicts must be solved through an accommodation of interests, for instance involving development, agriculture, infrastructure or landscape management,
- area-related rights and obligations must be sorted out, for instance if use restrictions, compensation and substitution obligations or reforestation are involved,
- plots must be effectively redesigned as to their location, form, size, service infrastructure and in relation to neighbouring plots,
- the ability to dispose freely of privately owned land must be restored, for instance through reuniting separate ownership of land and buildings,
- the privatisation of formerly state-owned agricultural and forestry property must be supported,
- farmed land must be designed in an effective agri-structural manner in view of the increasing percentage of leased land in agricultural enterprises.

In order to shape the future in rural areas together, administrative action for the application of rural development instruments must be brought up to date according to the following action guidelines:

Preparation is the key to efficient rural development

The condition for good rural development is a thorough preparation of the procedures to be used. For this purpose all stakeholdes must gather around a table in order to facilitate discussion on all concerns relevant to the application of the procedure. As there is a strong focus on the goals, even in the preliminary stages, the procedure can be implemented in a clear thematic and timely framework.

Drafting and co-ordinating rural development schemes jointly

Development opportunities for rural areas must be promoted in order to achieve an effective and integrated development scheme. The combined efforts of all relevant stakeholders based on partnership and dialogue are necessary. Financial and human resources should be pooled, in co-ordinating different plans, in launching and taking up initiatives of communities and citizens and in acting rapidly, efficiently and to the benefit of the citizens and rural development in the future

Citizen participation secures acceptance

Pure expert planning is to be replaced by open planning methods which actively involve citizens. The knowledge, experience and ideas of citizens with regard to the development of their immediate home environment must be used. Working groups, village and land workshops and discussions on models for regional and village development are designed to enable citizens to draw up development goals jointly with the planning authorities. Intelligible "bottom-up" decision-making processes lead to a high degree of acceptance and strengthen accountability.

Controlling rural development through moderation

A moderator must be appointed to control the land development process. It is his/her task to moderate the concerns of all stakeholders and to facilitate a planning result, which can achieve consensus, is geared toward implementation and has financial backing. The decision as to who will assume the function of moderator must be taken on the basis of the given conditions.

By mutual agreement, this function can be assumed by politicians, representatives of the Laender, regional or municipal administrations.

16. Summary

One characteristic of water management in Germany is the clear separation between state institutions with global responsibility for the protection and management of water resources on the one hand, and the private or municipal operators carrying out specific functions of relevance to water management on the other hand. The state administration, as a rule, has no direct interest in water use or the use of water bodies so that in principle conflicts with private interests do not occur. Any significant use of a water body has to be permitted by the competent supervisory authority and no special rights or privileges result from private ownership of water courses which, in any case, exists only for the minor water ones.

The implementation of environmental policy through direct regulation by prescriptions, prohibitions and limit values has, in water resources protection and management, been combined with economic instruments, both for setting incentives and providing revenue. A characteristic of water management, land improvement, water supply and sewerage in Germany is the diversity of small, municipal or regional operating units.

Municipal self-government in cities, towns, municipal associations and rural districts follows political boundaries. Whereas these small-scale units are appropriate for decision-making and operational water distribution and sewerage, larger associations are sometimes needed for water catchment and sewage treatment. The functional self-government in water management associations have proved to be effective for water management functions such as flood control, irrigation and drainage which cannot be achieved within political boundaries, or for functions like long-distance water transfer or the joint operation of (large) sewage treatment plants which require municipal cooperation at a regional level to reach regional objectives. Member's contributions, as well as voting rights, are based on an assessment of respective benefits, leading to equitable shares in making contributions.

At the root of the strength and stability of self-governing units is their financial independence. It follows from cost-recovering water prices and sewerage charges as well as the financing of associations through member's contributions that the associations and municipal operators of water supply and - with some qualifications especially in the new Lõnder - sewerage do not, in principle, rely on external subsidies.

The concentration of expert knowledge in the technical and scientific associations is also a strength of the institutional system in Germany. Through the voluntary cooperation of experts and institutions, the rules of good practice and the state of the art are developed and are generally made available as rules and standards. The competence of the committee work in these associations is recognised by legislators and implementing authorities in that they refer to the rules and standards of the associations.

The motto for integrated rural development is:

Plan jointly, coordinate your actions, secure a speedy implementation, pool financial resources.

Giving lasting support to the development of municipalities, agriculture, forestry and the natural balance means to actively promote employment for people in rural areas. Agri-structural development planning, land consolidation, special property rules in the new Lõnder and village renewal provide partnership in land management.

Germany does not suffer from water scarcity, however, water saving measures are taken in all producing sectors. Agriculture, too needs water of good quality for growing crops of good quality and improving productivity. It needs land improvement for this purpose including rural development for other income possibilities.

Literature :

CORREIA, Francisco Nunes, KRAEMER, R. Andreas (editors), Lõnderarbeitsgemeinschaft Wasser (LAWA): EUROWATER, volume 1 "Institutionen der Wasserwirtschaft in Europa; volume 2 "Dimensionen Europõischer Wasserpolitik", Springer-Verlag, Berlin, Heidelberg, 1997

Bundesministerium f³r Ernõhrung, Landwirtschaft und Forsten (Federal Ministry for Food, Agriculture and Forestry): Draft Guidelines for Rural Development - Shaping the future in rural areas together, 1998

Bundesministerium f³r Umwelt, Naturschutz und Reaktorsicherheit (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety): Environmental Policy - Water Resources Management in Germany, 1998

GUYANA

1. INTRODUCTION

Guyana with a land area of two hundred and sixteen thousand (216,000) square kilometres is located on the mainland of South America fronting the Atlantic Coast in the north and Venezuela, Brazil and Suriname in the west, south and east respectively. The country is divided administratively into ten (10) Regions with most of the population concentrated on a narrow strip along the coast between the Pomeroon and Corentyne Rivers.

The width of the coastal plain ranges between ten (10) kilometres to about eighty (80) kilometres near the Berbice River. The coastal plain extends along two hundred and seventy (270) kilometres of shoreline and covers an area of approximately ten thousand, four hundred square kilometres (approximately 5% of the total land area). There are many rivers and streams crossing the land mass and the country is regarded as the "**Land of Many Waters**."

On the coast, the average land levels are approximately one (1) meter below mean high water level. An extensive system of sea defences protects the coast against flooding during high tides which are semi-diurnal. Drainage is effected through sluice gates and pump stations which release flood water during low stages of the tide.

Ground levels rise gradually to between nine (9) metres to fifteen (15) metres above mean sea level along the northern boundary of the upland white sand hills which is a well defined terrace. Further the altitude increases to some one hundred and twenty (120) metres.

The white sands cover an extensive part of Guyana up to one hundred and sixty (160) kilometres from the coastal plain. They are characterized by gently undulating topography, shaped mostly by stream erosion. The more sizable rivers such as the Berbice, Essequibo and Demerara have dissected the white sand formation down to the underlying Pre-Cambrian basement.

The coastal plain has rich alluvial soil suitable for cultivation of paddy, sugar cane, and other non traditional crops. This, coupled with round the year cropping season, makes agriculture the most important economic activity in the country. Surface water is mainly utilized for agriculture. Guyana's agricultural production is five times larger than what it requires for its internal consumption. 80% of its produce is therefore, marketed outside the country and agriculture is the biggest foreign exchange earner for the present.

Adequate and timely provision of water is essential for intensive cultivation. Any shortage will affect agriculture production, economic and social activities, and cause hardship to the population. Since rainfall is unevenly distributed in time and space, it has been considered important to develop an effective drainage and irrigation system on the coastal areas for dependable cultivation.

The coastal plain is also endowed with ground water, which provides a source of domestic water supply, with the white sand outcrop serving as the major area of natural recharge. Considering the proximity of the sea and the risks of the salinization of coastal wells and the aquifer, ground water utilization strategy has to ensure safe and long term operation free from sea water intrusion.

The interior of the country has vast potential for hydropower, but this resource has not been tapped to date except for 500 MW Station at Moca Moca in Region 9.

2. RESOURCE MANAGEMENT

The climate of Guyana is equatorial, its main features being high but variable tropical rainfall, high humidity and narrow variations of temperature. There are normally two (2) dry seasons lasting from February to April and August to November. The mean yearly temperature is 80^0 F. The August to October period is regarded as hot. In the interior the mean temperature is higher ranging from 66^0 F to over 100^0 F. The yearly rainfall is subjected to marked variation. Two wet seasons from about the middle of April to the middle of August and middle of November to middle of January are normal, but it has been known that one wet and one dry period may not occur in any one year.

In order to protect the agricultural and residential areas from flooding from the sea, it is necessary to maintain an elaborate system of sea defences; comprising earthen sea dams, reinforced concrete sea walls with masonry wall and recently constructed rock armour walls (rip rap). The problem of obtaining adequate drainage at moderate cost is a constant and difficult one in view of the fact that the average rainfall per annum is approximately 2500mm and the coastal plain is below the sea level. Drainage by gravity is possible only when the tide is low, and this form of drainage is affected by the ever changing levels of the foreshore outside the sea defences. On this account it has been necessary in many areas to resort to the expensive method of drainage by pumps.

Another major difficulty is the problem of ensuring an adequate supply of irrigation water when needed for the cultivation of the two main-crops - sugar cane and paddy. The supply of irrigation water comes mainly from shallow reservoirs or conservancies (2m to 3m deep) selected behind the cultivated lands and is conveyed by gravity flow through a system of canals.

The present drainage and irrigation infrastructure caters to approximately 237,000 ha of agricultural land. About 66,000 ha are under sugar cane cultivation and are mostly managed by the GUYSUCO. An equal amount is under rice cultivation and the remaining area is devoted to cattle and non-traditional crops such as root and tuber crops, fruit and vegetables.

In all the Regions, the D & I system consists of an extensive network of drainage and irrigation canals, structures and access roads. The main irrigation canals flow into the secondary canals and the flows are controlled by the head regulators. Farmers obtain water from the secondary canals by way of gravity flow through wooden gates. The main drainage canals receive the flow of secondary canals and empty directly into the sea through sluices or into facade drains which empty into the sea through sluices. The total length of the irrigation canals in Guyana is 485 km of main canals and 1100 km of the secondary canals. Similarly, the main drainage infrastructure is about 500 km in length while the length of the secondary drainage system is 1500 km. There is also a network of access roads that runs through the farms along this drainage and irrigation system and is about 1100 km in length. There are more than a thousand water control structures. The details of regional distribution of the drainage and irrigation system is shown in table 1..

Table 1. Regional distribution of D&I works (Figures in km)

Region	Main Irrigation Canal	Secondary Irrigation Canal	Main Drains	Secondary Drains	Farm Access Road
2	87.4	216.3	117.3	274.1	359.0
3	146.7	62.6	101.1	116.3	96.0
4	32.8	87.5	39.2	216.8	95.2
5	51.2	373.6	100.2	396.8	106.3
6	117.1	358.7	146.6	479.0	440
TOTAL	435.2	1098.7	504.4	1483	1096.5

The coastal region abstracts potable water from the Artesian Coastal Aquifer comprising the Upper Sand, (A) sand and (B) sand. The Upper sands aquifer, which underlies the upper and young Demerara clays was found to be of poor quality, saline with a high iron content and abstraction from it ceased in 1913. The A sand aquifer found at depth one hundred and fifty (150) metres to two hundred and fifteen (215) metres has water with a low chloride content, although the iron content is high. The B sand aquifer is generally found at a depth of three hundred and sixty (360) metres to four hundred (400) metres below ground level. The quality of water is superior to that of the A sands. However, it does contain a trace of hydrogen sulfide.

Direct recharge of the sand aquifer beneath the coastal plain is prevented by about fifty (50) metres of relatively impermeable Coropina and Demerara Clays. The greatest potential for recharge is therefore the white sand hills, which are permeable and well drained. A high portion of the rainfall infiltrates the sands and enters the ground water system.

An estimate has been made of recharge through the white sands out crop, based on a monthly water balance. An approximate estimate indicates that 157 - 471 MCM per m drawdown is available and that water levels can be lowered in the future by some 15-25m. Present exploitation is estimated at 65 MCM/yr of which 60MCM/yr is abstracted from the A aquifer. The Georgetown water supply system is presently supplemented by surface water from the East Demerara Water Conservancy, but this will be replaced in the future programme by further subsurface abstraction. The river water in coastal areas is saline for a major distance up stream due to tidal influence. This water is therefore unsuitable for drinking and agricultural use.

In the interior areas, potable water is supplied free of charge by the state where there are small communities and abstraction can be achieved by shallow wells or storage of rainwater.

Although Guyana has great potential for hydropower, the development is still at its infancy stage. The hydropower Division functions under the Guyana Natural Resource Agency (GNRA).

3. INSTITUTIONAL DIMENSIONS

ORGANIZATION OF THE SECTOR

The present administrative organization of Guyana's water resources has been in place for over a century. There are some fifteen agencies administering in excess of eighteen (18) different pieces of legislation relating to water and their functions either directly or indirectly often overlap.

The functions of the more important of these agencies are as follows :

HYDRO-METEOROLOGICAL DIVISION OF THE MINISTRY OF AGRICULTURE

This Division is responsible for reporting and forecasting on the entire meteorological spectrum, the incidence and distribution of rainfall; the properties, flow and general hydrology of surface water and ground water, river flows and tidal phenomenon.

LAND & SURVEYS DEPARTMENT OF THE MINISTRY OF AGRICULTURE

This Department has custodial responsibility over all rivers and creeks of Guyana, except as comprised within a state forest declared under the Forest Act. Permission for navigation may be obtained from the Commissioner of Land and Surveys or as the case maybe, the Conservator of Forests. A more comprehensive set of responsibilities is defined in the River Navigation Act which makes provision for safe and convenient navigation of the rivers of Guyana. This Department also administers the provisions of the State Lands Act.

GUYANA SUGAR CORPORATION

The Guyana Sugar Corporation (GUYSUCO), in whose hands the nationalized lands and supporting services infrastructure were placed, gained control of vast waterways on the Coast. With that control also devolved responsibility for the management of water not only for the purpose of drainage and irrigation but also for transportation. GUYSUCO have about 66,000 ha under sugar cultivation.

REGIONAL DEMOCRATIC COUNCILS

Between 1983 and 1994 these were responsible for the management and operation of drainage and irrigation networks outside the sugar industry. Since 1994, they are acting as the agents for the NDIB who absorbed these responsibilities.

SEA DEFENCE BOARD

The Board which is responsible for the management of the coastline of some 260 miles oversees the construction and maintenance of sea defences, which comprise earthen dams, concrete sea defences, rip rap, natural sand reefs, etc.

NATIONAL DRAINAGE AND IRRIGATION BOARD

National Drainage and Irrigation Board (NDIB) is responsible for construction, operation and maintenance of drainage and irrigation infrastructure in Declared Drainage and Irrigation Areas totaling 166,112 ha.

TRANSPORT AND HARBOURS DEPARTMENT

The Transport and Harbours Department (T&H.D) is responsible for the management of Government vessels, and the control, regulation, improvement and lighting of the ports of Georgetown and New Amsterdam.

MAHAICA MAHAICONY AUTHORITY

The Mahaica Mahaicony Authority (MMA) was established in 1977, as a corporate body to develop lands and water control facilities in the coastal areas between the Berbice and Mahaica Rivers.

GEORGETOWN SEWERAGE & WATER COMMISSIONERS

The Georgetown Sewerage and Water Commissioners (G.S&W.C.) is responsible for the care, inspection, maintenance and management of the sewage and water works in Georgetown.

EAST DEMERARA WATER CONSERVANCY

The East Demerara Water Conservancy was designed as much for irrigation and flood control as for the improvement of domestic water supplies for the city of Georgetown. It is managed by a Board of Commissioners and supplies irrigation to the agricultural areas in Region 4.

BOERASIRIE CONSERVANCY (WEST DEMERARA)

The Boerasirie Conservancy was designed mainly for irrigation. A Board of Commissioners manages it. It supplies irrigation to agricultural areas in region 3.

GUYANA WATER AUTHORITY

The Guyana Water Authority (GUYWA) has defined responsibilities to enable it to eventually take over the control and administration throughout Guyana of something more than fresh water supplies. The Act establishing GUYWA was expected inter alia to :

(a) Control and regulate the collection, production, treatment, storage, transmission, distribution and use of water and to make orders with respect thereto.

(b) Construct, acquire, provide, operate and maintain waterworks and to develop and make available supplies of water to the public.

HYDROPOWER DIVISION

The Hydropower Division was established in the Guyana Natural Resource Agency under the hydroelectric power act. Its job is to ensure that all potential hydropower sites are vested in and remain the property of the state subject only to any prior rights that may have been appropriated by individuals or other authorities before 1956 when this Act was passed.

CENTRAL BOARD OF HEALTH

The Central Board of Health was established under the Public Health Act and has the responsibility inter alia for taking all such measures as may be desirable to secure the preparation, effectual carrying out and co-ordination of measures conducive to public health. The Act then proceeded to state that :

> "No system shall be constructed, for the purpose of receiving, conducting, storing, disinfecting and distributing of any water used by man for drinking, or for domestic purposes, or for manufacturing food, or drink for the use of man without the approval of the Board; and such system for the purpose aforesaid when established, and all existing systems, save any administered by or vested in any Authority by virtue of any Act, shall be subject to the sanitary supervision and direction of the Board."

MUNICIPAL AND DISTRICT COUNCILS

The duty of the Councils is to provide a supply of water, proper and sufficient for sanitary and domestic purposes, for extinguishing fires, and for private use, in the city of Georgetown and the town of New Amsterdam.

CHARACTERISTICS OF WATER AGENCIES

The institutional characteristics of the water resources agencies can be grouped into five (5), not always exclusive, categories.

(i) Authorities performing monitoring functions
(ii) Authorities performing supervisory functions
(iii) Authorities performing development functions
(iv) Authorities performing management functions
(v) Authorities performing multiple functions

Table (2) indicates the functions which each of the agencies/institutions perform

Table 2. Institutions/Agencies and their functions

Institution/Agencies	Functions			
	Management	Monitoring	Supervisory	Development
1. Hydrometeorological Division		*		
2. Land & Surveys Dept.	*	*	*	*
3. Guyana Sugar Corporation	*	*	*	*
4. Regional Democratic Councils	*	*	*	*
5. Sea Defence Board	*	*	*	*
6. National Drainage & Irrigation Board	*	*	*	*
7. Transport & Harbour Dept.		*	*	*
8. Mahaica Mahaicony Authority	*	*	*	*
9. Georgetown Sewerage & Water Commission	*	*	*	*
10. East Demerara Water Conservancy	*	*		
11. Boerasire Conservancy	*	*		
12. Guyana Water Authority	*	*	*	*
13. Hydro Power Division	*			*
14. Central Board of Health	*	*		
15. Municipal & District Councils	*	*	*	*

4. ISSUES AND CONSTRAINTS

INSTITUTIONAL FRAMEWORK

The multiplicity of agencies characterized by lack of clear policy objectives, inadequate coordination, overlapping jurisdiction and significant variations among regions in organization and effectiveness hinders in realization of the overall objective of the sector. The objective is defined as improved water use with financial sustainability, equity and efficiency as the guiding principles.

NON-PARTICIPATION OF BENEFICIARIES IN SYSTEM MANAGEMENT

There is minimal direct involvement of beneficiaries in the system management. They have almost no representation or voice in planning and very little participation in maintenance. This results in inadequate rate collection, poor maintenance and unreliable services. Rate collection is currently only about 30%. Farmers/Users are unwilling to pay for the poor quality of services currently being provided by public agencies, while the main reason for the poor services is the severe financial constraints experienced by these public agencies.

FINANCIAL

Financing for both the capital projects and operation and maintenance expenses has been inadequate. The government policy guidelines to all the service sectors provide recovery of the O & M cost from the beneficiaries. This has, however, been difficult to realise by the public agencies administering the service.

DATA COLLECTION

Data Collection in respect to hydrology, meteorology water and land use is inadequate. It needs to be strengthened with monitoring stations increased and modernized. Along with data collection, necessary modern equipment and analytical tools need to be put in place for better project planning, design and system management.

INSTITUTION DEVELOPMENT AND CAPACITY BUILDING

The institutions handling the water related services, particularly the sea defences, drainage and irrigation, potable water supply and hydrometerology are professionally inadequate. They also need better co-ordination by putting them perhaps under one administrative ministry; each agency strengthened in terms of institutional infrastructure and professional and related capability. Thin spreading of Guyana's small professional manpower resources needs to be avoided by removing the multiplicity of institutions with overlapping jurisdiction.

5. THE VISION

POLICY

1. Sea Defences a management structure, responsible to a Cabinet Sub-committee which shall oversee/ co-ordinate the work/activities of all water related agencies/users. This structure can be described as the National Water Commission (NWC).

It is necessary to have central co-ordination and representative user participation in all facets of water management to ensure that there is no duplication of efforts or conflict in use and that interests are identified and represented. The NWC will also be authorised to evolve the mechanisms for the implementation of the National Water Policy (NWP) and the provisions of the National Development Strategy pertaining to water and flood control.

2. Continued support for a centralised electronic water information system with capability to store, analyse, retrieve and disseminate information.

A standardised national information system should be established with a network of data banks and compatible data bases allowing for exchange of data. Apart from the data on water availability and actual water use, the system should also include a comprehensive and reasonably reliable timely projection of future demands for water for diverse purposes.

3. Periodic assessment of water resources, both surface and ground water and their utilizable component on a basin - wise basis

Water is a dynamic resource whose availability varies in space and time. The unit for resource assessment and development planning should be a river basin/watershed/hydrological unit. Comprehensive data pertaining to resource availability, utilization and needs are required for sound scientific planning.

4. Integrated land and water use planning and support for sustainable watershed management.

There should be a close integration of water use and land use policies. The water planning must consider land capability and should be supportive of land improvement. Sustainable watershed management is necessary to ensure soil conservation and allow for possible ground water recharge. Catchment area treatment and conservation of existing forest should be promoted to reduce the intensity of floods.

5. adequate adaptation and application of science and technology in all areas of operational and development exercises.

For effective management of water resources, the frontiers need to be pushed forward in several directions by intensifying research and application efforts in various areas-hydrology, considering among other parameters the implications of climate change, geohydrology, river hydraulics, overland flow mechanics, ground water recharge, prevention of salinity ingress, crops and cropping systems, sedimentation of reservoirs, the safety and longevity of water related structures, better water management practices, water use efficiency and improvement in operational technology etc. The implementing agencies should have links with suitable International Centres of Excellence in their respective areas of operation.

6. legal support for the use of ground water for domestic use only until further exploitation can be supported by confirmation of sustainability in resource use.

Ground water is of immense value and a natural resource which may or may not be naturally sustainable in Guyana. Unless adequate recharge is assured, groundwater should be utilised for domestic uses only. This most valuable resource should not be mined; hence, the legal instruments should be put in place to ensure that this resource is utilised sustainably.

7. public awareness for promotion to utilise more surface water in order that ground water resources can be conserved for future necessary use.

A public awareness strategy should be in place to emphasise the value of both surface and ground water resources. Users to be encouraged to utilise more surface water as it is available abundantly in relation to the country's present and future needs. The strategy will not only conserve ground water but will also prevent salt water intrusion in the coastal aquifers.

8. adequate storage of surface water to provide for the needs of the multiple users.

Surface water storage facilitates agricultural, domestic and other uses. Information available indicates a competition for this commodity during times of scarcity which is not due to inadequate rainfall but because of avoidable spillage and inadequate storage. Efforts need to be made to store sufficient water for all uses and planning should consider a projected water demand for at least 50 years ahead.

9. an acceptable priority for water use.

This is necessary since cost is attached to the production of water. Therefore, water for various usage must be value related. Furthermore, Guyana is though, blessed with heavy rainfall, the wetness is seasonal. On occasions, the seasons are often absent. Thus, it is necessary to have such measures which will optimise the use of all available water on such occasions.

10. feasible cost recovery with adequate provision for operation and management of water systems, ensuring that there is a fair quality/quantity relationship.

The "user-must-pay" principle needs to be adopted. However, the cost of water used should take into consideration the feasible level of recovery from the user. The feasible cost recovery should recognise, adequately, the fairness in quantity/quality relationship and equity. Certain users tend to pollute the water supply; it needs to be recognised that such users compensate for the unacceptable deterioration of the water quality.

11. provision for flood/drought issues inclusive of consideration to discharge excess surface waters.

Adequate flood cushion should be provided in water storage projects where ever feasible to facilitate better flood management. Low rainfall areas should be made less vulnerable to drought-associated problems through soil moisture conservation measures and the transfer of surface water from surplus areas where feasible. The drainage of agriculture and homestead lands should be an integral components of water, urban and sea defense planning.

12. multipurpose project planning.

Water resource development project should as far as possible be planned and developed as multipurpose projects with basins as units of planning. Hydropower development should receive prime consideration as economic well- being is linked with power availability. This form of energy is clean, economical and Guyana has a vast potential for its development.

13. continued support for sea/river defenses which are necessary to protect the inland fresh water resources and the coastal plain.

The erosion of land and ingress of salt water whether by the sea in coastal areas or by river water inland, be minimised by suitable cost effective measures. The objectives of sea and river defence should be to hold the coast/bank line.

14. satisfactory hydro-environmental strategy to address water quality protection, saline intrusion and sewage discharge.

There is great need for satisfactory hydro-environmental strategy to address water quality protection, saline intrusion and sewage discharge.

15. institutional strengthening and personnel capacity building.

The institutions tasked with the development and management of water resources for different uses and purposes should be adequately strengthened in terms of modern technology and professional capability. They should have an organised program of training of their professionals in latest project planning and management methods.

16. gender and water

The traditionally accepted view that men and women have clearly defined and specific roles with respect to water use and management is no longer tenable. Put simply, this view asserts that men use water for “productive” purposes and women for “domestic” purposes. In this context, men are seen as the decision makers and policy formulators and women as the haulers and users of water. Any strategy which seeks to overhaul and redefine water policy for the twenty first century will need to adopt a more inclusive role for women. Opportunities need to be created for women to be more involved in the decisions affecting water availability and use, and in the management of water resources at all levels, beginning with the local communities. This is becoming more urgent as women, in addition to their “traditional roles” become users of water for productive purposes. At the same time, men must be sensitized and their awareness heightened regarding the impact of water policies on the lives of women and children, especially girls with respect to health, education and housing.

DEVELOPMENT STRATEGY

A national development strategy for Guyana is under formulation. The intent is to have shared development through a participatory economy. Water is recognized as an important element of social and economic change and a comprehensive development strategy has been worked out for the various use sectors.

A fifty year strategy for drainage and irrigation component development has been drawn up which consists of three phases; short term, medium term and long term. The fifty year objective through the identified projects is to provide irrigation to most of the potential agricultural land including the lands of the three agriculturally significant islands; Leguan, Hogg and Wakenaam. In addition to modernizing the existing D & I infrastructure, new long outstanding water development projects are proposed to be executed bringing an additional area of 120,000 ha under assured irrigation and drainage which will fetch 500 M tones of agricultural produce worth 200 M US$ every year generating direct employment to 1000 families in agricultural activities.

A thirty year time frame has been outlined for strengthening the hydrological and weather related monitoring and forecast activities which is as follows:

Short Term Plan (Upto 10 years)

- Continue the programme to automate the climate observing network including a Data Collection Platform (DCP) that includes eight synoptic stations, five agro-climate stations and twenty hydrological stations.
- Acquire two weather radars to provide rain estimates on an aerial basis and to improve very short range forecasts for aviation, construction and mining.
- Continue the computerization programme so that suitable and adequate computers are available for data storage, processing and other tasks.
- Improve the TV forecast presentation and the newspaper forecasts.
- Strengthen the unit in terms of staff, training facility, work environment and office support equipment.

Long Term Plan (up to 30 years)

- Implement a flood/ drought warning system. This will include collection of real time data via DCP.
- Develop computer based forecast systems for weather and climate and flood and drought forecast generation.
- Decentralize the department's operations by establishing regional offices which will then be responsible for data collection in the region and will provide forecasts, etc. to regional users. Forecasts will still be made by the central offices but will be transmitted to regional offices in real time. This will become important as ecotourism develops into a thriving economic activity in the country.
- Expand the agricultural sub-programme so that hydrometeorological advisories be changed from general information to which satisfy particular needs such as rice, sugar, coffee, poultry, cattle, vegetable etc.

6. ACTION UPDATE

The D & I and Sea Defences infrastructure which was in a state of total disarray some five years back has now been significantly rehabilitated. The USAID, World Bank, and IDB assistances have been made available for infrastructure and institution rebuilding. Finance is assured for rehabilitation of the complete system in about three years time from now.

Beneficiary participation in system management has been accepted and five water users associations established in five areas of MMA/ADA on experimental basis. The delegation Agreement to transfer the D & I system in these area to WUAs is approved. The deficiencies of the system wherever occurring are being attended to ensure a fully functional system transfer. The experiment will extend to other areas if results are positive.

A new D & I legislation has been drafted to replace the more than fifty year old D & I act. The new act embodies the policy directives of the cabinet to the D & I sector and evolves a system of financing which makes the distinction between private and public elements of the services provided by D & I and ensures the financial sustainability. It also evolves new institutional arrangements including the legislative framework for the recognition and operation of WUAs.

The National Drainage and Irrigation Board is being institutionally strengthened; both in respect of personnel capacity building and infrastructure upgrade. The services of a Dutch international consultancy firm NEDECO have been hired for the purpose. The Commonwealth Secretariat has also provided experts services to achieve these goals.

Assistance of the Government of Italy has been ensured for execution of MMA/ADA phase II and phase III projects. Necessary equipment for execution of the project are in the process of being procured.

7. SUMMARY

Efforts to satisfy the water needs of the nation have intensified in the last five (5) years. The thrust of institutional action is three fold: to upgrade the water infrastructure and expand its availability; to establish appropriate mechanisms to ensure that all improvements in the infrastructure are reflected in better conditions for the individual; and to protect the revamped and new system from premature deterioration due to poor operation and maintenance through participatory approach ensuring sustainability, equity and efficiency. The institutional action seeks/shall seek to develop and systematise “best practices and uses” for the sector.

The proposed national water policy describes the policy vision to water sector. The national development strategy for water management outlines the action plan for short and long term implementation. The thrust is to develop Guyana’s agriculture to serve as the food basket of the Caribbean and exploit its land, water and climatic potential for all round growth and prosperity of the country and the region.

The last five years have witnessed a determined stride in the right direction.

HUNGARY

1. OVERVIEW OF NATIONAL POLICIES AND DEVELOPMENT PLANS

- The processes and decisions in water management are influenced by a number of governmental and non-governmental institutions in Hungary. The laws on water management, environmental protection and regional policy, together with subsequent acts of legislation create the basis of harmonization, although some legal and other criteria of implementation are still unclear.
- Water policy making has long traditions in Hungary. However, the changes in political regime, restructuring of economy and the shift to market economy, further the requirements of sustainable development made new approaches to water policy formulation necessary.
- The new water policy of Hungary has been shaped during the recent years. One of the most important objectives of the new water management policy is to upgrade the surface- and subsurface waters to the status defined in the EU directives, which will require development efforts much greater than the present ones in the domain of water management.
- Water management planning - and catchment development planning as part thereof - have long traditions in Hungary. New features of recently started catchment management planning are the preparation of a consultation plan and the requirement of taking account of market economy conditions and ecosystems.
- River Basin Management plans have been proposed for 33 area units (river basins) in Hungary. These river basins conform to the boundaries of the catchments drained by the streams and canals. The particular water management conditions in Hungary are

characterized by the fact that over one-half of the 33 area units are in river basins of which a major part extends to the territory of a neighbouring country.

- Notwithstanding the recompensation and privatisation following the political change in the year 1990, being considered practically completed, the Hungarian agriculture is still in transition from several points of view. The estate structure and farm constitution resulting from large-scale changes in the property relations are ambiguous; their further changes can surely be expected.

1. PRESENT STATUS OF WATER

- Water has always played a decisive role in the life of the Hungarian people, which prompted the early development of a hydrographic observation and data processing network. Readings on the Danube river gauge at Budapest have been taken regularly since 1823. The national hydrographic observation network was established in 1886, the results of which have been presented since 1895 in uninterrupted sequence of Hydrographic Yearbooks (from 1998 also on CD-ROM).
- Over the past 150 years, human activities had a significant impact on runoff conditions in Hungary. Cuts have shortened the course of the River Tisza by close to 500 kilometers. Embankments have prevented river floods from spreading annually to one-fourth of the country, while from another one-fourth the excess runoff is drained by means of artificial facilities. Without these measures one-half of lands would be inundated periodically or permanently.
- Over large parts of the country, the runoff coefficient is very low, its magnitude depending in many places on the capacity and operation of the artificial drainage facilities. Dry and wet periods alternate. In areas, where the abundance of water has caused problems for several years, droughts have caused heavy losses subsequently. The low runoff coefficient has water quality impacts as well (less water will wash less pollutants from the catchment).
- General water quality along the Hungarian section of the major streams is classified satisfactory.
- The groundwaters close to the surface are polluted. The bank filtered- and karst waters, and the waters stored in deeper aquifers are still generally of good quality. An ambitious action program is being implemented for the protection of developed and potentially vulnerable future sources of supply.
- The overall conclusion arrived at from the foregoing is that the surface and subsurface water resources in Hungary are large enough on the long-term average to meet the demands as regards both quantity and quality.
- The magnitude of the surface water resources is determined by the fact that 95 per cent thereof originate abroad and that reservoirs have been built beyond the borders. The demands for surface water arising in Hungary, especially those in the Tisza Valley, can be met by water routing and transfers alone. Considerable efforts have been made at ensuring the desired level of supply to the large lakes, even by drawing on groundwater resources.
- The supplementary water resources needed to control eutrophication are often absent, river training works to accelerate flow are often omitted, or limited in their extent because of the very high costs involved.
- Disregarding a few parts with unfavourable hydrogeological conditions in the country, groundwater resources are available in volumes sufficiently large to meet the demands. Major drops in the water table in the surroundings of high-rate abstractions are evidences of water uses surpassing the rate of recharge, for controlling which legal measures must be introduced. Groundwater quality varies with the depth of the aquifers, but can be upgraded to drinking standards by simple treatment methods.

- Growing vulnerability of the sources of supply and the trends detectable in the records imply, however, that owing to pollution of communal, industrial and agricultural origin, the quality of groundwaters has deteriorated in recent years. With the aim of controlling groundwater pollution, a government program was launched in 1993 to protect the sources of supply.
- The water resources available almost everywhere in Hungary are large enough to meet the water demands. The majority of the problems and difficulties encountered in meeting the needs of society for water are associated with quality. Over 95 per cent of the surface water resources originate abroad, making both quantity and quality management difficult, in that the methods of international water management must be resorted to. The normally good relations of Hungary with her neighbours in water affairs have contributed to settling such problems.
- The water demands of agriculture, power generation and industry can generally be met presently. In the absence of medium- and long-term development plans in the various sectors of economy, the future demands are difficult to quantify. Recent economic difficulties of the users have discouraged water consumption considerably in agriculture and industry alike. Efforts must be made at reorganizing and developing agriculture and industry in a manner that is compatible with the needs of ecology. Limitations must be imposed on unauthorized irrigation abstractions from groundwater on the Danube-Tisza Divide.
- Ecological water demands and uses are relatively new in Hungary, though considerable efforts have been made over long years to provide compensation water of the required quantity and quality to water bodies suited to recreation uses.
- Water related activities and the legal regulation thereof have long traditions in Hungary. By subjecting all water uses (abstractions and discharge into a natural recipient water body) to a permit, the regulation is a comprehensive one.
- The water and environmental authorities are involved in the procedure as professional authorities.
- The sharing of authority functions within the sphere of water management among the water authorities and the community self-governments means at the same time the completeness of function performance in the fields of water abstraction, water supply and other water management activities.
- Cottage industries have been started all over the country, the operation of which is impossible to control and which discharge potentially hazardous substances into waters.
- Striving for higher profits, the newly founded industries pay little attention to minimizing the risks to the environment.
- Farming operations have applied fertilizers at rates considerably higher than necessary. The excess has accumulated in the soil and is now washed into the surface water bodies by erosion.
- Several industrialized animal farms dispose of the liquid manure produced in an unsatisfactory manner, causing soil and groundwater pollution.
- Ownership rights in agriculture are unclear in a number of places. The water management associations have no information on several owners of property in their area. Drainage and irrigation of the lands split up into small holdings are unsolved.
- Many of the new landowners have no farming experience and their farm water management awareness is inadequate to serve as a groundwork of farm water management based on ecological systems.
- Organized tourism is not truly concerned with the preservation of ecological values. Therefore the unorganized, spontaneous type of tourism is liable to cause considerable harm to the aquatic environment. “Public access“ to several water bodies is unregulated.
- Water provision is ensured by the 1.401 km long irrigation and 3.142 km long double-use canals owned by the state and managed by the district water authorities.

- Close to one-fourth of the country's territory is exposed to flood hazards. In the protected flood plains 2.5 million people live in over 700 communities. Flood control to these areas is provided by levees of 4.220 km total length, of which only 58 per cent have dimensions complying with the provisions presently in force. Another cause of concern is that in recent years lack of funding has prevented maintenance work on the embankments, as a consequence of which even the safety of those having adequate dimensions has become questionable.
- Close to one-half of the country's territory consists of lowlands, which have no natural drainage, and from which the accumulating snowmelt and storm runoff must be removed by artificial measures.
- Of the small streams in Hungary, sections of 5.300 km total length are maintained by the state water agencies, while water management associations and the local self governments are responsible for maintaining 21.100 km thereof.
- The most important tasks in the domain of controlling water related losses include performance of the outstanding maintenance works, clarifying the ownership conditions, upgrading the riparian landscapes and erosion control.

3. PRESENT STATUS OF FOOD

3.1 LAND RESOURCES AND LAND USE

- In Hungary the arable land exceeds 6 million hectares, from which the grassland (meadows and pastures) is 1,5-2 million hectares.
- In plant production both super-intensive, intensive, general and extensive forms of farming exist. Considerable part of the average yields, especially the cereals are higher than the world average.
- Irrigated fields exceed 130.000 hectares which is half of the area equipped for irrigation.
- On the 95 percent of the cultivated land is rain-fed, which provide sufficient income to the farmers even in years with average precipitation.
- On forested river-banks water tolerant and water requiring tree species (willow, alder, poplar) can be found. Sometimes can be met with orchards, where plums and walnuts are frequent.
- In some areas which experience drought frequently, suffer heavy losses in production.
- The most characteristic climatic effect is between semi-arid and semi-humid. Humid type weather appears only on small area on the western part of the country, near to the Alps. From 10 years 4 is droughty, but in 3 years excessive precipitation causes over-abundant situation. It is typical that on the same area - especially on the Great Hungarian Plain – may be drought-stricken in one year but in other years suffer from floods and/or inland water surplus. Therefore there are watercourses established for „double-use“ (used for irrigation and also for drainage).
- Because of the basin type situation of the country the protection of arable soil is very important. During floods mainly grassland areas are used as emergency reservoirs.
- In the surrounding of bigger and permanent reservoirs the seepage water can be found near to the surface depending on the water level in the storage basin. Water logging and acidification occur in soils under periodic inundation. The same symptom was noticed in the 70s and 80s caused partly by the overdosage of fertilizers, too.

3.2 AGRONOMIC FACTORS, PRODUCTIVITY

- A very large proportion of the land of the country is good for agricultural production. Majority of the soils are suitable for the successful production of the most important plants used for food or fodder.

3.3 CROPS GROWN

- Cereals has prominent role in arable production. The greatest sowing area belongs to the winter wheat and corn, perennial crops are grown for forage (e.g. perennial papillionaceae) or for seed-grain (e.g. rape). On the arable land, the cultivation of sunflower and sugar beet is also significant.
- Among the fruits apple and drupes (peach, apricot, plum, cherry, sour-cherry) are important, but the berry-fruits are also grown.
- In the intensive orchards micro-irrigation methods are used. Recently the use of fertigation is also increasing.
- Among the plantations the vineyards and apple orchards are most important. However - after the collapse of the soviet market - grape growing and vine production has declined. The development strategy can now be the switch-over from quantity production to quality one. Especially on hilly areas the new vine-cellars are producing good quality vine which have attained world wide popularity.
- Forests cover 18 percent of the total area, composition of which is on the plain mainly acacia, poplar and black pine, on the mountains different deciduous trees.
- Fish husbandry has been introduced to revive dead channels, lakes and reservoirs. Special fish ponds have been established for this purpose.
- Some changes in land use will be made: about 20 percent of the present arable land will be converted to grassland and forest.
- Among horticultural plants mainly the growing of vegetables will increase.
- The use of artificial fertilizers declined to the tenth of the amount in 1985 only. Mostly livestock manure is used for organic fertilization, beneficial effects of which are effective through the increasing of biological activity and water retention capacity of the soils.
- The use of plant protective herbicides and pesticides is also declining, but not in as dramatic way as in the case of fertilizers.
- Food supply in Hungary is excellent. Except for tropical fruits, everything can be grown in the country. There are more offers than requirements. In nutrition, carbohydrates and fats are dominant, while the consumption is lower than desirable in case of vitamin-rich vegetables and fruit. The habits of the former rural life and diet are changing rather slowly.

3.4 IMPORT-EXPORT

- The import of foodstuffs does not exceed 10 percent of the total consumption.
- In food export mainly the raw products (wheat grain, fruits, etc) are determinant. The volume of former agrarian export has decreased to the half size. The consequence of this is the 10-12 percent increase of unemployment from agricultural sector, and about the same coming from the industry.
- Security of the food storage is solved, the scale of quality degradation is low.

4. PRESENT STATUS OF RURAL DEVELOPMENT

- The direct state functions comprise the construction, maintenance and operation of the transfer and regional projects, which create the infrastructure in particular areas for farm irrigation developments by ensuring water for, and conveying it to, the irrigation sections. Farm irrigation development is beyond the sphere of the state functions. Such projects are implemented by associations, the collective efforts of interested farming operations, or with financing by an economic corporation. State support to such projects may be granted on an application basis. The emergence of small farms is likely to increase area irrigated from groundwater abstracted from shallow, dug wells. The small groundwater volumes abstracted by the individual farmers may in combination affect adversely the subsurface supplies within a brief period of time.

- The merits of the Hungarian water law include the simple, clear structure, the accurate allocation of functions and responsibilities (state, self-government, water user) and the unambiguous identification of ownership (exclusive state property, state property, self-government- and private property) covering all projects and waters. The distinction between operating functions emerging from ownership responsibility and administration functions emerging from state responsibility is also considered among the particular features.
- Legal regulation of water related activities has long traditions in Hungary. The first water law entered into force in 1885, the second in 1964, while the third in 1996. A permit was required for any water management activity since 1885. These permits have been registered ever since in the Water Book. The water laws represented advanced legal instruments in their time and this is why they remained in force for extended periods of time. Water pollution was prohibited by the law of 1885 already. the water laws have always responded to the felt necessities of society, economy and politics of a particular period. Comprehensive legislation on water pollution control was accordingly introduced as late as 1964.
- Enactment of the water management law in 1995 was prompted by a number circumstances, including the change in political and economic regime, privatization, the transition to a market economy and harmonization with the EU. Water management is presently regulated by a host of laws, law decrees and standard specifications, of which the laws on water management, environmental protection, nature conservation, regional development and forestry are the salient ones. In the formulation of these account has already been taken of the conditions of a market economy and of the requirements of harmonization with the EU.
- A comprehensive legal framework of water resources management, environmental protection and water pollution control had been developed in Hungary, but the implementation thereof was ineffective.
- One of the outstanding present goals of water management is - with special regard to integration with the EU - to meet the water demands arising in the sectors of economy while complying with the requirements of ecological quality. This goal is apparently in conflict with the basic principles of profit-oriented market economy, the actors of which must realize that this is the only possible way of development.
- The environment-oriented approach is, for instance, reflected by the obligation of the buyer to remedy the environmental harms caused during the former operation of a privatized company. The same applies to the identified polluters of water and soil.
- The discontinuation of subsidies had a profound impact on water management. One of important tasks of water management is the application of non-structural methods, the perfection, introduction and implementation of legal and market oriented regulatory measures.
- Water management education has a well developed background in Hungary. Major problems have been encountered in recent years on account of the meagre budget appropriations for such purposes. At the same time, broadening international relations and opportunities for students and young professors to study abroad have played a significant role since the early ’90s. New types of university and continued education (for instance training water- and environmental managers) have contributed to the development of water management.

5. FUTURE SCENARIOS AND AIMS

- Effective water management needs the integration with the economy, with the environmental and nature protection, with regional development, and with social movements.

- Our aim is to create such a situation in which the international cooperation in water management could be raised to a higher level either in the use of water resources or in the conservation and improvement of their quality, or in the increasing of safety in flood control.
- For the future, on-going governmental programs must provide for the protection of drinking water resources, for water caused damages, and sewage treatment as high priorities. There is welcome trend toward construction of lakes and small reservoirs. Considerable problems have resulted on the Danube-Tisza-table-land region by the rapid lowering of the water-table, the solution of which and the attainment of the water recovery in this region directly influences the life, subsistence, and future of 250.000 people living there.
- In water management, the further clarification regarding division of responsibility between the owners and participants is to be expected; government will properly finance the maintenance of the state-owned main constructions, while the financing of the not state owned projects will be solved by the new owners (local authorities, communities, companies, associations, private owners).
- The measure as well as the danger of water pollution originating from agricultural activities will decrease mainly because of the use of environment friendly technologies. By the development and conscious utilization of the drought mitigation strategy new plant production alternatives will be introduced into the practice for the reduction of water scarcity. On the irrigated fields intelligent automatic systems will provide the full water- and nutrient requirement of the plants during their whole vegetation period. On the irrigated fields the drought sensitivity of the present farming methods will decrease about 50 percent by the wide use of precision irrigation techniques and water saving methods, and in the proper operation of irrigation equipment the prediction- and extension training services of the INTERNET will play a considerable role.
- In Hungary water will be treated as an economic good instead of a social good, therefore its price will be determined basically - and rather in the future - according to its market value; this hopefully will considerably influence the use of the water saving methods increase awareness about the importance of water.
- Besides meeting the traditional water demands, special demands (e.g., those related to ecology, recreation, landscape aesthetics, a pleasing environment, etc.) will require greater attention in the future.

6. CHALLENGES FOR THE FUTURE

- One of the most comprehensive current programs of Hungarian economy and society is the preparation for integration with the EU, under which a number of major problems await solution, also in the domain of water management.
- A broad spectrum of instruments have been applied in Hungary to promote integration. The new type of country-wide river basin management planning started recently and scheduled for completion within a few years is expected to become an effective tool thereof. Along with planning, the recent legislation on water management, environmental protection, nature conservation and regional development will also assist administration in realizing integration. Non-legislative instruments and market oriented regulatory measures may also provide powerful incentives towards integration.
- In the context of the uses of natural waters mention must be made of the work to be started in the near future, on surveying and development planning of the river basins, which would consider quantity and quality of all types of water resource in the catchment and aim to provide an optimal answer to potential water demands.
- Growing ecological water demands will have to be anticipated, but these must be met from surface water resources.
- Over the next decades, the main concern in Hungary will be to supply water of the desired quality to the consumers, the quantity demands will be met readily. The water rates will be

proportional to the costs and will therefore be high. The population will be encouraged to economize on water, so that no major increase in domestic demand is expected. Owing to the high costs of water supply and waste water treatment, industry is also expected to introduce water saving and clean technologies. Farmers will resort to irrigation for growing high-value crops only, in the absence of considerable state support irrigation will prove uneconomical. The demand for ecological water and water-side recreation is likely to grow appreciably. The latter will raise the ecological, leisure-time and aesthetic value of the water bodies, further the appreciation of the water-side cultural heritage.

- The first steps towards implementing the quality concept in water management have been made. The importance of quality awareness and “consumer-oriented“ attitude is emphasized at control and execution levels alike. Financial resources are sought for introducing the quality assurance and management systems in production and services, in this context for accrediting and notifying, the certifying and managing organizations, further for the comprehensive modernization of the technical regulatory framework.
- The main consideration in the development of the institutional background of water management in Hungary over the next decade will be the harmonization of policies with the EU.
- The chances of the present upward trend in industry and agriculture to proceed along the principles of sustainable development are good, but the risk of owners concentrating on profits alone and neglecting environmental requirements is also great. Under the changed set of conditions the water- and environmental administrations will have to play important roles in ensuring environment - compatible, sustainable development by a carefully elaborated and enforced complex of regulatory measures.
- Environmentalist movements have grown vigorous and general public awareness of water- and environment related issues has also evolved. These may offer guarantees for the realization of ecosystems-oriented water management, while meeting the water demands of the various sectors of economy.
- The water resources of Hungary, both on and below the surface, are characterized by the broad spectrum of their potential uses. Water uses being of concern to all actors in the social and economic sphere, at the same time the abstractions and water uses interacting with each other, strong legislative regulation is necessary, to make access to water resources a citizen’s right to everybody.
- In the early ´90s (following the regime change) Hungary has embarked upon an ambitious program of legislation under which the law on water management has also been adopted. The laws most relevant to the subject under consideration are those on water management, environmental protection, nature conservation and regional development. Besides enforcement the new laws and other legal measures, compliance with these must be ensured. Advanced legal measures have existed formerly on water management and on the protection of the aquatic environment in Hungary, but these were not enforced satisfactorily.
- Public awareness of water and environmental protection issues has grown appreciably in recent years, but have not become truly effective. Owing to the economic depression, problems other than pollution control and environmental protection were of concern to the population.
- One of the most important methods of conflict resolution is the involvement of the public into the processes of decisions making. This has been recognized already, though the mechanisms of effective public participation and conflict handling have found no widespread application yet.
- It has not been realized still that the involvement of the public in decision making is an expensive exercise, yet the results offset the efforts and costs thereof.
- Several new legal institutions have been introduced in Hungarian legislation, including the establishment of a public consultative body and forum to promote the balanced development

of water resources and to prepare strategic decisions in the prevention of water damages. Public involvement in water management decision making is thus made possible. The provisions on the operation of public water utilities, on the methods thereof, including the possibility of concession arrangements, are also advanced features of the law.

- The environmentalist groups have still considerable influence on the public and the successive governments in Hungary. Some environmentalist organizations have played unquestionably important roles in protecting the aquatic environment and ecosystems. At the same time extreme views have been voiced and in some government orders on the aquatic environment, political, rather than environmental or water resources management considerations predominate.
- Reviewing the history of the past 15 years it is concluded that the professional in state water administration and water management in general have performed their functions correctly, keeping public interests in view, but have failed in recognizing in time the characteristics of the democratization process, have not involved the public into the decision making processes and have omitted image building in water management (PR work), which became the source of several problems. The public administration institutions, self governments and private companies operating in the field of water management conduct presently a successful public policy, take efforts at maintaining good relations with NGOs critial of water management activities. The institutional, legal forms of these relations are being developed.
- Traditionally good relations have existed in Hungary between the institutions of public water administration and the national and international professional and scientific organizations. Good examples of cooperation between the professional and scientific bodies can also be quoted. For example, the Hungarian representatives/officers of the international water management organizations re-convened annually under the auspices of the Hungarian Hydrological Society to coordinate their activities. They organize several joint events, or invite each other to their events. The international water management organizations provide also assistance in inter-governmental cooperation by identifying and analyzing problems, conflict situations and the potential solutions, promoting the avoidance, alleviation and solution of conflicts. They accelerate significantly European integration and harmonization. In professional and scientific fields (education, research-development) they make participation in the activities of the EU member states possible earlier than over the official channels of international politics. Examples thereof can already be mentioned, in that Hungarian professionals are actively involved in the activities of a number of European professional and scientific organizations and in the Central-East-European working groups thereof.
- Water management research is adversely affected by the fact that there are virtually no funds available for basic research and those of applied research-development are also very limited. Domestic and international research projects financed from international funds have beneficial effects. Special attention is called in this respect to the research projects under the Danube Environmental Program, in several of which teams from over ten countries are involved. This kind of scientific collaboration may open new perspectives in water management, in particular international river basin management.

INDIA

HISTORICAL REVIEW

There was no State Policy for the development of resources during the early phase of British Rule in India. Some important steps taken during British rule were :

- Introduction of land tenure;
- Opening of road and rail communication;
- Promotion of export trade in certain agricultural commodities; and
- During the 1st decade of the last century, the Department of Agriculture at the national centre and in the provinces were organised.

MILESTONES

The Forest Research Institute was set up in 1890. On the recommendation of the First Irrigation Commission, attention was devoted to irrigation schemes, mainly of a protective nature in water scarce areas.

During the great economic depression of 1929-33, despite some expansion in the protected manufacturing sector of the economy, there was stagnation. During the decade preceding the depression, western economies had a spell of expansion of output, income and employment. A new economic policy characterised by increased state intervention emerged in the western economies during the depression, while in India the traditional "Laissez faire" continued.

The separation of Burma in 1937 involved considerable economic recession, as close links existed between India and Burma.

With the outbreak of World War II there was dislocation of the normal flow of goods, particularly primary products from the foreign agricultural sector.

The Japanese occupation of Myanmar (Burma) and the consequential loss of imports of Burma rice completely upset the food strategy of the Government of India. Various steps were taken to develop a comprehensive and integrated policy for the development of agriculture in the basic food plan for distribution of food grains in the country under the situation of scarcity.

Irrigation in India dates to prehistoric times. Irrigation received due attention even before Independence in 1947, by the Hindu, Muslim and British rulers as it was an important input for successful crop growth in most parts of the country. The development of irrigation continued at a slow pace until partition. Irrigated in India at the time of partition was 2.26 $x10^7$ ha.

Partition of India in 1947 brought about a far-reaching imbalances in the agriculture sector. The “Grow-more-food” campaign was therefore placed on a planned basis from 1947-48. The appointment of the Planning Commission in 1950 and implementation of Five Year Plans and agricultural development (including animal husbandry, forestry, and fisheries) became a major objective in the consistent plans of action. The concept of self-sufficiency in food-grains by the end of March, 1952 was modified to call for a relative self-sufficiency which implied that some imports of food-grains might be necessary to meet emergencies, to build reserve stocks and to compensate for loss due to diversion from food to cash crops.

PLANNED DEVELOPMENT OF WATER RESOURCES

In the initial period of developing water resources, the rapid harnessing of these resources was the prime objective. State Governments were encouraged to expeditiously formulate and develop water resource projects for specific purposes such as irrigation, flood control, hydro-power generation, drinking water supply, industrial and various miscellaneous other reasons. A large number of projects comprising dams, barrages, hydropower structures, and canal networks have been completed throughout India in successive Five Year Plans.

MILESTONES

Earlier legislation concerning Environmental Protection include the "Indian Penal Code" and the "Code of Criminal Procedure". Environmental protection laws have been enacted under the Environment Protection Act, 1986, the Air Prevention and Control Policy Act, 1981, the Water Prevention and Control of Pollution Act, 1974, the Hazardous Waste Management and Handing Rules, 1989, the Public Liability Insurance Act, 1991 and the National Environmental Tribunal Act, 1995.

Among the specific Natural Resources Protection Acts are the Wild Life (Protection) Act, 1972 and the Forests (Conservation) Act, 1980. Comprehensive Legislation is necessary and therefore a cross medium approach was adopted to remove a multiplicity of legislation besides removing the overlapping and ambiguous policies then in vogue.

NATIONAL WATER POLICY

India adopted a National Water Policy in September, 1987 which recognised water as one of the crucial elements in its planning and development . After the adoption of this Policy a number of issues and challenges emerged in the development and management of water resources. Therefore this Policy should be updated by the National Water Resources Council.

WATER FOR FOOD AND RURAL DEVELOPMENT

River Systems: The river systems in India are classified into two groups namely perennial rivers of Himalayan origin and the rivers of peninsula India.

Precipitation: The rainfall in India is confined to 3-4 months in a year and varies from 100 mm in the western parts of Rajasthan to over 1000 mm in Cherrapunji in Meghalaya.

Principal Water Resources: The principal ones are :

- surface waters from rivers and streams, and
- ground water.

India has 24 river basins comprising 12 major and 12 medium and small basins. Figure-1 shows these basins in India. Out of a total precipitation of about $4x10^{11}m^3$ the water available is about $1.953\ x10^{11}m^3$. Details are given in Table 1.

USABLE WATER RESOURCES

The average yearly usable surface water is $6.9x10^{11}m^3$ and ground water*, $3.96x10^{11}m^3$ for a total of $1.086x10^{12}m^3$. The annual replenished ground water is estimated as $4.32x10^{11}m^3$.

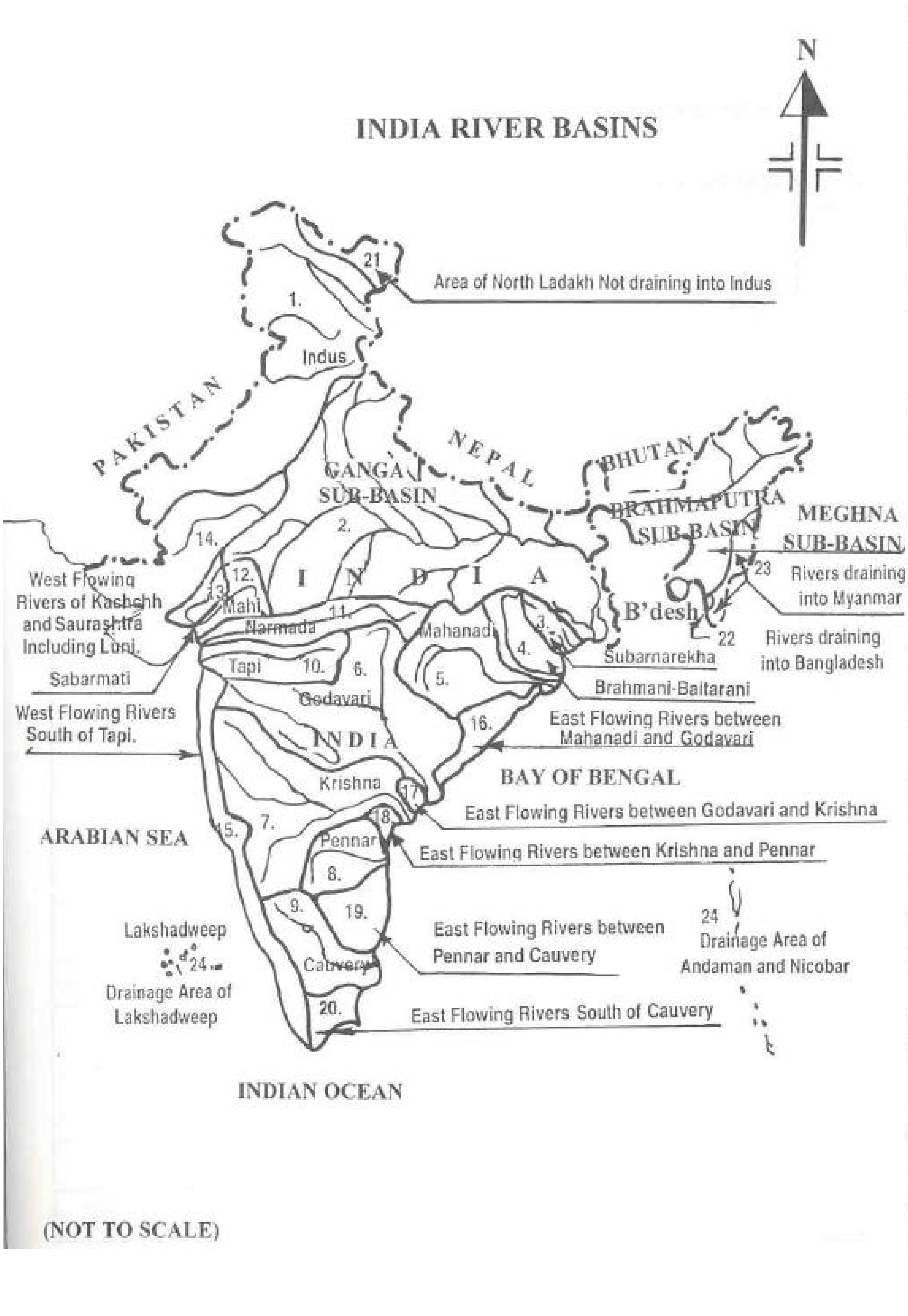
Present Use

The capacity of live storage in dams and reservoirs in India is about $1.77x10^{11}m^3$. Dams to create additional live storage of $7.5x10^{10}m^3$ are under various stages of construction. Dams in planing stages will provide an additional live storage of $1.32x10^{11}m^3$. The present use of surface and ground water is about 70% and 30% respectively of the usable resources as shown in the following table:

Purpose	Present Utilisation (1997) (BCM)
Irrigation	501
Domestic	30
Industrial	20
Energy	20
Others	34
Total	605

Development of Irrigation Potential

At the end of 1995-96 there were $8.852\ x10^7m^3$ ha compared to $2.26\ x10^7m^3$ ha in 1947. Out of the present total irrigated area, that from ground water is $4.58\ x10^7m^3$ ha.



INDIA RIVER BASINS
N
Area of North Ladakh Not draining into Indus
Indus
PAKISTAN
NEPAL
BHUTAN
GANGA SUB-BASIN
BRAHMAPUTRA SUB-BASIN
MEGHNA SUB-BASIN
Rivers draining into Myanmar
Rivers draining into Bangladesh
B'desh
INDIA
West Flowing Rivers of Kachchh and Saurashtra Including Luni.
Sabarmati
Mahi
Narmada
Tapi
Godavari
Mahanadi
Subarnarekha
Brahmani-Baitarani
West Flowing Rivers South of Tapi.
East Flowing Rivers between Mahanadi and Godavari
BAY OF BENGAL
Krishna
East Flowing Rivers between Godavari and Krishna
ARABIAN SEA
Pennar
East Flowing Rivers between Krishna and Pennar
Lakshadweep
Drainage Area of Lakshadweep
East Flowing Rivers between Pennar and Cauvery
Drainage Area of Andaman and Nicobar
Cauvery
East Flowing Rivers South of Cauvery
INDIAN OCEAN
(NOT TO SCALE)

Table 1. Water Resources Potential and Status of Live Storage in The River Basins of India

(Unit b.cu.m.)

Sr. No.	Name of the River Basin	Average annual potential in the river	Estimated utilisable flow exclu-ding ground water	Live Storage		
				Live completed projects storage	Ongoing projects	Proposed projects
1	Indus (upto border)	73.31	46.00	13.85	2.45	0.27
2	a Ganga	525.02	250.00	36.84	17.12	29.56
	b Brahmaputra,	629.05	24.00	1.10	2.40	63.35
	b Barak & Others	48.36				
3	Subernarekha	12.37	6.81	0.65	1.65	1.59
4	Brahamani and Baitarni	28.48	18.30	4.76	0.24	8.72
5	Mahanadi	66.88	49.99	8.49	5.39	10.96
6	Godavari	110.54	76.30	12.51	10.65	8.28
7	Krishna	69.81	58.00	34.48	7.78	0.13
8	Pennar	6.32	6.86	0.38	2.13	
9	Cauvery	21.36	19.00	7.43	0.39	0.34
10	Tapi	14.88	14.50	8.53	1.00	1.99
11	Narmada	45.64	34.50	6.60	16.72	0.46
12	Mahi	11.02	3.10	4.75	0.36	0.02
13	Sabarmati	3.81	1.93	1.35	0.12	0.09
14	West flowing Rivers of Kutch, Saurashtra including Luni	15.10	14.98	4.31	0.58	3.14
15	West flowing Rivers South of Tapi	200.94	36.21	17.35	4.97	2.54
16	East Flowing & Rivers from Mahanadi to Godavari	17.08		1.63	1.45	0.86
17.	East flowing Rivers between Godavari and Krishna	1.81	13.11			
18	East flowing Rivers between Krishan and Pennar	3.63		-		
19	East flowing Rivers between Pennar and Cauvery	9.98	16.73	1.42	0.02	0
20	East flowing Rivers South of Cauvery	6.48				
21	Area of North Ladakh not Draining into Indus	NA	NA	NA	NA	NA
22	Rivers Draining in to Bangladesh	8.57	NA	NA	NA	NA
23	Rivers Draining in to Myanmmar	22.43	NA	0.31	NA	NA
24	Drainage areas of Andman, Nicobar and Lakshadwee Island	NA	NA	NA	NA	NA
	Total	1952.87	690.32	173.71	75.43	132.32
	Say	1953.00	690.00	174.00	76.00	132.00

Source : Report of the National Commission Integrated Water Resources Development in (1999)

Electricity plays an important role in the agricultural sector. Agriculture remained in second place following industry among the consumers of electricity. Electrical consumption in agriculture increased from1892 Giga watt hours (GWH) in 1965-66 to 85736 GWH in 1995-96 which registered an annual growth rate of 13.6% against a growth rate for total consumption of 8.1%. The total power generated in 1994-95 was 350,490.4 GWH of which hydro-power generated was 82,712.0 GWH. This is less than the electricity consumed by agriculture in 1995-96 i.e. 85,736.0 GWH. In other words the entire hydro-power generated is insufficient to meet the demand of agriculture. The percentage of consumption has increased from 7% in 1965-66 to 31% in 1995-96. During 1995-96 the state of Maharashtra with a consumption of 13621 GWH for agriculture was the greatest of all states followed by Andhra Pradesh, Gujarat, Uttar Pradesh and Madhya Pradesh having a consumption of 11775, 10152, 9888 and 8235 GWH respectively. Agriculture consumed 30, 50, 39, 37 and 36% respectively of electricity for the above five states. Andhra Pradesh remained at the top using half of the electricity. There were 10.7×10^6 electrical irrigation pumps on 31st March 1995. The total installed capacity in 1995-96 was 83,288 MW of which 20,976 MW (25.1%) was hydro-power.

The Central Electricity Authority (CEA) carried out a re-assessment of the hydro-electric potential in India during 1987 and assessed it at 84,044 MW or 60% of the load excluding contributions from small schemes. This hydro-potential when fully developed will probably result in an installed capacity of 150,000 MW on the basis of an average load. The demand for electricity in India has been growing at an average annual compound growth rate of 8 to 9 %. The installed capacity is in the order of 210,000 MW which will meet the demand by the end of the XI Plan and 350,000 MW by the year 2020. The total demand for hydro-electricity by agriculture will be 140,000 MW assuming it needs 40% of the total power.

Irrigation Potential

A broad assessment in 1960 of the area that can be brought under irrigation indicated that the irrigation potential of the country is about 1.13×10^8 ha. An analysis of the irrigation potential is that major systems will be 5.8×10^7 ha, medium systems 1.5×10^7 ha by minor surface water schemes i.e. the total of 7.3×10^7 ha by surface water and 4×10^7 ha by minor ground water schemes. Present indications are, however, that the ultimate irrigation potential from major and medium surface water projects is 5.848×10^7 ha, 1.738×10^7 ha. by minor surface water and 6.405×10^7 ha by minor ground water schemes. Thus the total irrigation potential by the present estimate is 1.399×10^8 ha. The gross irrigated area is projected as 9.5×10^7 ha by 2025.

PRESENT STATUS OF FOOD

Land Resources

The total geographical area of India is 3.2873×10^8 ha. Of this only 3.0485×10^8 ha constituting about 93% of the total accounted for in the latest available Land Use Statistics. There has been no appreciable increase in the net sown area during 1970-71. The details of the Land Use Classification Statistics (from 1950-51 to 1994-95) are given in the table.

According to Water and Related Statistics published by the Central Water Commission, 8.5×10^6 ha of land are water logged in the country and nearly 2.46×10^6 ha are estimated to have inadequate drainage systems within irrigation commands. Similarly out of 5.5×10^6 ha of land are affected by salinity, and a further 3.06×10^6 ha are affected by irrigation related problems. The total land affected by water logging and salinity is 1.4×10^7 ha of which 5.52×10^6 ha are caused by irrigation related problems and inadequate drainage. The net sown area has been stabilised from 1.41 to 1.425×10^8 ha which is about 77% of the cultivable area in India.

Table 2. Land use clasification

Headings	1950-51	60-61	70-71	80-81	89-90	90-91	91-92 (P)	92-93 (P)	93-94 (P)	94-95	% of reporting area
1I. Geographical Area											
II. Reporting area for land utilisation statistics (1 to 5)	284.32	289.46	303.76	304.15	304.88	304.88	304.90	304.84	304.88	304.88	100.00
1. Forests	40.48	54.05	63.91	67.47	67.41	67.80	67.87	87.98	68.28	68.39	22.4
2. Not available for cultivation (a+b)	47.52	50.75	44.64	39.62	40.96	40.48	40.74	40.91	40.90	41.28	13.6
(a) Area under non agricultural uses	9.36	14.84	16.48	19.66	21.26	21.09	21.47	21.87	22.21	22.51	7.4
(b) Baren and un-culturable land	38.16	35.91	28.16	19.96	19.70	19.39	19.27	19.04	18.69	18.77	6.2
3. Other uncultivated land excluding fallow land (a+b+c+)	49.45	37.64	36.06	32.31	30.20	30.22	30.05	29.40	29.07	29.08	9.6
(a) Permanent features and other crazing lands	6.68	13.97	13.26	11.97	11.30	11.40	11.30	11.07	10.97	11.24	3.7
(b) Land under miscellaneous tree crops and groves not included in the net area sown	19.83	4.46	4.30	3.60	3.80	3.82	3.76	3.76	3.69	3.63	1.2
(c) Culturable waste	22.94	19.21	17.50	16.74	15.10	15.00	14.99	14.57	14.41	14.21	4.7
4. Fallow lands (a+b)											
(a) Fallow land other than current fallows	17.44	11.18	8.76	9.92	10.27	9.68	9.94	9.68	9.63	9.77	3.2
(b) Current fallows	10.68	11.64	11.12	14.83	13.70	13.70	14.67	14.15	14.38	13.53	4.4
5. Net area sown (6-7)	118.75	133.20	140.27	140.00	142.34	143.00	141.63	142.72	142.42	142.82	46.8
6. Total cropped area (Gross cropped area)	131.89	152.77	165.79	172.63	182.27	185.74	182.24	185.70	186.60	188.15	-
7. Area sown more than once	13.14	19.57	25.52	32.63	39.93	42.74	40.61	42.98	44.18	45.33	-
8. - Cropping intensity*	111.07	114.69	118.19	123.31	128.05	129.89	128.67	130.10	134.00	131.70	
III. Net irrigated area	20.85	24.66	31.10	38.72	46.70	47.78	49.87	50.30	51.34	53.00	-
IV. Gross irrigated area	22.56	27.98	38.19	49.73	61.85	62.47	65.68	66.76	68.25	70.64	-

** Source : Agricultural statistics at a glance (March 1998), Ministry of Agriculture, Government of India*

Food Production

All India Food Grain Production from 1950-51 to 1997-98 is given in the graph. During the period 1950-51 to 1960-61, food-grain production showed a rising trend at a rate of 3.3% per annum. During the second period 1960-61 to 1973-74, production only rose at a rate of 2.6% per annum. Compared to the first period, food grain production during the second period is more stable. The high rate of growth achieved in food-grain production is the result of a planned development. It was not accompanied by stability. However, the high rate of growth achieved during 1973-74 to 1996-97 is more stable.

Food Security

In the past, food and nutritional security have been largely interpreted to mean an adequate availability of basic food grains in the country as a whole. The concept of food security now needs to be broadened to include people's access to basic nutritional requirements both physically and economically. It is necessary to develop strategies by which inadequacies can be overcome by integrating the full production and distribution systems with the employment and poverty alleviation programmes. Considering the 180 kg per person per year which is normally taken as the minimum food requirement to be too inadequate to define food scarcity for Vision purposes, there is a general feeling that food security should be defined at a higher level than this minimum norm as an increasing standard of living over the next few decades is likely to change the norms of food consumption. Considering this fact, food security should be defined in concrete terms rather than in terms of simple quantity. Among the factors that are likely to influence the future food security status are population increases and food production.

Food security implies a situation where everyone has access, at all times, to the food needed for an active and healthy life. Thus the essential elements of food security are :

a. adequate availability of food,
b. efficient distribution through trade and/or public distribution systems, and
c. availability of adequate purchasing power in the hands of the people.

An approach to national food security which relies largely on domestic production of food needed for consumption as well as for building buffer stocks, is a strategy of self-sufficiency. However a strategy for food security should not preclude external trade in food. Trade may take place on the margin and according to need : exports in surplus situations and imports in deficit periods. The strategy for food security based largely on self-sufficiency in food production has the advantage of promoting both productivity and purchasing power among small peasants and agricultural labourers. Ensuring food security for India has been a major pre-occupation of the government since Independence.

Apart from policies to promote domestic food grain output with a minimum support price, the current food security system consists of procurement of storages, public distribution, maintenance of buffer stocks, and open market sales. Trade in food grains, which is highly regulated even now, was never a strategic instrument for a food security system in India. The success, in terms of self-sufficiency in production and relative price stability, has not, however, been without significant cost to the economy. The system of food security, as it evolved over time, has tended to consume substantial financial resources because of high subsides.

Self-sufficiency in production of food grains is often advocated as a first step towards attaining food security for a county of India's size for a number of reasons. The first, the world's food grain market is narrow compared to India's domestic produce and consumption. For example, the size of the international rice market is about 1.2 to1.3×10^7 tonnes. India produces 8×10^7 tonnes of rice. Although the world wheat market is comparatively large at 1.1-1.2×10^8 tonnes, it is cartelised. India produces about 6.5×10^7 tonnes of wheat. Under such a situation, large scale imports of say 10% of its requirement can make India vulnerable to sharp rises in the world price of food grains.

Secondly, the strategy of self-sufficiency in food serves the goal of national security. Dependence on food aid or large scale imports may entail unacceptable comprises on national security policies. Third, the county is heavily populated and food production is a predominant means of livelihood for a large section of peasant cultivators and agricultural labourers, who cannot easily move to other occupations, at least for quite sometime. Last, but not least, most of the time the country continues to produce cheaper food grains, particularly cereals, compared to the CIF cost of imports. Significant strides have been made in the domestic production of food grains and other cereals. India's position in world agriculture in 1996 is given in the Table 3.

Adequate availability of food at the national level does not necessarily lead to adequate availability in all the regions, especially in deficit and inaccessible regions of a county. Market imperfections and Government restrictions hamper the free movement of food grains across international borders. A common market is the best guarantee for establishing an efficient distribution network. Apart from strengthening and expanding the market, there is a need to disperse food grain production to deficit regions in order to ensure physical access to food for all at affordable prices. The strategy of dispersal of production has several other spin-off benefits. First, hitherto deficit regions will increasingly contribute to an incremental production since the yield rates in traditional surplus regions have plateaued. Second, large transaction costs involved in the import of food grains from a few surplus pockets to all corners of the country can be avoided. Third, widely dispersed employment and income effects, implicit in such a strategy, will serve the objective of poverty alleviation.

Fluctuating food grains production is a world-wide phenomenon and therefore, shortage and surpluses are the recurring themes for individual countries. In order to avoid paying more than necessary for import and receiving less than due on export, it is essential to build up sufficient capacity to hold back from purchases or sales for short periods. This capacity is essentially a derivative of a strong buffer stock management. As a matter of fact, India should take advantage of the International "Futures" in the food grains, primarily rice and wheat markets, as a medium of buffer stock management at relatively low volumes. The "Futures" can ensure a stable equilibrium in the price of food grains even in a situation of low domestic stocks. However, to be effective the Government of India, though its agencies, must have a sustained presence in the International "Futures" market.

There is a strong case to liberalize the trade, not only in food grains but also in all other agricultural commodities. On the export side, opportunities of export of food grains and other rainfed agricultural products such as cotton and fruits will open up. On the import side, opening up India's agriculture to more competition would result in more efficient gains for all crops and improve incentives to producers of food grains and cotton. India should aim to be more than a marginal exporter of basic agricultural commodities. This will strengthen the food security system.

POPULATION

The total population of India in 1991 was $8.463 x 10^8$ after examining the latest trends and views expressed by different demographers, the higher and lower limits of India's population in 2025 are $1.333 x 10^9$ (Visaria and Visaria (Standard)) and $1.2863x1x10^9$ (United Nations, the low variant).

The projected future population and the decennial growth of the population since 1901 to 1991 (actual figures) are given in the graph. The rural population, which is about 74.3% of the total population in1991 is expected to go down to 50% by 2050 as per the low urban population projections. The percentage distribution of Main Workers into cultivators, agricultural labourers, household industry workers and other workers according to the 1981-91 census are given as follows :

- there was a decline in cultivators and a small increase in agricultural labourers during the 1981-91 decade;

Table 3. India's position in World Agriculture – 1996

Item	India	World	Share %	India's Rank	Next to
Area (Million ha.)**					
Total Area	329	13383	2.5	Seventh	Canada, USA, China, Brazil, Australia, Russian
Land Area Canada	297	13048	2.3	Seventh	Fed. USA, China,
Arable Land Russian	166F	1362	12.2	Second	Brazil, Australia,
Irrigation	50F	255	19.6	Frist	Fed. USA, USA
Population (Million)					
Total	945	5768	16.4	Second	China
Agriculture	541	2592	20.9	Second	China
ECONOMICALLY ACTIVE					
Population (Million)					
Total	410	2568	14.8	Second	China
Agriculture	541	2592	20.9	Second	China
CROP PRODUCTION (Million Tonnes)					
Cereals	214*	2050	10.4	Third	China, USA
Wheat	63*	585	10.8	Second	China
Rice	120*	562	21.4	Second	China
Coarse Grain	31*	902	3.4	Fifth	USA, China, Brazil Russian Fed.
Potatoes	18F	295	6.1	Sixth	China, Russian Fed. Poland, USA, Ukraine
Total Pulses	15F	57	26.3	First	–
Groundnut	8*	29	27.6	Second	China
Tobacco Leaves	0.51*	6.51	7.8	Third	China, USA
Rapeseed	6*	30	20.0	Second	China
Coffee (green)	0.18*	5.93	3.0	Ninth	Brazil, Clombia, Indonesia Mexico, Ethiopia, Uganda Vietnam, Guatemala
Sugarcane	255*	1193	21.4	Second	Brazil
Tea	0.72F	2.62	27.5	First	
Jute & Allied Fibres	1.72F	3.02	57.0	First	
Cotton (lint)	2.55*	18.82	13.5	Third	USA, China
LIVESTOCK NUMBERS (Million head)					
Cattle	196*	1320	14.8	First	
Buffaloes	80*	152	52.6	First	
Camels	1.52F	19.29	7.9	Third	Somalia, Sudan
Sheep	45*	1048	4.3	Fifth	Australia, China, New Zealand, Iran
Goats	120*	674	17.8	Second	China
Chicken	610	12952	4.7	Fifth	China, USA, Brazil, Indonesia
IMPLEMENTS (Thousands Numbers)**					
Tractors-in-use	1355	26197	5.2	Fourth	USA Japan Italy

* Unofficial Figure ** Figures relate to 1995

Source : Agricultural Statistics At a Glance, March, 1998, Ministry of Agriculture, Government of India.

- the most striking feature was the marked decline in the proportion of male cultivators and an increase in the proportion of female agricultural labourers,
- overall, however, there has been an increase in he number of agricultural labourers.

The percentage distribution of main workers as compared to cultivators, agricultural labourers, household industry workers and other workers, according to the 1981-91 Census is given in Table 4.

Table 4. Percentage Distribution of Main Workers As Cultivator, Agricultural Labourers, Household Industry Workers and other Workers 1981-91

Sl. No.	India/State or Union Territory	Total Rural Urban	Persons Males Females	Cultivators		Agricultural Labourers		Household Industry Workers		Other Workers	
				1981	1991	1981	1991	1981	1991	1981	1991
1.	India*	Total	Persons	41.58	38.75	24.94	26.15	3.47	3.63	30.01	31.47
			Males	43.70	40.01	19.56	20.09	3.18	3.33	33.56	35.76
			Females	33.20	34.55	46.18	43.56	4.59	4.63	16.03	17.26
		Rural	Persons	51.10	48.47	29.88	31.77	3.08	3.08	15.94	16.68
			Males	55.16	51.79	24.00	26.11	2.87	2.84	17.97	19.26
			Females	37.07	38.98	50.20	47.94	3.79	3.76	8.94	9.32
		Urban	Persons	5.13	4.99	6.05	6.66	4.94	5.57	83.88	82.78
			Males	5.20	4.90	4.66	5.35	4.21	4.82	85.93	84.93
			Females	4.66	5.54	16.57	14.89	10.48	10.30	68.29	69.27
	India (Excluding Assam and Jammu & Kashmir)	Total	Persons	41.45	38.43	25.12	26.49	3.45	3.66	29.98	31.42
			Males	43.58	39.72	19.71	21.11	3.17	3.37	33.54	35.80
			Females	33.09	34.15	46.34	44.29	4.57	4.62	16.00	16.94
		Rural	Persons	50.95	48.22	30.09	32.29	3.07	3.10	15.89	16.39
			Males	55.03	51.61	24.19	26.48	2.86	2.87	17.92	19.04
			Females	36.94	38.58	50.36	48.83	3.77	3.75	8.93	8.84
		Urban	Persons	5.11	5.00	6.08	6.79	4.91	5.59	83.90	82.70
			Males	5.17	4.92	4.68	5.40	4.18	4.83	85.97	84.85
			Females	4.63	5.54	16.65	15.00	10.44	10.30	68.28	69.16

* The proportions for the 1981 census excludes assam where the 1981 census could not be held and the proportion for the 1991 census excludes jammu & kashmir where the 1991 census has not been held.

RURAL DEVELOPMENT

Agriculture provides the livelihood for the largest number of people. Robust growth in this sector guarantees the achievement of broad-based growth of income levels and employment especially in rural areas. The strategy of agricultural development is centred around achieving the objectives of sustainability of employment generation, food and nutrition security, and equity and poverty alleviation. Efforts have to be made to achieve a growth rate of 4.5% per annum in agricultural output in order to a make a significant impact on overall growth and poverty.

Agriculture has not benefited as much as it should have from the policies of economic liberalization because agriculture continues to suffer from too many restrictions and impediments which prevent framers from marketing their produce at attractive prices. The opening of an export market for agricultural products will help to shift the problems of trade in favour of agriculture and this should help to raise rural incomes. But broad-based agricultural development also requires substantial investment in economic infrastructure especially in irrigation, rural roads and the creation of markets.

Agriculture growth is a pre-requisite for the economy and social development of the country. Agriculture contributes 28% of GNP, about 60% of employment and is primarily a source of livelihood in rural areas which account for 75% of India's population and 80% of its poor. Irrigated agriculture contributes nearly 56% of agriculture output. Between 1970-71 to 1993-94, the net sown area virtually remained uncharged (from 1.4027 to1.421x10^8ha). Hence the increased production is attributable to an increase in yields through an increase in cropping intensity and utilization of better inputs. Irrigation is a vital input to increase agricultural output to keep pace with the food requirements of an ever increasing population. India had the largest irrigated area at the end of 1996 among the countries of the world. This greatly increased food grain production. Employment in agricultural productivity from irrigated agriculture is one of the main objectives of the command area development programme. An analysis of the data of productivity in respect of some selected projects under the command area development programme indicates that staple crops like paddy and wheat have registered an increase of productivity of 50% and 85% respectively.

Provided the required investments are made and adequate availability ensured, the country's agro-climatic situations and the present state of agricultural development will provide opportunities for a substantial increase in the production of food grains even without expanding the net sown area in food grains.

Poverty eradication is one of the major objectives of the planned development. Thirty six percent of the Indian population was below the poverty line in 1993-94, the last year in which data are available. The absolute number of poor was 3.29x10^8 out of which 2.44x10^8 (37% of the rural population) live in rural areas. The incidence of poverty declined from 54.9% in 1973-74 to 36% in 1993-94. But the absolute number of poor did not decline much over this period of 20 years. The same may be the scenario in 2025 when the incidence of poverty may decline to 24% but the absolute numbers will remain at 3.2x10^8 out of a total population of 1.33x10^9.

Poverty can effectively be eradicated only when the poor start contributing to the growth by their active involvement in the growth of India. This is possible if process of social mobilisation encourages participatory approaches, institution and empowerment of the people. There are many rural poverty alleviation programmes like the Integrated Rural Development Programme (IPRD) which aims at providing self-employment to the rural poor through the acquisition of production assets or appropriate skills which will generate additional income on a sustained basis to enable them to cross the poverty line.

The scheme of TRYSEM (Training of Rural Youth for Self-Employment) facilitating components of IRDP aims at providing basic technical and entrepreneurial skills to the rural people to enable them to take up income generating activities. There is another scheme, namely SITRA (Supply of Employment Cheap Tools) for rural artisans, launched in1992 which provides kits of hand tools for a variety of crafts (except weavers, tailors, and bidi workers). There are also a number of other schemes like DWCRA (Development of Children and Women in Rural Areas), (JRY) Jawahar Rozgar Yojna, EAS (Employment Assurance Scheme), MWS (Million Well Scheme) and NASP, (National Social Assistance Programme).

RURAL WATER SUPPLY AND SANITATION

Recent published data indicates that rural water supply programmes have covered 3.4 lakh villages/habitats during the 8th Plan. In terms of population, according to the 1991 census, about 86.74% of the rural population is expected to have been provided with access to safe drinking water. By the end of 2002, 100% coverage of habitats will have sufficient water, and provide quality monitoring and surveillance systems throughout the country, rearranging the structure and functioning of rural water supply planning and implementing agencies. It will take all these measures to ensure the sustainability of drinking water sources.

Recent data show that the population covered by sanitary latrines has increased from 11% to about 16%. This is inclusive of efforts by IAY, JRY, UNICEF, CAPART and centrally and state sponsored rural sanitation programmes. The existing policy, subsiding under the rural sanitation programme, is provided to people below the poverty line for construction of individual household latrines and conversion of dry into sanitary latrines. It can be presumed that rural sanitation could be increased to 50% from the present 16% by 2025.

FUTURE DEMAND for FOOD

The demand for food averages about 3.45×10^8 tonnes. This has to be met from both rainfed and irrigated areas. Apart from these, there are non-food grain demands in regard to other food related items and also demands for fibres and industrial oil seeds, which have to be met from the land. The amount of land used for agriculture depends on its productivity. Assuming a national average yield of 1.25 t/ha for un-irrigated crops and 2.75 t/ha for irrigated crops, the likely land use plan in 2025 will be as follows :

Net Sown Area	=	1.42×10^8ha
Gross sown Area	=	2.00×10^8ha
Gross Irrigated Area	=	9.5×10^7ha
Gross Cropped Area (Rainfed)	=	1.08×10^6 ha
Gross Irrigated Area (Food grains)	=	6.5×10^7 ha
Gross Crop Area (Rainfed) Food grains	=	7.2×10^7 ha
Food Production from Irrigated Areas	=	2.25×10^6 tonnes
Food Production from Rainfed Areas	=	9.0×10^8 tonnes
Total Food Production	=	3.15×10^8 Tonnes

FUTURE DEMAND FOR WATER FOR AGRICULTURE

The gross irrigated area of 9.5×10^7 ha can be achieved through the following plan :

S.No.	Source of Irrigation	Area (in Million Hectare)	Gross Delta (in Meters)	Gross Use (in BCM)
1.	Surface Irrigation	47	0.73	340
2.	Irrigation from Ground Water	48	0.51	240
	Total	95		580

DEMAND FOR DOMESTIC WATER

Water for consumption, health and hygiene necessarily has to receive priority in both vision and planning. Up until today we have had a reasonable water supply for most of our urban and the majority of our rural areas. However, there is a large variability in the quantity supplied to urban areas. It varies from 10 to 500 LPCD and in rural areas from 5 to 70 LPCD. There is a need to have much more water provided to the rural areas and a more equitable distribution in the urban areas. A norm of 220 LPCD for urban areas and 150 LPCD for rural areas has been suggested by the National Commission of Integrated Water Development. These goals can be achieved by 2050 AD. The norms proposed by 2025 are 220 LPCD for urban areas and 70 LPCD for rural areas. The total water required for drinking by 2025 is $6x10^{10}m^3$. It is expected that 80% of the domestic water will be recycled and the consumptive demand will be 20%.

INDUSTRIAL AND OTHER DEMANDS

Industrial requirements are estimated to be around $1.2x10^{14}m^3$ gross, of which the net requirement may be $6/5x10^7$. Apart from this the requirement for maintaining the ecology of the rivers and for maintaining navigability in the lower reaches would be around $2x10^7$. Water requirements for the energy/power sector has been estimated as $3.5\ x10^{10}m^3$. The water requirement for hydro power generation is mostly non consumptive. However, the evaporation losses from reservoirs in 2025 have been estimated to be $5\ x10^{10}m^3$. The requirement for navigation in water channels are mostly met by seasonal flows in various river systems or canals. However, the actual release downstream of the Farakka Barrage for the year 2025 has been projected at $1\ x10^{10}m^3$ by the National Commission.

Thus the total water requirement for 2025 can be abstracted as follows :

Sl. No.	Item	Gross Requirement (in BCM)	Net Requirement (in BCM)
1.	Agricultural	580	350
2.	Domestic Water Demands	60	12
3.	Energy & Hydro-Power	85	61
4.	Industry	120	65
5.	Navigation & Ecology	10	0
	Total	800	488

CONCLUSIONS AND VISION

(i) Water Requirements

It is clearly seen that water planning for the year 2025 calls for the irrigation of $9.5\text{-}20x10^7$ ha which is less than the irrigation potential of $1.39x10^8$ ha achievable through conventional means. This clearly indicates that conventional means of in-basin surface and ground water development will suffice.

Gross water demand is large at $8x10^{11}m^3$. As per the current thinking the utilisable water resource is limited to only $1.086x10^{12}m^3$ made up of $6.9x10^{11}m^3$ through surface sources and $3.96x10^{11}m^3$ through ground sources. With increased water withdrawls, a large scale recycling of water would become inevitable and ground water will be augmented by return flows from agriculture and domestic uses. Similarly recycled water will be added to surface water. In view of this, net water requirement will be $4.88x10^{11}m^3$. This again indicates that if utilisation by conventional means alone is considered, there will be marginal water shortages. These shortages naturally would be far more serious in the water short basins like the Cauvery, Pennar, Sabarmati, Mahi, and Krishna basins.

Thus the Water Vision for 2025 has to stress on initiating measures for unconventional means such as inter-basin water transfers and artificial recharge as essential ingredients for meeting the day-time demands, keeping in view the possibility of occurrences of drought.

The net water requirements are much smaller at $6.85 \times 10^{11} m^3$. These are smaller than the available water resources of around $1.87 \times 10^{12} m^3$. Thus no import of water from other areas is necessary. However, the net use of such large quantities as $6.85 \times 10^{11} m^3$ will require a large scale storage development. Considering that the total live storage which is possible to develop within India is $3.84 \times 10^{11} m^3$ then some storages in other countries may have to support the development.

The large difference between gross and net utilisation of about $5.85 \times 10^{11} m^3$ indicates that in 2025 re-circulation through return flows would be in the order of $5.6 \times 10^{11} m^3$ which is about 30% of the $1.87 \times 10^{12} m^3$ water available. Thus the pollution hazards in both surface and ground water, particularly in regard to ground water, will be a cause for serious concern and have to be addressed in the Vision.

(ii) Development of Eastern Region

In view of the fact that there is a relatively smaller opportunity of increasing food production in the agriculturally advanced regions like Punjab and Haryana with present technology, the eastern region holds the most promise for future food security. The agricultural production potential of the plains of the eastern regions is sufficiently high and is comparable to the agriculturally advanced regions of the country. The management of water is a critical factor in the realisation of this production potential.

(iii) Reclamation of Land

According to the Water and Related Statistics published by the Central Water Commission, 8.5×10^6 ha of land are water logged in the country and nearly 2.46×10^6 ha is estimated to be caused by inadequate drainage systems in irrigation commands. Similarly out of 5.5×10^6 ha of land are affected by salinity and as much as 3.06×10^6 ha comprise the area affected by irrigation related problems.

The waterlogged areas can be reclaimed by surface and sub-surface drainage and also by conjunctive use. ICID and CWC have already published guidelines for the Conjunctive Use of Surface and Groundwater. Reclamation of saline and alkaline land will be a more complex job, involving leaching, soil additions, sub-surface drainage and trunk drains.

(iv) Water Conservation Methods

Even though the supply of water is to be increased before the year 2025, water conservation measures such as water management, reducing evaporation and evapo- transpiration, better irrigation practices and adoption of sprinkler and drip irrigation methods, maintenance of irrigation systems, conjunctive use and the recycling and reuse of water must be introduced. All of these measures will greatly assist in saving water.

INDONESIA

1. GENERAL

1.1 Indonesia is one of the world's largest archipelagos stretching across $5x10^3$ km and is the fourth largest in population after China, India, and the United States of America. It is estimated that its population will grow to between 2.6 and $2.8x10^8$ in less than 29 years before it stabilises at a zero growth rate. Indonesians live on about 6,000 islands within an Archipelago of well over 17,000 islands and a land area of $2x10^8$ ha. Some of the larger islands are very sparsely populated while islands such as Java, Madura and Bali are very densely populated. The land varies in topography from high mountainous peaks to low wetlands and lush tropical forests.

1.2 In 1969, the population stood at $1.2x10^8$ people. With rice imports of $2x10^6$ t, the country was the largest importer of rice in the world.

1.3 The eco-system is one of the richest in the world and is home to many diverse species of plants, animals, birds and insects. There is great ethnic and linguistic diversity and in the remoter regions there are still many traditional people whose perceived interests are often in conflict with the concepts of modern economic development.

1.4 Until about 1985, the country maintained a relatively low profile in the international, economic and business arena. Things changed dramatically in the late eighties and early nineties leading to unprecedented economic expansion and an influx of businesses and investment from foreign sources.

2. PRESENT SITUATION OF WATER

2.1. Indonesia also has abundant water resources almost in every region. At present it is estimated that the total water resources reach about $4.032,266 \times 10^{12}$ m^3 per year or equal to 2,110 mm/year. It is estimated that with this amount of water resources there are about 2.4×10^6 ha of new irrigation which can be opened. However, the use of these water resources is still not entirely recommended. More than 80% of the present water resources are used for agriculture.

2.2. The average annual availability of water is 1.4×10^4 m^3 per capita is large at first glance adequate for all the country's needs. But things are very different on a regional basis. Of the 90 major river basins into which we have sub-divide our water resources, more than 20 face critical water shortages. Furthermore catchment degradation threatens food security and rural prosperity.

2.3. There are several hundred river basins spanning the country. On a national scale, water resources have been classified into 90 river basins ranging in catchment areas from about 2×10^3 km^2 to over 1×10^5 km^2 for some of the less developed basins. The population supported by some of the major river basins on the densely populated island of Java exceed 1×10^7 people, while other basins in more sparsely populated regions support less than 1×10^6 people.

The average annual rainfall varies from 1×10^6 mm to 5×10^6 mm with an average of about 2.7×10^6 mm. The total average yield from all the river basins was estimated to be of the order of 1.4×10^7 m^3 per capita per annum in 1990. There are, however, wide regional differences and the per capita availability in some of the basins in Java is less than a tenth of the national average. There are also seasonal and longer term variations which cause serious concerns about water availability. Unless the storage capacity of reservoirs is raised two or three times the present total of about 1×10^{10} m^3 will not meet the nation's future needs. A large part of the present storage capacity is confined to a few very large reservoirs in Java and Sumatera.

2.4. Starting from about 1975, the government invested heavily in new projects for water resource development primarily for irrigated agriculture. These included irrigation and drainage systems, reclamation of permanently or periodically flooded low lying wetlands, water conservation, flood control and river basin management. At that time most of the government's efforts to improve the infrastructure for irrigation and drainage was concentrated on what were described as government managed systems. The total area of irrigated land was about 5×10^6 ha with an average size of about 6 ha $x10^2$. Well over a third of the total government unmanaged irrigated area was served by systems of less than 5 ha $x10^2$ each.

2.5. Concerns arose at that time about the shortcomings of operation and maintenance (O&M) of new and rehabilitated systems. The wisdom of continuing investment in irrigated agriculture when even the cost of O&M was not being recovered from the beneficiaries was in question. Following a comprehensive review of the performance of irrigated agriculture as a whole the government introduced a set of six policies related to the O&M of irrigation and drainage systems. As part of the 1987 Policy Statement on O&M it was decided to introduce an Irrigation Service Fee on all irrigated systems and also to hand over systems serving less than 5 ha $x10^2$ to Water Users. The Government introduced a well coordinated programme to physically upgrade water systems and to establish and strengthen water user's associations.

2.6. The irrigated area at present is just over 5.5×10^6 ha excluding the farmer managed systems which serve an additional 1.6×10^6 ha. Most irrigation is run -of- the- river systems and the lands cannot be defined as arid or semi-arid using terminology and definitions from other countries which have significant areas under irrigation. Most agricultural areas receive abundant rainfall. The problem is with the availability of water at critical times in the food-crop growing process. There is also a highly pronounced dry season in most areas during five to six months of the year. Lands which look lush and green during the wet months need irrigation for sustainable food crop production during the dry monts.

2.7. Roughly a third of all government managed systems serve less than $5x10^2$ ha. About $4x10^5$ ha of these smaller systems have already been handed over to Water User's Associations after upgrading them and strengthening the institutions.

2.8. Starting from about 1974, the government studied several small and medium scale irrigation systems serving between 1.5 and 5 $x10^2$ ha. An integrated approach was used involving social, agricultural, environmental and engineering aspects. Some of the schemes had been started by farmers in newly settled areas of Sumatera and Sulawesi and involved a substantial amount of land clearance and levelling for irrigated rice fields and development of tertiary systems. The Sederhana or simple irrigation development program has continued from it's origins until recently, focussing on integrated development and the establishment and strengthening of water User's Associations in a large number of provinces.

2.9. Outside the Government managed area there were many smaller irrigation systems serving areas of less than $1.5x10^2$ ha, some as small as two to five ha. These were spread throughout the densely populated rural and uphill areas mainly on Java, Bali and Sumatera. A study of these farmer managed systems showed that there was great potential to raise agricultural production through relatively small outlays on the rehabilitation of headworks and provision of simple structures mobilizing local skilled people for their construction. With a good approach it would also be possible to involve farmer groups from the very early stages of planning with the result that the sense of ownership and optimization were automatically enhanced. Farmers were often the instigators of the rehabilitation and were prepared to contribute in labour or in kind if not in cash up to 59% of the construction costs. No major impediments existed to obtain full benefits within a very short period and there was no further burden to the government with respect to O&M.

Rapid progress was made in the 1990s on the rehabilitation and improvement of almost $1.6x10^6$ ha of these small farmer-managed systems which now contribute a significant part of the rice production, especially in Java, Bali and Sumatera.

2.10. Several lessons have been learnt with respect to the development and transfer of small scale irrigation systems. At present estimates, these systems serve a total irrigated area in excess of $3x10^6$ ha, and are the main source of livelihood for about $1x10^7$ farm families or approximately $4.5x10^7$ people. However, the investment has not yielded the anticipated benefit in all cases because of shortcomings in inter-sectoral coordination, the expense and logistical coordination of large scale transmigration programmes and the slower than expected pace of establishment and strengthening of water user's groups and farmer's organizations. The transfer of smaller systems serving less than 500 ha as envisaged in the 1987 O&M Policy Statement has not proceeded to the full area of $1.5x10^6$ ha.

The implementation of an Irrigation Service Fee for the O&M of larger systems was not very successful. The result is that the government is still carrying a large portion of expenditure on efficient O&M especially for the major headworks such as dams and head regulators and for the main conveyance systems.

2.11. With agricultural activities consuming 80% of the water supplied from our storage and irrigation systems, urban areas suffer substantial strains on the quality and quantity of water available for domestic, municipal and industrial use. In densely populated basins water use for irrigated agriculture will be more and more in direct competition with domestic, municipal and industrial supplies as well as for tourism and recreational uses.

3. PRESENT SITUATION OF FOOD

3.1. Rice is the staple food of most people in Indonesia. Though it is also possible to cultivate rice in several agro-ecosystem, most paddy is cultivated in wet land. In a few cases, paddy is also cultivated on dry land swamp areas. In addition, secondary crops, particularly legumes, play a significant role because they are the main protein source for most people.

Food self sufficiency is now an emerging issue in Indonesia. It is realized that with the economic turmoil facing the country, a stable food production system is critical. Food import grows year by year due to the unstable domestic production. However, Indonesia still has an abundant food resource.

3.2. Agriculture in Indonesia in1996, not including Maluku and Irian Jaya, covered $5.92x10^7$ ha. The largest area of agricultural land is used for estate crop ($1.45x10^7$ ha or 24.5%), followed by dry land ($1.16x10^7$ ha or 19.5%), woodland ($9.4x10^6$ ha or 16.0%), and paddy fields ($8.5x10^6$ ha or 14.1%).

Food crops are mainly produced on wetland paddy ($9.9x10^6$ ha and $4.56x10^7$ ton), maize ($3.4x10^6$ ha producing $2.7x10^6$ ton), followed by dryland paddy, cassava and soybean. Wetland and dry land paddy is mainly found in the islands of Java and Sumatra, followed by Sulawesi and Kalimantan. Secondary crops such as maize, cassava, sweet potato, groundnut and soybean are cultivated and produced throughout Indonesia, mainly in the islands of Java and Sumatra. The highest in total production is cassava ($1.5x10^6$ t), followed by maize ($8.8x10^6$ t) and soybean ($1.43x10^6$ t). Fruit crops are planted on all islands, mainly on Java, Sumatra and Sulawesi. Vegetables are cultivated on the islands of Java and Sumatra, but also on all other islands with smaller harvest areas and lower production. There are two different kinds of estates, namely large and small estates. Oil palm represents the largest area in large estates and coconut is the major crop in small holder estates. Cinchona is typically planted in large estates as well as sugarcane. No data are available from the small holders estates.

Animal husbandry includes seven kinds: dairy cow, beef cow, buffalo, horse, goat, sheep and pig. Cows, goats and sheep are mainly found in the island of Java as well as goats and sheep. Buffalo are on Sumatera and horses on Bali, Nusa Tenggara and Sulawesi. Poultry includes domestic hens, layers, broiler and ducks which are mainly found on Sumatera, Java and Sulawesi. Fishery is divided into marine fishery or wild fish which are caught and fish culture which includes open water, brackish water and fresh water fish culture. With these food resources, the average availability of calories, protein and fat per capita is 2.833 kcal, 65.27 g and 53.23 g respectively.

Regarding paddy fields, more than 50% of our wetland has been irrigated with a variety of technology. Wetland is the main area for paddy cultivation and secondary crops. Wetland is agricultural land, compartmentalized and separated by small dykes to hold water, where the main crop is usually wetland paddy without considering the status of the land. It includes land that is registered at the land income tax office, regional development contribution, 'village community' land, illegal ownership, swamps for rice cultivation, and newly opened lands. Wet rice fields includes irrigated rice fields, rain-fed fields and valleys.

3,3. Government plans place a great emphasis on the well being of the majority of rural people who are engaged in agricultural activities. Almost 90% of the people in the rural areas are farmers and their dependents. The combined policies of investment in irrigated agriculture and improved water management were to establish and strengthen village-level institutions and cooperatives which help to secure food self-sufficiency especially of rice, and thus prosperity in rural areas.

3.4. Since 1965, food production has been considered synonymous with rice production because there was a great shortage of this staple food. Almost 85% of the rice was grown on irrigated lands and more than 80% of water abstracted from our rivers and from groundwater sources were used for irrigated agriculture. Investment in agriculture in general and in the rehabilitation, improvement and expansion of irrigation and drainage systems in particular, resulted in the country reaching self sufficiency in rice by 1984, when the population had reached about $1.6x10^8$.

3.5. The main features of irrigated agriculture of that period was that, except for a small area of sugar cane, rice was the predominant irrigated crop and was grown on small land holdings of less than half a hectare on average. In densely populated Java and Bali, the average land holdings are even less than 0.25 ha. A major proportion of rice was produced on the irrigated lands using traditional methods of flood irrigation on small land holdings.

3.6. For the past two decades, since1970, the government of Indonesia has devoted its effort to a sustainable increase in food production. Many programs have been implemented and resulted in the remarkable achievement which, by 1984, Indonesia reached self-sufficiency of rice. At present, many programs are still being implemented as rice self sufficiency was achieved only for two to three years. Since then, Indonesia faces a rice and secondary crop deficit.

The current program for increasing food production consists of several actions as follows: :

(i) Intensification program. This program is aimed to increase yield on existing land. In particular, the program involves continuous improvement of intensification by providing assistance to farmers in acquiring production inputs through providing agricultural credit (KUT), introducing new technology, mechanization, and improving the irrigation infrastructure through INSUS (Special Intensification) and SUPRA INSUS (Improved Special Intensification) programmes.

(ii) Agricultural land extension. Indonesia still has an abundant land resource, which is suitable for agriculture. As part of the effort to fulfill the demand for food, one strategy is to open new agriculture areas. Every year about $6x10^4$ ha of new land is opened. Meanwhile, since 1994, a remarkable land area ($1x10^6$ ha) have been opened as a crash program for food production.

4. PRESENT SITUATION OF RURAL DEVELOPMENT

4.1 The rural areas account for 80% of Indonesia. It is the living area of about 70% of Indonesian households which are mostly engaged in agriculture. In 1993 the number of agricultural households were about 78.46% of the rural households. During the period from 1983 to 1993, the agricultural production area has increased significantly, except for food crops which only increased slightly. Significant contributions are from fisheries, forestry, small holder estate crops and livestock. At the same time, non-agricultural sectors increased rapidly and consequentially provided a greater variety of work opportunities in the rural areas. In 1983, the variety index of work opportunity in the rural areas was about 2.93, in1993 it increased to 4.94. Another remarkable achievement during the period of 1983 to1993 was that the absolute income of rural households increased by 16.5%. The table below shows a comparison of income structure of rural households between 1983 and 1993.

Structure of Income of Rural Household by the type of sources (percent)

Source of Income	1983	1993
A. Agriculture Sector	54.97	50.00
1. Food crops	29.07	19.26
2. Estate crops	13.86	15
3. Livestock	8.58	6.53
4. Fishery	2.56	4.49
5. Forestry	0.90	4.72
B. Non Agriculture Sector	10.99	10.74
C. Non Business	0.75	4.03
D. Laboring	25	21.99
E. Others	8.29	13.24

Source: Proceeding of Rural Dynamics Workshop, 1998

4.2. Irrigated agriculture provides employment and income for over 50% of the working population of Indonesia. In the rural areas almost 90% of the heads of households are engaged in farm related activities. We erroneously assumed in the 1980s that through subsidies on fertilizers and the programmes of intensification and extension services provided by the Government, we would bring prosperity to the farmers. Indeed, up to a certain point, it was true that there was an element of prosperity with better housing, transportation and access, more educational and health facilities etc. Farmers and their cooperatives owned motor vehicles, there was increased literacy among the children, banking facilities were introduced into the sub-districts and villages, and radio, television, and newspapers, penetrated even the most remote villages. In spite of this development, there was rapid urbanization and the incomes, employment and facilities in the metropolitan areas, especially Jakarta and Surabaya and the conglomerations around those big cities, life became far more comfortable and affluent than anything which had been enjoyed by the villagers in the rural areas. We imposed controls on the price of rice with the result that it was more affordable to the urban dwellers. These policies marginalised those who were engaged in agriculture.

4.3 In general, farming is seen as an activity fit for only the least educated in modern terms. This is further aggravated by false perceptions such as the low economic well being of those engaged in agriculture, and low personal esteem because farming is considered dirty or ungentlemanly work. There is a very accelerated migration of younger more educated people from the farming areas to urban areas where they seek work as industrial labourers or domestic servants because anything appears to be better than the drudgery of working under traditional farming conditions.

4.4. The size of land owned and cultivated determines the income of a household. In rural areas an average agricultural household occupies 0.86 ha. However, a recent survey shows that about 50% occupy less than 0.5 ha.

4.5 The development in rural areas has improved significantly within recent years. In particular, since the 1970s, the government has introduced improvements to the rural infrastructure by introducing the INPRES Program (Presidential Instruction). This program covers budget assistance at the village level for road pavement, elementary school buildings, health centres and electricity. It has significantly improved the rural infrastructure and benefited many the rural people. An overview of this rural infrastructure development follows :

4.6 Road: According to the Central Bureau of Statistics (CBS), 80% of the rural villages can now be accessed by four wheel transportation which has supported improvement of marketing agricultural products. In addition, 8.7% are accessible by water transportation.

4.7 Electricity: The rural electricity program has supported the development of pumped irrigation of groundwater as well as surface water. The program has supported also the development of home industries and other small industries in the rural areas.

4.8 Potable water. The development of a clean water infrastructure in rural areas has been improved significantly. In 1993, the percentage of households which acquired their water from a pipeline reached 14.7%, from groundwater pumping 10.4%, and from wells 52.3%. The water supply infrastructure development in rural areas has grown at about 7% per year. However, there are still 22.6% of the households which get their water directly from springs and rivers.

4.9 Despite the rural development that has been programmed, there is still significant evidence of poverty in rural areas. According to CBS (1994), in 1993, $25.9x10^6$ people in Indonesia (13.7% of the total population) were still living below the subsistence level. Among them, $17.2x10^6$ lived in rural areas.

4.10 Based on years of experience, we should now involve the villagers far more, starting from the initial feasibility of multi-sectoral projects to integrated planning and implementation within clearly defined concepts, frameworks, objectives and targets.

5. THE FUTURE

5.1. FOOD

5.1.1 Generally the policy objectives of the Indonesian agricultural sector include improving the economy of the rural poor, improving food security and enhancing the export capacity of some agricultural commodities. Within the context of improving food security, achieving self-sufficiency in rice and other basic commodities is an essential measure as it will also control inflation and save scarce foreign exchange. Policy measures are focussed on ensuring that there is an adequate supply of basic inputs such as fertilizers, quality seeds and approved pesticides for integrated pest management. Policy measures have also been taken to improve the efficiency of irrigation and water resource management, since the improvement of agricultural productivity is focussed on the existing irrigation schemes, especially in Java, Sumatera, Sulawesi, Bali and Lombok, and in reclaimed tidal land swamp areas.

5.1.2 Agricultural diversification should still be an important goal for longer term growth in rural areas, particularly in enhancing export driven commodities such as cash crops, horticultural crops and coastal fisheries.

5.1.3 In the future, Indonesia is willing to reduce its rice consumption per capita by introducing a greater variety of food such as fish, meat and poultry. It is expected that in the year 2025 rice consumption per capita will drop to about 100 kg per year which will lead to a significant reduction in the demand for rice. However, the decline will be followed by an increase in the demand for livestock cereals.

5.1.4 Under the new policy, the demand for unhusked rice in 2025 (population will be about

$2.8x10^8$) will drop to only $2.8x10^7$ t from about $3.3x10^7$t at present. Considering these projections, the level of self-sufficiency in rice production will be attained in 2025.

5.1.5 The increasing demand for feedstock cereals which generally require less water, there will be no significant increase in the demand for water. However, there will need to be an adjustment in irrigation infrastructures from a 'wetland paddy type' to a 'dry land secondary crop type'.

5.2. RURAL DEVELOPMENT

The direct consequences of a strong agricultural sector growth are clear. It will raise their comes of some of the poorer citizens and it will also provide a safety net for the newly unemployed by giving earning opportunities to returning migrants from urban areas until broader economic conditions improve. Clearly, the more rapid the agricultural growth, the stronger the anti-poverty benefits. Given the macroeconomic imperative of encouraging flows of resources into agriculture and rural development, the greater will be the benefit to the economy as a whole.

5.2.2 It is also expected that the size of farmlands will increase as the growing rural economics will support rural people in other services, such as merchandise, commodity cooperatives and small industries. Mechanization will be widely applied in food crop agriculture and more professionally hired labour will be needed.

5.2.3 The Indonesian economy, despite having a gloomy short-term outlook, retains several potential bright spots which, in combination with firm, consistent implementation of the on-going government reform programs will rekindle growth. Agriculture, for example, is expected to recover gradually and faster relative to other sectors, adding to local incomes, demands and revitalizing other sector activities. Export of cash crops, livestock, and fish could rise significantly even in the short term. At some point in the next few years Indonesia will resume growth, albeit not at the pace of recent decades.

5.2.4 The economy continues to possess significant strengths because of the untapped potential of rich natural resources, a large domestic market, innovative farmer communities, an increasing number of educated people, a reserve of water resources and an infrastructure already in place.

5.3 WATER SECTOR

5.3.1 Several river basin territories are considered strategic. Therefore policy measures must continue to be taken. For instance, the implementation of the Coordinated and Integrated River Basin Management Plan is a necessary condition for successful national economic development.

Within the spirit of decentralization of various aspects of economic development, the participatory irrigation management policy needs to be reformed. Over time the role of the water users association will be strengthened and empowered. It will gradually be given a larger jurisdiction by taking into account the limited financial and operational capacity of the local rural community.

5.3.2 The management of water resources which is eco-regional specific is needed to support the growing peri-urban horticultural commodities and an expanding coastal shrimp industry. Development of micro-irrigation is needed to support peri-urban agriculture and adequate flows of water are needed to ensure a water supply for shrimp culture. This implies immediate efforts to develop key integrated water resource management procedures and guidelines. These procedures include inter-sectoral water allocation and reallocation, introducing and sustaining water user fees, integration of groundwater and surface water management, and allocation of responsibilities for the maintenance of key river structures and flood control management.

5.3.3 Other areas of concern include the coordination and management of water resources and their conservation and utilization in a sustainable manner. A series of legislative measures and organizational changes were made in the early 1990s to accommodate these concerns, including the elevation of water resources to a separate sector of the economy.

5.3.4 We expect that in the near future there will be an increased degree of urbanization and industrialization. The economy has been diversified to a number of non-oil and non-food sectors, thus raising competition for water from sectors other than agriculture. However, food and agriculture remain the primary concerns and with a resumption of the importation of rice and several other very important foods and commodities the water resources sector has to respond in a positive manner to increase the efficiency of agricultural production through better water management and the enhancement of yields through better agronomic practices.

5.3.5 Realizing the increasingly complex long-term investment challenges and management problems, the government will continue the reformulation of the water sector. Structural adjustment, which had been started and will support food security programs, public health, and prevention of environmental damage will also be reformed. The reform will handle the inappropriate and ineffective legal structures, regulations, policies and institutions by changing sector policies, using more effective institutional frameworks, improving planning and management systems as well as increasing beneficiary participation.

5.3.6 The specific objectives to improve sector reforms:

- The national institutional framework for the development of water resources and management, will consist of :

  (i) establishing a sector coordination framework;
  (ii) reviewing current policies and procedures and adopting a National Water Resources Policy;
  (iii) providing stakeholders with participatory institutions;
  (iv) improving data networks and management information systems; and
  (v) improving the National Hydrological and Water Quality Data Collection and Management System.

- The organizational and financial framework for the management of river basins will consist of :

  (i) setting up basin level provincial management units in less developed river basins;
  (ii) establishing self-financing, autonomous river basin management corporations in strategic river basins; and
  (iii) establishing a formal national water and water quality rights framework.

- Regional water quality management regulatory institutions and implementation which will consist of :

  (i) regulatory powers for water quality management; and
  (ii) establishment of basin water quality management institutions.

- National irrigation management policy, institutions and regulations to enhance participatory irrigation management will consist of:

  (i) the empowerment of farmer irrigation organizations;
  (ii) the reorganizayion of irrigation agencies which will give more participation to the water users associations (WUA);

(iii) financing of WUA activities by revision of the existing irrigation service fee procedure to get sustainability, efficiency of O&M and rehabilitation activities; and
(iv) transferring the responsibility for irrigation O&M financing to local governments.

6. CONCLUDING REMARKS

Looking to the first 25 years of the 21st century in the third millennium, the vision for the sector must concentrate on the following issues which have already been identified:

6.1. Make rural development in general and particularly agricultural activities in terms of job satisfaction and income as attractive as any other sector of the economy, including marketing aspects, rural banking and information technology. Otherwise, it will be impossible to persuade enterprising and well educated young people to consider farm related enterprises as viable occupations.

6.2. Rank water and food related activities, including farms, with other activities and make them as transparent. Make small and medium scale enterprises commercially viable and increase training programs to prepare individuals, groups and rural cooperatives in handling better financial and human resource management to improve the business efficiency of their enterprises.

6.3. Reform the existing water policies, strategies and regulations to strengthen the management and development of the water sector.

6.4. Enhance the integration of activities on water and food to make seed farms, nurseries, hatcheries, extension services, post harvest handling, marketing and distribution of foodstuffs as science and technology oriented disciplines.

6.5. Encourage rural people to participate actively in discussions between the pros and cons of conserving a sustainable environment whilst pursuing food production and other activities in amenity sports, recreation, parks, sanctuaries, tourism, research and development especially in rural areas.

6.6. Make the rural areas attractive enough to become commuter belts for the urban workers without reducing fertile farmland for agriculture. The challenge is to avoid the feeling that rich urbanites are exploiting poor farm workers. Minimum wages must apply in all locations so that people have enough for their basic needs of food, clothing and shelter in a modern economy.

6.7. Reintroduce institutional and legislative reform at the grassroots level, including the traditional rules and regulations, so that rural people are again aware of their rights and responsibilities to participate in national development programs.

IRAN

GEOGRAPHY AND POPULATION

The Islamic Republic of Iran covers a total area of about 1.65 million km² and is bordered by Azerbaijan, Armenia, the Caspian Sea and Turkmenistan to the north, Afghanistan and Pakistan to the east, the Oman sea and the Persian Gulf to the south, and Iraq and Turkey to the west. About 52 % of the country area consists of mountains and deserts and some 16% of the country has an elevation of more than 2 000 m above sea level. The largest mountain massif is that of the Zagros, which runs from north-western Iran first southwards to the shores of the Persian Gulf and then continues eastwards till the most south-eastern province. Other mountain ranges run from the north-west to the east along the southern edge of the Caspian Sea. Finally, along the eastern frontier of Iran several scattered mountain chains exist. The Central or Interior Plateau is located in between these mountain chains and covers over 50% of the country. It is partly covered by a remarkable salt swamp (kavir) and partly by areas of loose sand or stones with stretches of better land near the foothills of the surrounding mountains.

The cultivable area is estimated at about 51 million ha, which is 31% of the total area. In 1993 about 18.5 million ha, or 36% of the cultivable area, were considered usable for agriculture, while 14.4 million ha were actually cultivated. Of this area, 12.8 million ha consisted of annual crops and 1.6 million ha of permanent crops. About 70 % of the landholders possess less than 5.5 ha (of which on average 2.13 ha irrigated and 3.25 ha rainfed).

Table 1 - Basic statistics and population

Physical areas:			
Area of the country	-----	164 800 000	ha
Cultivable area	-----	51 000 000	ha
Cultivated area	1997	13 793 263	ha
- annual crops	1997	12 106 644	ha
- permanent crops	1997	1 686 619	ha
Population:			
Total population	1996	60 050 000	inhabitants
Population density	1996	36.4	inhab./km²
Rural population	1996	38.3	%
Water supply coverage:			
Urban population	1996	95	%
Rural population	1996	86	%

The total population is about 60.05 million (1996), of which 38.3% is rural. The average population density is 36.4 inhabitants/km, but it ranges from less than 10 in the eastern part of the country up to more than 150 in the Gilan province, located in the Caspian Plain in the north, which is by far the most densely populated region in the country. In the Tehran province, where the capital is located, the population density reaches 400 inhabitants/ km². The annual demographic growth rate was estimated at 3.9% over the period 1976-1986 and at 2.46% over the period 1986-1991 and 1.47 over the period 1991-1996.

TABLE 2 - Water: sources and use

Renewable water resources:			
Average precipitation		252	mm/r
		415.3	km³/yr
Internal renewable water resources		121	km³/yr
Total (actual) renewable water resources	1996	130	km³/yr
Dependency ratio	1996	7	%
Total (actual! Renewable water resources per inhabitant	1996	2165	m³/yr
Total dam capacity	1993	39200	10^6 m³
Water withdrawal:			
- agricultural	1996	81400	10^6 m³/yr
- domestic	1996	4 500	10^6 m³/yr
- industrial	1996	900	10^6 m³/yr
Total water withdrawal		86800	10^6 m³/yr
per inhabitant	1996	1445	m³/yr
as % of total (actual) renewable water resources		66.7	%
Other water withdrawal	1996	16000	10^6 m³/yr
Average groundwater depletion	1993	3 795	10^6 m³/yr
Wastewater - Non-conventional water sources:			
Wastewater:			
- produced wastewater (Agricultural , urban & Industrial)	1996	29000	10^6 m³/yr
- treated wastewater	1996	250	10^6 m³/yr
- reused treated wastewater		-	10^6 m³/yr
Desalinated water	1991	2.9	10^6 m³/yr

CLIMATE AND WATER RESOURCES

Climate

The climate of Iran is one of great extremes due to its geographic location and varied topography. The summer is extremely hot with temperatures in the interior rising possibly higher than anywhere else in the world, certainly over 55°C has been recorded. In winter, however, the great altitude of much of the country and its continental situation result in far lower temperatures than one would expect to find in a country in such low latitudes. Minus 30°C can be recorded in the north-west and minus 20°C is common in many places.

Annual rainfall ranges from less than 50 mm in the deserts to more than 1600 mrn on the Caspian Plain. The average annual rainfall is 252 mm and approximately 90% of the country is arid or semiarid. Overall, about two-thirds of the country receives less than 250 mm of rainfall per year.

Water resources

Iran can be divided into the following major river basins: the Central Plateau in the middle, the Lake Orumieh basin in the north-west, the Persian Gulf and the Oman sea basin in the west and south, the Lake Hamoun basin in the east, the Kara-Kum basin in the north-east and the Caspian Sea basin in the north. With an area of 424 240 km², the Caspian Sea is the largest landlocked water body in the world and its surface lies about 22 metres below sea level. The rainfall characteristics of the above basins are summarized in Table 4.

TABLE 3 - Irrigation and drainage

Irrigation potential	1995	15000000	ha
Irrigation:			
1. Full or partial control irrigation: equipped area	1993	7 264 194	ha
- surface irrigation	1993	7 173 494	ha
- sprinkler irrigation	1993	47 200	ha
- micro-irrigation	1993	43 500	ha
% of area irrigated from groundwater	1993	50.1	%
% of area irrigated from surface water	1993	49.9	%
% of area irrigated from non-conventional sources	1993	0.0	%
% of equipped area actually irrigated	1993	100	%
2. Spate irrigation area		-	ha
3. Equipped wetland and inland valley bottoms (i.v.b.)		-	ha
Total irrigation (1 + 2 + 3)	1993	7 264 194	ha
- as % of cultivated area		51	%
4. Flood recession cropping area	1993	10 000	ha
Total water managed area (1 +2+3+4)	1993	7 274 194	ha
- as % of cultivated area		51	%
- increase over last 10 years	1983-93	30	%
- power irrigated area as % of water managed area	1993	36.0	%
Full or partial control irrigation schemes: Criteria			
Large-scale schemes > 50 ha	1991	708 260	ha
Medium-scale schemes	1991	3 159 924	ha
Small-scale schemes < 10 ha	1991	3 396 010	ha
Total number of households in irrigation	1991	2 620 000	
Irrigated crops:			
Total irrigated grain production	1993	10000000	tons
as % of total grain production	1993	61	%

Harvested crops under irrigation (full or partial control)	1993	7 264 194	ha
- permanent crops: total	1993	1 564 884	ha
- annual crops: total	1993	5 699 310	ha
. wheat	1993	2 340 676	ha
. other cereals (barley and rice)	1993	1 256 310	ha
. fodder crops	1993	790 063	ha
. vegetables	1993	425 116	ha
. other annual crops	1993	887 145	ha
Drainage - Environment:			
Drained area	1995	40 000	ha
as % of cultivated area		0.3	%
- drained areas in full or partial control irrigated areas	1995	40 000	ha
- drained areas in equipped wetland and i.v.b		-	ha
- other drained areas		-	ha
- total drained area with subsurface drains	1995	40 000	ha
- total drained area with surface drains		-	ha
Flood-protected area		-	ha
Area salinized by irrigation	1993	2 100 000	ha
Population affected by water-borne diseases		-	inhabitants

TABLE 4 - Rainfall in the major basins in Iran

Basin	Total area (km^2)	As % of total area	Rainfall (mm/year)	Rainfall (km^3/year)	As % of total rainfall
Central Plateau	832 000	51	165	138	33
Persian Gulf and Gulf of Oman	431 000	26	366	158	38
Caspian Sea	178 000	11	430	77	19
Lake Hamoun and Kara-Kum	150 000	9	142	21	5
Lake Orumie	57 000	3	370	21	5
Total	1 648 000	100	252	415	100

All these basins, except the Persian Gulf and Oman sea, are interior basins. There are several large rivers, the only navigable one of which is Karun, the others being too steep and irregular. The Karun river, with a total length of 890 km, flows in the south-west of the country to Aruand Rud, which is formed by the Euphrates and the Tigris after their confluence. The few streams that empty into the Central Plateau dissipate into the saline marshes. All streams are seasonable and variable. Spring floods do enormous damage, while there is little water flow in summer when most streams disappear. Water is however stored naturally underground, finding its outlet in subterranean water canals (qanats) and springs. It can also be tapped by wells.

Internal renewable water resources are estimated at 121 km^3/year. Surface runoff represents a total of 97.3 km^3 /year, of which 5.4 km^3/year comes from drainage of the aquifers, and groundwater recharge is estimated at about 49.3 km^3/year, of which 12.7 km^3/year is obtained from infiltration in the river bed. Iran receives 6.7 km^3/year of surface water from Pakistan and some water from Afghanistan through the Helmand river. The flow of the Arax river, at the border with Azerbaijan, is estimated at 4.63 km^3/year. The surface runoff to the sea and to other countries is estimated at 55.9 km^3/year. The total safe yield of groundwater (including non renewable water or unknown groundwater inflow from other countries) has been estimated at 49.3 km³/year. (including return flow from different water uses).

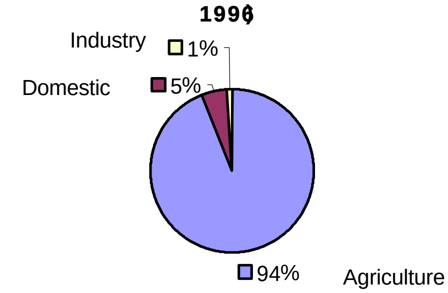
Dams

Dams have always played an important role in harnessing Iran's precious water reserves and the long-term objective of Iran's water resources development plan is based on the control and regulation of water resources through dams. In 1996, 58 storage dams were in operation with a total regulation capacity of 24.7 km³. At the same time, 48 storage dams were under construction with a design regulation capacity of 12.2 km³. In 1996, the annual electricity production from dams was 8000 GWH, which is 10 % of the total energy production of the country. Dams also play an important role in flood control through routing of floods. Several reservoirs behind the dams seem to offer good sailing and water-skiing facilities, but have not been used for recreation so far.

Water use

The total agricultural, domestic and industrial water withdrawal was estimated at about 86.4 km³ in 1996 (Figure 1). Although this is equal to 66% of the actual available renewable water resources, current annual abstruction from aquifers (from 49 km³ in 1990 up to 57 km³ in 1993) is already more than the estimated safe yield (46 km³). In some plains of the country there are over abstruction from groundwater which total amount of over abstraction is about 4 km^3 of the same time there is some limited possibility for development of groundwater in other aquifers.

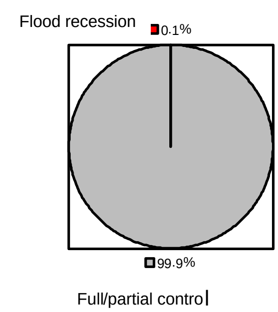
Figure 1 Water withdrawal (total: 86.400 km^3 in 1996)



IRRIGATION AND DRAINAGE DEVELOPMENT

The problem of water supply has been a constant preoccupation in Iran since the beginning of the country's history, thousands of years ago. Its inhabitants learnt to design and implement efficient techniques for harnessing limited water resources and for irrigation. Apart from the qanat, which was a major source of irrigation and domestic water supply for centuries, Iranians have in the past built dams of various types and weirs. Some of these head control structures, built as long as 1000 years ago, are still in good condition.

Figure 2 - Distribution of the water managed area (total: 7274194 ha in 1993)

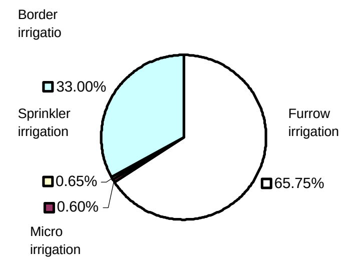


Agricultural land availability is not a major constraint in the development of Iranian agriculture. The major constraint is the availability of water for the development of these lands. The irrigation potential, based on land and water resources, has been estimated at about 15 million ha, or 29% of the cultivable area. However, this would require optimum storage and water use.

In 1993 out of 14382 million ha of cultivated land 7264 million ha, or 51 %, were equipped for full or partial control irrigation. Annual irrigated crops covered 5 699 million ha and permanent irrigated trees covered 1565 million ha. In addition, flood recession cropping is practiced on an area of about 10000 ha in the southwest (Figure2).

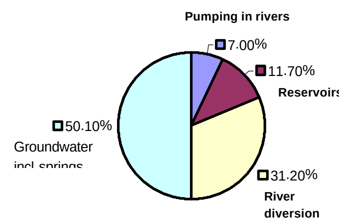
Surface irrigation techniques are used on 98.75 % of the area equipped for irrigation and 1.25 % benefits from a pressurized irrigation system (Figure 3). About half the area is irrigated from groundwater, including spring water (Figure 4). According to the landholding and technologies which are used, the farming systems are grouped as: small farms (< 10 ha) 47%, medium size farms (10-50 ha) 43%, and large farms (>50 ha) 10% (Figure 5) .

Figure 3 - Irrigation techniques f/p (total : 7264194 ha in 1993)

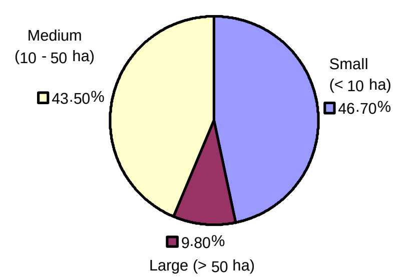


The cost of surface irrigation development varies from $US 2 300/ha for large to $US 2500/ ha for medium and $US 2 600/ha for small schemes. Average operation and maintenance costs are estimated at $US 130, 175 and 60 per ha and per year respectively. The cost of micro-irrigation and sprinkler irrigation development is estimated at about $US2200 and 1 200/ha. The average price of water delivered to farmers by government is $US 0.2 to 0.8/ 1000m³, while the cost of withdrawal of groundwater by the farmer is $US 5 to 9/1 000 m³ and the cost for regulating surface water in existing projects is $US 3 to 5 per 1 000 m³. These figures are subjected to change according to different rate of exchange of foreign currencies. This means that the government heavily subsidizes delivered water, which is probably one of the main reasons for the low irrigation efficiency throughout the country.

Figure 4 - Origin irrigation water f/p (total : 7264194 ha in 1993)



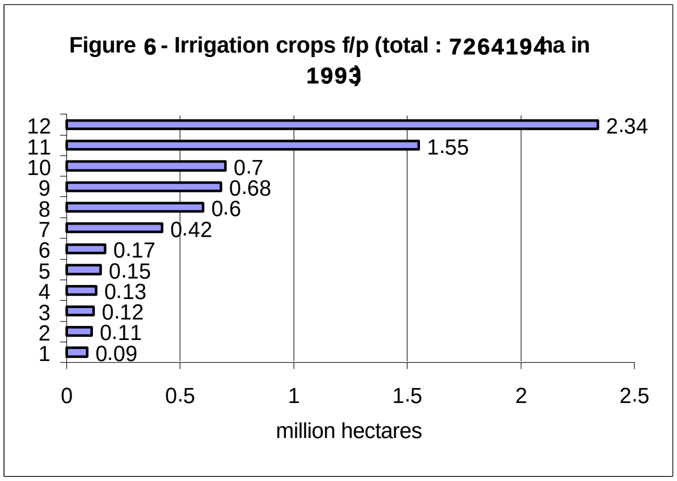
Figuer 5 - Types of f/p control irrigation schemes (total : 7264194 ha in 1991)



On-farm application rates in the country are rather high and in general irrigation has a low efficiency, 32% on average at national level. Major causes of inefficiency include: careless operation, poor maintenance, negligible water prices, fragmentation of responsibilities among different governmental agencies and inadequate training of farmers. Low irrigation efficiency causes waterlogging and salinization in the irrigated areas, which are a major problem in Iran. No comprehensive study has been undertaken regarding the extent of irrigation-induced salinity, but according to an estimate (ICID, 1977) for the year 1974 about 38% of the irrigated area in Iran had soils with considerable salinity and drainage problems. Over 2 million ha are estimated to be salt-affected and/or waterlogged at present.

By far the most important irrigated crop is wheat covering almost one-third of the total irrigated area, followed by irrigated fruit trees, covering one fifth of the total area (Figure 6). Other major irrigated crops are barley, rice, vegetables and pulses Wheat is also by far the most important rainfed crop covering 4.47 million ha, or almost two-thirds of the rainfed area. The yield for irrigated wheat was estimated at 2.78 tons/ha in 1993 against 0.95 tons/ha for rainfed wheat.

1-Wheat	2- Fruit trees	3- Fodder	4-Barley
5-Rice	6- Vegetables	7-Pulses	8-Sugar beet
9-Potatoes	10-Oil crops	11-Cotton	12- Other



INSTITUTIONAL ENVIRONMENT

According to the water legislation, three ministries are in charge of water resources assessment and development:

- The Ministry of Energy (MOE) has two responsibilities: energy supplies and water resources. In the field of irrigation, it is in charge of the construction of large hydraulic works, including dams and primary and secondary irrigation and drainage canals for the distribution of water. Within MOE, the Water Affairs Department (WAD) is responsible for overseeing and coordinating planning, development, management and conservation of water resources. Fourteen publicly owned Regional Water Authorities (RWA), reporting directly to MOE, are responsible for feasibility studies, project execution and subsequent management of water resources. The Operation and Maintenance of primary and secondary irrigation and drainage canals are operated by operation and maintenance corporations affiliated to MOE.
- The Ministry of Agriculture (MOA) is responsible for supervising rainfed and irrigated crop development. It is in charge of subsurface drains, tertiary and quaternary canals as well as on farm development and irrigation techniques, planned and operated by the Provincial Agricultural Organizations and the Deputy Ministry for Infrastructure Affairs of the Ministry of Agriculture.
- The Ministry of Jihad-e-Sazandagi (MOJ) deals with watershed management and rural development.

TRENDS IN WATER RESOURCES MANAGEMENT

Agriculture is one of the main priorities in national development plans. The annual increase in irrigated land over 15 years (1978-1993) was 3.8% along with a 4.4% annual increase for agricultural water supply. An increase of 500 000 ha of irrigated land and an increase of 10 km^3/year of agricultural water supply was planned in the second national five-year plan (1995 - 2000).

At present, a big gap exists between water delivery from the main canals and water application in the field. Compared to the large investments for water resources development, little has been done to improve irrigation water use at farm level. Water is delivered to old traditional irrigation canals and on-farm conveyance and the use of irrigation water is generally rudimentary and wasteful. The use of earth bunds, unlined canals and poor levelling combined with low water charges have resulted in very low levels of water conveyance and use efficiencies (32% as a national average) and caused the emergence of serious drainage problems.

A fundamental review of the organizational chart and institutional changes were made to improve this situation. Since 1992, the Deputy Ministry for Infrastructure Affairs of the Ministry of

Agriculture created five departments: farm development, pressurized irrigation systems, water supply, hydraulic constructions and operation and maintenance.

The government policy includes:

- An increase in irrigation efficiency by changing the surface irrigation techniques to pressurized irrigation.
- The establishment of a land Bank to facilitate the on-farm development and hand over the structures to the farmers groups.
- A change in water pricing and delivery methods;
- large-scale privatization.

MAIN SOURCES OF INFORMATION

Bureau of Information and Statistics. 1994. Agricultural Statistics Yearbook 1993. Deputy Ministry of Plan and Project, Ministry of Agriculture.

Bureau of Operation and Maintenance of Dams and Irrigation Networks. 1995. Water utilization in the year 1993. Deputy Ministry of Water Affairs, Ministry of Agriculture.

Deputy Ministry for Infrastructure Affairs. 1991. Summary of the social and agricultural economy of Iran. Ministry of Agriculture.

Keshavarz, M.A. 1993. Improvement of farm level infrastructures. Deputy Ministry for Infrastructure Affairs. Ministry of Agriculture.

Shakiebie. 1994. Seventh Iranian National Seminar on Irrigation and Drainage. IRNCID, Ministry of Energy.

Statistical Centre. 1994. Yearly Statistical Book 1993. Plan and Budget Organization.

Water and Sewage Engineering Co. Situation of water and wastewater in the country in 1992. Ministry of Energy.

World Bank. 1993. Staff appraisal report: Irrigation improvement project. Report No. 11393-lRN.

Yekom Consulting Engineers. 1995. Cost of Irrigation and Drainage Projects - Tender Documents.

ISRAEL

ABSTRACT

Israel achievements in water resources development, agricultural production and irrigation technology are matched by the magnitude of the still facing problems of quantity, quality and cost of water for irrigation. Major constraints among others include: increased water scarcity; depleting resources, frequent droughts; degradation of water quality; technological uncertainty and high cost of non-conventional sources; rapid urbanization, abandonment and desertification of agricultural land. However, to maintain the Israeli agriculture's unique and remarkable achievements, under a dynamic and changing world, new policies related to future needs for water, food security and agricultural production are being crystallized, aiming to make the agricultural industry freely competing with industrial and domestic users. Emphasis is on integrated water management of conventional and non-conventional sources, increased water use efficiency, coupled with advanced agricultural production. Furthermore, assuming that the peace process would create a strong regional commitment to avert water crisis, regional cooperation in agricultural production, water resources development, water transfer and interconnection of water systems can be envisaged.

1. INTRODUCTION

Israel on a land area of 20,770 km2 is divisible into three longitudinal strips running from north to south. The average annual rainfall varies from 600 - 700 mm in the north to 30 mm at the south. Israel's population is 6.0 million, of which 90% lives in urban areas and 10% in rural areas. The number of farming households is 25,000. Farm employment contributes 3.1 per cent, of the total employment or approximately 67,000 persons. Out of the total area, arable land amounts to

652,000 ha. The area actually irrigated is 230,000 ha or approximately 35 per cent of the arable land. The land holding allotted to a farming unit in the collective and cooperative settlements vary in size according to the soil and climatic conditions. The average holding is 7 ha.

The prevailing arid and semi arid conditions of Israel make irrigation imperative for the development of intensive agriculture and food production. Available renewable potential is already fully utilized, while the widening gap between supply and demand is made up with marginal resources, especially, reclaimed municipal wastewater which is becoming an increasingly important source of water for agricultural and industrial purposes. Cloud seeding is practiced, adding 10 - 15% of rainfall, and desalination of brackish and sea water is fast expanding. Water scarcity is further compounded by rapid degradation of water quality. Due to global warming and frequent droughts, the regime of the natural replenishment is decreasing while influxes of pollutants, due to man made activity above the aquifers, are increasing, resulting in the increase in mineral and other pollutants contents in groundwater.

Agriculture which dominated the national economy in the early years has gradually decreased as reflected by the sector contribution to the national product. Fierce competition with other markets and reduced government involvement in terms of protective quotas, direct support and subsidies were the major factors contributing to the fall. As the result, far reaching economic and organizational adjustments were made within the sector, encompassing: production, economic framework and organizational structure. Structural changes included rapid industrialization of the farm settlement and reduced degree of cooperation within the farming communities, at the local and regional levels. Changes were also made in the family production units, the supporting cooperative organizations and especially the change of focus from direct production to agro-industry and services.

The above process, constraints and anticipated initiatives and development to achieve sustainability by the year 2025 are discussed, highlighting concerns about the sector vulnerability, development plans and sector vision for the future.

2. AGRICULTURE SECTOR POLICY ISSUES

Agricultural production and Crop Diversification : Currently, irrigated agriculture still consumes more than 60% of available water resources, while contributing only 2 % of the GDP. Agriculture has therefore reached a turning point in which the highly capable industry have to be diverted from conventional production into advanced production systems, capable of competing with industrial and economic users on available water resources. A competitive market orientation is essential for the transformation in production and cropping systems.

New production systems are being envisaged, having the capability to :

- compete with other economic sectors on available water resources
- produce high value crops, innovative highly productive and less demanding in water
- favorably competing with import from external markets.

Other aspect being considered is:

- the transition of agricultural production from the temperate coastal plain to the arid south and the related effects on production and the desert ecology

Agriculture and the Environment : Agricultural production is considered to be compatible with the environmental protection and issues of open space, soil conservation and protection of the natural vegetation and water resources can greatly benefit from appropriate agricultural production systems. Accordingly, sustainable use of brackish and effluents without detrimental effects on the environment, water conservation and extremely efficient use of water in agriculture alleviating environmental pollution are attempted. Short, medium and long term targets are being evolved, as related to the following :

- efficient production to avoid agricultural waste;
- reduced use of fertilizer and pesticides;
- recycling of wastewater, sludge and compost;
- use of brackish and wastewater for irrigation
- rational use of land and water resources, and
- production of functional food.

Water Management : To cope with the combined process of water, agricultural production and environment, a restructuring of water management is being conducted, aiming to reduce the heavy reliance on costly non-conventional resources and the need to rationalize the use and conservation of natural resources in general and in agriculture in particular. Water as an economic good and a greater public participation and involvement in planning implementation and operation stages of development related to agriculture and environment is being achieved. Functions previously performed by the government are being transferred to the private sector, using free trade and economic principles, although environmental, social (ability to pay) and food security aspects are not overlooked.

Guiding principles include :

- economic value of water and water as an economic good is considered,
- charging the full cost of water is attempted,
- greater public participation in the planning, implementation and operation stages of water systems is pursued,
- the private sector is encouraged to fulfill functions previously performed by the government
- environmental, social (ability to pay) and food security aspects are considered.

3. WATER RESOURCES

Available Resources : The average annual renewable potential amount to some 1,600 MCM, of which about 95% are already exploited and used for domestic consumption and irrigation. About 80% of the water potential lies in the northern parts, hence, large quantities of water have to be conveyed over 200 km to supply the water needs. Surface water contributes about 33% and groundwater supply the difference, mainly from two major aquifers. Artificial recharge is practiced through spreading basins and single and dual purpose deep wells connected to the National Water Carrier. Currently, about 275 MCM of effluents, treated to varying degrees, are already utilized for irrigation, about 65% of the generated wastewater. Cloud seeding has been practiced for last 30 years, yielding a significant increase of 10 - 15% in rainfall. Several small and medium desalination plants have been installed, for desalination of brackish and sea water for domestic water supply, including a 10,000 cum/day sea water desalination plant in Eilat. Available water resources and water budget figures, for the years 1997 - 2020 are given in Table 1.

Table 1. Water Supply and Demand – Israel 1997-2020 (MCM/year)

Water Supply								
Year	Population (Million)	Water Sources					Total
		Surface Water	Ground water	Brackish Water	Treated Effluents	Desali-nated	
1997	5.8	600	1020	125	275	10	2030
2010	7.4	645	1050	165	470	100	2430
2020	8.6	660	1075	180	565	200	2680

Water Demand						
Year	Urban Sector	Agricultural Irrigation				Total
		Fresh	Brackish	Effluents	Total	
1997	772	880	103	275	1258	1960
2005	980	750	95	380	1250	2220
2010	1060	680	85	495	1260	2430
2020	1330	600	60	565	1350	2680

Source: Israel Water Commission, 1998

Water Allocation : In 1959, a comprehensive water law was passed making water resources a public property and regulating water resources exploitation, allocation and prevention of pollution and water conservation. Under the law all available water resources are under public domain and made available for use by the consumers as directed by the water Commissioner, the sole statutory body responsible for executing the State's water policy, regarding exploitation, allocation and conservation of water. The Water Commissioner issues abstraction license and allocations to consumers.

Water Supply and Demand **:** Annual renewable water resources amount to about 1.7 billion cum, compared to an annual water demand of about 2000 MCM/year, of which about one half is used for agriculture and the remaining is used by the urban and industrial sectors. All the Israeli settlements are served by public waterworks supplying an average of about 250 litres/capita/day. Similarly, about 95% of the return flow is collected and about 80% is adequately treated and in many cases reused for irrigation (42%). Currently, the urban sector consumes about 700 MCM and the annual increase is about 20 MCM per year, about 4%. Israel population is projected to increase to about 8.5 million by the year 2020 and urban water consumption to about 1 billion cum.

Drought Management **:** Water is supplied from all available resources including: groundwater, storm water, treated effluents and desalinated water. To overcome spatial and temporal gaps between supply and demand, most of the country's fresh water resources are inter-connected into the National Water Carrier. The Carrier, the backbone of the national system, conveys an annual amount of about 1,100 MCM over 180 km from north to south. An integrated network of pumping stations, reservoirs, canals and pipelines is used to supply water under pressure for all the domestic, industrial and irrigation consumers. During the winter months, excess supply is used for artificial recharge of the aquifers and establishment of hydraulic barriers. Thus, groundwater abstraction is used to balance between wet and dry years, providing 55 to 70% of the total supply, based on the prevailing climatic and hydrological conditions in a specific year.

Water Quality **:** The quality of supplied water in Israel varies from very low salinity water of the Upper Jordan River (10 mg/l of chlorides), to medium salinity in of the Kineret and major aquifers (100 - 200 mg/l of chlorides) and excessive salinity in the non renewable aquifers in the south (more than 1500 mg/l of chlorides). Due to irrigation, a gradual increase in salinity and other pollutants is observes. Based on past trends, more than 25% of available groundwater will have a chlorides content of more than 250 mg/l by the year 2025.

Water Conservation **:** Best technology and best practices are being applied to protect and minimize the pollution of water resources. Water conservation maps, restricting land use activities above groundwater resources, were produced to protect the underlying resources. A regular monitoring of water resources is being conducted. Natural replenishment and recharge, water table levels, abstraction, salinity (chlorides) and pollution (nitrates) data are continuously recorded and reported. The data provide an effective tool to influence the planning, the development process and permissible emission of pollutants to the environment.

Public water conservation campaigns coupled with technical and economic measures are also being applied to reduce consumption and to increase awareness to water scarcity and water quality conditions.

Financial, Institutional and Management Programs **:** The Government through the relevant ministries provides grants and low interest loans for the improvement and expansion of water supply and wastewater treatment plants.

4. AGRICULTURE

Agricultural Economy **:** Israel's agricultural sector is characterized by an intensive production systems, stemming from the need to overcome the scarcity of natural resources, particularly water and arable land. Despite the continuous decrease in the number of farmers, agriculture still plays a significant role in the national economy, contributing, in 1996, about 1.9 % of the GDP, 7% of exports and 3.1 % of the total work force (66,500). Agriculture is particularly important for the outlying areas where agriculture provides the sole means of livelihood for the population. Israel produces 92% of its own requirements, supplemented by imports of grains, oil seeds, meat, coffee and sugar. Agricultural export amount to US $ 1.42 billion (7% of the total export). In addition, the production of agricultural inputs stands at over $2 billion, of which 70% is exported.

Agricultural Production **:** Agricultural production encompasses citrus, avocado and deciduous tree plantations, field crops of which cotton is the major crop, vegetables and flowers and fish ponds. Most of arable land estimated at about 430,000 ha is cultivated and about 50% is irrigated. The extent of the irrigated area varies and depends on the water resources capacity and agricultural commodities market, within a particular year. Agricultural production figures for 1996 and projections for 2020 are given in Table 2.

From the above figures, the total cultivated area and water available for irrigation will not significantly changed over the planning period, but the water quality will be dramatically reduced, by large substitution of fresh water with treated effluents. Other changes will include :

- transition and shifting of agriculture production to the arid south
- substitution of fresh water for brackish and wastewater effluents for irrigation
- adaptation to open markets and free competitive trade, requiring further R&D to strengthen the Israeli advantages and identify new ones.

- development of water and salinity tolerant crops and further diversification
- environmental protection/recycling of agricultural waste

Table 2. Cultivated Area, Major Crops and Irrigation Water Use, 1996 and 2020

Major Crops	Cultivated Area (ha 000)		Irrigation Water Use MCM/Year					
			Fresh Water		Marginal Sources		Total	
	1996	2020	1996	2020	1996	2020	1996	2020
Tree Plantation	84	82	490		70		560	
Field Crops	233	240	185		205		380	
Vegetables & flowers	43	55	175		25		190	
Fish Ponds	3	3	30		70		100	
Fallow	68	70						
TOTAL	428	430	880	600	378	750	1265	1350
Of which: Irrigated land	183	200						
Dry Land & Fallow	245	230						

Source : Compiled from Central Planning Authority, Ministry of Agriculture, 1998.

Crop Diversification : Market forces at home and abroad, and a scarcity of land, labour and water are forcing major changes. Increasingly, there is a shift from extensively farmed mass produced crops to intensive growing of products, like hybrid tomatoes or genetically engineered banana tree saplings. Moreover, to enable the growth of crops under a wide range of climatic conditions, advanced growing methods are used including greenhouses with climatic control systems, soilless culture and biological pest control.

Israeli science has already acquired the basic capability in genetic engineering and biotechnology, essential to support large scale production of innovative products, such as :

- large scale production of hybrid seeds and other propagation material,
- production of medicinal plants for the extraction of natural plant extracts for use in medicine and food industries.
- production of engineered organisms for crop protection, substituting expensive and environmentally harmful chemical pesticides
- conversion of conventional and low income agricultural production systems into agro-industrial systems, producing high value plant extracts and other sophisticated products of high commercial value.
- utilization of reclaimed wastewater for the irrigation of patented hybrid seeds.

To achieve the necessary transformation in agricultural production, the existing R&D infrastructure has also to change to support large scale production of patented and protected propagation material and other high value added products. The necessary R&D related to environmentally friendly applications in agriculture has also to be developed.

Aqua-culture **:** Intensive form of aquaculture, using saline and sea water are extensively used in man-made ponds and reservoirs and off-shore floating cages. Advanced water purification techniques, oxygen diffusion and protein rich food are used to increase production rate from 0.5 kg per cum to 20 kg and more in a controlled system.

5. BIODIVERSITY

Natural Vegetation **:** Israel is known for its richness in natural vegetation and diversified species of Mediterranean, Irano-Turanian and saharo-Arabian origin, where domestication of Old World crops began. Beyond the intrinsic value, the diversified plant population has been an extremely valuable genetic source for improvement of agricultural crops and extraction of specific drugs. The active ingredients in more than 25% of medical prescriptions derive from natural plants, while the demand for genes and chemicals that remained untapped within the world remaining wild life is fast growing.

Extinction of Species **:** Despite the overwhelming demand for new genes and chemicals, biodiversity is affected by human activities, leading to unintended reductions in diversity of the live organisms. Although the conversion of land into areas of intensive agriculture and urbanization is absolutely inevitable and in many ways compatible with the functioning of ecosystems, the current extinction of species is exceeding the current rate of speciation. In Israel, because of the rapid increase in population and urbanization, the fragmenting landscapes and ecosystems for intensive agriculture, rapid urbanization, transport development(railway, roads, such as the Trans-Israel Highway, etc.) or of drying up or wetting wetlands for tourism, the genetic resources of native species are under a serious threat of extinction.

Israeli Gene Bank (IGB) : To avoid the disappearance and the extinction of endangered species and on the other hand to beneficially exploit the natural endowment, IGB was established having the responsibility for: development of in-situ conservation techniques; formation of gene banks; search for plants potentially suitable for extraction of beneficial substances; and, promote regional and international cooperation in preservation of species and biological diversity. A strategy is being pursued with an overview of genetic conservation, conceptualizing measures and implementation plans which will contribute to gene resource conservation, including :

- identification of target species for conservation
- identification of immediate and future threats to the gene pool of target species.

6. IRRIGATION

Irrigation Water Use **:** The agricultural sector consumes about 1200 MCM/year to irrigate about 200,000 ha. Irrigation water comprises of fresh and marginal water. This quantity has not changed significantly over the last 20 years, despite the significant increase in agricultural production. In future, the total consumption will not be reduced, although the quality of supply will be drastically reduced.

Irrigation Water control **:** Computers were introduced to allow real-time operation of the irrigation systems, providing precision, reliability and savings in manpower. Recently, satellite linked valve control was implemented to control distant water systems. Soil and plant moisture sensors are also used to provide information on moisture, allowing automatic operation of the system when needed.

Irrigation Efficiency **:** The wide scale adoption of low volume irrigation systems (e.g., drip, micro-sprinklers) and automation has increased the average efficiency to 90% as compared to 64% for furrow irrigation. Other factors include :

- water metering
- water pricing policy,
- computerization and remote control of irrigation

- fertigation - fertilizer application via the irrigation systems

As a result, the average requirement of water per unit of land area has decreased form 8,700 m3/ha in 1975 to 5,500 m3/ha in 1995. At the same time agricultural output has increased twelve fold, while total water consumption by the sector has remained almost constant. Further irrigation efficiency is being attempted by regulating water application to each individual plant, using individual moisture sensing emitters. The root volume can be controlled, leading to a shortening of the crop growing cycle. Also, it is assumed that plant metabolism can be manipulated changing crop leaves radiative characteristics, to reduce the transpiration rate per unit of yield and biomass.

Pricing of water for irrigation **:** The average water cost indicated by the National Water Co. - Mekorot. is US C 31/cum. water charges for the various consumers are fixed by a parliamentary committee. Recently, an Increasing Block Rate Prices system is applied, leading to 10 - 15% savings in water used for irrigation, as shown in Table 3.

Table 3. Block Rate Tariffs for irrigation water supply - Mekorot, 1996

Water Source	Part of Allocation (%)	Price (US C/cum)
Fresh Water	1 - 50	15
	50 - 80	18
	80 - 100	21
	Average	19
Tertiary Effluents	Low Season	14
	High Season	15
Secondary Effluents	Average Price	12

Source : Israel Water Commission, 1996

Government Subsidy **:** Currently Government support amounts to bout 20% of the cost, although a substantial increase in water charges coupled with a restructuring of the National Water Company - Mekorot has resulted in a significant reduction in Government subsidy from 50% in 1992 to about 20% in 1996.

7. ENVIRONMENTAL ASPECTS

Sustainable Agriculture : Environmentally Friendly agriculture rationalizes agricultural activities in an attempt to alleviate environmental pollution and to minimize waste generation and maximize reuse of wastes. Measures adopted for short, medium and long term include :

- controlled plant nutrition and released/leaching of nutrients and pesticides, under irrigation and composting
- development of alternative soil phyto-sanitation techniques
- maximum recycling of wastewater, sludge and compost, and,
- reduction of salinity constituents and potentially toxic trace elements in sewage effluents
- understanding the long term effects of irrigation with effluents, and
- rational use of land and water resources

8. INSTITUTIONAL REFORM

Sector Deregulation **:** The Israeli water economy is on the verge of a major reform in which seeing water as a cheaply available public resource is to be abandoned and a new policy reflecting water's limited supply and competitive economic value is to be fully considered. The general view is that market forces and sector deregulation are the most suitable tool for the efficient use in the agricultural sector. Accordingly, the role of the National Water Company - Mekorot is to be limited to the operation of the main grid - National Carrier, while new private regional water supply schemes will be created and defined as public service under the supervision of the Water Commissioner.

Water Tariff **:** Water tariffs that were largely determined by the government, based on the existing block rate and the non-tradable allocation are to be changed into a market negotiating systems. Israel has already embarked on the political process of positioning agriculture in the proper place vis-a-vis national water allocation and use policies which were fully debated by a public hearing committee. To balance between supply and demand, a shadow price reflecting the water value at source will be added to water charge, thus rendering the historic allocations into a non - effective issue, but maintaining their regulation order in case of emergency or under a series of drought years. The price of water will include not only the direct costs but also its scarcity value, quality deterioration, over exploitation (mining) on one hand, and the social aspects, such as access to water and the ability to pay of low income groups, on the other. Subsidised prices if available will be fully indicated and calculated reflecting their portion of the full costs and budgeted for each specific system.

Water Trading : Shares allocation attracting dividends and voting rights will replace existing water rights. The shareholders will control the performance of the new regional corporations, while external efficiency will be achieved by the market forces and the value of the shares in the financial market.

9. DISCUSSION

Strategic issues, describing water industry and agricultural production situation, and possible solutions to achieve sustainable water world and best practices were discussed, covering constraints and anticipated initiatives and development to achieve sustainability towards 2025, including possible commitments to avert water crisis. An unprecedented water crisis could however increase the scarcity and quality degradation of renewable and accessible water resources, while water related disasters and diseases could trigger a chain of consequences, leading to reduced consumer confidence in public water supply systems, decline in food production and massive desertification. Therefore, for a sustainable situation, further technological improvements are necessary, to increase efficiency and positive impacts of integrated water management, across sub-sectors and uses, increasing allocation efficiency and preventing local conflicts.

For best use of local advantages, under dynamic and changing world, Israel is already in the process of crystallizing development policy to support decision making with regards to future needs in water and agriculture. The science-based technologies which have brought about so far, the dramatic increases in the quantity and quality of the country's agricultural produce, through a two-way flow of information between research personnel and farmers will be further exploited to support the necessary transformation of the sector to a sustainable world. A continuing growth in agricultural production, using the same amount of land and water, and less, is anticipated due to the close co-operation between researchers, extension workers, farmers and agro-industries, in which government agencies, academic institutions and co-operative bodies work together on a challenging economic and a social goal.

Improved production systems, highly productive, less demanding in land and water, adequately competing with other industrial and economic users will be developed. The hi-tech agriculture, incorporating new cultivation techniques and new crops, adjusted to irrigation with brackish and secondary effluents will be expanded. Further improvement of water use efficiency (improved distribution systems and ultra low volume irrigation) and techniques suitable for irrigation with marginal resources and soil amelioration will be applied, contributing to sustainable land use and conservation of agricultural land. Similarly, various innovations are expected to influence the water balance including: induced rainfall, improved forecasting techniques of rainfall and water balance, elucidation of the global warming and its effects on water resources and economic competitive desalination systems.

It is also assumed that a strong commitment to avert water crisis will emerge, seeing water as an economic good dealt with financial and economic terms. An economic approach will induce the reallocation of water resources, leading to efficient production and allocation systems, suitable to irrigation under water scarcity conditions. Sustainable use of good and poor quality water, conservation of rivers, water courses and aquifers will be achieved, while still considering social, cultural and environmental goals.

On a regional scale, by all standards Israeli agriculture is very small and bears no competition to the regional agriculture. Most of the innovations are transferred to the world at large as agricultural produce, production inputs and know-how. For many years, Israel has also been sharing its expertise with the developing world and most of its accumulated experience in agriculture, irrigation technology and water management was found to be easily adaptable to the needs of developing countries.

Cooperation within the region has already commenced and water issues form part of the peace treaties with the Kingdom of Jordan and the Palestinian Authority. Agricultural enterprises and joint ventures are already well established in several countries, within the region, taking advantage of the Israeli technology and the land, water and manpower availability and other economic incentives in neighboring countries. Based on on-going cooperation, a set of local and regional targets, related to water resources development, regional water transfer and interconnection of water systems, can be reached.

ITALY

EXECUTIVE SUMMARY

To cope with the increasing demand of water resources, besides the search of new available resources which however appears to be quite difficult today in Italy, and the occurrence of drought events, it appears to be of fundamental importance to achieve the optimization and rationalization of the water now available and used. Such an increasing demand is part of a more complex national situation, which has rendered the water resource availability a more difficult problem in the past years.

Out of the many problems involved in the water use in Italy, two of them are particularly felt in the last decade: (i) the scarcity of the resource, and (ii) its pollution. Among the various possibilities for a correct management of the water resources, one is the enhancement of surface and groundwater abstractions, limiting at the same time the sources of possible pollution. The other option for a correct water management is a rational use of the resource available.

Research institutions and the scientific community have been involved in giving their best support and numerous initiatives have been started, giving rise to better perspectives for the future. A complex machinery has been put into motion, in which all the technical bodies of the administration, at various level, have been given appropriate responsibility, particularly in case of emergency. Essential for the success of such a machinery, besides maintaining a close tie with the research institutions and scientific community, is an adequate technical staff, able to cope with event at the right time and in the most effective way.

1. OVERVIEW OF NATIONAL POLICIES AND DEVELOPMENT PLANS

Both the water availability and demand are deeply influenced by the National Policies, the latter being often crucial in institutional management of the water resources.

Cornerstones of the National Policies are the Law 319/75 (also denoted as "Merli" Law), the Law 183/89 and the Law "Provisions in Water Resources" 36/94, better known as "Galli" Law.

The Law 319 was formulated addressing - the pollution emergencies in the water resources. Its aim is the regulation of the pollutant discharges, fixing appropriate contaminant concentration limits, and imposing the water deputation.

In line with the increased sensibility towards the defense of the environment, the Law 183 includes modern concepts concerning the rational and safe use of the land and water. The Law deals with the global management of the water-bodies, the basins and related Authorities as optimal intervention ambits, within the general framework of land defense.

The Law 36 came five years later, in 1994, and its main objective was the reorganization of the water systems on the basis of efficiency and economic criteria, leading to an integrated and comprehensive management of the water resource. Furthermore, it is stated that the use of water for human needs is priority. Other kinds of use are admitted when the resource is sufficient, provided that they do not offend the quality of the water for the human consumption.

The basin Authority periodically defines and updates the water budget in order to assure the equilibrium between the available resources in the area and the different uses.

In order to assure the equilibrium between resources available and needs, the Authority of the competent river basin take care of the planning of the water policy as function of the prescribed use. In the basins characterized by relevant withdrawals or water transfers, these are regulated in order to maintain the minimum flow needed to preserve the river-bed and the associated ecosystems.

One of the main objectives of Law 36 is the saving of water, which is obtained through a series of measures, the most important being the following:

- the restoration of the leaking water distribution networks;
- the installation of dual distribution networks in new urban and industrial settlements of relevant dimensions;
- diffusion of techniques and methods for the water saving in the urban, industrial and agricultural sectors.

The second, important objective was the treatment of the urban wastewater, according to the European Community Law N.271/91.

2. PRESENT STATUS OF WATER

The Italian water balance is represented in Table 1. The average precipitation depth is about I meter, corresponding to approximately 300 billions cubic meters (hereinafter bcm) of water stored in Italy. Rainfall is extremely variable in the country, both spatially and temporally as brought out in Table 2.

Table 1. National water balance

	Average volume ($10^9 m^3$/year)	%
Surface flow	155	52.3
Subsurface flow to the sea	12	4.1
Losses	129	43.6
Total flow	296	100

As shown in Table 1, the surface water (which also includes groundwater) is about 155 bcm per year, and this value represents the potentially available water. Not all of this water is directly available for civil use, since part of it belongs to bodies that are difficult to exploit. Potential water availability has been estimated as about 110 bcm. However, considering the existing water systems in Italy (dams, reservoirs, etc.), the exploitable water resources in Italy are estimated as approximately 40 bcm per year (see Table 3).

Table 2. Water resource by geographic areas

	Precipitation volume ($10^9 m^3$/year)	%	Surface water volume ($10^9 m^3$/year)	%
North	121.0	40.8	81.8	52.8
Center	65.6	22.2	30.1	19.4
South	72.3	24.4	32.1	20.7
Sicily	18.8	6.4	4.9	3.2
Sardinia	18.3	6.2	6.1	3.9
Italy	296.0	100.0	155.0	100.0

Table 3. Water available

	Volume ($10^9 m^3$/year)
Mean annual	155.0
Potential	110.0
Exploitable	40.0
Regulated	8.4

The quantity of water in the subsurface is about 13 bcm per year, where only 3.5 bcm are potentially available (see Table 4). According to a recent study, it has been estimated that the total amount of groundwater flowing in Italy is about 40 bcm per year, where 30 bcm are relative to the large regional aquifers, and the remaining 10 bcm contribute to local aquifers balance. About 30% of the latter are related to spring outflow.

The global national needs for water can be estimated as 50 bcm per year. Most of this volume is devoted to agriculture (30 bcm), and the remaining is for industrial use (14.2 bcm) and municipal water supply (5.8 bcm). These are rough estimates that can be in error, in particular for the agricultural use; for the industrial use, only the water-demanding industries have been considered (Table 5).

Table 4. Subsurface water

Region	Volume (10^9m^3/year)	%
North	8.52	66.5
Center	1.45	11.2
South	1.84	14.2
Islands	1.05	8.1
Total	12.96	100.0

Table 5. Water demand in Italy

	Volume (10^9m^3/year)	%
Total	50.00	100.0
Agriculture	30.00	60.0
Industry	14.20	28.4
Civil use	5.80	11.6
Domestic	3.90	68.0
- non domestic	0.52	9.0
- public	0.46	8.0
- industrial	0.87	15.0

It can be seen that the amount of water used in Italy is about 30% of the mean annual precipitation water, it exceeds by 10 bcm the real availability, representing the 45% of the potential water. These numbers point out the water emergency occurring in Italy and the high water exploitation.

The mains source of water for civil use is surface water, either natural or artificially distributed (Table 6).

Table 6. Sources of water supplied

	Volume (10^9m^3/year)	%
Groundwater	12.0	24.0
- wells	9.0	18.0
- springs	3.0	6.0
Surface water	38.0	76.0
Total	Say 50	100.0

The annual amount of water used by the municipal water supply systems in Italy is around 5.8 bcm, for a 300 liters/person per day. The water is obtained by both groundwater (50%), springs (40%) and surface water (10%).

The quantity of water used for agricultural purposes is generally uncertain, but can be estimated as about 30 bcm per year, and the use is different in the North of Italy (78%), the Center (5.5%) and the South (16.5%). The main source is surface water from rivers (67%), followed by reservoirs (6%) and groundwater from wells (27%). In the average, 37.5% of the irrigation water is lost by evapotranspiration, while the remaining 63.5% is dispersed and generally contributes to the replenishment of groundwater. The mean annual volume of water used by the industries is 14 bcm, subdivided in 60% (North) and 20% for both Center and South Italy. Power plants use amounts the about 4 bcm.

In this perspective of a rather overexploitation of the water resources, it should be considered that the Italian territory is subject to drought problems, in particular the Southern regions. Recent drought events have stimulated the scientific concern to promote "ad hoc" investigations for the purpose of learning as much as possible about the Italian situation. The following aspects have been analyzed specifically: (i) changes in the hydrological cycle; (ii) limitation of current activities related to the use of water, such as urban, agriculture and industrial supply; (iii) the need for measurements to estimate the reduction of income for an impeded water related activity or the search for a surrogate activity.

More knowledge is still needed about several aspects. In particular, as far changes in the hydrological cycle are concerned, some uncertainty persists as to whether the phenomenon can be considered a continuous trend toward drier periods or whether it is simply an alternation of dry and wet years. The peculiarity of the 1988-1990 events was not the actual low rainfall over a single year (such years have occurred also in the past), but the fact that it was the sequence of three years with very little precipitation. The situation was evenly distributed over the entire national territory.

The analysis has been extended to the behavior of the rivers, finding, for a number of representative rivers, a substantial deficit, which, over the three-year period concerned, reached a total of the order of the annual surface runoff.

Drought has also affected groundwater: in the Northern flatlands the aquifer, largely depleted by potable use and irrigation, displayed an unusual lowering of the water table, which lasted long after the period of scarcity was over. In the Central and Southern regions the yield of many springs was greatly diminished.

The recent droughts were perceived mainly as a change of climate. There were no substantial large-scale effects except for some small alterations in the growth of certain crops in limited areas. The climatic change has interfered substantially with various water dependent activities, which could not be performed correctly. In the Northern areas, the decrease of the average rainfall caused the farmers serious problems. In the Southern regions the rain shortage accentuated a chronic incapability to meet potable and domestic demands. Some large urban communities were no longer able to rely on the capability of their water supply systems.

The impossibility of filling some reservoir during such events raised some criticism about the water management criteria adopted so far. According to such criteria, the construction of large reservoirs was deemed a reliable tool to store the meteorological water and conspicuous financial resources were invested for this end.

Any kind intervention requires an assessment to be made of the damage, the true extend of which is always difficult to define. In any case the measures an Authority has to undertake vary according to the type of water utilization.

As regard irrigation, a survey confirmed that in 1989 several districts of Sicily and Sardinia only a few plots could be saved of the thousand of hectares usually irrigated.

The priority given to potable use allowed the demand to be met with no significant shortfall. An exception to this was some urban agglomerations in the South and in the larger islands, where the chronic scarcity was largely aggravated.

Hydroelectricity has been badly affected by drought. Generating plant equipped with reservoirs was not only unable to store the required amount of water, but also suffered a reduction of power as an effect of the lower head. In such conditions the pumped storage, characteristic of the most technologically advanced plants, was able to make only a very small contribution. Run-of-plants suffered from shortage of water and low river level, and likewise did the thermal plants, because of the unavailability of cooling water.

The impact of water shortage was very heavy on ecology and preservation of aquatic life, as water withdrawal from bodies was particularly intensive in the absence of other resources. Low flow in a river meant poor dilution of the discharged pollutants, and thus a risk of harming aquatic life. This kind of damage was very serious and persisted long after the emergency had passed.

As shown by the 1988-1990 event, a drought, with its associated shortage of water and severe effect on water resources management can deeply impact the economy of an entire region. As such events are likely to be repeated, the responsible Authority should work out rational management criteria to set up suitable conditions for coping with the effects of a foreseeable drought and reducing the damage to the water related activities. Such criteria would rely on both technical and economic measures and require a thorough inventory of all surfaces and underground availability, as well as the existing discharges. They also entail adopting technologies and management policies capable of making an appreciable impact on the whole economic system in which the water resource is located. In addition to technical and economic measures, the sensitivity of the people involved is of fundamental importance, particularly in reducing water consumption.

A shortage of available water leads, first of all, to increased conflict among the users, as the exploitation level of Italian resources is very high in all the regions also in view of the severe constraints imposed by the deteriorated quality. Potable use comes first and claims the highest quality resources, but agriculture demands the largest quantities. Water for industrial uses are related to advanced economic development and their reduction can cause unfair social effects, such as unemployment and emigration. The use of water for hydropower, although non-consumptive, can be only partially implemented.

3. PRESENT STATUS OF FOOD

Italy with a surface area of 301.302 km2, has a central location in the Mediterranean basin.

Italian climate is characterized by a spatial highly variable precipitation, concentrated over short periods of the year (mainly spring and autumn, by a large inter-annual variability and by frequent extreme event such flood and drought.

Actual sunshine hours increase to a mean of 7 hours in winter and to 8-10 hours in summer time. Potential evapotranspiration in summer rangers from 5 to 8 mm/day in Italy respectively in North and Southern region.

Consequently the drought period becomes longer from North to the South with values varying from I to 6 month and with deficit values in the peak month ranging from 150 to more than 230 mm.

In the Central regions irrigation is indispensable to obtain high yield whereas in Southern regions the spring-summer crops cannot grow without irrigation.

The today problems for the irrigated agriculture in Italy are related to the limited water availability and to high labour cost; for this is now increasing the diffusion of the irrigation methods that can reduce water losses, improve water use efficiency and lower the labour cost; one of these methods is the localized irrigation, now largely applied to Northern orchard and to vegetable crops, particularly in greenhouses and protected crops, and tree crops on Southern regions.

Irrigation scheduling is planned with the aim to obtain the conditions of maximum economic return that, for most crops, is very close to the conditions of maximum evapotranspiration rate.

Among the different methods of irrigation scheduling are more frequently used those based on soil moisture value and meteorological parameters, mainly class A pan evaporimeter and EtO values.

Recently for the availability of innovative communication and informatic technology, some systems based on agrometeorological approach have been set up which allow an efficient exchange of information between the Extension Service and the farmers.

For the particular position of the peninsula the Italian climate appears very responsive to the influences of both global changes and human action. Significant aspects of the global and regional changes are: increase of the sea level; reduction of glaciated areas; increase of climate variability; increase of evaporation process; extension of the urban heat isles: growing frequency of very concentrated rainfall episodes.

All these conditions increase the risk of the land degradation, salinization and deterioration of soil structure favouring frequent slope processes - from superficial erosion to mass movement - with heavy repercussion on flood phenomena in the valley and plain areas.

Overgrazing in the semi-arid areas of South Italy, the practice of burning residual of cereal crop, the over exploitation practices without restoring organic matter lead to soil degradation and erosion and to the risk of desertification of about 27% of the agricultural land.

The Country surface area divides naturally into :

- flat and valley areas (6.976.373 ha)
- mountain area (10.611.957 ha)
- and hill area (12.542.779 ha)

of which the 27% is along the coastline and the 73% is inland.

Here is reported the agricultural land use, as a percentage of the total surface area:

- forestry 22%
- cultivated crops (annual ploughing) 30%
- permanent and temporary grassland 16%
- arboriculture 10%
- urban, industrial and other use 22%

Cultivated crops

Cereals

The production of cereals in 1997 was seriously affected by a severe drought on the first months of the year, during the critical stage of crop growth.

The bread wheat is cultivated as rainfed in North and Central Italy; only very few areas on Central Italy are irrigated with supplementary irrigation.

Durum wheat cultivated on 1.665.000 ha, located in South and Central Italy, produced 3.885.000 t with an average yield of 2,3 t/ha showing a decrease of 11% in the central area and an increase in Southern region.

Durum wheat is a rainfed crop; it is usually sown in October in Central Italy and later in Southern region with a mean length of the growing season of 180 days.

The production of bread wheat can meet the 36% of the Italian food requirements whereas the durum wheat fulfil the 70% of the Country requirements.

Maize crop has assumed increasing importance in Italy economy; it is estimated that 1.035.000 ha were cultivated in 1997 mainly in Northern Italy. Planting normally takes place from mid April to early May whilst flowering and pollination occurs around the middle July and harvesting in September with a length of growing season variable from 100 to 150 days according the hybrid class and the area interested.

Maize is an irrigated crop: during pollination and seed setting an optimal soil moisture is of vital importance; in Southern regions the high air temperature can seriously affect grain formation and the yield even if the soil moisture is adequate.

Rice is cultivated in Northern Italy on 233.000 ha with a crop cycle of about 150 days depending on variety and location; the crop is normally transplanted from mid May in low-lands irrigated with the submergence method; the rice water requirement is very high; the ratio of rice grain yield to transpiration is about 1:1000 i.e. to produce I kg of rice 100 mm of water are needed.

The water requirements of the fruit species are highly varying with the species and variety, with the pedo-climate conditions and with the irrigation method. The most used method for fruit trees is the localized irrigation with trickle and drip equipment placed overhead or under the foliage of fruit trees.

Fruit and vegetables are important sources of vitamins and essential micro- nutrients in the diet and the Italian diet is usually very rich of vegetables and fruits.

Today in Italy is increasing the cultivation of medical plants; in 1997 some officinalis species were grown in 1.287 ha, on 1.111 little farms, of a mean surface of 1,16 ha, mainly located on Piemonte (586 ha) and Toscana (400 ha) regions.

The Italian food production is heavily dependent of an intensive agriculture where to optimize yield, high fertilizer application and intensive use of machines and irrigation are used and therefore a high crop productivity is obtained; however Italy does not produce all the food requirement and to meet it an annual volume of imports takes place.

4. PRESENT STATUS OF RURAL DEVELOPMENT

Italian population is 57.380.900 with a density of 190 inhabitants/Km^2 the average annual population growth rate is under zero.

The common dietary pattern of Italian population is milk, meat and wheat; the dietary energy supply is estimated to be above 2500 calories per caput; the vitamins deficit is under control.

The workers of agriculture sector were recently estimated to be 1.370.000 with a continuous negative trend; of these workers 467.000 are women (34%) part of which (298.000) are farm managers.

It is estimated that 2.470.600 farms are present in the country; 581.100 of these are managed by women.

The average surface of a farm is 5,6 ha.

The percentage of rural people versus the whole population is 20 in South Italy and only 5 in Lombardia region. Urbanisation and conversion of agricultural land to housing and industrial settlement is a growing harmful process and affect to great extent the most fertile lands along the coast areas. Effects of unplanned urbanisation are: the decreasing of ground water resources, the salinization and pollution of pyretic and deep groundwater, the loss of fertile and irrigated farmland.

The population of town and coast areas is increasing whereas the mountain and hill population is decreasing.

Furthermore the mountain population is getting more and more older (20% people are older than 65 years).

The GNP was 350.220 mld of dollars. The ratio Country deficit/GNP is decreasing of 2,7% and the inflation was decreased of 1,5%.

The country unemployment is 12,5% of all workers population; the highest values are in Southern region and concerns mainly the young people. The unemployment phenomenon is caused by a low economic growth, a high labour cost and an excessive charge of deduction for insurance.'

From the 1980 Italy became an area of mass immigration: at first from Maghreb region and after from other countries; according to recent estimates foreigners, from non-EC countries with regular sojourn permits, totalled 834.000 but with clandestine they probably reach 1.2-1.5 million; this immigration concerns mainly men (369 men for every 100 women). Immigration is characterized by initial precariousness and extreme mobility in rural environment, later immigrants concentrate in large cities.

The population students of primary shool is: 2.825.835, that of secondary shool: 1.907.024; that of the high school 2.687.181. The student of the Universities are 1.061.690.

5. FUTURE SCENARIOS AND AIMS

To cope with the increasing demand of water resources, besides the research of new available resources which however appears to be quite difficult today in Italy, and the occurrence of drought, it appears to be of fundamental importance the optimization and rationalization of the water now available and used. Such an increasing demand is part of a more complex national situation, which has rendered the water resource availability a more difficult problem in the last years. The main reasons are the following: (i) high population density; (ii) increasing urbanization and civil uses; (iii) lack of optimization of water supply systems; (iv) increasing industrial demand; (v) increase of cultivated areas, and crops changes, with more water needed; (vi) contamination of aquifers and rivers due to the usually uncontrolled pollutant discharges, of both civil and industrial settlements, to chemical substances used in the agricultural practices, and to coastal aquifers saline intrusion, caused by irrational management of the hydrogeological systems; (vii) closed Water cycle and lack of water reuse.

Thus, the problem derives from the different geographical and meteoclimatic conditions that are subjected the different regions in Italy, and from the seasonal variability, but also from a non-optimal use of the resource itself.

Out of the many problems involved in the water use in Italy, two of them are particularly felt in the last decade: (i) the scarcity of the resource, and (ii) its pollution. The two are strictly correlated, because water is contaminated by its use (industry, agriculture, domestic). The two effects combined together reduce the amount of water that can be effectively used, with the consequence that, to cope with scarcity, low quality water is often used. For example, the scarcity of water in many coastal regions of Italy induces exploitation of coastal aquifers, enhancing thus the problem of the saline intrusion. The situation is even worse for surface water, like rivers.

The water resources management in Italy has not always been correct, with large and sometime-uncontrolled exploitation of groundwater resources, pollution due to urban and industrial settlements, scarce reuse. Among the various possibilities for a correct management of the water resources, one is the enhancement of surface and groundwater remediation, limiting at the same time the sources of possible pollution.

The other option for a correct water management is a rational use of the resource available. Reuse and recycling of water can be a promising way to meet increasing demand, together with middle or long distance conveyance of temporary surplus from nearby zones. Collecting "all the available droplets of meteoric water" is a very common goal in many arid and sub-arid countries. This kind of experience could be transferred to Italy, where in the hilly areas of the central and southern regions a long tradition is still practiced of setting up very small ponds with a storage capacity of a few thousand cubic meters.

Another practice currently adopted in arid zones is that of shrinking the catchment down to the size of a tiny basin, sometimes surrounding the single plant to be irrigated. This practice of "micro- catchment" has its prototype on the small islands scattered in the Mediterranean Sea. Several refinements have been proposed in order to increase runoff capture, such as lining the ground surface with a flexible membrane or bituminous compounds, or by using materials able to develop an impervious crust. It is unlikely, however, that such structures can be extensively introduced, as the cost of manpower has risen tremendously in recent decades.

In the driest areas of Southern Italy the probability of having a smaller amount of rainfall has been the cause of some concern to scientists and people responsible for water problems. In this context, initiatives have been taken to ascertain the feasibility of artificially increasing the precipitation. The results, however, have not so far been encouraging; particularly when the high costs are compared with the benefits obtained. The expected benefits are therefore limited to a small area and so far there is no real chance in sight of increasing water resource availability in this way.

Efforts can be made to ascertain the feasibility of using saline water for irrigation, taking into account the extensive availability of brackish water in Italian coastal areas. Saline water can affect irrigation in several ways, as the salt reduces both the capabilities of crops to benefit from water and soil infiltration capacity. Nevertheless, experiments conducted with different crops and water having various salinity contents have given encouraging results. It is necessary to perform the watering procedures according to the natural water characteristic, the crop species and the degree of soil permeability. Saline water can be blended with freshwater and raw wastewater to dilute the salt and increase the usable volume.

The use of domestic water for agricultural purposes dates back to the origin of human life. The development of large-scale irrigation schemes for the huge amount of wastewater currently discharged by the urban communities is now an important part of planning activities. It is also considered as a complementary approach to waste water reclamation and to activate more efficient ties between environment and agriculture. Obviously, as the main difficulty in the use of urban wastewater is health hazard and risk of disease, primary-level treatment and disinfection are strongly recommended. The content of some pollutants, particularly organic compounds, can be advantageous for soil fertility provided the concentration is below a certain level. Irrigation demand is concentrated in shortly seasonal periods, while wastewater is usually constantly available throughout the year. This imposes the construction of storage ponds, in which water can also undergo some oxidation, but with an increased concern regarding smell and risk of disease.

Treated wastewater can be stored in underground aquifers, thus enhancing the well-known practice of artificial recharge by means of dispersion ponds or wells.

Seawater can be a valid alternative source, allowing freshwater to be reserved for more rigorous qualitative requirements. Seawater can be used efficiently, without any treatment, for cooling purposes in industrial plants and for thermal electricity generation.

The success of water desalination has been so far heavily conditioned by the cost of energy. For this reason, desalination can be considered only in cases of high priority uses or when the revenues of the industrial process repay its cost. For small islands, especially during the tourist season, it has been ascertained that, by adopting the proper technologies, overall processing costs can be brought down to levels comparable with the cost of conveying fresh water from the mainland.

Lack of water necessarily entails readjusting demands for all uses. As a quite general criterion, this measure could involve considerations concerning the economic and living conditions of the entire area affected by water scarcity. The possibility of revising water demand is based in particular on an insight into the mechanisms governing the various forms of utilization.

Recent studies supported by a national census have confirmed the shortfall of potable water demand in the various regions. Moreover, large losses due to leakage have been ascertained both in main pipelines and in the urban delivery networks. There is therefore a need to find proper criteria to assess water demand, taking into account the real aspects, such the size and the economic level of the community to be served, as well as the climatic conditions. The measures to be taken in the domestic and urban sector can be elaborated in different ways, but the most effective ones seem to be to: (i) locate and seal leakages in the distribution networks; (ii) adopt suitable tariffs to penalize excessive water withdrawal; (iii) install a double distribution network that can be separately provide potable water and lower quality water suitable for other uses (washing, gardening, fire fighting); (iv) raise people's awareness level concerning the advantages of saving water.

In agricultural activities, the switching from irrigated to dry crops could be an interesting issue, with effects impacting on all the living conditions. In many parts of the country the reforestation of large areas is perhaps more promising than the cultivation of high water-demanding vegetables, which are not always competitive with similar products from other areas with more water. To change the cultivation patterns takes a long time, as it entails the transformation of entire economic sectors and has to cope with the deep-rooted traditions of the populations concerned.

A set of measures that can be implemented more rapidly and have a lower social and economic impact is the best way to deliver water to crops. An interesting solution can be, for instance, to adopt sprinkle and trickle irrigation instead of the high water-demanding furrow techniques. It should be stressed that rational water delivery, depending on the season, the kind and the growth level of the crop and with the proper use of fertilizers, is the best way of conducting an irrigation plant.

Similar problems can be tackled in the industrial sector, switching towards low water demanding processes and enhancing water recycle and reuse. In fact, as far as freshwater "consumption" is concerned (i.e. the quantity not returned to water bodies after use), a country-wide investigation carried out on industrial plants equipped with meters or provided with known pump ratings, indicated that the actual consumption is of the order of 4-5% of the total water withdrawn. This enhances the possibility of recycling at least part of the total quantity discharged from production processes, in order to obtain a further reduction in the withdrawal from water bodies. It has been estimated that recycling allowed a 15% saving already in 1981. These considerations are even more relevant to future projections, in view of the general tendency in certain categories for new industries to adopt innovative technologies involving a higher degree of recycling.

The measures herein described need a long time to be implemented and entail technical intervention and financial support that is not always available. The benefits may accrue only very slowly; several years after the measures have been adopted.

6. CHALLENGES FOR THE FUTURE

The recent drought events involved many communities, which were prepared to reduce their impact to an acceptable level. However, there was a lack of similar experiences in recent times and the shortage of water was almost unexpected. As the singularity of these events was that they occurred consecutively, even though the single years were not "per se" extremely dry, there was no chance on relying on multi-annual regulation, as is generally assumed in planning water resources.

Drought and flood events in the last years have called the attention of Government, Administrations and people, stressing the need of intervention measures with an appropriate scientific support. The problem of forecasting and preventing a drought has become acute only very recently, as it is of remediating the effects. The problem is exacerbated by improper land use and resources exploitation. Increase of population, urbanization and switch from agriculture to industry has motivated a deep change of the living pattern in all the Italian regions. Consequently the construction of buildings, roads and large paved areas has followed criteria of immediate economical return, in which water aspects were not properly considered. At the same time, the increasing demand has fostered intensive withdrawal, leaving very little room to an exploitation that takes into account the risk of a scarce availability of water. In this quite general perspective, the possibility of facing high-return period droughts has almost vanished. The extreme events have come therefore unexpectedly and people were almost unprepared to face them and provide adequate remedy. The ultimate effect was that the damage caused by these events had to be paid by the entire community, with serious consequence on all the country's economy.

These results have motivated the public concern in a way that some measures have been taken, not always under a perspective able to cope with the real complexities experienced. Among these measures, Law 183/89 has been able to introduce new basic concepts to develop more rational criteria of water management. Fundamental is the identification of the river catchment as the main territorial entity on which the exploitation and protection of water resources can be performed in a more rational way, even though this concept has worked properly so far only in the largest river basins, with few opportunities in the high number of small catchments spread over the Italian territory.

Research institutions and the scientific community have been involved in giving their best support and numerous initiatives have been started, giving rise to better perspectives for the future. A complex machinery has been put into motion, in which all the technical bodies of the administration, at various level, have been given appropriate responsibility, particularly in case of emergency.

Essential for the success of such a machinery, besides maintaining a close tie with the research institutions and scientific community, is an adequate technical staff, able to cope with event at the right time and in the most effective way.

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EXECUTIVE SUMMARY

The main objective of this document is to clarify the recent focusing point of Japanese agricultural water related professionals.

Overview of National Policies : The most fundamental Japanese agricultural law is "Agricultural Basic Law". This Agricultural Basic Law is presently under reformation. The Old Agricultural Basic Law was mainly concerned with the production of foods, whereas the New Agricultural Basic Law will include multi–functional roles of agriculture and rural areas. The idea of these multi-functional roles includes preservation of the national land and the environment, providing beautiful landscapes, creation of resident-friendly countryside, etc.

Present Status of Water : Japanese land consists of four islands, all surrounded by the sea. The total land area is 370 thousand square kilometers. Honsyu-island is the largest of the four islands. The shape of this island is long and narrow, having most of the large cities of the country. In the island, a mountain range goes horizontally through the center of the island, like a backbone. Most of the rivers in the island run perpendicular to the mountain range, resulting in each river having a small basin area and very steep slopes. Japanese annual average precipitation, 1,700 mm, is rather evenly distributed through out the year; Japan has no distinct dry period. The water use is fully developed through history, and droughts occur frequently.

Present Status of Food : As for foods, Japan is importing a large part of its consumption from abroad. The self sufficiency rate has decreased from 73% in 1965 to 41% in 1997 when calculated by calorie basis.

Present Status of Rural Development : One important point for agriculture is pursuing a potential Japanese food production increase. The establishment of a production infrastructure, and support for agriculture in hilly and mountainous (disadvantageous) areas are essential.

Another important point is to realize the multi-functional roles of rural areas.

Future Scenarios and Aims : Other than the quantity of water resources, a lot of stress is put on the notion of a sound water circulation. The Liaison Committee among Ministries and Agencies was set up in 1998, in order to obtain consensus among those various ministries and agencies for constructing a sound water circulation system.

Challenges for the Future : Measures for preserving water environment (water quality, ecological system, landscape, etc.) need to be developed. Therefore, a new support system should be established to maintain and manage irrigation facilities in the community, and to strengthen the functions of water for the community through the effective use of agricultural water.

1. OVER VIEW OF NATIONAL POLICIES AND DEVELOPMENT PLAN

The Agricultural Basic Law established in 1961 has long been serving as the fundamental philosophy and basic guideline for formulating policies on Japanese agriculture. In those past years, the agricultural environment has been experiencing more severe situations, such as the decreasing food supply capability, the dwindling farm workforce, aging of core farmers, increased abandonment of cultivation of farm lands. In order to secure a same and comfortable life for the general public in the coming 21st century, it is important to secure a stable food supply and support the fulfillment of multi-functional roles of agriculture through the sustainable development of agriculture and rural areas in Japan.

The existing Agricultural Basic Law is being revised.

2. PRESENT STATUS OF WATER

2.1 WATER RESOURCES

2.1.1 Precipitation

Japan is located in the Asia monsoonal area, which has one of the highest precipitations in the world. Japan has an average annual precipitation of 1,714 mm, according to data gathered from 1,300 sites around the country by the National Land Agency from 1966-1995. Japan thus receives twice the world average for annual precipitation of about 970 mm. However, the annual per capita precipitation is only 5,200 m^3/year-person, or about one-fifth the world annual average of 27,000 m^3/year-person. Thus, Japan’s precipitation is not really abundant compared with that of other countries.

2.1.2 Potential Water Resources

The amount of potential water resources of Japan is about 420 billion m^3 for a normal year and about 280 billion m^3 for a dry year.

Japan normally experiences heavy rains in the rainy season in June and July, and during typhoon season in August and September. Japan has a generally steep topography and relatively short rivers. Therefore, considerable portion of potential water resources is not used, and flows directly into the ocean. The amount of actual water resources is about 60% to 70% of potential, in dry years, while it differs from region to region depending on topography, geology and distribution of precipitation over time. Small islands and peninsulas, in particular, have greater per capita potential water resources due to their smaller populations, but rainwater flows into the ocean fairly rapidly in these areas because they rarely have large rivers. It is therefore more difficult to develop water resources effectively in such areas.

In a dry year, potential water resources are approximately 70% of those of a normal year, on average; less in Kyushu and Okinawa, more in regions of with heavy snowfall, such as Tohoku and Hokuriku.

Precipitation data from 1956 to 1995 shows that the potential water resources in dry years have declined in these years. For example, from 1956 to 1975, one year per decade had annual potential water resources of 335 billion m^3. By contrast the same amount of potential resources was seen every four years from 1976 to 1995. This decrease in potential resources may be a cause of water shortage in these years.

2.2 WATER RESOURCES USAGE

2.2.1 Current State of Water Use

A total of approximately 91 billion m^3 of water used in 1993, based on the amounts taken from reservoirs. A breakdown of the total water used shows that roughly 32.4 billion m^3 is used in municipal areas for domestic, commercial, and industrial purposes, and about 58.6 billion m^3 for agricultural use.

Domestic and commercial use of water has been on an upward trend since 1975, but has increased more slowly in recent years, declining slightly in 1993. The amount of water used in industry declined until the first half of 1980's, due in part to the increased use of recycled water. Industrial usage later turned upward, but has fallen in both 1992 and 1993. Total municipal water use was nearly flat until the latter half of 1980's, and has increased slightly since 1987, with changes in lifestyle and the economic expansion of the period, but decreased in 1993.

Use of water in agriculture is nearly unchanged in recent years because reductions in the amount of land under rice cultivation have been offset by an increase in irrigation for other crops.

2.2.2 Agricultural Water

(1) Agricultural water Usage

Water use for agriculture has recently been flat nationwide, with a slight decrease in rice paddy irrigation offset by an increase in irrigation for other crops.

Irrigation of rice paddies, which takes up the largest portion of agricultural water usage, dropped only slightly, in spite of decreased rice paddy acreage, partly because of the increased water use per unit area in paddies and the lower rate of recycling due to the digging of separate canals for irrigation and drainage. Demand for water in rice paddies is seen from mid-April through September, with peaks during tillage before the crop is transplanted, and in the season after mid-summer drainage. Water use during tillage in particular, has risen recently. There is a small demand for water during seasons other than the ones mentioned above, for secondary crop farming and crop rotation.

Irrigation for other types of crops is expected to continue to increase because the area land with access to irrigation is increasing and in many cases, agricultural chemicals and fertilizers are mixed with the water that is used to irrigate these fields. The supply or water to green-houses particularly, has increased steadily in recent years, and their growing popularity has increased the demand for water in winter.

Water usage in livestock farming is expected to continue to increase because of the growth in the number of livestock.

Aquaculture is also growing, although it accounts for a small portion of all agricultural land. Water culture, which is a form of liquid culture, is the main form of liquid culture in terms total area.

Irrigation channels have traditionally served several functions in agricultural areas, such as supplying water to wash crops and agricultural machinery, fire protection and preservation of the rural environment. To maintain and promote the use of such functions, various approaches are being taken in the improvement of irrigation channels, including construction of recreational areas, with trees and shrubs planted along irrigation channels.

3. PRESENT STATUS OF FOOD

Present status of food is brought out in the “Report Submitted to the Prime Minister by the Investigative Council on Basic Problems Concerning Food, Agriculture and Rural Areas” as summarised, is given below:

A. Serious problems facing food, agriculture

(1) With the expanding gap between supply and demand structures of food, the food self-sufficiency ratio has been decreasing. (Self-sufficiency ratio, which was 73 % in 1965, dropped to 41 % in 1997 when calculated by calorie basis.)

(2) Use of farmland is becoming less efficient, and the overall vitality of core farm work forces is weakening.

B. Public expectations of food, agriculture and rural areas

(1) Securing a stable food supply.

(2) A secure supply of a large variety of safe and high-quality foods. The sound development of food industries.

(3) Strengthening Japan’s agriculture and supplying foods at reasonable prices.

(4) Further introduction of market mechanism and stabilization of farm management

4. PRESENT STATUS OF RURAL DEVELOPMENT

This present aims of rural development as stated in the “Report Submitted to the Prime Minister by the Investigative Council on Basic Problems Concerning Food, Agriculture and Rural Areas” are:

A. Pursuing Japanese agriculture’s development potential

(1) Renovation of the agricultural structure for generations to come

(2) Fostering a variety of motivated farmers and assisting them in developing their businesses

(3) Effective fulfillment of the role of agriculture in preserving the cyclical function of nature

(4) Establishment of a production infrastructure

B. Enabling agriculture and rural areas to fulfill their multi-functional roles

(1) Paying attention to the multi-functional roles of agriculture and rural areas (Multi-functional roles such as preserving the national land and the environment, and providing a beautiful landscape, etc.)

(2) Comprehensive improvement measures to create beautiful, resident-friendly countryside

(3) Public support for the agriculture in hilly and mountainous areas (disadvantageous areas)

5. FUTURE SCENARIOS AND AIMS

5.1 INTRODUCTION

Future Administration in Irrigation Regarding Water Circulation in Catchment Areas is discussed in this section.

5.2 WATER CIRCULATION IN CATCHMENT AREAS

In the process of running off to the ocean, water for irrigation is drawn from rivers and underground to places where people live and work through networks of canals in catchment areas. The water also forms the water environment of the region.

The used water is returned from the places where people live and work to rivers and underground, and is recycled at the places where people live and work located downstream of rivers through rivers and underground. By repeating this cycle many times, a broad water environment across a wide catchment area is formed that supports our production and lives. In rice growing agriculture, water is recycled in the tertiary and secondary canal levels many times by irrigation and drainage canals.

5.3 ROLE OF AGRICULTURAL WATER USE IN WATER CIRCULATION SYSTEM

Agriculture, forestry and fishery activities are maintained by utilizing the reproductive power of nature itself, and rely on the natural environment including the air, water and soil. Industrial activity is also based on the circulation of natural materials. The rural environment forms the basis of semi-artificial, semi-natural, or secondary nature, which is formed by humans using nature continuously for agricultural production.

Japan has much precipitation and steep mountains cover 70% of the land, so the country is prone to disasters. However, to prevent floods, forests and agricultural lands which account for most of the land use in catchment areas contribute as follows through sound production activity by farmers and forestry workers :

(1) prevent soil erosion and debris avalanche;

(2) help the percolation and storage of precipitation; and

(3) return most of the water to rivers eventually.

Forests, agricultural lands and coastal areas have various functions including purification of water, preservation of various biota, conservation of the natural environment, and landscape greening.

Use for irrigation accounts for two thirds of the water requirement, and extensive networks of irrigation canals have been built that comprise much of the water circulation system in catchment areas.

While much of the surface water runs off into the ocean due to the steep and short rivers caused by topography, agricultural lands and networks of irrigation canals on the ground reduce such water run-off by retaining the water. This effect helps to stabilize surface water and ground water in the downstream region of the area. Agricultural water use thus serves to preserve water, not just use it for irrigation.

In addition, agricultural water use helps to purify water through natural purification in paddy fields and irrigation canals as well as form the basis of the ecosystem by its process of circulation and recycling. Furthermore, water for agriculture is used not only for irrigation, but also for general water use in the region including melting snow, fire-fighting, conservation of the ecosystem and landscape, and other functions in the region.

The basic structure of land and water usage is the result of activities of people who have protected farm lands and forests and managed water as a part of farming and forestry. Because these activities have been continued and communities have been maintained, Japan's rich green land is productive, and the water circulation system in catchment areas has been secured by using water for irrigation.

In considering policies for building a sound water circulation system, the various roles of forests, farmlands, coastal areas, agriculture, forestry and fishery must be properly considered.

5.4 ISSUES CONCERNING SOUND WATER CIRCULATION SYSTEM

In Japan, agriculture, forestry and fisheries are controlled to stabilize the food supply, to develop agricultural, forestry and fishery villages, to preserve the land, and to contribute to the growth of the economy and society. Such management has, directly and indirectly, supported many functions such as conservation of the land and environment of forests, farmlands and coastal areas.
However, in line with recent changes in economic and social conditions, catchment areas have also been changing drastically. Such change includes :

- development of urbanization, with farmers and non-farmers living alongside each other in agricultural and rural communities, decrease of area of water and greenery (forests, farmlands, ponds and lakes where algae are planted, tidal lands and so on), and increase of area where water cannot percolate into the ground;
- delay of growth and thinning of forests, abandonment of cultivation of farm lands, and careless irrigation management caused by worsening depopulation and aging, poorer management of agriculture and forestry due to declining prices of agricultural products and wood (less incentive to manage agriculture and forestry by farmers and workers in the forestry industry);
- increase of outflow of pollutants which degrade the water caused by improved living standards and changes in industrial structure.

Some regions clearly witness the problems including less stable flow in the rivers, less water resources and groundwater, water pollution in closed water areas, decrease of aquatic livestock, loss of landscape, and others. Such problems concern various fields in order to secure a sound water circulation system in catchment areas.

Necessity of Maintaining Functions of Forests and Farmlands

(1) Decrease of forest area, delay of growth and thinning of forests, decrease of farming area (especially, paddy fields), abandonment of cultivation of farm lands, declining water storage capacity in catchment areas due to change of cropping from rice to other crops, less stable river flow, and cultivation of water resources and groundwater

(2) Increase of water demand for environmental reasons (creation of pleasant waterfronts, dilution of household drainage and so forth), caused by urbanization and farmers and non-farmers living alongside in agricultural and rural communities

(3) Weakening of Land Improvement Districts (In Japan, a water users' association is called a Land Improvement District or LID) which would preserve the water circulation system by maintaining irrigation facilities, and resulting careless management of water

(4) Lowering of functions including purification of water, conservation of ecosystem, formation of traditional landscapes by agricultural water, and increase in concrete lining of canal and pipes to boost agricultural productivity

Coping with Tight Water Demand

(6) Because of the trend of less precipitation in recent years and difficulties of developing new water resources, the water system cannot meet demand, so existing water resources must be reorganized to use water more effectively.

Coping with Water Pollution

(7) Water pollution in agricultural water, public water areas and groundwater due to various types of waste water from households flowing into agricultural canals, improper treatment of livestock excrement, improper use of chemical fertilizers and agrochemicals, and others (especially, water quality deterioration is serious in closed water areas such as lakes and marshes, inland seas and bays)

(8) Natural recycling, which is a core function of agriculture, should be promoted (restructure the recycling system).

5.5 CONSIDERATIONS FOR SOUND WATER CIRCULATION SYSTEM

(1) Establishment of Objectives of Sound Water Circulation System

A sound water circulation system means that quantity and quality of water are secured when the water is used by recycling among rivers, underground and the places where people live and work. This requires the following:

(1) Ensuring the various functions of forests and farm lands, including the stable flow of rivers, cultivation of water resources and groundwater, and water purification

(2) Stable use of water by developing and maintaining water resource facilities

(3) Treating water pollutants caused by production and living activities

(4) Preserving biota, the natural environment, and landscape

(2) Role of Irrigation in the Water Circulation System

In order to build a sound water circulation system, it is essential that the ministries and agencies concerned and those living in catchment areas (irrigators, inhabitants and so on) recognize the role of forests, farm lands and agricultural activity in the water circulation system.

It is necessary to quantify the circulation of irrigation and functions of cultivating water resources in each catchment area. Furthermore, it is also necessary to promote awareness that irrigation is one water use and that being just a water consumer is superficial. Using water for agriculture means creating it, not just consuming it.

(3) Importance of Autonomous Approach in Catchment Areas

Each catchment area has its own topography, social and economic conditions, and historical background of water. So, not only water use but also the types of water circulation vary among catchment areas. Sound water circulation is achieved through sound economic and social activities by the people who live in the area. An independent approach by the inhabitants is required. For these reasons, the construction of a sound water circulation system should be approached as a problem for the local people; a consensus is required among the stakeholders, including those who use directly water in the catchment areas, fishermen, and other interested parties. It is neither sound to regulate by national standards, laws and regulations, nor to use compulsory administration. Therefore, an autonomous approach in the catchment area is the basis of a sound water circulation.

Sound production and living activities support sound water circulation, and so every approaches by those who actually use water are important. It is necessary to form a consensus and common objectives for actions among water users. The administration (central and prefectural governments) should neither mandate these objectives nor regulate, but should cooperate with water users and the local people. The administration should also deal with the issues that cannot be addressed by water users and the local people, and should support the self-governing activities in catchment areas by listening to the needs of these people.

(4) Defining the Roles of Land Improvement Districts

Close cooperation is needed among private water users, the local people, and the “public” municipal governments. But, a sound water circulation system cannot be built through cooperation with the private and public sectors alone. The “communal” existence of Land Improvement Districts is very important.

In Japan, irrigation has been managed by people in the villages, and farm villages have been formed under irrigation orders based on rules developed over time. So, the environment in Japanese traditional farm villages is preserved mainly by the water users’ associations originally established for allocating agricultural water,. Diversion facilities which were used to allocate water to tertiary canals in the community and ditches in each field were managed by each community, and the management was based on the principle of “communal activity” symbolized by compulsory services, while water users’ associations have managed main headwork and canals, and distributed water properly to each community. These compulsory services in each community were not confined to management of water, but covered all things including management of water for households and farm roads required in the community.

Land Improvement Districts have gathered much know-how about how to manage the environment in Japanese traditional farm villages. But due to the critical situation facing agriculture and farm villages including low prices for agricultural products, urbanization and farmers and non-farmers living alongside in agricultural and rural communities, depopulation and aging, Land Improvement Districts are being forced to operate on a weaker financial basis and less communal function within the community.

On the other hand, with the progress of urbanization and farmers and non-farmers living alongside in the community, irrigation management must play an ever greater role, including dealing with larger inflows of sewage from households, and providing water areas for recreation. Therefore, municipal governments are increasingly becoming involved to the management of irrigation facilities. However, in districts where farmers and Land Improvement Districts are minor, it is difficult to reach agreement to support Land Improvement Districts by the municipal governments.

Therefore, Land Improvement Districts must urgently be positioned not only as entities for managing agricultural water but also for managing the environment and resources in the community. It is also necessary to restructure the community in the region where farmers and non-farmers live together, and to build a system that they can manage by themselves in coordination with the Land Improvement Districts. Private farmers and non-farmers, communal Land Improvement Districts, and public municipal governments must share the roles and cooperate with each other. Since irrigation supports a sound water circulation system, preservation of the environment of agricultural villages should become a nationwide movement by people including city-dwellers, with Land Improvement Districts as the driving force. The active management of local resources and environment must be considered carefully.

(5) How to Coordinate Irrigation (Allocation of Water Resources)

Allocation of water resources in the existing system of the River Act has generally been decided by the river administrator, Ministry of Construction, for the public interest. Ministry of Construction is responsible for granting permission to use irrigation. However, the irrigation situation, including the higher demand for water for water use per hectare, the trend of repeated water shortages, and new demand for water for the environment and others, is changing, and it is also becoming difficult to develop new water resources. It is thus important to restructure the surface water use system, and also to utilize limited water resources effectively.

However, coordination of irrigation, that is, allocation of water resources, cannot be managed centrally and appropriately by the public river administrator, because it is different from flood control. Coordination of irrigation is based on coordination among various irrigation parties. This coordination is result of the self-governing function in basin areas. Irrigation coordination associations, therefore, is needed to be established for negotiating and coordinating among all of the water users (not necessarily for the whole system) who are involved in order to allocate water properly over a wide area. In doing this, the departments and agencies for irrigation, and the river administrator should serve as advisers, and should generally reflect the intentions of water users summarized by the irrigation coordination association in the management of agricultural water use and river management. This falls into line with the demand for minimum involvement by the government (to reduce administration costs) in recent years.

(6) Role of Agricultural Administration — Preservation of Farm Lands and Forests on Hillsides and Mountainous Regions

From the viewpoint of the water circulation system, hillsides and mountainous regions conserve the land by preventing soil erosion, floods, as well as cultivate water resources by forests and farm lands because of their locations. The various functions of such forests and farmlands protect economic and social activities in the downstream areas.

Farming of hillsides and mountainous regions is being abandoned due to aging of people and depopulation. Because the water circulation system must be secured, it is necessary to preserve farm lands by taking measures including conserving terraced paddy fields, preventing the abandonment of agricultural lands, and managing agricultural lands in uncultivated.

6. CHALLENGES FOR THE FUTURE

1) Water Quality

It is important to continue improving sewage treatment plants in agricultural village projects.

It is also important to decrease the environmental load by encouraging the recycling of resources through re-use of treated water for irrigation, and encouraging people to return sludge, kitchen garbage and livestock excrement to farm lands.

Regarding pollutants from so-called non-point sources, that is, livestock excrement, measures are needed for pollution sources. These measures include the development of an environment-friendly agricultural system, enforcement of proper treatment of livestock excrement, and promotion of recycling. For polluted water of low density and polluted groundwater, it is difficult to take similar measures as for the treatment of sewage in urban areas. Measures such as using water hyacinth and ditch weeds, purification through gravel, and use of local resources such as charcoal, suitable for the agricultural areas should be developed.

2) Ecological System and Landscape

Improvement of agriculture and farm villages has to be designed to increase productivity, and project measures have emphasized rationality, soundness and economy because the projects have sought to alleviate the burden on the beneficiaries (farmers). However, as people become more interested in environmental problems, projects to raise the value of farm villages by focusing more on harmony with agricultural environment have become more common.

Therefore, it is essential to restore the functions of agricultural water, such as preserving recreation and ecosystem. Projects must increasingly consider harmony with the natural environment, together with the problems of sharing the costs in order to preserve agricultural land and the environment.

3) Water for the Community

Agricultural water is not used only for irrigation water, but has many uses for the community including improvement of the village environment. Hence, the importance of agricultural water is increasing as urbanization progresses and farmers and non-farmers live alongside in agricultural and rural communities.

Therefore, a new support system should be established to keep and manage irrigation facilities in the community, and to strengthen the functions of water for the community through the effective use of agricultural water by re-using.

Emphasis should be placed on promoting a system for reusing irrigation and restraining water pollutants in the whole community by using water purification ponds with aquatic plants and the like.

Report of Japanese Podium Application
With Comments for Model Improvement

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The uniqueness of Podium is that it is handled with the macros of a spreadsheet application. The consequences of changes in variables are shown graphically. Podium is aimed exclusively at the analysis of various scenarios. For this purpose, it is very successful in supplying a common platform for discussion to different countries.

Podium is designed to provide the direct consequences of economic and environmental changes that will affect the water balance in 2025. To derive these consequences, all that is required are data in 1995 for a set of variables and their rate of growth to the year 2025.

The simplicity of this model makes it very useful for providing what-if implications.

1. RUNNING THE JAPAN MODEL

We ran the Japan model with some assumptions and elaboration of default data. Details of these are discussed in the appendixes.

Running the model, we found the annual water productivity rose from 1.14kg/m^3 to 1.53kg/m^3. The consumptive use fell from 7.14km^3 to 6.45 km^3.

However, we must remember that this improvement is largely resulted from the increase of yield from 4.48 t/ha to 6.01 t/ha.

2. LIMITATIONS OF THE MODEL

The most important problem of the model is that cereal's requirement and production (demand and supply) are determined independently. This problem is related to international trade.

The model permits a difference between cereal consumption and production. This difference must be cancelled out by the foreign trade factor. However, there are no restrictions posed on trade. If there is a cereal shortage, that country can import as it wishes without reducing other countries' imports. This means that there can be many sets of variables that make cereal production and requirement equal.

Price is what the model does not handle. We know Podium is unique and powerful because its structure is simple and concise. However, more beneficial possibilities can be provided if foreign trade restrict to some extent our demand and supply of cereal. In other words, the problem here is how to deal with the price of goods and the connection between countries.

Another problem we noticed is that average values for the amount of water resources in a country are limited in significance, while those for food are always meaningful. This is because water cannot be transported for long distances without a fairly large amount of investment for constructing canals. Food prices, on the contrary, tend to be averaged in a country because food is easily transported from places where prices are lower to where prices are higher. Maybe in the next step of the development of the Podium model, possible future water projects will have to be considered. In deriving the conclusion for the Vision for "Water for Food," this point has to be taken into consideration.

Podium may be controversial in its model structure, but what we really need is a common platform for the discussion of future water balances, which Podium provides.

APPENDIX 1 : SOME NOTES ON RUNNING THE JAPAN MODEL

We need to note on some assumptions and data revisions.

The data revision policy is that if default data are based on the FAO statistics, then they are used. For the data that have been "estimated," other national statistics are used.

1. FOREIGN TRADE

It is taken as given that cereal requirement and the production (demand and supply) should be equal. It seems that Podium does not necessarily require this condition, however, the assumption is quite natural in order to derive a meaningful result.

We assume that a shortage of cereal can be met by an increase in imports.

2. KINDS OF CEREALS

Cereals are taken as being divided into the categories of "rice" and "other cereals," Rice consisted of more than 90% of area harvested in 1995. Other cereals were mainly wheat and barley. Maize, millets and oats were far less than 1%, while area growing buckwheat was about 1% of the total.

3. IRRIGATION

The irrigation intensity was assumed to be 100%. This is because the intensity of the area used has been slightly less than 100% in recent years. Rice production was assumed to be done with irrigation while other crops were grown in rain-fed areas.

4. SEASONS

Rice is regarded as being produced in the wet season, while the production of other cereals is divided into two seasons.

Data Source

[1] Ministry of Agriculture, Forestry and Fisheries of Japan, The Statistics Agricultural Land Use, 1995, 1996

[2] FAOSTAT, http://apps.fao.org/

[3] Ministry of Agriculture, Forestry and Fisheries of Japan, Census of Agriculture, 1995

ESTIMATING YIELD IN JAPAN MODEL

Step 1 : Target Cereals and their Harvested Area

We assume cereals of Japan are classified as rice and other cereals. As shown in the Table 1, the other cereals are grown in only 10% of the total cereal area. They mainly consist of wheat and barley.

Summarizing Table 1, Table 2 gives the area for rice and other cereals grown in the paddy fields fields.

Table 1. Harvested Area for Cereals (ha)

	1,994	1,995	1,996	Total
Rice	2,212,000	2,118,000	1,977,000	6,307,000
Millets (Paddy fields)	200	200	200	600
Millets (fields)	200	200	200	600
Wheat and barley	115,500	113,700	117,800	347,000
Wheat and barley	98,700	96,500	97,700	292,900
Oats (Paddy fields)	542	594	750	1,886
Oats (Fields)	611	492	472	1,575
Maize (Paddy fields)	16	6	4	26
Maize (Fields)	153	114	98	365
Buckwheat (Paddy fields)	10,100	11,800	15,300	37,200
Buckwheat (Fields)	10,100	10,800	11,100	32,000
Total	2,448,122	2,352,406	2,220,624	7,021,152

Source: Statistics of Agricultural Land Use, 1995,1996, Ministry of Agriculture, Forestry and Fishery

Millets appear in the FAO statistics. We could not find the equivalents in our statistical source. We assumed they can be divided half for the paddy fields and the other half for the fields.

Table 2. Harvested Area for Rice and the Other Cereals (ha)

	1,994	1,995	1,996	Ave. (1,000ha)
Rice	2,212,000	2,118,000	1,977,000	2,102
Other than rice	236,122	234,406	243,624	238
Paddy fields	126,358	126,300	134,054	129
Fields	109,764	108,106	109,570	109
Total	2,448,122	2,352,406	2,220,624	2,340

Other cereals than rice can be grown in fields and paddy fields. Paddy fields for the other cereals can be (1) converted from rice production because of the diversification policy, and 2) secondary crop to the rice production. We assume here that the former is in the wet season and the latter is in the dry season.

For the other cereals grown in the fields, we just assume half of them is in the wet season, and another half is in the dry season. We also assume rice is produced in the wet season.
We assume rice is grown in the irrigated area and the other cereals are grown in the rain-fed area.

We have the statistical data of paddy fields which are used for the other crops than rice in the secondary season (Table 3). By this table we can assume the area for the other cereals grown in the paddy field

Table 3. Paddy Fields Used for the Other Crops than Rice in the Secondary Season in 1995 (ha)

Paddy fields for rice	2,094,879
Paddy fields for secondary crop	103,061
Percentage of paddy fields for secondary crop	4.9%

Source : Census of Agriculture, 1995, Ministry of Agriculture, Forestry and Fishery

The assumptions on the division of land are shown as Table 4. Table 5 gives the actual value derived from the assumptions and data given thereby.

Table 4. The Division of Cereals

	Wet	Dry
Irrigated	Rice	None
Rain-fed	A	B

A. Half of the other cereals in the fields, and the other cereals in the paddy fields by the diversification policy.
B. Half of the other cereals in the fields, and the other cereals in the paddy fields as a secondary crop

Table 5. The Area of Cereals (1,000ha)

	Wet	Dry
Irrigated	2,102	0
Rain-fed	177	61

Step 2 : Irrigation Intensity

Table 6 gives the percentage of agricultural land use. We assume the irrigation intensity is 100%.

Table 6. Percentage of Agricultural Land Use

	1993	1994	1995
Paddy fields	99.1	98.6	96.1
Fields	101.0	100.3	99.4

Source : Statistics of Agricultural Land Use, 1996, Ministry of Agriculture, Forestry and Fishery

Step 3 : Yield

Table 7 is the production of cereals.

Table 7. Production of Cereals (t)

	1994	1995	1996	Total
(1) Cereals, Total	15,787,290	14,121,900	13,668,250	43,577,440
(2) Cereals (Rice Milled Eqv)	10,800,282	9,648,045	9,362,560	29,810,887
(3) Cereals ther than rice	811,290	686,900	738,250	2,236,440
Rice, Paddy	14,976,000	13,435,000	12,930,000	41,341,000
Wheat	564,800	443,600	478,100	1,486,500
Barley	224,800	218,200	233,200	676,200
Maize	420	300	250	970
Oats	2,570	3,000	2,000	7,570
Millet	700	700	700	2100
Buckwheat	18,000	21,100	24,000	63,100

Source : FAOSTAT(www.fao.org)

To evaluate the yield as rice milled equivalent, we have the conversion rate from the total of 1) and 2) in the Table 7 as 29,810,887 / 43,577,400. Table 8 shows the production calculated as this. Table 9 and Table 10 is the yield we need.

Table 8. Production of Cereals as the Rice Milled Equivalent (ha)

	1994	1995	1996	Total
Rice	10,244,930	9,190,748	8,845,283	28,280,961

Table 9. Yield (t/ha)

	1994	1995	1996	Total
Rice	4.63	4.34	4.47	4.48

Table 10. Yield (t/ha)

Yield		Wet	Dry
Irrigated		4.48	To be Computed
Rain-fed		To be Computed	To be Computed

Step 4 : Required Data Revision

		1995	2025
1.	Irrigation Intensity	100.0%	100.0%
2.	Rain-fed Intensity Deriving from Table 5…	134.6%	134.6%
3.	Percentage of Irrigated Area with Cereals Regarding all and only the paddy field is irrigated…	77.6%	77.6%
4.	Irrigated Yield S2/S1	100.0%	100.0%
5.	Import (million tons) Assuming all the cereal shortage can be cancelled out…	9.94	10.07

REPUBLIC OF KOREA

EXECUTIVE SUMMARY

The agricultural water and farmland are two essential resources that should be conserved to ensure the sustainable agriculture and the sound rural society. The natural and socio-economic environments in Korea urgently require the conservation of agricultural and rural water in its quantity and quality.

The annual amount of total water consumption is estimated as 23.8% (30.1 billion m^3) out of the total amount of annual water resources (126.7 billion m^3) in Korea. Of this amount, 50%(14.9 billion m^3) out of total consumption is used for agricultural production. Pollutants from point sources such as municipal sewage, industrial wastes and livestock wastes and from non-point sources such as fertilizers and pesticides applied over the agricultural system have deteriorated the quality of agricultural water. Its organic pollutant and highly concentrated nitrate and phosphorus known as the cause material for lake and reservoir eutrophication characterize contamination of agricultural water.

Four most significant national issues for the development and management of the water for food and rural development are identified as follows:

The most significant issue is the development of agricultural and rural water resources under the spirit of environmentally sound and sustainable development. The construction of medium size multipurpose dams and irrigation reservoirs is recommended for supplying the increased water use. Enhancing existing reservoirs is advisable because of its fruitful merits. Linked operation of dams in a basin or transfer of water between different watershed areas is also the apparent method within some degree of limitations.

The second is water saving by a good water management and reasonable maintenance. The water saving is the most environmentally protective and sustainable conservation method for the sake of its advantages as well as its effectiveness on reducing the new construction needs to meet the increased water demand. The effective use of reservoir storage, water saving irrigation, construction of concrete ditch, and water management by Telecontrol/Telemetering (TC/TM) system are the relevant methods fall into this category.

The third is protection of water from pollution. Watershed management is essential. Pollutant sources should be regulated by prohibiting the discharge of themselves. Fundamental environmental protection facilities must be broadened and enhanced. Water quality monitoring system should also be strengthened. Ground water should be conserved.

The fourth is the rearrangement of water management organizations and water laws. Many kinds of water laws must be unified and clarified. Two independent organizations for the agricultural and rural water development and for the management and maintenance of developed water, respectively, should be merged into one agency for more effective operation in the forthcoming 21st century.

1. OVERVIEW OF NATIONAL POLICIES AND DEVELOPMENT PLANS

Korea is now being recognized as one of the most successful Asian countries in overcoming the recent economic peril. A strong and consistent policy mixed with fiscal and monetary policy instruments has been focused on increasing the efficiency of the whole economy and stabilizing the foreign exchange market.

This recent economic situation has been the most severe crisis since 1960s, which was caused mainly by unfavorable domestic business environments including weakness of the financial market structure, fundamental weakness of the economic structure, and partly by the worldwide economic recession and lack of information on foreign financial markets.

The agricultural sector was not excepted from the peril to the whole economy. The economic crisis led to a decrease in farm incomes because of high production costs, leading in turn, to an increase in farm debts for the individual farm household.

The new Government, launched in February 1998, has taken a series of countermeasures to overcome the economic crisis and thereby to revitalize the national economy.

It is foreseen that within the agricultural sector in Korea in the 21st century the market will be open, and its competitiveness will be significantly developed. The government's agricultural policy would shift to a free open market system under the WTO system. As the world market for agricultural products is foreseen to be unstable due to the increasing world population and global climatic changes, there will be greater concern about food security for all. This was also noted at the World Food Summit held in November 1996. Internally, besides supplying agricultural products, non-trade concerns about agriculture and rural communities, such as food security, environmental protection and balanced regional development, which will not reflect in the market price, are expected to increase. As a result common interest in the economic and social safety nets would be widely expanded. A stable supply of agricultural products of high quality will be necessary due to the changes in consumer preferences in food products. Significant changes in the agricultural marketing system are also expected as technology develops in many areas. Nation- and region-specific farming will be accelerated in accordance with the development of world agricultural market system. A harmonious policy for the unification of South and North Korean agricultural sectors, which would contribute to a future unified Korea, should be considered. These situations require continuous investment in the agricultural sector, but inefficient management of agricultural funds in the past becomes one of the problems, and therefore increasing investment efficiency and reforming the relevant organizations are strongly suggested.

Korea has a relatively high annual rainfall at 1.3 times the world average. However, the average amount of rainfall per capita per annum is about one-ninth of the world average because of the high population density; this is the main reason for a possible water shortage. Large seasonal variations in rainfall frequently result in floods in the summer rainy season and drought in spring and winter. Korea also has difficulty in managing water resources because the amount of rainfall varies from region to region due to the varied geographical characteristics. A stable water supply for rice production is very important because rice is a staple food. Water resource development for agricultural needs therefore has priority among public investment plans.

Changes in farming patterns such as direct seeding for paddy rice and agricultural mechanization have led to increased demands for peak irrigation water. Value-adding efforts through crop diversification and high quality production have also increased needs for irrigation water. Moreover, urbanization and industrialization of rural areas are additional sources of residential and industrial water demands. Water contamination caused by residential, industrial, and livestock spills will make the water shortage problems worse in the 21st century. Water distribution will be a critical issue among the users, of which the portion of agricultural users will decrease from its current majority.

2. PRESENT STATUS OF WATER

Korea has 1,274mm of average annual precipitation, which is estimated at 126.7 billion m^3 of water in volume. Out of 126.7 billion m^3 of water, 69.7 billion m^3 discharges to rivers and streams showing a 55% runoff rate and 57 billion m^3 evaporates or infiltrates as a direct loss. Total available surface and ground water is estimated at 47.2 billion m^3 which includes 23.0 billion m^3 of river flows during the non-flood season, 10.8 billion m^3 of stored water in multipurpose dams and agricultural reservoirs and 13.4 billion m^3 of ground water.

Water demand has been steadily increasing for the last several decades due to the increase in population, irrigation area and industries, as well as the rapid expansion of urban areas. The water demand in 1994 amounted to about 30.1 billion m^3 which comprises 6.2 billion m^3 of municipal use, 2.6 billion m^3 of industrial use, 14.9 billion m^3 of agricultural use and 6.4 billion m^3 of instream flow augmentation. Half of the total water demand came from agricultural use.

The usable water potential is estimated at 83.1billion m^3. The water potential consists of 69.7 billion m^3 of river discharge and 13.4 billion m^3 of ground water.

Of the 69.7 billion m^3 of surface water potential, about 27.5 billion m^3 (17.2 billion m^3 of river flows and 10.3 billion m^3 of reservoir storage) is being used and the remaining 42.2 billion m^3 is assumed to be the potential to be developed. Excluding 3.4 billion m^3 of developed ground water (1997), of the 13.4 billion m^3 of total available ground water, 10 billion m^3 becomes potentially developable ground water. Therefore, the amount of water potential to be developed totals 53 billion m^3, which are 42.2 billion m^3 of surface water and 10.8 billion m^3 of ground water.

According to the long-term plans for water resources development, approximately 5.1 billion m^3 of surface water is scheduled to be developed by the end of 2011. The plan includes the construction of 28 multipurpose dams with a storage capacity of 4.3 billion m^3 and many agricultural dams with a total storage capacity of 0.8 billion m^3. A great number of small-scale ground water development projects will be executed by various sectors. However, water resources development has become more difficult in recent years due to an increase in construction and compensation costs, limited appropriate dam sites, and strong opposition from the inhabitants and environmental concerns.

About 18,000 agricultural dams together have 3.0 billion m^3 of effective storage capacity and irrigate about 506 thousand ha of rice paddies. Most agricultural reservoirs have small storage capacities with less than one million m^3 and only 377 reservoirs have more than one million m^3 of effective storage capacity. The 35 existing large dams for hydro-electric power generation, municipal or industrial water supply and flood control have a total storage capacity of 13.5 billion m^3 and effective storage of 9.3 billion m^3. Seventeen large dams having a total storage capacity of 3.9 billion m^3 are currently under construction.

Since approximately two-thirds of river water flows during the three months of the flood season, much of flood discharge flows directly into sea. Therefore, only 46.7 billion m^3 from 69.7 billion m^3 of river discharge can be considered available. River discharges show considerable variation from season to season. River's discharge remains low during dry season from October to June and runs high during the wet season from July to September.

A total of 14.9 billion m^3 of water for agricultural purpose is withdrawn from reservoirs (9.4 billion m^3), pumping stations (2.7 billion m^3), headworks (1.9 billion m^3), tube-wells and other sources (0.9 billion m^3). Most agricultural water is used for paddy rice and about 500 million m^3 of water is applied for upland crops. The water for non-agricultural use amounted to 15.2 billion m^3 which includes 6.2 billion m^3 for municipal use (41%), 2.6 billion m^3 for industrial use (17%) and 6.4 billion m^3 for instream flow augmentation (42%).

In Korea, basin management to continue safe water supply mainly depends on the construction of multipurpose dams and agricultural dams as well as reforestation. The government is preparing an integrated basin management plan including water quantity and quality control in order to maintain a stable supply of clean and fresh water.

Used for domestic, industrial, agricultural and other purposes, total 3.4 billion m^3 of ground water was mined from about 946 thousand wells in 1997. The ground water use consists of 1.6 billion m^3 (47.2%) for domestic use, 1.5 billion m^3 (43.9%) for agricultural use, 200 million m^3 (6.6%) for industrial use and 79 million m^3 (2.3%) for other uses. Domestic and agricultural uses of ground water cover about 91% of the total use. The use of ground water has sharply increased in recent years. Especially in coastal areas where main river systems do not pass nearby, ground water has become a major water source.

Water pollution has accelerated since the 1970s and water quality improvement has become a major task in the 1990s. In order to monitor water quality, 1,698 water quality measuring stations are operated throughout the country: rivers (530), reservoirs (153), domestic water sources (589), agricultural water sources (300), and others (126).

Ground water table drawdown and ground water contamination occurred in some areas and many small wells have been abandoned in urban areas.

Water pollution is caused mainly by domestic, industrial and livestock wastes. A total of 398 wastewater treatment plants treat about 10 million m^3 of waste discharge and many other plants are under construction or are planned.

Damages to crops by high salinity of irrigation water do not occur because irrigation water generally does not contain excessive salts and more than 1,000 mm of yearly precipitation flushes salts in soils.

Efficiency of agricultural water use is reported to be 80~85% for rice irrigation and 60~85% for upland crop irrigation. The measure of efficiency in rice irrigation includes only seepage loss through canals while operational losses are not properly counted. Therefore, actual rice irrigation efficiency seems to be considerably lower than 80%.

Wastewater recycling is in an initial stage in Korea.

Approximately 160 thousand m^3 of seawater is desalinized at 16 stations for supplying drinking water, mostly on island areas.

The total volume of annual wastewater is estimated at 8.0 billion m^3. About 45% (3.6 billion m^3) is treated and the remaining 55% (4.4 billion m^3) is discharged to rivers or reservoirs or seeps into ground water. The untreated wastewater is assumed to be the main source of water quality degradation.

3. PRESENT STATUS OF FOOD

The Republic of Korea had 99,373 km^2 of national land in 1977, which included 64,413 km^2 (64.8%) of forest, 19,235 km^2 (19.4%) of cultivated land, 2,822 km^2 (2.8%) of rivers and 12,903km^2 of other types (13%). The average amount of cultivated land per capita was 0.042 ha and the average farm household had 1.336 ha including 0.808 ha of rice paddy and 0.528 ha of upland. The mountainous forest areas cover about two-thirds of the national land. The cultivated land is mainly composed of 7,607 km^2 of uplands and 11,628 km^2 of paddy fields. The uplands comprised 473 km^2 of orchards and 511 km^2 of pastures. The cultivated land and forest have been shown to bear a sharp decreasing trend since the 1980s by being converted into roads, houses, industrial sites and other purposes.

The cultivated land is utilized to grow food crops (1,314 thousand ha), vegetables (285 thousand ha), oil and cash crops (108 thousand ha), orchards (174 thousand ha), green house crops (92 thousand ha), some permanent crops (25 thousand ha), and other products (98 thousand ha).

A total of 2,096 thousand ha of yearly land use indicates a 107.8% land use rate by growing two or three crops on some parts of the cultivated land. The cultivated areas for food crops cover rice (1,052 thousand ha), barley and wheat (70 thousand ha), miscellaneous grains (30 thousand ha), pulses (122 thousand ha) and potatoes (40 thousand ha).

The climatic conditions in Korea allow one harvest of most crops except some vegetables and food crops. The agricultural productivity of major crops is relatively high with high inputs of fertilizers and chemicals, applying advanced farming skills, intensive extension and farm mechanization. The yields of paddy rice, barley, wheat, potato, maize and pulse in 1997 recorded 6,950kg, 3,820kg, 4,040kg, 5,000kg, 4,110kg and 1,570kg per ha, respectively.

The yield of rice in Korea is the highest among all the food crops and indicates a high level in the world as well. Chinese cabbage is the most widely grown among the vegetables and yields 65,210kg per ha each season. Apples are one of the major fruits and harvests are 16,300kg per ha.

The production of major crops in 1997 were 5,449,561 tons of rice; 195,495 tons barley and wheat, 218,369 tons of potatoes, 97,402 tons of miscellaneous grains, 181,738 tons of pulses, 588,686 tons of vegetables, 2,451,653 tons of fruits and 33,393 tons of cash crops.

Rice, a staple food in Korea, was grown in more than half of the total cultivated land. In southern part of Korea barley and wheat were grown as second crops in rice paddies after harvesting the rice in November until the early 1980s. However, imported barley and wheat have replaced domestic products and nowadays only a small number of farmers grow these for their family's consumption.

Cattle, chickens and pigs are major meat products in Korea. The numbers of native beef cattle, pigs and chickens had sharply increased during the five years from 1992 to 1997.

The numbers of livestock and poultry farms were sharply reduced during the same period. The reduction of livestock and poultry farms means an increase of the number of cattle, pigs or chickens raised in a single house. The raw feed for livestock and poultry are grains, bran, vegetable protein, animal protein, inorganic substances, etc.

Chemical fertilizers have been overused and it has caused harm to soil and waters through residues. Agrochemicals were mainly used for rice, fruits and vegetables. However, overuse of agrochemicals has caused problems for human health, ecosystems, water quality, etc. Therefore, the government plans to reduce the use of chemical fertilizers and agrochemicals by promoting natural, organic fertilizer use.

A number of households have adopted environmentally favorable farming and the number is increasing continuously

A large portion of farm work, which was previously done by laborer or cows, has been replaced by agricultural machinery such as the power tiller, farm tractor, rice transplanter and combine.

Most of the rice farming work from nursing to harvesting has been mechanized and the rate of mechanization with the exception of drying rice has reached 98%.

There are four major agricultural cooperatives in Korea. The government plans to merge these cooperatives into a single cooperative.

Average nutrient consumption per capita per day is of the order of 2,957kcal, which is provided by combined intake of cereals, starchy roots, pulses etc.

A total national cereal production of 5,081,000 tons compared to 18,673,000 tons of domestic consumption in 1996 showed a self-sufficiency rate of only 27,2%. The self-sufficiency rates of rice (89.9%) and barley (73.5%) were relatively high, self-sufficiency rates of wheat (0.4%) and maize (0.8%) were extremely low. Low national production and dependence on imported wheat and maize caused an overall low self-sufficiency rate for cereals. A large portion of imported wheat and maize were used for livestock and poultry feed so that the self-sufficiency rate of cereal excluding animal feed reached 52.4%.

The self-sufficiency rates of pulses (11.7%) and oil crops (42.1%) were relatively low. But the self-sufficiency rates of starchy roots (99.6%), fruits (92.6%), vegetables (98.7%), eggs (100%), fish and shellfish (95.1%), and seaweed (126.7%) were high.

4. PRESENT STATUS OF RURAL DEVELOPMENT

As a result of concentrated efforts in agricultural water resource development by Korean government, 882,000 ha of the rice production area was converted into irrigated paddy fields by 1997, which accounts for 76% of total rice production area. However, about 50% of the irrigated paddy fields are still subject to possible damage from the drought with 10-year frequency because of poor irrigation facilities. Besides these problems, 10,000 reservoir (55% of the 18,000 existing reservoirs) do not function well due to this deterioration.

Major physiographic constraints are large mountainous areas, which are prone to erosion due to steep slopes and high intensity rainfall. These conditions limit development in the mountain area. Similarly the absolute shortage of flat plain area has led to the conversion of farming areas into industrial and urban areas. The recent development of industry as well as urbanization due to the increase of population is the major causes of the reduction in farmland.

The population as of 1997 is about 46 million, with a growth rate of 0.98%, population density of 463 persons per km^2, birth rate of 1.6 per female and death rate of 5.4(male 6, female 4.7) per 1,000 persons. The male-female ratio is 101.5%.

The farm population consists of 4.47 million (male 2.15 million: female 2.32 million) which is 9.7% of total population.

The human development index of Korea is 0.89 based on the average life span of 71.5, the literacy rate of 97.9% and the percentage of school attendance at 82%.

The Korean national economy has been steadily developed since the 1960s. The Gross Domestic Product (GDP) was US$ 480.2 billion in 1996, and dropped to US$ 437.4 billion in 1997. Gross National Product (GNP) per capita decreased from US$ 10,543 in 1996 to US$ 9,511 in 1997. The economic growth rate was 8.7% in 1995, 6.9% in 1996, and 4.9% in 1997. The gross saving ratio in 1997 was 34.6%: 24.3% in the private sector and 10.3% in the government sector.

Export volume increased sharply from US $ 1.0 billion in 1970 to US $ 63.0 billion in 1990, and it reached US $ 136.2 billion in 1997.

Household energy has been changed from coal to oil and gas during the last decade. For cooking, imported natural gas and propane gas are major energy sources. For heating, natural gas is used in the city areas and oil in the rural areas.

An autonomous system in local government was adopted in 1990, whereby local governments have increased power in administration and financing. Local governors and local assembly members are selected by direct election by the people.

5. FUTURE SCENARIOS AND AIMS

Water demand increases continuously, requiring that development is sustained in respect in water quantity as well as water quality. The national goal is to attain self-sufficiency in staple food production, and this requires irrigation water development and preservation of farmland.

Also, rural development for farm production as well as rural living conditions is necessary to achieve equitable regional living standards and to prevent a concentration of the population into the urban areas.

Considering the increase in water demand, water resources development is seriously needed. However, most of proper dam sites have been developed, and planning for new dams is difficult because of national conservation supported by environmentalists as well as because of high development costs.

Water consumption for agriculture utilizes 50% of totals the available water resources. Therefore, water saving farming needs to be developed to reduce water use in the agriculture sector and divert more water to other sectors

The on-going government plan for rural water development, which started in 1994, will be finalized in 2004. The plan aims to increase the ratio of irrigated paddy fields to the total, from

76% in 1997 to 88% in 2004. For this purpose, a total of 14,420 billion won (US$ 11.5 billion) will be invested.

The government expects that rural water development will also be achieved after 2004, and that most of the paddy fields, except those in mountainous areas, will be provided with irrigation facilities, attaining 94% irrigation in paddy fields.

Agricultural water resource development in the 21st century should aim at (1) transition of single purpose development for agricultural use into the multipurpose development, (2) site-specific and systemized water resource development, (3) developing harmonized systems of existing and newly-built facilities, (4) developing efficient water management systems, (5) expanding systems for repairing and improving the existing facilities to increase safety and use efficiency, (6) developing technology and systems for scientific and efficient water management structure(such as Telecontrol/Telemetring, or TC/TM), preparing for a decrease in the farm population and aging in rural areas, and (7)water resource development related to rural village development and agricultural infrastructure projects.

Inter-basin water resources development along the major rivers will be further studied in the future to cope with the problems of national water shortage.

For the efficient use of water and savings in management labors, automation of water management has been studied, and some pilot schemes are being executed. The automation will be expanded in response to the need for water savings and higher labor costs.

Also, the communication network, Agri-Net, will be established to give and exchange information between concerned agencies and farmers. The Agri-Net will become a useful tool for training farmers, the dissemination of new technology and the marketing of agricultural products.

A programme of farmland consolidation, on-farm development provision of irrigation and drainage canals and farm roads, and on-farm drainage improvement works has been implemented in large percentage of area and will be continued.

Operation and maintenance of irrigation systems and water management have been performed by Farmland Improvement Associations (FIA), autonomous irrigation organization with a 90-year history.

In the year 2000, a government corporation will merge all Farmland Improvement Associations, ending the 90-year history of these autonomous farmers' organizations. This change causes about after a decade in which the FIAs have lost most of their independent sources of income and seen a reduction in water charges while dependence on government subsidies has increased. While this shift in structure will produce changes, encouraging participator management will be an important issue to resolve in the future.

From the beginning of the installation of modern irrigation systems around 1910,

The irrigation association has acted as an owner of irrigation projects although under government guidance and supervision. Therefore turning over the system to the government was not necessary.

There is no private water resource and irrigation development except a number of tideland reclamation areas that were developed by private companies. All the investment costs and a part of operational and maintenance costs have been borne by the government budget since 1988.

Historically, community water rights have been recognized, and as such, water was owned by the community and not by individual farmer. Water was a social good in these days, even if self-help works were needed. After establishing Irrigation Associations from the 1910s to the 1950s, farmers have had to pay water charges and part of the construction costs, changing the concept to be more closely tied to the economy.

Since the last decade, the concept of water had changed again from economic back to social, as a result of on the increase of subsidies.

Water charges had been based on operational and maintenance costs along with long-term loans for part of the initial construction costs. Since 1988 under the policy changes farmers have started to pay certain fixed amounts depending on the area irrigated (5kg paddy per 10a). Any shortage in operational and maintenance costs is subsidized through the government budget. As a result, farmers and the operating organization have little interest in water pricing.

The Republic of Korea shares several rivers and watersheds with North Korea. Some experts propose joint study and development for the basins, but politically it has been difficult to proceed.

6. CHALLENGES FOR THE FUTURE

Investment in water for food and rural development has increased remarkably in Korea, where the total investment since 1945 has amounted to US$17.5 billion. The corresponding increase in irrigated areas for example, was 0.188 to 0.882 million ha. Although there is evidence that investment in irrigation has declined in recent years, irrigation development will continue to receive a high priority due to limited land and water availability for further expansion.

As regards the agriculture and rural development policy, Korea has become a newly industrialized country, which means that agriculture is no longer the most important economic sector. However, increased food production and self-sufficiency in food are still important agricultural policy objectives. Even though the irrigated agricultural area has substantially increased, there remains a high proportion of farmland (usually over 50% on the basis of a 10-year drought recurrence interval) which is non-irrigated or rainfed.

The main policy objectives for water for food and rural development in Korea are (1) to establish an agricultural production structure that ensure a stable supply of staple foods and paddy rice and (2) to create a better rural living environment with coexistence among the primary, secondary, and tertiary industries in rural areas.

Several national visions for rural agriculture have been identified as follows.

1. To strengthen the development of the agricultural production infrastructure, particularly that of paddy rice for stable self-sufficiency in staple foods. This will include: the development of water resources for agricultural and rural use as a provision against drought, drainage improvement projects, the completion of un-finished large scale farmland reclamation projects for ensuring high quality farmland.
2. To establish agriculture's production base early on to make mechanized farming possible. This will include an agricultural road improvement project, a farmland consolidation project and the development of upland production base.
3. To scale up the investment for the efficient management of water resources and related structures and facilities. This will also include the reorganization of agencies in charge of development and management of agricultural and rural water as well as rehabilitation and modernization of hydraulic structures and facilities.
4. To shift the development method for the preservation and conservation of national land and the environment. Disaster prevention and the conservation of farmland are also important from the viewpoint of national land conservation.

5. To pursue rural development where the primary, secondary, and tertiary industries coexist in rural areas. This will include the village sewage projects and integrated rural development projects.

6. To strengthen international cooperation and to study the North Korean agricultural production infrastructure as a provision for reunification.

Self-sufficiency in staple foods will be achieved through to the stable agricultural production. Living conditions in rural areas together with production infrastructures will improve as well for the creation of attractive living environments. In the 21st century, rural areas in Korea will be brought into the complex society where urban and rural populations are mixed and where areas function as a supporting background to large metropolitan areas.

Rainfall is one of the constraints to water resources development. Seasonal distribution of rainfall is concentrated in summer season (about two thirds of the yearly rainfall), causing flood damage along the rivers and in low land. And water shortage is common in the spring and winter season. Because of such hydrological conditions, reservoirs are a major source of water and supply irrigation water to 58% of all irrigated paddy fields. Unfortunately there are almost no more appropriate sites for reservoirs, and this is one of the constraints in water resources development.

Water pollution is also serious. Population increases, urbanization, industrialization and higher living standard have brought water quality problems.

Until 1988 and 1989, part of the farmers' contribution to the investment costs was made in the form of long-term loans and their yearly repayment. Upon political consideration, farmers were exempted from sharing investment costs and part of the operation and maintenance (O & M) costs. So, all the investment costs and part of the O & M costs were borne by the Government budget. This new policy limited the availability of funds for water resources development. More interest was bestowed on social and political costs than economic costs.

In Korea, the public have the impression that there is enough water, because they experience floods very often. When there is long drought, the government and the public realize the importance of water. Spring droughts are especially important to overcome by national efforts to transplant rice in its due season. In recent history, investment in water resources development has been heaviest just after drought years.

Water management in the irrigation sector has been done by Farmland Improvement Associations. Irregular rainfall requires irrigation at one time and drainage at other times. This makes good water management and saving water very difficult.

Public awareness of water development was very high about two decades ago. New irrigation systems were welcomed by farmers and local communities, because irrigated farming resulted in great increase in yield. Also, agriculture was a major industry then, which many people depended on.

Recently public awareness of the environment has increased and has lessened the public support for water resources development. Now, several reservoir sites are planned, but are caught in disputes between the government and environmentalists. Governmental efforts to persuade and guide the public are urgently very needed in order to meet future demands for water.

Korea has no international boundaries on land except with North Korea. However, the air masses which bring cloud, and rain also can bring pollution. A large amount of weather comes from the west and so air pollution in China can affect the quality of rainwater in Korea. Acid rain is found all over the Korean territory indicating that cooperation between Korea and China would be indispensable. Mitigating air pollution in China would positively effect the Korean water resources.

Table 1. Agriculture in the national economy

Class	Units	1970	1980	1990	1996	1997(P)
GNP						
-Total	Bn.won	2,771	38,148	179,539	389,913	420,987
-Agriculture	Bn.won	646	4,773	13,262	21,094	20,661
(% of total)	(%)	(23.3)	(12.5)	(7.4)	(5.4)	(4.9)
Employment						
-Total	Thousands	9,617	13,683	18,085	20,764	21,048
-Agriculture	Thousands	4,756	4,429	3,100	2,298	2,215
(% of total)	(%)	(49.5)	(32.4)	(17.1)	(11.1)	

Source: Major Agricultural Indicators. MAF, MOFE, Korea. 1998

Table 2. Storage Capacity of Dams

(Unit: billion m³/yr)

Classification	Total	Multi-purpose	Hydro-power Generation	Municipal & Industrial water supply	Flood Control	Agricultural Reservoir
Number of Dams	435	10	10	15	6	395
Total Storage Capacity	15.2	11.1	1.9	0.5	0.7	1.0
Effective Storage Capacity	10.8	7.6	1.4	0.4	0.5	1.0

* Agricultural Reservoirs are above 20 m of dam height

Table 3. Runoff Discharge of Rivers

(Unit: billion m³/yr)

Total Water Resources	Losses	Average River Discharge	Major River	Small River	Other	Runoff Rate
126.7	57.0	69.7	45.9	19.5	4.3	55%

Table 4. Statues of Water Use in different Users

(Unit: billion m³/yr)

Total	Municipal Use	Industrial Use	Agricultural	Instream Flow Augmentation
30.1	6.2	2.6	14.9	6.4

Table 5. Agricultural Water Use

(Unit: billion m^3/yr)

Total	Irrigated Paddy	Non-irrigated Paddy	Upland Irrigation	Remark
14.9	11.5	2.9	0.5	

Table 6. Ground Water Mining

(Unit: billion m^3/yr)

Total		Domestic Purpose		Industrial Purpose		Agricultural Purpose		Others	
No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
946,181 (100%)	33.82 (100%)	571,663 (60.4)	15.97 (47.2)	11,883 (1.3)	2.20 (6.6)	358,239 (37.9)	14.86 (43.9)	4,396 (0.4)	0.79 (2.3)

Table 7. Consumptive Use of Paddy Rice

(Unit: billion m^3/yr)

Paddy Area (1000ha)			Consumptive Use	Effective Rainfall	Net Duty Of Water	Gross Duty of Water
Total	Irrigated	Non-irrigated				
1163	882	281	19.01	7.69	11.32	13.32

Table 8. Number of Water Quality Measuring Stations

Class	Total	River	Reservoir	Domestic water sources	Agriculture water sources	Urban source	Industrial Waste Water
Number	1,540	530	153	582	149	52	74

Table 9. Agricultural land

Classification	Units	1970	1980	1990	1995	1996	1997(P)
Total land(A)	1000ha	9,848	9,899	9,927	9,927	9,931	9,931
Agricultural area(B)	1000ha	2,298	2,196	2,109	1,985	1,985	1,924
Ratio(B/A)	(%)	(23.3)	(22.2)	(21.2)	(20.0)	(19.6)	(19.4)
Paddy Fields	1000ha	1,273	1,307	1,345	1,206	1,176	1,163
(% of Agri. area)	(%)	(55.4)	(59.5)	(63.8)	(60.8)	(60.5)	(60.4)
Uplands	1000ha	1,025	889	764	779	759	76.1
(% of Agri. area)	(%)	(44.6)	(40.5)	(36.2)	(39.3)	(39.5)	(39.6)

Source: Major Agricultural Indicators. MAF, Korea, 1998

Table 10. Farm population and numbers

Classification	Units	1970	1980	1990	1996	1997(P)
Population						
-Total(A)	1,000	32,241	32,124	42,869	45,545	46,061
-Agriculture(B)	1,000	14,422	10,827	6,661	4,692	4,468
Share(B/A)	(%)	(44.7)	(28.4)	(15.5)	(10.3)	(9.7)
Farm numbers	1000	2,483	2,155	1,797	1,480	1,440
-Full-time farmers	(%)	67.7	76.2	59.6	56.5	58.7
-Part-time Farmers	(%)	32.3	23.8	40.5	43.5	41.3

Source: Major Agricultural Indicators. MAF, Korea, 1998

Table 11. Cropping pattern by area and production value

Area : 1000ha, Values: Billion-Won

Classification	Total	Rice	Barley	Pulses	Potatoes	Vegetables	Fruits	Others
Area (%)	2,097 (100.0)	1,052 (50.2)	70 (3.3)	122 (5.8)	41 (1.9)	364 (17.3)	176 (8.4)	272 (13.0)
Production Value	28,129 (100%)	8,163 (30.6)	294 (1.0)	354 (1.3)	540 (1.9)	6,356 (22.6)	2,524 (9.0)	9,448 (33.6)

Source : Major Agricultural Indicators. MAF, Korea, 1998

Table 12. Self-Sufficiency Rate of Each Food Group (1996)

(Unit: 1,000 M/T)

Products	Production	Domestic Consumption	Self-sufficiency Rate(%)
1. Cereals	5,081	18,673	27.2
Rice	4,695	5,225	89.9
Barley	288	392	73.5
Wheat	11	2,882	0.4
Maize	74	8,996	0.8

LITHUANIA

1. OVERVIEW OF NATIONAL POLICIES AND DEVELOPMENT PLANS

Lithuania, with a total area of 6.52x10^{4} km^{2}, is one of the three Baltic states. It is bordered in the north-west by the Baltic Sea, in the north by Latvia, in the east and south-east by Belarus, in the south-west by Poland and in the west by Russia.

The cultivable area is estimated at about 3.9 x10^{6} ha, which is 60% of the total area of the country. The central and western parts of Lithuania are the best regions for crop production, especially the Middle Lowlands. Agriculture is being restructured and land ownership rights are being returned to their former owners. Three different types of farming now characterize the structure of Lithuanian agriculture. In 1998, private commercial farms occupy some 55% of the farmland. Company commercial farms occupy about 15% and small holdings, with an average size of 2 ha, occupy another 21%. The remaining land is either state owned or rented out to various types of farmers..

Real economic growth has been the principal economic factor in Lithuania the past few years. From 1995 to 1997 the gross domestic product (GDP), grew by 6.1%. Inflation fell to below a single-digi, employment remained high (unemployment in 1997 was only 5.9%) and normal trade and investment was established with both the countries of the West and former trading partners of the East. A currency peg was used to anchor the price system and stabilized financing was provided by the International Monitary Fund (IMF) and other multilateral creditors to rebuild foreign exchange reserves and to finance the importation of fuel, raw material and capital goods.

This export-led recovery resulted in an upsurge of trans-shipment activity through the Klaipeda port, as Lithuania began to serve as a natural bridge for East-West trade in Europe. Gradually, key industries were restructured to produce goods demanded by international markets. A number of large traditional industries, in areas such as petroleum refining, cement and fertilizer production, clawed back production levels and resumed traditional exports. In the light industry sector, food processing, textile production and dairy production boosted exports. Activities in the service sector continued to record rapid growth, especially in areas such as transport, financing, retailing and tourism. Starting in 1994, real wages began to rise (the average monthly wage in 1998 was $US256 and the minimum monthly earnings were $US100), contributing to a recovery in consumer demand. Rising real wages sparked an upturn in the construction sector and allowed higher levels of consumer spending, particularly on durable items such as cars and electronic goods.

The macro environment for agriculture improved relatively early in this reform period. The difficulties of adjustment from the old distorted production system, however, were combined with the problems of coping with pressure created by the new liberal policies and, as a result, social tension increased in rural areas. The Government responded to these tensions and to the initial political and economic difficulties of agricultural transition with increased intervention and protection, rather than accelerating the transition. It was a wrong response to real problems. Financial protection provided a safeguard for a system which needed a basic overhaul, and therefore prolonged the pain of adjustment. The new Government, which took office in late 1996, recognized the fact that the agricultural sector's level of financial dependency on the state was no longer sustainable, and in the beginning of 1997, began implementing a better targeted, more transparent, more cost effective, and less distorted support system for farms and rural communities. These reforms have set a new direction for agricultural support policies that are more market-friendly and provide an improved framework for longer term reforms and investment – something the sector badly needed.

Progress in creating a new farming structure and in land privatization, while significant, is far from complete. The privatization and restructuring of agroprocessing followed a path similar to that of the other Baltic countries, providing preferential purchasing rights for raw material producers. The initial phase of privatization is over, but the objective of creating real owners with adequate capital is only partially realized. Both agricultural and agroprocessing enterprises have major efficiency problems, and with some exceptions, are not ready yet to cope with the challenge of competition created by EU membership.

For a small country such as Lithuania, with significant agricultural resources, the most appropriate way of preparing the sector for EU accession is to develop an agricultural system which is competitive on the open market. Such a system, both in size and structure, needs to be quite different from the system that was in place during the Soviet era. It is essential, therefore, that the policy response to rural social problems and demands of the agricultural sector for more support take an appropriate form – namely, focusing on efficiency and competitiveness enhancement and not on policies that delay unavoidable change or maintain or increase distortions. In addition to maintaining and strengthening the course of new agriculture-related macro-economic policies, acceleration of unfinished reforms in farming and land property relations, as well as in agroprocessing, seems to be the most important means of improving competitiveness, efficiency and farm incomes.

2. PRESENT STATUS OF WATER

2.1. WATER RESOURCES

2.1.1. River basins and water resources.

Lithuania is a country with a transitional climate between maritime and continental. In the 12-15 kilometres-wide coastal zone it is maritime and in the eastern part of the country it is continental.

The mean annual precipitation is 748 mm, ranging from less than 550 mm in the north to a maximum of more than 846 mm in the Zemaiciai hills. Over two thirds of its precipitation occurs during the warm (summer) period, from April to October.

Rivers and lakes have long been used as waterways although, with the exception of the Nemunas (Neman) River in the southern part of the country, they are not very suitable for navigation. Within the country, there are 722 rivers of 10 km and longer and 21 of them are more than 100 km long. Most of the rivers flow across the Middle Lowland and the western part of the Zemaiciai Upland. There are over 3,000 lakes, 25 with areas of 10 km^2 and more. They cover 1.5% of the total area of the country. Most lakes are concentrated in the Aukstaiciai Uplands in the eastern part of the country.

Six major river basins can be distinguished in Lithuania:

- By far the largest river basin is the Nemunas basin, covering 65.9% of the country. The incoming water from Belarus is estimated at 9.28 km^3/year, of which 2.48 km^3/year comes through the sub-basin of the Neris river. Incoming water through the sub-basin of the Sesupe river is estimated at 1.26 km^3/year, of which 0.04 km^3/year is from Poland and 1.22 km^3/year from Russia. The flow of the Nemanas River to the sea is estimated at 21.19 km^3/year.

- The Lielupe river basin covers 16.4% of the country in the north. The outflow to Latvia is estimated at 2.00 km^3/year.

- In the north-west is the Venta basin, covering 9.1% of the country. The outflow to Latvia is estimated at 1.30 km^3/year.

- The group of coastal basins cover 4.4 km^3 and their total outflow to the sea is estimated at 0.9 km^3/year. The north-west of the country is part of the Dauguva basin, which covers 4.1% of the country, and the outflow to Latvia is estimated at 0.50 km^3/year.

- Finally, in the south-west is the Prieglius basin, covering less than 0.1% of the country, and with an estimated outflow to Russia of 0.01 km^3/year.

Total Internal Renewable Surface Water Resources (IRSWR) are estimated at 15.36 km^3/year. The total Internal Renewable Groundwater Resources (IRGWR) are estimated at 1.2 km^3/year. The table below summarizes the IRSWR.

Internal renewable surface water resources *(in km^3/year)*

Name of basins						
Nemunas	Lielupe	Venta	Sea basins	Dauguva	Prieglius	Total
10.65	2.00	1.30	0.90	0.50	0.01	15.36

2.1.2. Water reservoirs

One large dam - the Kaunas dam, built on the Nemunas river for hydropower generation, has a total capacity of 0.46 km^3 and a useful capacity of 0.22 km^3. About 376 river dams have been built for the storage of irrigation water. Their total capacity is 1.36 km^3 and their useful capacity is 0.23 km^3. The reservoirs also have potential and to some extent are used for fishery, recreation and generating hydropower.

2.1.3. Water use

In 1997, the total water consumption for agriculture, domestic and industrial purposes was 4.786×10^9 m^3, of which 2.3×10^7 m^3 for drinking water, 9.3×10^7 m^3 for fisheries and 1.5×10^6 m^3 for other purposes.

During the recent years of agricultural reform there has been a reduction of agricultural production because of the reduced buying capacity of newly established farmers, many of whom could not afford to buy enough fertilisers and pesticides, or who reduced their use in favour of organic fertilisers such as manure. This resulted in a significant decrease in the nutrients leached from the soil, so groundwater became cleaner.

In 1991, the total groundwater abstracted from about 12,000 tube wells was 5.8×10^8 m^3. In 1997, it decreased to 2.34×10^8 m^3 due to the reduction of industrial production or to water saving measures introduced in the industry as well as to the decrease of domestic water withdrawal. As a result of the increase in the price of water for domestic purposes, many water consumers installed water meters and started saving water. An increase in water consumption is expected in the near future due to an expected recovery of industry and to an increase in living standards, leading again to an increase in domestic water use.

2.2. IRRIGATION

2.2.1. Irrigation development

In Lithuania, the first steps in water management were made in the beginning of the 20th century, starting with the beginning of cultivation in the Nemunas River delta. In the delta about 4×10^4 ha of meadows in polders are protected against flooding by dams. Pumping stations are necessary to remove excess water since, after floods, the water level in the Nemunas River is high and water cannot flow naturally from the polder. Already 106 of such pumping stations have been installed. On the other hand in dry periods, when the water level is low, crops may lack moisture. In order to remedy this, sluices were installed in the polders which helped to regulate the water level in the ditches and thus irrigate in dry periods. In 1976, 2,200 such systems, called sluice systems, were installed. However, they were not used for long. Sprinkler irrigation soon proved to be better and more effective under Lithuanian conditions.

Since 1965, a lot of research on sprinkler irrigation has been carried out in the country. The first sprinkler irrigation systems were installed in 1965 in Kaunas and Kedainiai districts in the centre of the country, where, for some time, domestic wastewater was used for irrigation. However, after a break-out of cholera in the region in about 1970, the construction of domestic wastewater systems for irrigation was forbidden.

During the period 1973-1985, 33 industrial pig complexes were built within the country. Irrigation systems were installed on 6 600 ha close to these complexes, using the dung as fertilizer.

The construction of irrigation systems is rather expensive, on average US$7,500/ha, because of the need to construct water reservoirs. The average cost of operation and maintenance is estimated at US$250/ha per year. Nevertheless, the construction of irrigation systems increased rapidly. By the end of 1970, water managed areas, all equipped for full or partial controled irrigation, was 5.1×10^3 ha; in 1990 it was 4.27×10^4 ha.

In the past, large (100 to 200 ha) irrigation systems have been installed without taking into consideration the boundaries of lands of former owners. As a result, many irrigation systems stopped functioning after the kolkhozes broke-up and the real owners started to work their small (8 - 20 ha) plots of land. This is the reason for the rapid decrease of irrigation in recent years: while $4.27x10^{4}$ ha were equipped for irrigation in 1990, only $8.122x10^{3}$ ha remained in 1998. The rest have been destroyed as the new land owners were not interested in usin the large, costly irrigation systems.

Salinization of soils is not a danger. In general, irrigated lands are drained as well and the groundwater level is sufficiently low.

2.3. LAND DRAINAGE

2.3.1. Land reclamation and drainage development

Land drainage has become a rather important sector influencing the whole agricultural production process in Lithuania. The $2.6x10^{6}$ ha of drained land make up 80% of the agricultural land area. Around 90% of agricultural products are produced on drained lands.

The length of subsurface drains about $1.6x10^{6}$ km. The drainage water is collected and transferred by $5.3x10^{4}$ km of open ditches and $1x10^{4}$ km of interceptor ditches, both including around $7.3x10^{6}$ different hydraulic structures.

Taking into consideration the very high value of investment in agriculture for land improvement, it is evident that the maintenance of these structures is a prime priority.

2.3.2. Administration and financing

As all land reclamation structures belonged till now to the State, the administration, management and financing of land reclamation works were the duties of the state land reclamation services. The two levels of land reclamation offices had been established for this purpose. The ownership and administration rights were delegated to the county administrations. The organisation of maintenance, reparation, rehabilitation and construction of land reclamation structures are within the responsibility of district land reclamation offices, which are in some counties actually part of the agricultural offices. All works, except some maintenance works executed under “usage agreements“, are being financed through State budget funds. Those funds are target and can only be used for the land reclamation purposes.

Since 1996 the state targeted funds for land reclamation were not used to pay the staff members of land reclamation services. They were assigned as civil servants and paid from the administration funds of county and regional governments.

A new system of drainage management and financing is being developed with contributions from all beneficiaries, as described below.

3. PRESENT STATUS OF FOOD

3.1. CONDITIONS FOR THE PRODUCTION

Lithuania is one of the northern European countries. The warm period of the year when cultivation of crops takes place (+6C and above) normally lasts for five months. The cultivation of some vegetable and flower species, which are of greater value, can continue for longer periods in glasshouses.

Lowlands, which are the larger part of Lithuania, are separated by upland hills (the highest 292m), form several north-south stretches. Hilly areas occupy about 20% of farm lands; farming conditions are rather poor here, especially with the soils being constantly exposed to erosion.

The weather in Lithuania is unstable with frequent thaws in winter and cloud, damp, cool weather in summer. The average annual temperature is about 6C. Extensive rainfall tends to interfere with harvesting both in early summer (fodder grass) and in autumn (cereals, flax, potatoes, etc.). However, recently, extremely dry periods have occurred, particularly in the spring, which have had adverse effects on the growth of early planted vegetables.

Different types of soils can be found in Lithuania. Low fertile acid soddy podzolic sandy loams as well as sands and drained soddy podzolic gleys account for 63%. Fertile soddy calcerous soils, predominantly loams and drained soddy gleys cover 26% of the area. The rest is occupied by boggy, riverside and some others types of soils. The most productive soils are found in central Lithuania. The western part is mostly covered with humid acid soils, whereas sandy hilly woodlands prevail in eastern Lithuania, which results in rather poor conditions for farming. With the bulk of the very humid lands having been drained, spring work can be started earlier and higher yields can be obtained and processed into quality produce.

The area of the Republic of Lithuania is $6.53x10^{6}$ km^{2}. Farm lands cover 53% of the total area of Lithuania, with arable lands and grasslands accounting for 73 and 11.2% respectively, the rest is occupied by orchards (1.1%), roads and area under buildings (2.9%), forests and water (4.9%), slopes, sands, shrubs, area being improved, etc. (6.9%).

In Lithuania normal growth conditions are ensured for grains – wheat, rye, barley, oats. Corn is used for green forage, a somewhat smaller amount of forage is obtained from peas, lupine, fodder beans, vetches. Extensive areas are occupied by fodder, of which clover and alfalfa are the most important. There is also buckwheat grown increasingly. High yields are obtained from flax and potatoes. Sugar beets are delivered to local sugar refineries, fodder beets are grown for livestock. A large amount of land is under potatoes, flowers and apples. Currants, cherries and other berries, including strawberries and other fruits are grown in smaller amounts. The cultivation of mushrooms has begun and increased during past few years.

Livestock products and grain play the most important role in agricultural production. The bulk of harvested grain produced is fed to animals. A large number of cattle is raised for milk, beef and dairy products. Pigs and poultry, particularly hens, are raised for meat and eggs. Fewer sheep are kept and more goats have been kept recently.

According to the data of the Statistics Department, animal production accounts for about 60% of agricultural production. Half of it consists of cattle, swine and poultr. The other half are dairy cattle and poultry for eggs. The greater part of plant production consists of grains, potatoes, fodder plants, such technical crops as sugar beet, flax, rape, vegetables, fruit and berries, which are much the smaller part.

According to the statistical data of January 1, 1999, farmers work 37.4%, agricultural partnerships, other agricultural enterprises 12.9% and other users 16.2% of the agricultural land.

Only half of the now existing agricultural companies (partnerships) are still operational.

Actually there are too many small–scale farms in Lithuania where farming is hardly efficient in comparison with that of medium to large–scale farms. The average size of the farm was the precondition of the land restitution model adopted in Lithuania, where successors had been able to divide former farms. The actual size of an individual holding is around 7.5 ha. But this figure does not correspond to the average figure for operating farms. It is known that farmers take some land on lease, so they actually work 17 to 18 ha of land on average. The land market in the coming years should increase the movement of land which will result in larger farms. This process is already going on in Lithuania.

It is easier for farmers to work when they form co-operatives. In co-operatives they can manage better with the technology they have and can buy new technologies cheaper, and market their products more efficiently more quickly. Lithuania is only at the beginning of agricultural co-operatives. In 1997 there were 184 agricultural co-operatives in Lithuania, and only a small number of them were specialized: plant growing or plant and cattle (mixed), or providing to plant and cattle enterprises. It is foreseen that there will be co-operatives involving enterprises for processing farm products in the near future.

3.2. THE MAIN FOOD PRODUCTION SECTORS

3.2.1. Grain crops

Grain crops occupy most of the arable land. They occupy approximately 43 to 48% of the total crop area. The annual grain harvest averages from 2.7 – 3.3×10^6 tonnes per year, with 2.4 to 3.2 tonnes per ha. The annual internal needs for food wheat and rye is only about 400 tonne, the rest being exported or fed to animals. Supply to the international grain market is difficult because of low prices and the need to subsidise exports. The trend of the State policy for the coming years is to stop supporting farmers through price but rather to introduce a direct payment support system. Most grain should be oriented towards feed grain. An increase in efficiency is a prerequisite for profit with grain crops.

3.2.2.Potatoes

In Lithuania potatoes have been highly valued and regarded since olden times. The area under this crop in 1997 accounted for 4.7% of the cropland. Their yield in 1997 was 15.1 tones per hectare. The total potato harvest was 1.8298×10^6 tonnes. Potatoes can be cultivated without irrigation under local conditions. The trend is to introduce high efficiency technologies to reduce production costs and increase farm profits with this crop.

3.2.3. Sugar Beet

Sugar beets used to cover 1.4 – 1.6 % of the total area in crops. In 1997 the sugar beet harvest was 28.4 t/ha and the total yield made 1.0019×10^6 tonnes. Sugar beets are grown in the central part of Lithuania where soil conditions are considered good for this crop. Irrigation is not required for sugar beets.

The sugar is being one local product regulated by the State. Production is expected to be maintained at around 1.1 to 1.2×10^5 tonnes of sugar which require around 9 to 10×10^7 tonnes of sugar beets. The private owners of the four sugar refineries have plans modernize the process to reduce production costs. Thus, sugar should be easier to market abroad.

3.2.4. Vegetables, mushrooms, fruits, flowers

The area occupied by vegetables makes more than 1% of total area under crops. There are over 50 species of vegetables and spice plants grown in Lithuania. Vegetable production amounts to 2.6×10^5 tonnes in less productive years and up to 4×10^5 .tonnes in more productive years. At present the demand for vegetables is being satisfied 60% from open fields and greenhouses satisfy only 15% of the demand. The rest is imported by private businesses.

Cultivated mushrooms (field and oyster mushrooms) are also grown in Lithuania. More than 100 farmers are engaged in growing mushrooms.

In 1997 gardens and berry plantations occupied 3.85×10^4 ha. In productive years the fruit and berry harvest exceeds 2.7×10^5 tonnes.

Flowers are grown both in the open and under cover. In greenhouses cut flowers such as roses, chrysanthemums, freesias, orchids and potted flowers such as cyclamens, azaleas and gloxinias are grown. Tulips, gladioli, daffodils, lilies are grown outside. The most popular are bulbous flowers.

Irrigation is a rather important precondition for the commercial cultivation of vegetables in Lithuania. The new farm structure requires new, mainly small-scale irrigation systems. The water resource potential is sufficient enough to develop this type of farming. The main problem here is the need to invest in modern horticultural technologies and irrigation techniques.

3.2.5. Cattle

Cattle husbandry is the main branch of animal husbandry in Lithuania. This supplies milk and most meat. The country is fully sufficient in meat and dairy products and exports about half its production. The dependency on prices in the external market is rather high and the State is obliged to maintain export subsidies.

The Lithuanian meat and dairy industries are in the process of modernising their technologies in order to be certified as exporters of their products. The marketing and intervention institutions have been settled to assist local producers.

The water resources available in Lithuania are sufficient in quantity and in quality to develop this sector.

3.2.6. Swine

Pig breeding is the second major branch of animal husbandry in Lithuania. In 1998 the number of pigs was around 1.1×10^6 and was only 41% of the swine kept before rather large reduction in production caused by the lack of market and low producer prices. Traditional Lithuanian pork products do have not too much prospects because of the situation in the world pork market.

At present there are 33 large pig complexes built earlier, producing annually from 1.2×10^4 to 5.4×10^4 pigs per year in addition to many small producers. The big complexes still cause considerable environmental problems in managing their wastes. The actual environmental regulations are, however, rather strict forcing the industrial and farm units to consider the environmental concerns.

3.2.7. Poultry

Poultry is the third major branch of animal production in Lithuania after cattle b and pig breeding. Hens are raised mainly for eggs and broiler type chicken for meat. In 1997 annual egg production on average was 258 eggs per laying hen in the agricultural joint stock company poultry yards. In the near future the total number of poultry should stay around 1.3 to 1.5×10^7, which could give the country sufficiency in these products. Competition in the market of poultry meat is, however, rather high and the production level will depend significantly on the ability of Lithuanian producers to compete with imported suppliers.

3.2.8. Fodder production

The area sown to fodder crops accounts for about 2/3 of the total farmed land. Approximately 35 to 40% of the food required by livestock is given in concentrate form. Concentrates include spring grain and legume crops, combined feed: protein, mineral and vitamin supplements, cake and sugar beet pulp. It accounts for 85 to 100% of pig and poultry diets. In the Lithuanian Grain Processing Enterprises $5x10^{5}$ tonnes of compound feed are produced. The capacities of these enterprises are five times more important than the concentrate enteprises.

The production of fodder depends on the trends of development of livestock. The potentials are, however, rather good. Irrigation is not required too much to produce fodder but satisfactory drainage creates rather good conditions for these cops.

4. PRESENT STATUS OF RURAL DEVELOPMENT

The population Lithuania is $3.7x10^{6}$ (1995), of which 28% is rural. The average population density is 57 inhabitants/km^{2}, but varies from 28 in the Utena district to almost 95 in the Vilnius district, where the capital Vilnius is located. Annual population growth was only 0.2% in 1993, while in 1994 and 1995 there was even a population decline of 1%. Actually this ratio is rather stable

About one-third of Lithuania's population lives in rural areas. The rural population is $1.1788x10^{6}$ in a total population of $3.704x10^{6}$. In 1998, about 22% of the total labour force was engaged in agriculture, including forestry, and agriculture accounted for an estimated 11% of the GDP. The proportion of rural population slightly increased during the transition period. The average rural income is only 70% of the average urban income. In the former period, development policies were focused on urban industrial areas. Basic services such as water supply, sewage systems, and telecommunications were well developed in larger villages but not in the countryside. There has been only limited improvement and maintenance of that infrastructure in recent years. Despite the shortcomings of the infrastructure, rural areas in Lithuania have the potential to develop viable local economies. The privatization, and the transition in general, has already resulted in a significant increase in rural trading service and small-scale production activities.

Adjustment in the agricultural sector, in particular land reform, has boosted employment in rural areas. However, many of the new jobs created have had the effect of creating under-employment, so they are likely to prove only temporary as the sector modernizes and adapts to a more competitive market environment.

During the former period, little attention was paid to environmental issues. Although the agricultural sector cannot be considered as a major source of environmental damage, the rural environment in Lithuania shows serious environmental degradation. The main damage was done by large-scale animal production units contaminating groundwater sources in many areas due to the lack of adequate facilities and use of wastewater. The decline in agricultural production resulted in the closing of some of these large-scale livestock complexes and reduced this type of pollution considerably. Yet other environmental concerns remain, such as soil erosion and compaction, due mainly too heavy machinery and inadequate farming practices. In northern Lithuania in particular, water and wind erosion continue to be a major cause of concern, especially in environmentally sensitive areas. It is estimated that almost 20% of agricultural land in Lithuania is subject to some degree of erosion. Excessive use and misuse of fertilizer and chemicals in the past have also caused environmental problems. However, the dramatic decline in the use of these inputs during the transition period has resulted in positive environmental consequences.

The majority of experts have evaluated the current ecological situation as satisfactory and have evaluated drinking water quality as satisfactory. All reported that the worst drinking water quality was in shaft wells which are common on countryside farms and in towns close to individual houses. In many cases there are individual gardens, heavily fertilized, close to those wells. The quality of artesian water wells is in general better.

The quality of river water was assessed as the worst. At present they are mostly polluted by industry and waste waters. The impact of agricultural production has decreased due to the reduction in use of fertilizers and pesticides. The water situation in lakes was evaluated as the best. The situation in the Baltic Sea was assessed as satisfactory.

5. FUTURE SCENARIOS AND AIMS

5.1. FOOD AND RURAL DEVELOPMENT CONCEPT

The Lithuanian rural policies will be based on developing agriculture as a sustainable sector taking into consideration the rural population development trends. The share of rural population involved in agriculture will have to decrease about half during the coming period of 10 to 20 years as the result of the establishment and modernisation of new private farms. Employment in the countryside will remain a major issue. The national policy thus will be based on integrated rural development taking into consideration new business development, the use of natural resources in a sustainable way, development of agroenvironmental programmes and supporting measures.

The Lithuanian desire to join the EU in the near future is defining our main policies. The agricultural sector will be oriented towards modernization, efficiency and sustainability. That will require investment in farm infrastructures and the maintenance of investments. Another sector is land reclamation which will remain rather important in developing modern agriculture.

5.2. LAND RECLAMATION INFRASTRUCTURE DEVELOPMENT TRENDS

The development of land reclamation systems will be directed towards the following:

- maintaining the drainage area: *new drainage systems could be built with State funds only in exceptional cases and only for the market oriented farms*;
- priority works will be the maintenance and rehabilitation of existing drainage systems and hydraulic structures in the areas used for agriculture;
- the first step in the privatisation of land reclamation systems and structures should be started;
- establishment of users' associations and the improvement of management should take place;
- new principles for the financing of land reclamation including the contribution of all owners and users will be introduced; and the
- renaturalisation of some unproductive drained lands will be started.

5.2.1. Development of ownership of land drainage systems and structures

The ownership of land reclamation systems and structures should be revised. These include people, legal entities, state or municipalities, all of whom could be named as owners of land reclamation structures. In revising the ownership rights the scale of engineering structures should be taken on consideration as follows:

- principal ditches and collectors which serve groups of users as well as the structures considered as dangerous, should remain the ownership of the state. They should be maintained with state funds. The county land reclamation services should administrate them. *The Ministry of Agriculture should establish the criteria to be used to list the structures maintained as state ownership.*
- drainage systems and clearly defined parts of systems draining the lands of private owners should become their property. That will motivate owners to take care of, maintain and repair them with minimum funds. The privatisation of those systems and structures will start after the preparation and introduction of the needed legal basis. The process of privatisation of

drainage systems and structures should have started a few years ago when land reform was started. Unfortunately it was decided to wait till the land reform finished in the whole of Lithuania. Actually it is not considered as being the most appropriate solution. It is difficult to predict when the real end of land reform will be, or when the land will stop moving from one hand to another, as the land market should be active until some farms become larger and others stop their farming business and sell their land.

The privatisation principles will be discussed and will be the subject of amendments to the Land Reclamation Law.

It is evident that many farmers will lease land from other owners. The special agreement procedure must be adopted to rent with land and the land reclamation structures which are part of many properties. This kind of renting agreement will define to the renting farmer his obligations to maintain the structures and his other responsibilities.

5.2.2. Associations of drainage users

Drainage systems in Lithuania were mainly built during the period of large collective farms and therefore are large. In re-establishing the ownership of land, the boundaries of properties do not correspond to the boundaries of drainage systems for they usually serve the lands of several farmers. It is impossible to separate them. This complicates the task of management, maintenance works and definition of responsibilities of farmers depending on the same drainage system.

A model association of drainage users is under development. It is not a very simple task. The model of some European countries with rather old traditions of water management associations can not be simply transferred to Lithuania. Specific conditions must be taken into consideration. The psychological aspects are very sensitive following the long period of s collective farming. People are afraid of different forms of co-operatives which plays an important role in establishing associations of drainage users in Lithuania.

The draft proposal for a Land reclamation Law is under preparation and includes all the necessary legal background to establish associations of drainage users. A pilot association will then be established to test the model and to adopt a final version of the law.

5.2.3. Development of financing for land reclamation works

Privatisation and the establishment of associations of drainage users will be successful only with a complex development of a flexible model of financing for land reclamation. Owners and users must be responsible for some of the funding for land reclamation structures.

The Lithuanian farmers are not strong enough to take charge of all costs themselves. They are now just getting ownership of their land and have to build up their farms first. It is evident that in the initial stage the State must subsidise the land reclamation works. The idea is that owners and users of drainage systems must take most of the maintenance costs from the beginning, but the State budget must support farmers with funds for the reparation and rehabilitation of drainage systems, as these works are rather complicated and costly. Later, with a gradual increase of contributions from users, there can be a decrease in State subsidies.

There are big discussions concerning the allocation of State funds for the construction of new drainage systems on new private farmlands. The total drainage area in Lithuania is large and therefore the State should not finance the reclamation works of new land. Practically, there are cases when some new farmers have a very strong interest in draining a few hectares because their property is not well suited for agricultural production. The new strategy will define the participation of a farmer in investment and the contribution from State funds.

5.2.4. Naturalisation of drained areas

The intensity of land use changes after it becomes private. In some less favourable agricultural areas of Lithuania there are those lands which have been drained previously, but not being used intensively for agricultural production. Some plots contain drainage structures already depreciated or functioning improperly. The rehabilitation of these plots would be rather costly and the investment would not be recovered by output from the land. Much of this land could be left aside. Their naturalisation is related to the intention of owners. The State is going to establish the procedures to motivate people in less favourable areas "to produce nature" in place of producing agricultural products. This motivation is related to the economical tools of compensation, which have yet to be prepared.

The task of our engineering service dealing with the problems of land reclamation is to identify the plots for naturalisation and to separate them from the functioning drainage systems in order not to damage them when the ground water level is raised. The Ministry of Agriculture is ready to prepare the method of evaluation of drained lands which could be naturalised as well as to establish a technical guide for separating such plots from functioning drainage systems. It is important, however, to know the willingness of people to agree to such a proposal.

6. CHALLENGES FOR THE FUTURE

The country is in the process of formulating its vision for the future of rural development. It is evident that this process should be based on an integrated rural development effort. In order to achieve this, short term, mid term and long term vision documents are proposed.

The short and mid-term visions are based on the necessary steps to achieve the long term goal. Land reform is expected to be accomplished by the years 2000-2002. The reform of agriculture and the whole rural sector will be directed towards modernisation and sustainable development.

The long term vision is based on the sustainable development of a rural society and rural natural resources. Agriculture will maintain its share of about 10 to 15% of the GDP. Food self-sufficiency will be ensured and the export of meat and dairy products will take place according to the production level. Competitive agricultural and processing industries will participate on an equal basis in the international market which is becoming more and more open. The rural policy will be based on the sustainable efforts of the preservation of water resources, biodiversity and methods of saving the environment by the activities of rural businesses. Lithuania should expect to be part of the European Market and have its rural policy harmonised with the that of Europe.

Water resources should be protected against pollution and saving methods introduced later. The availability of renewable water resources is a precondition for the sustainable development of the rural economy.

The National Agriculture Development Programme prepared in 1995 and updated in 1997 has defined the main trends towards integrated rural development. The Lithuanian Rural Support Fund established in 1997 has become a support tool for its implementation. The investment support programmes toward the restructuring of agriculture will replace the income support programme, although the later is still dominating.

The following steps are important to facilitate redevelopment:

(a) 18 tabpost-privatisation programs should facilitate the restructuring and consolidation of enterprises privatised by allowing unrestricted free trade in the shares owned by workers and producers of raw material;
(b) 18 tabthe emergence of a secondary market for the shares of agroprocessing enterprises should be promoted and facilitated (including the Government's rapid divestiture of remaining state shares in food industry enterprises and the promotion of

foreign investment);

(c) 18 tabcompetition should be increased by the enactment and enforcement of anti-monopoly legislation;

(d) 18 tabstrictly enforced bankruptcy legislation should be used to consolidate the newly established private sector, especially the segment predominantly owned by processing co-operatives;

(e) 18 tabthe emergence of rural small and medium-sized agroprocessing and service enterprises should be facilitated by improved registration procedures and advice.

A new policy of integrated rural development is currently being implemented in Lithuania which is aimed at developing rural infrastructures and providing off-farm employment in rural areas. The main challenge facing policy makers in Lithuania is to develop rural policies that provide a balance of economic opportunities and social conditions without distorting market signals. The linkages between the agricultural and non-agricultural areas of the rural economy are rather important. The reform of agriculture cannot be successful without the recovery of the non-agricultural segments of the rural economy. At the same time, a prospering rural economy requires a developed and competitive agriculture. The Government needs to recognise that the rural recovery in Lithuania requires a complex and comprehensive approach which will integrate agriculture into an overall rural development strategy. Such a strategy should include specific measures based on a broader social consensus. The major components of such a program should include:

(a) 18 tabsupport for the emergence of competitive agriculture,

(b) 18 tabdevelopment of a rural service sector and industries to provide off-farm employment and an additional demand for agricultural and other products,

(c) 18 tabimprovement of the rural infrastructure, and

(d) 18 tabdevelopment of an appropriate social policy for the specific conditions and needs of rural Lithuania.

Sustainable and ecological agriculture should protect the surrounding environment. The mid-term strategy for the implementation of agroenvironmental measures are being prepared for Lithuania. It includes the preparation of a Code of Good Agricultural Practice as the tool for the reduction of pollution from agricultural sources as well as the motivation and support for developing organic agriculture.

Water resource management in rural Lithuania will be based on managing the water quality and the infrastructures such as drainage of agricultural land, irrigation schemes, waste water disposals in the settlements and other users.

In future small-scale irrigation will probably take place more spontaneously under free market forces without government promotion. At present, stronger farmers already show such initiative. They buy foreign irrigation equipment from their own resources or by with credit from a bank. Irrigation water charges do not yet exist, but agreements have to be made with the Ministry of Environment to ensure that no damage to the environment will be made.

Several wastewater treatment plants have been or are being built or reconstructed. The target is to have efficient waste water treatment units at each water using and polluting point. This will require adequate financial resources. The polluter-pays and the user-pays principles are to be applied on a larger scale in the rural areas because it is already efficient with urban water management.

The international co-operation and technical assistance projects are contributing to these developments. The international efforts are rather important in the integrated water resource management as water resources have no boundaries and efforts to sustain them should be internationally recognised and integrated.

MACEDONIA

1. OVERVIEW OF NATIONAL POLICIES AND DEVELOPMENT PLANS IN MACEDONIA

The Republic of Macedonia is a democratic country in transition, with market-oriented economy and liberal market relations.

The strategy of the economic development is based on the available resources. The natural resources of the Republic of Macedonia are characterized more with diversification than with abundance. The resources are relatively modest, but they are not a limiting factor for development.

Water as a natural national wealth and a good of common interest is a dominant priority in everyday life. Water represents a factor that to some extent determines and limits the development. The role of the state is to regulate the conditions and methods of water use, protection against harmful influence of waters, protection of waters against pollution and water resources management through the Law on Waters and other legal acts. Maintenance and improvement of water regime and planning of rational use of waters shall be carried out in accordance with the Water Master Plan of the Republic of Macedonia. The interest of the Republic of Macedonia, as a country with international waters, is to regulate the water relations with neighboring countries based upon mutual agreements.

The heterogeneous configuration, climate, soil and other factors of the environment create conditions for the existence of different ecological regions in the Republic of Macedonia from the aspect of extension, assortments of the agricultural crops and intensity in production. The agricultural land of the Republic of Macedonia is around 1.285.000 ha, out of which roughly 50%

is arable land. Private owners own approximately 80% of the arable land, and the rest is in the hands of agricultural combinates that are in a process of transformation. The present agricultural policy supports the developing concept of the agriculture in conditions of complete privatization. The global balances between the production and domestic demand show that the production structure of agriculture is oriented toward entire provision of the population with own production of food; at the same time it is oriented to produce surplus for export. The Republic of Macedonia searches its development perspective in agriculture in an emphasized exporting policy. Modernization of the production and its export orientation are those characteristics from where the credit support of the agriculture starts through foreign investments.

The rural development presents one important strategic issue in the concept of the long-term spatial development of the Republic of Macedonia. The planning concept of development of the rural areas through the Spatial Plan of the Republic of Macedonia, presents an integral concept of the Spatial development of the country. An improvement of the living conditions of the rural population through plan oriented regulation of the settlements and improvement of the communal infrastructure is a basic determination of the state.

2. PRESENT STATUS OF WATER

Available water resources :

The total water resources of the Republic of Macedonia are estimated at 6,37 billion m3 in a normal year and 4,80 billion m3 in a dry year, out of which 80% are carried in the Vardar basin. The annual resources potential per capita is of about 3.000 m3, which is on the low side but more than the potential of e.g. Germany and a number of other European countries (European average approx. 1.900 m3/capita). The main problem arising in the field of availability of water resources is the uneven spatial and timely distribution over the country, showing altogether more favorable conditions in the western part, but being characterized over all the national territory by a timely distribution which presents long drought spells and high intensity rainfalls which constitute at the same time a threat for crops and which prone erosion phenomena.

About 85% of the surface water origins in the country, while only 15% of the water is inflowing to the country from the neighboring countries.

The River Vardar catchment area covers an area of 20.661 km2, or 80,4% of the total territory of the country. The average annual volume of discharged water on the border with Greece is approximately 4,6 billion m3.

The groundwater does not have an impact on the balance of available water, but it is important because of its quality. One part of this water enriches the underground reservoirs - aquifers, mainly located in the main valleys of the country. There are no sufficient data about the available underground water by its quality and quantity.

There are three large natural lakes in Macedonia: Ohrid, Prespa and Doyran Lake. All of them are shared with the neighboring countries.

Dams and Reservoirs :

The uneven distribution of the surface water in space and time in the Republic of Macedonia, impedes to a great extent the utilization of water resources. Therefore, construction of dams and creation of reservoirs that would improve the water regime is an imperative and a key solution that will enable full and efficient utilization of water both for the needs of the water management and protection of the human environment from their harmful effects.

As to the catchment areas, 13 big dams were built in the Vardar catchment area, and 3 dams in each of the Strumica and Cm Drim catchment areas.

Currently two large dams are under construction: Koziak (114m) and Lisice (66m). Both reservoirs will supply water for several purposes.

The total volume of the water storage accounts to 1.849,55 million m3. The stored water is used for meeting the requirements of water supply for the population and industry, irrigation, production of electric power, flood control, maintaining the biological minimum, sports, recreation and tourism.

In the Republic of Macedonia there are over 120 small dams that provide water for irrigation of smaller areas, water supply of the rural settlements and local industries, and fish breeding in cages. The level of the small dams is from a few meters to 28 meters, while the volume of stored water amounts from 10.000 m3 to 1.000.000 m3.

Climate and Rainfall :

The territory of the Republic of Macedonia is under the influence of a modified Mediterranean type of climate resulting from its exposure to the Continental, Middle European and dry Easter climate influences, the influence of the mountain climate, as well as the secondary factors - relief and height (going up to 2.600m).

As a result of the climate corridors, the relief in the inland area and its high latitude, there is a great spatial variability of different climatic parameters: rainfall, temperature, atmospheric pressure, winds, shortage of moisture and other factors significant for the water regime.

The distribution of the rainfall is very unfavorable in space and time and modest in quantity as a result of the Continental climate and the Mediterranean influence. The uneven distribution in time and space results in long dry periods (summer-autumn and shorter winter period). On the other hand, the abundant rainfall appears during the period of October-December, and smaller in quantity during the period of March-May. Such a distribution of the precipitation, together with the other meteorological phenomena categorizes Macedonia as a semi-arid country. The average sum of annual precipitation in the entire Republic accounts for approximately 733 mm, with extremes varying from 500 to 1250 mm.

Water demands :

Listed demands are according to the data from 1996 :	mill m^3/year	%
- water supply of municipalities:	214	11,6
- water supply of industry:	274	14,8
- irrigation	1.155	62,6
- fish ponds	202	11,0
Total :	1.846	100

The major use-sector of the water is irrigation. The arable agricultural area in the Republic of Macedonia accounts for approximately 665.000 hectares, whilst the potential for irrigation is estimated at approximately 400.000 hectares, i.e. 60% of the total arable land.

Until now about 160 smaller and larger irrigation schemes have been built covering an area of 163.700 hectares of fertile arable land, i.e. 41 % of the area that may be irrigated.

Out of the total area under irrigation - 163.700 hectares, about 100.000 hectares (61%) are irrigated by sprinkling, and 63.700 hectares (39%) with other types of surface irrigation. Taking into consideration that the period of exploitation of the existing schemes is rather long (25-30 years), as well as that they have not yet been fully constructed, that their infrastructure has not been regularly maintained, unequally managed, out of the areas designed by the project, only 77.35%, or 126.617 hectares are actually irrigated.

Irrigation serves as a basis to reclaim agricultural potentials of the country. In order to maximize the economic effects in the future, priority is given to the rehabilitation and reconstruction of the existing old infrastructure (126,617 hectares).

Presently a Project on Irrigation Rehabilitation and Restructuring is under implementation at three large irrigation schemes in Macedonia, covering an area of 47.000 ha. Beside the physical rehabilitation of the irrigation facilities (canals, irrigation network, etc), policy reforms regarding the transformation process of operation and maintenance including overall organizational structures of the irrigation sector is being examined and will be implemented shortly. The process of participatory management is realized through the gradual establishment of water user associations.

Water is also used for energy production. Hydro power accounts for only 10% of the total energy production in the country. The hydro potential is not sufficiently developed, so the future activities should include the construction of new hydro plants.

Water quality

The water quality condition in the Republic of Macedonia indicates that the natural balance of the rivers is already largely disturbed due to the pollution which is extremely high downstream of towns, where the industries are located, and the discharging of their wastewater has significant contribution. There is a somewhat lower pollution in those sections that are passing through not so densely populated areas, but even there the pollution is higher than the admitted levels.

As annually some 550 million m3 of water are repeatedly recycled in the receiving water body, the amount of concentration of pollutants it carries increases substantially. In relation to the location, the quality of the water resources varies largely between satisfactory and poor, and at many locations the water is highly polluted. It is evident that there is a need to undertake urgent measures for improving the water quality in the country.

According to the water balance for the current condition there is sufficient water in all regions, except in Strumica catchment area (southeast part), where there is a shortage of water of about 40% in the average dry year. The only sustainable solution in order to meet the demands is construction of dams on the rivers and streams.

This sector is in the process of transformation with some unresolved issues and problems, and time will be needed to establish a system which will respect water as an economic dimension.

Drainage Systems

The need to build drainage systems been present for a long time in the regions of Skopje, Pelagonija, Struga, Strumitsa, Kochani, Ovche Pole, Prespa.

The first works were started in the area of Skopje back in 1929 and with more or less intensity have been pursued until present days in most larger valleys in Macedonia.

The drainage systems cover a total area of 82.195 hectares. The situation of the drainage systems is not fully satisfactory.

Flood Control

One of the basic water management activities of special importance for the economic and social development is the river training. Water current arrangement means undertaking such measures in the river basin and in the riverbed that would improve the flow regime of the watercourse, the situation of the riverbeds and their immediate surrounding.

Large systems for flood control have been built for the regions of Skopje, Pelagonija, Strumica and Struga. Actually one major dam is under construction which will allow a decisively improved flood control of Skopje region, namely the dam Kozjak on Treska River with a retention volume of 100 million M3 for flood control only, out of a total retention volume of 550 million m3.

Erosion and Torrent Control

Erosion and torrents are the cause for destruction and degradation of large areas of productive soil, damage and devastation of industrial facilities, irrigation schemes, hydro power systems, water supply facilities and systems etc. The destructive effect of the erosion that are manifested in losses of the bio genetic nature, soil productivity, results in low yields per unit area, as well as in unproductive and degraded soil layers.

As a result of the soil erosion, there is average annual erosion of the arable soil layer (productive land) 20 cm deep, covering an area of 8.500 ha, or 0,33% of the total area of the Republic.

The erosion also has a negative impact on the areas covered by reservoirs by filling them with erosive sediments. According to the research, the annual sedimentation of erosive sediments in the reservoirs is approximately 3.000.000 m3, which means loss of the same amount of space for water.

Taking into consideration the harmful effect of erosion, numerous protective and melioration measures have been undertaken, As a result, erosion on mountain slopes and in torrents have been reduced considerably; efforts in the field of erosion control, reforestation and torrent control have nevertheless to be continuously pursued as has been demonstrated by the dramatic effects of the rains and the floods of July-August 1995.

3. PRESENT STATUS OF FOOD

The agricultural population in the period immediately after the World War 11 accounted for 72% of the total population. In the subsequent period migration from the villages into the towns escalated, so that the percentage of the agricultural population dropped to 22% in 1981, and in 1991 it dropped further to 14,7%. According to the last census of 1994, the agricultural population accounted for 11,79% of the total population.

Around 40% of the agricultural population in 1994 fall into the category of active population and can be considered as a work force organized in agricultural family units.

The total agricultural land surface amounts to 1.285.000 ha (average 1985 - 94). Arable land accounts for 647.000 ha, and is almost entirely in the valley basins. Pastureland accounts for 649.000 ha (average 1985-94), 36,5% of which is mountain and highland pasture and approximately 63,5% on rolling hilly terrain in the valley basins.

The arable land is almost completely in the sub-mediterranean and continental agro-climatic regions, whereas pastures dominate in the mountain regions. The sub-mediterranean and continental regions are characterized by drought, which is the principal limiting factor in utilization of the potential for a wider assortment and production intensity. The irrigation systems built so far cover a total area of around 164.000 ha, out of which around 127.000 ha can be effectively irrigated for the reasons explained in Chapter 2. In the period from 1988 to 1994 on average only

50-70% of this surface was annually used for irrigated production. There exist plans for the completion of the physical infrastructure of irrigation schemes in order to allow production on some 170.000 ha. According to the Spatial Plan of RM, the total irrigation potential of the country would amount to 370.000 ha, or more than half of the arable surface.

The degradation of the soil is a serious issue, since the erosion caused by water - in a stronger or milder form is to be encountered in 37% of the territory of Macedonia. In 1993, prior to the privatization of the agricultural sector, public farms production (companies and cooperatives) accounted for 23,4%, and private farm units for 76,6% of the GNP. The public sectors share in the value of the total agricultural market surpluses (intended for export) is 67%, which is double that of private farms. The private sector owned approx. 70% of the arable land and more than 90% of the tractors in Macedonia.

In contrast to the decrease in the number of the active agricultural population, there has been an increase in the number of private farms; as a result, the average size of the land property has been decreasing: 3,14 ha in 1960, 2,04 ha in 1980 and 1,29 ha in 1994 per family farm. The properties are split into many separate plots per household (7,7 on average), each with an average size of 0,14 ha. This land tenure structure largely limits the profitability and competitiveness of the private farming units. The detailed land use is given in Table 1.

Table 1. Land use in 1997

Land Use	Status 1997 ‘000 ha	Share in %
Agricultural land, total	1285	100
Cultivated area	647	50,3 (100)
Arable land and gardens	546	42,5 (84,3)
Orchards	18	1,4 (2,8)
Vineyards	29	2,3 (4,5)
Meadows	54	4,2 (8,3)
Pastures	636	49, 7
Ponds, reed beds and fishponds	2	/

Self Sufficiency

In general, Macedonia has self sufficiency in food production. The demand is covered by import of agricultural products, and the excess production is exported. Traditional markets for the Macedonian products have, however, changed recently due to political and economic developments in the region and due to market protection measures of EU and other countries.

Trade balance in the agricultural sector is negative, the imports usually outweigh exports. It should be noted that Macedonian economy as a small and relatively closed market is heavily influenced by external trade and political developments. Macedonia is not yet a member of the WTO, but the strategic efforts of the Government are directed toward membership in this and other international organizations.

There are national stock reserves of main strategic agricultural products. They are used also as a buffer to amortize the market price fluctuations in the sector.

Land Tenure Policy

The enlargement of family farms is possible through several ways: land purchase, leasing, concessions (namely, inclusion in the processes of privatization), through association of farmers for particular production and especially through land consolidation.

Forestry

In 1979, in the Republic of Macedonia the forests occupied a surface of 905.600 ha, or 35,2% of the total territory of the country. In the mean time, until 1996, another 110.000 ha were reforested, but the results were not always successful, and they were not analyzed and assessed since.

The situation in forestry is not completely satisfactory in regard to reserves and the utilization of the estate and the wood products and equipment.

4. PRESENT STATUS OF RURAL DEVELOPMENT

In the Republic of Macedonia there are 1604 villages (census 1994) with a total number of 818.300 inhabitants. Favorable geo-morphological conditions exist in 38% of the rural settlements placed in the flat areas and in 40% of the villages located in hilly areas. Around 22% of the rural settlements are placed in complex geo-morphological conditions in the mountains. According to the available area, in the western part of the country 46%, in the eastern part 27% and in the central part along River Vardar 27% of the rural settlements are located.

The total agricultural area in Macedonia has decreased by about 250.000 ha over the last 30 years from 1,54 to 1,28 million hectares. There is also a constant decrease in the number of active agricultural population.

In a large number of the villages in Macedonia the main infrastructural problems have been resolved. Many rural settlements have connections with nearby town centers by an asphalt road (7.500 km of local roads). Large proportion of the villages have electricity, they either have own water supply or are connected to a regional water supply system; there is regular post service, access to health care etc. At the same time, the State (Government), according to its development policy, is actively engaged in provision of the rural population with all the necessary services (general infrastructure, electricity, water supply, health care, education and others). However, a great disparity between different regions and locations is notable. In most regions of the country the process of urbanization of rural settlements takes place, in other locations there is an apparent absence of a coherent development policy so that the productive and social infrastructure still shows considerable deficiencies with the consequence that people will abandon their villages and migrate to urban centers.

Concerning the education of the rural population, the number of illiterate is small. The majority has completed secondary school, and there are also a significant number of people with a university degree (further information in the statistical yearbooks of RM). However, the professional profile often does not comply with the actual needs of healthy and sustainable agricultural production, which would be necessary for sound rural development.

Commercial activities in rural areas are not very well developed, and are limited to a certain number of agricultural products, which may be sold on the local markets.

High agricultural production risks due to climate and market conditions make the economic situation of farmers rather insecure. Nevertheless, in the contrary to people who are active in the public sector and in the other parts of the economy, farmers have the possibility of subsistence production.

Present trends of social and economic development, in spite of achieved results in the agriculture and the rural areas, has allowed migration from village to urban areas to be uncontrolled and irregular. That has lead to depopulation of many rural settlements and significant increase in urban population. This was on one hand, a result of industrialization and urbanization in the towns and rationalization through mechanization of the individual farm sector on the other hand. A number of people could not commute daily, due to bad conditions of roads and means of transportation, and decided to move altogether to the nearby urban centers. Since some of them were permanently settled in the towns, they had to quit their agricultural activities, and could no longer utilize their land potential. As a result of this development, around 150.000 ha of arable land is not being used, and there is a significant decrease of heads of livestock. All this elements led to significant decrease of agricultural production.

Industrial employment opportunities are mainly concentrated in urban centers, and only few jobs exist in food processing and other industries in rural areas. This leads to a particularly precarious situation in hilly or mountainous regions where the production risks are even higher than in the valley bottoms and where the farms can hardly provide the food necessary for the family. Rural areas are large consumers of agricultural machines and equipment, fertilizers, plant protection chemicals, industrially processed food etc. Agricultural production permits the development of food processing industry and increases the scope and varieties of secondary agricultural products. Agriculture, interacting with food processing industry may constitute a significant economic factor in the region. In this context, a number of governmental institutions together with international non- governmental organizations presently work on the preparation of projects in agriculture and food processing industry, with the objective to provide new working places in the rural areas. The aim of these projects is "to integrate the production, from the traditional one to new cooperation with the modem industry".

5. FUTURE SCENARIOS AND AIMS

In principle, the water resources in Republic of Macedonia are sufficient, but in their spatial and timely distribution, not all the needs can be met. In all our considerations we have to think of the sustainability of the measures we implement.

The Water Resources Management Information System is one of the most important strategic national documents, the preparation of which is based on a modern dynamic approach and which will allow managing, developing and planning of the water resources. The project just started and it is planned to complete the basic version up to the end of 2003, while the updating of the data will be in regular time intervals.

One of the future priority activities, directly linked to the WMP is the establishing and renovation of the water resources monitoring, especially for the main surface water, cross- boundary rivers, lakes, reservoirs and underground water. The lack of underground water data should be overcome in the future, performing comprehensive investigations and researches all over the country.

The actual situation of the water management sector would be analyzed in order to define the priorities for the technical projects. First of all, the existing schemes and systems should be rehabilitated in order to achieve the designed parameters, if in the actual economic and market situation these parameters seem to be valid. Simultaneously, reforms in the management, maintenance and operation process should take place. Irrigation as the highest water user should be examined with care in order to reduce the water losses in the schemes. The priority should be rehabilitation and modernization of the existing schemes, completion of the schemes, provision of modem irrigation equipment, installation of measuring devices for consumed water and development and application of transparent pricing policies. Regarding the construction of new structures and systems, the priority should be given to multi purpose projects, which meet the demands of wider regions.

According to the opinion of some local experts, the future solutions are to be sought in the transfer of waters from one into another catchment area. Whether this is the best solution for Macedonia, or the development of the economy and populations in this region is to be downgraded, must be a subject of an extensive technical, economic, sociological and financial analysis and eventually be part of a political process. The nature does not forget the mistakes made in the global water resource planning, and the future generation would have to pay a very high price.

Since the availability of water resources is very limited, the water quality and preservation of a clean and healthy environment constitutes an important goal of the water management. High priority should be given to the measures and activities regarding the water quality protection, including relevant measures for the protection of catchment areas and against soil erosion.

They should be economically justified and be implemented in a sustainable organizational setup in order to achieve required goals.

The development of the water management in the Republic of Macedonia should follow the positive examples of the developed countries in order to rise up this sector from the margins of the economy currents. Whereas so far the engineering capacity of our staff is very well developed, the management capacity does not keep pace with the requirements. The management professionalism has a high need for upgrading.

Public awareness that water has an economic value and that everyone should pay for the consumed water, still is very low. Public campaigns or other appropriate measures are to be carried out in order to strengthen the public awareness of the importance of water.

In the period of accession of the Republic of Macedonia to the European Union, the harmonization of the Macedonian legislation with the one in the EU, concerning water quality and environmental protection, has to be achieved. The long term objective of the water sector for the year 2025 will be the full implementation of the set standards.

Production and demand of agricultural products now and in the year 2025

The present growth rate of the population in Macedonia is estimated by the Republic Statistical Institute to be 1,0065 annually. If this trend continues in the future, the total population in Macedonia in 2025 will be around 2.350.000. The forecasts for the food (agricultural products) demand for the future period are based on this assumpted growth rate.

The future orientation of the agricultural production will be toward meeting the domestic demand, and also toward export products. The second development alternative gives better results in this respect. The export surplus of apples, grapes and vegetables will be 2/3 of the production, as well as 90% of the vine produced. The production and export level of lamb and eggs will remain more or less the same, and the production of beef and milk will be balanced with the demand, thus achieving 100% self-sufficiency. Increase of tobacco production and export is also foreseen.

The Republic of Macedonia has a relatively dry climate and the existence of irrigation systems in number of regions will ensure stability of water supply for the agriculture. This is very important since agriculture is an important sector of the economy of the country. Particularly, if the projections of the global warming are correct the possible effect on Macedonia as a temperate region will be an increase of the hydrological and climatic extremes. Having already a large spatial and seasonal variation in the water resources availability, proper water resources policy in irrigation systems development is a must.

Another important issue of the water resources development in the agricultural sector and the country in general is the protection of the environment. Therefore the further development should take under scrutiny all projects in order to safeguard the environment and the water resources and provide sustainability.

Sustainability has to be obtained not only in an environmental sense. There is also technical, economical, political and financial sustainability of development projects and it has to be preserved. One of the issues that has to receive utmost attention in the future is changing of the attitude of the general public and the agricultural producers that the water is a common good free of charge. The water is an economic good and the costs for providing it have to be recovered.

Therefore, the full cost recovery principle must be implemented in the future to secure sustainability of both the water infrastructure and involved institutions on one hand, and the environment and the future generations on the other hand.

The development strategy in the forestry sector is to increase the intensity of utilization by improvement of the forest structure and increase in the forest areas. This development strategy *ll also have positive effects in reducing erosion. In the timber industry modernization of the existing capacities is expected.

6. CHALLENGES OF THE FUTURE

One of the most important goals of the Republic of Macedonia is the preparation for integration into the EU. This political option creates a number of problems that result from the differences in policies, in the legislation for water management, environmental protection and regional development which all have to be aligned to EU standards and regulations.

The short and mid term vision of development in the water management sector will be precisely described in the new digitized Water Master Plan which is under preparation. It can be expected that this tool will allow to solve the most important questions of water allocation, development of agriculture and rural development.

In anticipation of the increase in water demands by all sectors it is of prime importance to reduce the losses in the water supply networks and think about possibilities to transfer water from the western parts to the eastern parts of the country.

Irrigation is a key factor for the Republic of Macedonia to utilize its resources and, thus, gain comparative advantages in agricultural production. In the Public Investment Program (PIP), prepared by the Government of Macedonia and water management as a whole and irrigation particularly are treated as priorities in directing the investments.

In regard to the use of water, public awareness as to quantitative and qualitative aspects has to be created or raised by means of public campaigns or other appropriate measures. People must understand and accept that water is an economic and public good which has a price; whoever consumes water has to bear the full costs including the operation and maintenance costs for the delivery system, as well as the external and opportunity costs. In the same spirit whoever contributes to its deterioration has to bear the full costs for re-establishing the previous quality.

Macedonia is a small and relatively closed market, and as such it is depends strongly on external trade relationships. In order to intensify international trade relationships, the Government follows the strategy to tie links to international organizations and is actually negotiating membership in WTO (World Trade Organization).

Presently the country is facing important problems relating to the ownership and utilization of the land. Processes have been initiated to introduce private farm management into state-owned agricultural combinates by means of concessions and privatization; it is expected that these measures will lead to a more rational and sustainable utilization of the land, of the machinery and labor and that overall efficiency will be increased. These processes stand at their beginning and are far from being achieved. The reform in the agricultural sector cannot be successfully done without an improvement (qualitative and quantitative) of non-agricultural segments of the rural economy.

Presently the Government of Macedonia, supported by different research institutes is reflecting on a strategy for sustainable development of the rural society and the steps to be taken in order to implement it.

The following issues will be in the center of interest of Macedonia in the coming 25 years :

- Reconstruction and rehabilitation of the existing water supply systems which will allow a reduction of the losses to 15-20 %;
- Extension of the existing local and regional water supply systems and construction of new ones;
- Completion, reconstruction and rehabilitation of large parts of the existing irrigation schemes with a particular emphasis on the increase of the water efficiency;
- Establishment of sustainable procedures for operation and management of irrigation schemes and water supply systems;
- Construction of new irrigation schemes in reference to the evolution of the internal and external market for irrigated crops;
- Construction of sewerage systems and waste water treatment plants for the major cites, rural settlements and industry accompanied by the introduction of the "polluter pays principle";
- Improvement of solid waste management in economical and ecological terms;
- Safeguard of surface and groundwater quality by the establishment of protection zones and monitoring networks;
- Identification and implementation of an efficient balance between public and private management in agricultural production;
- Identification and implementation of organizational structures in the water management sector which are able to react in an appropriate manner to internal and external modifications of the framework conditions;
- Giving the uncultivated arable land on private farm management by means of concessions, leases and other forms;
- Strengthen the agricultural production so as to cope with domestic demands and allow for an increase of export and obtain a positive trade balance for agricultural products;
- Implementation of a land consolidation program, thus providing the agricultural producers with a more stable and favorable economic status;
- Improvement of public and private services in all sectors of rural life;
- Creation of favorable conditions for diversification of activities in the rural areas (agro and food processing industry, tourism, hunting, fishing etc.).

MALAYSIA

1. PRESENT SITUATION - WATER

1.1 Malaysia receives an annual average rainfall of more than 2500 mm, mainly due to the Southwest and Northeast monsoons. The country is therefore rich in water resources when compared to the other regions of the world. The average annual water resources on a total land mass of 330,000km^2 amount to 990 billion m^3. Out of which, 360 billion m^3, or 36% returns to the atmosphere as evapotranspiration, 566 billion m^3, or 57% appear as surface runoff and the remaining 64 billion m^3, or 7% go to the recharge of groundwater. Of the total 566 billion m^3 of surface runoff, 147 billion m^3 are found in Peninsular Malaysia, 113 billion m^3 in Sabah and 306 billion m^3 in Sarawak.

1.2. Water is used for a variety of purposes. Consumptive water use is largely for irrigation, industrial and domestic water supply and to a minor extent for mining and fisheries. Instream water uses which are non-consumptive in nature include hydropower, navigation, recreation and fisheries.

1.3 Irrigation water demand which totalled 9.0 billion m^3 in 1990 accounted for about 78 % of the total consumptive use of water. Until 1960, irrigation schemes were designed for single crop rice production during the wet season as a supplementary source of water supply. Since then, irrigation development has rapidly expanded into the double cropping of paddy to meet the dual objectives of increasing food production and to raise the income levels of the farmers. There are some 564,000 hectares of wet paddy land in Malaysia, of which 322,000 hectares is capable of double cropping. Farmers in irrigation and drainage areas are required to pay water rates ranging from RM 10-15 per ha which represent less than 10 % of the annual recurrent operation and maintenance cost.

1.4 The present domestic and industrial water use is estimated to be 2.6 billion m^3/year accounting for about 20 % of the total water consumption in 1990. At this level of utilisation, about 78% of the total population are served by public water supply, with a service factor of 96% for urban areas and 66 % for rural areas. Due to the rapid population increase and the growth of industries, the annual water demand has been expanding at about 12%. In rural areas, the main problem of water supply is related to the availability of suitable sources in terms of quantity and quality. In urban areas, many water supply systems are overloaded due to rapid growth in demand. Generally, water tariffs (at about RM 1 per m^3) are low and hence are unable to generate sufficient revenue to cover the full cost of capital investment and, operation and maintenance.

1.5 With accelerated urbanisation and industrialisation, the demand for power has been increasing rapidly. In 1993, the annual output of hydropower totalled some 4,500 Gwh accounting for about 16 % of the total power supply in the country. The total hydropower potential for the country has been estimated at 123,000 Gwh of which about 85% are found in the States of Sabah and Sarawak.

1.6 Mining and fisheries are minor water consumers. Navigation and fisheries are generally of local importance except in certain areas where rivers still form the major means of transportation. With rapid urbanisation and improvement in the standard of living, water for recreational purposes is in greater demand. Water quality is rapidly becoming an important concern as a direct consequence of accelerated economic development in the past two decades. In 1994, a survey by the Department of Environment revealed that out of 116 rivers monitored for pollution, 14 were found to be badly polluted, 73 slightly polluted and 38 rivers fall under the clean category. The overall trend of river water quality has shown a deterioration at a rate of 0.55 %.

1.7 The Government is primarily responsible for the planning, development and management of water resources projects in the country. For this purpose, there are a number of government departments and agencies each responsible for a particular component or function related to water resources but there is no single agency entrusted with the overall responsibility of holistic planning and management. For example, the Department of Irrigation and Drainage is responsible for the implementation of irrigation and drainage works, the Public Works Department for domestic and industrial water supply and Department of Environment for water pollution control. Conflicts in water resources management such as allocation of water rights, flood management, pollution control, environmental preservation, etc are resolved through inter-agency coordination and consultation. The primary role of water resources management is expected to come from the state governments and their agencies since ownership and administration of water is a state matter under the Federal Constitution. There are weaknesses in the current legal and institutional framework for the integrated planning and management of water resources both at the state and federal levels.

2. PRESENT SITUATION - FOOD

2.1 Prior to 1990, agriculture has been a major contributor to the economic growth of Malaysia. With the shift of economic policy towards industrialization since the mid 1980's, investors tend to invest more in industries rather than agriculture, resulting in the declining share of the agricultural sector in the GDP of the country. The agricultural sector also faces an acute shortage in labour due to the generally better incomes from working in factories and other industrial and commercial ventures. This has resulted in a gradual increase of non-planted or idle paddy land in many irrigation areas in the country.

2.2 As the nation develops, it is only natural that people look for better quality of life which includes amongst other things, higher quality and more nutritious food. The local production of food has increased at about 4.2 percent per annum during 1985-1995 period. But this could not meet the increasing local demand for food resulting in a steady increase in food import since 1990. In 1997, total food imports amounted to about RM10.0 billion, as compared to RM4.6 billion in 1990. However, as a result of the economic slowdown affecting the South East Asian nations, the Government of Malaysia has put a renewed emphasis on food production to cut down the outflow of foreign exchange for import of food. Major food imports include wheat, maize, sugar, rice, dairy products, fish, fruits and vegetable and meat products.

2.3 In Malaysia, there has been a long history of planting rice under rainfed conditions in pocket areas located along the flood plains of rivers. In the early 1900s, large scale irrigation systems were first introduced, notably in the Kerian Irrigation Scheme and the Wan Mat Saman Scheme. In 1932 the Department of Irrigation and Drainage (DID) was established and together with the Department of Agriculture (DOA), formed the prime movers of organized and systematic irrigation development in the country. These include the development of new areas as well as upgrading of existing schemes. In the 1960s, double cropping was widely introduced to meet the twin objectives of increasing food production and income levels of the rural poor. Water resources development became an important component of irrigation projects with the construction of storage dams, barrages and pumping stations, followed by extensive network of irrigation canals, drains and farm roads.

2.4 In the 1980s, the Government took a bold decision to confine further irrigation development works to the eight major granary areas of the country. Irrigation and drainage facilities were intensified and extended to the tertiary level to improve on-farm water management to enable the cultivation of high yielding varieties of rice. This period also saw the successful introduction of farm mechanization, and the rapid replacement of labour-intensive transplanting to direct seeding methods. In the 1990s, major efforts were made in the upgrading of infrastructures to support farm mechanization and direct seeding, including improvement to farm roads, field drainage and land levelling. Estate type management for more organized and economic operation as against individual farmer operation was promoted. At the same time, some of the smaller irrigation schemes which are unattractive for rice cultivation are encouraged to diversify into alternative non-paddy crops and aquaculture.

2.5 The total physical paddy area (covering irrigated and non-irrigated) in Malaysia is about 598,483 ha in 1993. About 322,000 hectares or 48 percent of the total paddy areas in the country are provided with extensive irrigation and drainage facilities while the remaining are rainfed areas (see Table 1) . Of the irrigated areas, 290,000 hectares are found in Peninsula Malaysia, 17,000 hectares in Sabah and 15,000 hectares in Sarawak. About 217,000 hectares of the irrigated paddy areas in Peninsular Malaysia have been designated as main granary areas while another 28,000 hectares located all over the country are classified as mini-granary areas (see Figure 1). The paddy growing area is expected to decline with time as a result of conversion of paddy land for other landuse including urbanisation. It is forecasted that paddy growing area will decline to about 475,000 ha in the year 2005 and 450,000 ha by the year 2010 (see Table 2).

2.6 The total paddy production increased from 1.7 million tonnes in 1985 to 2.1 million tonnes in 1995 while the average yield per hectare per season increased from 2.7 tonnes in 1985 to 3.2 tonnes in 1995. The eight main granary areas which accounted for 72 percent of the total paddy production recorded an increase in yield per hectare per season from 3.3 tonnes in 1985 to 4.0 tonnes in 1995.Over the 1985-1995 period, domestic production accounted for about 77 percent of the total domestic consumption. In 1995 the importation of rice amounted to 427,570 tonnes valued at RM356.1 million. However, the per capita consumption of rice has declined from 102.2 kilogram in 1985 to 86.9 kilogram in 1995.

2.7 The cultivation of rice has always been accorded special emphasis based on the strategic importance of rice as a staple food. Massive public investments in infrastructure and support services were made and various price/income support measures were provided to sustain a reasonable level of profitability or income to the rice farmers. The Government sets a floor price for paddy in addition to price and fertiliser subsidies. As of January 1998, the floor prices for Grade I and Grade II paddy is RM555.00 and RM517.00 per tonne respectively. The price subsidy is set at RM248.10 per tonne irrespective of paddy grade. Finally, fertiliser subsidy at 300 kg per ha is available to farmers with farm holdings of less than 2.43 ha.

2.8 In Malaysia, paddy is produced mainly by small holders with an average farm size of about 1.06 hectares. There are approximately 296,000 paddy farmers of which 116,000 are full time farmers depending on paddy cultivation for their livelihood. Sixty five percent of the paddy farmers have farms of less than one hectare while only four percent have more than three hectares.

2.9 The fruit industry is a small holder based industry involving 270,000 farmers. In 1995, the area under fruits was 257,600 hectares out of which 86,210 hectares were planted on a commercial basis (see Table 3). For the 1985-1995 period, the production of fresh fruits increased at the rate of 4.8 percent per annum from 638,100 tonnes to 1,019,900 tonnes. Exports of fresh and processed fruits increased from RM182.4 million in 1985 to RM335.6 million in 1995, while imports of fresh and processed fruits also increased from RM257.2 million in 1985 to RM444.3 million in 1995. Overall, Malaysia is still a net importer of fruits and fruit products. Most of the raw materials required for processing are outsourced from other producing countries due to the lack of comparative advantage in producing fruits for processing.

2.10 The area under vegetables cultivation has increased from 31,840 hectares in 1985 to 42,240 hectares in 1995 (Table 3). The production of vegetables has increased from 540,700 tonnes in 1985 to 718,100 tonnes in 1995 at an average growth rate of about 2.9 percent per annum. The export of vegetables has increased at the rate of 15.2 percent per annum from RM39 million in 1985 to RM160 million in 1995 while the value of import has increased from RM276 million in 1985 to RM685 million in 1995. Hence, Malaysia is also a net importer of vegetables and vegetable products.

3. FUTURE SCENARIOS AND AIMS

3.1 The growth of population and the expansion of the industrial and manufacturing sector have led to a rapid increase in water demand in the country. The domestic and industrial water demand has increased from about 1.3 billion m^3 in 1980 to 2.6 billion m^3 in 1990 and is projected to reach 4.8 billion m^3 by the year 2000. The irrigation water demand is increasing less rapidly from about 7.4 billion m^3 in 1980 to 9.0 billion m^3 in 1990 and is expected to reach 10.4 billion m^3 by the year 2000. The aggregate total water demand is therefore estimated at 15.2 billion m^3 by the year 2000 as compared to 11.6 billion m^3 in 1990 with the domestic and industrial water supply sector registering the highest percentage increase.

3.2 The domestic consumption of rice is projected to increase from 1.8 million tonnes in 1995 to about 2.3 million tonnes in 2010 as a result of population increase despite the declining per capita consumption of rice. Under the National Agricultural Policy, the local production of rice is expected to meet about 65 % of the domestic demand. The increase in production is targeted to come from higher productivity in the existing granary areas since there is no plan to increase the area under paddy cultivation. In fact, the MUDA granary area (97,257 ha) has experienced a loss of about 3 % of its irrigated area as a result of conversion to urban land use during the past 20 years and is projected to lose another 3 % by the year 2015. Greater emphasis will be given to increasing productivity of existing irrigation schemes through the adoption of the latest biotechnologies and promotion of local research and development efforts. For the above purpose, there is a need to strengthen research capacity and to provide incentives to encourage research and development efforts in the government as well as private sectors.

3.3 With the increase in income levels and higher standard of living, one could also expect a changing preference towards higher quality rice which are largely imported. Given the price premium for higher quality rice, there is potential for domestic production of this type of rice to meet the expanding local demand.

3.3 While the contribution of the agricultural sector to the Gross Domestic Product (GDP) is projected to decline from 13.5 % in 1995 to about 7.1 % by the year 2010, the absolute GDP value of the agricultural sector is expected to register an increase, i.e. from RM16.23 billion in 1995 to about RM 23 billion in 2010. The agricultural sector will continue to play a major role as a prime supplier of raw materials to the expanding resource-based industries. The work force in the agricultural sector is expected to decline from 1.43 million to 0.93 million by the year 2010. The annual productivity per worker will, however, increase from RM11,360.00 in 1995 to RM24,730.00 in 2010 (see Table 4), thus accounting for the positive growth of the GDP in this sector. The continued success and competitiveness of the agricultural sector to a large extent depends on the success of the various measures taken to reduce labour requirements and to increase productivity of the agricultural workers.

3.5 The prospect for fruit and vegetable production is also bright due to the expected increase in the demand for domestic food products. The per capita fruit consumption is expected to increase from 49.9 kg in 1995 to 65.1 kg in 2010 representing an annual increase of 1.8 %. The area under orchards is expected to increase from 257,000 ha in 1995 to 373,200 ha in 2010. Water resources development and on-farm irrigation and drainage infrastructure are essential to help to achieve the above output target for fruit production which is expected to reach 2.23 million tonnes by the year 2010 as compared to the 1995 output of 1.02 million tonnes. Similarly, for vegetables, the annual per capita consumption is expected to increase at a rate of 1.8 % per annum to reach 63.6 kg in 2010. To meet this demand, the area under vegetable production is expected to increase from 42,240 ha in 1995 to 86,200 ha in 2010 resulting in a projected output of 1.6 million tonnes of vegetables in 2010. The government will also promote the development of organic farming as well as large-scale estate approach in the cultivation of vegetables, following the success of the estate/plantation approach for cash crops such as rubber and oil palm.

3.6 The increase in food production as described above can only be achieved if there are adequate measures to develop and manage water resources to meet the present and future need of the sector. In this respect, there are already signs of water distress in some of the irrigation schemes which are even more apparent during the drought years such as the 1998 drought associated with the EL-Nino phenomena affecting the Asia Pacific region. There had been considerable investment by the government in the development of water resources for all the eight granary areas in the country during the period 1960-1990. Further capital investment will be required to provide additional storage regulation facilities in order to improve the reliability of the irrigation water supply in a number of the granary areas.

3.7 The irrigation sector is also expected to face mounting pressures from the domestic and industrial water supply sector over its share of the water resources in a river basin wide context. In water-stressed basin, there is a need to develop interbasin or even interstate transfer of water subject to technical and economic feasibility. In practical situations, it is often found that many of these proposals can be cost prohibitive, even for domestic and industrial water supply projects under the present pricing policy and structure. Hence in the near future, many of the water allocation conflicts between agriculture and non-agriculture sectors may have to be resolved through a policy of reconciliation. Every effort should be made to improve water use efficiency or to cut down undue losses as compared to the construction of massive new capital works. Where the conditions are favourable, groundwater resources could also be developed to supplement surface water resources for agricultural and non-agricultural purposes.

3.8 The private sector is expected to play an increasingly larger role in the implementation of infrastructure development works in water resources. This will be particularly true in the utility services sector such as water supply and waste water treatment where there is a clear mechanism of cost recovery from the project beneficiaries. In the light of the privatisation policy advocated by the Government, the role of the government institutions in water resources is expected to undergo fundamental structural changes. It can be expected that the development role of the government departments/agencies will diminish with time while the planning, regulatory and enforcement capacities will have to be strengthened. This would require the establishment of high-level integrated and multi-disciplinary institutions at basin, state and national levels to ensure the systematic development and management of land and water resources based on the concepts of environmental preservation and sustainable development.

3.9 There is a pressing need to improve the water use efficiency of all irrigation projects in the country. At present, the irrigation efficiency is about 50 % for the larger schemes while some of the smaller schemes may be operating at an efficiency of less than 40 %. In water-stressed areas, such low efficiencies can no longer be tolerated. The improvement of irrigation water efficiency would involve a sustained programme of works and activities involving a combination of structural and non structural measures, with the latter playing a dominant role. On the former, there are plans to provide more efficient on-farm facilities and to introduce water recycling systems where they are technically and economically viable. On the latter, real-time monitoring system will be installed to operate the source and control facilities in these irrigation projects to cut down losses and to maximise the use of effective rainfall. The importance of stakeholder participation is also recognised and a major concerted effort is currently in progress to promote the establishment of Water Users Groups in all the granary areas. It is expected that by 2010, these Water Users Groups will be fully operational in all the granary areas of the country. Through these efforts, it is hoped that irrigation efficiency can be raised to a higher level of about 60-65 % by the year 2010.

4. CHALLENGES FOR THE FUTURE

4.1. While Malaysia is moving rapidly towards industrialisation, food production, particularly in the case of its staple food (rice) will continue to receive the attention of the economic planners and policy makers. Under the National Agricultural Policy, the production of rice has been set at 65 % self sufficiency level after taking into consideration that Malaysia is a high cost rice producer compared to her neighbours and the thin and volatile global trade of rice as a commodity. Rice production in Malaysia is facing a host of physical and operational constraints such as shortage of land and water resources, escalating prices of agricultural inputs, labour shortages, low water use efficiency, low adoption of technology, uneconomic land holdings, high post-harvesting losses, inadequacy of infrastructural facilities, etc. A clear long term vision supported by workable and comprehensive strategies will be required to achieve the above production target. The production of other food crops will be determined by market forces but suitable incentives should be provided to help increase production in order to cut down the hefty food import bill which has escalated over the years with the rise in population and general income levels of the people.

4.2 As the country develops, the total demand for water is expected to increase rapidly resulting in a gradual increase in the marginal economic cost of water, particularly in areas where water resources are in short supply as compared to the demand. The agriculture and food sector which is a major consumer for water will be under increasing pressure from the other competing water users who are able to offer higher economic return for the water consumed. There will be a tendency for both political decision makers and the farmers themselves to move away from agriculture in favour of higher-return economic activities despite that fact that very high investment has gone into the irrigation infrastructure. If this situation is not managed properly, it will have a great impact on self sufficiency level of food production in the country. In addition, the development cost of new irrigation projects can be rather high and suitable land for such development is also limited. In this respect, it is worthwhile to consider revitalising some of the idle paddy lands in existing irrigation schemes for paddy production by taking advantage of the sunk cost of the infrastructure. Irrigation and water managers must also implement the necessary measures to improve the water use efficiency (currently at a rather low level of about 50 %) and the production efficiency of water (currently at less than 0.2 kg of rice per cubic meter of water) of their existing and planned future irrigation schemes. This will contribute to higher economic return to sustain the viability of the irrigation or agricultural sector vis-a-vis the other non-agriculture economic activities.

4.3 It is necessary and timely to promote integrated water resources management at the basin or national level to ensure that water resources, in terms of quantity or quality will not become a constraint to the sustainability of future socio-economic development activities. This would required assessment and evaluation of the water resources potential of a river basin at an early stage and the formulation of a rational water resources allocation policy and a long term development and management master plan, to ensure the optimum use of resources and the sustainability of all existing and planned future development. . The country must also devote suitable and appropriate human and financial resources to implement the required water resources development and management master plan. In the light of the privatisation policy of the Government, there is a need to establish integrated and multi-disciplinary institutions to carry out the functions of planning and regulatory control of water resources and land use changes at basin, state and national level.

4.4 The agriculture sector should also address the issues of pollution from the use of pesticides, herbicides and fertilisers. Environmental concern should be an important consideration in project planning and subsequent operation of the works to ensure the sustainability of the agricultural sector. The Government should provide suitable incentives for the farmers to practice ecological and organic farming. The consumers should be made aware that the higher cost of organic foods is not just for food safety, but also for the intangible benefit resulting from the enhancement of the environment such as the reduction of air and water pollution.

4.5 It is also not uncommon to find that in the event of a drought, the agricultural water supply sector is often cut back or ceased all together to save water to meet human and industrial needs, a practice which is unfair and often detrimental to the welfare and livelihood of the farmers. It is necessary to address the issues of risk in farming due to natural disasters such as floods and droughts to promote the viability and sustainability of food production as an economic enterprise and a socio-political responsibility. Amongst other things, this may involve a clear policy and programme of disaster mitigation and assistance which could include elements of crop damage compensation, subsidy and crop insurance.

4.6 While irrigation development is a major contributor to the higher production of rice, it must be stressed that the full potential of irrigation can only be achieved when it is supported by modern agronomic practices which amongst other things include the use of improved genetic or planting material. There is a big variation in the average crop yields of irrigated schemes in Malaysia ranging from 3.5 to 8 tonnes of paddy per hectare per planting season in the designated granary areas of the country where the soil and water conditions are fairly similar. The lower range of paddy yield in irrigated schemes is certainly rather depressing since some of the non-irrigated schemes are capable of producing about 2 tonnes per hectare per planting season. There is a need to promote closer cooperation between the engineering and non-engineering inputs of irrigation development projects to realise the full yield potential of irrigated agriculture to ensure the continual success, competitiveness and sustainability of these projects.

4.7 The success and continued existence of irrigation projects should be evaluated from a broader perspective of rural development and social well-being and not just from a narrow and simplistic viewpoint of crop yield and farm income increase. While the income improvement per household may not be outstanding, the overall improvement to the local economy can be tremendous since the number of beneficiaries is large. The uplifting of a local economy is often achieved through the development of related agrobased industries and other consumer-driven commercial activities offering off-farm employment opportunities which can eventually become a significant if not the major income of the farming communities. The improvement of accessibility through the provision of farm roads has led to greater mobility of the residents, thereby enabling them to avail themselves to the other lucrative economic activities in the vicinities. The quality of life has also improved with the provision of clean water supply, health care, school and welfare facilities. The transformation of a single-purpose irrigation project for increasing rice production into one offering the full benefits of rural/regional development requires careful planning and synergistic input of the other agencies. It is also a more effective and less disruptive long term solution to the rural-urban migration problem in the country.

Table 1. Distribution of Paddy Areas, 1993 (hectares)

State	Irrigated Areas	Non-Irrigated Areas*	Total
Perlis	22,039	3,648	25,687
Kedah	93,670	24,857	118,527
Pulau Pinang	14,895	225	15,120
Perak	49,029	4,225	53,284
Selangor	19,583	106	19,689
Negeri Sembilan	8,680	1,449	10,129
Melaka	6,183	3,435	9,618
Johor	3,055	746	3,801
Pahang	17,388	13,796	31,184
Terengganu	14,843	12,173	27,016
Kelantan	40,032	25,382	65,414
Sabah	17,163	33,639	50,802
Sarawak	15,136	153,076	168,212
Total	321,696	276,787	598,483

Source : Ministry of Agriculture

Note : * Includes dry paddy areas

Table 2. Forecast of Agricultural Land Use, 1995 – 2010 ('000 hectares)

Item	1995	2000	2005	2010	Average Annual Growth Rate (%)			
					1995–2000	2000–2005	2005–2010	1995–2010
Rubber	1,679.0	1,560.0	1,395.0	1,185.0	-1.5	-2.2	-3.2	-2.3
Oil Palm	2,539.9	3,131.0	3,461.0	3,637.0	4.3	2.0	1.0	2.4
Cocoa	190.7	163.8	160.0	160.0	-3.0	-0.5	0.0	-1.2
Paddy[1]	672.8	521.2	475.0	450.0	-5.0	-1.8	-1.1	-2.6
Coconut	248.9	213.8	193.2	175.5	-3.0	-2.0	-1.9	-2.3
Pepper	10.2	9.2	8.5	8.1	-2.0	-1.6	-1.0	-1.5
Vegetables[1]	42.2	48.3	63.7	86.2	2.7	5.7	6.2	4.9
Fruits	257.7	291.5	329.8	373.2	2.5	2.5	2.5	2.5
Tobacco[1]	10.5	9.3	7.8	6.2	-2.4	-3.5	-4.5	-3.5
Others[2]	99.1	106.4	111.4	130.0	1.4	0.9	3.1	1.8
Total	5,751.0	6,054.5	6,205.4	6,211.20	1.0	0.5	0.0	0.5

Sources : Economic Planning Unit

Ministry Of Agriculture

Notes : [1] Paddy, vegetables and tobacco are based on planted area

[2] Others include sugarcane, coffee, sago, tea and floriculture

Table 3. Agricultural Land Use, 1985 – 1995 ('000 hectares)

Item	1985	1990	1995	Average Annual Growth Rate (%)		
				1995–1990	1990–1995	1985–1995
Rubber	1,948.7	1,836.7	1,679.0	-1.2	-1.8	-1.5
Oil Palm	1,482.4	2,029.5	2,539.9	6.5	4.6	5.5
Cocoa	303.9	419.1	190.7	6.6	-14.6	-4.6
Paddy[1]	655.0	680.6	672.8	0.8	-0.2	0.3
Coconut	334.1	315.6	248.9	-1.1	-4.6	-2.9
Pepper	5.4	11.5	10.2	16.3	-2.4	6.6
Vegetables[1]	31.8	35.2	42.2	2.1	3.7	2.9
Fruits	150.1	204.6	257.7	6.4	4.7	5.6
Tobacco[1]	16.2	10.2	10.5	-8.8	0.6	-4.2
Others[2]	94.3	94.8	99.1	0.1	0.9	0.5
Total	5,021.8	5,637.6	5,751.0	2.3	0.4	1.4

Sources : Economic Planning Unit
Department of Statistics

Notes : [1] Paddy, vegetables and tobacco are based on planted area
[2] Others include sugarcane, coffee, sago, tea and floriculture

Table 4. Employment and Productivity In Agriculture, 1985 – 2010

Year	Agriculture			Total	
	Employment ('000)	% of Total Employment	Productivity Per Worker (RM in 1978 prices)	Employment ('000)	Productivity Per Worker (RM in 1978 prices
1985	1,796	31.3	6,600	5,737	9,950
1990	1,738	26.0	8,530	6,685	11,870
1995	1,429	18.0	11,360	7,937	15,160
2000	1,280	14.1	14,450	9,066	17,460
2005	1,100	10.9	18,450	10,053	22,640
2010	930	8.4	24,730	11,099	29,060
Average Annual Growth Rate (%)					
1985 – 1995	-2.3		5.6	3.3	4.3
1995 – 2010	-2.8		5.3	2.3	4.4

Sources : Economic Planning Unit
Department of Statistics

MEXICO

PRESENT OUTLOOK

Mexico has a territorial extension of approximately two million square kilometers, with around 96 millions of inhabitants, of which 30% live in rural areas.

In accordance with the National Employment Survey for 1995, the rural population involved in agricultural activities in the rural zones was estimated As 9.7 million of which 33% owned land, the 9% were landless producers and the 58% workers: 24% where paid and 34% were unpaid. Of the rural population, 50% are below the age for work , and of the employed population, 39% are workers over 40 years of age. The principal segment that contributes immigrants to the urban zones and to other countries is that of 15 to 39 years, the most productive. With differences between regions, the role of woman in agricultural and livestock activities and in access to the land has become more important. Presently, 26% of the agricultural workers are women.

Some constant facts persist in the evolution of the rural population: high rates of fertility and migratory flows that maintain the volume of population in the rural areas without significant variations, and a tendency to the dispersion in small locations that continues to increase.

In accordance with research by the Economical Commission for the Latin America and the National Institute of Statistics, Geography and Informatics, published in 1993, the rural population in conditions of extreme poverty represented in 1992 close to 8.8 millions of people, which a segment, between 1.0 and 1.2 millions is constituted by seasonal journeymen, of which approximately 650 000 have to move to regions far from their places of origin, mainly to the north and northwest of the country and to the United States of America. Half of these workers are landless indigenous people; and a third are women.

In relation to the climate, in Mexico the annual average rainfall as of 777 mm, concentrated in three months, from July to September. The space distribution of rainfall and temperatures produces a great variety of climates, that range from arid (31%) and semi-arid (36%) conditions in the northern region, to the humid tropic (33%) in the southeast. Nearly 27% of the rainfall, that is 410 billion cubic meters converts into superficial runoff that feeding 13 main rivers of the nation. The renewable volume of groundwater is estimated at 31 billion cubic meters and non renewable supplies, stored in aquifers, amount to 100 billion.

In the northern part of Mexico and in the highlands, representing more than a half of the national territory, runoff amounts to only 20%. In spite of the fact that in this region lives 76% of the total population where 70% of the industries are established and where 40% of croplands are located.

The southeastern part of Mexico, which is less than a fourth of the total land surface, with only 24% of the population of the country and very little industry, receives 67% of total runoff.

The wrong space and time distribution of water have compelled government and private enterprises to develop an important infrastructure, in order to regulate their availability. At present, Mexico has a hydraulic infrastructure that supplies a large part of water demand for urban centers, food production, the industry and generation of electric energy. Also, the majority of the largest rivers are partially or totally controlled by multiple uses dams.

The average volumes utilized in Mexico, according their use, are, summarized in the following chart.

User of water in Mexico (Volumes in millions of cubic meters)

Type of use	Extraction			Use			
	Superficial	Ground	Total	Losses	Available water	Consumption	Waste water
Agriculture	41,850	16,274	58,124	16,616	41,508	29,056	12,452
Livestock	735	585	1,300	65	1,235	1,050	185
Urban-Domestic	3,560	9,622	13,182	5,266	7,916	1,609	6,307
Industrial	560	1,679	2,239	105	2,124	1,814	320
Total	46,705	28,140	74,845	22,052	52,793	33,529	19,264
% of use/ Total	62.40	37.60	100.00	29.46	70.54	44.80	25.74

Fuente : CNA (195)

A little over a fourth part of the water extracted for the different uses, returns as waste water, generally polluted, because only 536 million m3 of this volume are treated, which represents less than 3%. A large part of this volume is used again, mainly in the agricultural sector, with the risk of contamination of aquifers.

It should be stressed that, the volume of water loss, is often reused in irrigation down stream or recharging aquifers, exception made of the volumes that go to the sea, mainly in the coastal irrigated zones.

The irrigated areas represent the 30 percent of the agricultural cultivated land, they generate 50 percent of the value of the agricultural production, 70 percent of exports and 80 percent of the employment in the farm land; around 400 thousand hectares have problems of salinity and more than 80, out of a total of 258 aquifers are over exploited. This trend compromises profitability and the possibilities for a productive advance in this sector.

The irrigation sector has an average productivity three times larger than that of the rain fed sector; however, the value of the production has had strong variations, due not only to the availability of water and the state of the infrastructure, but also to variations in the yields, in the costs of products and of the inputs and of the composition of the pattern of crops.

The use of water in agriculture represents the 80% of the total of use of water; however, it is worthy to note that demands in the other sectors have grown at rates larger than that of the agricultural sector. Actually, the urban use has grown at annual median rate of 7.5%;. which implies that in ten years the volume used has doubled, while that of the agriculture has almost remained constant. For this reason, there are conflicts between users of the different productive sectors.

Also, as an effect of the over exploitation of the resources, there are economical and ecological problems that affect other users of the resource. The over exploitation of the aquifers, has a consequence; an increase in the costs of extraction of water from the wells and the concentration of salts in these aquifers, as well as negative effects such as the settlement of the ground and the disappearance of springs.

The inefficient management of water utilized for irrigation, is not only the origin of problems and conflicts. It is also a factor that limits the achievement of higher yields in irrigated agriculture. This reason calls for an improvement in water use to satisfy the requirements of other sectors, in areas of conflict and scarcity, and of expansion of the surface dedicated to double crops.

At a macro level, the faulty management of water, is generating recurrent economical crisis in zones where water is scarce; in the management of reservoirs problems arise when utilizing maximum water available each year, without considering that the reservoirs have an important function of regulation, in order to store water in wet years with purpose of using it in dry years. Also, in the allocation of volumes for the different, users without an adequate consideration and there are cases where users of some sectors are provided with more water than necessary, while others in the same basin, suffer from scarcity. This is related to problems of water management and related legal issues.

At parcel level, the mismanagement of water generates multiple problems, some consequences may be: an increase of ground water levels, soils salinization, lower yields, waste of water in damage of other users and pollution of excess water.

In our country the large works of hydraulic infrastructure have already been developed; the expansion of this frontier represents investments in the order of 10 thousand dollars per hectare for which a partial solution aims to the technification of irrigation. The change from gravity to pressure irrigation costs one thousand dollars per hectare and the increase in productivity is very significant.

There are wide disparities in the regional distribution of productivity. The northwest region presents the largest capability to produce crops with high added value in relation to the size of its economically active population and to the number of production units. In this region, the gross value of agriculture and livestock production per productive unit is three times larger than that of the central region and almost 12 times larger than those of the south and southeast regions.

Productivity gaps show the feasibility to triple the yields in some very well identified regions in relation to the national average by introducing state of the art technology in irrigation, mechanization, use of improved seeds, fertilization, and weeds plagues control.

Main factors that have influenced the limited performance of the sector are mainly the following:

- Opening of land for cultivation each time of lesser quality and a progressive degradation of agricultural soils and range lands.
- Decapitalization, with notable exceptions in the segment of commercial agriculture and intensive technified cattle breeding, mainly for export; which is the result of an insufficient and uncertain profitability linked to unfavorable rural-urban prices.
- Exhaustion and distortion of a policy of development of the farmland in spite of the magnitude of granted supports, showed its inefficiency in encouraging private investment, rational use of the natural resources and know how to improve the living conditions of the majority of the rural population and of the development of their productive potential.
- Limited application of technological advances. Important technological advances have been achieved, but concentrated in the exploitations that are traditionally more profitable.
- Inadequate and rigid productive structure.
- Excessive division of the land holdings and of its exploitation that imposes limits to investment and to the acquisition of better technologies.
- Insufficient development of local and regional markets, without the stimulus of competition.
- Reduced and declining availability of financing, in internationally competitive terms.
- Low growth rate of agricultural and livestock production for the last 30 years, below the population growth, generating negative growing balances in foreign trade.
- Excluding some large size irrigated exploitations, there are profitability and productive capitalization problems of the sector facing a great potential for development on basis of higher efficiency, specially among small scale producers.
- There is a strong inequality in productive and technological development levels between regions and even in activities within the same geographical zone. Exploitations with state of the art technologies in irrigation coexist with others with traditional productive procedures and low productivity.
- Large part of the poverty of the country is concentrated in the rural areas. Over three fourths of the rural population don't have an income high enough to satisfy all their basic needs, and approximately two thirds of the population of the country in extreme poverty live in the rural areas.

AGRICULTURAL ALLIANCE

The problems mentioned above and the influencing factors are being taken care mainly with support of the Agricultural Alliance Program, in operation since 1996. It is a multiple-component program that gives financial support to producers that are able to develop their own viable projects technically, economically, and ecologically sustainable. The producers decide their actions and participation in the investment. The results achieved to date have been encouraging and the new approach and guidelines will lead the way, within the possibilities of the country, for a better development of the agricultural sector at the turn of the new millennium.

The policies and use of the available funds will be directed to diminish the above mentioned negative factors. The results show that we are succeeding with production and productivity increases with the end result of higher income levels and a better quality of life for the rural population.

The Agricultural Alliance is the result of the agreement between producers, Federal and State Governments. It was designed after a detailed diagnosis of the agricultural sector which had highlighted above mentioned problems. For this reason, it was designed to fulfill the following objectives: recover the profitability of agricultural production; increase production above the demographic growth; fight poverty; maintain a positive trade balance and provide population with food at competitive prices.

In the context of the Alliance, the federal concept plays a key role. The Federal Government defines the general policies for development of the agricultural sector, the establishment of standards and rules for the allocation of resources and their expenditure, as well as the evaluation of results. States governments determine local priorities, coordinate specific actions and the organization of producers for production and marketing. In this new approach, it is fundamental that producers, based on their own decisions, decide the programs and actions they participate in, according to their needs and their financial capability, their technological level and their financial and economic viability analyses.

For the operation of the programs of the Agricultural Alliance, the Federal Government signed agreements with the Governments of the States, and the funds were administered through the States Trusts for Distribution of Funds, that were created for this purpose. State Councils were established with the participation of all the producers' organizations to define priorities. "Produce" institutions, with the purpose of speeding the technological change were also established.

The programs of the Alliance were grouped in five categories that cover the scope and activities of the agricultural sector :

- Agricultural promotion that comprises several programs, including fertigation, mechanization, and specific product-based projects.
- Livestock promotion like the program for establishment of rangelands, dairy products promotion, genetic improvement and better livestock.
- Rural development: training and extension, elementary technical assistance, and rural equipment.
- Agricultural sanitation: programs for animal and vegetable sanitation.
- Transference of technology.

The Program for Temporary Employment is being implemented in a coordinated way, with the agricultural side operated by the Agriculture, Livestock and Rural Development Secretariat (SAGAR), and the development of rural communities operated by the Secretariat of Social Development (SEDESOL).

As an example of operation of the programs of the Alliance, we have that of Fertigation, whose main objective is to increase the productivity of irrigated areas based on projects that include the use of irrigation and fertilization, allowing a more efficient water use, lowering energy and fertilizers costs, and increasing yields.

The Program includes the following concepts of investment: high and low pressure irrigation systems, fertigation equipment, pipes, pumps, filters, watermeters, designs and executive projects and technical assistance. Since farmers are in charge of actions, they directly contract supply and installation.

The Federal Government contributes with 35 percent of total investment or up to 305 dollars per hectare and the State Governments with an additional 10 percent. The producers participate with their own resources, coming from credits, labor or local materials.

Projects executed with support of the Program of Fertigation during the last three years, have benefited some 50,000 producers, achieving technological improvement of 345,519 hectares.

An analysis of 1996 actions was elaborated to determine the impacts of the Program, the main achievements are :

- Estimated water saving of 40% and of electricity 32%.
- Increase of 18% in harvested area and of 30% in production and 17% of additional cropped surface area.
- Increase of 116,000 work-days per year.
- Increase of 28% in the volume of agricultural products for export.
- The return of the projects is 16% and that of the producers reaches 25%.
- The beneficiaries express that they have succeeded in increasing their available income, which allowed 49% of them to make investments in equipment, improvement of housing, furniture and food.

PERSPECTIVES

Mexico's population in the year 2025 is estimated at 130 million inhabitants, that means that an increase of 30% is required to satisfy the basic food needs of the population.

The food security may be achieved via transference of technology and growth of productivity, considering that the extension of agricultural frontier in the country is practically exhausted, based on a more intensive and sustainable use of available resources.

In rural development two aspects should be considered: to provide more public services and to create more productive employments, better paid and in a permanent way.

It is a priority to continue with the technification. Of the 6.3 million of irrigated hectares only 700 thousand are technified, intensifying efforts in the next 12 years could bring 4 million more hectares, in the case that producers :

- Adopt in a large scale the use of proven technologies, sustained by training and technical assistance, in irrigation, drainage and soil conservation, in order to produce in an adequate sustainable way products in quantity and quality.
- Apply better inputs according to the specific conditions of their farms and fulfill certification and sanitary regulations.
- Adopt integrated systems for best plague combat and nutrition of plants and holistics in the livestock production that will reduce the risk of contamination by agro chemicals.
- Improve the use of natural resources, in conditions that preserve the environment as a priority, a balance should be reached in the exploitation of the aquifers.
- Achieve a better access to credit, in competitive conditions of opportunity and cost and schemes adequate to their specific needs.
- Modify their productive and organizational structure to adjust it to the markets requirements, with more profitable products and activities. A good effort is required to invest in order to improve the marketing facilities.
- Family integration in backyard activities and their productive diversification in which the water factor is determinant.

The governmental institutions that take part in the agricultural sector, have to:

- Reinforce the institutional coordination and with the organizations of not governmental and private producers, promoting the creation and adaptation of producers organizations under specific objectives, like basin councils, saving and loans institutions, and fundamentally of marketing.
- Analyze and plan the intersectorial and regional competition for the use of the natural resources in an agriculture-forestry-pasture context of the ecosystems of microbasins, and in a wide context of hydrographic basins. It also includes the effective use of labor, participation

of rural women and families, and the impacts for income in education, health and welfare and other services like electricity, drinking water, drainage, and roads.

- Continue supporting the investigation and technological development, sanitary regulations, the channels of internal marketing and the international negotiations in order to strengthen their contribution to the trade balance of the country.
- Reduce the post-harvest losses by means of the better handling of the products, define normalization standards, and develop quality control procedures, not only for the agricultural products but also in the materials and components of the irrigation systems.
- Promote the use of technologies in arid and semiarid areas that diminish the features of desertification, use of alternate sources of renewable energy, as well as the control and handling of resources in the humid and subhumid regions.
- Reinforce the issues of technical specialized assistance, not only in the irrigation but also in conservation of land and water, the utilization of fodder and range land and agricultural sanity.
- Search for alternatives of more accessible financing for producers, that also satisfy the rules of the funding institutions. Furthermore promote the organization and development of participation of savings and loan institutions.
- Improve the efficiencies of the water use and rehabilitate and modernize the operation and conservation of the irrigation and urban water infrastructure.
- Use water of low quality or recycled, with a previous study of their application using appropriate technologies.
- Raise awareness on the population on the use and rational management of water; emphasizing to the rural population the fundamental importance of this resource.
- Increase the propagation of the results of the Alliance for the Agriculture, that has led to measures like the agricultural and livestock national policy, which has in a short period of time, showed the technical, economical and social viability of a sustainable development. In the case of the Fertigation Program it has succeeded in increasing the income of the producers, the generation of employments and the exports, upon reaching profitability and quantity of the agricultural production; besides improving the efficiency in the use of the natural resources water and soil and protection of the environment.

The rural development, in these irrigated zones, undoubtedly will increase gradually, specially with the generation of better paid employments including, of course, the agroindustrial activity, the incorporation of productive projects and sustainable miniproducers and it will detonate the non-agricultural activities that will be carried out by members of the same community.

The major challenge of Mexico, at the turn of the XXI century, is to reduce the poverty of people who live in the rural areas.

NEPAL

EXECUTIVE SUMMARY

Nepal is endowed with abundant water resources from the availability point of view. The waters are regarded as the key strategic natural resources having the potential to be the catalyst for all round development and economic growth of the country.

The vision of the future is that Nepal's poverty can be eliminated by water resources development led through agricultural growth. The strategy for economic development, employment and poverty alleviation is based on the background of the country's unexploited potential in the agriculture sector given by suitable agro ecology, substantial irrigation potential, low technology use at present, possibility of regional cooperation and large market across the border and engagement of about 80% population in agriculture.

Water resource planning approach in the country had been concentrated at sub-sector level and investment decisions made on a project by project basis. This fragmented manner of planning by different government organizations have so far, failed to address the complex and interrelated issues. Multiple users: agriculture, domestic water agencies and industry - utilize the water resources of each river basin without any special attention to river basin water availability. The groundwater resource in the terai plains is grossly under utilized and needs legislative measures for its planned development and management. Details about issues, and constraints, trade offs about alternative choices and various alternatives are to be analyzed under the ongoing national water resources strategy formulation.

The identified outstanding issues related to irrigated agriculture include (i) developed irrigation facilities not utilized to the optimum; (ii) lack of basic inputs; (iii) organization and management deficiency leading to inefficient program implementation; (iv) problem of cost recovery in government irrigation schemes; (v) high capital cost requirements for physical infrastructure development; (vi) problem of river management; (vii) absence of objective investment criteria in the development of irrigated agriculture; (viii) lack of cooperation among the users and government agencies; etc.

Farmer managed irrigation systems (FMIS) have played important roles and contributed to the evolution and development of irrigated agriculture in Nepal. Over 75% of irrigated area is under these FMIS and are managed by farmers on self-help basis. The FMIS are operated in a demand-driven mode and have assured participation of users at every stage. Nepal's vision in the promotion and development of irrigated agriculture is to initiate and retain these characteristics in government operated irrigation schemes as well. The current irrigation policy of the government calls for the promotion of participatory mode of program implementation and the FMIS provide excellent examples for learning.

In this vision paper a review of the country's policy on water resources with a focus on irrigation potential has been presented. Brief discussion on status of water, food and rural development in the country has been outlined. Issues, constraints and actions needed in policy, institutions and irrigation have been identified.

The Policy Dialogue Model (PODIUM) has been used to determine increasing water demand and the production of the required cereals in 2025 as a result of population growth and changing diets.

1. NATIONAL POLICIES AND DEVELOPMENT PLANS

1.1 OVERVIEW OF PREVIOUS PLANS

Planned development efforts in Nepal began shortly after the political reforms in 1951. Prior to 1951, the main focus of the government was maintaining law and order and revenue collection. After 1951, the new government placed emphasis in disbanding the pre-existing feudal agrarian system and developing agriculture through various reform measures. Accordingly, Tenancy Rights Acquisition Act 1952 was enacted and a Land Reform Commission was commissioned to take up problems on tenancy rights, land revenue and agricultural credit. The year was also crucial as a first step of government policy towards ensuring adequate food production by creating the Ministry of Agriculture and two separate departments for Agriculture and Irrigation to look after the sustainable development of agricultural production and irrigated agriculture.

In 1955, a thirteen point program largely to safeguard the interest of the farmers was declared by the government. Then the first five year development plan was implemented in 1956. So far eight development plans have already been launched and ninth five year plan is underway. All the periodic plans have given agriculture as the top priority sector of the economy and irrigation is the component of major investment. The need to increase agricultural production through widespread use of appropriate technologies and inputs and better co-ordination of related line agencies was always felt by the government. Accordingly, various policies and strategies for increasing agricultural production (food production) were taken up by the government in each five year development plan.

Beginning 1988, a number of policy reforms have been introduced emphasizing participation of user beneficiaries of irrigation development and management. Water Resources Act (1992), Water Resources Regulation, 1993 and the 1997 amendment of Irrigation Policy (1992) have attempted to create policy environment to enable and foster users' participation in government sector irrigation schemes.

The Eight Five Year Plan (1992 - 97) earmarked 25.7% of the development budget for the agricultural sector. The plan had following objectives for agricultural development: (i) to assist in boosting national economy by increasing agricultural production by specializing cropping areas on topographical basis;, (ii) to increase overall production and productivity for meeting national demand for food; (iii) to increase production and productivity of raw materials required for the development of agro-based industries; (iv) to create opportunities for productive employment for a large number of small and marginal farmers; and (v) to maintain balance between agricultural development and environmental protection.

The strategic policies of the Eight Plan were as follows: (i) to develop agricultural service centers in local areas for disseminating technology transfer; (ii) to arrange parental seed for production and monitor regularly the production activities; (iii) to promote private participation in the supply of chemical fertilizers; (iv) to hand over or lease out government farm to private sector; (v) to develop long term agricultural development plan; (vi) to accord top priority for private sector participation in providing veterinary and pathological services; (vii) to boost the activities of Nepal Agricultural Research Council (NARC) for quality and intensive agricultural research; (viii) to encourage women's participation in agricultural development activities; and (ix) to lift restriction in the mobility of agricultural product across the districts of the country.

1.2 LONG TERM DEVELOPMENT CONCEPT

The basic objective of the ongoing Ninth Plan (1997 - 2002) is poverty alleviation. This plan was formulated on the basis of the long-term Agriculture Perspective Plan (1995 - 2015) which convened only in 1997. Unlike in the previous plans where there were too many priorities, in the present plan limited priorities are taken to effectively deal with. The major goal of the long-term vision is to reduce the poverty figure of over 45% to 10% of the population in 20 years time.

The long-term development vision is summarized as follows :

- to follow the global trend in liberal, open, free market oriented philosophy
- to increase private sector participation with attraction for bringing foreign investment and also to increase competitiveness of private sectors (local)
- to involve public sector for promotion of poverty alleviation which will be gradually decreased.
- to create enabling environment for fostering private sector to increase economic and social development.

In general, macro policy in Nepal is favorable to the development of the agricultural sector. The major problem lies with the effective implementation. Though the overall objectives of the APP are reported to confirm with government's macro policy, there remain considerable doubt about how the plan will be implemented with the lack of substantial fund. The plan has predicted on acceleration of the agricultural growth rate by two percent point per annum so that the growth rate of agricultural output per capita of the total population increases by five times from its current 0.5 percent to a 2.5 percent. The APP has also emphasized on (i) a priority package program that set a small number of essential priorities for growth and integrating them in a package which is to be applied block by block in each district, (ii) increase in real rural income to stimulate growth in demand for high value agricultural and non-agricultural production and (iii) non-agricultural growth which will generate substantial employment in the rural areas. This is expected to contribute in a sharp decline in poverty and diffusion of urbanization associated with accelerated agricultural growth. The APP strategy for growth is essentially year-round irrigation, technology and fertilizer. The APP's strategy for agricultural take off encompasses the priorities for different sectors such as input priorities, output priorities, institutional priorities and policy priorities.

Priority

The following sectors are prioritized (in the given order of merit) in the current plan with focus on poverty alleviation.

- agriculture
- electricity and energy
- human resources and social sector
- tourism and industries
- physical infrastructure

2. STATUS OF WATER

2.1 SURFACE WATER

In Nepal, the water resources are regarded us the key strategic natural resource having the potential to be the catalyst for all round development and economic growth of the country. Nepal has a monsoon type climate. The total rainfall varies between 1,000 to 4,000 mm with an annual average of 1,814 mm. More than 75% rainfall occurs during four months of the monsoon period (June - September). The total annual surface runoff has been estimated to be 225 billion cubic meters (BCM) (equivalent to over 10,000 cubic meters per capita) of which 12 BCM is estimated to be entering from the upper catchments located in China, while about 15 BCM has been estimated to be entering into the border rivers between Nepal and India from the tributaries located in the Indian side. The seasonal distribution of flow is extremely varied as low as 1.5% to 2.4% of total runoff in the months of January, February and March, and as high as 20 to 27% in the months of July and August for snowfed rivers, while these figures for purely rainfed rivers are respectively 0.5% to 3% in the months of March, April and May and 20% to 30% in the months of July and August.

There are seventeen river basins in the Nepalese river system covering a total drainage area of 191,007 km^2 of which 22% or 42,030 km^2 lies in China and 5% or 9,850 km^2 is in India. Karnali, Sapta Gandaki and Sapta Koshi are the major river basins with their origins in the Himalayas and account for around 80% runoff. The Babai, West Rapti, Bagmati, Kamala and Kankai are medium river basins accounting for about 7% of the runoff. The southern rivers, with origins in the Siwalik Hill Range, are Bering, Balan, Khutiya, Pathraiya, Lal Bakaiya, Ratu, Sirsia, Manusmara and Banganga. These rivers are seasonal with little flows during non-monsoon periods. The Mahakali and Mechi rivers form the western and eastern frontiers with India.

2.2 GROUNDWATER

Available information show that a good potential for groundwater extraction exists specially in the southern plains (Terai) and inner valleys of the hills and mountainous regions. Much of the terai physiographic region and some parts of Siwalik valleys are undertain by shallow or deep aquifers, many of which are suitable for exploitation as sources of irrigation and drinking waters.

The annual recharge estimates range from 124 to 685 mm. The corresponding volume of water available for groundwater abstractions is estimated to be between 5.8 BCM and 12 BCM, however based on the measurements of the seasonal fluctuations of the water table in shallow tubewells the groundwater reserve is reported to be about 8.8 BCM annually.

2.3 IRRIGATION POTENTIAL AND DEVELOPMENT

Including 412,000 ha (presently non-agriculture) of land, the total irrigable land of the country has been estimated to be 2,178,000 ha, of which a net command of 1,091,000 ha receive irrigation water supply. This includes both surface water and groundwater irrigation (Table 2.1). Nepal has a long history of irrigated agriculture, mainly through farmer managed irrigation systems (FMIS). About 75% of the total irrigated area is under these FMIS, whereas the agency managed irrigation systems (AMIS) irrigate the remainder. One estimate suggests that about 200,000 ha of the irrigated area is under groundwater schemes, of which 75% is again under farmer managed shallow tubewell (STWs), and the remainder under agency managed deep tubewells (DTWs). About 37,000 STWs and 400 DTWs are installed in the terai.

It is to be noted that except one system (Banganga system with 6200 ha) all the areas under existing irrigation systems are dependent on transit flow availability at the sources, and therefore, the irrigated area varies from season to season and from region to region. The total year-round irrigated area including the farmers' systems has been estimated to be only 418,000 ha.

None of the irrigation systems in Nepal measures the quantum of water supplied to irrigation. The only available data are (i) annual diversion requirements for monsoon and year-round irrigation based on physiographic regions, and (ii) irrigation command areas splitted into seasonal (monsoon) and year-round. The Agriculture Perspective Plan (APP) estimated the water use for irrigation with a total of 17,000 million cubic meters which is less than 8% of the country's total water resource potential.

The priority in the current Ninth Plan and the APP is to develop groundwater through low cost STWs and farmers' surface irrigation systems which will be managed by the users themselves.

As mentioned earlier, the year-round irrigation coverage is still only about 38% of the potential irrigable land, that also including the land mostly irrigated by traditionals farmers' system (without full or partial control permanent structures/equipments). Thus, the withdrawal would have to be gradually increased to ultimately cover all the potential irrigable land on year-round basis with a view to increase the food production to feed the growing population. It could, however, be expected that through modernization of irrigation systems and adoption of improved water management practices, the water requirements per hectare could be greatly reduced.

The present focus has been to develop quick yielding small irrigation systems. Despite considerable investments in infrastructure development and well trained codre of technicians for design, development, operation and management, the public sector irrigation schemes have been performing below expectations. The irrigation efficiencies are around 30%, the crop productivities are stagnant or declining and the problem of system management has remained an issue.

2.4 IRRIGATION MANAGEMENT

As the government managed irrigation schemes are characterized by low performance in terms of water use efficiency, crop productivity and backlog of deferred maintenance, it has been recognized that for improved management of available supply of irrigation water the participation of beneficiary farmers is crucial. Accordingly, the following policy elements have been emphasized by the government :

Area and Use	Mountains	Hills	Terai	Total
Geographical Area	5170	6140	3410	14720
Cultivated Area	227	1055	1359	2641
Irrigable Area (including forest land)	61	373	1744	2178
Irrigable Area (excluding forest land)	60	368	1338	1766
Irrigable Area (infrastructure developed)	52	253	786	1091
Actually Commanded	40	208	520	768
Year-round	20	110	288	418
Monsoon	20	98	232	350
Area under agency managed systems	1	15	251	267
Area under agency assisted farmer managed systems	10	48	274	332
Area under farmer development and farmer managed systems	41	190	261	492

Source: Nepal Agriculture Perspective Plan, 1995; and Department of Irrigation Documents, 1997.

- The irrigation projects managed at the government level would be gradually transferred to Water Users' Associations (WUAs). Such transfer would be effected to the schemes of upto 2000 ha in the terai and 500 ha in the hills and mountains. Larger systems may remain under the joint management of the WUAs and the government;

- No water service charge would be levied to schemes transferred to WUAs; the user farmers will be made to generate the resources locally and manage the systems;

- Before transferring the schemes to WUAs, the schemes would be rehabilitated and strengthened in accordance with the demand of WUAs. For this, cost sharing mechanism would be introduced with a view to enhance their capability and provide WUAs a sense of feeling of ownership in the schemes to be turned over.

The 1997 Amendment of the Irrigation Policy, 1992 promulgated by the Ministry of Water Resources declares that the role of the government shall focus on areas of wider national importance such as review and development sectoral policy on irrigation, resource mobilization, economic analysis and technological development while maximizing the participation of the private and non-government sectors in the implementation and operation of programs for irrigation development. The policy emphasizes sustainable and environmental friendly utilization of irrigation water and demand driven approach to irrigation development.

2.5 WATER USE FOR DOMESTIC AND OTHER PURPOSES

Water withdrawal for domestic sector are from different types of sources such as springs, wells (open and tube), rivers/streams, traditional stone taps and piped system (modern). The withdrawal data exists only for publicly developed piped system, particularly the supply added since 1974. For other uses such data are not available. However, a feasibility study conducted by Thai Study Team in November 1993 on the Kodkhu Water Supply Project estimates that the industrial consumption (including commercial and institutional) for the urban valley like Kathmandu constitutes about 5% of the domestic demand in the year 1991. Based on this, estimate has been made to provide indicative idea of aggregate water use in industrial, commercial and institutional sectors.

It is reported that population covered by the piped domestic water supply reached 67% and 39% in the fiscal year 1992/93 in urban and rural areas respectively. Viewing at the statistical data on quantum of piped water supply for the fiscal year 1994/95, the average consumption per capita per day in the areas having access to piped water comes to be around 83 liters.

2.6 HYDROPOWER

Hydropower is considered as a viable means of economic growth for the country's overall development. Though there is total hydropower potential of 83,000 MW, 42,000 MW is reported to be economically viable. However, this has been only a mirage as less than 1% of the potential has been exploited so far. Nepal is in a favorable position to supply water to China and India through construction of large reservoirs.

2.7 BASIN MANAGEMENT

Nepal's population which currently stands at 21 million persons, is estimated to grow at the rate of 2.5% per annum exceeding the growth rate in food production. This is the prominent factor that has placed additional pressures on the country's water resources. Further, there is growing demand for water for higher priority non-agricultural uses that could reduce the supply for irrigation. Population growth and urbanization will increase water demands, most notably for drinking water and sanitation. Tourism, which is fast becoming the dominant sector of the economy, will increase the demand for water for environmental and recreational purposes. These trends have set the stage for intense inter sectoral competition for water in several locations. It is not possible to improve irrigation in isolation form the management of water for other purposes. This calls for integrated water management on the basin perspective and the planners have realized this and there are moves for changes in policies and institutional reforms. Research and development activities are foreseen for the development of integrated water management plans and the development of effective water management institutions.

3. PRESENT STATUS OF FOOD

About 80% of Nepal's population are farmers. Share of agriculture in GDP continues to decline and dwindles around 40% in recent years. The decline is due to the growth in other sectors like industry/manufacturing and service sector contributing 19.8% and 37.2% respectively. Agriculture is still the single largest sector with respect to income and employment and the per capita food availability stands at 276 kilograms. Over 45% of the people are below poverty line and 90% of them live in rural areas. The country with surplus food two decades ago has gone a net importer these years. Increase in population has outpaced agricultural growth resulting higher demand for food steadily. Per capita GDP increased only by 0.9% per year during 1964 - 94.

3.1 LAND DISTRIBUTION, FOOD DEMAND AND NUTRITIONAL NEEDS

Land distribution is very skewed. Over 50% of households own only 6.6% of the total cultivated land, while more than two-thirds of the households own less than a hectare, and about 10% of the households are landless.

The National Planning Commission had fixed for a variety of planning purposes minimum daily calorie requirements based on WHO guidelines, adjusted for climatic variations and demographic composition. These are 2,140 kilo calorie (kcal) per capita for the terai and 2,340 for both hills and mountains (higher to account for higher requirements due to climate conditions), for a national average of 2,250. The daily calories intake per capita in 1995 is estimated to be 2268 Kcal.

Effective food demand is a different matter and depends on income, prices and other socio-economic factors. There is dominance of foodgrains in local food consumption. Aggregate cereal consumption is higher in the terai (a cereal surplus region) relative to the hills/mountains (a deficit region). In general, rice is preferred than maize or wheat. The current consumption pattern largely reflects the subsistence nature of the economy.

3.2 LAND USE

There are three distinct and parallel ecological zones which run east to west: the southern terai plain starting from less than a 30 meters to the midhills and then up to the northern mountains scaling higher than 8,800 meters. This variation in agro-ecology suggests corresponding microclimates ranging from tropical to temperate regimes. Hence, the physiography provides opportunity for growing large number of agricultural commodities.

The present land use suggests that some 20% of the country's land is under cultivation, about 7% further suitable for agriculture but not farmed yet (Table 3.1).

Table 3.1. Land Use Statistics ('000 ha)

Item	Area (000 ha)	Percentage
Agricultural land cultivated	2,968	20.1
Agricultural land uncultivated	987	6.7
Forest (including shrub)	6,306	42.8
Pasture	1,757	11.9
Other	2,730	18.5
Total	14,748	100.0

Source : ASD, MOA, 1998.

Forest land covers significant (42.8%) portion of the nation, and pasture about 12%. However, degraded forests and overgrazed pasture have aggravated the already deteriorating soil fertility impacting adversely on the quest for increase.

Of the kingdom's total area, 42% falls in the mid hills, 35% in the mountains and the rest 23% in the terai. In terms of the cultivated land the terai, hills and mountains account for 42%, 50% and 8% respectively. Taking into account the gross cropped area, the terai alone accounts for 53%; and 48% of the area is under food crops.

3.3 IMPORTANT AGRICULTURAL PRODUCTS

3.3.1 Food crops

Paddy, maize, wheat, barley and finger millet are the major food crops in Nepal. In terms of hectarage, paddy alone occupies 46% of the cropped area. Similarly, maize and wheat respectively are the second and third important food crops (Table 3.2.1). Millet and barley are the minor crops. On the production front the contribution of these crops to the national granary follow the same pattern as in the hectarage.

Table 3.2.1 Area, Production and Yield of Major Food Crop, 1997

Crops	Area (000 ha)	Production (000 MT)	Yield (MT/ha)
Paddy	1506.0	3641.0	2.42
Maize	799.0	1367.0	1.71
Wheat	640.0	1030.0	1.61
Millet	262.0	285.0	1.08
Barley	35.6	37.0	1.04
Total	3242.6	6360.0	

Source : Agricultural Statistics Division, Ministry of Agriculture, Nepal.

Nepalese agricultural policy is based on food deficit implying that the investment efforts are geared towards raising the productivity of agricultural commodities. Past experience with agricultural growth shows only 3 percent a year, during the past two decades. The productivity of most major food crops have not increased appreciably. The increase in production comes mostly from area expansion rather than the realization of green revolution as witnessed by some countries in South Asia. Annual growth rates of paddy and wheat were respectively 0.54% and 0.29% in 1961-63 to 1991-93 (APP, 1995).

3.3.2 Non-cereal crops

Fruits, vegetables, potato, oilseed, sugarcane, pulses and tobacco are other non-cereal crops grown in the kingdom. These have registered slow growth over time, except in fisheries and sugarcane. Table 3.3.2 shows the area, production and yield of major non-cereal crops.

Table 3.2.2. Area, Production and Yield of Non-cereals, 1988-89 and 1997-98

Crops	1988-89			1997-98		
	Area (000 ha)	Production (000 MT)	Yield (MT/ha)	Area (000 ha)	Production (000 MT)	Yield (MT/ha)
Potato	81	641	7.86	116	972	8.4
Oilseed	155	99	0.64	179	110	0.6
Sugarcane	29	903	30.6	49	1763	36
Pulses	262*	154*	0.59*	310	211	0.68
Tobacco	7	5	0.7	4.8	3.8	0.79
Fruits	56**	378**	9.97**	65	415	9.49
Vegetables	140*	1128*	8.0*	150	1449	9.6
Fish***	4.4	6.98	1.6	5.4	12.4	2.3

*1991-92; **1993-94, yield of productive trees only; ***Data of pond fish culture only; area pertains to water surface

Source : ASD, MOA, 1998

3.3.3 Use of Modern Technology

High yielding varieties (HYVs) and chemical fertilizer are the key modern inputs that augment agricultural productivity significantly. Irrigation, of course, interacts positively to this effect. Cultural practices and judicious use of pesticides have their role to play.

A government owned Agriculture Inputs Corporation (AIC) used to be the sole distributor of chemical fertilizer. A shift in fertilizer policy has resulted into the deregulation of fertilizer sale which depends on complete importation since there is no fertilizer factory in the country. Privatization has been slow because of the absence of fertilizer act.

The consumption of chemical fertilizer is one of the lowest in the world, about 30 kilograms of nutrient per hectare. In 1997-98, area planted to HYVs in paddy, maize and wheat stood at 64%, 64% and 87% respectively. Nepal's agricultural research has placed thrust on major cereals for food security reasons. But numerous micro-climatic regimes have constrained the adoption of HYVs, among other things.

Because of the difficult and rugged terrain in the hills and mountains, farm mechanization is limited to the terai plain alone. Average landholding size is small (about 0.95 ha), and fragmentation is widespread.

Popular cropping pattern is paddy based in the irrigated lowland, followed by wheat, pulses or vegetables in the winter. In the mid hills summer maize dominates the cropping pattern in the uplands, followed by wheat in the winter. Many cropping patterns are practiced as there are varied micro-climates.

Production losses are encountered both in the store and on the farm. Typical losses in cereals range normally from 5-15%.

Most of the cereals are traded internally as food deficit does not permit exportation.

3.4 FOOD BALANCE SHEET

Table 3.3 shows the edible cereal grain production requirement and the balance.

Table 3.3 Edible Cereal Grain Production and Requirement in Nepal, 1989-90 and 1996-97.

Crops	1989-90 (MT)	1996-97 (MT)
Rice	1,831,713	2,002,747
Maize	857,846	894,779
Wheat	667,972	827,438
Millet	184,546	236,982
Barley	7,510	10,641
Total	3,549,587	3,972,587
Requirement	3,559,011	4,079,135
Balance	-9,424	-106,548

Source : Marketing Development Division, Department of Agriculture, 1998.

The increasing food deficit is primarily due to higher population growth which has outpaced the agricultural growth. The food shortage is especially in the hills and mountains.

4. PRESENT STATUS OF RURAL DEVELOPMENT

4.1 THE COUNTRY

The kingdom of Nepal is a land-locked country between India and China. Communications with the outside world came relatively recently while the internal road network is still at an early development state. Large parts of mountain and western part of the country are almost totally undeveloped with no vehicular access. Several other rural areas of the country lack good access and essential infrastructures.

Nepal is one of the least developed countries with a per capita income of US $ 200. With a population of about 21 million, 90% earn their living in agriculture, and out of the total area of 147,181 km^2, only some 3 million ha are cultivated. The terai, hills and mountain represent 45%, 47% and 8% respectively. Female slightly outrun the male population with a ratio of 1.03.

Population growth remains high at 2.5% per year (1981 -91). The incidence of poverty is growing as the proportion of poor in the total population has increased from 31% in 1977/78, 42% in 1984 /85 to 45% in 1996. Nepal lags behind other South Asian neighbors not only in economic progress but also in key human indicators - such as adult literacy, mother and child mortality, food consumption, provision of safe water, sanitation, health services etc. The adult literacy rate is very low at around 27% (12.8% for women and 39.7% for men). The net primary school enrollment is 64 and the net secondary school enrollment rate is 30%, with the rate for girls only about a third of that for boys. (Development Corporation Report, UNDP, 1995). About four-fifth of the total population has no access to sanitation and nearly half is deprived of potable water. Two-thirds of under-five deaths are associated with malnutrition and only six percent of births are attended by trained health personnel. The maternal mortality rate is at 8.5 per thousand and the infant mortality rate is 98 per 1000. The UNFPA report (The State of World Population 1997) shows that life expectancy at birth for male stand at 57.6 and for female 57% which is modest increase from 1991 census with 53 for female and 54 for male. Some eighty percent of the population live in rural areas and are restrained by poor natural resources, hilly and mountainous terrain and under developed infrastructure, which have combined to limit agricultural development and thus perpetuate poverty.

Various physiographical, geological and hydrological factors contribute to the high incidence of natural disasters, e.g. the seismic faults passing through the country, the high elevation of the mountain slopes, and high skewed rainfall due to monsoon. At the same time, the pervasive poverty and the rapid population growth have further compounded the disaster scenario of the country, causing the high degree of environmental deterioration, and the increased encroachment in the marginal lands. Of all the major hazards, earthquake is potentially the most devastating. Most of the housing in Nepal are vulnerable even to moderate earthquake. Earthquakes of 1934, 1967, 1980 and 1988 are considered devastating. In these earthquakes alone more than 17,000 people lost weir lives.

In Nepal, monsoon clouds bring torrential rainfall to the southern slope of the Himalayas, which causes landslides and flash floods in the middle hills and floods in the terai plains. Floods and landslides will continue to become a growing threat to the country, since the natural erosion in the hills and mountains is being accelerated by geological processes and human interventions. The increased deforestation and indiscriminate cultivation have aggravated the soil erosion in the fragile mountain ecosystem.

Drought is another disaster effecting the lives of people. The severe drought of 1981/82 caused heavy damage to crops leading to a decline of 1.4% GDP. Drought of 1994/95, also did considerable damage to agricultural production.

The incidence of poverty is much higher in hills and mountains than in the terai. More striking are the difference in the level of poverty between rural and urban areas. As a result of low income and high prices due to poor transport network, the terai surplus does not easily flow to the hills and mountains districts, rather much of the surplus goes to India. One implication of this from a food security perspective is that food adequacy at the national level is not a sufficient guarantee for Nepal’s food security. The proportion of people in rural areas under poverty line is much higher as compared to the urban areas.

The rate of underemployment in Nepal is found to be about 40% of the available person days per year. With this, the rural poor lack land asset as the average operational land holding of a poor farmer is reported to be about 0.14 ha per capita in terai and 0.05 ha per capita in the hills. The absence of year round irrigation facility coupled with this small land holding keeps a farmer at subsistence level and underemployed on his farm. The major assets which a poor person possesses is the unskilled labor which s/he is compelled to sell at desperately low wage. As there is excess supply of unskilled labor force, their marginal productivity is almost negligible. In addition, the absence of off-farm employment opportunities has made the demand for labor highly seasonal.

Currently, agriculture can provide gainful employment for 55 days a year in the hilly region and 180 days in terai. Alternative employment opportunities are very limited in rural areas. It is because of this economic desperation that many laborers migrate to urban areas, and to India temporarily to work as unskilled laborers.

Ecologically, there has been a shift of population from rural to urban areas, and also from hills to terai. Total urban population accounted for 6.3% in 1981 while it registered 9.2% in 1991 and it is growing annually. Further, population growth in terai is higher than in hills and mountains. This can be attributed to hill-to-terai migration. Because of increase in population, the pressure on arable land has tremendously increased, resulting in annual deforestation of 58,000 ha (3.5% annual rate of deforestation). The very high population density to arable land (8.6 persons per ha), has forced the farmers to cultivate marginal land and encroach forest area which, in turn, leads to soil erosion and declining crop productivity. Excessive siltation and flash floods have become common due to rapid degradation of natural resource base.

4.2 ECONOMIC AND SOCIAL POLICIES

All planning documents in Nepal have recognized the high incidence of poverty and food insecurity. Hence, one of their stated objectives has been poverty alleviation. Governments have realized that poverty in Nepal is so widespread that it can only be eradicated through rapid growth in food production and incomes in rural areas, where the majority of the poor are located. Nepal, unlike many developing countries, never has a program of large-scale direct intervention in the food sector, such as generalized, or even targeted, subsidies. Therefore, general agricultural and rural development policies and programs were one and the same thing as food security programs. In view of the higher incidence of food insecurity and poverty in remote hills and mountain areas, the government implemented with donor support in the 1970s and 1980s a number of integrated rural development programs which had food and nutrition components. In addition, several programs were in operation aimed at improving nutrition situation for targeted groups.

The government also implemented a number of income generating credit programs targeted at the poor. The largest among these is the Small Farmer Development Program (started in 1975) which currently covers about 180 000 farmers throughout the country. Similar programs launched in the early 1980s were Production Credit for Rural Women (1982) and Intensive Banking Program implemented by commercial banks. More recent targeted programs include Rural Self-Help Fund, which aims to assist selected NGOs to help the poor take up productive, income generating, labor intensive activities on a group basis, and the Grameen Bikas Banks which, together with Grameen Bank Replicators established by NGOs, has a current membership of about 45 200 poor women organized in 9 100 groups. In addition, two large-scale employment generating programs that have been completed or on-going for some time are Special Public Works Program, sponsored by the ILO, and the Food-for-Work Program of the WFP.

4.3 DECENTRALIZATION / DEMOCRATIZATION

Decentralization has been one of the policy cornerstones embedded with the 1990 constitution promulgated after the restoration of democracy after a popular revolt. The main purpose is to empower local bodies, Village Development Committees and District Development Committees, to transform them into local self-governments able to bear responsibility of planning, implementing, and managing resources at local level as well as to institute sustainable development as the prime objective of decentralization. Local election has been held in accordance with the 1997 decentralization ordinance and the Decentralization Act 1999 has been enacted. With this Act, the local governments will be able to address the development issues at the local levels.

Stable government at the center backed by absolute majority in the House of Representatives is the prerequisite for attracting foreign investment and long-term planning of sustainable development activities. Recently, in May 1999, Nepal went to the national polls for the House and a government with absolute majority of a single right wing political party along with a strong opposition dominated by a communist party has been elected. This important event is expected to create a conducive environment for the country's overall development.

5. FUTURE SCENARIOUS AND AIMS

5.1 GROWING SCARCITY OF WATER RESOURCE

Increasing population and industrial expansion, together with a growing demand from urbanization and irrigation sector is to continue to result in increased competition for water. In terms of volume, irrigation is the greatest water user with over 95% of the total water consumed being used in this sector. When considering the various sectors of water users, water supply for households both socially and legally has been given high priority and this is followed by agriculture. Industrial expansion (including tourism), though at present not consuming much water, is another national objective requiring more and more water with its expansion.

On the supply side, Nepal's water sources are facing many environmental hazards. The quantity of dependable flow is reported to be declining and the peak monsoon flows increasing due to the loss of vegetative cover in the catchment area while the quality is also declining due to increased pollution.

When looking at the varying annual volumes of water available and the growing demands from the various sectors, the average total volume of water available for irrigation is expected to decrease and the variability of supply to increase. Uncertainties will increase making it more and more difficult to plan cropping calendars for irrigated agriculture.

Statistical figures indicate that there is plenty of water in Nepal, the question is how much of the water is actually available for irrigation at the time of requirement at a reasonable cost. With substantial investment already made in the irrigation sector, cost of irrigation per hectare is increasing as economically feasible schemes have already been taken up. Most of the irrigation projects constructed by the government divert water from medium size rivers originating from the middle hills. These rivers, though perennial, have wide seasonal functions in discharge. The unreliable river flows coupled with the inefficient management appear to be the factors contributing to poor performance of the irrigation systems. Tapping the large Himalayan rivers for irrigation and/or hydropower generation, though promising, needs bilateral and multilateral cooperation as well as considerable resources.

5.2 NEEDS FOR RIVER BASIN APPROACH

It is increasingly being realized that the goal of optimizing the beneficial utilization of water in all its dimensions can only be achieved by analyzing water use in the context of water balance of the whole river basin. This is essential as water resource systems are highly integrated systems and apparent gains in one part of the system can be offset by losses in other parts. Similarly, one system's drainage can be another system's water supply. Looking into the water scarce scenario in some of the river valleys, inter basin diversion (e.g. Sunkoshi - Kamala, Bheri -Babai, etc) are also planned for the future.

5.3 CONJUNCTIVE MANAGEMENT OF SURFACE AND GROUNDWATERS

Groundwater is another accessible resource in the terai. One estimate suggests that 726,000 ha of terai land have good potential for shallow tubewells (STWs) and another 305,000 ha have marginal potential. A further 190,000 ha show good potential for deep and medium tubewells. However, this area overlaps the STW area by an unstated amount.

As surface water alone because of seasonal flow variations at the systems river source, are unlikely to provide year round irrigation, development of groundwater and surface water schemes for conjunctive management is a viable option for the increased agricultural production and rural development.

5.4 REGIONAL COOPERATION

Nepal's four major rivers, Koshi, Gandak, Karnali and Mahakali contribute about 71% of the Ganges dry season flows and 41% of the total annual flows. With a high population density and an escalating demand for water in the Gangetic plain, there is an increasing tendency to use water in the territories by the upper riperian, be they sovereign nations or even states within that nation. Nepal and India have separate agreements for Koshi, Gandak and Mahakali. Similarly, India and Bangladesh have Farakka Treaty on the sharing of the Ganges waters, Regional cooperation especially on the water resource development and management among these countries would be in their common interest which could be materialized through negotiations.

5.5 HIGH PRODUCTIVITY GROWTH SCENARIO

As proposed by APP the irrigated area in Nepal is to be substantially increased in the next two decades. Year-round irrigation is the main component of APP strategy. The Plan calls for 34 thousand hectares to be added per year to the year round irrigated area, on an average of this about 70% is from groundwater irrigation. By the end of APP period, the unirrigated area will decline to 14% of the arable area in terai and 67% in the hills. In addition, it assumes increases of 50% in the growth rates of research expenditures and modern variety coverage. The APP aims at increasing the agricultural growth from the previous trend level of about 2.3% to 5%. It is expected that in an agriculture dominated economy, agricultural growth stimulates also the growth in non-agriculture sector. The growth in agriculture helps poverty alleviation first through the increase in agriculture sector and then also through induced effect in non-agriculture sector. It is estimated that through the successful implementation of this plan, poverty will be reduced to 14% from the present level of over 45% population below poverty line.

6. CHALLENGES FOR THE FUTURE

6.1 MAJOR CHALLENGES AND CONSTRAINTS

The major challenge facing Nepal in agricultural development, food security and rural development on the way to 2025 is growing food deficits, both nationally and locally, which has pushed the incidence of food insecurity to unacceptable levels. Other possible consequences include rapidly rising and unsustainable food import bills and further environmental degradation, as farming moves on to marginal areas.

A consensus exists on the constraints to rapid growth of agriculture in Nepal. Despite government efforts over the past three decades, agricultural productivity remains very low, relative to what has been proven to be economically feasible in Nepal as well as achievements in similar environments in India. Moreover, a high rate of population growth also reduced the benefits from whatever progress there was made in production and incomes. Public sector investments in key areas such as irrigation, research and extension proved to be much less effective than expected. Also, agricultural policies suffered from a lack of clear focus and implementation was weak.

Categorically there are five major problem areas which have adversely affected the performance of the agricultural sector in Nepal. First, the government assisted irrigation systems which have received the major share of investment in agriculture in the last three decades have been performing below expectations in terms of reliable and adequate water delivery to farmers, thus limiting gains from new agricultural technology. Second, the public sector, which until recently had a monopoly on the importation and distribution of fertilizer, failed to meet the demand of farmers to substantially improve crop productivity. Third, the lack of responsiveness of research system to the actual conditions of farmers in the design of new technology has been a major problem. The failure to develop technology for rainfed and low input conditions, which predominate in the country, has constrained agricultural growth. Fourth, neglect of marketing in government agricultural programs has severely limited growth even in those areas where farmers have demonstrated their ability to generate surplus production. Fifth, the macro economic policy environment which prevailed in the past was not particularly conducive to agricultural growth. The exchange rate discouraged agricultural exports and pricing policies for major inputs and outputs remain distorted. Also, public sector undertakings enjoyed preferential treatment and private sector faced restrictions.

6.2 POLICY, INSTITUTIONAL IMPLICATIONS AND MAJOR ISSUES IN IRRIGATED AGRICULTURE

A detailed analysis of past weaknesses in the area of policy and institutional and proposed changes required for achieving the targeted high growth rate in agriculture are rumanarized in the policy and institutional matrix.

In irrigation the following issues have been identified :

- Developed irrigation facilities not utilized to the optimum/lack of basic inputs
- Organization and management deficiency
- Problem of cost recovery, adequate operation and maintenance
- Problem of high cost of irrigation projects
- Lack of objective criteria for guiding investment in irrigation development
- River management
- Adoption of new technology/poor research base.

These issues and the associated constraints along with the strategies to be taken in the future are summarized in the following matrix.

Nepal - Policy and Institutional Matrix

Policy	Constraints	Actions
Population	High population growth	Step by efforts to control population, step up women's and information education
Public sector investment	Thin distribution of agricultural investments in large areas	Concentrate public-sector resources to priority areas as identified by the APP (irrigation, fertilizer, research and agricultural roads)
Decentralization and private sector development	Weak local political bodies to plan and implement; weak private sector to provide technical services; insufficient decentralization of power and resources	Speed up decentralization program; empower local political bodies and increase their capacity to plan and implement; encourage NGOs; create a conducive environment for maximum participation of private sector in inputs delivery and services
Institutions	Slow response of institutions to changing development needs; agrarian institutions not supportive of high agricultural growth; impediments to marketing	Create new and/or reorient existing institutions as called for in the APP (e.g. capacity in agricultural roads, groundwater); reform land tenure laws to encourage investment by tillers on land; take measures, including

		legislative to create competitive markets
Inputs and technology	Insufficient supply of inputs, constrained both by subsidy policies and weak delivery capacity; fragmentation of research resources and manpower	Eliminate subsidies that have constrained aggregate supply in the past; involve private sector in delivery of inputs, credit and services; re-orient agricultural research resources as called for in the APP; shift priority to groundwater and support farmer managed irrigation systems; strengthen private sector capacity in groundwater development.

7. POLICY DIALOGUE MODEL (PODIUM)

The Podium model developed jointly by IWMI (International Water Management Institute and IFPRI (International Food Policy Research Institute) has been used to determine increasing grain requirements and water demand. The model also computes the production of the required cereals using data and estimates of yields and cultivated areas both in rainfed and irrigated conditions.

Issues, constraints and strategies in irrigation sector

Issue	Constraints	Strategies
Performance of Public Sector Irrigation Schemes	Poor Maintenance (canal and drainage system deterioration, siltation) Ineffective control structures (water losses, untimely delivery)	Management Transfer to Users Full Recovery of O&M needs from users Conjunctive Management Interbasin water transfer
River Management	Deforestation in Watersheds Flood plain encroachment Inundation in tail reaches	Integration of watershed management with rural development programs Participatory mode of implementation Promote intersectoral linkages Develop common programs with the neighboring SAARC nations
Costs of Irrigation Projects (Surface and Groundwater)	Poor planning design, technology, non-involvement of farmers Poor quality of construction Involvement of expensive consultants Weak construction industry Time/cost overruns	Strengthen planning, M&E Adoption of low cost and environment friendly technology / Groundwater legislation Use local experts/labor/ construction materials Strengthen R&D and develop linkages with sister agencies.
Criteria for guiding investment in irrigation development/management	Investment based on supply considerations and ad hoc decisions inefficient water use	Investment plans based on objective criteria Promote conjunctive water management

	Seasonal irrigation Lack of conjunctive water use Policy gaps/implementation	Participatory mode of program development On-farm water management introduce micro irrigation.
Organization and Management	Lack of accountability of public institutions to users Limited skills/motivations of agency staff Weak agriculture - irrigation sister agency linkage Lack of data	Strengthen water users associations (WUAs) Active involvement of women farmers Involve private sectors (NGOs) Strengthen planning/design Develop linkages with other institutions Strong monitoring

RESULTS

According to the UN medium projection, in the next 25 years Nepal's population will grow from 21.9 to 38.0 million people. The urban population is growing at a faster rate than the rural. In 1995, 90% lived in rural areas, whereas in 2025 it is predicated that 77% will live in rural areas. It is foreseen that the calorie intake will increase along with income from 2268 Kcal/day/cap in 1995 to 2700 Kcal/day/cap in 2025. Meat consumption increases slightly but the bulk of food consist of grain (70%). The population growth combined with changes in diet will lead to an increase of grain requirements from 3.97 million ton in 1995 to 8.3 million ton in 2025. This is compatible with predictions made by Thapa and Rosegrant (Winrock, 1995), using the high-income scenario. Over the last decades Nepal tried to be self-sufficient in grains. The last few years the gap between consumption and production is increasing since the population growth is higher than the growth in agricultural production. Still, the import is very small in comparison with the domestic production. If Nepal is to be self-sufficient in grains in 2025, what will be the requirement in terms of land and water resources? The APP mentions an increase in irrigated area of 34,000 ha per annum during the coming 20 years from 1995 onwards, that is from 0.88 million ha to 1.56 million hectares in 2015. If this growth rate can be maintained till 2025 the ultimate irrigation potential of 1.7 million hectares will be reached. If the irrigation intensity improves to 150% irrigated cereal yields (milled rice equivalent[1]) need to increase from 2.0 to 3.5 ton/ha. An enormous investment will be needed to expand the irrigated area to this extent. If irrigated cereal yields would double from 2.0 to 4.0 ton/ha and the intensity reaches 175%, only 1.23 million hectares of irrigated area would be needed, instead of 1.7 million hectares. More emphasis on productivity and intensifying agriculture at the existing irrigated area might prove a cheaper and more achievable option, than doubling the irrigated area. Water withdrawals for irrigation will be around 10 km3 in the year 2025, depending on the scenario chosen. This is less than 6% of the available water resources.

CONCLUSION

Water availability will not be a limiting factor for development in the country. However, substantial increases in agricultural production will be needed if Nepal is to be grain self-sufficient by the year 2025. Over the last decades the emphasis in the irrigated sector has been laid on expanding the irrigated area. However, the productivity of the existing irrigated area is stagnating at a very low level, whereas in rainfed areas yields show even a declining trend. To achieve grain self-sufficiency yields in irrigated area should be improved considerably. If this is not achieved, Nepal will be food importer by 2025, despite the huge investments in the construction of irrigation infrastructure, foreseen in the APP.

THE NETHERLANDS

PREFACE

During the past three years the Ministry of Transport, Public Works and Water Management of The Netherlands has prepared the 'Fourth National Policy Document on Water Management in The Netherlands'. The document was published in March 1999. During its preparation intensive studies were conducted on various important issues to prepare a vision on the future of water management in The Netherlands. In parallel, a wide range of consultations were held with all the stakeholders, associations and the general public. Based on this information a policy document has been prepared. The document has been approved by Parliament.

While this work was recently done, the Netherlands National Committee for Irrigation and Drainage (NETHCID) requested the Ministry if, for the preparation of our country position paper, we could use the policy document. It agreed. Therefore the core of this paper is composed of the parts of the policy document that are directly, or indirectly, related to the role of water for agriculture and rural development. In addition, some information has been added on agriculture and rural development in The Netherlands as well as on the longer term perspective for The Netherlands as a low lying country in the deltas of the rivers Rhine, Meuse and Scheldt and bordering the North Sea.

EXECUTIVE SUMMARY

The Netherlands is a low lying, densely populated country bordering the North Sea. The major part of the country consists of lagoon and delta type areas, originating from the deltas of the

Rhine, Meuse and Scheldt rivers. The Dutch have made this area inhabitable by reclamation and protection against water. But to create their country the Dutch had to fight for centuries against water coming from the North Sea, the rivers, rainfall, or from waves on the lakes during storm surges.

The present land area comprises $3.4x10^6$ ha, of which about one third is situated below mean sea level, whereas about 60% of the land is protected against flooding. The Netherlands is a very densely populated country, varying from 190 inhabitants per km^2 in the northern part to 915 inhabitants per km^2 in the low lying western part. The cities and industrial areas are mainly located in the western part, whereas the agricultural lands are spread throughout the country. The forests and nature reserves are located predominantly on the relatively wet soils in the western and northern part and on the sandy soils in the dunes and in the eastern part.

The major part of this country position paper is devoted to the National Policy on Water Management in The Netherlands which recently has been formulated in the Fourth National Policy Document on Water Management. The policies contained in the Fourth National Policy Document on Water Management encompass the period 1998 - 2006, with occasional glimpses into the more distant future. In addition a 'philosophic' view has been given on the long-term future scenarios and aims, resulting in the challenges for the future.

'A safe and habitable country with a healthy and sustainable water systems': this is the aim which Dutch water management faces the future in 1998, the year which marks the two-hundredth anniversary of the Netherlands Directorate-General for Public Works and Water Management ('Rijkswaterstaat'). The first part, to ensure a safe and habitable country, has existed for centuries and is in fact what gave rise to the establishment of 'Rijkswaterstaat' in 1798. After all, the nature of The Netherlands as a water-logged country is such that it must constantly be protected against flooding from the sea and rivers. At the same time, a constant effort has had to be invested in the consolidation of the soft subsurface in order to keep the country habitable and cultivable. The second part, to ensure 'healthy and sustainable water systems', has a much shorter history. It was not until the late 1960s that the problem of surface water pollution led to systematic action to tackle the main sources of pollution. By that time, the poor quality of the surface water presented a threat not only to public health but also to wildlife habitats. The two halves of the aim were initially addressed via a two-track policy approach, but during the 1980s there was a growing realisation that the aim of public safety and habitability could not be viewed in isolation from that of a healthy and sustainable water system. Moreover, it became clear that water management could achieve these aims much more effectively and efficiently if the policies directed at them were not only closely interrelated but also carefully co-ordinated with other relevant areas of policy. In the 1980s, this became known as integrated water management.

This philosophy was developed further in the Third National Policy Document on Water Management (NW3), published in 1989. Integrated water management and the water systems approach have become key concepts in the water management of the 1990s. Thanks to the support the NW3 attracted from the various authorities concerned with water management in The Netherlands, much of it has now been translated into concrete measures and the combined aim is now somewhat closer to realization. However, despite the success of this policy and management based on it, it has still proved necessary to conduct a new review of water management policies and to modify them where necessary in light of new social trends, continuing subsidence, expected climate change and other factors. The results of this process are formulated in the policy directions mapped out in the Fourth National Policy Document on Water Management (NW4). NW4 focuses on the development of an integrated approach to water systems at various levels, starting close to home and moving gradually outward to the great oceans. The advantage of this approach is that it reveals the interrelationship between the various levels of scale and it makes it easier for users and managers to identify with the issues. Because the subjects of flood protection, water depletion, emissions and aquatic soils have been regularly in the limelight over the last few years as major policy issues on which NW4 would produce decisions, these themes have been given their own separate section in the policy document alongside consideration of the water systems as a whole.

Directly related to water for food and rural development is the fact that new farming methods have impaired nature and landscape, whereas increasing urbanization and expanding highway and railroad infrastructures have put the rural area of The Netherlands under great pressure. Additional factors are the growing interest in nature and landscape development and conservation, the ecological awareness, and the increasing need for outdoor recreation. In other words, the rural area of The Netherlands needed to be assigned other functions in addition to agriculture. Therefore the general objective of land development in The Netherlands is to improve the layout and infrastructure of the rural area in accordance with the functions of the area that are indicated within the framework of physical planning. Measures can be taken for improving the socio-economic conditions in the agricultural sector (agriculture, horticulture, forestry) and the conditions of other sectors (like development, conservation nature, and outdoor recreation). These measures refer to construction and improvement of rural roads, the water management system, exchange of agricultural land between farmers (in order to come to a more economic ownership) and improvement of field drainage, as well as delineating lands for other public uses with the related physical works.

Regarding challenges for the future it is important that the processes and trends be observed - the rise of the sea level, subsidence, higher requirements for safety, water quality and environment - will continue in the next century and will make the delta area of the Rhine, Meuse and Scheldt rivers even more vulnerable. A new picture of the future is taking shape in which water management will have to be adjusted because of the accelerated rise of the sea level, the additional intervention in the regime of surface and ground water due to the continuing urbanization and a large-scale use of underground construction.

1. INTRODUCTION

The Netherlands is a low lying, densely populated country bordering the North Sea. The major part consists of lagoon and delta type areas, originating from the deltas of the Rhine, Meuse and Scheldt rivers. The Dutch have made this area inhabitable by reclamation and protection against the water. But for this creation of their country the Dutch had to fight for centuries against water coming from the North Sea, the rivers, rainfall, or from waves on the lakes during storm surges.

The present land area of The Netherlands comprises $3.4x10^6$ ha. As a result of land reclamation and subsidence about 30% is situated below mean sea level, whereas about 60% of the land is protected against flooding.

The Netherlands is a very densely populated country, varying from 190 inhabitants per km^2 in the northern part to 915 inhabitants per km^2 in the low lying western part. The cities and industrial areas (8%) are mainly located in the western part, whereas the agricultural lands (71%) are spread all over the country. The forests and nature reserves (9%) are located predominantly on the relatively wet soils in the western and northern part and on the sandy soils in the dunes and in the eastern part.

This country position paper starts with a brief description of the history of water management in The Netherlands. The major part of the paper is devoted to the National policy on water management which recently has been formulated in the Fourth National Policy Document on Water Management. The policies contained in NE4 encompass the 1998 - 2006 period, with occasional glimpses into the more distant future. In addition attention is paid to the present status of food and rural development. At the end a 'philosophic' view gives long term future scenarios and aims, resulting in the challenges for the future.

2 WATER MANAGEMENT IN THE NETHERLANDS

2.1 INTRODUCTION

History

The history of water management shows how the original natural landscape was transformed into a man-made landscape in a never-ending struggle with water. At present 'Laag-Nederland' (the low part of The Netherlands) in particular, virtually constitutes one hydraulic work, mainly created by man: a patchwork of lands gained from the sea, polders, lakes and meres, crossed by innumerable ditches and canals. Characteristic of water management throughout the centuries has been its small scale, great attention to the maintenance of existing works and its careful management. Although large-scale hydraulic works were accomplished at regular intervals, specific local conditions have always been taken into account. Inhabitants of the coastal areas settled on the levees and creek ridges along the rivers and salt marshes, on the sandy grounds and the strips of clay behind the dunes long before the Christian era. There is evidence that around 100 BC the first small hydraulic works were carried out in the western part of The Netherlands. However, the fight against water that resulted in the present situation of The Netherlands started in the 9th century on a minor scale involving a small number of inhabitants with modest demands. People were faced with technical problems that required solutions, if they were to survive. However, these provisions entailed new problems. A clear example is provided in structures to protect the land from the floods of rivers and the sea.

In the 9th century people started to move into the adjacent, huge peat areas. They lowered the groundwater level of these waste lands, which were situated a few metres above mean sea level, by digging a system of ditches to the lower adjacent waters. This cultivation process was competed in the 14th century. It has left its ineradicable mark on the landscape of the west The Netherlands. The expansion of these, at first massive, interventions in the hydrological situation repeatedly stagnated in the 12th and 13th centuries as a result of a series of severe storm surges, swallowing up large parts of the cultivated land gained and allowing the present IJsselmeer to be transformed from a small inland sea into a large estuary, called the Zuiderzee.

In this period local communities that were located in the first danger zone started to connect their local dikes. This was the start of collective dike construction. This second radical intervention in the hydrological system caused a chain reaction that is still going on. The immediate hydraulic effect of impoldering and the accompanying upheaval of the water storage and flooding across the land was a rise in flood levels. Impoldering of a certain area also affects the flood levels in other areas and so the rise spread further and further. The more people wanted to protect themselves against higher floods, the more the flood levels rose. In the longer term, impoldering has a morphological effect as well. According to the local situation a drop or a rise in the river bed may occur, mainly caused by accretion. This, again, leads to a further rise of flood levels. As the river sediments can no longer be deposited on the flood plains after impoldering, there is no further gain of land.

The protection against floods naturally improved the living conditions of the inhabitants and resulted in higher crop yields and more diversification. The cultivation of the peat lands caused a considerable drop of the surface level due to subsidence and oxidation. The subsidence of the deeper sub-soil layers, due to natural causes, continued as well. These processes resulted in a drop of the ground level, amounting to two to three metres in the course of the centuries. This made it necessary, sooner here and later there, to impolder the old cultivated grounds, initially by means of small sluices that could be opened at low outside water. During the15th century windmills brought help. During the 19th century these windmills, in their turn, were replaced by steam engines and in the 20th century by electric and diesel engines.

Thus, one simple intervention in the natural condition of the deltas has had far-reaching consequences. Suggestions have been made to surrender certain parts in 'Laag-Nederland' to water in order to partly restore the natural processes, but this has only been done on a very small scale because of opposition from inhabitants.

Present day and future water management

'A safe and habitable country with healthy and sustainable water systems' this is the aim with which Dutch water management faces the future in 1998, the year which marks the 200th anniversary of The Netherlands Directorate-General for Public Works and Water Management ('Rijkswaterstaat'). The first part of this aim, to ensure a safe and habitable country, has existed for centuries and is in fact what gave rise to the establishment of 'Rijkswaterstaat' in 1798. After all, the nature of our low-lying, water-logged country is such that it must constantly be protected against flooding from the sea and the rivers. At the same time, a constant effort must be invested in the consolidation of the soft subsurface in order to keep the country habitable and cultivable.

Water systems approach

The second part of the aim, to ensure 'healthy and sustainable water systems', has a much shorter history. It was not until the late 1960s that the problem of surface water pollution led to systematic action to tackle the main sources of pollution. By that time, the poor quality of surface waters was presenting a threat not only to public health but also to wildlife habitats. The two halves of the aim were initially addressed via a two-track policy approach, but during the 1980s there was realized that the aim of public safety and habitability could not be viewed in isolation from that of healthy and sustainable water systems. Moreover, it became clear that water management could achieve these aims much more effectively and efficiently if the policies directed at them were not only closely interrelated with each other but also carefully co-ordinated with other relevant areas of policy. In the mid-1980s, this realization became known as integrated water management.

Integrated water management

This philosophy was developed further in the Third National Policy Document on Water Management (NW3), published in 1989, and integrated water management and the water systems approach have become key concepts in the water management of the 1990s. Thanks to the support the NW3 attracted from various authorities concerned with water management in The Netherlands, much of it has now been translated into concrete measures and the combined aim is now somewhat closer to achievement. However, despite the success of this policy and management based on it, it has still proved necessary to conduct a new review of water management policies and to modify them where necessary in the light of new social trends, continuing subsidence, expected climate change and other factors. The results of this process were formulated in the policy directions mapped out in the Fourth National Policy Document on Water Management (NW4) which focuses on the development of an integrated approach to water systems at various levels of scale, starting close to home and moving gradually outward to the great oceans. The advantage of this approach is not only that it reveals the interrelationship between the various levels of scale, but also that it makes it easier for users and managers to identify with the issues.

Themes

Because the subjects of flood protection, water depletion, emissions and aquatic soils have been regularly in the limelight over the last few years as major policy issues on which NW4 would produce decisions, these themes have been given their own separate section in the policy document, alongside the consideration of the water systems as a whole.

2.2 STRATEGY, KEY POLICIES AND PROSPECTS

Integrated water management

NW3 set out a new strategy under the name of integrated water management. This was based on the view that the aims of water management could only be achieved via an integrated approach. Integrated water management has been a success and NW4 wholeheartedly pursues the same approach. The process of public consultation revealed the need both for more vigorous implementation and for a broader and deeper integrated water management approach. The Dutch Aquatic Outlook project has demonstrated that a number of NW3 objectives cannot be achieved within the time-limits set for them in the policy document unless policies are modified. In recent years the threat of flooding along the various branches of the Rhine and the floods in the Meuse basin have made it clear that measures to prevent repetition of these events will involve more than simply raising the dikes. A strategy directed at a sustainable solution demands measures relating to the wider situation, and not just to the dikes or the river system itself. For this reason, NW4 advocates improved co-ordination between policies on water management, physical planning and the environment. It argues that the co-ordinated policies should take account of all the various interests involved, including flood protection, agriculture, ecology, public water supplies, transport, recreation and the fishing industry. At the same time, they should provide scope for tailor-made local solutions, leading to a combination of an integrated generic approach aimed at achieving common countrywide targets and a specific regional elaboration of policies which takes account of local circumstances and opportunities.

Major economic interests

Water is of great economic significance to The Netherlands: it is a means of transport, a production factor in agriculture and industry, the raw material of public water supplies, a cooling agent and an intrinsic feature in the landscape, ecology, culture and history. Investing in effective water management (protection and exploitation) will lay the basis for the development of a high-quality industrialised society. The replacement value of the investments protected by the flood defences is estimated at over NLG $4x10^{10}$ ($2x10^{10}$ US$). Constant consideration and care of the country's water systems is an absolute precondition for the development and preservation of The Netherlands.

Responding to events

Water presents a threat whenever there is too much or too little, or when it is too warm or too polluted. For centuries, people in The Netherlands have been constructing and adding to an astonishing infrastructure, from drainage ditch to river system, designed to control the country's water resources and protect it against flooding. The decisions underlying their various contributions reflected the priorities of their day: agriculture, shipping and flood protection, or more recently the environment, landscape and ecology. In the future, such decisions will have to take account of the expected climatic changes, rises in sea-level and continuing subsidence.

Main aim of NW4

The main aim of NW4 is to have and maintain a safe and habitable country and to develop and maintain healthy and resilient water systems which will continue to guarantee sustained use.

Increase integration and involvement

Over the last 25 years, there have been rapid advances in The Netherlands not only in water management policies but also in policies on the environment, physical planning and ecology. These have helped to guide the development of society. Problems have been identified in a wide variety of sectors and many of them have been solved. Unfortunately, there has not always been sufficient recognition of the logical interrelationships between the various policy fields. Greater integration is needed. The future water management policy represents a change: a switch from addressing problems as they arise to looking ahead and encouraging positive development. The water systems need to be flexible and resilient. Instead of constantly correcting what has gone wrong, it is preferable to prevent damage occurring in the first place, to conserve what is good and if possible to create scope for the exploitation of new opportunities. Policy has moved further in some areas than in others. Some areas are currently making the transition from one stage to another.

Increasing resilience

An important principle for future water management is to base measures on natural processes and to restore the resilience of water systems. This can be achieved by encouraging water conservation and buffering to make areas more self-sufficient. This will have the additional advantage of alleviating current water depletion problems and contamination by non-indigenous water. It can also help to expand wetland areas and prevent flooding. It will help to ensure that problems are resolved within river basins rather than transferred to adjacent areas.

In terms of reducing pollution, much has already been achieved, but that is no reason to sit back and rest. Use functions are still being restricted and necessary modifications of the hydrological system complicated by continuing diffuse pollution and the legacy of past pollution in the form of contaminated aquatic soils. Water managers will not be able to relax their attention with regard to pollution. On the contrary, they must tackle these problems with renewed vigour.

Area-specific policies

The water management policies can only succeed if they are pursued in co-operation with those directly involved and therefore through measures in their direct vicinity. This means that local and regional problems must be addressed wherever possible at that level. Accordingly, national objectives and standards must provide scope for area-specific policies at a local or regional level. This requires a new approach and the modification of norms and targets set in the water evaluation policy document.

Framework for some area-specific water system policies

The main features of the national framework for area-specific water system policies are dictated by:

- the functions assigned to the main water system, as shown in NW3, combined with the course set for rural areas;
- the basic principles of integrated water management as laid down in NW3:
- stand-still principle, precautionary principle, 'polluter pays' principle and the water systems approach. In addition, other policy fields must also recognise the need to concern themselves with water systems. Water is not only a factor in the economy, ecology, and social and administrative structure of the country, but also a basic factor on which to structure
- physical planning;
- policies for the rural areas as laid down in the Green Space Structure Plan and the policies for the major rivers as laid down in the 'Room for the Rivers' policy approach;
- countrywide norms for water, soil and air, as laid down in past or future national policy documents; and
- the policies outlined in NW4 and National Environment Protection Program (NEPP3).

Prospects

The policies in the NW4 are expected to produce a further improvement in the functioning of water systems. The government proposes to make an extra NLG $3x10^9$ available up to the end of

2015 to protect the country against flooding. This sum is intended (in this order of priority) to restore revetments of the dikes around the coast and the Ijsselmeer, to ensure the safety of areas protected by river dikes and to protect against flooding in the undiked sections of the Meuse. This financial injection will be sufficient to fund most of the new approaches to flood prevention along the major rivers - an approach that will provide lasting protection for the areas themselves and have a positive impact on the ecological and recreational value of the river flood plains.

This approach, aimed at increasing the resilience of water systems by basing measures as far as possible on natural processes, can also be translated to other areas. The prime example is the coast, but the approach is also relevant to water management in urban areas. In the latter case, closer co-operation between municipalities and water-boards will provide opportunities to enhance the various functions of water in the urban areas and reduce adverse effects on the surrounding area.

The new policy of strengthening the relationship between water management and other policy fields - the environment, physical planning and ecology - should prove beneficial to all the policy fields involved. In physical planning, the new approach will mean that water is regarded as a basic factor on which to structure planning.

Further progress in combating water depletion seems to be achievable through a combination of function modification, water management measures and - in some cases - restricting or reallocating licences for groundwater abstraction. It is still thought feasible to achieve the objective of rehabilitating 40% of the area affected by 2010, although to do so will require considerable effort by provincial authorities and water-boards.

There is particular concern at present about the contamination of aquatic soils by surface water pollution from diffuse sources. The Action Plan on Diffuse Sources represents a major move in the right direction, but must still be regarded as merely the first step towards the achievement of longer-term water and soil quality goals. Contaminated sediments increase the cost of management and maintenance. On the basis of current budgets, measures to clean up severely contaminated sites and restore functions in various localities will take a long time to complete (between 25 and 40 years).

2.3 WATER SYSTEMS

This section focuses on water systems, starting locally and working outwards. It looks first at the regional waters, beginning with the water in built-up areas. Then it turns to the major rivers, the Blue Heart and the southern delta.

Urban water

Waters in urban areas are an integral part of regional water systems and cannot be viewed in isolation. Nevertheless, there are reasons for devoting a separate part to urban water management. The problems of flooding and groundwater seepage, waste water and water consumption are different from those in rural areas. The ecological potential of the urban water system is under-exploited. Urban water is a hitherto forgotten part of regional water systems. A new appreciation and upgrading can have extremely positive results both for the urban water bodies themselves and for the regional systems.

Recently there have been a number of promising schemes directed at more sustainable management of urban water. Major elements in these are domestic measures to save water, the separation of urban run-off from the sewage system, the retention of rainwater in ponds and in the ground, and a new appreciation of the value of water systems in relation to the lay-out of new or established residential areas.

Regional waters

Management of the usually small-scale regional water systems will be heavily influenced by the close interaction between land and water. Water management cannot be viewed in isolation from land use. Success will be wholly dependent on the adoption of an integrated approach on a regional scale. There will be a close relationship between subsidence and the assignment of functions. An integrated approach will be adopted to water management, physical planning and ecological and environmental policies for the region. Local groundwater situations will become the basis for regional planning. Water as a basic principle underlying planning will be the linchpin in regional water management.

Eutrophication of lakes will be reduced. The natural resilience of water systems will be restored or enhanced. Pollution problems will no longer be passed on from one water system to another. Since aquatic soils will be of good quality, dredging spoil can once again be dispersed on land. The water depletion objectives will be achieved and maintained. Policies on water management, physical planning, ecology, the environment and agriculture will all be fully harmonised. Progress will be made in reducing/delaying subsidence by changing functions and taking measures, particularly in parts of The Netherlands below sea-level.

The major rivers

With regard to the major rivers, the main challenge over the coming decades will be to maintain flood protection in the face of larger design discharges, while at the same time conserving landscape, ecological and historical features, promoting navigational use and creating new wildlife areas. In other words, integrated river management. Sustainable flood protection along the rivers will be achieved through a combination of measures: retaining the water, giving the rivers more room to expand and taking precautionary measures. Integrated river management calls for an approach encompassing the entire river basin. Close co-operation with the other riparian states along the Rhine, Meuse and Scheldt will be vital. Water management, physical planning and habitat creation will go hand in hand.

Over the coming decades, the winter beds of the major rivers will undergo dramatic changes. Fifteen years from now, the rivers should be flowing over beds designed to optimise the safe discharge of water and ice. Barges will make their way easily between seaports and the hinterland. The major rivers will form blue ribbons connecting the North Sea and areas upstream and the winter beds will be closely related in ecological and landscape terms to adjacent areas outside the dikes and beyond. A few polders will be reserved for temporary storage of water during times of exceptional peak discharges.

The achievement of this scenario will be associated with a radical reassignment of functions and large-scale engineering works. Rivers will be given room to expand as they did in the past, primarily by making their winter beds broader and deeper. Here and there, a main dike may be moved landward, but landscape, ecological and historical features will be respected and integrated wherever possible. The river landscape will change, but will remain typically Dutch: small-scale landscapes will open out occasionally into wide panoramas and riverside towns and villages will not be allowed to expand at the expense of the river, but will retain their links with it. The area around major rivers will be a splendid place for people to spend their leisure time. Therefore the Government will :

- allow the rivers more room to expand. The government will pursue policies based on the philosophy underlying the 'Room for the Rivers' approach. Wherever possible, unnatural obstacles will be removed, side-channels will be restored and winter beds will be deepened;
- draft a plan for the expansion of the flow area of the Rhine and the Meuse, to be completed by the year 2000 and implemented in 2000 - 2015 (central and local governments). This will create opportunities for enhancing the National Ecological Network of protected areas. Dike strengthening will become the flood protection measure of last resort;

- increase co-ordination between water management, physical planning and habitat creation. The long-term strategy for the major rivers will be rooted in a national physical planning policy;
- encourage the rapid establishment of international action programmes for the protection and exploitation of the major rivers and the achievement of sustainable river flood protection. A high priority will be given to implement these programmes;
- during discussions on the EU framework directive on water, advocate integrated management of the (transborder) major rivers as an interpretation of the concept of 'river basin management';
- promote efficient navigation by dealing with deficiencies in the inland waterway infrastructure;
- give a high priority within regional and urban water management to retaining water longer within river basins.

The Blue Heart

The IJsselmeer, the Markermeer, the chain of inland lakes between Kampen and Almere known as the Randmeren, the Amsterdam-Rhine Canal and the North Sea Canal are all man-made water systems and all part of the same storage basin: the vital Blue Heart of The Netherlands. Fed by the various branches of the Rhine, the Blue Heart plays a crucial role in the water management of the northern half of The Netherlands. The Heart is engineered in accordance with current ideas, but is not completely up to date. Its present infrastructure takes no account of the wish to meet the rapidly increasing demand for water by eventually abstracting more surface water. Nor does it take account of rises in sea-level. The management of water levels is unnatural, but cannot be changed without modifying the infrastructure of the surrounding areas. Where the rivers flow out into the sea, there is a sharp division between fresh water and salt. Demand for recreational uses is increasing and will have to be controlled. At the same time, commercial shipping is also of growing importance. More and more claims are being made on the limited space available. It is time to draw up an integrated scenario for the future development of the IJsselmeer area.

Consensus needs to be reached about the hydrological design of the Blue Heart. Its scale and openness offer scope for almost every conceivable water-related function and its ecological features and potential for water-based recreation will make it an area of international importance. Flood protection will continue to be guaranteed.

The southern delta

The southern delta, originally an area of interconnected estuaries, has changed considerably over recent decades. Over the years taken to implement the Delta Project (designed to protect against flooding), policy came increasingly to be directed at maximising the conservation of the area's valuable ecological features. This led to parallel investments in conservation and, where necessary, restoration of healthy water systems in the Eastern Scheldt, Grevelingen, Veerse Meer, Western Scheldt, Volkerak-Zoommeer and Haringvliet-Hollandsch Diep. Despite the frequently valuable ecological features of these systems, the compartmentalisation required for greater flood protection produced sharp divisions which can also make an area vulnerable from the hydrological and ecological points of view. Partial restoration of the links between the systems would not only increase their resilience but also restore saline gradients and so provide opportunities for further enhancement of the ecology.

The natural processes in the Delta should be restored and enhanced. There should be a greater exchange of water between the various compartments. Natural, gradual transitions will be restored and water levels will fluctuate in a natural way. Flood protection will be maintained.

2.4 THEMES

Apart from defining the water systems and the policies to be developed for them, this section addresses some specific topics on which policy decisions have been widely expected.

Flood protection

Without the dikes and dunes, more than half of The Netherlands would be regularly inundated. So the extensive system of dikes and dunes is essential to the safety and habitability of the country and an absolute precondition for healthy economic development. The Dikes Act is the statutory basis for flood protection. For centuries, flood protection has been synonymous with dike-building and maintenance. However, the floods of recent years have taught us that sustainable protection means more than periodic dike strengthening. It can best be achieved by working hand in hand with natural processes We need to step back and give the rivers, estuaries and coast more room to evolve.

In a country like The Netherlands, flood protection must never be neglected. The management and maintenance of flood defences must always be a top priority. Climate changes may soon lead to higher design water levels. Our water systems need room to evolve if they are to cope with uncertain and unforeseen future developments. For the rivers, this means water conservation throughout the entire river basin and enlarging the flow area of the river rather than embarking on a further round of dike strengthening. Where the coast is concerned, it means extensive sand nourishment instead of 'hard' engineering structures. Room for water also means that we may sometimes need to take a step back and, for instance, stop building in the flood plains of the rivers, on the beaches and in the dunes facing the sea, and reserve land for possible future use to maintain flood protection.

Where flood defences are concerned, measures relating to the sea defences have the highest priority followed by those in the diked sections of the rivers. Both situations have risks to human life and little advance warning. Measures along the undiked sections of the rivers have a lower priority because they present no risk to human life. But there is no such thing as absolute safety. Whatever we do, we may at some time face a water level which our flood defences are simply not designed to withstand. We must learn to live with the awareness of that residual risk and be prepared to cope with such circumstances if they occur.

Related to flood protection the following actions will be undertaken :

- completing of the Delta Plan for the Great Rivers;
- assessment of the safety of the primary defences (dike authorities; first round: now to 2001; second round: 2001 - 2006). Development of safety standards for non-primary flood defences (provinces and water-boards);
- preparation to change to an approach based on flood risk for areas within ring dikes;
- initiation of a debate about residual risks. Co-operation with municipalities and water-boards to develop plans to deal with the threat of any real flood emergency.

Water depletion

A total of 6.2×10^3 km^2 of Dutch countryside is regarded as suffering from water depletion. The figures belie The Netherlands' watery reputation. Water depletion is in fact one of the main causes of deterioration in habitat quality in The Netherlands. NW3 recognised the problem and since its publication there has been a widespread effort to combat it. The rehabilitation of the affected land calls for measures both within the areas and outside them. Surrounding areas may have a broad range of uses, from residential to agricultural. For this reason, many areas suffering from water depletion may require an integrated approach extending far beyond the borders of the area itself - an integrated approach which brings together the necessary quality and quantity standards from wetlands to regional water systems. This kind of approach is necessary but complicated. Central government will continue to encourage and support that approach throughout the plan period.

The objective for 2010 is a 40% reduction in the area of countryside suffering from water depletion as compared with the 1985 figure. In order to achieve this, an integrated approach will be developed to deal with water depletion in relation to other water management issues. Eventually, target groundwater levels will be achieved throughout the country.

Aquatic soils

The quality of recently formed aquatic soils shows distinct improvement compared with that of earlier sediments, but even so there is still widespread pollution. This substantially increases the cost of maintenance dredging to ensure adequate river discharge and navigational depth. In addition, the restoration of water systems requires not only clean water but also uncontaminated aquatic soils. The main solution is to tackle the sources of pollution, but there is also a need to remove severely contaminated aquatic soils. Over the next few years consideration will be given to replacing the rigid classification of dredging spoil with a more flexible approach by which spoil will be dispersed where this would do no harm to the recipient system, treated (separation, purification, use) where financially feasible, and dumped only as a still indispensable, but environmentally and cost-effective, last resort.

Eventually it must be possible once again to use dredging spoil from maintenance work on shipping channels, ports, canals, ditches, etc. as a valuable raw material for a variety of uses. This will reduce the need for treatment and make dumping a thing of the past. The following actions are planned :

- to explore the potential for storing dredged spoil in deep pits located, for example, in the river flood plains;
- to build a large spoil storage depot in the Hollandsch Diep;
- to use simple sand-separation techniques at large storage sites;
- to give further encouragement for re-use of dredging spoil, either immediately or following treatment;
- to draft a 10-year scenario for the remediation of aquatic soils;
- to promote active management of aquatic and other soils; and
- to continue for the time being - subject to conditions - with the dispersion of slightly contaminated spoil both on land and in surface waters.

2.5 ADMINISTRATIVE STRUCTURE

NW3 introduced the concept of integrated water management. To put this concept into practice, it was necessary to create water-boards able to apply a fully integrated approach to manage the quantity and quality of water. The creation of such water control bodies required mergers between existing boards. This has considerably reduced the number of water-boards (from 2,300 to less than 60). The basic principles of NW3 still apply. The modifications proposed here are a question of 'fine-tuning': shifting the emphasis from a debate on structure to the optimization of implementation. This may mean that some operational duties relating to the management of groundwater and waterways have to be delegated from the provinces to the water-boards.

2.6 INSTRUMENTS

Social trends have become more complex, faster changing and often larger in scale. Policy on the physical environment, of which water management policy is a part, cannot escape the consequences of these developments. At the provincial level, various moves have been made in the direction of a more integrated planning process. This good example deserves to be followed.

Research on the introduction of a levy on various diffuse sources has been shown to be limited. To combat water depletion, the area-specific (GEBEVE) scheme will be extended for another two years. For the time being, no activities will be developed in the direction of integrated legislation. Developments concerning the financing of water management and European legislation may eventually produce a further integration of the present national legislation. The process of public consultation will be used in the preparation of various plans for major water systems.

2.7 INTERNATIONAL WATER POLICIES

States sharing river basins have a joint responsibility for the quality and functioning of those systems and for organizing and supervising their use. This includes responsibility for flood protection and for the seas into which the rivers discharge. This responsibility should be expressed at the most appropriate level within the framework established by international covenants. Public accountability is an important aspect of this responsibility. There is a need for rationalisation of international consultations in order to increase consistency and prevent duplication of effort.

For each water system/level of scale there should be a single forum, pursuing an integrated approach. The division of responsibilities between the different forums should be consistent, there should be close co-operation between them, and processes of consultation should be clear and transparent.

The basic terms of international water management policies should be established in general forums such as the EU and the UN. But the identification and, where possible, resolution of problems should take place at the level of regional seas or river basins and parts of them, with action programmes serving as frameworks for integration. Particular problems can be tackled at the EU or UN level where desirable. There should be effective feedback mechanisms for this, as well as between the various area-specific organisations. There also needs to be regular bilateral co-operation (between neighbouring countries and other strategically important partners) and national co-operation (between lower tiers of government and interest groups). The international forums should themselves maintain an open attitude towards the outside world. Dutch water management expertise should be systematically deployed in other countries, with a particular focus on the sustainable development of water systems.

This results in the following activities :

- to merge different international forums dealing with the same water system, especially the Rhine, the Meuse and the Scheldt, with the aim of improving integration;
- to establish an EU directive on water, placing the key emphasis on co-ordination, subsidiarity, transparency and the reduction of bureaucracy;
- to systematize the lower tiers of government and international non-governmental organisations in the work of international river basin commissions;
- to present to parliament an action plan setting out the priorities for Dutch efforts in the field of water management elsewhere in the world.

2.8 FINANCIAL AND ECONOMIC CONSEQUENCES

The last few years have seen considerable financial boosts to the implementation of integrated water management work, both in areas of central government responsibility and in the those of regional water management by water-boards, provinces and municipalities. The NW4 builds on the pointers provided by NW3 and on the efforts made so far. In addition, water management has been given a substantial additional financial injection to fund the new approach to deal with flood protection along the major rivers.

In estimating the financial consequences, a distinction is drawn between the maintenance of current practices and the introduction of supplementary measures. Maintenance of current practices is taken as the reference point for calculating the consequences of implementing supplementary measures. Supplementary measures can be based on either existing or new policies.

New policy, as far as the central government is concerned, means measures directed at the achievement of new objectives. In the case of this policy, the objectives relating to the expansion of rivers, a new approach marks the prevention of river flooding. Here too, however, the policy sets no new safety objective but opts for a new and more sustainable approach to the achievement of the existing safety standards. The estimates of the costs involved in maintaining current practices and introducing supplementary measures are based on the measures already described.

Estimates of public expenditure on current practices

Municipalities

The cost estimates for urban water management relate to the management of sewage systems in urban and surrounding rural areas to be connected to the system. Total annual costs are currently in the region of NLG 1.5×10^9. Maintenance of current practices, as laid down in the Sewerage Memorandum, demands an overall investment of NLG 7×10^9 guilders: around 5×10^9 to catch up on overdue maintenance work and 2×10^9 to reduce storm overflows from sewage systems. The total annual costs to municipalities as a result of this investment (totalling around NLG 9×10^9) are expected to amount to almost NLG 2×10^9 in 2005: an average annual increase of 3.6% over the 1998 - 2006 plan period. This is entirely due to policies already agreed upon.

Water-boards

Water quality management is the largest category of expenditure relating to the duties of water-boards. Over the 1995 - 2001 period, a total of NLG 7.4×10^9 will be invested, most of it in sewage treatment plants. The nitrogen removal programme for sewage treatment is due to be completed in 2005. Annual expenditure on water quality management is expected to rise over the plan period (1998 - 2006) by approximately 2.2% towards the end of the period.

Over the 1995 - 2001 period, water-boards will invest almost NLG 2×10^9 in flood defences including contributions from other tiers of government and third parties. The greater part of the investment will be in the primary flood defences. This will consist both of routine work and dike strengthening under the Delta Plan for the Great Rivers. Total annual expenditure on flood defences is expected to rise by only 0.4% a year over the 1998 - 2006 plan period. Over the 1995 - 2001 period, water-boards will also invest almost NLG 2×10^9 in water quantity management. Relatively small proportions of this sum will take the form of specific investments relating to aquatic soils, water depletion and urban water management. Total annual expenditure on the management of water quantity is expected to rise by 0.2% a year over the 1998 - 2006 plan period.

Provinces

The function of provinces regarding water management is primarily strategic. This is expressed chiefly through the planning process (provincial water management plan). They also have a number of executive responsibilities in the field of groundwater management (under the Groundwater Act) and the management of inland waterways. Lastly, they subsidise dike strengthening work along the major rivers. Maintenance of current practices will have the following financial consequences.

The resources available for investment in improving flood defences are given by the provinces to the water-boards as their contribution to the improvement works. In total, the provinces will contribute around NLG 1.3×10^9 towards the implementation of the Delta Plan for the Great Rivers averaging approximately NLG 2.5×10^8 a year, an annual contribution of over NLG 2×10^7 will also be given to the water-boards for the maintenance of flood defences.

Expenditure on waterway management and related quantitative management of surface water will total approximately NLG 1.8×10^8 a year. The part for the Fries-Groningen canals will be funded by the central government since these canals function as national waterways.

Expenditure on strategic and operational groundwater management totals about NLG 2.6×10^7 a year and is partially funded by income from groundwater charges. The increase in groundwater charges means that administrative costs and the costs of projects to combat water depletion can in some cases be met by groundwater charges over the next few years. In the course of the plan period, this may produce an increase in annual expenditure amounting to around NLG 2×10^7..

Central government

Maintenance of current central government practices will have the following financial consequences. Central government expenditure on water management currently totals around NLG 1.8×10^9 a year. Some 20% of this is general expenditure on staff and equipment which cannot be ascribed to specific areas of water management.

About 47% of spending on water management is for central government maintenance and restoration of water systems, investments in and maintenance of waterways and harbours, monitoring and research. In 1996, around NLG 9.3×10^7 was spent on infrastructure and restoration. The multi-year estimates show spending declining to around NLG 7.3×10^7 by 2001.

Some NLG 3×10^8 a year is currently available for central government work on flood defences. The policy of dynamic coastal management will demand additional resources, particularly to compensate for sand deficits in deep waters. The present budget includes financial provision for spending on this within the plan period.

More than NLG $2. \times 10^8$ a year will be required to manage aquatic soils, to dredge approach channels, waterways and harbours to maintain navigational depth, to construct and manage disposal sites for dredging spoil (including treatment of dredgings containing sand), and t remedy aquatic soils. The central government will make available around NLG 2×10^7 a year to remove contaminated sediment from regional waters.

In addition to carrying out its own management responsibilities, central government currently contributes NLG 1.5×10^6 a year to regional water management. This contribution relates primarily to the costs of maintaining waterways where such maintenance has been devolved by central government to provinces, water-boards and municipalities as part of the general policy of decentralisation, and to the costs of changing land use related to water management.

Estimates of public expenditure on supplementary measures

The policy described in NW4 will lead to the maintenance of current practices based on existing policy and also to a new approach and an intensification of current activities.

3. PRESENT STATUS OF FOOD AND RURAL DEVELOPMENT

Agriculture in The Netherlands has significantly changed during the past decades. For example the cultivation of a traditional crop like wheat has been reduced due to its low price. In the past decennia there has been a significant increase in greenhouse cultivation and in the number of cows, pigs and chicken raised. At present The Netherlands is still a large exporter of agricultural products. However the export products mainly refer to flowers, vegetables and dairy products. Basic food products are largely imported.

The economic boom of the 1950s and 1960s produced drastic changes in all social sectors and also dramatically influenced the Dutch agricultural sector. Modern production techniques realized an enormous advance in agriculture, and mechanisation enabled farmers to cultivate significant larger areas with less manual input. Through land consolidation projects, parcel sizes were enlarged, field drainage was improved, and the farm road network modernized. In combination with the use of fertilisers and pesticides, these measures played a significant role in making the agricultural output of The Netherlands one of the highest in the world.

Advances also have their drawbacks, and the above developments are no exception to this rule. The new farming methods have impaired nature and landscape, whereas the increasing urbanization and expanding highway and railroad infrastructure have put the rural area under great pressure. Additional factors are the growing interest in nature, landscape development and conservation, ecological awareness, and the increasing need for outdoor recreation. In other words, the rural area needed to be assigned other functions in addition to agriculture.

The general objective of land development in The Netherlands is 'to improve the layout and infrastructure of the rural area in accordance with the functions of the area that are indicated within the framework of physical planning'. Measures can be taken for improving the socio-economic conditions in the agricultural sector and the conditions of other sectors such as the conservation of landscape, nature and outdoor recreation. These measures refer to construction and improvement of rural roads, water management systems, exchange of agricultural land between farmers and improvement of field drainage, as well as delineation of lands for other public uses.

4. CHALLENGES FOR THE FUTURE

In a delta area there is no final solution or permanent situation. The history of water management in The Netherlands shows how the original natural landscape was transformed into a man-made landscape in a never-ending struggle with water. Because of a great susceptibility of delta areas to intervention in the given physiographic condition, chain reactions also occur in other areas where economic development has led to certain activities. A few examples:

- mining of natural gas, resulting in subsidence and consequences for water management;
- deepening of approaches and harbours, resulting in an increased intrusion of sea water;
- expansion of green-houses with consequences for drainage and water quality requirements.

There are no grounds to suppose that in the future such activities will come to an end, and new developments will have to be reckoned with. There is no prospect of a permanent situation. Therefore a 'philosophic' longer term outlook of water management in The Netherlands will conclude this paper.

Analysis of the history of water management and its future prospects

An insight in the history of water management is essential to identify trends in existing developments and to be prepared for the consequences of possible future developments. The execution of works in water management and land reclamation depends on factors from one of three groups :

- incentives for the acceptance of a change;
- technical and other factors that make a change feasible;
- social conditions.

Together they form necessary conditions, but they are not enough to explain the historical developments. For the Dutch delta, it appears that the chance factor of disasters, threats and storm surges at sea are involved. Also characteristic of the Dutch delta area is that situations occurred that constituted a real threat to the country's survival, This was cause for great concern. Sometimes the technical solution was known, sometimes people did not see a way out but then a technical innovation was introduced and saved the day.

Possible developments in water management in The Netherlands

The processes and trends observed in the Netherlands - rise of the sea level, subsidence, higher requirements for safety, water quality and environment - will continue in the long term and will make the deltas of the Rhine and Meuse even more vulnerable. In addition, some factors, partly deterministic partly stochastic, are becoming apparent. They are :

- a change in the local climate, the hydrology of the Rhine and Meuse and the regime of storm surges;
- an accelerated rise of the sea level;
- increasing urbanization;
- large-scale underground works for traffic, industry and habitation;
- the occurrence of a 'super storm surge', surpassing by far the normative storm surges, with the chance of such a super storm surge occurring being 1% in a hundred years (return period 10,000 years);
- the occurrence of a 'super river surge', also much higher than the normal high water;
- the lack of a major storm surge for one or two generations;
- other events that are unknown so far, or are considered beyond the bounds of the possible (wars, earthquakes, loss of faith in the future and so on).

Of all these deterministic factors and chance hits, most attention is, of course, centred on the consequences of the greenhouse effect and the subsequent accelerated rise of the sea level, for this constitutes the most direct threat. Comprehensive international research has been conducted into the magnitude of this rise and the time span in which it will take place, using models of the hydrological cycle of water, the GCMs (Global Circulation Models). Although these models are based on the laws of physics, they produce rather divergent results according to the presuppositions that are to be entered. There are models predicting an additional rise of a few decimetres over a period of around 100 years and then there are models with a predicted rise of some metres over a period of around 300 years. A lowering of the sea level may also be possible. Under these circumstances it seems preferable to work out a few different scenarios of rises in sea level, namely what works should be undertaken to compensate for these rises, in what time span could the works be executed and in what order? As reliable predictions concerning the rate of the rise in sea level cannot be expected for another few decades, a strategy will have to be outlined that can be constantly adjusted to the actual developments. However, determining this rise, or the relative subsidence, is turning out to be less simple than one might think, mainly due to local differences and the lack of fixed measuring points. Everything seems to subside or, sometimes, to rise temporarily. That is why a network of stations throughout The Netherlands has been established, where, by measuring the differences in gravity of a certain level mark over a certain period, the change in absolute height

None the less, an accelerated rise in the average sea level need not be a disaster for the Dutch delta. The necessary technological equipment is present and experience with the strategy to be pursued has been gained during the past eight to ten centuries. Our land has subsided two to three metres due to natural and anthropogenic causes and, during the first centuries, people only had primitive technology at their disposal.

Financially, an accelerated rise in the sea level means a setback, but not so acute as generally assumed. If a rise of 0.7 m over of 100 years is taken, instead of the current 0.18 m, which is regarded by many to be the average or the most probable figure, the necessary provisions with regard to safety, drainage and urban areas would cost circa 3.5×10^{10} guilders. This amounts to not more than 0.5% of the Gross National Product, provided the expenditure can be spread over 100 years. Even with a 'maximum scenario' of 5 m in 300 years, expenditure for hydraulic and other works will be minor if compared to the expenditure for social services, education and defence. It should be kept in mind that these estimates are based on existing technology, whereas it may be assumed that in future it will be feasible to build more cheaply, thanks to the availability of such things as cheap acceptable nuclear energy, light building materials and synthetics for facing dikes and banks.

A new picture of the future is taking shape, in which water management in The Netherlands will have to be adjusted as a result of the accelerated rise of the sea level, the additional intervention of surface and ground water due to the continuing urbanization and a large-scale use of underground construction. Several scenarios of a new infrastructure for water management in the Dutch coastal area, if the sea level rises by a few metres, have been developed. In one of these essential elements are the construction of a vanguard dike between the cities Den Helder and Hoek van Holland about 15 to 25 km in front of the present coastline and the creation of a lagoon and large-scale drainage of discharge from the great rivers. Another version entails the construction of a vanguard dike parallel to the present coastline contiguous to the Belgian and German coastal areas. From a technological point of view, no special problems are expected, but from an organisational and administrative point of view, it cannot yet be foreseen how measures can be taken in the framework of integrated water management.

Perhaps the biggest setback will be caused by sea storm surges that have been misjudged in Dutch history from 1134 and 1421 until 1953. Among the present inhabitants of the low part of The Netherlands the feeling prevails, just as it did 40 years ago, that the problem of safety from floods has been solved now that the normative storm surge has been determined at 1.15 m higher than the 1953 storm surge at Hoek van Holland. The recurrence of this normative storm surge is 1×10^4 years. However, it can be concluded from the delta report that a storm surge 2 to 3 m above the 1953 storm surge and so 1 to 2 m higher than the storm surge that determines the height and strength of the primary defence line could occur.

The non-occurrence of critical storm surges may lead to misjudgments. Experiences with rare events seem not to be passed on and after one or two generations people tend to forget a disaster or ignore reality when other urgent problems present themselves.

NIGERIA

1. THE VISION

1.1 The Context

Human food requirement consists of four principal sources - water, agricultural crops, livestock and fisheries. Essentially, the demand for food depends on population and the dietary habits/per capita daily calorie intake of the people under consideration. On the other hand, the food requirement of the nation is dependent on an additional factor namely; food import and export balance. Consequently, there are basically three ways to produce this food requirement; through rain-fed agriculture, irrigated agriculture and food import. In all cases water is the most important determinant to increased food production and rural development.

More than 70% of the working adult population of Nigeria are employed in the agricultural sector directly and indirectly. Over 90% of Nigeria's agricultural output comes from peasant farmers who dwell in the rural area where 60% of the population live. The vast majority of these farmers have limited access to modern inputs and other productive resources and are unlikely to have access to pesticides, fertilizers, hybrid seeds and irrigation without some form of public sector intervention. It is also significant to state that the majority of these resource poor farmers are women.

The recent call for evolution towards "an agriculture machine that is sustainable, market-led and consumer focussed" needs to be carefully implemented to avoid social instability. For Nigeria (at least for some time to come) prosperous agriculture should continue to be the engine for poverty elimination, sustainable development and food security. The strategies should therefore be primarily based on agricultural and rural development with expansion of irrigated areas to develop rural economies and to reduce the pressure in urban areas.

Policies for the allocation of water and other resources to food production and rural development must however consider the prevailing economic, social and environmental opportunities and constraints. To this end, we require a clear statement of our collective Vision for the future that is not contestable and that cannot be altered by any personal considerations. We could differ in the way we go about achieving the goals, but it is very essential that we have unity in the vision.

1.2 Vision Statement

At the heart of the vision of water for food and rural development is a healthy Nigerian population with access to adequate nutrition. This would require efficient and effective utilisation of water in a manner that is sustainable and equitable to the cultivators, and non cultivators of food, now and into the future. Specifically, the features of the Vision are as follows :

* A vibrant nation whose population is living in security with reliable access to food, adequate social services, educational and employment opportunities in and out of agriculture.

* A sustainable agricultural and rural development that promotes healthy natural environment that does not run down the ecosystems and natural resource based of tomorrow, in order to deliver the food and rural development requirement of today.

* Creating an equitable, egalitarian and result oriented society that is focussed not only on input but output and outcome of every policy, activity, project and programme.

* Promote communities that would be reasonably in control of their livelihoods and projects; while establishing reasonable equity in socio-economic amenities, services and conditions, including tenure and title to land and water rights.

* The integrated development of water resources for the controlled water application in an extended or all year-round agricultural production, so as to stabilize food production; and to compensate for the production variability arising from insufficiency and non-uniform distribution of rainfall.

* The improvement of socio-economic well being of rural community by providing gainful and all year-round employment and assured water supply to the rural areas; and the establishment of small-scale agro-industry.

1.3 Driving Forces of Change

A number of powerful and pervasive forces will drive and condition changes in all economic and social sectors of the nation over the coming years. These forces though are global in nature, yet the extent of their impact varies from one nation to another and from region to region. A realistic vision of the future must take them into account. Consequently to enable us realise the forgoing vision of the future of water in food and rural development, a number of the major driving forces, important opportunities, constraints, and issues would be briefly analysed.

The major driving forces are broadly classified under seven headings :

* population growth;
* urbanisation;
* technological innovations;
* energy prices;
* market economics and trade liberalisation;
* environmental awareness; and

* global warming.

These together and/or individually would influence the demand for food, water for all uses, and rural development. These therefore are in a sense also the operating environment in which the vision would have to be achieved. The driving forces and the framework for establishing the demand for food, water, rural development and the required political environment would be briefly discussed later.

2. CURRENT SITUATION AND TREND OF FOOD PRODUCTION IN NIGERIA

2.1 Climatic and Physical Characteristics of Nigeria

Agriculture employs three quarters of the Nigerian working population, but agricultural landholdings are generally small and scattered. The average number of farm plots per household ranges between 2 and 28 plots and between 0.5 and 5.0 ha, increasing in size from the south towards the north. Farming is generally rainfed and of the subsistence variety.

The major crops grown in the country can be divided into two main groups: food crops (produced for consumption) and export products. Despite the importance of the export crops, the primary policy of agriculture is to make Nigeria self-sufficient in its food and fibre requirements.

Nigeria is listed by FAO among nations that are at the moment technically unable to meet their food needs from rainfed production at low level of inputs and appear likely to remain so even at intermediate levels of inputs at some time between 2000 and 2025.

Nigeria occupies an area of 923 768 km2. The country lies between latitudes 4o and 14o north of the equator and longitudes 3o and 15o east of Greenwich. There are wide climatic and rainfall variations found in the country due to its location south of the path of the westerly winds in the north and almost out of equatorial doldrums of the south of Nigeria. Consequently, it is in the heart of the trade wind belt with generally "summer" rains and "winter" drought.

Rainfall averages over 2000 mm per annum in the southeast, 1000 mm in the centre reducing to as low as 500 mm in the north east. In the same areas the mean annual pan evaporation is 2450 mm and 2620 mm per annum respectively. Similarly, the vegetation of thick mangrove forests and dense rain forests in the south gives way to a near-desert condition in the northeastern corner of the country.

The county is divided into eight agro-ecological zones (as per Table 1) for the purpose of irrigation practices based on rainfall and temperature which are the most significant parameters.

2.2 Demand Projection for Food in 2025

2.2.1 Demographic Trends

The total population of Nigeria according to 1991 census was about 88.5 million people. The "Economic and statistical Review" published by National Planning Commission revealed that population growth rate has been stable at 2.83% while infant mortality has reduced. The estimated growth rates of population for 2000-2010, and 2010-2025 are estimated to reduce to about 2.70, 2.60 respectively. The notional "plateau" population of the nation is yet to be reliably

Table 1. Agro-ecological Zones of Nigeria with some Climatic Characteristics

Zones description	% land	Annual rainfall (mm)	Monthly temperature (°C)		
			Maximum	Normal	Minimum
Semi-arid	4	400-600	40	33-32	13
Dry sub-humid	27	600-1000	49	31-21	12
Sub-humid	26	1000-1300	37	30-23	14
Humid	21	1100-1400	37	30-26	18
Very humid	14	1120-2000	37	28-24	21
Ultra humid (flood)	2	2000+	33	28-25	23
Mountainous	4	1400-2000	32	29-14	5
Plateau	2	1400-1500	36	24-20	14

Source: Modified from FAO (1991)

determined. Some have however, suggested that around 410 million or about five times our current population may be all that can be supported by our available resources and that it would be reached towards the end of the twenty first century.

Table 2. Present and Future Population Project

Annual Growth%	1991-2000 2.83	2000-2010 2.80	2010-2025 2.75	2025 2.70
Population (in Million)	1991 88.517	2000 113.790	2010 145.896	2025 219.165

Source: Modified from JICA - Nigeria Water Resources Master-plan Study Report

As shown in the table above, the population is expected to increase from 88.517 million in 1991 to about 219.165 million by the year 2025, representing an increase of 248% over the years.

2.2.2 Nutrition

Food security, considered as the access to food at all times by all peoples, is one of the major concerns of the Federal Government of Nigeria. Food demand grows at the same pace as the population growth but because of the modification of the diet in the cities (increasing consumption of rice and wheat among the cereals), part of the demand would have to be met through food imports.

Taking a per capita allowance of about 2,200 calories per person per day to meet basic nutritional needs, and after making some allowances for wastage and conversion of grain into protein, it has been worked out that around 1 tonne of grain equivalent per year could well meet the basic needs of a typical family of five.

The most important component in the food basket of the nation is cereals and tubers, which includes rice, maize, corn, millet sorghum, yam and cassava. Millet, sorghum and maize are produced under rainfed condition, consequently their production is subject to large annual variations. More than 70 percent of the rice cultivated in Nigeria is grown from irrigated farmland, nonetheless its production is also subject to variations since the functioning of the fadamas schemes depends on the level of the flood and actually on the level of the precipitation in the catchment.

Projections by the World Bank suggest that the demand for all types of cereals will increase globally by 2.5 percent a year between 1990 and 2000, and with rising incomes, fall to 2.3

percent a year for the succeeding twenty five years. These figures are rather conservative for Nigeria and estimate that demand for cereals (especially rice) could well rise to 3.5 percent between 1990 and 2000 before dropping to about 2.5 percent between 2000 and 2025.

2.2.3 Food Export and Import

The physical output of agricultural exports in terms of aggregate index (base 1960) fell from 105.6 in 1970 to 63.8 in 1975. This sharp drop was attributed mainly to the five-year drought, but the situation has been aggravated in recent years by rural migration to the cities. Between 1966/67 and 1991/92 agriculture's share of General Domestic Product (GDP) fell from 59.7% to 35% as a result of reduced agricultural output and the greatly increased output of the petroleum sector.

In response to the production shortages, the country has been importing basic food items such as g rains, milk, fish, sugar and the like.

For the most recent years for which statistics are available, the food balance in terms of cereals is indicated in Table 3. Cereal imports mainly concerned wheat and rice. However, while local rice production represents between 60-63% of the domestic rice supply, the local production of wheat is negligible.

It is expected that the growing urbanisation will increase the wheat and rice consumption and consequently the imports of these two cereals, unless an important effort is made to develop the rice production locally or within the region. However, there is little hope to significantly develop the production of wheat, for obvious climatic constraints.

Table 3. Food balance in Nigeria in 1000 metric tons - Average 1994-96

Product	Production	Import	Total domestic Supply
Wheat	135	1,832	1,967
Rice	1,877	1,198	3,075

2.2.4 Cereal Requirement Estimate for the Next 25 years

It has been estimated that the gross cereal supply in 2025 would reach approximately 62,000 tons for the nation. When compared to the present production trend, the 2025 target does not seem to be unattainable.

According to FAO-IPTRID, rice production and imports would exhibit linear growth of an average of 122 000 tons per year and 83 000 tons per year respectively for the whole of West Africa. If we take half of this for Nigeria, in the absence of better parameter and assume the same pace would be maintained in the future, rice production and imports of Nigeria, would reach some 3 400 000 and 2 250 000 tons, respectively.

2.3 Potential

2.3.1 Rainfed Agriculture

In 1987, FAO prepared a working document on the "Need and Justification of Irrigation Development" which undertook a scientific assessment of the size of populations that the agricultural land resources of African countries can support. The report assumed a projected population for Nigeria in year 2025 of 238 million, 47.90 million hectares of potential rainfed land and 2.00 million and 3.73 million hectares potential shorter and longer transport irrigable land. The shorter transport irrigable lands was defined as land close to the source of the irrigation water i.e. transport distances were limited to those within one agro ecological zone. On the other hand, longer transport referred to land further away from source: irrigation water may be transported from one agro-ecological zone to another. The potentials were calculated for three alternate levels of inputs namely, low level of inputs, intermediate level of input and high level of input.

Low level of inputs, corresponds broadly to customary practice, with fallow periods to maintain soil fertility and to control pests, with manual labour, no fertilizer and pesticide applications, no soil conservation measures and hence with full productivity losses arising from land degradation, and cultivation of the traditionally grown mixture of crops on all potentially cultivable rainfed lands.

Intermediate level of inputs, assumes the use of improved hand tools and/or animal power and simple implements, some improved genetic material, some fertilizer and pesticide application, some simple soil conservation measures lessening productivity losses farmland degradation, and cultivation of a combination of the traditionally growth mixture of crops and the most calorie (protein) productive crops, on all potentially cultivable rainfed lands.

High level of inputs, assumes complete mechanisation, full use of optimum genetic material, necessary farm chemicals and soil conservation measures, and cultivation of the most caloric (protein) productive crops on all potentially cultivable rainfed lands.

Table 4 shows the results of the study for Nigeria in relation to the population estimates in 2000 and 2025 and three levels of inputs.

Globally, for the whole of West Africa, the present population (2000) could scarcely be supported by the rainfed production with the low level of inputs without the assistance of irrigation. But more specifically, Nigeria along with a number of other countries in the sub-region have already exceeded the theoretical supportable population at low level of inputs and would exceed the supportable population at even intermediate level of inputs before year 2025. Obviously, measures have to be taken to improve not only i the level of inputs but also to develop irrigation.

The intermediate level of inputs would be largely sufficient to support the present population and even twice as much as the 2025 expected population in the sub-region, with a very limited contribution from irritation. However, Nigeria and some countries would either have to substantially improve the inputs significant to be able to feed the population without irrigation and without imports.

Table 4. Population estimate and potential population supporting capacity of Nigeria (in million persons)

Country	Pop 2000	Pop 2025	Potential Low input	Population Int. Input	Supporting Capacity High input
Nigeria	128.8	238.4	54.4	206.5	700.7

2.3.2 Water Resources Potential (Extent and Distribution)

The water resources potential of the country is estimated to be 250,000 million cubic metres (MCM) comprising 190,000 MCM of surface water with the balance in the form of groundwater. This not withstanding, water is still a limiting factor to agriculture in much of the country but most especially in the semi-arid and dry sub-humid zones lying above latitude 11o North.

A recent survey by JICA suggest that 39% of the land mass is potentially suitable for agriculture and out of this between 4.0 and 4.5 million ha (approximately 4.5 to 5.0%of the land) are judged suitable for irrigated agriculture but only 1.1 million ha can be supported fully by the water available, the remaining 3.4 million ha being fadama.

2.3.3 Water Regimes in Agriculture (Irrigated and Drained Fields)

The nation is believed to have short-transport irrigable land (land close to the source of the irrigation water i.e. within the same agro-ecological zone) capable of supporting about 16 million persons at intermediate and 32 million at high levels of inputs.

Overall, the nation has substantial resources of both rainfed and irrigable land. In view of differences in production potentials in various agro-ecological zones however, irrigation, which is already important will continue to be justified, particularly in the more marginal northern region, for the local production of high value perishables, and perhaps for rice and some export crops.

The development of water resources especially for irrigation purposes in Nigeria dates back to the Precolonial era. The traditional application of water to land for dry season farming in the Northern Nigeria was one of the earliest attempts made towards increasing agricultural production. This not withstanding, Nigeria has not developed irrigation to the same extent as other developing nations, particularly in Asia. Only about a million hectare is currently irrigated in Nigeria. By contrast, India, which has about 3.5 times the land mass of Nigeria, irrigates nearly forty-five (45) times as much land.

As a result of FAO and US Bureau of Reclamation studies in the early 1970s, three pilot public irrigation schemes were developed, all in the sub-arid and dry sub-humid agro-ecological zones, namely: Bakolori Scheme, the Kano River Irrigation Scheme and the Chad Basin Scheme. The success of these pilot schemes coupled with the five-year drought (1970-1975) led to the establishment of 11 River Basin Development Authorities (RBDAs).

Until then water resources development for agricultural purposes was in the hands of the private sector for the production of sugar cane with only a minor role by states in the northern region of Nigeria. Irrigation practice was rudimentary, using residual flood waters and moisture in the low lands called fadama (flash flood plains), and supplemented with shaduf (a traditional device that lifts water onto the land). The main corps produced using these traditional methods of irrigation were vegetables and rice.

The initial case for development of irrigation in Nigeria was based in part therefore, on the need to sustain a growth in the food supply that would broadly lead to national food security. Records reveal that between 1976 and 1990, about US$ 2000 million of public funds were invested in the development of large to medium scale public irrigation projects. Consequently, irrigated agriculture witnessed a spectacular growth, rising from slightly more than 25,000 ha of irrigated farmland in 1975 to the current 974,900 ha. Surface irrigation in its various forms (basins, borders and furrows) issued predominantly for water applications in both public and private irrigation schemes.

Areas under irrigation include areas equipped with full or partial water control, spate irrigation, equipped wetlands and inland valley bottoms (including fadamas), irrespective of their size or management type. From a survey undertaken by FMWR i 1995 it appears that irrigated areas in Nigeria amounts to some 974 900 hectares. However, the exact amount of land under irrigation is difficult to estimate, because there is no clear commonly agreed definition of irrigation that is adopted by all. It is often difficult to classify certain categories of water management like the residual fadamas and water harvesting methods which sometimes have some form of water control and/or sometimes are just cultivated wetlands with hydraulic structures for drainage but not for irrigation.

Estimates of irrigated area and of irrigated crops vary greatly from one source to the other. The most reliable estimate of the total water managed area is about 975,000 ha, but it is not clear if this includes double cropping. It remains that the accuracy and reliability of the information vary greatly between zones and categories of information, as does the year in which the data was gathered.

Three main categories of irrigation development exist in Nigeria today (see table 5), namely public irrigation schemes, which are systems under government control (formal irrigation); the farmer-owned and operated irrigation schemes (informal irrigation) that receive assistance from government in the form of subsidies and training; and residual flood plains fadama, where no government aid is supplied and is based on traditional irrigation practices. The most important irrigated crops are rice, wheat, and vegetables. Together they occupy about 90 to 95 per cent of the total water managed area.

Table 5. State of Irrigation Systems

Category	Distribution		1991 (ha)	1993 (ha)
Formal Irrigation (public irrigation Projects)	Full or Partial control	Equipped	118621	119350
		Actually irrigated	62086	71700
Informal irrigation (farmer-owned and operated irrigation projects	Full or partial	Lift or shallow tubewell	101000	161700
	Equipped wetland	Flood control (improved fadama)	13200	18500
Residual fadama	Flood plains		723714	724000

Source: JICA, Adeniji, FACU and other works.

At 1998 price, the average cost for irrigation development was estimated at N750,000 per ha. Annual operation and maintenance costs ranged between N5,000 per ha for gravity systems and N22,000 per ha for pumping systems, and up to N30,000 per ha for sprinkler irrigation systems.

Based on past trends and on the present agricultural policy of Nigeria, we have tentatively elaborated a scenario of irrigation between years 2000 and 2025. The scenario does not foresee a significant increase of irrigated area between now and year 2025. According to our projection, land under irrigation has increased at less than 1% per annum in the last decade. It is not foreseen that the situation would change significantly because of many reasons. We therefore assumed not more than 2% annual increase which we see the nation increase the area under irrigation from the current 974 5000 hectares to 1 567 422 hectares in 2025, while the harvested irrigated areas would increase from the estimated current figure of (974 500*1.2) = 1 169 400 hectares to about (1 567 422 * 1.5) = 2 351 133 hectares in 2025.

2.4 Agricultural water use and the environment

2.4.1 Effects of other activities on agriculture

Because water is essential for agriculture, the most important external environmental effects on agriculture are related to the availability and quality of water.

Surface and subsurface water flows are changing due to changes in landuse in Nigeria. Important changes are due to agriculture itself, logging, urbanization and development of infrastructure. These reduce the water retention capacity of the land, especially if combined with drainage and trained rivers for flood protection. The quicker storm water runoff have resulted in higher flood with higher inundation risks downstream of most of our storage structures.

On the other hand, the quicker runoff provides less opportunity to recharge the groundwater and therefore the flows in dry periods will decrease. Consequently the need for additional storage increases. Deforestation, resettlement, fish migration and the like are all issues that call for more integrated land and water management.

The urbanization will also increase withdrawals for domestic and industrial use resulting in less water being made available for agriculture. Though the quantity of water withdrawal for domestic and industrial uses might be relatively small, the quality of the return flows from both are often seriously degraded and makes its reuse difficult without expensive treatment.

The scarcity of freshwater resources may necessitate the reuse of drainage water for irrigation. However, the degradation of certain groundwater systems can be made even worse where recycling of water is practiced as the reuse of water may ultimately lead to an increase of undesirable chemical loads in the water. Similarly, effluents from industrial and municipal sources will be also used for irrigation. The use of such contaminated water would carry certain risks to human health and the flora and fauna ecosystem.

2.4.2 Effects of agriculture on the environment

Agriculture itself has also an important impact on the environment. Pollutant sources from land use and poorly managed agriculture is causing widespread deterioration of ground and surface water.

Over irrigation results in waterlogging and the consequent accumulation of salts will lead to salinization of top soils and groundwater if not provided with proper drainage. Intensification of agriculture may lead to an increase in degradation of water quality and irrigated land because of an increasing intensify of inputs in agriculture.

In water scarce region to the north of Nigeria, there will be an increase in use of brackish water and sewage effluents for irrigation. Recycling of water although it may improve efficiency of use of water, it could also reduce both surface and groundwater quality. Moreover, increased water withdrawals will lead to salt intrusion in estuaries and over-draughted coastal aquifers. Managing water quality to prevent these conditions requires careful assessment, and monitoring of inflows and effluent water. At the same time, recycling and reuse systems should take into account its cumulative effect over time, and its impact on the soil and water environment.

The protection of waters, however, does not only refer to the prevention of pollution but also to the recovery, conservation and the development of their self-purifying power. In this sense, the restoration of rivers and lakes is an important task to be accomplished.

Trans-sectoral measures on water retention in the catchments should be undertaken through a close interdisciplinary cooperation the awareness of flood hazards in areas protected by the dikes with a view to reduce the flood damage risks through regulated utilization of flood plains.

3. FOOD PRODUCTION, TRADE, AND RELATED WATER ISSUES IN THE YEAR 2025

3.1 Meeting Demands for Water and Food in 2025

Irrigation and drainage infrastructure is a vital and necessary leg of the Green Revolution triangle of seeds, fertiliser, and water control. As such, it has played a critical role in the prevention of famines and widespread starvation and in the rising standard of living of millions of farmers in parts of the nation. Nevertheless, the performance of many irrigation and drainage system is significantly below potential due to a variety of shortcomings. These include poor initial design, use of inappropriate technology, distribution system layouts that did not adequately reflect existing conditions, unsupportive governance environments, and poor management systems.

The most obvious manifestations of these shortcomings are unreliable main system water supply, water wastage and poor maintenance practices. Improvements in tertiary level water management by farmers are often thwarted by unreliable water supplies. Users are discouraged from organising themselves and participating in the operation and management of the water delivery system, and unwilling to pay water charges when service is poor and unreliable. Insufficient funding for maintenance and ineffective use of the funds that are available results in rapid deterioration of infrastructure leading to further problems such as inequitable water distribution, waterlogging, and reduced productivity.

Irrigation management institutions fail to utilise women's skills and knowledge effectively. The importance of women farmers is increasing as fewer and fewer men farm. With the projected urbanisation, men would increasingly leave the rural areas to work in cities where they can earn higher wages, but often leaving the women behind to tend to the farms.

There is widespread concern about the financial sustainability of irrigation. Investment cost for developing public irrigation schemes were partly or fully subsidised. More importantly, the recurrent costs of operation and maintenance are seldom recovered directly from farmers, resulting in stagnation in further development of irrigated fields. Such short sighted operation and maintenance policies have reduced the economic life of irrigation facilities and led to impaired water delivery capacities. Nigeria need to shift emphasis towards rehabilitation and modernisation of existing systems, but the cycle of construction-deterioration-rehabilitation has to be broken through greater mobilisation of resources from the farmers themselves to ensure adequate O&M of the systems.

Before considering the options available to us in meeting expected demands for water and food, let us review the trends and forces affecting the future of agriculture. The most significant socio-economic change in the Nigeria, is related to demography in the form rapid population growth and urbanisation. Urban population is expected to grow at an average rate of 4.2%, i.e. slightly less than during the past decades when the urban growth averaged 6.3%. The increasing proportion of the urban population expected to reach 63% of the national population in 2025 will significantly modify the socio-economic landscape of the nation.

Major changes induced by urbanisation and by the resultant specialisation of the role of consumers/producers, will affect the diet: mostly wheat, rice and vegetables in the cities; traditional cereals, tubers and roots in the rural areas. Animal protein consumption will certainly increase in the urban environment while it will remain low among the rural populations.

Wheat can hardly be produced in Nigeria and will continue to be imported unless government can encourage the use of substitute cereals for bread. Using traditional cereals such as sorghum, millet and maize to produce bread will slow down slightly the increase of wheat imports which may reach some 2.5 million tons in 2025.

Assuming that the rice consumption would increase at the same pace as the urban population - 4.2% - the demand for rice would reach 11 million tons in 2025. To produce that amount of rice would require more than 2 million hectares, mostly irrigated, which would be difficult to achieve. Therefore, part of our rice requirement will continue to be imported. However, an important effort will have to be made to significantly increase the production, at least to maintain the present proportion of local production versus total demand, equal to 63 percent. This target would still require some 6 million tons of rice to be produced from at least 1.3 million hectares irrigated. The relatively lower price of rice from Asia will continue to make local rice less competitive unless efforts are made to substantially increase the performance of irrigation agriculture.

Some irrigation schemes were implemented with the object of reducing the dependence on imported rice, and wheat but very few were really successful. Kano River Irrigation Project and the case of Office du Niger in Mali are however a good example of successful irrigation schemes. Investment for expansion and rehabilitation would be constrained by the level of unpaid loans which remains very high and the cost of construction and rehabilitation is exorbitant although this is envisaged to decline as a result of the crusade to instill transparency and curb corruption which would instill increased competition and farmers' participation in the financing the operation and maintenance.

An alternative for low-cost rice production may be in the development of fadama and the new Community Based Medium Scale Irrigation Schemes of RBDAs which will put substantial area under irrigation at lower cost per hectare.

A number of initiatives have been undertaken to promote rational lowland development, especially in narrow fadama, strips, which are scattered everywhere in Nigeria. Improved and locally adapted irrigation techniques are being promoted by several research institutes, led by the West African Rice Development Association (WARDA), which manages an Inland Valley Consortium composed of several national and international research institutes. Technical documents have been published both for the humid tropics and the Sahelo-Sudanian zone. Development projects are implemented in most countries with the financial assistance of bilateral and international donors.

Rice production exploiting surface water during or just after the rainy season has been the main objective of most of the projects, whereas shallow aquifers and lowlands areas may also be a reliable source of water for vegetable production during the dry season. New FAO initiatives in SPFS are underway to promote micro-scale irrigation using low-cost technologies to access water (e.g. hand dug wells) and to pump this water (e.g. treadle or small gasoline driven pumps).

A number of issues need to be addressed in order to assess the sustainable development potential of the fadamas :

* Availability of manpower during the rainy season while most of the farmers are busy with the rainfed cultivation.
* Availability of water resources for agricultural production and to address the environmental issues (extensive cattle husbandry, bio-diversity, etc).
* Sustained assessment and monitoring of the aquifers to avoid their over-exploitation.
* Since traditionally fadamas are mostly cultivated by women, efforts should be made to prevent their being sidelined from development projects.
* Address the conflicts between agricultural development, environmental issues and cattle husbandry.

With the exception of a few favourable conventional irrigation schemes, fadamas are likely to be the main source of local rice production in the future. However, WARDA reports that significant potential for rainfed rice production exists, thanks to new varieties recently developed, but which still need to be disseminated among the farmers of the humid zone of the West Africa.

Fruits and vegetables production increased significantly during the last 20 years probably in relation to the growing urbanisation but also in response to change in the diet, even in rural areas. The sudden acceleration of vegetable production in the early 1980s correspond to the drought period when the Governments decided to promote small-scale irrigation projects, mostly based on shallow groundwater, in order to offset the cereal production deficit due to the drought. It is remarkable to note that vegetable production is twice as much as the rice production.

IMPACT model projects suggest that cropped area will expand only slightly (0.25% per annum) during the coming quarter-century while irrigated area grows by 0.6% annually between 1995 and 2020, less than half the annual growth rate of 1.5% during 1982-1993. The model predicts that cereal prices will remain stable until about 2010, after which they will fall modestly. This itself is a sharp departure from recent trends, which have seen cereal prices declining fairly rapidly over the past two decades. Stable prices will tend to encourage input use, tickling yield growth rates upward.

Population growth reduces the per capita availability of fresh water supplies, leading to stress or even scarcity. Under a new classification scheme, a country with an annual renewable fresh water supply per capita of more than 1,700 cubic meters (m3) will experience only occasional local water shortages. A country having a supply of less than 1,000 m3 per capita per year will experience chronic water shortages which will hamper economic development and lead to serious environmental degradation.

Nigeria has sufficient water potential to meet the 2025 requirements, but will have to more than double their efforts to develop water sources to do so. However, finding the financial resources to build enough water development projects to accomplish this will be extremely difficult.

3.2 Reallocation and Reuse

It is inevitable agriculture, as the largest water user in many river basins will be called upon to relinquish supplies it currently withdraws from the river to other users. We must not lose sight of the fact, however, that perhaps two-thirds of the water diverted by irrigation typically returns to the river downstream. Water is often used and reused many times on its way from an upper watershed to the sea.

Reliable systems of property rights for water are important precursors to orderly transfers of water among users and uses in future.

3.3 More crop per drop

With the trends described above, it is obvious that we would have to fee more people with less water. This requires application and further development of a mix of site specific solutions in the fields of technology, policies, management and institutions.

3.3.1 Technology/Crop Yields

There is an enormous potential in Nigeria through development of irrigation for higher yields, which could possibly be achieved by advances in bio-technology through development of higher producing, pest and drought resistant crops. However, seeing the present state of affairs, there is little likelihood of a substantial breakthrough. Only comparatively small advances in the order of five to ten percent may be expected.

3.3.2 Productivity of rainfed agricultural

More than three quarters of the national agricultural area is rainfed. In development of rainfed agriculture use can be made of the water fraction that otherwise would have returned back to the atmosphere through direct evaporation and transpiration. Increasing, the potential of rainfed agriculture would make a significant impact in the national food production. However, precipitation patterns differ across the agro-ecological areas and the potential to improve yields in rainfed agriculture is strongly related to these. Nigeria need to develop more vigorously the intermediate low cost water and soil conservation technologies which include water harvesting and soil tillage, mulching, bunding, terracing, etc; these could significantly reduce the water risk and lead to an substantial increase in yield.

The ultimately the risks associated with rainfall would only be minimised through a reliable supply of water in case of shortage and a good drainage.

3.3.3 Policies

* Level the playing field: subsidies and taxes

* Fund research: agricultural, irrigation and drainage technology, irrigation and drainage management
* Charging systems for water and power
* Encourage private manufacturers of irrigation equipment and drainage pipe

3.3.4 Institutions

* IMT
* Reorient IDs
* Links irrigation research, irrigation education, and system management organisations

3.3.5 Water rights

Clear, objective and transparent systems of water rights are a first condition for reliable services and accountability. One of the elements to be considered is the social function of water, especially the protection of rural poor. Such systems, would require appropriate administration for planning purposes but also to protect society and the poor against undesired market effects.

3.3.6 Water pricing and cost recovery

Water pricing provides a means of financing water services and is an essential element in service-client accountability mechanisms.

3.4 Expanding areas

More production can be realised by developing new areas. Expansion of rainfed agriculture will in most cases include conversion of natural forests, mountain slopes or marginal soils, resulting in disturbed ecosystems and increased erosion. To achieve a same production increment, less land has to be developed if provided with irrigation. However, the best places are already occupied and development of new areas will be more costly.

much attention has to be paid to the rehabilitation of poorly performing systems, especially those degraded due to poor management. Development of drainage systems and improved water management practices could return large areas to productive use.

4. CONCLUSIONS

Rainfed agriculture will remain the main producer of traditional cereals and tubers. Self sufficiency of traditional cereals is important for the household food security of rural populations. Rainfed production will grow at the rate of the rural population.

Irrigation will grow as fast as the urban demand in fruit, vegetable an rice. However, at the national level, wheat will continue to be imported, while rice production will increase yet the percentage of import may have to be kept at its present level. Local rice production would mostly come irrigated farms and be supplemented from fadamas and rainfed production.

PAKISTAN

ABSTRACT

Water is a precious commodity that is to be maintained in its natural form. A little rise in glacier melts where from most of the Rivers take their major flows might drown entire habitat of earth. Pakistan has 16-Mha Irrigated agriculture, which is depending on a total of 173 Bm^3 of water. The waterlogging and salinity, theft of canal water, over-exploitation of fresh groundwater, low efficiency in delivery and use, inequitable distribution, inadequate maintenance and inefficient cost recovery have been recognised as main problems of Pakistan's Irrigation System.

The present population of Pakistan is 130 millions out of which rural population is 67.5%, which by the year 2010 would rise to 175 millions. In order to be self reliant in agriculture, the yields are to be increased by 50%, cropping intensity is to be maintained to the level of150% and additional area of 2Mha is to be brought under irrigation command. The water resources engineers and planners find a great economical advantage in the storage of some part of non-utilized 28.83 Bm^3 in some suitable reservoirs. Proposals for construction of a replacement dam on the main Indus, and increasing the height of Mangla dam over River Jhelum are actively considered. However aquifers are not seriously considered though they are environment-friendly and offer better under ground storage at lesser cost.

It is recommended that new alternatives should be worked out to stagger the summer peaks and rejuvenation of silted reservoirs. The programs involving field drainage, transition of tube wells to the private sector, lining of tertiary canals in the saline ground water zone, improved irrigation methods, appropriate cropping pattern and water pricing mechanism, should be taken as key factors for the prosperity of irrigated agriculture and rural areas of Pakistan.

INTRODUCTION

Water is a precious gift of Mother Nature that is to be maintained in its natural form. Though its 97.5% stays in the oceans, and the 2.5% is fresh (Shiklomanov, 1998), the 0.26 % of the total amount of fresh water is enough to meet the requirement of this globe. If the temperatures were to rise a little due to man made interference, little more melts out of 2.5% fresh water would cause such devastating floods and rise in water level that entire habitat of earth could be submerged.

Pakistan is basically an agricultural country whose agriculture mostly depends on irrigation. Out of its total area of 79.61 Million hectares (Mha), forests are on 3.44 Mha while irrigated agriculture is spread over 16 Mha. The country lies in the arid or semi-arid part of the world between 24°N and 37°N latitude and between 61°E and 77°45_E longitude. Though most part of the country has an arid climate, Indus River system compensates its water shortage. The rivers have their origin in the higher altitudes and derive their flows primarily from snowmelt and then from monsoon rains. The irrigation management in Pakistan plays a vital role in most of the development programs. However the availability of irrigation water at the time when plants require also is equally important.

It has been observed world over that even if water supplies were derived from storage reservoirs; unforeseeable events often disrupted original service targets (Perry, and Narayanamurthy; 1998). The misuse of irrigation water not only has deprived another legitimate user but also has created the problem of waterlogging and secondary salinity at the places even away from the place of its misuse. The World Bank identifies, waterlogging and salinity, theft of canal water, over-exploitation of fresh groundwater, low efficiency in delivery and use, inequitable distribution, inadequate maintenance and inefficient cost recovery as the main problems of Pakistan's Irrigation System (World Bank, 1994). Thus new strategies are to be adopted to improve water and soil management aiming at water savings, conservation of ground water resources and increased yields.

It can be very well imagined that the livelihood of rural population is mainly on agriculture where small home dairy used to be a co-subsistence job. Due to presence of animals, the farming community had an urge for crop rotation with fodder crops like sorghum, maize, alfalfa, clover, and some leguminous crops. In order to increase cultivation intensity, timelines in sowing and harvesting became a favorable factor for adaptation of mechanized cultivation. But due to small land-holdings, only big landowners and others who extended farm machinery services on rental basis could purchase tractor and implements. Unfortunately, the lack of expertise and non-existence of user organizations created a vacuum of accountability so that the rental works became quite sub-standard. As a result, shallow tillage, increased soil compaction, and poor land drainage deterred any significant increased in crop yields.

The cardinal principles of irrigation distribution in Pakistan have a legacy of British colonial era when population was less and investments on development works were probably assigned short recovery period. The irrigation distribution was therefore designed to cover maximum area. In most of the perennial systems, the allocation of water at the outlet was designed for a cropping intensity of 25 and 50 percent for Rabi (winter) and Kharif (summer) cropping respectively. About 210 l/s were allocated for 1000 ha (1.8 mm/day) for this 75% intensity, which was forcing the farmer to leave 75% fallow in Rabi and 50% in Kharif for preparation of next season crop and sun bathing. The non-perennial canals were allocated about 1330 l/s for 1000ha for rice cultivation, which was equivalent to 8.64 mm/day for 100% cultivation in a single season. The operation of the system is still based on a continuously running fixed rotational supply system, which is closed only for one moth of winter to desilt the canals. The supply to canals is also stopped during peak of floods so that silt does not enter the canal systems.

NINTH FIVE-YEAR PLAN (1998-2003)

This plan emphasizes on management cum development package for water resources through conservation, high efficiency irrigation systems, conjunctive use of surface and ground water, and on development of new or replacement reservoirs. It is a continuation of the 8^{t}h five-year (1993-1998), which was aimed at progressive additions to irrigation supply from new surface irrigation schemes, transition of tubewells from public to private sector, improvement and management of existing irrigation system, and protection of lands and infrastructure from waterlogging, salinity and floods.

The 9th five-year plan promotes efficient irrigation techniques, encourages multi-objective scientific reservoir operation for irrigation, flood control and hydel power generation. It also includes affirmative action with respect to non-classical areas such as private partner ship, participatory development, good governance, environment protection, and water legislation. It envisages to generate 4.32 MAF of water by conserving measures and installation of tubewells; to reclaim1.21 ha of disastrous area under National Drainage Program (NDP), and to construct at least one major reservoir.

WATER AND AGRICULTURE IN THE YEAR 2010

The population of Pakistan in 1998 has been increased by a growth rate of 2.61%. The strength of rural population is 67.5% with a 6.6 house hold size and feminine gender as 32% of total population (Population & Housing Census of Pakistan, 1998). Looking into population reduction from 3.66% in 1981 to 2.61% in 1998, the projected population by the year 2010 would be 175 millions. As the economy of Pakistan mainly depends on the prosperity of its irrigated agriculture, first of all the agriculture and water sectors should be made self-sustained and then further export oriented advancements could be planned. In Table 1, it can be seen that with the present yield trends, country would require 40.44 Mha of land and 256.6 Bm^3 of water.

FOOD AND WATER REQUIREMENTS.

By the year 2010, the water requirement for the domestic purpose at an average consumption rate of 100 l/capita would be 6.4 Bm^3. Taking at least the same volume for Industrial sector, non agricultural demand would be about 13 Bm^3. The demand for agricultural sector has been projected via Table 1, which goes for a supply of 257 Bm^3, against a combined supply of 203 Bm^3 from surface and ground water resources at the farm gate (Table 3). Thus 33% of yield increase is to be achieved within next 11 years at annual growth rate of 3%. This increase would none the less require 190% cropping intensity, which virtually would give no time for keeping land fallow. Alternatively if yields were increased by a growth rate of 3.8%, 50% increase in yields could have achieved up to the year 2010. For this alternative, crop water requirement would be 171 Bm^3 and cropping intensity 169% but it might put the land under the pathogenic and fertility stresses. It would therefore be more desirable to keep cropping intensity to 150% and bring another area of 2Mha under irrigation command.

WATER RESOURCES

The surface flow from the Indus River System (IRS) is the main source of water supply in the Indus valley. Though the ground water makes a modest contribution at the farm gates yet it takes its origin from the seepage of the conveyance system, and percolation from fields and rainfall excessive to the water holding capacity of the soil.

Table 1. Land and Water Requirement for the Year 2010 (Population: 175M)

Commodity	Commodity Individual Kg	Requirements Total M t	Crop Delta.@ Farm Gate (m)	Agri. Yields t/ha	Requirements Land (Mha)	Requirements Water (Bm^3)
Wheat	138	24.15	0.5	2.1	11.50	57.50
Rice	23	4.03	1.17	1.83	2.20	25.73
Maize	10	1.75	1	0.6	2.92	29.17
Pulses	7	1.23	0.37	0.58	2.11	7.81
Other Grains	5	0.88	0.3	0.52	1.68	5.05
Fruits	59	10.33	2	12	0.86	17.21
Vegetables	45	7.88	1	7.5	1.05	10.50
Sugarcane	338	59.15	1.3	46.9	1.26	16.38
Oil Seeds	68	11.90	0.4	1	11.90	47.60
Cotton	17	2.98	0.8	0.6	4.96	39.67
Total					40.44	256.647

Surface Water: The Indus Basin covers 70% of the country's area, and forms the major water source (Document of the World Bank, 1994). The post Tarbella (1976-77 to 1994-95) record of IRS is illustrated via Figure 1, which shows that mean annual flow at rim stations is 163.68 and 10.61 Bm^3 from Western and Eastern Rivers respectively. However the means from 1937-38 to 1994-195, yield the annual flows of 167.67 and 20.34 Bm^3. Logically the present situation of flow would be based on historical record of Indus and post Tarbella record of Eastern Rivers, which is 167.67 and 10.61 Bm^3. The contribution of about 7 Bm^3 form small rivers Soan and Haro should also be added for proper water accounting.

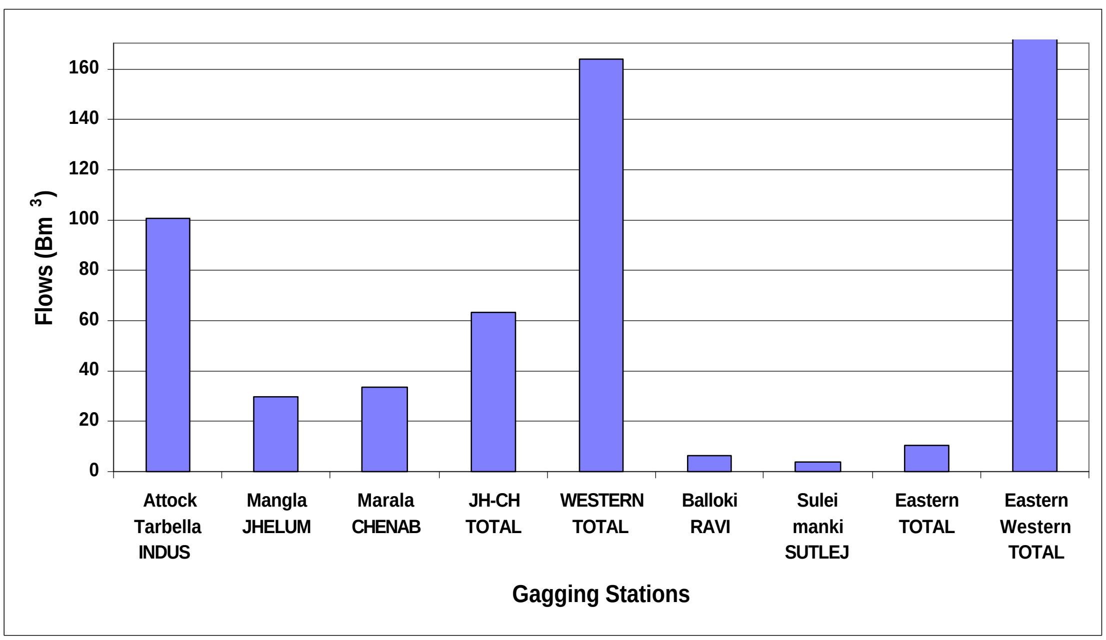

Figure 1. Surface flows in the IRS (Bm^3) from 1876-77 to 1994-95

The mean monthly flows in the main Indus are shown in Table 2. It can be seen that 78% of flow takes place in five months from May through September. Consequently the dependable supply based on Western Rivers is presented in Table 3. The water accounting shows that water consumption in this country is at equilibrium with mean annual supply. For a population of 175 millions and above the annual availability of water would remain below 869 m^3 per capita. It appears that on one hand the water resources of the country are fixed and are mostly exploited, then on the other hand the demand is on a permanent rise. The decision-makers have thus no choice but to increase the water use efficiency of crops to help achieve sustainability in the agriculture and water sectors.

Table 2. Mean Monthly Flows in The Indus (Bm3) From 1940-41 To 1996-97

MONTH	Mandori		Kalabagh		Sukkur		Kotri	
	(Bm^3)	%	(Bm^3)	%	(Bm^3)	%	(Bm^3)	%
JAN	2.51	2%	2.25	2%	1.29	1%	1.32	2%
FEB	2.76	2%	2.31	2%	0.46	1%	0.65	1%
MAR	3.63	3%	3.08	3%	0.81	1%	0.73	1%
APR	5.58	5%	4.75	4%	2.55	3%	2.06	3%
MAY	10.25	9%	9	8%	5.21	6%	4.23	5%
JUN	19.06	16%	16.9	16%	9.61	10%	7.16	9%
JUL	26.32	23%	24.4	23%	21.78	24%	15.9	20%
AUG	23.81	20%	23.1	22%	31.57	34%	26.9	34%
SEP	11.28	10%	11	10%	13.66	15%	14.7	19%
OCT	5.24	4%	4.53	4%	3.27	4%	4	5%
NOV	3.28	3%	2.74	3%	0.75	1%	1.17	1%
DEC	2.9	2%	2.37	2%	0.67	1%	0.78	1%
TOTAL	116.6	100%	106	100%	91.63	100%	79.6	100%

Table 3. Average Annually Possible Availability of Water at Farm Gate

	Source	Bm^3
A	Water in Indus system at Rim Stations	173
B	Direct precipitation	49
C	Total Available (A+B)	222
D	Evaporation Losses @ 10% of (C)	22
E	Deep percolation @ 4% of (C)	9
F	Seepage from conveyance @15% of (A)	26
G	Water release downstream Kotri	12
H	Surface Water at Farm gate (C-D-E-F-G)	153
I	Groundwater supply	53
J	Total at the Farm	206
K	Non Agricultural Demands	9
L	Field Losses @ 30% of (J)	62
M	Leaching @15% of (J)	31
N	Total for crop use (J-K-L)	135
O	Ground Water Potential (F+L-I-M)	4

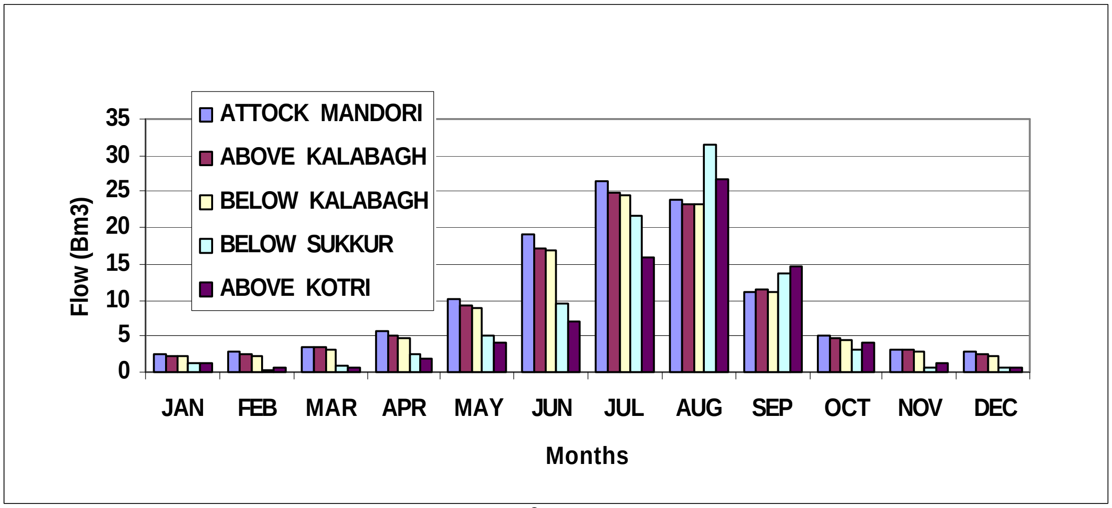

Figure 2. Mean monthly flow (Bm^3) in Indus from 1940-41 to 1996-97

Ground Water : It is very important renewable resource of Pakistan. The Indus basin has a huge unconfined aquifer, which presently contributes about 53 Bm^3 but at the sea level depth it is invariably underlain by seawater. Its main source is seepage from irrigation conveyance system and percolation from the irrigation fields. In seventies when population of the country was less, the concern of public sector was to lower down the groundwater through drainage wells. But with the increase in population, increased food demand brought in the investments of private sector to pump out the fresh ground water to meet with the deficiencies of irrigation at critical stages of crop growth. Out of an annual ground water withdrawal of 53 Bm^3, the private sector is now pumping about 45Bm^3 through small size tube wells.

Over the last three decades about 13500 saline tubewells have been installed in the public sector over a gross area of about 3.7 Mha. The use of ground water from public sector tube wells in fresh zones for irrigation purposes motivated the private sector to meet the irrigation deficits at critical growth stages through their own tubewells. Currently there are over 450,00 private tube wells installed for irrigation purposes. There are estimates on ground water discharge and recharge, one of them shows that the groundwater pumpage in the Indus Basin has reached to 59 Bm^3 in 1996-97, out of which 47 Bm^3 are contributed from private tubewells. The estimated usable groundwater potential is suggested about 66 Bm^3, leaving an unused balance of about 7 Bm^3.

Since there is a gap of 21 Bm^3, any miscalculated abstraction of groundwater would lead to ground water mining and its degradation from salt-water upcoming and encroachment. Thus further analysis was made to find out the impact of various permutations of evaporation, deep percolation, seepage, and field losses on the net availability of water for crop at the farm and for additional ground water potential (Table 4). The basis of calculation is that total flow to the IRS is 222 Bm^3 and ground water pumpage is 53 Bm^3.The above table illustrates that quantum of ground water can be increased through saving of non-recoverable losses like evaporation and

Table 4. Effect of Water Loss Parameters on Availability of Water for Crops

Losses (%)				Available Water (Bm^3)	
Evaporation	Deep Percolation	Seepage	Field	Net For Crops	FGW Potential
10%	4%	15%	30%	144.2	3.8
10%	2%	15%	30%	147.3	4.5
10%	0%	15%	30%	150.4	5.2
10%	0%	12.5%	30%	153.4	1.5
10%	0%	17.5%	30%	147.4	8.9
10%	0%	20%	30%	144.3	12.5
10%	2%	20%	30%	141.2	11.9
7.50%	0%	20%	30%	148.2	13.4
7.50%	0%	20%	35%	137.6	24.0
10%	4%	15%	35%	133.9	14.1
10%	2%	15%	35%	136.8	15.0
10%	0%	15%	35%	139.7	15.9
10%	0%	12.5%	35%	142.5	12.5
10%	0%	17.5%	35%	136.8	19.4

deep percolation. Where as by making saving in seepage, ground water potential is reduced, saving in the field loss would only redistribute the flow between crops and ground water potential. Thus one should be aware of the fact that indiscriminate pumping without proper monitoring mechanism and lack of knowledge of chemistry and hydrodynamics of aquifer would be causing up coning of saline ground water. It is feared that aquifer is already polluted because the salinity of tubewells has increased at many places. In addition to that terming the water of 1000-ppm salt content as fresh is encouraging pumping of saline water. For agriculture purpose, water is called fresh when its EC is less than 1500 micro mhos, SAR is less than 10 and RSP is less than 2.5 (NESPAK et al, 1993). In the absence any channel of salt pickup and its removal from the project area, a continuous accumulation of salts at the soil surface and underlying root zone would be taking place. Ground water pumping should be integrated with equity between incoming and outgoing salts. Provision of artificial recharge to ground water especially during floods should be made to compensate the total pumping with its recharge.

RESERVOIRS

The sustainability of the irrigation and agriculture systems is mainly dependent on the actual flow of the rivers taking place in 5 months of high summer. Thus to stagger the peak summer flows three surface reservoirs have been constructed in the past. The Mangla reservoir was constructed in 1967 on River Jhelum for a live storage capacity of 6.6 Bm^3, whereas Chashma and Tarbella were constructed on main Indus in 1971 and1975 for 0.6 Bm^3 and 11.5 Bm^3 respectively. After a passage of two and half decades not only the storage capacity of existing reservoirs has been decreased by 22% but also the population has increased more than100%. As a result a dire need has arisen to build replacement reservoirs as well as some additional ones to help enhance the operational flexibility of available water resources in the deficit periods. The 35-year pre-Tarbella data (Table 5) from 1962-63 to 1996-97 shows that mean annual flow downstream Kotri is 53.42 Bm^3. The 21-year (1976-77 to 1996-97) post-Tarbella data also show a 51.74 Bm^3 flow downstream Kotri. The policy makers of the country foresee a serious food crisis, and cannot justify the escape of average annual flow of 51.74 Bm^3 downstream of Kotri. Taking out the average annual contribution of 10.61 Bm^3 from Eastern Rivers and the committed down-stream Kotri flow of 12.3 Bm^3 volume, the water resources engineers and planners find a great economical advantage in the storage 28.83 Bm^3 in some suitable reservoirs.

Table 5. Post- and Pre - Tarbella Mean Flows in the Indus River

	Gagging Stations									
	Attock		Above Kalabagh		Above Guddu		Above Sukkur		Below Kotri	
	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre
Season	21-Yr	35-Yr	21-Yr	35-Yr	21-Yr	35-Yr	21-Yr	35-Yr	21-Yr	35-Yr
	Flow (Bm^3)									
Kharif	95.0	95.3	83.4	85.3	101.9	101.6	92.9	92.3	48.6	50.7
Rabi	28.6	23.1	24.1	20.6	21.2	18.8	18.6	17.1	3.1	2.8
Annual	123.6	118.4	107.5	105.8	123.1	120.4	111.6	109.4	51.7	53.4

The hydro-geological and topographical conditions of the country favour construction of new reservoirs only on the Indus River. The Post-Tarbella (1977-78 to 1990-91) record also shows an unused escape of 18.71 Bm^3 down stream Panjnad. This much volume of non-utilised flow cannot be overlooked now. In addition to that, flow in the River Jhelum (Figure 4) indicates that there are some occasions when annual flows are much lower than the mean values of 24.83 Bm^3. Under such circumstances a supplementing alternative could be evaluated whether or not height of Mangla dam could be raised to add the storage capacity of the reservoir and to generate its power potential. This proposal would further ensure the guaranteed supply from the Mangla reservoir because storage from preceding year surplus flows, would help mitigate floods in Punjab and minimise escape of flood water downstream Panjnad.

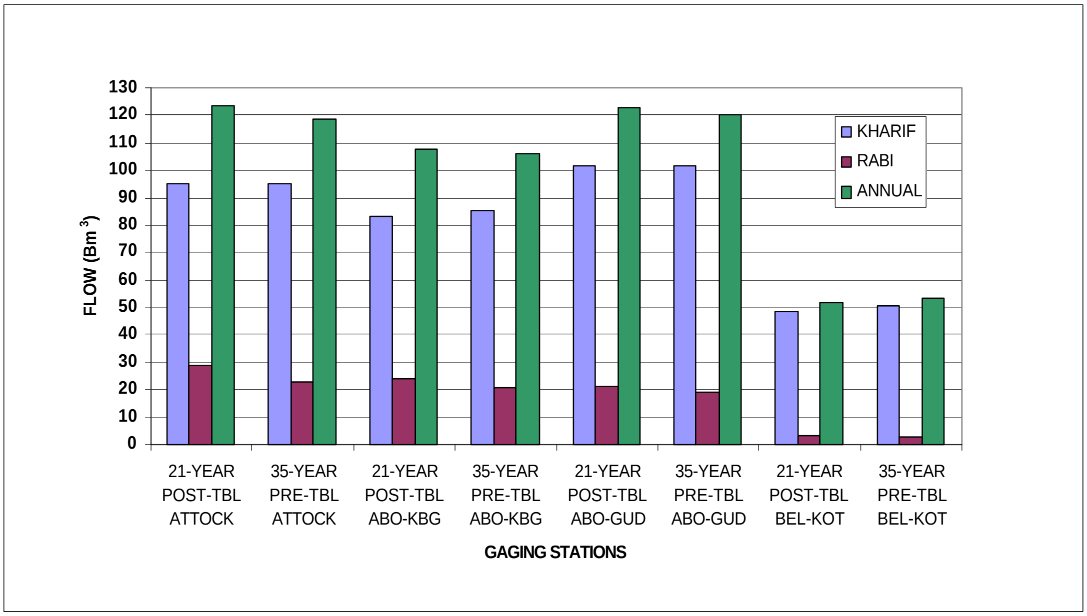

Figure 3. Post-Tarbella and Pre-Tarbella Indus flows (Bm^3)

Till now full attention has been focussed on surface reservoirs though the ground water reservoir (aquifer) has much more storage capability at lesser cost and in an environment friendly atmosphere. As the aquifers are prone to pollution by salt-water intrusion when groundwater is being mined, it is more important to store floodwater through artificial recharge. It is highly advantageous to simulate the ground water pumping conditions with shallow partially penetrating skimming wells (Chandio and Larock,1984; Chandio and Chandio,1992). But restraint should also be applied against the accumulation of salts in the agricultural fields.

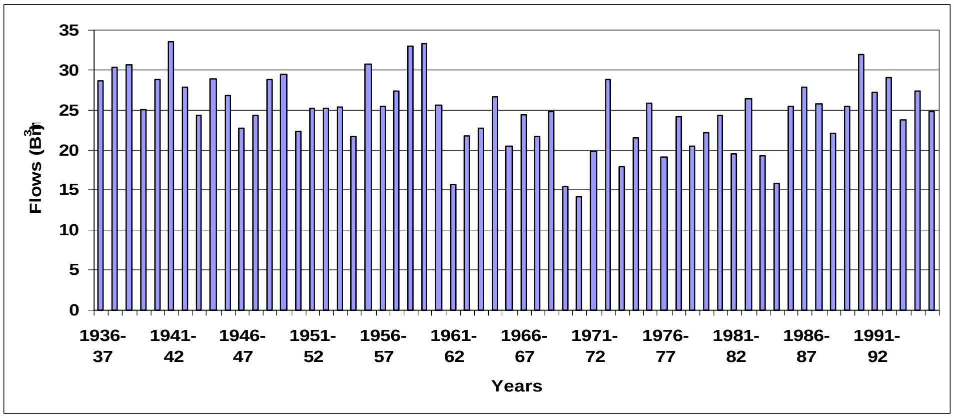

Figure 4. Mean annual flows in river Jhelum from 1936-37 to 1994-95

WATER MANAGEMENT

Field Drainage

Drainage is the main concern of irrigated agriculture in the world. Management and disposal of drainage water is though an expensive challenge but it is rewarding because it helps increase the crop yields to a greater extent. In order to achieve 50% increase in agricultural yields, drainage is the main tool but it should be properly inter-linked with disposal of effluent out side the irrigation command. The Government of Pakistan initiated the construction of Salinity Control and Reclamation Projects (SCARPs) in early sixty's. Because the initial investment was considered a decisive factor, tube well technology for drainage was favored. Latter on the heavy operational and repair costs, and pumping of saline water from under ground brackish water zone tilted the balance in favor of shallow tube wells or even pipe drainage system. The tubewells have contributed to the salt accumulation in the soil surface because the equality between incoming and outgoing salts was not maintained and the water table virtually lowered by evaporation and transpiration only (Shaikh 1992).

By June 1995, SCARPs completed drainage facilities in a gross area of 6.02 Mha at a cost of Rs 25 billion. In addition to that new projects were undertaken over an area of 2.96 Mha at a cost of Rs 42 billions. However, the monitoring of the completed projects indicated that some of them have failed to deliver their expected results so much so that about 2.02 to 2.42 Mha of irrigated area persistently remained under high watertable. In view of that scenario, the National Drainage Program (NDP) was approved in 1997 for a total cost of Rs 31.4 billions.

Table 6. Summary of The Major Project Activities in NDP-I

	Integrated Irrigation and Drainage Programs				Drainage Programs		
Nature of projects/ schemes	Drainage and irrigation	Canal remode-lling	Intercept or drains	FGW tube-wells	Surface drains	Tile drainage	SGW tube-wells
	Size						
New	225400 ha	347 Km	269 Km		77 Km	10500 ha	
Off-Farm	Rehabilitation/ Remodeling of Existing				3173 Km		
Drainage	Extension of Existing				925 Km		
and	Rehabilitation and Replacement			6296 Km	34000 ha	863	
O&M	O&M through Performance Contract				7703 Km		
On-Farm							
Drainage	Transfer of Projects			1522 Tubewells			
	Transfer/ Construction/O&M			52740 Km		3745 ha	
Biological Control of Waterlogging						16400 ha	
Water Course Improvement/Lining in Saline Groundwater Area						500 Nos	

The NDP is another help to drainage sector but one may be genuinely afraid of its duplicity of previous engineering works, which have already shown a poor performance. The rehabilitation of saline ground water (SGW) tubewells may not be required if one wants to protect environment, and on farm surface drains may fail due to poor embankment stability, silting, weeding and land use problems. Similarly, interceptor drains would not be economical due to induced recycling of seepage water and indifference attitude of farmers to these drains. It would have been more appropriate to replace interceptor drains with field drains because each kilometer of interceptor drain could be surrogated by a 45-ha field drainage. The field drainage units could be handed over to the farmers without capital recovery with the condition that the user groups would not be provided with canal water, and the user groups would also bear all O&M costs. Following is the summary of proposed works:

In spite of all these efforts, about 6.5-Mha land would require field drainage facilities. This fact necessitates a continuous program of field drainage through shallow wells, tile drains, and surface drains, which should be well connected with out fall drains

Improved Irrigation Methods

In Pakistan, basin, furrow, and border irrigation methods are traditionally practiced; the basin method is most common. Due to higher field application efficiency, the drip, bubbler, and sprinkler irrigation methods have been introduced in Balochistan under International support programs but due to their expensiveness, they have not yet been adopted by the private sector. The National organisations like Pakistan Council of Research in Water Resources (PCRWR), and Pakistan Agriculture Research Council (PARC) are also making their research-based efforts to popularise these methods.

Experiments on vegetable crops conducted at the campus of Drainage Research Centre (DRC), Tandojam of the PCRWR show that on 12-year research basis, drip irrigation has 2.4 times higher water-use efficiency ratio over furrow irrigation. However, soil salinity increased in three years from 1.2 to 7.7 dS/m. It needed leaching after every three years but the rainfall automatically achieved the condition of leaching. The capital cost of drip is to the tune of US$ 5000/ha. It suggests that it could be introduced to orchards and higher priced vegetables.

The sprinkler irrigation method had 25 to 28% higher water use efficiency than basin method for cotton and wheat respectively. The capital cost of solid set system was about US$ 4000/ha. Both, the drip and sprinkler irrigation systems can be introduced to achieve higher water application efficiency at the places where irrigation tubewells are installed. Developing local manufacturing capability with some multi-national companies can reduce the capital cost of drip and sprinkler systems.

To minimise the conveyance losses, the On-Farm Water Management Departments are working on partial lining of water courses. As the pace of work is slow, piped watercourse of 45-cm internal diameter was tested to work under similar flow conditions to lined and earthen water courses. Its working was compared at a flow rate of 80 l/s wherein the piped watercourse had 21% saving in losses over earthen watercourse and 9% over lined watercourse, though both had same capital investment. The piped watercourse is working satisfactorily for about 9 years and up till now no repair and maintenance cost has been incurred on it.

Cropping Pattern

The land, water and climate play very important role in the adaptation of a cropping pattern, but traditions also affect the decision-making. It has been observed that many crops are grown in neglect to their appropriate environment. The water use efficiency is lowered down because of improper land levelling and due to water delivery on fixed rotation system. The banana and sugarcane growing has triggered water thefts because these crops require water more often than what does a fixed delivery system. Wherever banana is grown, it has become cause of high water table. Similarly cultivation of sugar cane is increasing all over the country, though the sucrose content and crop yield is very poor except in South. It is therefore proposed to introduce crop zoning and cropping pattern. The home dairy farming should be encouraged and leguminous and folder crops should be brought into crop rotation for better water use efficiency, nitrogen fixation, and weed control.

Water Pricing

The water pricing policies have a direct bearing on water equities. The traditional method levies water charges on the area of land cultivated irrespective of the volume being delivered at the farm gate. The landowners at the head reach of a watercourse always get water more than their share by depriving the ones at the tail of the same watercourse. In order to fill the gap between expenditure and revenues, water charges have been increased few times in the past but the revenue gap has not been bridged up. The Provincial Governments have created Provincial Irrigation and Drainage Authorities (PIDAs) but they have not yet delivered the goods in collection of more revenues.

The author is of the considered opinion that water metering should be introduced at all diversions where the in-charge of these units should be made responsible to collect the water charges according to volume of water passed under these structures. The irrigation authorities should be empowered to impose and collect heavy penalties on water thefts. This mechanism has been very successfully implemented in the energy sector where WAPDA management has been temporarily transferred to the Pakistan Army. The under-pricing of water and its inequitable distribution along with non-availability or violation of water rights are pushing the entire system to self-destruction.

RECOMMENDATIONS

The prosperity of Pakistan, especially its rural population is mainly attached with irrigated agriculture. The population might reach to 175 millions in the year 2010 that cannot be fed from prevailing agricultural system. Neither the land nor water is available to enhance the agricultural productivity through present poor rate of agricultural yields. The irrigation and drainage management is the key to break the slump in agriculture productivity. It is therefore recommended that :

1. The farming community should participate in the operation and revenue collection of the irrigation and drainage systems, and some portion of fresh tubewell should be disposed in the surface drains to maintain salinity equilibrium in the soil profile.
2. Lining of tertiary level canals in the saline ground water zone may be evaluated and their cost should be compared with the worth of water to be saved.
3. Additional Water storages including aquifers should be developed to stagger the peak flows of summer.
4. Possibility of raising the dam height of Mangla to increase the reservoir capacity should be explored to shave the flood peaks in the Punjab and to minimize escape of floodwater down stream Panjnad.
5. Disposal of drainage effluent should be routed to the sea.
6. Institutional reforms should be strengthened to enforce new water management policies and regulatory frameworks.

SUPPLEMENT DATA/INFORMATION ABOUT COUNTRY PAPER, (PAKISTAN)

The population of Pakistan, which is presently 130 million, is likely to reach the figure of 250 million by the year 2025. In order to meet the food requirements of ever-growing population it is necessary that available water resources should be properly planned, harnessed and managed. Their optimal use be made to bring additional barren lands under cultivation by providing proper irrigation facilities. Consequently increase per acre cropping yield. Pakistan receives some 146 MAF of water at rim stations out of which presently 106 MAF is used for irrigation purposes. The existing major storage reservoirs have a present capacity of 14 MAF. About 40 MAF is wasted due to lack of storage reservoir. This wastage of water can only be avoided by constructing additional storage reservoirs. Construction of new storage reservoirs (two Nos) will provide some 17 MAF of additional water. Besides this about 4 MAF water storage will be lost in the existing Tarbela & Mangla dams due to sedimentation and the net increase will be about 13 MAF. This water will be used to bring additional vergin Lands of 4 million hectares land under cultivation. Besides a saving of about 3 MAF can be achieved by improving irrigation infrastructure and by proper water management techniques. Thus optimal utilization of water resources and proper management at form level will ensure food and other rural development parameters by the year 2025. The projected Parameters of Pakistan related to Agriculture by the Year 2025 are given at next page.

S.No.	Item	Year 1998	Year 2025
1.	Population	130 Million	250 Million
2.	Water available at Canal heads	106 MAF	121 MAF
3.	Total area under Cultivation	17.2 Million ha	21.2 Million ha
4.	Yield (Irrigation area)	2.2 ton per ha	4.0 ton per ha
5.	Yield (Rain fed area)	1.5 ton per ha	2.2 ton per ha

POLAND

1. PHYSIOGRAPHY

With a surface area of 312 700 km2 Poland ranks among Europe's larger countries. Poland's territory is divided into 16 voivodships and 2 459 communes. Poland lies in Central Europe in the drainage basins of the Vistula (Wisla) and the Oder (Odra) river, in the Lowland zone, between the Baltic Sea and Carpathian Mountains. Poland's roughly square-shaped territory stretches from Mt. Opolonek in the south (49ºlatitude north) to the Rozewie headland in the north (54º50' latitude north). Its westernmost and easternmost points lie at 14º07' and 24º08' east longitude. Poland's location in the middle latitudes determines its climate, vegetation, soils etc.

Poland lies in a zone of transition between western Europe, mountainous and sea-penetrated, with diverse landscapes and regions, and the more solid and less heterogeneous block of eastern Europe.

Poland is bounded in the north by the Baltic Sea and Russia, sharing borders with Lithuania, Byelarus and Ukraine in the east, Czech and Slovak Republics in the south and Germany in the west.

With average height of 173 m, as compared to the European average of 330 m above the sea level (the lowest of all continents), Poland is largely a lowland country. 91.3% of its area lies in the lowland zone; upland and typically mountainous areas account for 7.7%, and 1% of its territory, respectively. However, even the lowlands are hilly in character having been shaped by the activity of continental glaciers (lake districts in the northern part of the country); true plains are only found in central Poland.

2. CLIMATE AND RAINFALL

Poland's climate is moderate i.e., intermediate between maritime and continental climates. Poland frequently finds itself in the zone of atmospheric fronts; the result are either fairly wet and mild winters, with average monthly temperature of around 0°C, or heavy and dry winters, with average monthly temperature of -10°C. A similar variation in air temperatures and precipitation occurs in the summer season, especially during the vegetation period. Hot and dry summers (with less than 20 mm of rainfall in June, July and August) may alternate with cold and wet summers with a monthly rainfall up to 150 or even 200 mm.

The prevailing western winds considerably increase air temperatures in areas lying along the Vistula and Oder Rivers but their impact on eastern regions of the country is in general negligible.

Annual isotherms range between 6.5°C and 8.5°C; average temperatures in January and June temperatures are range from - 1 °C to - 5 °C, 17°C to 19°C, respectively. Average monthly amplitudes of temperature calculated on the basis of average monthly temperature range between 19°C in the west and 22°C in the east. In the lowland region the vegetation season with average temperature of over 5°C lasts from 190 to 220 days.

Average annual rainfall is 583 mm and in most regions of the country ranges between 500 and 600 mm. In smaller areas in the uplands and the mountains along Poland's southern border annual rainfall may reach as much as 800 - 1500 mm; Central Poland receives 450 - 550 mm, the coastal zone 500 - 600 mm. Two-thirds of annual rainfall occurs in the summer. Snow accounts for two thirds of winter (December - March) precipitation.

During the growing season potential evapotranspiration in most of the country exceeds precipitation. Only in the mountain zone and the seacoast average precipitation is high enough to satisfy the requirements of agricultural plants.

Crops cultivated in Poland in general do not require irrigation during the growing season. However, in areas of light soil dry spells are likely to occur leading to substantial losses in yields. Preventive measures include cultivation suitable crops and appropriate crop rotation; improvement of water conditions is achieved by raising water retention in the soil profile. Nevertheless, irrigation in areas of light soil appears to be necessary, especially in areas sown with valuable crops.

In contrast, areas with heavier soils require draining especially in the spring, in places where the ground-water level does not subside sufficiently early, which has an adverse effect on yields. In such cases drainage is the most appropriate method of soil amelioration.

Grasslands usually encountered in river valleys and areas of local low relief having a relatively high ground-water table also require draining. While rapid runoff of surplus water, especially in the spring, makes possible earlier development of the plants it also increases the risk of greater soil moisture deficiency during the growing season, intensified by high water consumption of grassland plants. In such cases irrigation is needed to meet the additional water requirements of grassland plants in the growing season to ensure sufficiently high yields; the drainage system consists of open ditches and drains while additional water requirements are met through sub-irrigation as well as flooding and borderstrip irrigation.

3. POPULATION AND SIZE OF FARM HOLDINGS

With over 38 million inhabitants and population density at 119 people/km² Poland is one of the more populated countries in Europe.

Some 30% of the population live in rural areas making their living from agriculture.

The prevailing form of ownership of the land is private property. Until 1989 roughly 25% of the land was under a system of state farms most of which were dismantled following the political transition of 1989.

Farm holdings vary widely in terms of size. The relevant figures for 1999 were as follows:

Area of farm holding	Percentage of all farm holdings
Less than 1 hectare	2.5%
1 - 5 ha	52.8%
5 - 10 ha	27.3%
Over 10 ha	17.4%

A visible tendency towards increasing the number of smaller farm holdings is being registered in recent years in favour of larger holdings with an area of 20 - 50 hectares. Change is stimulated by government policy.

Crop structure is as follows: cereals - over 51%, potatoes - 12.9%, industrial crops - ca 7.2% of all arable land. Wheat is the main cereal crop, at 2.43 million ha, followed by barley and oats, at 1.23 and 0.67 million hectares. The area under wheat and barley is steadily increasing while an opposite tendency is registered for sugar beet, potatoes and oil plants.

4. LAND RESOURCES

The total land area of Poland is 30,450,000 ha. The two main forms of land use are agriculture and forestry. Farmland and forests jointly occupy nearly 88% of Poland's territory. Farmland, which accounts for 60.1 % includes arable land and permanent grassland, at 14,829,000 and 3,891,00 hectares respectively.

The area of farmland is steadily shrinking. Since 1979 it decreased by 1,786,000 ha to 18,784,000 ha in 1997.

This decline, coupled with population increase, has led to the decrease in the per capita acreage of farmland: from 0.54 ha per person in 1980 to only 0.45 ha in 1997.

Permanent grassland, both permanent meadows and pasture, occupy about 3,900,000 ha, 12.5% of Poland's territory .

Meadows in Poland are to a large extent non-natural. They developed as a result of clearing of riverside forest or conversion of former ploughland into grassland. Natural concentrations of meadows occur only locally, mainly in the mountains.

Peatlands are found in many river valleys and lowland areas. Most of them were drained and converted into grassland (Table 1). Despite this, peatlands still retain many nature values and need to be protected. This presents a challenge to agriculture and management of drainage irrigation systems.

Table 1. Utilisation of peat bogs

Type of utilisation	Acreage (thousand ha)	Share [%]
Peat bogs in natural state	120.0	8.8
Meadows	960.0	70.7
Forests	120.0	8.8
Former peat bogs (with adjoining areas)	150.0	11.0
Protected peat bogs	6.1	0.4
Extraction area	2.5	0.2

On Poland's territory there are over 8,000 lakes of over 1 ha in area. Most of them are of glacial origin. The largest number of lakes is found in the Pomeranian and Masurian Lake Districts.
Acreage occupied by surface waters in 1997 was 826,000 ha, 2.6% of area of Poland. In comparison to 1980, this area increased as a result of the construction of several new reservoirs. Some of them were built for irrigation purposes.

Other forms of land use i.e., areas of development, and wasteland account for 6.0% of Poland's territory. All of these forms of land use show a growing trend.

Poland has many different soils. Sandy formations (20% of particles less than 0.2mm in diameter) occupy about 50 % of the total area. Their water properties depend upon the depth of the ground-water table, substratum soil profile layers, and content of silt particles less than 0.02 mm in diameter. Appropriate agrotechnical and land reclamation (water conservation) measures are necessary for the improvements of these soils. The main type of soils include swampy boulder loam, organogenic soils developed on peat, alluvial soils, silty and loess formations. More data on soil types in Poland are shown in Table 2.

Table 2. Parent rock - soil types in Poland

Parent rock of soils (types)	Percentage of total acreage of soil [%]	Percentage of acreage of farmland [%]
1. Gravels	0.9	0.5
2. Loose and light weakly loamy sands	34.6	24.8
3. Deep loamy sands and overlying loose sands	10.2	12.4
4. Loamy sands on more cohesive base	7.3	8.6
5. Sandy clays	8.5	10.2
6. Medium and cohesive clays	9.6	13.2
7. Loams	0.8	1.0
8. Loam deposits of water origin	4.2	4.6
9. Loess and loessic deposits	3.5	4.8
10. Alluvial deposits	4.7	5.8
11. Limestone rock (rendzina)	1.1	1.6
12. Massive rock of different origin	6.1	3.9
13. Organic and mineral-organic sediments	8.5	9.6

It is thought that reclamation measures are indispensable to bolster agricultural production by improving crop environment and consequently, increasing soil productivity. Both draining and irrigation measures have to be considered.

Average quality of Poland's soil is fairly low. Only about 23% of arable soils may be considered good or very good (classes I - IIIb), while poorest soils (classes V - VI) account for over 30% of Polish ploughland. Soil quality classification in grasslands is even less favourable: class I - III

soils account for only about 15%, class IV soils - for 38%, while class V - VI soils are most widespread, accounting for as much as 47% of total area of grassland.
In some regions of the country, particularly in the south and southwest, extensive areas of soils have suffered chemical degradation as a result of excessive accumulation of trace elements in surface layers.

About 4% of farmland contains higher amounts of heavy metals. This may be qualified as slight contamination. The total acreage of farmland classified as chemically degraded (in a varying degree) is about 150,000 ha, i.e., less than 1% of the total area.

Despite the development of agriculture and industry Poland still retains many areas valuable for nature. Of special value are wetland areas characterized by high biodiversity. A part of them has been drained and is used extensively for agriculture as low yield meadows and pasture. Extensive areas are under legal protection. Some restrictions in agricultural use have likewise been introduced in areas of infiltration, important for the recharging of aquifers and in areas of drainage basins of particular importance for good water quality in rivers.

5. WATER RESOURCES

Poland is one of the European countries with quite limited water resources. Renewable resources of surface water, i.e., mean annual outflow from the area of Poland, is 1580 m3 per capita as compared to the European index of 4560 m3. To make things worse Poland's poor water resources are substantially variable in time and space.

Figure 5 presents the spatial distribution of multiannual average figures for surface water resources, calculated per inhabitant.

In Poland's climatic conditions peak flows in rivers occur in spring while lowest levels are recorded in autumn and winter. The ratio between the maximum and the minimum average monthly outflow from the area of Poland is about 2.3. The same ratio is considerably higher for some rivers reaching double digit figures in mountain streams and smaller lowland rivers. Momentary flows vary even more. For example, in the case of the Wisloka river, the ratio between the minimum and maximum flow is as high as 1 : 1000. Precipitation is similarly unevenly distributed in space and time. Average annual precipitation in Poland is around 600 mm but in some years it may fall below 400 mm or exceed 800 mm. Much larger differences become apparent when short-term precipitation is analysed. They are responsible for the frequent occurrence of extreme phenomena such as floods and drought.

It is estimated that floods in the Vistula catchment area occur on the average every 5 years as compared to every 7 - 10 years in the Odra catchment. Surplus water in agriculture results not only from floods but also from long - lasting excess moisture levels in the soil. As late as in the 19th century Europe experienced periods of starvation caused by wet years. The last great flood occurred in the Odra basin in July 1997 causing incalculable economic and social losses. At the same time many regions of the country suffer from severe atmospheric, hydrological or soil drought leading to serious losses for the national economy, and in particular, for agriculture. It has been estimated that the drought of 1992 which affected almost the entire territory of Poland caused an at least 20% decrease in yields.

Water deficit in agriculture is strongly felt in the central belt of the Polish lowlands. According to statistical data from the late 1970s the acreage of override agricultural land was around 4 million ha. This poor condition of the land is caused by extensive deforestation done in the past as well as by improper management of the water resources.

It is believed that protection of water resources must consist of storing as much water as possible from the spring meltwater and from periods of intensive precipitation. The condition of the water system could be significantly improved by the conscious and appropriate shaping of the agricultural landscape.

Agriculture poses a threat to the quality of surface- and groundwater. Substances are eroded from farmland and leach into waters; they include mainly, organic matter, phosphorus and nitrogen compounds from artificial and organic fertiliser used in agriculture, toxic substances originating from herbicides and insecticides used in agriculture and forestry. It is estimated that over 50% of the nitrogen load and 40% of the phosphorus compound load in water runoff comes from agriculture.

Water intake has been increasing steadily exceeding in volume over the last several decades reaching 15 km³ annually in late 1970s. In the 1980s it levelled off due to economic recession even decreasing slightly early in the 1990s (Table 3). To a large extent this was achieved by the introduction of economic standards imposing more economic use of water.

Table 3. Water intake for economic requirements [km^3/year]

Intake	Year				
	1980	1985	1990	1995	1998
Total	14.18	15.45	14.25	13.27	13.80
Including : Industry	10.14	10.92	9.55	8.88	9.10
Municipal economy	2.72	2.93	3.00	2.87	2.85
Agriculture and forestry	1.32	1.61	1.69	1.52	1.43

6. BRIEF HISTORY OF IRRIGATION AND DRAINAGE

The first hydraulic projects for agricultural purposes were undertaken in Poland during the Middle Ages. Embankments were built to protect lowland areas against flooding and ditches were constructed to drain water from swampy areas. But the largest area was drained after the 1945. Annually, over 200 thousand hectares of agricultural land were drained for some years, as may be seen from Table 4.

Nowadays reclamation of new land has practically stopped. No more than 10 000 hectares of arable land is drained annually at present.. Drainage in river valleys has ceased. Most of the reclamation projects undertaken are associated with the reconstruction of irrigation systems, construction of water reservoirs or weirs to increase the water level in some rivers.

Table 4. Average area drained annually in Poland

Years	The area drained [hectares per year]
1951 - 1955	95 000
1956 - 1960	102 000
1961 - 1965	245 000
1966 - 1970	260 000
1971 - 1975	205 000
1976 - 1980	120 000
1981 - 1985	72 000
1986 - 1990	102 000
1991 - 1995	20 000

Nevertheless, it is worth noting that a substantial area of agricultural land in Poland is fitted with hydraulic structures, mainly for soil dewatering. The type and number of land reclamation (land improvement) structures is shown in Table 5.

Table 5. Land reclamation (land improvement) structures

Land reclamation area and structures	Units	Amount
Area ameliorated	Thousand hectares	6 690
• arable land	Thousand hectares	4 725
• grassland	Thousand hectares	1 965
Area irrigated	Thousand hectares	480
• arable land	Thousand hectares	62
• grassland	Thousand hectares	418
Hydraulic structures managed by farmers		
• ditches and small watercourses	Km	283 746
• pipes (without sprinkler irrigation)	Km	8 211
Hydraulic structures managed by the State		
• regulated rivers and canals	Km	49 588
• unregulated rivers	Km	24 796
• leeves (embankments)	Km	8 371
• pumping stations	number/m^3 . s	592/170
• water reservoirs	number/mln.m^3	185/170

As may be seen from Table 5 most of the agricultural land is drained without possibility to irrigate. Covered plastic or ceramic drains have been installed for dewatering arable soils. Irrigation systems were installed primarily in orchards and vegetable gardens. Grasslands, mainly those found in river valleys, have been drained by open ditches. About 25% of the drained grassland may be irrigated. The subirrigation system is the only method used for irrigating grasslands.

Agriculture development plans foresee that some 2 mln hectares of farmland will be taken out from agricultural production. This applies mainly to poor soils or river valleys of high nature value. It is estimated that some 10% of irrigation-drainage systems will be dismantled. Consequently, no larger irrigation or drainage projects are planned for construction in the coming years.

Irrigation is carried out in smaller areas, mainly in orchards and in vegetable gardens. At the same time action is being taken to renaturalize a part of the drained river valleys and introduce solutions designed to increase retention capacity, some of it targeted on water conservation.

RUSSIA

SUMMARY

The basins of the Caspian Sea and the Sea of Azov (the European part of Russia), where over 80% of the population of Russia and its main industrial and agricultural production enterprises are concentrated, have less than 8% of the annual volume of the country's river runoff. Water withdrawal in some of the river basins here amounts to 50% and more. Moreover, the irrigable capacity of rivers is rather limited and in some rivers it is on the verge of exhaustion. The intense use of water resources has led to deterioration of their quality and even to their depletion, especially small rivers, and to worsening of the water management situation in most regions of Russia.

According to the WATER CODE of the Russian Federation (1995) "Payment for water use is the basic principle of economic regulation of the use, rehabilitation and protection of water bodies". To realize this provision the Federal law on Payment for Use of Water Bodies (May 1998) established payment for all types of water withdrawal from water bodies, exempting from payment until January 2003 water withdrawal by agricultural enterprises and peasant farms for irrigation of lands and water supply of animal breeding farms.

In recent years efforts have been undertaken to improve the water management situation through elaboration of the Federal goal-oriented programmes such as "Potable water supply to the Population of Russia", "Regeneration of the Volga", "Improvement of ecological situation in the Basin of the Baltic Sea", "Flood control measures", etc. At present, the CONCEPTION of the State Policy on Use, Rehabilitation and Protection of Water Bodies as well as the Federal programme "WATER for RUSSIA" are under preparation.

The amount of arable land area in Russia (124,5 million ha in 1997) makes up 0.85 ha per capita. However, due to the low energy coefficient (0.19) depending on heat and moisture supply, the amount of arable land area will drop to 0.16 ha per capita. The agroecological zoning revealed that out of 206 million ha of agricultural land area 80% of these lands needed various reclamation improvements to reduce the impacts of adverse natural and antropogenic processes (erosion, waterlogging, salinization, etc.). The reduction of agricultural output by 1.5 times from 1991 to 1996 was, among other things, caused by aggravation of agricultural lands condition and soil fertility. In this situation, the Federal Law on Governmental Regulation for Providing Agricultural Lands Fertility was adopted in 1998. The CONCEPTION of the Federal Programme on Providing for Fertility Restoration of Agricultural Lands for 2001-2010 was elaborated in1999.

In 1997 there were 28.8 thou. agricultural enterprises in Russia (11.2 thou old enterprises and 17.6 thou. new joint-stock companies, partnerships, etc.) with 50% of the share in the total crop output; 274 thou peasant (individual) farms with 2% of the share in the total crop output; and the numerous personal household plots of citizens with 48% of the share in the total crop output.

In 1996, the gross crop yields with regard to all categories of farms were characterized as follows: 69340 thou tons of grain crops and legumes, 49380 thou tons of potatoes and vegetables, 16170 thou tons of sugar beet, 2765 thou tons of sunflower (seeds), 3025 thou tons of fruits and berries. The consumption of the basic agricultural products per capita in 1997 was characterized as follows: 117kg of bread, 125kg of potatoes, 75kg of vegetables, 33kg of sugar,7.9kg of vegetable oil, 31 kg of fruits and berries.

In Russia, the irrigated land area increased from 1.5 million ha in 1965 to 6.1 million ha in 1990 and drained land area increased from 3.1 million ha in 11970 to 5.1 million ha in 1990. By that time the entire volume of rice, 30% of maize, 80% of vegetables and 25% of forage were obtained on the irrigated lands (less than 5% of the total arable land area). During the transition period (1990s) the irrigated land area decreased by 1.4 million ha and that of drained lands by 0.4 million ha, and their contribution to agricultural production reduced.

Under that conditions, the most important task is to maintain the irrigation and drainage potential formed during the 1960s-1980s primarily through comprehensive optimal conditions for obtaining high crop yields. The Federal Law on Land Reclamation (1996) provides further development of irrigation and drainage in the country.

The important issues of future in the field of water and land resources management and development in the Russian Federation are as follows :

- elaboration and implementation of the Federal Programme on Rational Use of Water Bodies for the perspective 2010 (“WATER for RUSSIA”).
- elaboration and realization of the Federal Programme on Providing for Fertility Restoration of Agricultural Lands for 2001-2010, that will allow to obtain annually additional crop output of 70 million ton in terms of grain, including 27-28 million ton of proper grain crops.
- implementation of measures on rehabilitation and reconstruction of irrigation and drainage system on the total area of 5 million ha for 2001-2010 as a part of the Federal programme “FERTILITY”
- elaboration and implementation of the CONCEPTION of new land reclamation development in the Russian Federation after 2010 for the further growth of crop production.

1. GEOGRAPHIC CONDITIONS.

The Russian Federation is located in the eastern part of Europe and in the northern part of Asia. Its area totals 17.07 million km^2 (45% of this area is covered by forests, 4% - by water, about 13% - by agricultural lands, 19% - by deer pastures, 19% by other lands).

Russia is surrounded by the seas of the Atlantic Ocean (the Baltic Sea, the Black Sea, the Sea of Azov), by the Caspian Sea, and of the Arctic Ocean and Pacific Ocean. In the west, Russia borders upon Baltic states, Belarus and the Ukraine; in the south, it borders upon Georgia, Azerbaijan, Kazakhstan, Mongolia, China. The boundary between the European and Asian parts of Russia runs along the Urals.

The flora and fauna of Russia have zonal distribution. The following zones are clearly defined from the north to the south: arctic, tundra, forest-tundra, forest, forest-steppe, steppe and semidesert, and the desert zone being in the Caspian Sea area.

The largest part of the territory of Russia is within the limits of the cold and the temperate agroclimatic belts. The warm belt covers an insignificant portion of the Black Sea area in the south of the European Part of the country.

The mean temperature of January in Russia varies from -1^0 to -50^0C and that of July - from $+1^0$ to 25^0C. The yearly precipitation varies from 100 to 1000mm. Many areas of Siberia and Far East Feature permafrost, which covers 11 million km^2, or more than 60% of the total area of Russia.

The largest rivers of the European part of Russia are the rivers of Volga, Don (flowing to the south), Northern Dvina (flowing to the north). The largest rivers of the Asian part of Russia are the rivers of Ob, Irtysh, Yenisei, Lena (flowing to the north), Amur (flowing to the east).

By the beginning of 1998, the country's population numbered 146.7 millions, including 107.1 millions of urban population and 39.6 millions of rural population.

The Russian Federation incorporates 89 Subjects, including 21 republics, 6 territories (krais), 49 provinces (oblasts), 1 autonomous province, 10 autonomous districts (okrugs) and 2 cities of the federal subordination (Moscow and Saint Petersburg).

2. WATER RESOURCES MANAGEMENT.

Water sector of Russia consists of a water resource complex and a water-consuming complex.

Water resource complex is based on the river runoff, which in normal years makes up $4262km^3$, 90% of this amount is accounted for the basins of the Arctic and Pacific Oceans. However, over 80% of the population of Russia and its main industrial and agricultural potential are concentrated in the basins of the Caspian Sea and the Sea of Azov, which are accounted for less than 8% of the annual volume of river runoff in the country. In addition to this, the present operational groundwater resources in proved deposits is equal to $28km^3$. The predicted potential groundwater resources of Russia exceed $300km^3$ a year.

The role of water in the life of the people is formulated in the WATER CODE of Russian Federation adopted by the State Duma in October 1995: "Water is the most important component of natural environment, renewable, limited, and vulnerable natural resource, used and conserved in the Russian Federation as the basis of life and activity of peoples, living on its territory, securing economic, social, ecological welfare of population, existence of animal and vegetable kingdom".

The Ministry of Natural Resources and its Department of Water Resources Management are responsible for the water resource complex. The Ministry has 84 territorial committees in the Subjects (regions) of the Russian Federation and 12 interregional river basin arrangements (agreements) dealing with water resources management.

The intense use of water resources, especially in the last 50 years, has led to deterioration of their quality and even to their depletion, especially small rivers, and to worsening of the water management situation in most regions of Russia. The causes of such situation are follows: unsatisfactory realization of the measures for protection of surface and underground waters throughout the water catchment area, slow introduction of water-saving technologies and economic incentives ensuring the effective use of water resources, inadequate attention of the State to the water protection and use.

In recent years measures are taken to realize the WATER CODE of the Russian Federation through the Federal goal-oriented programmes such as “Portable Water Supply to the Population”, “Regeneration of the Volga”, “Flood Control Measures”, and others. New Sanitary Standards and Rules have been developed and introduced for the portable water quality control. New methods of treatment of waste and natural water are developed. Technological production processes are gradually introduced with use of no or few water. The experience continues being accumulated and realized for prevention and elimination of emergency situations. The theoretical and methodological basis is perfected for the hydroenvironmental monitoring.

According to the WATER CODE of the Russian Federation “Payment for water use is the basic principle of economic regulation of the use, rehabilitation and protection of water bodies”. To realize this provision the Federal Law on Payment for Use of Water Bodies was adopted in May 1998.

The Law covers such types of water use as water withdrawal from water bodies by industrial enterprises, housing facilities and public utilities; meeting the demand of power generation in water; use of water bodies as wastewater receivers; and some other types of water use. The Law exempts from payment until January 1, 2003 water withdrawal by agricultural enterprises and peasant (individual) farms for irrigation of lands and water supply of animal breeding farms.

The Law also exempts water users from payment for drainage wastewater discharge, provided the concentration of harmful substances in drainage water does not exceed the concentration of such substances in a water receiver. The share of payment for use of water bodies in the cost price of industrial production amounts to 0.5%; it amounts to 1% in the cost price of power generation and its supply, and up to 2% in the cost price of municipal services. It has been found that 50% of the payment amount transferred to the budget should be addressed to rehabilitation and protection of water bodies and streams.

To practically realize the sources of funding provided for by the Federal legislation and formed on the basis of water users’ payments it is necessary to develop a series of By-laws. For example, the Subjects of the Russian Federation should on the base of the Federal Law adopt their own laws on payment for use of water bodies. By April 1999, 58 Subjects of the Russian Federation adopted such local laws.

The water-consuming complex is responsible for water withdrawal from water bodies and for water use in different branches of the national economy, among which agriculture is the most water-consuming branch except power generation. During 1991 - 1995, the annual water withdrawal averaged: 26km^3 of water by agriculture, including irrigation and rural water supply; 36.5km^3 of water by power generation plants; 2km^3 of water by fuel industry; 3.1km^3 of water by ferrous and non ferrous metallurgy; 2.8km^3 of water by chemical industry; 4 km^3 of water by machine building industry; 13.1 km^3 of water by housing facilities and public utilities, etc. In 1996 total water withdrawal in Russia was 92.3km^3, of this amount 79.4km^3 of water were withdrawn from surface water sources and 12.9 km^3 of water - from subsurface water sources.

If we take into consideration that water withdrawn by power generation industry is mainly used for cooling the technological equipment, it becomes evident that agriculture is not only the largest water-consuming sector, but also the largest water production sector, because the sector itselves provides for the withdrawal of the whole water amount required (for irrigation, agriculture water supply, processing of agricultural products, etc.). Agencies for operation of irrigation canals and waterworks as well as the territorial agencies for land reclamation and rural water supply in the regions of Russia are subordinated to the Ministry of Agriculture and Food, which has the Department of Land Reclamation and Rural Water Supply. There are 111 reservoirs each over 10 million m^3 in storage capacity (32% of their total number in the country) and 1768 reservoirs from 1 to 10 million m^3 in storage capacity (91% of their total number) under the jurisdiction of the Ministry of Agriculture and Food.

Out of the total withdrawn amount (92.3 km^3) in 1996 73.2km^3 of water were used, including 14km^3 (19.1%) for domestic needs, 38.9km^3 (53.1%) for industrial production needs, 10.5km^3 (14.3%) for irrigation, 3.2km^3 (4.5%) for rural water supply, 4.6km^3 (6.3%) for agricultural production enterprises, and 2.0km^3 (2.7%) for other needs.

Although Russia is classified by UN as a country with low-level water stress, which uses less than 10% of the available water resources, water withdrawal in some of the river basins amounts 50% and more. Moreover, the irrigable capacity of rivers in southern and south-eastern regions of Russia is rather limited and in some rivers it is on the verge of exhaustion. Out of 5 million ha of irrigated lands in Russia up to 87% of these lands is located in European part of the country (southern and south-eastern regions) with scarce water resources.

In addition to payment for water withdrawal, there is payment for water delivery from a water bodies to a water user's off-take point. At present, there is no such payment in irrigation. Under the condition of free of charge water use, operating cost of interfarm irrigation and drainage systems should be covered from the State budget, namely, from the amount transferred as land tax.

In future under the condition of commercialization of economic relations between water management organizations and agricultural enterprises within the system of Ministry of Agriculture and Food, the payment for water delivery is necessary to compensate the cost of systems operation and running water management organizations. Numerous studies performed by Russian scientists have contributed to the establishment of the methodological and theoretical basis for commercialization of water use and introduction of water charges in irrigation farming. From the 1960 s to the 1980 s, experiments aimed at introduction of water use in some irrigation systems were carried out in Russia and in the former Soviet Union. The experiments produced positive results: reduction in water consumption, in the cost of water delivery, in the cost of allowances for operating personnel; yield growth.

3. LAND RESOURCES USE.

Condition of agricultural lands. The vast territory of Russia (1707.5 million ha) is responsible for the erroneous opinion about unlimited and inexhaustible land resources of the country.

The agricultural land area of Russia (206 million ha in 1997) involves: 124.5 million ha of arable lands, 18 million ha of hay lands, 55 million ha of lands under pastures.

The amount of arable land area in Russia makes up 0.85 ha per capita. However, arable lands of different countries do not have similar biological productivity, which is specified by the energy coefficient depending on heat and moisture supply. The energy coefficient for the Russian arable land area averages 0.19. If we take into account this coefficient, the amount of arable land area will drop to o.16 ha per capita, that is much lower than in a series of countries.

During the transitional period, considerable reduction of agricultural production was observed. The volume of agricultural output dropped from 191.1 billion roubles in the year 1991 to 131.2 billion roubles in the year 1996 (in prices of the year 1991). The reduction of the volume of agricultural output was, among other things, caused by aggravation of agricultural lands condition and soil fertility.

The agroecological zoning of agricultural land area, which was carried out in 1996, revealed that 80% of these lands needed different types of reclamation improvements to reduce the impacts of adverse natural and antropogenic processes (water and wind erosion, overwetting and waterlogging, salinization, etc.).

For the last years, soil fertility has noticeably decreased. Considerable reduction (several times) of organic fertilizer application is accompanied by drastic decrease of humus reserves in soils that may cause the development of an irreversible process of soil fertility deterioration. The application of mineral fertilizers has also dropped to the critical level due to dramatic rise in their prices, that leads to the loss of soil productivity. The desertification process as a result of extremely intense antropogenic load is particularly evident in the areas adjoining the Caspian Sea, in the lower part of the Volga basin, and in areas of Northern Caucasia.

At the beginning of the transitional period the Federal Comprehensive Programme of Improving the Fertility of Russian Soil was adapted for 1992-2000, however, this Programme is not being carried out fully, due to inadequate state financing and lack of money the farms have. Though the implemented work has allowed to reduce to some extent the negative processes in crop production, the main tendencies of lowering the soil fertility continue.

In this connection, the Federal Law on Governmental Regulation for Providing Agricultural Lands Fertility was adopted in 1998. The Law envisages the complex of activities on agricultural land fertility restoration, including the implementation of agrotechnical, agrochemical, erosion-control, different land reclamation measures, improvement of chemical and physical soil properties, etc. The Law defines the responsibilities of the state administration of different levels, bodies of local self-government, as well as owners and users of land plots on the matters of soil fertility restoration. The federal and regional goal-oriented programmes are should be elaborated to provide for land fertility. The CONSEPTION of the Federal Programme on Providing for Fertility Restoration of Agricultural Lands was elaborated in 1999.

Agricultural production. As of January 1, 1998, there were 28.8 thou enterprises in Russia specialized in agricultural production, including 11.2 thou old collective and state-owned enterprises, and 17.6 thou joint-stock companies, partnerships and other enterprises with new organizational and legal forms of management. Having 89.5% of sown area in 1997 they produced 92% of cereals, 9.3% of potatoes, 23.1% of vegetables, 96.3% of sugar beet, 84.6% of sunflower seeds and 96.2% of fodder crops out of the total production of these crops in the country. Their share in the total crop output was 50%.

In 1997, there were also 274 thou peasant (individual) farms which having 5.7% of sown area produced 7.5% of cereals, 1.2% of potatoes, 2.8% of vegetables, 2.9% of sugar beet, 14.2% of sunflower seeds and 2% of fodder crops. Their share in the total crop output was 2%.

In addition to this, the numerous personal household plots of citizens having 4.8% of sown area produced 0.5% of cereals, 89.5% of potatoes, 74.1% of vegetables, 0.8% of sugar beet, 1.2% of sunflower seeds and 1.8% of fodder crops. They had 48% of the share in total crop in the country.

In 1996, the sown areas and gross crop yields with regard to all categories of farms were characterized as follow :

Crop	Sown area (thou ha)	Gross crop yield (thou tons)
Grain crops and legumes	53390	69340
Potatoes and Vegetables	4280	49380
Sugar beet	1060	16170
Sunflower (seeds)	3860	2765

Soybeans	480	280
Fruits and berries	35600	3025

In 1997, the consumption of the basic agricultural products per capita was characterized as follows: 117 kg of bread, 125 kg of potatoes, 75 kg of vegetables, 33 kg of sugar, 7.9 kg of vegetable oil, 31 kg of fruits and berries.

4. LAND RECLAMATION DEVELOPMENT.

In 1960s - 1980s the land reclamation was given the leading role in agricultural development in Russia for its guaranteed contribution to the food production of the country. The irrigated land area increased from 1.5 million ha in 1965 to 6.1 million in 1990. About 60% of lands out of the total irrigated area was irrigated by sprinkling with the use of subsurface on-farm irrigation networks. According to the data for the years of 1986-1990, the share of crop produce from irrigated lands in the total crop production amounted to: 18-20% in Povolzhie, 24-30% in Northern Caucasia, and 5-8.2% in the remaining dry regions. The costs of crop produce obtained from 1 ha of irrigated and nonirrigated land area are correlating as follows :

> 6.5 in Povolzhie, 3.9 in Northern Caucasia, 4.2 in the Ural Region, 1.7-2.1 in the Central Chernozem Region. In 1990, it became possible to obtain on the irrigated lands (less than 5% of total arable land) the entire volume of rice, 30% of maize, 80% of vegetables and 25% of forage.

In the overmoistened zone of Russia the most intensive agricultural drainage construction was conducted in 1970 s - 1980 s. The drained land area increased from 3.1 million ha in 1970 to 5.1 million ha in 1990, including 3.2 million ha with subsurface drainage.

The transition from a centrally planned to market economy has not prevented the noticeable reduction of reclaimed lands in 1990s. The irrigated land area decreased by 1.4 million ha and that of drained lands by 0.4 million ha. The volume of work on operation and maintenance of irrigation and drainage systems was negligible. Water users were unable to pay for electric power, fuel, repair of sprinkling machines. The sprinkler fleet decreased by more than 40%. As a consequence, considerable crop yield decrease was recorded on these lands. The losses of agricultural production on irrigated lands in 1996, as compared to the year of 1990, amounted to 5170 billion roubles (in prices of 1996).

However, in spite of these unfavorable circumstances, the existing irrigation systems and irrigated lands provide for sustainable crop production in the Povolzhie, Northern Caucasian and Central regions and for the productivity level 2-3 times higher than in rainfed arable areas.

In 1996, the profit from crop production on irrigated lands as compared to rainfed lands was 3-4.5 times higher for cereals, 1.5-3.3 times higher for maise, 5.5 times higher for vegetables, 1.5 times higher for sugar beet, 1.4 times higher for perennial grasses for hay.

In 1996, the Federal Law on Land Reclamation was adopted. The Law has differentiated the types of property in irrigation and drainage systems and structures into: the state-owned property (federal and regional) and the property of water users, that serves as a basis for differentiation of responsibilities among the property owners in the development of land reclamation. According to the Law the Ministry of Agriculture and Food should pursue the governmental policy in the field of land reclamation through territorial agencies in the Subjects of the Federation, exploit irrigation and drainage systems and related structures referred to the federal property, work out Federal programs on land reclamation development, and make provisions for their implementation. Land reclamation is financed from the federal budget, from the funds of the Subjects of the Federation and funds of owners and users of reclaimed lands.

5. ISSUES OF FUTURE WATER AND LAND RESOURCES DEVELOPMENT.

5.1 WATER FOR RUSSIA

Social and economic transformations taking place in Russia, change of organizational and legal forms of the water users, introduction of the WATER CODE require the preparation of the relevant CONCEPTION of the State Policy on the Use, Rehabilitation and Protection of Water Bodies. The following principles should be taken into account when preparing the CONCEPTION: basin and eco-systematic approach to management of water use and protection of water bodies; ensurance of environmental and sanitary safety; sustainable and safe functioning of water systems; planned character and careful substantiation of the transformations; transfer of water management to self-financing; public's broad participation in the decision-making process.
Solving the above-mentioned problems should be based on the federal and regional water management programmes based on the schemes of integrated use and protection of water resources which are worked out at the level of the country, a region or a river basin.

The Federal programme "Rational use of water bodies for the perspective 2010." ("WATER for RUSSIA") is now under preparation. The improvement of water situation in the country;

guaranteed water supply to the population and for economic production; safety operation of hydrotechnical structures; reproduction, protection and rational use of water resources; and transformation of water relations into the market conditions are among the cardinal measures to be envisaged in the Federal programme "WATER for RUSSIA".

5.2 RESTORATION OF SOIL FERTILITY.

The Federal Laws on Land Reclamation (1996) and Governmental Regulation for Providing Agricultural Lands Fertility (1998) envisage the necessity to have federal goal-oriented programmes for providing the fertility of agricultural lands, formulated by the Government of the Russian Federation.

At present the CONSEPTION of the Federal Programme on Providing for Fertility Restoration of Agricultural Lands for 2001-2010 is elaborated by the Ministry of Agriculture and Food. According to the CONSEPTION there are necessity to undertake the complex of agrochemical, hydrotechnical, land clearing, erosion-control, forest improvement and other measures to stop the further soil fertility deterioration, ensure its stabilization and gradual improvement for increasing crop production.

The CONCEPTION envisages the main measures, terms and mechanism of their realization. Among the agrochemical measures there are liming of acid soils on the area of 58 million ha, rock phosphatization on the area of 29 million ha, gypsumming on the area 3 million ha, as well as the increase in application of organic and mineral fertilizer application. Land clearing is contemplated to implement on the area of 2.2 million ha. Provision is made for the execution of soil erosion control measure and recultivation of land affected by human activities with allocation accordingly 2.7 billion roubles and 5.5 billion roubles. Forest improvement measures (the main of them are the making of forest strips to protect the agricultural lands) are planned to implement on the area of 1.5 million ha. Hydrotechnical (land reclamation) measures should be carried out on the total area of 5.4 million ha, mainly reconstruction and rehabilitation of existing irrigation and drainage systems.

5.3 RECONSTRUCTION AND REHABILITATION OF IRRIGATION AND DRAINAGE SYSTEMS.

According to the CONSEPTION of the Federal Programme on Providing for the Fertility Restoration of Agricultural Lands for 2001-2010 hydrotechnical measures including reconstruction of the land reclamation systems will be a part of this Federal Programme.

CONCEPTION envisages to put into operation in 2001-2010 only 200 thou ha of new irrigated and 180 thou ha of new drained lands, and main attention is giving to reconstruction and rehabilitation of existing irrigation systems on the area of 3.1 million ha and drainage systems in overwetted zone on the area of 1.9 million ha.

At present the volume of work on reconstruction and rehabilitation of land reclamation systems are determined according to regions of Russia for inclusion of them in the Federal Programme. The farms, which efficiently use reclaimed lands are selected for priority implementation of reconstruction and rehabilitation of irrigation and drainage networks and irrigation equipment. The most important requirement for such selection is the interest of farms in the reconstruction and rehabilitation of land reclamation systems, and their ability to contribute in financing of the reconstruction work.

The rehabilitation, reconstruction and modernization of irrigation and drainage systems should solve the following problems :

- preservation of the created irrigation and drainage potential of the country, maintaining the contribution of irrigation and drainage into stabilization and development of crop production and animal husbandry;
- improvement of soil and hydrogeological condition of reclaimed lands and maintaining them at the environmentally safe level; utilization of saline drainage, wastewaters;
- reduction of unproductive irrigation water losses, use of water-saving technologies in irrigation;
- substitution of worn out equipment by new one, modernization of sprinkling machines with a view to reduce their weight and power consumption;
- adjustment of the disposition of sown area and the system of crop rotation on irrigated lands taking into account the availability of the agricultural enterprises having different organizational and legal forms of management and types of property, including individual peasant farms.

5.4 ECONOMIC, SOCIAL AND ENVIRONMENTAL EFFICIENCY OF MEASURES PROPOSED IN THE CONCEPTION OF THE FEDERAL PROGRAMME "FERTILITI" FOR 2001-2010.

Implementation of proposed in the CONCEPTION measures will provide for substantial growth of agricultural production, create the basis for food independence of Russia, secure the increase in consumption of home-produced food products and the income of agricultural producers. Together with the growth of the yield of grain and other crops the stability of agricultural production will increase, its dependence from unfavorable meteorological conditions will decrease.

Annual additional crop output in terms of grain will amount to 70 million ton including 27-28 million ton of proper grain-crops. The cost of additional output (1040 billion roubles in prices of the year 1999) will be 1.9 times higher as compared to the expenditures for the implementation of the proposed measures (555 billion roubles). More than 1 million places to work in agriculture and agro-processing sector will be preserved.

The realization of the Federal Programme "FERTILITY" for 2001-2010 will ensure the restoration of soil fertility, preservation and expansion of agricultural lands, the creation of conditions for social and economic development of rural areas.

The total area of the preserved agricultural lands will reach more than 5.8 million ha as a result of erosion-control, land clearing, land recultivation, forest plantings for land protection and other measures. Environmental impact of planned measures will be essential, the ecological equilibrium of landscapes will increase.

5.5 RECLAMATION OF NEW LANDS AFTER THE YEAR 2010.

According to the Master plan of integrated development of water and land resources of Russia the area of agricultural lands requiring irrigation amounts to 71.5 million ha including more than 50 million ha in the European part of Russia.

However, water resources (39.4 km^3 of surface water and 10.7 km^3 of groundwater), which can be used for irrigation, will make it possible to irrigate in Russia the total of 20 million ha, including 5 million ha of existing irrigated lands. Out of 15 million ha of lands, which can be irrigated after 2010, there are 4.3 million ha located in the European part of Russia, including 1.6 million ha in Povolzhie, 0.1 million ha in Northern Caucasia, 1.0 million ha in the Central and Central Chernozem Regions, 0.3 million ha in the Volgo-Vyatsky region, 1.1 million ha in the Urals Region and 0.2 million ha in the Northern Region.

The most effective regions for irrigation are Northern Caucasia, Povolzhie, the Central Chemozem, the Central and Volgo-Vyatsky Regions. The yield of irrigated crops here is near the upper possible level of biological productivity of the arable lands.

The area of new drained lands in overwetted zone of Russia may be increased by 7-8 million ha after the year 2010.

To determine the country’s need in reclamation of new lands and their possible contribution to agricultural production the CONCEPTION of land reclamation development in Russian Federation after the year 2010 should be elaborated taking into account the scientific and technological achievements and principles of establishing improved landscapes and environmentally sound use of water and land resources.

SLOVAK REPUBLIC

1. OVERVIEW OF THE NATIONAL POLICIES AND DEVELOPMENT PLANS

Slovakia's present period is an important landmark for the free market economy. Several years of decline in Slovakia's economic activity came to an end and revitalization in a stable macroeconomic environment begun. One of Slovakia's greatest natural resources is its agricultural and forested land, which accounts for 4.4 million hectares, 2.4 million of which is arable land suitable for agriculture. It is of immense national economic interest that the use of this natural resource be optimized.

Towards a solution to this situation, the government of the Slovak Republic adopted a whole range of one-time, as well. as, long-term measures. The most significant step was the acceptance of the basic principles and objectives of an agrarian policy, approved by parliament in 1993. It is based on the principle of economically utilizing the potential of arable lands, productive and human resources for the production of food and raw materials, while fully respecting the ecology, protection of the land and preservation of rural habitation.

Water management provides necessary services for society, such as protecting the land from floods, supplying the population, industry and agriculture with use and drinking, water, as well as, the protection of surface and groundwater from pollution.

The present structure of water management organizations in the area of land management accounts for about 85% of all water management activities, whereas other activities such as the maintenance of waste water purification plants, water treatment plants and minor reservoirs come under the administration of other departments. This vision is important for operative interventions and responses to crises, and also for ‘the-decision-making, process concerning the priorities of financial and pricing, policy and the coordination of ultra-regional waterworks.

Within the structure of water management there are four water-basin enterprises under which authority are 24,500 km of flowing water, more than 6,000 km of drainage canals and 228 km of irrigation conduits. Water-basin companies also manage 260 reservoirs whose total volume comes to 1.8 billion square meters of water, and monitor water quality. These organizations are responsible for the administration of 18 waterworks that generate energy. They also maintain dams that protect over 5,000 km of land from the threat of floods.

From a hydrological standpoint, Slovakia is the “rooftop of Europe”, with an uneven layout of its water sources. Every year, about 22 billion square meters of water flow out of Slovakia. up to 54% of all usable underground water comes from the Danubian Lowland and lower Vah, 27% is in Central Slovakia and 17% is in the east. There are ten regions in the Slovak Republic declared protected - water management regions with a total surface area of 7,000 km.

Running transformation and privatization in the area of water management enables Communities to realize their ability to solve the problems of drinking water supplies, canalization and purification of waste water, and to open the space for the investment of private capital.

The basic documents for implementation of the water management policy in Slovakia are :

- Program Declaration of Slovak Government
- Principles of water management policy in Slovak Republic
- Conception of water management policy in Slovak Republic
- General water management plan
- General schedule of protection and rational use of water in Slovak Republic

2. PRESENT STATE OF WATER MANAGEMENT

Surface water resources include watercourses, water reservoirs, lakes, ponds and transfer of water among, catchments. There flows about 3328 $m^3.s^{-1}$ of water in long term average (1930-1980) in total. From this amount only about 12 % (398 s^{-1}) rises on the Slovak territory. The rest flows from neighbouring countries, especially in river Danube. Minimal flows appear by the end of summer, in autumn and winter. In most of water courses significant imbalance of flow appears (rate of minimal and maximal flows) which considerably restricts economic water use. For example in the catchment of river Ipel’ is the rate from 1:2575 to 12 900, in catchment of river Vah from 1 : 109 to 487 and in river Danube from 1: 13,5 to 18.

In order to secure economical use of water and its energetic potential there have been (mostly after year 1945) 54 big water reservoirs constructed (with volume over 1 mil. m3), which are able to catch about 14 % of long term average annual discharge from the area. Water reservoirs improve small flows during dry seasons by about 55,5 $m^3.s^{-1}$, So that total improved flow reaches approximately 145,8 $m3.s^{-1}$. Besides above mentioned big water reservoirs there are approximately 300 small water reservoirs and ponds with total volume about 50 mil. m^3.

Subsurface water resources include soil water and ground water resources. Average annual volume of soil water on agricultural land in the Slovak Republic has been calculated (under condition of depth I m and humidity 25 %) to be about 7.0 billion of m^3 . This water is important from the point of view of production stability.

Ground water resources located are very uneven. Those near big, urban centres, which have been used at present, are practically exhausted. Many problems appear also in utilization of many resources due to their low capacity, threatening by pollution, or big distance from places of consumption. The resources are supplied mostly by precipitation. Natural water resources are calculated to 146,7 m-5, while recorded usable resources make 74,1 m^3 . This amount is gradually decreasing due to observed decrease of capacity of both ground water resources and water courses. Further decrease is caused by prohibition of use due to pollution.

Supply water delivery: Development of surface water taking in the Slovak Republic is characterized by following data in mil. m^3

Consumers	1990	1995	1996	1997
Public water mains	92,5	72,0	73,6	74,5
Agriculture	279,5	74,4	46,4	50,5
Industry. Power engineering	1018,1	661.8	701.7	685,6
Total	1390,1	808,2	821,7	810,6

Absolutely biggest decrease of water withdrawal has been recorded in user group `industry" including power engineering and other users. However, relatively biggest decrease appeared in water withdrawal for agriculture - water withdrawal in 1997 made only 20% from water taking in 1990.

Areas with water deficit especially for agriculture (comparing with theoretical requirements for irrigation) are lower sections of tributary flows of boundary rivers in southern part of Slovakia. in order to solve the deficit there have been proposes some measures - but they cannot be realized at present due to little water requirements and lack of finance.

Water courses and their use. Out of total water courses of length 49745 km., 32 632 km of are managed by the state public-profit enterprise - Slovak Water Management Enterprise. Its 4 branch works manage water economy, hydraulic structure and flood protection works in 4 most important river basins. Management in main river basins is executed with the help of water management systems; i.e. with the help of utilization of co-operation of natural flows, effects of water reservoirs, water transfers and water works. Besides that, part of small watercourses are managed by others like state forests, national parks, and other bodies. The Slovak Water Management Enterprise manages watercourses and constructions on them in a scope presented in Table 1.

Besides supplying the needs of water for all sectors, the hydraulic structures also provide necessary protection against flood as well as help navigation, facilitating production of energy and for leisure purposes, etc.

In order to increase agricultural production the irrigation systems have been constructed. During the period from 1960 to 1995, the irrigated area has increased from 25,000 ha to 308,200 ha. Irrigation works been constructed mostly in southern parts of the area, and in the East Slovak Lowlands. During the period 1971-1994 there was increase in irrigated area from 44,000 ha to 248,000 ha (in the year 1986) and the water withdrawal increased from 576 m3/ha to 1332 m3/ha in the year 1990.

Natural disasters on river flows (floods) arise due to extreme precipitation, long term precipitation and high water level in lowland sections of rivers, after sudden ice and snow melting, due to ice barriers, etc. Extreme floods appeared in the years 1954 and 1965 on river Danube, 1958 and 1960 on Vah, and repeating floods in the east Slovak Lowlands. Last floods in years 1996, 1997 and 1998 have arisen due to extremely intensive precipitation also in small catchments and caused significant damages. It has been confirmed, that on those river flows (Danube, Orava, Vah), where reservoirs with satisfactory accumulation volumes, and also other water works have been available were floods not hard, and damages not so high.

There appeared big, problems in lowland parts of river flows due to leaking of dikes. The problem of soil salinity is not important. Salt affected soils solonetz and solonchak appear only locally.

Potential of rivers is used also for electric power production in big and small power plants. Technically usable potential in realisable power plants represents average annual production of 6,608 GWh. In the year 1998 the production reached 4,630 GWh, and power of water power plants was increased to 2,487 MGW. The water power plants covered 20 % of total electric energy consumption.

Fulfillment of water management tasks depend on investment and operation development. This development depends on financial securing. Delivery of drinking water, discharge of used water, and water treatment for inhabitants are realized by limited prices which don't take into account requirements of new 'investment over the sum of depreciation. Payments for rivers management don't include (respectively include only a part) of public profit activities connected with use of energetic potential, flood protection, maintenance of navigation course, etc.

3. PRESENT STATE OF FOOD PRODUCTION

While evaluating the present state of food production, the development of agriculture after 1990 must be taken into account when significant changes appeared.

In following 5 years, the share of agriculture on gross domestic product made 4,4 %, with trend of further decrease.

The present total area of agricultural land is 2 444 600 ha. From this amount the arable land makes 1 472 200 ha which is 60,2 %. Perennial grassland, i.e. meadows and pastures make 845 600 ha, orchards make IS 900 ha and gardens make 77 900 ha. Vineyards and hop gardens occupy 30 000 ha. Forest area is 1993366 ha, water surfaces 93 476 ha, grassland 196 143 ha, and other area 176 054 ha.

Under the irrigation and drainage programme, an area of 308,000 ha has been brought under irrigation, especially on the most fertile soil. However, potential need is 892,000 ha. Moreover, according to evaluation of possible consequences of climate change in the Slovak Republic, there appears necessity of re-evaluation of irrigation and drainage programme as a whole. Preliminary results show that potential demand of irrigation is 700,000 ha as minimum. The irrigation systems cover 20.8 % of arable land at present. The need of drainage was calculated in the, framework of irrigation and drainage programme as 560 000 ha of agricultural land. At present is drainage realized on 460 000 ha. From this amount there is 4'30 000 ha of is subsurface drainage, which is 82 % from total need of drainage.

Salt affected soils, which appear in Slovakia, occupy only a small area and they are not important for economy.

From the total area of agricultural land, 49 % of soil is productive and 2% not productive, even unsuitable for agricultural production.

The problem of agricultural production reflects a fact, that cereals and oil crops are the easiest marketable crops at present.

In the framework of total agricultural area, 50,000 ha of land are managed by a system of organic agriculture, which makes 1,97 % of total area covering cereals, oil crops, legumes, sugar beet, flax, and fodders. The prevailing part of production is exported. Export prices of those products are higher by 25 - 30 % in comparison to prices on domestic market. From this production there are no products available on domestic market. Their application on domestic market depends very much on chance of early habits and price of products. This form of management is supported by state so far. It is done through the Ministry of Agriculture, which provides support of 2,000 S-k per hectare of arable land to farms managing, in the system of biological agriculture.

Analysis of food consumption in the Slovak Republic from 1990 shows, that early habits of inhabitants still do not correspond to new way of life, which considerably modified due to influence of civilization processes. Our meal is still energetically overextended and imbalanced from the point of view of nutrients. Big consumption of fats persists, although it is positive in this field, that consumption of plant fats and oils increases (by 56 % in comparison to 1990). The consumption of meat is 65.6 kg, which is still by 10 kg more than recommended annual rate.

4- PRESENT STATE OF RURAL DEVELOPMENT

Rural development plays an important role in social and economic development of Slovakia. According to official statistics, the Slovak Republic had a population of 5,325,000 as of 31.12. 1994. The total area of the country is 49,,035 square kilometres. The countryside is more densely populated with an average density of one hundred and nine (109) people per square kilometre.

The age structure of the inhabitants of Slovakia is quite favourable, with approximately 25 %of the populace in the pre-productive age category (below 15 years of age), 58 % of the populace in the productive age category (15 to 56 for women, and 15 to 60 for men), and 17 % of the populace past productive age (beyond 56 and 60 respectively for women and men). Retirement ages for women and men were legally established by the national government.

Demographic gender statistics indicate, that women are dominant (51.3 %), especially in the retirement segment of the populace.

As a criterion for area classification serves density of occupancy. The limit value 150 inhabitants/square kilometre is a criterion of ‚rural character of the area" (taken from OF-CD countries). According to this criterion, 78.4 % of inhabitants of Slovakia live in a country. Regions, where more than 50 % of inhabitants live in rural settlements, are rural regions. Regions, where from 15 to 50 % of inhabitants live in rural settlements are semi rural regions and those where less than 15 % of inhabitants live in rural settlements are urban regions.

Regional information indicates a spatially differentiated location of the populace: 42 % live in rural regions, 45 % in semi rural regions and 13 % in urban regions. In spite of a relatively high proportion of people living in rural regions, where Population density per square kilometre reaches 87 people, in semi rural regions is this number 105 people and in urban regions 1,022 people.

A large proportion, 31.8 % of rural inhabitants travel to work daily. Currently, the rural population is not primarily involved in agriculture with only 14 % of rural families relying on agriculture as their main source of income.

The topographical distinctions between the areas of Slovakia created inter regional differences in the utilization of the landscape. Land use for agriculture, in total area, is approximately 50 Proportionally, this land usage percentage is: 90 % in lowlands and 15 1116 in mountain regions. Conversely, in mountain regions 90 % is forested and 10 % is agricultural.

As far as qualification of people in agricultural enterprises, all of them are high-qualified experts. 95 % of managers of enterprises are graduated at universities; technicians are mostly school-leavers of secondary agricultural schools with general certificate of education and most of experts (tractor-drivers, repairmen, etc.) are school-leavers from 3-ear expert schools.

Non-qualified workers do only basic auxiliary service. Level of education in the country in Slovakia is almost the same as that in urban regions.

Agricultural production shared gross national product by 4.84 added value by 4.22 investment by 3.31 %, and employment by 5 %.

5. SCENARIOS AND FUTURE AIMS

Since the Slovak Republic lags behind western countries in development of drinking water delivery from public water mains, and in sewage, drinking water has been given top priority in water management. Other priorities areas are :

- Measures for protection of ground and surface waters against pollution from industry, stockpiles, and aerial pollution
- Increase of level of protection of an area against floods; protection against floods from internal waters and waterlogging; protection against soil erosion; increase of accumulation of waters discharged from the area; securing enough water resources for covering expected needs; (keeping ecological limits in water taking), and preparation of possibilities of building enough water reserves to tackle improper global climate influence on water resources.
- To improve the maintenance and then according to requirements gradually modernize equipment in already constructed irrigation systems (308,000 ha),
- Adopting measures for increasing agricultural production and changing of cropping pattern, gradually increasing water use in already constructed irrigation systems,
- Depending on increase of influence of climatic changes (decrease of moisture regime in soil) gradually build new irrigation systems and resources, especially in regions with favourable soil and human factors for development of agricultural production. There have been selected areas for extension of irrigated area to 500,000 - 700,000 ha. Similarly there are searched possibilities and allocated places for construction of necessary resources of supply water - reservoirs - especially in southern part of Slovakia.
- To reconstruct and extend protection dikes for protection of the area against floods, to adopt gradual measures for increase of protection effect of a forest in catchments of important rivers, to reconstruct drainage canals and repumping stations of internal water, to complete and extend these networks and repumping stations. In the framework of irrigation and drainage programme, in order to secure maximal agricultural production, there has been calculated drainage demand on 560,000 ha of agricultural land, but at present is the drainage realized on 460,000 ha (430,000 ha from it by subsurface drainage)
- To increase implementation of effective agrotechnical measures against erosion, because at present there is 55 % of agricultural land exposed to water erosion (17 % is extremely threatened), respectively 6 % to wind erosion
- Support of increase of utilization of energy/power potential of rivers with the help of construction of new water power plants and small water power plants,
- Revitalisation of improperly executed water courses improvement their return to their original state, rehabilitation of landscape, rehabilitation of wetland
- Improvement of navigation on Danube and according to need, gradual extension of canalisation on rivers Vah, Morava, and Bodrog,
- In catchments with lack of natural water resources, and without possibility of water accumulation, to supply water from neighbouring catchments according to prepared technical solutions,
- To keep balancing of water and management of water in rivers by water management organizations which act in the framework of catchments. Gradually transfer (except strategic resources and long-distance delivery systems of drinking, water) management and supply of drinking water, sewage and water treatment for inhabitants under responsibility of municipalities

- Gradually replace recent system of financing development of water management from one centre - state budget, and persisting system of limited prices for water management service with the system of prices based on payment of cost, with taking into account not only need of performance, but also necessary development. It will help to solve present problem of lack of finance in water management,
- To secure necessary finance not only from income from water sales, its sewage and treatment, but also from activities for public benefit (flood protection), for utilization of water energy, for keeping of navigation course, etc., but also through loan policy and subsidy policy.

Rural development plays an important role in social and economic development of Slovakia. Integration effort of the Slovak Republic connected to enter into European Union requires adapting system measures and courses in the field of rural development, so as to be comparable with member states of the European Union.

The following goals are set to be realised in the field of rural development:

- to keep population in the country and improve demographic development, especially in marginal settlements
- to create new vacancies in prospective rural traditional and non-traditional sectors
- to make attractive social environment of the country, especially for weak social groups of population (children, youth, women, pensioners),
- to develop regional culture, architecture and aesthetics in the country, traditional crafts and to support rehabilitation of rural spaces,
- to be aware that all activities in the country must protect and improve environment,
- to protect soil management also in non-competitive mountain regions, where it contributes landscape development, and has also ecological and social functions, including country
- settlement,
- to build technical-macro infrastructure in order to reach improvement of living, conditions and conditions for job in the country

6. CHALLENGES FOR FUTURE

For realising the vision's described above, the following activities are needed.

- completing of construction of not completed constructions,
- water management,
- improvement of maintenance and decrease of water losses,
- increase of number of settlements with public water main and sewage in compliance with directives of the European Union for member countries,
- improvement of flood protection,
- increase of participation of cities and villages in management and supply of drinking water, sewage and purification of water,
- securing finance by implementation of real prices for water management activities and activities of public interest which will enable to secure not only operation, but also development.

In the field of rural development, it will be necessary to take steps for keeping population in the country in control, improvement of age composition of inhabitants, creation of new vacancies, extending agriculture also in sub-mountain regions.

Implementation of scenarios and aims will require large investments. Rate and scope of implementation will depend on growth of economic level of the country, villages and income of inhabitants, on completing of restructuralization of industry and other productive branches, on development of home trade and establishment of products on foreign markets, on investment of foreign capital into development of productive structures of the country, on entering and active participation of the Slovak Republic in international integration groups, on support and application of results of research and science, on education of experts and managers.

So, the general development of the country and its agriculture, forest and water management will depend not only on internal, but also external conditions, i.e. on development whole world economy, trade and cooperation.

In the framework of fulfillment of vision programme it is expected to continue and enhance recent cooperation with neighbouring countries, especially with those with common borders with Slovakia. The field of cooperation will include not only bilateral cooperation in the field of boundary rivers, but also multinational cooperation on rivers crossing more countries (e.g. the Danube), membership in many specialized expert organizations, in the European Economic Committee of LTNO, as well as in solving of many international programmes.

Table 1

Parameter	Unit	Year							
		1990	1991	1992	1993	1994	1995	1996	1997
Length of natural water courses	Km	8368	8368	8437	8437	24719	25307	28676	28676
From this amount : regulated water courses	Km	3073	3082	3156	3158	7131	7140	7617	7617
Important water management and water supplying rivers	Km	7307	7307	7307	7307	7383	7383	9183	9183
Length of dikes	Km	2689	2690	2739	2751	2852	2852	2852	2852
Area threatened by floods Q10	Km2	1469	1469	1469	1469	1686	1686	1899	1859
Area threatened by floods Q100	Km2	2973	2973	2973	2973	3381	3381	3984	3984
Area protected against floods Q10 and more	Km2	4893	4893	4893	4893	5201	5201	5764	5764
Length of artificial canals and inlet canals	Km	737	737	737	773	774	775	1120	1120
Dams	Number	174	175	175	185	202	202	217	217
Pumping and repumping stations	Number	61	63	64	66	562	563	585	588
Big water reservoirs	Number	46	47	48	50	51	51	51	52
From this amount : multi purposive water reservoirs	Number	41	42	43	45	45	45	45	45
Drinking water reservoirs	Number	5	5	5	5	6	6	6	7
Total controlled volume	Mil.m3	1628	1631	1827	1830	1855	1855	1855	1865
From this amount : multipurposive water reservoirs	Mil.m3	1506	1509	1705	1708	1708	1708	1708	1708
Drinking water reservoirs	Mil.m3	122	122	122	122	147	147	147	157

* including Water Reservoir Zilina on river Vah, which is close before completing.

SLOVENIA

1. OVERVIEW OF NATIONAL POLICIES AND DEVELOPMENT PLANS

1.1 SLOVENIA AND ITS PEOPLE

Slovenia is a country about the size of Switzerland covering approximately 20,000 square km and borders on Italy, Austria, Hungary and Croatia. It was a population of 2,000,000 of which 90% are Slovene by nationality. 50% of the population reside in 50 cities and towns with Ljubljana as the largest with 270,000 inhabitants.

1.2 NATURAL RESOURCES

Natural agricultural resources in Slovenia are diverse, but mostly they can be characterized as unfavorable. The basic features are dense forest cover, unfavorable relief and a high proportion of pure grassland.

Forests cover more than 54 % of the land and in terms of the proportion of forests in total agricultural land, Slovenia is the third largest in Europe (after Sweden and Finland)

Agricultural production is rendered difficult in one way or another on more than 70 % of agricultural land. This fact places Slovenia among the countries with the most difficult conditions for agricultural production in Europe. The major portion of agricultural land with unfavorable conditions for production is located in the highland and mountain regions, which represent 49 % of all agricultural land in Slovenia. The unfavorable conditions do not in fact prevent agricultural production, but seriously affect the competitive and adaptive ability of Slovenian agriculture.

A high proportion of pure grassland and low proportion of arable land in the overall composition of the land also contribute to low adaptability. In Europe, only Ireland and Switzerland have a higher proportion of grassland in the overall land structure. It is understandable, therefore, that cattle breeding dominates in agricultural production in Slovenia.

2. PRESENT STATUS OF WATER

2.1 WATER RESOURCES AND QUALITY

Slovenia is a country rich in water resources. Rainfall during an average year amounts to 1.500 mm, reaching 3.000 mm in the west and 800 mm in the east. From a total average precipitation of 32.2 billion m³/year, about 18,7 billion drain into the rivers (of which approximately 80 % flow to the Danube and almost 20 % to the Adriatic Sea). The remaining precipitation infiltrates into groundwater or evaporates (vegetational evapotranspiration).

2.1.1 Groundwater and springs

The water abstracted from groundwater aquifers and springs is used for public supply. Water balances for individual aquifers are not available. The used aquifers are mostly shallow and located in the gravel beds along the valleys, where urbanization, industry and agriculture are concentrated. A large quantity of water from rainfall and runoff infiltrates the Karstic aquifers. Groundwater in gravel bed aquifers is located in the proximity of water users and easily tapped. The disadvantage of these sources is their exposure to the effects of urbanization, and to other environmental impacts which are difficult to control.

2.1.2 Quality of groundwater

Although the quality is generally acceptable by EU standards in most regions, these sources are being contaminated particularly by agricultural and also by industrial, and municipal contaminates.

The monitoring of water quality is carried out by the Hydrometeorological Institute. The program operates 84 sampling points in 18 different water-tables. In the western part (Vipava Valley) the underground water quality is relatively good.

Spring water quality in the Karstic area is also very sensitive to human activities. Untreated sewage is major pollution source here. In the Alpine hinterland, springs are much cleaner and used as a major source for domestic water supply.

2.1.3 Surface water

Slovenia has seven transboundary rivers: the Mura (from Austria to Croatia), the Drava (from Austria to Croatia), the Sava (to Croatia), the Vipava (to Italy), and the Soca (to Italy). The area of 16.500 km² is drained into the Black Sea (this is part of the Danube Drainage Basin) and 3.750 km² is drained into the Adriatic Sea. The Slovene share in the Danube river basin covers about 81 % of the country and hosts about 80 % of the total Slovene population. The main characteristics of river basins are presented in the following table 1.

Table 1. Main characteristics of river basins

Rivers	Precipitation ($10^6 m^3$ mm)	Flood plains (ha)	Drainage ($10^6 m^3$ /y, mm, %)	Population (% of nat. total)	Agriculture (% of nat. total)	Industry (% of nat. total)
Mura	1197, 861	18,700	340, 245, 28	7.0	23.7	6.0
Drava	3671, 1125	16,000	1832, 561, 50	20.9	24.3	20.7
Sava	20773, 1757	31,700	12294, 1040, 59	59.8	45.0	62.0
Total Danube Basin	25641, 1556	66,400	14466, 878, 56	87.7	93.0	88.7
Soca	5469, 2278	2,900	3812, 1588, 70	6.4	4.6	6.8
Primorska region	1070, 779	2,200	394, 287, 37	5.8	2.4	4.5
Total Adriatic Sea	6539, 1732	5,100	4206, 1114, 64	12.3	7.0	11.3
Total Slovenia	32180, 1589	71,500	18672, 922, 58	100.0	100.0	100.0

Source: Compiled from various sources.

Flood protection: To provide protection against frequent and devastating floods, about 10 % of low land water – i.e. 2.490 km of river stretch – has been regulated, 800 km of water streams are protected as natural heritage and 23.310 km preserve their natural appearance.

International cooperation: Slovenia participates in international projects for the protection and use of the Danube River, and signed bilateral agreements on water management cooperation with Austria, Croatia, Hungary and Italy.

2.1.4 Surface water quality

Surface waters are monitored by the Hydrometeorological Institute at more than 100 sampling points along the main rivers.

Surface water quality is classified into 4 classes: Mura river shows that quality of water has improved since 1989 from quality classes 2 to 3 in 1994, what is most probably due to rehabilitation measures taken in Austria. The situation is similar in the Drava river. The decreasing industrial pollution during recent years is considered to be the principal cause. The quality of Sava river has also improved recently, but it is still between classes 2 and 3. The river Soca in its entire drainage basin is classified in classes 1 or 2.

2.1.4 Water use and waste water

\Water uses : Surface water is the dominant source of cooling water in electricity generation, while groundwater is the major source for the public supply. Domestic use of water from both underground and surface resources increased between 1980 to 1994 by approx. 21 %. In 1994, domestic water use totaled 87 million m^3, and consumption per head stood at some 37,3 m^3/year, i.e. around 100 litters/day.

Manufacturing and agriculture use more surface than groundwater. In manufacturing, there was a reduction for some 50 % between 1980 and 1994 – almost equally shared by surface and groundwater sources. In agriculture, water use increased slowly, particularly from surface waters (Table 2).

Table 2. Water use (million m³)

	1980	1985	1990	1994
Surface water				
Public water supply	7	9	5	11
Electrisity production	65943	66210	50461	65087
Manufacturing industr.	104	65	77	47
Agriculture	0.2	3.9	2.9	3.2
Groundwater				
Public water supply	99	121	132	147
Electricity production	19	15	1	6
Manufacturing industr.	42	39	32	23
Agriculture	0	0	1	0.2

Source : ECE/IEDS database

2.1.5 Relevant Major Legislation/Regulations : Environmental Protection Act (EPAct)

The Environmental Protection Act (EPAct) and Law on Water have been prepared and are pending; whose objectives are to improve water quality. The Environmental Protection Act (EPAct), includes the implementation of regulations on the control of water pollution from point sources and non-point sources from agriculture. It sets out the principles of (i) control by State bodies, local authorities, and the polluters, (ii) the liabilities for pollution and damage, and (iii) public access to relevant information.

The general Law on Water is supposed to regulate discharges along rivers, calculates charges, and specifies EIA requirements in accordance with the EC water quality directives. In addition, in the scope of River Basin management plan a Master Plan for Sewage and Waste -Water Treatment is currently being prepared.

International cooperation on water management in Slovenia is well established, particularly in terms of bilateral agreements. Slovenia has joined the (i) ECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes and (ii) the Convention on Cooperation for the Protection and Sustainable Use of the River Danube and (iii) the Convention of protection of Mediterranean sea (Barcelona Convention). These agreements are particularly useful for settling future disputes. For example, the ongoing Slovenian Coastal Management Program will be efficient only if coastal management programs are also developed by Italy and Croatia.

3. PRESENT STATUS OF FOOD

3.1 LAND RESOURCES AND LAND USE

Out of the total area of Slovenia of 2.027 million ha, 54.3 percent is covered by forest and 38.5 percent is classified as agricultural land. About 70 percent of the agricultural land is less-favored hilly and mountainous regions, mainly used for permanent pasture. The total area in Slovenia that is classified as agricultural land (both farmed as well as not utilized) has itself been declining constantly over the past thirty years, but the process has accelerated considerably since independence. From 1970 until 1989 the average annual decline in agricultural land was 0.44 percent (from 944 928 ha to 869 829 ha), but between 1989 and 1997 the annual decline has averaged 1.34 percent. This fall corresponded an increase in forest area (overgrowing of agricultural land) and non-productive land (urbanization, infrastructure). The rapid reduction in arable land represents the most serious concern (since 1960 the area of arable land has been reduced by 48,000 ha). Regulations on protection of arable land against changes to its purpose place some limits on encroachments on agricultural land, but cannot properly protect the best agricultural land. (According to categorization data there are only 799,000 ha of agricultural land left in Slovenia, that is 70,000 ha less than what is shown by statistics). We have attempted to mitigate the consequences of such encroachment through intensive measures for land improvement by agricultural operations [drainage, irrigation, land consolidation; MAFF has sponsored the implementation of study for National Irrigation Program (NIP: 1993-1994) with the aim to secure quality food for the needs of the country. On the base of NIP MAFF is budgeting the implementation of irrigation systems on approximately 3.000 ha of agricultural land per year for the major agricultural products (mainly vegetables and fruit production). It is also important to mention that there was serious drop in productive land after the second world war due to fast urbanization which mainly occupied the best fertile soil. From 1945 till 1990 72.000 ha of the best productive land was urbanized. Government of Slovenia has therefore financed the implementation of drainage systems on approximately 72.000 ha on endowment basis. These systems are not maintained sufficiently and their efficiency is in diminishing stage]. that started extensively in early seventies and today the improved land produces 45 % of all corn, 40 % of sugar-beet and 30 % of wheat. Table 3 indicates the structure of land use in 1997, by ownership categories.

Table 3. Slovenia – Area by land use and ownership categories in 1997

	Total		Private		State	
	ha	percent of land	Ha	Percent of category	Ha	percent of category
Total area	2,027,245	100.00	1,420,343	70.06	606,902	29.94
Forests	1,098,844	54.20	719544	65.48	379,300	34.52
Bare land	142,902	7.05	32,722	22.90	110180	77.10
Fishponds	4,521	0.22	3,454	76.40	1067	23.60
Agricultural land	780,978	38.52	664,623	85.10	116,355	14.90
Not utilized agric. Land[1]	166,286	8.20	108,856	65.46	57,430	34.54
Not utilized agric. Land[2]	314,389	15.51	234,061	74.45	80,328	25.55
Area farmed	466,589	23.02	430,562	92.28	36,027	7.72
Arable land	173,658	8.57	148,601	85.57	25,057	14.43
Permanent grassland	265,486	13.10	258,954	97.54	6,532	2.46
Orchards	10,983	0.54	9,358	85.20	1,625	14.80
Vineyards	16,462	0.81	13,649	82.91	2,813	17.09

1. As reported by the Statistical Yearbook of the Republic of Slovenia (SYBRS) 1997.
2. As derived by subtracting from the total agricultural land the area farmed as reported by the Farm Structure Survey (FSS) 1997

Source. FSS 1997, and SYBRS 1997

Of the total agricultural land only 60 percent is farmed, and this is because of abandonment of much agricultural land previously used as pasture or extensive grassland, that is reverting to forests or meadows. Of the total farmed area only 173 658 ha, or 37.3 percent, is arable land, the bulk of the rest (56.7 percent) being grassland. A major reason for the abandonment of agricultural land, is the slow implementation of the Denationalization Law and resolution on the legal status of previous community pastures. Before collectivization, it was a common practice to use a certain area of pasture as a local community grazing land. After independence that community land was subject to decollectivization and local grazing groups were dismantled. Legal restrictions on land use have caused abandonment of those pastures and their afforestation. Besides that, the land cadastre was not regularly updated on actual land use and categories were not reflected in those records resulting in overestimates of productive land categories, and the apparent discrepancy shown in table 5 between the unutilized agricultural land, measured by different methods.

Noticeable from the table are the difference in percentages owned by the state among arable land, orchards, and vineyards on the one hand (where the state owns 14.6 percent of the total land), and grasslands on the other (where the state owns only 2.5 percent of the land). It is clear that there is still considerable state ownership of the more productive agricultural lands.

During the period of past political system, Slovenia maintained private land ownership. However, legal restrictions on maximum farm size prevented normal adjustment of farms to achieve economies of scale. Generally, policy measures and objectives were oriented towards “silent” collectivization. Upstream and downstream services were provided by local, government controlled co-operatives and large state farms. Overall agricultural policy was geared towards enlargement of state companies and collectivization, but farmers resisted giving up their land. They continued to farm on small farms, and to increase the family income, by finding employment in other sectors of economy. The processes of concentration of state owned companies were more pronounced in the regions with better conditions for agricultural production. The largest proportion of State owned arable land is in the north-east and flat Pomurska and Podravska regions (18 percent and 23 percent state ownership of arable land respectively), and these are the only regions with more then 50 percent of total area classified as agricultural land.

3.2 FARM SOCIO-ECONOMIC STRUCTURE

The farm structure in Slovenia is dual. Currently (1997) there are 90 612 agricultural holdings farmed by households (household holdings or HHs), and 219 agricultural enterprises or companies (ACs), which have evolved from the transformed former state farms. The number of ACs has increased since 1991 (from 189 to 219) due to break-up of some of the former state farms. However, between 1990 and 1997, the total number of employees in such farms has declined.

The agricultural households in Slovenia own more land than they farm. This is because much of the owned land is forest land, and land for other uses. As seen in table in Chapter 3.1 of the total designated agricultural land 85 percent, or 664 623 ha is privately owned, but this does not necessarily belong to agricultural households.

Almost all farm households own land, but their total land ownership has declined since 1991. At the same time there has been a shift within farm types, with the larger classes in all farm types and the supplementary farm households in all size classes expanding their total land ownership, at the expense of the households with smaller farm holdings, among the full and part time as well as the aged ones.

3.2 AGRICULTURE

Slovenian agriculture exhibits the characteristics of a typical temperate zone. More than half of agricultural production (54.5 percent) is accounted for by animal products. The most important crop product groups are cereals, fruits, grapes, must and wine. Among animal products, cattle, cow milk, and pigs predominate.

The most important arable crops on HHs in terms of area planted are; grain maize (28 percent of arable land of HHs), wheat (22 percent), silage maize (21 percent), and potatoes (13 percent). Dominant groups of crops on ACs are cereals and industrial crops (sugar beet and hops). The most important livestock animals in Slovenia are cattle pigs poultry horses (8 000) and sheep.

3.4 FOOD BALANCE OF SLOVENIA

The basic characteristic of food balance is low self-sufficiency in bread grains, sugar and edible oil. Self sufficiency in beef and wine is also low, given the local conditions, but we are self-sufficient in fruit. The export of potatoes is relatively small compared to production. Slovenia has an important surplus in hops (traditionally export-oriented production), poultry and milk. The estimated aggregate index of self-sufficiency in food is 93.3 %, although since much of the feed is imported (index of self-sufficiency in feed concentrates is 1 %) the real index of self-sufficiency is only 78 %.

Compared to Western Europe, the level of self-sufficiency in Slovenia is low. Self-sufficiency in bread grains, sugar and edible oil in Slovenia is among the lowest in Europe and does not assure satisfactory food security for the population. Under extreme circumstances we could even face famine.. The uneven food balance, however, originates in the unbalanced agricultural development. Development of animal husbandry was favored in disproportion to crop growing. Difficulties associated with milk surplus are similar to those in more developed European countries, although Slovenian agriculture does not meet the average level of production as present in Western Europe.

3.5 ECONOMIC STATUS OF AGRICULTURE

Financial results in Slovenian agriculture are generally poor. The economic situation as deteriorated since 1983, as the consequence of an unbalanced price policy (prices of agricultural products did not follow the general price growth) The deteriorating economic situation was strongly reflected in agricultural investments, which in the late eighties dropped by almost a third below the level in 1980. Financial results in crop production were always better than in animal husbandry.

3.6 COMPETITION OF SLOVENE AGRICULTURE ON FOREIGN MARKETS

According to production costs, Slovene agriculture is generally competitive in Europe. This is mainly due to the cheap labor force. Compared to neighboring countries, the agricultural worker in Slovenia earns on average from 145 % to 365 % less per hour. On the other hand, prices in foreign exchange are generally lower in the home country. Countries competing with Slovenia on the international market artificially lower their prices through export subsidies and this (without adequate measures at home) diminishes the competitiveness of Slovenian agricultural products.

3.7 INTERVENTION IN AGRICULTURE

Slovenia has had a continuous system of intervention since 1981 and production, economic and structure indices show positive results. Due to established i9ntervention system in agriculture it was possible to increase production of most products, improve the structure of production, improve the social and economic security of the farmers and keep agricultural land inhabited and cultivated.

4 PRESENT STATUS OF RURAL DEVELOPMENT

4.1 ANALYSIS OF THE GENERAL OBJECTIVES

Development of the food and agriculture sector in Slovenia is guided by the four main objectives of the “Development Strategy of Slovenian Agriculture”, that have been adopted by the parliament and reaffirmed by the later MAFF strategy document and the recent EU accession strategy document. These objectives are very general and open to wide interpretations:

Stable production of quality food at reasonable prices and food security

As noted earlier this goal means that price and intervention policy should aim at achieving an aggregate level of self sufficiency close to 100 percent, with specified target levels of self sufficiency for the major products, and that domestic prices should be stable.

The basic issue that needs to be discussed is the best way to achieve food security for the population. The major result of many years of research and experience in many parts of the world is that food self sufficiency is a costly way to achieve food security. The best way is a policy of open trade, coupled with an agriculture and food sector that generates enough resources (namely value added) that permits the purchase (from either domestic or international markets) of the food required for the economy. In fact this policy, if followed for the whole economy, is even more likely to achieve food security at least cost. Much higher degrees of self sufficiency can be generated if a policy relying on specialization according to comparative advantage (food quality) is followed. Food self sufficiency is justified only when a country is severely isolated, and seriously threatened with potential food embargoes and when food on foreign market is not of acceptable quality.
.

Preservation of population density, and agricultural land (preservation of production potential in case of interrupted supply), and protection of land and water from pollution

This goal has been interpreted to mean that all agricultural land is cultivated, the family farm as a multi-purpose unit is promoted, and that moderately intensive production and low livestock density is promoted to avoid environmental problems.

Slovenia is very small country and hence the distances between the rural and urban areas are quite small. In such a context there are many people that can live in rural areas and work in urban ones. For such people agriculture is not a significant economic activity, and is at most a hobby. On the other hand, such people, if they practise farming, they are more likely to adopt environmentally friendly practises, as they might be more concerned with the preservation of the environment, and less about income from agriculture.

Nevertheless, there are some relatively remote areas, where the population depends largely on agriculture. If agriculture is to be practiced by low intensity methods in such areas, however, agricultural incomes will be low, and this will not contribute to the objective of keeping these people in the relevant regions.

It thus appears that there might be some type of contradiction among the goals of preservation of regional population density, and the goal of environmentally friendly low intensity agriculture. The latter does not generate adequate income, which, however, is needed to keep people in the rural areas. Environmentally friendly production can be practiced when the producer either has other sources of income, or large enough scale of production to generate adequate income. Land, however, in Slovenia seems to be scarce to allow large scale of individual private agricultural production.

Permanent Increase in Competitiveness

While the goal of increased competitiveness is a valid one, it has been interpreted as meaning that the agricultural sector should support larger and more educated farmers, with more rationalized production, better technical services and better organization. The apparent underlying assumption is that such larger farmers are more efficient and hence more competitive.

Guaranteed parity income for above average producers

This goal in Slovenia means firstly maintaining production in regions with difficult production conditions (namely where all productive land is cultivated and hence there is no more room to expand), and also parity prices, direct payments, and support for complementary activities.

4.2 TRADE POLICY

Between 1993 and 1996, while aggregate exports and imports of Slovenia increased by 36.6 percent and 37.1 percent respectively, exports and imports of agricultural and fishing products increased by 20.9 percent and 36.2 percent respectively, while exports and imports of food manufactures increased by 10.5 percent and 33.4 percent respectively. Clearly the exports of agriculture and food products have increased much less than overall exports, while imports have changed very much in line with overall imports.

Total trade has mostly been redirected from countries which were part of Yugoslavia to other European countries. The EU has generally become the most important importer of Slovenian products.

4.3 PRICE POLICY

Until independence Slovenia had no agricultural policy of its own. Market and price policies fell entirely under the federal government, while former republics only had some competencies in the fields of structural policies. The first two steps in setting an independent agricultural policy were taken by adopting the “Strategy for Slovenian Agriculture”, in 1993 and by introducing foreign trade protectionism. The basic measure used in the Slovenian price policy is trade protectionism. There are no intervention mechanisms in the domestic market similar to those of the EU, and there are no administrative constraints on production similar to those of the EU, as there has been no need to introduce any.

5. FUTURE SCENARIOUS AND AIMS

5.1 A SUGGESTED STRATEGY FOR WATER MANAGEMENT

The authorities of Slovenia, in particular MoEPP, are aware of the importance of encouraging and developing tools to deal with water management. The decision to draft and enact the “Water Law” was particularly appropriate. In the light of the arrangements made to date, the law is supposed to be a comprehensive legal framework for water management. Accordingly, it is supposed to lay the ground for the necessary managerial decisions concerning water abstraction, water supply, preservation of water resources, water uses, and water related taxes and other payments. The law is supposed to prepare the ground for regulations to protect water against pollution with fuel, waste, sewage, etc. It is supposed to develop all administrative tools necessary for good water management.

The most important tasks of water management in Slovenia are :

To ensure safe water supply with suitable water quality in rivers and groundwater, and water treatment facilities throughout the country.

To prepare a coherent overall strategy on :

- national water planning program,
- national master plan for water resources and sewage treatment,
- general plans for groundwater resources,
- general plans for run-off basins.

Non of these exist today or is in developing stage. MoEPP could benefit from the allocation of more budgetary funds for research for compilation of data, the presentation of critical views regarding current priority issues as well as plans for the future. It is also necessary to develop forecasting tools like modeling, as well as methods for water treatment.

A reliable information system, which includes all the needed data, is necessary, as well as computing division, responsible for data collection, database development, data editing and analysis. The database system to be developed should e geo-referenced.

A good monitoring should be developed; the present monitoring should be extended to both individual and public supply systems, to help detect leakages and prevent quality incidents. Data should be used more systematically in analysis and for action plans.

For water-supply systems it is necessary to take immediate action to solve acute problems that endanger the safety of drinking-water supply because at the present time more than 20 % of the water-supply systems in Slovenia are not well ‘organized’. It seems that supply systems are not functioning well for lack of maintenance.

It is necessary to give more attention to water resources for rural development and food production and help MAFF to implement the programs on irrigation, drainage and physical planning of rural areas.

5.2 A SUGGESTED STRATEGY FOR THE AGRICULTURAL AND FOOD SECTORS

Despite the problems presented in previous chapter, it is the feeling that Slovenian agriculture, as well as food processing have considerable potential within the EU market, but currently they are overly burdened with structures and policies that carry over from the past, and prevent the dynamic elements within the two sectors to realize their potential. The food-processing sector has good technology, quality standards and competence. However, it is hampered by high raw material costs, and inability to adapt to changing market conditions because of the structure of ownership, and the difficulty of creating the appropriate management structures.

The basic thrust of the overall strategy is to pursue the development of high valued, quality based, differentiated, and internationally competitive agricultural and food products, oriented toward both domestic as well as international markets.

6 CHALLENGES FOR THE FUTURE

6.1 SPECIFIC POLICY DIRECTIONS AND RECOMMENDATIONS IN WATER MANAGEMENT SECTOR

All legal instruments that are necessary for a full implementation of the provision of the new ‘Water Law’ should be developed with high priority. Establishing a national strategy on water management is a matter of priority. It should include measure to prevent and reduce pollution from point source and diffuse sources.

The MoEPP should decide to extend the national water resources strategy into a comprehensive, long-term water management program, including specification of mechanisms for funding expenditures. The enforcement of all relevant legal instruments should be seen as indispensable in the implementation of the water resources strategy.

Water conservation measures should be defined with regard to industrial, municipal and agricultural water use. The setting of water prices at levels covering abstraction costs is a strategic objective in this connection.

Special attention should be given to water for rural development and food production (water resources for irrigation purposes, implementation of irrigation and drainage systems, maintenance of existing drainage systems, etc.) where MoEPP together with MAFF should find mutual solution for the implementation of the program.

In the near future, the allocation of available funds to the upgrading of existing and the construction of new waste-water treatment facilities, which clearly improve treatment efficiency, should be given priority over alternative uses of funds. The regulation implementing effluent monitoring by polluters should be prepared and enforced with priority.

Increased research funds should be allocated to the evaluation of water management practices as well as the formulation of alternative options. The Planning Division of the MoEPP should be put in a position enabling it to play the leading role in the specification of water management plans and related investment programs. If the creation of a formal regional level of administration is impossible, the Water Management Department of the MoEPP should implement regional water management.

Monitoring activities should be systematically extended to cover all existing water-supply systems, not only the public supply systems.

Monitoring data should be more extensively and systematically used in program analysis and for the preparation of action plans.

6.2 SPECIFIC POLICY DIRECTIONS AND RECOMMENDATIONS IN AGRICULTURAL SECTOR

The determination of Slovenian agricultural policy objectives for the development in future is based on the following guidelines:

- degree of economic and social development achieved in Slovenia,,
- developmental trends of developed countries and the necessary integration of Slovenia into the world economy,
- possibilities of agricultural development in terms of natural resources and marketing potential (at home and abroad),
- role of agriculture in maintaining the population density and constant soil fertility.

Goals of agricultural policy:

1. Stable production of cheap and quality food and food security in Slovenia
2. Preservation of population density, cultural regions and agricultural land (preservation of production potential in case of interrupted supply), protection of agricultural land and water from pollution and misuse
3. Permanent increase of competitiveness
4. Guaranteed parity income for above-average producers.

The concept of agricultural stemming from the defined objectives represents a combination of eco-social and market concepts. Its main feature is that in consideration of ecological and space limitations, it establishes a market economy in an appropriate manner…

The definition of development objectives represents a target scenario, where the desirable development is quantified (target scenario 3). It should be stressed, however, that there are no planning definitions. The displayed numerical figures of the target scenario serves mainly as a guide for agricultural policy.

6.3 WATER FOR FOOD AND RURAL DEVELOPMENT

Having in mind that there is approximately 800 mm (East) to 3000 mm (West) of precipitation per year, Slovenia could not be considered as country suffering deficiency of water. Rainfall is very unevenly distributed over the year, high maximums of rainfall occurs and a great deal of this water runs off into Black and Adriatic sea and also high minimums of rainfall occurs over the year; agricultural production often suffers serious droughts. There were serious droughts in the country as a whole in years 1983, 1985, 1988, 1992, 1993, 1994, while in some regions droughts occur every year (depending of the duration of rainfall absence, depth of the soil and its water retention characteristics, stage of crop growth, etc.).

To ensure stable and quality agricultural production MAFF planes on the base of National Irrigation Program of Slovenia to give financial support for the implementation the following water management actions for rural development:

- to ensure sufficient water resources for irrigation needs (water reservoirs, pumping stations, pipe distribution net),
- irrigation systems are supposed to be implemented on 3000 ha every year,
- drainage systems that were implemented in past 30 years (1969 – 1999) on approximately 72000 ha and are poorly maintained are supposed to be reconstructed where required and/or maintained properly. Financial support is being given to farmers for these actions.

SPAIN

GENERAL SUMMARY

Water

Very slight changes with little significance are foreseen for gross water demand, although this will have to be covered by better quality resources and, above all, much higher guarantees. For this purpose the tendency will be to install safer systems, on occasions with dual feed circuits to ensure supply, as in the case of highly profitable crops destined for export. In any case, competitive conflicts between the various sectors may worsen.

The most important environmental requirements should be covered by both the adoption of water saving policies and the so called "clean technologies". This item is of particular interest in the case of non-point pollution caused by the agricultural use of fertilisers and pesticides.

Although it is not foreseeable any important modification of irrigation water prices, the environmental policies addressed to obtain water savings and to improve its use practices, along with the modernization of infrastructures and the improvement of application systems (sprinkler and microirrigation), would certainly result in reductions of irrigation volumes that in some cases could compensate the demands of new irrigated areas. Any substantial increase of the irrigation water prices would certainly have very adverse effects on agriculture, particularly in fragile areas, leading to a reduction of both, the irrigated areas and the crop production followed by a massive abandonment of the rural milieu by the farmers, and the subsequent degradation of the environment.

Environmental policies will raise the production costs which, in certain cases, may result in a reduction of cultivated areas. However the greatest farming reductions are expected to be a consequence of the progressively lower aids from the UE Common Agricultural Policy (CAP), aimed to reduce the cropping intensity and to encourage the release of farm-land for environmental purposes envisaged in the same CAP.

On the other hand, the production reduction due to the abandonment of dry-farming marginal areas would be compensated by the higher productivity of other lands and by new areas put under irrigation.

Food Production

The food production system has reached a high level of stability, by combining an adequate level of self-sufficiency with the advantages of international commerce. However, if free trade is consolidated on a medium term basis between Europe and non European Mediterranean countries, this could cause a tense situation in the Spanish agricultural export area, especially where fruit and vegetables are concerned. This situation could have a repercussion on the profits of the sector, but would not affect water since, although demand may decrease, either pressure could be reduced on some of the aquifers which are currently over-exploited or spontaneous inter-sectorial water reassignment could be carried out.

Rural development

There remains very little to be done in Spain regarding rural irrigation policies. Policies for the founding of new population centres in the rural environment do not seem to be called for, since this is already occurring in regional middle size centres. However, development is expected to be maintained in new agricultural foodstuff industry development projects which will increase the possibilities of these regional centres. While there will be a very modest demand for quantities of water for these projects, high standards of quality and guarantees will be required.

In the same way, endogenous development processes may be encouraged which make the most of advantageous environmental conditions. These processes are linked with mountainous areas and natural open spaces. In these cases it is not a question of new water demand, rather it entails restriction of alternative uses which, due to their local nature, would have very little influence on total water demand.

1. **SUMMARY OF NATIONAL POLICY AND DEVELOPMENT PLANS.**

In Spain, the definition of national policy and development plans is conditioned by the liberal spirit which impregnates the Spanish Constitution of 1978, and the institutional norms of the European Union into which our country was incorporated in 1986. As a consequence of this, private enterprise has become the basic force behind economic and social development. The State performs a purely subsidiary planning function in the general activity of national economy. As a result, there are no General Development Plans currently in existence.

The agricultural policy is defined by the EU Common Agricultural Policy (CAP) and entails continuous and prolonged adaptation to the GATT agreements. CAP is constituted by a series of regulations which control the various sectors of agricultural production by means of Market Common Organisations. This endeavours to reach a commitment between two fundamental seemingly contradictory, objectives: 1) the maintenance of the farmers' income (to avoid their abandonment of the rural environment), and 2) to lower the prices of agricultural product (in order to keep them in line with international prices). Rural development is fostered by a series of policies and programs which encourage the implantation of activities, particularly food and/or any other kind of industries whether they are related or not with agricultural production, this type of actions aimed to improve the quality of life in the rural environment.

Recently, a National Irrigation Plan has been prepared, characterized for being an open document, which foresees a very limited development of new privately financed irrigation plans, whilst it presents ambitious plans for future consolidation, improvement and modernisation of existing irrigated areas.

Currently there exists a National Law for Land and Urban Order which is complemented by Regional Laws and Municipal Plans, all of them trying to adjust the urban development to the social evolution, which obviously affect the agricultural development. Municipal Urbanization Plans shall be approved by the respective Regional Government. Urban supply of drinking water is, by law, the direct responsibility of municipal authorities in both aspects, the execution of the required structures (distribution network, etc.) and their exploitation and maintenance.

There also exists a National R+D plan for the promotion of research and development, in which specific fields are included related with sectors considered as being extremely important, such as biotechnology, environment protection, efficient use of water and rural development. This R+D plan is coordinated by the Inter-ministerial Commission of Science and Technology - ICS&T, (Comision Intertninisterial de Ciencia y Tecnologia - CICYT).

The structuring element of water resources policy is hydraulic planning, which was introduced and regulated by the Water Law of 1985, the preparation of which is expressly attributed to the Central State Administration Department responsible of water issues. Presently, all Basin Hydrological Plans for all the Spanish basins have been approved by Government Royal Decree 1664/1998 of 24 July. However, there is still no National Hydrological Plan (NHP) which would homogenise the Basin Plans and also define the occasional inter-basin water transfers in the future. The National Hydrological Plan will require its approval by a Law passed by the National Parliament and legal decrees of the same rank will be needed for future inter-basin water transfers.

The hydrological planning work which was carried out during the period 1990-96 (a preliminary version of the NHP was presented in 1993) was the object of strong political opposition and lively social debate, and for this reason, the NHP was not approved. During 1999 the White Book of Water in Spain (Libro Blanco del Agua en Espafla), dealing with the use of water in Spain has been issued. This book endeavours to clear the ground before starting on the preparation of a new version of the NHP. The White Book contains no reference to a decision regarding water transfer policy, which is to be submitted to public consensus, before including it in the NHP. As water transfer acquires a relevant (and much debated) role, hydraulic planning will not be complete until the NHP has been published, debated and approved. Finally, a specific National Sanitation and Purification Plan has been in existence since 1995 which contains details of the investments required for waste water purifying which is distributed among the four administration levels. The action to be taken which is envisaged by the National Sanitation and Purification Plan, based on the European Union Directive 271/91, will culminate in the year 2005. There is a noticeable absence of a parallel national scheme for the improvement and modernisation of municipal networks for the internal distribution of drinking water.

The various policies for the protection and conservation of the environment also entail the integration and participation of the four previously mentioned responsible levels (European, National, Regional and Local). In this case, the international agreements to which Spain has subscribed act as elements of inspiration and/or as catalysts.

The action taken in hydrological-forest correction programmes arise from an integrated effort on the part of both the National Hydraulic Administration (responsible for basin management) and the Regional Governments (responsible for forest investments). This duplicity of responsibilities makes it difficult to carry out these programmes unless effective agreement exist between both Administrations.

2. PRESENT STATUS OF WATER

Overall, Spain can not be considered as a dry country, within a world-wide context. Mean annual rainfall is 684 mm/year, but annual rainfall varies a lot from one region to other, ranging from more than 1,600 mm over specific zones of national territory. Sometimes surpassing 2.000 mm, to some 300 mm in large south and southeastern areas of the peninsula, the lowest being 200 mm in some zones of the Canary Islands. The assessed total average run-off is some 111.000 hm^3/year which, for a surface of 504.750 km^2, represents a specific run-off of 220 mm/year.

As for water planning, Spain is divided into 14 peninsular and 2 insular hydrographic areas or basin districts, corresponding to the 16 main watersheds.

Flows and natural regulation

If the natural environment had not been artificially changed, only a small fraction of the total natural resources - around 8 % - would be presently used to satisfy the various water needs. This means that if nothing had been modified, currently only an absolute maximum of little more than 1 Mha would be irrigated, which is comparable to the irrigated surface on the eve of the 20th century when, actually, the water resources on rivers and aquifers were practically in their natural state.

Thanks to their important underground components, the most naturally regulated basins are that of Segura and Jucar rivers (near 30 % of the total supply). This encouraged in the past intensive population settlements and the development of extensive traditional irrigation systems on their fertile plains.

Present available resources.

Nowadays, Spain has some 1,200 large dams on operation, with a total capacity of over 56.000 hm^3. Table 1 shows the appreciable increase in usable volumes resulting from infrastructure regulation, which is placed around 35 % of the natural water supply as compared to the previous 8 %.

These works of regulation have been financed mainly (about 60 %) with public funds through the former Ministry of Public Works - MOP- (budgets of the General Directorate of Hydraulic Works) and the rest by the private hidro-power sector. The development of irrigation was carried out jointly by the former MOP and the Ministry of Agriculture, through the former National Institute for Colonization (later Institute for Reform and Rural Development-IRYDA- and presently evolved into the General Directorate for Rural Development). The construction and exploitation of these hydraulic infrastructures (dams and primary irrigation's canals of statal initiative) has been mainly carried out by the River Basin Authorities or Hydrographic Confederations, created from 1926 on, one for each of the main river basins; secondary irrigation network being the competence of the Ministry of Agriculture.

All users of the Hydraulic Public Domain shall compulsorily be grouped in Users Associations (UA) or Users Communities. Irrigators Communities (IC) are those where the majority of users are farmers irrigators. The establishment of the first Users-Irrigators associations may be dated back to well before the Middle Ages, their primitive ordinances and regulations being adapted throughout centuries to new social changes and requirements. It was the Water Act of 1879 the first legal body that explicitly recognizes their existence and assigns them their present legal status. They are institutions of public law that cover the relations of the farmers with the water Administration, and among the farmers themselves, their main roles being the sound allocation of water volumes granted by the Administration for equitable distribution among irrigators, as well as collection of irrigation tariffs, irrigation organization, disputes settlement by Water Juries, etc. Several UA have even intervened on the creation and exploitation of new irrigated areas. These Communities are syndicated (federated) at both basin and national levels, the National Federation of Irrigators Communities of Spain gathering the practical totality of the Irrigators Communities constituted in Spain.

Artificial Recharge

The first recharge facilities in Spain were located in the surrounding districts of Barcelona, on the alluvial fans of the rivers Besos and Llobregat. Wells located in the latter delta region are used to recharge aquifers during some years, up to a maximum of 20 hm^3/year, using surplus water from a wastewater treatment plant. Other interesting experiences which although they are not comparable to the one previously mentioned, due to the length of time it has been operating, are those performed on the island of Mallorca, in the Llano in Palma, the Boqueron experience in the Segura basin, etc.

Since 1984, a number of trials have been carried out in different areas of Spain. The results obtained are encouraging, although it must be pointed out that despite the use of artificial recharging, there is a moderate hope to achieve a significant increase in the available resources of the country. However, using artificial recharge may be possible to solve or mitigate some of the local problems, thus improving the guarantee of water supply.

Desalination

Sea water desalination has been used in Spain since 1969, for urban water supplies in Ceuta, Lanzarote, Fuerteventura and Gran Canaria, all of them having in common the very poor availability of water resources.

Overall, sea water desalination currently contributes to the hydrological cycle, with some 222 Hm^3/Year, which places Spain in the leading position in Europe, owing 30% of the total desalination equipment installed in the whole continent.

Demand for water for supply to populated areas

This includes water for domestic use (homes), municipal (garden irrigation, fire services, etc.), collective (public services, such as hospitals and schools), industrial, commercial and even agricultural.

In practice, it is much more difficult to differentiate the share of water volumes consumed by industries connected to the municipal network, and those assigned to urban needs. As an indication, the volume consumed by small industries and services which are supplied by the municipal network represents approximately 25% of the total water registered by meters, and this is usually computed as a demand for urban supply.

Tourism and second homes generate a significant demand for water in Spain, frequently surpassing by far the demand of the regular population during peak periods due to the generalized use of swimming pools and other high water consuming leisure facilities.

Considering that Spain's current population is slightly more than 39 million persons, the total present water demand of populated areas is estimated to amount to some 4.700 hm^3/year.

Demand for water for industrial use

Available data usually refer to large industries, which in general are self-sufficient with reference to water supply. Small and medium sized industries supplied from the urban network are usually included within the urban sector, which leads to infra-evaluation of the whole industrial demand.

Current total demand for industries not connected to the municipal network is for some 1,600 hm^3/year (Table 2).

Demand for water for agricultural use

Demand for agricultural use is for some 24.000 hm^3/year, out of which more than half corresponds to the great basins of the rivers Ebro, Duero and Guadalquivir.

3. PRESENT STATUS OF FOOD

The **evolution of the demand for food** is clearly defined on a quantitative basis, although the quality of the product is increasingly becoming the starting point for food product development.

The average Spanish diet can be considered to be correct. However, consumer's trends show a slow approximation to the eating habits of other centre and northern European countries, not forgetting some other influences due to fashion pressure, whereby some of the typical features of the Mediterranean diet are losing ground. Specifically, the following changes have been identified:

- A slow and gradual reduction in the per capita consumption of food.
- An steady decrease in the consumption of bread, rice and cereal by-products. Decrease in consumption of pulses.
- Increase in meat consumption.
- Greater use of processed products, such as the following:
  Meat by-products, such as the traditional Spanish products (hams, salted meats and other cured products), and also newly introduced products (hamburgers and sausages).
- Consumption of dairy by-products which, in many cases, replace fruit for dessert.
- Processed fruit and vegetables, either canned or frozen.
- Industrial sweet products, biscuits and buns.

4. PRESENT STATUS OF RURAL DEVELOPMENT

Spain covers a total area of 50,479,500 ha, of which 26,025,700 ha (51 %) can be used for agricultural purposes, the remaining 49 % being unsuitable for agricultural use. Of total area suitable for agricultural purposes, 87% is used for rain-fed farming and the remaining 13 % is irrigated, this latter generating 55 % of total agricultural production, which means a production equivalence of 1 ha under irrigation to 6,5 ha of rain-fed land.

Total area equipped for irrigation in Spain, able to be supplied by irrigation networks, covers 3.76 Mha, out of which 3.345 Mha, are effectively irrigated each year. Of this actually irrigated area, 2.263 Mha are irrigated using surface waters, 0.942 Mha use underground water, 98,000 ha are supplied with water transfers, 24,000 ha with return flows, 17,000 ha with treated waste water and some 550 ha are irrigated with desalined water, either from sea or brackish sources.

Only 1.521 Mha of the total surface under irrigation are considered as having been adequately or over-irrigated, whilst 1.824 Mha are insufficiently supplied.

As for the application methods, 1.98 Mha use gravity, 0.80 Mha sprinkler and 0.563 Mha micro-irrigation systems.

Due to the long tradition of Spain in irrigation, many of the infrastructures still used are very old; prior to 1900, 1.077 Mha were under irrigation, which increased to 1.81 Mha by 1960, this meaning that more than half of irrigation systems operating today are more than 40 years old, and quite a lot of them even more than one century old. This has led the present National Irrigation Plan (NIP) to consider the need to carry out improvements and consolidation works on some 2.33 Mha of irrigated areas for a 20 years period, and 1.11 Mha before the year 2008. These works would include repairs on infrastructures and modifications on distribution and application systems.

At present there are more than 2.5 Mha protected areas, even though more than 5 Mha are considered to be areas of outstanding environmental value. River banks reach a length of some 1 00.000 kms.

With regards to Spanish soils, some areas at the Lower Guadalquivir Basin are affected by some salinity problems and others, at the Segura and Ebro Basins suffer from hydromorphic processes due to poor water drainage conditions.

The general quality of surface water is good with only localised problems caused by salinity in the upper Guadiana region, in the Guadalquivir and Segura areas, and also in the coastal regions of the Júcar Basin, the Eastern Pyrennees and in the South of Spain.

As for the quality of underground waters, 28 % of Spanish aquifers are subject to a high risk of pollution, 3 4 % to a medium risk and 3 8 % have low pollution hazards.

At the present time, Spanish agriculture is very strongly conditioned by the European Union CAP and by the aids received within this framework from the EU, although there are certain limitations with regard to areas and crops which deserve to receiving aids.

In 1997 the total Spanish active population was around 16 Mpers, out of which 1,254,000 persons (7,8 %) were directly related with agriculture, 8 1 % of them had a job and 19 % were unemployed. The latest employment assessments say that irrigation gives employment to some 550,000 workers (about the- half of the rural man-power), the remaining 466,000 persons being absorbed by dry fanning. From these figures it can be observed that irrigation and dry farming provide employment to almost 15 pers/100 ha, and to 2.4 pers/100 ha, respectively.

Anyway, over the last few years a trend to reduce the agricultural work-force has been observed, and percentages have approached those of the more industialised countries like, for instance, the United States. It shall be emphasized that due to the Spanish topography, in addition to the land ownership infrastructure whereby properties are usually divided into very small fields - Spain's average 2.5 ha/owner - there will not be easy to equal or even to approximate the US percentages,

it is foreseeable that competitive foreign markets will lead Spanish agriculture to take maximum advantage of its climatic conditions, in order to obtain high value products which require substantial labour-force supply. Even though percentages of agricultural population have not decreased in relation to the overall active population, it could happen that many of the dry farming workers who are about to abandon rain-fed areas because of their unprofitabilty, will go over to certain irrigated areas where cultivation of extra intensive, high value crops makes them highly profitable.

The known decrease of natality in Spain (lowest world-wide) force to consider a realistic labour scenario where the lack of Spanish workers to carry out intensive, high labour demanding agricultural tasks, in top profitable farming systems, shall be covered in the near future by immigrants from other countries, in order to maintain the present productivity of the tremendous investments made by entrepreneurs.

5. FUTURE SCENARIOS AND AIMS

Availability of water resources

The present situation and the conditioning factors described in previous paragraphs (especially those concerning availability and localisation of water resources, climatic conditions, the influence of tradition in hydraulic work, the extensive of the irrigated land, European Water Directives, evolution forecast for agricultural markets, population monopolies, industrial policies, environmental policies, etc.) as well as the agreements reached with Portugal in 1998, will condition the evolution of the water sector in Spain in the future. Any analysis for the future is based on the current, relatively stable, situation in agricultural production, which is characterised by the balanced situation of foreign agricultural trade. This situation ensures that a reasonable degree self-sufficiency in food production will be maintained.

In general thanks to the huge efforts made in the field of hydraulic civil works field, Spain can now count on the sufficient number of water resources and infrastructures needed to cover its needs for food and to allow a high rate of development on most part of its territory, thus enabling sustained advantage to be taken of its resources. The achievement of this objective enabled the substantial efforts made during the 20 century which were mostly financed by the public sector. Currently, Spain counts on more than 1,200 dams, which ensure water supply to the population and allow irrigation to take place on more than 3.5 Mha. Aquifers are extensively used in the wide open spaces over the whole country. The Mediterranean and Southern Atlantic Coastal Basins would be excluded from a quantitative resource/demand balance, since in these areas, demands exert pressure on available resources, thereby fulfilling socio-economic development.

Presently the main threat to agriculture are extreme phenomena such as droughts and floods which constitute a permanent source of concern, because of the frequent occurrence of this type of phenomena in Spain,

In order to provide demands for the future, various basic scenarios can be established from a perspective focused on an analysis of water demand, but always within two extremes or limits. First of all, it seems a good idea to set forth the subject of the scenario of the consolidation of the present demand, (because this takes first place and also because it is very close to the probable foreseeable situation) which would contemplate reduction of increased demands which would always be located outside the areas with heavy pressures on existing resources. In an extreme scenario, the envisaged increased demand would always be reduced, and would stem from public acts with specific social objectives (such as the fight against population migration. environment protection, income policies, etc.) and they would be located in areas rich in water resources (basins on the upper half of the Atlantic coast, and the river Ebro basin). The limitations of state investment proposals strengthen the possibility of future evolution on this scenario. The main efforts and activities of the Administration with regards to hydraulic matters will be directed towards the quality of water offered to satisfy demands, and even looking at increasing the supply guarantee. Public investment will also centre on waste water treatment, keeping in mind the principle that "polluter pays", so that the entailed costs will be charged to the responsible of the pollution.

As opposed to the previous scenario, another one is that based on an substantial increase in demand (a developing scenario) for the primary sector (mainly for irrigation). The increase would be centred on Spanish coastal territory (Mediterranean and South Atlantic), where climatic conditions allow crops of fruits and vegetables to be produced for acquisition by foreign markets. The relevant water demand generated by this production would have to be satisfied with resources from other basins (water transfers), since these coastal areas suffer from structural water deficit, because of having already been severely exploited their own resources. The cost of these water transfers would be substantial, and would have to be borne almost totally by the user, with no type of subsidy. It would also have other effects of a social, political and environmental nature, which would also have to be accepted by the general public.

One third different scenario could be envisaged. In this case, the relevant increase of the demand would be localised in other parts of Spain (inland territory), where water supply could be covered with local supplies. Due to the climatic condition of these inland areas, the crops would be of the continental type, which are not easily accepted by foreign markets. In addition to this, in economic terms, the reduced profitability of this type of investment, within a scenario of progressive decrease of aids from the EU-CAP, render improbable any hypothesis like this one.

In any case, in the Mediterranean and the South Atlantic coastal areas, a process which is presently being planned will be put into operation. This plans to use non-conventional resources (re-use of treated waste water, desalination and savings produced by infrastructure improvement). The intensity and scope of this process will depend mainly on the evolution of the cost of these technologies, and on economic and financial feasibility of the use of these resources. Various hypothesis and scenarios can be contemplated in order to increase the use of these non-conventional water resources. It is very probable that there will be a considerable increase in the areas served by these water resources provided that modem irrigation techniques (sprinkler, micro-irrigation) are used and water will be handled more efficiently.

Financing of this sector should cease to have priority in the public budget. Water users should support a larger absolute and relative load, and financial assets which are not involved with this sector could also participate in the financing of specific projects, concentrating on those projects (not too many) which are profitable enough to allow investment recovery such as, for instance, those related to drinking water supply.

The concept of security in the supply of food based on self-sufficiency on a national level, has gradually evolved over the last few years due to both the development of communication and means of transport, and also the market globalisation. These factors have helped people to gain more confidence in commerce than in the maintenance of expensive storage reserves.

World projections have estimated that population figures for the year 2025 will reach the 8.000 million mark, with a very uneven population growth in different geographical areas. The increase in food production however (mainly cereals), will be placed between 1.5-1.7 %. Other forecasts are more pessimistic, considering that demographic increase will be practically null and the only hope will lie in the possibility of improving efficiency in food distribution.

With regards to Spain, a minimum variation in population levels is foreseen, and it is estimated that this will remain stable at around the 40 million people or even decrease a little.

Agricultural production will probably remain as it is, due to the confluence of two opposed trends: on the one hand, intensification of crop production, improvement in yield and slight increase in irrigated areas, which will hardly surpass the barrier of 3,8 Mha; on the other hand, the reduction of cropped areas, mainly rain-fed fanning zones along with the adoption of measures to protect the environment such as reduced amounts of manure in vulnerable areas, restriction in the use of agri-chemicals, and the so-called ecological agriculture, will all serve to reduce commodities considerably.

At the same time, commercial trading will be intensified. Foreign commerce is undergoing constant growth. During the period 1987-1997, imports have increased by 256% and exports by 285%, representing 52% of total final agrarian production in the year 1997.

6. CHALLENGES FOR THE FUTURE

The entire Spanish society is committed to the task of consolidating and improving systems to be applied in order to achieve a sustainable and efficient exploitation of the country available water resources. This generic commitment is manifest in various challenges which have to be overcome; challenges which extend to political, organisational, institutional, financial, social, etc. sectorial levels.

Over recent years, an improvement has been observed in the traditional policy of public offer of water resources by the Spanish public sector. This policy emerged at the beginning of the twentieth century, as a response to transformation processes and has been one of the pillars of national development. It was based on the construction of regulating hydraulic (dams), conveyance (channels) and irrigation structures by the public sector, and also on their exploitation and maintenance (although with very heavily subsidised prices). This new policy which has already been at the establishment stage for some years, is much more complex and flexible, its main feature being that the public sector now places more emphasis on management, and this is to be developed with the aims of increased users participation.

Water management should be wise, global and integral (holistic). Management will extend not only to resources, but also to demand. Additionally, it will be responsible for managing hydraulic structures of the public domain and also infrastructures which are of public ownership. User participation should impregnate all aspects of water management. Public activity should concentrate on taking environmental hydraulic action, thus assuming a subsidiary role. This applies especially when action has to be taken in the wake of substantial swelling of water levels, since in these cases there is no direct or individual beneficiary to bear the cost. The public sector will also be responsible for improving the quality of water in the river beds, by reducing specific kind of pollution (but always transferring the costs to the responsible agent) and by promoting improvements in agricultural practice, in order to reduce the origin of non-point pollution. Finally, it is up to the public sector to inform users of the new and complex technologies, This information should be extended to all levels of the general public, to encourage the rational and efficient use of this resource.

The limitation of the functions covered by the public sector is a corollary of social and economic development in Spain, and any efforts to play the leading role on the part of the state would be totally superfluous. Hydraulic administration should limit its actions to those absolutely essential cases mentioned previously, by limiting its vocation as constructors and by concentrating its efforts on management functions. The hydraulic public administration faces a far reaching challenge: to assume this change in its functions and to fulfil its new role of organisational management. The private sector (mainly user associations) should gradually take over the tasks presently performed by the public administration, such as operating and maintenance of existing infrastructures. The users should face the challenge of assuming the leading role in the field of operation and maintenance of infrastructures, even in their promotion and execution. To do this, they should update their own means, by elevating their technical patrimony to a degree similar to those demonstrated in legal matters. The users (irrigable land, municipalities, etc.) can not ignore the challenge of a rational use of a very scarce resource, and should maintain their networks in a good condition.

Alterations will also be made to the present situation of the financial and economic scope, giving rise to other challenges. When performing new functions, the users will observe a certain increase in the tariffs obtained from the use of water. However, they should have no fear of the possibility that irrigation will be abandoned in general (mass), since the cost of water represents a low percentage with respect to the amount of the gross production.

The financing of new infrastructures will stem from previous direct participation by the beneficiaries. They should finance themselves with private funds (with some public incentives due to the fact that this will have a positive effect on the environment) in order to carry out new improvement and modernising of irrigation projects. Non- conventional resources should also be mobilised (mainly) with private funds, which will probably act as a discouraging factor.

In the future, and thanks to the Agreement reached with Portugal no water conflicts of an international nature are envisaged. The good relations with Portugal will be kept in order to maintain the sustainable exploitation and protection of the transboundaries basins shared by the two countries. The co-operation procedures agreed upon in this Agreement, will be established in these common basins, in addition to those allocated by way of new community or international directives. Planning and coordinated management will be the objectives to be attained in these shared basins in the very near future.

The possibility of a climatic change (which although not demonstrated can not be ignored) constitutes a risk which can not be overlooked. Although climatic change should be another reason for anxiety, it should not become a paralysing element.

On the other hand, the numerous types of specific internal conflicts which have arisen in our country should be faced up to and resolved. These conflicts, caused by specific matters and topics, could get worse if they are not resolved with the pertinent agreements. Future commitments will be a basic element in the definition of the future of the sector.

Firstly, in the next century Spaniards should work out the means of achieving a consensus on matters of economic use versus environmental values. In other words, a feasible commitment should be reached (with feasible aspects and with no contradictions) between the matter of the application of water for economic reasons (essential for our development and welfare) and the effects of environmental improvement (fundamental element in the quality of life). In countries with a Mediterranean climate, it is neither easy nor cheap to achieve compatibility between economic development and the conservation of the water related environment. The full repercussion (internalisation) of environmental costs on the present users is unthinkable, and for this reason, these costs should be borne to a great extent by the public. In any case, the wastewater treatment plants should be the object of special attention, in order to improve the water quality of flowing streams.

In the second place, an agreement should be reached by the social institutions regarding the sharing out of economic water costs. Users should be committed to this agreement, by accepting the concept of water as an additional production factor.

On the other hand, in those areas which suffer periodic droughts, the various user associations and the hydraulic Administration should endeavour to resolve the conflicts caused by this structural shortage. At its present stage, technology offers various alternative solutions to eradicate this periodic shortage (not forgetting previous agreements reached for temporary reassignment of rights of use during droughts).

Finally, a solution must be found to the existing profound conflicts of a regional nature, by trying to reach a balance between territories regarding the water sector. In the event new lines of actions are planned for water resource transfer, a previous agreement should be reached with mutual acceptance between the donor and the receiving basins. The agreement, which should be legalised by a National Parliament law, should contain a definition of the basic norms for the planned exploitation and eventual compensation payments and the way in which they are to be paid should be agreed upon in the contract.

First of all a and in order to overcome these conflicts, it would be desirable to reach a consensus with the adequate social and regional scope, since in Spain matters connected with water reach emotional levels which override economical aspect, and for this reason it may not be easy to reach a consensus. Solutions are always easier to find to conflicts of this type outside the drought periods, when tension created by the lack of water hinders constructive dialogue which is essential to reach a consensus. Once the consensus has been reached, the agreements are raised to a political level so that specific norms may be included, resulting in the corresponding modification of the Spanish water legislation.

Consequently, both hydrological planning and hydraulic policies should be based on wide, stable and lasting agreements in both national and regional Administrations, as this is the only way to make productive progress in the elaboration and the procurement of legal approval of the NHP. It would be very negative if the water policy remained in the same field as everyday fierce political controversy, and on the contrary, it would be very positive if this matter emerged from this field when it could be adapted to solid agreement parameters.

Overcoming these conflicts quickly and efficiently is the main challenge to be faced by the Spanish society in the coming years.

SRI LANKA

1. INTRODUCTION

Issues of water for food and rural development in the year 2025 can be analyzed in terms of two distinct dimensions, one consisting of the issues connected with the quantity and the other consisting of the issues connected with quality. Though both quantity and quality issues are inter-related and inter-active, for the easiness of analysis, those would be analyzed separately, in the presentation. The probable and desirable scenario is arrived in terms of quantity and quality and the probable degree of severity is assessed given that scenario. Though it is unlikely that Sri Lanka will face a crisis in water, there are areas for caution and concern. Monitoring of the identified events is emphasized and an institution is identified for exercising the same.

This is the consensus reached after two national consultations where all water sector organizations took part. About 20 separate experts on various areas made their separate presentations on selected themes during the consultation.

2. QUANTITY ISSUES

2.1 DEMOGRAPHICS

Sri Lanka has unique features among the rest of the developing nations for many reasons. It has a very high physical quality of life index in the developing world. It has achieved very high success in containing its population growth and its almost par with the developed world when compared to the rate of increase in population. It is assessed that Sri Lanka has the fastest aging population in the world, not only due to birth control but also due to it’s literate, health conscious public, who are supplied with modern health facilities by the state at subsidized prices or entirely freely. For these reasons the population in the island country is likely to stabilize around 23 million or even less but with an aging population than now during this review period.

2.2 FOOD HABITS AND AGRICULTURAL WATER DEMAND

The food habits are likely to change towards a more nutritious and balanced diet with a less calorie intake because of the aging population. There will be higher urban population and a hurried life style and hence there will be more demand for bread instead of rice. Therefore there is likely to be a stagnant demand especially for local grains that requires higher amount of water, compared with other agricultural produce that depends on water.

People will prefer fish or Soya products to meet their protein requirement than meat due to rising awareness about health and rising religious sentiments that are expected to rise further with higher economic achievements. This will also create lesser demand for grains whereas bulk grain produce goes to feed cattle and meat producing animals in other countries.

2.3 SANITARY WATER DEMANDS

It is expected that the urban water demand will fall due to the aging population with people using hot water and therefore consume less quantity as a result. A cost based tariff system will manage the demand, though such a tariff system will also ensure minimum quality water for all irrespective of their capacity to pay. It is also expected that new technological innovations will provide further avenues to reduce waste of treated water.

2.4 RURAL DEVELOPMENT

It is expected that even in the year 2025 sizable proportion of the population will live in the rural areas and they will engage in creative crafts for exports. Those crafts will require less water as they would be more labor intensive (both physical and mental labor).

2.5 WATER RESOURCES POTENTIAL

It still has untapped surface and ground water potential in some of the areas in the country even after developing a substantial amount of water resources to become a very high person made per capita storage of surface water, a very high per capita area under irrigation, etc., in the world.

2.6 COMPETITION FOR WATER

Due to above reasons, it is very unlikely that there will be a severe shortage of water in the country. However there will be some competition for water among various sectors of economy especially in areas where there is potential for urban and industrial growth. Such competition will be a highly localized event.

2.7 ALLOCATION OF WATER TO EFFICIENT SECTORS

A pricing mechanism, limited to the areas mentioned above, could solve the crisis by providing legal avenues for selling and buying water entitlements in the open market, subjected to some regulation in order to ensure that marginalized groups and larger interests of the nation such as environment and health, are protected. This would ensure the allocation of water to more efficient sectors of the economy while having minimum effects on the social harmony, standards of living of the poor and marginalized and also in other spheres of life and environment.

2.8 DEMAND MANAGEMENT

Some relief in the way of reducing this localized demand also could be obtained by adopting water saving technologies (which could be made mandatory for heavy and selected water users) that facilitate demand management. These could include drip and sprinkler irrigation, demand driven but pay for the quantity systems, etc.. Crop diversification is also seen as an activity that could be in a demand management agenda (this is currently being done in some of the water short schemes in the dry zone part of the Sri Lanka and the number of schemes cultivating diversified crops is increasing).

2.9 IMPROVING THE SUPPLY SIDE OF WATER

Apart from developing the untapped river basins and micro catchments within the already developed river basins, increase in supply through transbasin diversions, rain water harvesting and controlled extraction of ground water also could reduce the local shortages to some extent.

3. QUALITY ISSUES

Apart from the issues regarding quantity, water quality will also become an issue for concern. It will create problems in the supply side of water economics. Hence greater attention in this area is vital.

3.1 THE EXOGENOUS AND ENDOGENOUS NATURE OF QUALITY ISSUES, GLOBAL CLIMATIC CHANGES AND MAN MADE INTERVENTIONS

Global climatic changes are likely to raise the sea level further creating salinity in the ground water in the coastal belt and in the surface water bodies close to river estuaries. Even the man made activities like uncontrolled felling of trees is likely to create problems like soil erosion that already has reached quite sizable proportion in recent times and which has increased the treatment costs of water and suitability of water for other users. Though former is somewhat outside our control (exogenous) the latter is within (endogenous). Already restrictions are imposed on felling of trees and measures are likely to be taken up for preserving already exposed land. Even salt water exclusion measures could reduce salt concentrations that would otherwise occur as a result of sea level increase close to river mouths. Those are likely to arrest these negative trends to some extent.

3.2 AGRO-CHEMICAL USE

The excessive use of agro-chemicals has already created some concerns but this is not likely to continue as already programs are in force to educate the farmers regarding the availability of other options and those messages are being received well by a sizable portion of the farmers.

3.3 OTHER POLLUTANTS FROM INDUSTRIES AND URBAN DWELLING

The input of pollutants is also seen as a major concern. There are already pollutant permits that one has to obtain from the environmental authority before one is entitle to dispose waste drainage to a public stream or a storage reservoir. Principle of pollutant pays for the waste he produces will facilitate producers to reduce the harmful contents in the waste to manageable limits.

3.4 EXCESSIVE EXTRACTION OF GROUND WATER

The other major threat to water quality comes from excessive extraction of ground water. However this is only evident in the Northern parts of the country and with the increase use of ground water for agriculture it is likely that similar situations can occur in the north-central and north-western part of the country too. A system of permits issued by a central authority that is vested with the responsibility of controlling ground water could reduce some of the harmful effects.

4. NECESSITY TO WATCH AND THE INSTITUTION IN WATCHING

Sri Lanka, though is not likely to face a crisis situation in water by year 2025, will definitely have a quite a few areas for concern which need constant monitoring starting from now on, in order to contain the issues addressed in this presentation at manageable limits as and when they become crucial. The Water Resources Authority which is proposed to be set up soon can undertake this watchdog role that is vital to keep Sri Lanka alive to the issues of water in the third decade of the new millennium.

5. CONCLUSION

Water both in terms of quality and quantity are unlikely to become determinant factors to Sri Lanka though it would be a major issue for many other countries. However there are major areas of concern. Monitoring the trends in those areas will be sufficient to prevent any major catastrophe, though such a possibility is remote given the probable and desirable Sri Lankan scenario.

TANZANIA

1. INTRODUCTION

1.1 THE COUNTRY

Tanzania lies on the East Coast of Africa between 1° and 11° S latitude and between 29o and 40°E Longitude. It is bordered by Kenya in the North and shares Lake Victoria with Kenya and Uganda in the West. Tanzania has frontiers with Rwanda, Burundi, and Democratic Republic of Congo in the Southwest, and Zambia, Malawi, and Mozambique in the South.

1.2 LAND

The land area of Tanzania is about 1 million square kilometres. This includes the offshore islands of Zanzibar, Pemba and Mafia.

Tanzania is dominated by the effects of plate tectonic movements, which have formed a dramatic landscape of mountains, lakes and rolling plains. To the Northwest the huge Lake Victoria Basin separates the western and eastern rift valleys and the separation is continued by the central plateau which is more than 2000m in elevation. The Northeast border with Kenya is dominated by Mt. Meru and Mt. Kilimanjaro the highest peak in Africa and associated spectacular lakes, calderas and grassland steppes.

A second mountain ranges the Southern Highlands separates the Eastern Plateau from the rest of the country. The coastal belt is an important rice growing area.

1.3 CLIMATE

The climate is tropical with general rainfall low and unreliable. Only few areas receive 1000 mm annually, but in average rainfall ranges between 600 - 800 mm annually. Rainfall in the north of the country is bimodal (long rains from March - May, short rains from October - December). The South regions experience a single wet season from November - April. The normal topical temperature pattern is affected by altitude over most of the western half of the country with minimum temperature below 15o C from June to August. Light intensity is good throughout the country.

1.4 POPULATION

Estimates put the population figure at around 30 million at an annual growth rate of 2.8%. More than 80% of the people live in rural areas.

1.5 AGRICULTURE

Tanzania's economy continues to be dominated by agricultural production, which accounts more than 50% of GDP. Output remains predominantly based on smallholder production. Estate cultivation was centred on sisal, sugar, tea and to a lesser extent coffee, tobacco, rice, wheat and wattle. Traditional exports such as coffee, cotton, sisal, cashewnuts, cloves, tea and tobacco remain the pillars of export income generation.

Recently the Tanzania government has placed a great deal of emphasis on agricultural export diversification stressing the switch from traditional to non-traditional exports such as horticulture products, spices and manufactured goods.

In addition to the above switch the government of Tanzania is placing more to enhance large scale irrigation projects. These projects are vital especially when the drought effects are observes which affected key food production areas in Tanzania.

1.6 INDUSTRY

The Tanzania's industrial sector is still weak though remarkable gains have been observed in the production of cement, soft drinks, food processing and corrugated iron sheeting. The industrial sector contributed approximately 11% to the GDP of the nation.

2. IRRIGATION PERSPECTIVE IN TANZANIA

Tanzania has vast undeveloped land resources. Various estimates have indicated that the country has a potential total arable area of about 40 million hectares. Of this total figure only some 6.3 million hectares are currently under crop production, 5.2 million hectares by smallholders with the balance being farmed by parastatals and private sector concerns.

Until recently irrigation in Tanzania took place on traditional irrigation schemes, some of which are many hundred of years old. Although such schemes have worked well for countless generations, but are now inadequate due to:

(i) sharp increases in population

(ii) fair wear and tear

(iii) catchment degradation and other environmental problems such as waterlogging and salinity.

The traditional schemes have therefore become increasingly inadequate in recent decades.

The response to the increasing shortcomings of the irrigation schemes from the colonial times until recently has largely been to construct expensive new schemes for the smallholder, parastatal and private sectors. The great majority of these schemes have failed with the exception of those serving the private sector.

This approach has resulted into a gross distortion in the financing of the sector. It should be visualized that irrigation in Tanzania is still very important as it helps in achieving the following primary objective :

(i) Satisfying subsistence requirements in many parts of the country - equals increased food security at household level.

(ii) Generating local surpluses of main staples, particularly rice in order to achieve food security in the country.

(iii) Ensuring the production of much need dietary supplements such as vegetable fruits and pulses.

Having seen this great importance, the sector has developed a strategy, which is a planning, and coordination framework called the National Irrigation Development Plan (NIDP). This is essentially a response to the pressing need for :

(i) food security

(ii) economic growth

(iii) counter measures against the drought cycle which dominates agricultural production in Tanzania.

Types and Methods of Irrigation - Tanzania.

Table 2.1. Types of Irrigation - Tanzania

Area by Farm Type	Unit	Area
* Estates, outgrowers, medium to large commercial farms	ha	2400
* Parastatal/government farms	ha	19,700
* Smallholder, small commercial	ha	359,000
Total area under Irrigation	ha	381,000

Table 2.2. Methods of Irrigation - Tanzania

Area by Farm Type	Unit	Area
Formal Irrigation	ha	26,000
Traditional Irrigation	ha	85,000
Natural flooding/water Harvesting	ha	270,000
Total Present Irrigated Area	ha	381,000
Formal Irrigation methods	Surface	

2.1 EXISTING TYPES OF IRRIGATION SYSTEMS IN TANZANIA

Surface Irrigation

There are a wide variety of irrigation systems used in our country. The predominant one is surface irrigation. In this system which is very common for small holders, distribution is usually by lined and unlined canals. Included in this category is the water harvesting or use of flood recession, which although informal but its still considered as surface method. Furrows and basins are widely used in this. This system does give rise to salinity, but once attention is paid to adequate drainage, the problem is overcome.

Conventional Sprinkler Irrigation

This is widely used by large scale commercial farmers. It is not common among the smallholders as these are too many mechanical parts to break or lose but also requires pumping. In Tanzania, very few schemes use this approach.

Drip Irrigation

It is widely used on coffee and other crops. If well designed the system performs well. The system is rarely used in Tanzania.

3. PERFORMANCE OF IRRIGATION IN TANZANIA

The development of irrigated agriculture in Tanzania has been very slow. Various reports indicate poor performance. The rate of implementation of new schemes and t he operational performance of existing schemes are inadequate as visualized by the Task Force of National Agricultural Policy.

Public sector irrigation development in Tanzania has followed three different paths.

(i) The construction of new irrigated estates for parastatal operations.

(ii) The construction of new modern style scheme for smallholder occupation and operation

(iii) The rehabilitation or upgrading of traditional irrigation schemes.

The overall performance in the rehabilitation has been generally good, though only few schemes have been addressed in this aspect. The rate of development of new schemes has been slow to pick up, despite the slow increase still the performance is below expectations. Among the reasons for this minimal performance are :

(i) absence of vital irrigation data for planning purposes

(ii) lack of resources on the part of the government e.g. funds and trained irrigation personnel.

(iii) absence of national irrigation investment criteria

(iv) lack of a national coordination for irrigation development despite available funding from donor agencies and NGOs.

3.1 OPERATIONAL PERFORMANCE

In theory all public sector irrigation scheme have been constructed mainly for the purpose of producing crops in order to meet the National food consumption demand.

Traditional irrigation schemes using water harvesting and simple river diversions produce the bulk of rice for local consumption. With improved water management production in some areas have increased by 400 percent. The yield for different irrigation schemes are as shown below.

Table 3.1. Production on different types of existing schemes in Tanzania

S.No.	Type of scheme	Yield (t/ha)	Comments
1.	Traditionally irrigated	1.0-2.0	Scheme comprises water harvesting and River diversions.
2.	Improved traditional	4.0	There is River diversion and improved land development
3.	New Smallholder	2.0-6.0	In this category some of the schemes are: * Mechanised with high inputs * Using modern varieties * Having 3 crops in 2 years.
4.	Irrigation state farms	3.0-4.0	Schemes are high input packages, mechanised operations, modern varieties, but all single cropped.

As seen in Table 3.1, the state or parastatal farms could have been expected to have a high yield as they employ medium to high packages. But reverse is the case, this attributed by:

(i) Inadequate machinery for land preparation and harvesting
(ii) Poor seed quality badly adulterated with wild rice
(iii) Poor designs
(iv) Inadequate operation and maintenance of the irrigation infrastructure
(v) Impossible cropping patterns and,
(vi) Poor weed control and husbandry.

3.2 EVALUATION OF PERFORMANCE

The report of the investigation on irrigation development by the Task Force on National Agricultural Policy pointed the following areas as contributing to the poor performance of both large and small scale irrigation scheme :

(i) absence of irrigation policy
(ii) reliance on sophisticated irrigation technique
(iii) lack of staff experienced in designing and constructing large scale irrigation schemes
(iv) poor planning or irrigation projects, particularly peasant irrigation schemes.

Large scale private sector schemes are to be encouraged so long as :

* They are financially sustainable independently of the state
* They are environmentally and socially acceptable
* Do not put an unacceptable strain a natural resources or compete for resources with existing economic activities.

3.3 CONSTRAINTS ON SUCCESSFUL IRRIGATION

Several studies have identified and analysed a number of constraining influences which causes this. They can be condensed into, the Lack of well articulated policy and strategy framework, poor understanding of the real resource endowment of the country and acute financial and technological shortcomings.

4. INTERVENTION

Having seen the poor performance of the schemes three kinds of interventions are envisaged, and they can be prioritised as follows :

Priority 1 - Rehabilitation or Upgrading of Traditional Irrigation schemes

This will help to increase the water use efficiency. In this aspect the improved river basin water management has to be central in this upgrading. It should be understood that the improved drainage system in order to increase return flows to the natural drainage system thereby reducing or avoiding losses from unnaturally water logged areas have to be seriously undertaken.

Priority 2 - Schemes based on Water Harvesting Technology

This is more workable on the marginal areas. The advantage is that producers need only to be provided with appropriate technology. This means, a minimum technical intervention using simple flood management is required. Infrastructure is required to simply divert flood peaks from rivers into the fields. Such technology is simple and cheap and involves little operational sophistication. It is practised in Tanzania, in the central regions.

Priority 3 - New smallholder Schemes

In this aspect farmers are required to be sensitised and organised into workable Water Users Organisation (WUA)'s. Having done this assignment, then the construction of a new scheme can commence.

5. IMPLEMENTATION

Having set the priorities right the following design issues and consideration should be the guideline.

* Designs should be as simple as possible
* There should be standardisation of the designs
* Avoid redundant activities
* Provide miscellaneous structures
* Provide protection works for hydraulic structures

A point worth noting is that, Tanzania has just more than 30% of the area under traditional irrigation, this implies that more work has to be done so that those few schemes can be prioritised which could be very productive.

6. CONCLUSIONS

* Poor performance have mainly been caused by ineffective coordination and planning
* Absence of a commitment of funds to the irrigation sector have added the poor performance status
* Constraints should be removed
* Undertaking sustainable water resource utilisation is vital

6.1 RECOMMENDATION

It is recommended that :

(i) Serious considerations should be given to the national irrigation development plan
(ii) Funds should be made available to the department.

THAILAND

1. GENERAL INFORMATION ABOUT THAILAND

1.1 Geographical

Thailand, a tropical land in the center of Indochina Peninsula, is bordered on the north by the Lao People's Democratic Republic (Lao PDR), on the east by the Lao PDR and Cambodia, on the south by the Gulf of Thailand and Malaysia, and on the west by Union of Myanmar and the Andaman Sea. The total land area is about 513,00 km2 with the present population of about 60 million inhabitants.

Rainfall during the southwest monsoon, i.e. May to October, accounts for 85 to 90 per cent of the annual rainfall and varies significantly over the different parts of the country. The annual rainfall is about 1,200 mm in the northern mountainous region, 1,300 mm in the central plain, below 1,000 mm in the western strip of the north-east plateau and increases to 1,600 mm towards the far east end of the north-east plateau. The east coast peninsula receives additional rainfall from the northeast monsoon during November through January and annual rainfalls of 1,800 mm and 2,500 mm are observed over the eastern and western coasts of the peninsula respectively.

1.2 Agricultural Sector

Thailand in fact is today recognised as one of the world's most important and diverse food producers. Year - round sunshine regular rainfall, fertile soil, and mile upon mile of open coastline have given the kingdom a long tradition of agriculture and fishery, while a rich cultural heritage has evolved a highly distinctive cuisine.

Total agricultural area is about 265,200 km2 , where only 49,600 km2 (18.70%) has been irrigated. The main agricultural products are :- rice, rubber, maize, cassava, sugarcane fruits and vegetables. The utilization of farm holding land of about 51% is paddy land with yield 44 tons/ha of rice.

In 1998, Thailand can produce 20 million tons of rice from the whole country

2. WATER RESOURCES INFORMATION

2.1 Surface water resources

Thailand, with an area of about 513,000 km2 , can be divided hydrologically into 25 river basins. The average annual rainfall for all over the country is about 1,700 mm. The total volume of water from the rainfall in all river basins in Thailand is estimated at 800,000 million m.3, of which 75 per cent or around 600,000 million m.3 is lost through evaporation, evapotranspiration and infiltration and the remaining 25 per cent of 200,000 million m.3 constitutes the runoff that flows in rivers and streams. While the population of Thailand is around 60 million. Therefore, the availability of water resources is 3,300 m.3 per person each year which is statistically considered to be highly adequate. The data on surface water resources in Thailand are as shown below :

Regions in Thailand	Catchment areas (km2)	Average annual rainfall (mm/year)	Amount of rainfall (million m3)	Amount of runoff off (million m3)
Northern	169,640	1,280	217,140	65,140
Central	30,130	1,270	38,270	7,650
Northeastern	168,840	1,460	246,500	36,680
Eastern	34,280	2,140	73,360	22,000
Western	39,840	1,520	60,560	18,170
Southern	70,140	2,340	164,130	49,240
Total	512,870	-	799,960	198,880

2.2 Groundwater resources

Groundwater is an important source of water supply in Thailand. Public water supplies for one - fifth of the nation's 220 towns and cities and for half of the 700 Sanitary Districts are derived from groundwater. It is estimated that 75 per cent of domestic water is obtained from groundwater sources. Groundwater system in Thailand is mainly recharged by rainfall of about 40,000 million m.3 and seepage from the rivers. It was estimated from previous hydrological balance studies that about 12.5 to 18 per cent of rainfall would infiltrate the soils and about 9 per cent of rainfall would reach the aquifers. However, this estimate is valid only for the basins under favorable geologic conditions such as those in the Northern Highlands, the Upper Central Plain and along the Gulf Coastal Plain. For the other basins such as those in the Lower Central Plain including Bangkok and in the Khorat Plateau, it was estimated that only 5-6 per cent of rainfall reaches the aquifer.

More than 200,000 groundwater well projects were undertaken by both government and private with total capacity of about 7.55 million m.3/day. (2,700 million m.3 /year) It is estimated that 75 per cent of domestic water is obtained from groundwater sources which can be served approximately 35 million of people in villages and urbans area.

2.3 Water Provision and Water Demand

The average annual rainfall of the whole country is about 1,700 mm. ranging from 1,200 mm annually in the north and central plain up to 2,000 - 2,700 mm. in the western part of the south and the eastern part of the country. About 29% of the surface runoff, approximately 70,770 mcm. annually, is kept in various sizes of about 650 large and medium scale together with 60,000 small scale water resources development projects all over the kingdom covering about 31 million rai (4.96 million ha.) irrigable area.

Although the water resources development programme has been implemented continuously for more than 80 years, but rapid rural development, industrialization, tourist development and income growth raise the water demand for domestic use, agriculture and other purposes drastically. Inefficient use of water by various sectors and deteriorating water quality due to excessive use of fertilizer and pesticides, urban sewage and industrial wastes also create more serious problems to availability and adequacy of water resources. The present water demand for irrigable areas and other uses for the whole country is estimated to be 68,000 mcm./year and expected to be 86,000 mcm./year in 2006. Hence, the nation is facing serious supply constraints to further growth due to various impacts problems in the water resources development scheme. Water provision and water demand in each river basin are as shown in the table :

2.4 Water Resources Management in Thailand

Thailand's past three decades of sustained and rapid economic development stimulated an explosive expansion of demand for water services:- for power, irrigation and domestic and industrial water supply. The Government devoted significant resources to meeting these demands, and an approach toward water management in Thailand emerged with emphasis on expansion of access to services - electricity, irrigation, water supply for domestic purposes.

This approach was successful in giving millions of Thai access to potable drinking water, water to produce cheap and abundant food, and to generate hydroelectricity. However, as water has become increasingly scarce, this approach is no longer appropriate. The Government now faces a different and more complex set of challenges, comprising both supply and demand-side questions:

- Is the resource base, including both water and watersheds, being managed in a sustainable manner?
- Are there opportunities for more effective management of existing sources of supply?
- Who will be allocated the water and how will it be allocated?
- Who will provide and deliver services and who will pay for them?

3. CHALLENGES FACING WATER SECTOR

3.1 National level

In the past, Thailand had paid not much attention to water resources management because water was abundant, anyone could get the required amount of water from rivers, lakes, canals or directly from rainfall. Most of water programs were dedicated to water development during that time. Even when population and economic activities have increased, there was still lack of water resources management practice. This was due to some reasons which can be identified as follow :

- **Government Policy.** Government policy had no sufficient clear-cut on water resources management to be adopted as guidances for practice. Emphasis was placed only on development or provision of water and there was no master plan in water resources management in river basins.

- **Structure of Organization and Centralization.** Problem of fragmentation prevails in water sector management. There are more than 30 agencies in 9 ministries work in water resources development and furthermore, 7 national committees involved in this field. This makes things complicated and even confused. Local administrations have no role in management of their own sources of water.

- **Budgeting.** At present, budget is allocated to each agency considering their requests. In such process, it lacks the method for problem-solving in each area as a whole and causes less effective in implementation. This is also the problem facing water resources management.

- **Legal Framework.** There are several acts concerning water resources but not even one directly relates to water resources management. Therefore, it is necessary to draft such a law that can react properly to increasing problems or requirements.

- **Available Information.** Because of too much implementing agencies, information on water resources development scatters all around. This makes it difficult to plan for efficient programs in water development. In addition, it is hard to formulate new projects under such circumstance.

3.2 Basin level

The unclear policy, legal and institutional framework governing basin areas makes it difficult to effectively implement basin management. Inadequate and sometimes conflicting legislation is a problem. Also, there are multiple agencies involved in basin management, and none of them have clear responsibility for basin management and development.

Forest cover in the northern river basins has declined from 28% to 18% over the past 25 years, and continues to be under pressure despite a logging ban. Forest loss is due to the combined effects of illegal logging operations and the increasing population pressures on land resources, the latter fueled by the need to provide food, income and shelter for increasing highland populations. Traditional shifting cultivation rotations have become shorter under the influence of high hilltribe population growth rates (3.8% per annum), increased competition for land from the lowland Thai communities and the inward migration from neighboring countries. The combined effect of declining land productivity and increasing population results in further forest encroachment, usually on land forms that are unsuitable for cropping activities. The problem has been aggravated by the financial crisis faced by Thailand since July 1997 which has caused large scale urban unemployment. Many of these unemployed workers have returned to their home villages for subsistence support. This has caused increased need to expand the land area under cultivation, and increased forest fires have resulted from the increased land clearing.

Loss of forest cover and inappropriate land-use practices have detrimentally affected the hydrology of these basins, and resulted in topsoil erosion (1250 tons/ha), sedimentation of waterways and storage structures, and is also thought to contribute to increased wet season run-off and consequent downstream flooding, and reduced dry season stream flows. Thus, improved management of these upper watersheds is of vital importance.

4. NATIONAL VISION ON WATER FOR FOOD AND RURAL DEVELOPMENT

56% of Thai population are farmers. Water becomes basic material for agricultural production. 71% of total amount of available water is allocated to agriculture. However, water is greatly needed for other purposes such as domestic (4.6%), industrial development (2%), ecological balance (22.4%) hydropower, fishery, and recreation which are the basic elements for economic and social development of Thailand.

With the recognition of water usefulness, Thailand has established the national vision on water for food and rural development including as follows :

1. to build water sources , from large to small scale, in the productive river basins in order to support the demand of water for agriculture in the rainy season and drought season. The target is to increase irrigated area from the current 5,000,000 ha to 7,023,000 ha within 15 years
2. to reduce the water leakage (waste) rate in the irrigation system to the international standard and to raise the capacity of distribution system for an efficient use of water in agricultural sector.
3. to promote crop diversification by turning to crop that needs less of water as the means to cut down water use in agriculture.
4. to find the solution to shortages of water for consumption in remote areas by emphasizing the provision of sufficient and good quality of water for people
5. to reserve water for the healthy functioning of ecosystems which is the basic element of the production of food, reduction of flood risk and filtering of harmful pollutants

5. APPROACH TOWARD PROBLEM SOLVING

The mechanisms or methods to achieve the national vision have to be undertaken and incorporated in the development as well as the management plans for water resource in order to utilize this finite resource for its ultimate purpose and in sustainable manner. The mechanisms or methods suggested are :

5.1 Water Resources Development

- **Increase of Storage Capacity**. In the past 50 years, Thailand's water resources development focused on establishing large, medium, and small - scale irrigation projects which can store about 70,700 mcm. of water, out of 244,400 mcm of average annual runoff . Although the country's average availability of storage water is relatively high, many river basin such as the Chao Phraya River Basin have experienced water shortage. The current water resources development should hence emphasize increasing water storage as well as the use of transbasin diversion system and it should be immediately implemented.

- Rainfed Area Development. To solve the problems of water shortage outside the irrigated area or the rainfed area where the natural water sources are scarce, small- scale water sources such as farm pond, shallow well, deep well, and rain harvesting tank should be developed extensively so that there will be sufficient water for domestic consumption and for farming.

- **Groundwater Development.** Groundwater, one of an important source of water is developed for domestic uses and for industry because of insufficiency of surface water. Moreover the usage of groundwater increase considerably, resulting from the city expansion and industrial growth. In some area such as rainfed area, groundwater is widely use in supplementary for agricultural purpose.

  The studies of groundwater potentials and impacts on groundwater exploitation have already been performed but focused on some specific area and the result of the study has not clearly shown the groundwater potential. Therefore, the study shall be executed urgently in order to determine the groundwater resource potential, the groundwater usage, hydrogeology, the impact of groundwater untilization and a study of conjunctive use of surface water and groundwater in order to control groundwater development activity and to prevent the environmental impacts.

Water Provision and Water Demand
Description of 25 River Basins in Thailand

Basin No.	Name of River Basins	Catchment Average Area	Runoff (mcm.)	Storage capacity (mcm.)	Irrigation Area (rai)	Water Requirement (MCM./year) Domestic Consumption	Tourism Industry	Ecological Balance	Irrigation Agriculture	Hydropower
1	Salawin	17,920	8,571	24.00	188,948.00	11.96	4.46	1,027.81	616.93	-
2	Mae Khong	57,422	19,362	1,551.00	1,692,333.00	132.57	1.98	1,145.69	4,323.33	-
3	Kok	7,895	5,279	30.00	520,767.00	14.90	0.43	680.00	401.39	-
4	Shi	49,477	8,752	4,246.00	1,863,173.00	195.17	49.62	573.33	3,052.82	2,156.00
5	Mun	69,700	26,655	4,255.00	1,819,785.00	337.88	94.30	956.63	2,628.85	591.30
6	Ping	33,898	7,965	14,107.00	1,942,927.00	75.26	1.00	457.27	2,428.20	3,623.00
7	Wang	10,791	1,104	197.00	472,350.00	20.21	1.00	48.00	487.42	45.00
8	Yom	23,616	3,117	98.00	994,205.00	53.87	0.08	315.36	859.13	-
9	Nan	34,330	9,158	9,619.00	1,780,637.00	66.29	0.32	315.36	2,870.80	2,583.00
10	Chao Phraya	20,125	22,015	33.00	5,731,375.00	1,594.40	646.05	1,250.00	8,768.59	-
11	Sakaekrang	5,191	1,297	162.00	436,410.00	8.62	-	3.35	878.75	-
12	Pasak	16,292	2,820	124.00	661,120.00	72.32	23.28	158.00	927.38	-
13	Thachin	13,682	22,300	416.00	2,385,259.00	94.94	310.25	1,000.00	4,292.11	-
14	Mae Klong	30,837	7,973	26,690.00	3,400,000.00	20.34	-	1,577.00	4,323.33	4,670.00
15	Prachinburi	10,481	5,192	57.00	733,862.00	8.08	2.78	377.00	838.32	-
16	Bang Pakong	7,978	3,713	74.00	1,353,263.00	14.18	9.05	946.00	2,243.60	1.94
17	Tonglesap	4,150	6,266	96.00	123,720.00	12.60	-	9.80	197.00	-
18	East Coast	13,830	11,115	565.00	427,000.00	129.10	83.50	74.70	578.46	79.00
19	Phetchaburi	5,603	1,400	750.00	562,688.00	14.30	2.90	67.00	1,110.00	693.00
20	Prachuap Khiri Khan Coast	6,745	1,420	537.00	327,015.00	18.00	2.97	39.10	1,383.00	-
21	South East Coast	26,353	23,270	5.00	1,780,481.00	56.40	8.70	161.70	1,129.10	2,577.00
22	Ta Pi	12,225	12,513	5,865.00	245,970.00	25.90	10.00	3,085.20	144.60	2,596.00
23	Songkhla Lake	8,495	4,896	28.00	905,550.00	56.45	37.50	312.00	2,994.70	-
24	Pattani	3,858	2,738	1,420.00	337,878.00	31.20	2.44	670.80	441.11	1,152.00
25	South West Coast	21,172	25,540	20.00	339,273.00	53.20	18.90	74.80	253.00	-
	TOTAL	512,066	244,431	#####	######	3,118.14	1,311.51	15,325.90	48,171.92	20,767.24

- **Rehabilitation and Modernization of the Irrigation Project**. Many irrigation projects have been intensively developed to increase agricultural production within the basin, particularly in the Chao Phraya basin. However, not only agricultural sector, but also urban and industrial sectors have rapid development and raised water demand. Therefore, in order to achieve the water management goals, the most urgent activity is to improve the water delivery system performance. However most irrigation projects are relatively old and having poor operational performance. Through, the process of implementation plan are :

  - To formulate criteria for prioritizing and ranking the existing irrigation projects which needed the rehabilitation and modernization.

  - To prepare an in-depth feasibility study including engineering design on rehabilitation and modernization to increase operational efficiency in water delivery system.

- **Upper Watershed Development :** Loss of forest cover and inappropriate land use changes in highland areas are detrimentally affecting hydrology of river basins. The impacts include decreased infiltration, increased runoff, erosion and downstream sedimentation. The development which reducing these impacts by protecting the headwaters of the river basin are :

  - **Reforestation.** At present, Thailand's forest cover has dwindled to only 25 percent, estimated at about 1.3 million ha of the country's total land area. The forest land is expected to be 40 percent by reforestation for the next 20 years.

  - **Check dams.** Small weirs need to be built to raise the water level and direct the water along ditches towards crop lasts on both sides of the stream. The retained water will seep into the groundy spreading moisture along both sides of the stream.

  - **Vetiver grass.** A living barrier conserving and returning nature to the land. Using vetiver grass for soil and water conservation by : preventing damage to step terraces and hillside ditch, solving the problem of gully erosion, conserving soil moisture.

5.2 Water Resources Management

- **Integrated water resources management.** Development and conservation of water of resources on various scales, comprise of potential, coordinate public and private sector efforts in management and maintenance of existing water resources. According to the guidelines in the 8th National Plan (1996-2001) the development and conservation of both surface and groundwater resources will be a systematic river basin approach with regard to economic and social factors as well as environmental impact.

  There are a number of agencies dealing independently with water resources management resulting in work duplications and lack of cooperation among themselves, therefore, in 1996 the Office of the National Water Resources Committee was established in order that it will work as apex body for the management in all regions, the river basin committees are also planned to established in 25 river basins all over the country in the near future.

  Since there is no comprehensive act on water resources and moreover the existing regulations being used by various government agencies are differently there fore, it is essential to have a new water resources act for the common practice for all agencies concerned. Presently, the draft on water resources act has been formulated and being on the proceeding of submission to the cabinet.

The master plan on water resources development, water allocation, water conservation, flood mitigation and water quality will be formulated for all 25 river basins. It is planned to set up the uniform measures and analytical methods to assess data and establish a data network system for possible exchanging and disseminating of the information.

People's awareness in natural resources and environmental conservation has been increasing considerably. Public and private sectors' participation in natural resources management has also been mentioned in the new Constitution. Besides, environmental consideration has been taken into account in all water sources development as imposed by the law that the feasibility study of any project must include the Environmental Impact Assessment (EIA) and its solutions to the problem.

- **Policy issues in the economical use of water.** Due to serious shortage of water resources, there is an urgent need for a comprehensive policy reform to improve the efficiency of water utilization. To reduce the leakages in urban water supply systems from about 40 to 25 percent requires a large amount of investment. Therefore, the Metropolitan Water Authority (MWA) and the provincial Water Authority (PWA) are privatized in some areas. Increasing the potential of water saving in irrigated agriculture through rehabilitation and modernization of Department in the Chao Phraya Basin. At the same time, the changes agricultured system from high water consumption crop to lower consumption crop may be one of an important strategies to reduce water use in agriculture. Water charge is considered to be used as the economic instrument. However, the careful consideration about the rate used among the various economic sector is needed to avoid resistance and bias. Public relations and campaign to water user group for realization and participation on the economical use of water are also needed.

- **The River Basin Water Resources Management Master Plan** . The objective of the study and formulation of the river basin master plan is to formulate the plan that represents the framework for operational agencies to adopt and implement to fulfill the need for management of water resources in the river basin. It will state the exact relationship between water resources and other resources in each area of the river basin which can be considered with consistency and as a system. Interest is also placed on demand for water in each river basin which will affect water resources development projects. People participation is another important factor in establishing the plan.

The river basin water resources management master plan will be devided into 5 aspects :

- Master plan on water development
- Master plan on water allocation and usage
- Master plan on water conservation
- Master plan on flood mitigation
- Master plan on polluted water treatment

- **The Draft Water Resources Law.** The drafted water resources law which is at present under the procedure to be enforced, aims at managing and coping all the problems in water sector created by lack of systematic development in the past. It is, therefore, expedient to formulate measures to manage and control activities concerning water resources and other related resources. In this draft water resources law, water resources management at national and local level are established as the agencies to manage this sector for the whole country. Principles and measures for water allocation are determined and also flood control, mitigation and water conservation and development.

Institutional Framework. There are a number of agencies dealing independently with water resources management resulting in work duplications and lack of cooperation among themselves. Therefore, it is essential that central agency in water sector had been established to work as apex body for the management of water resources.

- **Information Network.** It is important to create and develop water resources information system which now scatters and unstandardizes in different agencies. Information needed in water resources management includes the information of other related resources and activities such as land and land use, forest land, some other social and economic information etc. Network of information is necessary for planning and its implementation.

6. CONCLUSION

In the past 50 years, water resources management in Thailand has put more emphasis on water sources development resulting in many small, medium and large-scale construction projects.

At present, the situation has changed as environmental impact has emerged as a limitation of water sources development approach.

However, there is growing demand of water use for domestic consumption and agricultural and industrial development, Therefore, the Government of Thailand has taken initiative in adopting integrated water resources management principle for implementation at a river basin level. Under this approach, the Government will attach equal importance to both development and management aspects of water resources in Thailand

GREAT BRITAIN

1. GEOGRAPHY AND GEOLOGY

The United Kingdom of Great Britain comprises England, Scotland, Wales and Northern Ireland. It lies on the western edge of Europe and is surrounded by sea. No part of the country is more than 120km from tidal waters. The total area of the United Kingdom is 24.1 miffion ha.

Great Britain can be divided roughly into two main areas - lowland Britain and highland Britain. In the former, in the midlands, southern and eastern England lies the new and softer rocks. The hilfier areas, in Scotland, most of Wales, the broad central uplands known as the Pennines, and the Lake District consist mainly of outcrops of very old rocks.

Lowland Britain and most of Northern Ireland is under 300m above sea level. The younger rocks in this area break down more easily into soil; and so the greater part of lowland Britain comprises cultivated and settled areas, with varying textured soils from clay to sandy loam silt and peat. The soils on the hills are poor and thin, supporting coarse grasses, bracken, heather or trees.

2. CLIMATE AND RAINFALL

The climate of Great Britain is temperate and equitable. The prevailing winds are south- westerly and the climate is largely determined by that of the eastern Atlantic, although during the winter months easterly winds may bring a cold, dry, continental type of weather. The average range of temperature between winter and summer varies from 7' to 12'C, being highest inland in the eastern part of England.

During a normal summer the temperature occasionally rises above 27'C; winter temperatures below -7'C are rare. Sunshine decreases from north to south. The average summer (April -

September) potential evapotranspiration ranges from about 230mm in the Scottish highlands to 500mm in East Anglia.

The average annual rainfall over Great Britain is about 1,080 mm, ranging from over 4,000 mm in a few points in the hills of Wales, Northern Ireland and Scotland to 500 mm in parts of East Anglia.

3. POPULATION AND LAND USE

The population of Great Britain is about 56 million, giving an average population density of about 230 inhabitants/km^2 with over 80% of the people living in towns.

For many centuries most of the land in Britain lay in estates ranging in size from a few hundred hectares upwards, comprising farms of varying sizes let to tenants, Due to social changes and heavy estate duties, farms were sold and many were bought by the tenants. About half the farms in Great Britain today are owner occupied. The trend is towards larger units, particularly for arable farming.

Of the total area of Great Britain of 24 million ha, about 7 million ha is arable land, I I million ha permanent grassland, 2 million ha is forested land and the rest, 4 million ha, is built on or wasteland.

4. WATER RESOURCES AND IRRIGATION

River water quality has improved over the last few decades as a result of improvements to effluent quality, particularly from sewage treatment works run by the private water companies. The quality of most rivers is now adequate for use for irrigation and attention is now being given to the control of diffuse sources of pollution, particularly from the use of pesticides and fertilisers on fields. Control of such pollutants is essential to ensure that groundwater resources are not polluted.

All irrigation is carried out on an individual farm basis; there are no area or district schemes organised by public authorities. Some 90% of outside irrigation is spray. Trickle systems are used to a greater extent under glass and are becoming more popular for certain outside fruit crops where there is little cultivation and the pipes can remain in place for some years.

The quantity of water licensed for abstraction in England and Wales for spray irrigation in 1995 was 289 million m^3 (approximately 45% direct from surface, 40% from groundwater and 15% from surface water via reservoirs). In addition to this some 3% of the total demand for irrigation was taken from the public niains. Spray irrigation in England and Wales is concentrated in East Anglia, parts of the Trent Valley in the Mdlands and the Somerset levels and Wye Valleys.

The area of crops irrigated in Scotland and Northern Ireland is very small and not included in the statistics.

Across England and Wales in an average year only 2% of the total water abstracted is for spray irrigation and agriculture, compared to 51 % for public supply. However, in East Anglia where spray irrigation is concentrated the proportion is higher and on a warm summer day the amount taken for spray irrigation can exceed that taken directly from rivers and boreholes for public water supply.
Demand for irrigation is forecast to increase substantially, particularly if climate change leads to warmer and drier summers. Much of the demand is driven by supermarkets seeking good quality vegetables and fruit. Reliable irrigation will improve the appearance and yield of crops and reduce the need for chemicals. Vegetable production is now an international business with British farmers competing with European and other countries without the benefit of subsidies and supports provided to cereal producers.

5. INSTITUTIONAL ARRANGEMENTS

England and Wales

The Environment Agency was set up by the British Government in 1997 to "protect and improve the environment for current and future generations". Amongst other responsibilities it is the licensing authority for water abstraction and has powers to protect people and property in low lying areas from flooding.

The Agency has a statutory duty to secure the proper use of water resources, which includes;

- assessing the need for new developments and licences;
- ensuring that the most appropriate schemes are licensed, taking into account the environmental impact of new developments and the impact on existing users.

The Agency owns and operates a few raw water transfer and environmental support shemes. The financing, promotion and development of new schemes will normally be the concern of the main beneficiaries. The initiative for developing schemes rests with the water companies or other private sector investors. The Government and Environment Agency do not give grants for irrigation schemes.

Farmers who wish to irrigate using spray equipment must have a licence from the Environment Agency. At present, trickle irrigation is not licensable, although the Government plans to introduce legislation to bring it under control.

In some areas the Agency is not issuing any further summer surface water or groundwater abstraction licences because the limited resources are already committed to other users and/or the ecological requirements of streams and wetlands. In these areas expansion of irrigation can only be by abstracting winter water flows for storage in a reservoir for use in the irrigation season.

Many of the most productive agricultural areas He in flood plains. Major drainage systems, often managed by Internal Drainage Boards, support local field drainage. The Environment Agency is responsible for the "main" rivers and sea defences, and work with financial support from the Ministry of Agriculture, Fisheries and Food and local authorities to maintain defence standards. In recent years there has been greater emphasis on protecting urban areas from flooding and protection of agricultural land is a lower priority.

The Agency's Shoreline Management Plans are an example of the strategic approach to sea defences it is taking. It is working with the natural geomorphological processes, including where appropriate adopting 'managed retreat' options.

6. A VISION FOR THE 21st CENTURY

The vision statement: "the future is a world of well-fed people in a healthy environment containing viable and stable ecosystems" has been proposed as the basis of the vision for water for food and rural development in the 21' Century. This section suggests principles to support that vision and a minor change of wording.

The concept of stable ecosystems implies that nature can be protected from natural as wen as man made forces. Scientists now consider it is unlikely that the climate win stay as it is. The world is now about 0.6'C warmer than it was a hundred years ago and the three warmest years globally have all occurred in the last decade. Stable ecosystems, in the sense that a particular site's characteristics do not evolve, is probably not feasible, and 'diverse'ecosystems would be a better phrase.

The following principles support a vision "a future is a world of well-fed people in a healthy environment containing viable and diverse ecosystems".

Sustainable Development : ensuring no long term systematic deterioration in the water environment due to water resource development and water use; considering the full fife cost and environmental consequences of actions.

Precautionary principle - where significant environmental damage may occur, but knowledge on the matter is incomplete, decisions made and measures implemented should err on the side of caution.

Demand management - managing water use by economic incentives and other measures to make more efficient use of water, control waste and consumption, eg through leakage reduction and metering, irrigation scheduling and trickle irrigation.

Twin Track Approach - making better use of available resources whilst planning to develop new resources as and when required, having considered the economic, social and environmental impacts.

Integrated river basin management - achieving the 'right' quality and quantity of water in the 'right' place at the 'right' time. For example the Environment Agency's Local Environment Agency Plans (LEAPS) are based on river basins and cover 0 the functions of the Agency including water quality, waste regulation, flood defence, large industrial processes and water resources. They provide an open consultative approach to catchment management including ground and surface water protection.

Environmentally sound market orientated agriculture - encouraging and supporting an efficient and competitive industry. This is Rely to include reform of the CAP and replacement of production subsidies with subsidies to support more nature-friendly farming practices.

Ensure environmental protection - valuing, restoring and protecting the natural ecology and rural landscape. This will require ensuring adequate water supplies, and is likely to require action at some sites damaged by licensed abstractions.

Encourage Research and Development - encourage research and development and develop the exchange of best practices across all aspects of water for food and rural development, for example more efficient irrigation techniques and drought tolerant crops.
Encourage stakeholder and public participation - stakeholder and public participation enables wider awareness and consideration of issues and improved decision making.

7. CONCLUSIONS

The vision statement: "the future is a world of well-fed people in a healthy environment containing viable and diverse ecosystems" is attainable. It will require governments, institutions and individuals to anticipate changes, use opportunities and manage the various natural and man-made stresses and strains. The goal is sustainable development, with full support from stakeholders. The British section of ICID will press for a holistic management approach and will support and encourage those adopting it.

UKRAINE

SUMMARY

Ukraine is situated on the South-West of Eastern-European plain. Ukraine is bordered on the West and South-West by Poland, Hungary and Romania, on the North by Belarus, on the East by Russia, on South-West by Moldova, on the South it surrounded by the Sea of Azov and Black Sea. The area of Ukraine is 603.7 sq. km, the population is about 53 million. The forests cover less than 20% of the land. More than 3/4 the territory are ploughed up, the greater half of the land territory is set aside for cereals, fodder crops and technical cultures. Most of Ukraine has a moderately continental climate, 2/3 of the territory is under conditions of unfavorable water regime and it gave rise to the development of reclamation on this territory. The major river, fed by numerous tributaries, is the Dnieper which bisects the country into two party - Right-bank and Left-bank parts. The rivers of Southern and Steppe zones are often dried up in summer. Thawed snow play the main role in the feeding of plaint rivers (50-80%). The reserves of water resources are about 95 billion cubic meters, including 3.2 billion of cubic meters of underground water. During the period transition economy Ukraine experienced great difficulties related to the agriculture. The lack of the laws for the land and ownership, financial difficulties in purchasing of materials, equipment and technologies led to the decay in agriculture as a whole and in irrigated agriculture in particular. At present the conditions are favorable in using the new advanced resource-saving and ecologically clean technologies for obtaining high yields of agricultural production, revival of agriculture and maintaining of ecologically safe environment.

Most urgent national problems, up to 2025 year, in the field of water and land resources use will be the following.

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Natural :

- deficiency of fresh water availability;
- uneven distribution and availability of good quality surface and ground waters;
- uneven distribution of soils with potentially high fertility over different territories, their insufficient natural moisture storage.

Ecological :

- unsatisfactory quality of limited operational resources of surface and ground waters, pollution of rivers and water reservoirs with industrial,, domestic and farm wastes, high evaporation etc.;
- over-use of ground water for agricultural and rural settlements insufficient natural and artificial territory drainability;
- destructive action of floods and freshets on non-regulated mountain and foot-hills rivers;
- extensive agricultural development lowering in soil's fertility due to over use and lack of the necessary quantity of fertilizers;
- contamination of soils by the heavy metals radioactive strontium and caesium, weeds, pathogenic organisms and crop pests etc.

Economic :

- inadequate financial resources in state budget for the protection of water and land resources;
- absence of adequate payment for water and land use.

Technical :

- unjustified intense agricultural land development resulted in natural landscape exhaustion, considerable decrease of biodiversity and productivity, their self-regulated capability as well surface protecting and water regulating functions; ,* inadequate power for mechanization of agricultural

Administrative-origanizational :

- absence of a unified state body for the sound management of natural resources of the country including water and soil, their protection and revival;
- absence of real mechanism of charges for their use resulting in their extensive use.

1. OVERVIEW OF NATIONAL POLICY AND DEVELOPMENT PLANS

As an independent state Ukraine appeared on the word map in 1991. With industry and agriculture accounting for 60% and 40% of GDP, Ukraine could be classified amongst the industrial-agricultural countries. The major branches of industry (60% GDP) are metal, machine-building, chemistry, energy industry. 40% of (GDP) are formed in agriculture. Ukraine possesses favorable climatic and lands conditions for the development of agrarian economic sectors. Official national policy in the field of rational water and land resources use in Ukraine is absent so far. Our government draws main attention to the problem of food provision of our population and solves it by the way of state investments and lowering taxes for agriculture.

2. WATER MANAGEMENT

2.1 WATER SYSTEMS

2.1.1 Surface water

Potentially available for use river waters of Ukraine are estimated at 209.8 cubic km., but only half of the volume can be considered as state water fund. River flow excluding Danube river in low water years runs to 55.9 cubic km. and in average water years it accounts for 87.1 cubic km., within Ukraine being formed 29.7 and 41.4 cubic km. respectively. The main river of Ukraine is Dnieper, it is followed by Dnester, Severskiy Donesch,l Ugniy Bug and others. More than half of rivers flow over the lands where water consumption does not exceed 5% of national,, that is why water provision of the rest territories is achieved though water storage in 1087 water reservoirs with total capacity of 55 cubic km.(up to 43.8 cubic kin. is accumulated in the cascade of Dnieper water reservoirs). Theses waters are further redistributed by seven large channels.

2.1.2 Groundwater

Forecast resources of ground waters are estimated to be 22.5 cubic km. per year and they in general (820/o) belong to the basins of Dnieper, North Donets and Dnestor. Operational storage of ground waters is equal to 5.7 cubic km. per year. More than 110 thousand wells are drilled for extraction of ground waters. Beside this, in rural areas these waters are used through 1.9 million wells.

2.1.3 Wastewater

2.1.4 Water systems used

Pattern of water consumption in main economy branches of Ukraine shows that as compared to 1990, total water intake from all sources has decreased by 45% that resulted in the same fall of non-returnable water consumption and offtake up to 43% and 45% respectively. This points at the fact that change of water consumption pattern is conditioned only by fall of production but not through its water saving technologies.

Primarily total water intake is from rivers - 78-81%, followed by ground waters -12%, sea waters - 3-4% and mine waters - 3-5%.

2.2 WATER MANAGEMENT ISSUES

2.2.1 Waters scarcity

Annual average water provision of Ukraine per inhabitant is 15 times lower of standard which is determined by Europe Economic Commission of UNO.

The shortage of fresh water strengthens due to the contamination of surface and underground water.

2.2.2 Causes of worse water quality

According to the data of State Committee of Water Economy in different years, from 22% to 58% of waters were taken. It accounts for less than marginal value of 70% which was set on the Water Resources Conference under the guidance of UNO. In 8 regions of Ukraine, however, in average water years the intake runs to more than 70% of available resources and in seven others it corresponds to 200-1600%. In the years of low water the situation sharply becomes worse.

On South and East territories of Ukraine with the area of 320 thousand km2 annual amount of surface and underground flow, for the last two decades, was equal to II cubic km., and off take due to economy activities - 15.6 cubic km. Main source of sweet waters here is rainfalls - 168.2 cubic km, river and ground waters - 25.8 cubic km., 86% of which is evaporated. Thus, about half of the territory of Ukraine represents giant evaporator and as a result, steady deterioration of surface and ground waters quality is going on.

2.2.3 Radioactive contamination of water and bottom sedimentation

Radioactive contamination of considerable territory was occurred in 1986 year due to the accident on Chernobyl Atomic Station. with an area of 3189 km2 have become totally unsuited to human settlement.

2.2.4 Technologies for Water treatment

Water destined for the drinking and technical needs as well as industrial and municipal sewage requires appropriate treatment.

2.2.5 Floods

Nearly every 10 years the disastrous over-flooding occurs on mountain rivers of Ukrainian Karpaty including frontiers. In recent years they became more frequent due to the increased precipitation and atmospheric sediments load caused by unreasonable economic activity in the catchments. As a result the breaching of protective embankments, occurs frequently resulting in the flooding of settlements and damages.

2.2.6 Total evaluation of ecological state of water resources

As per available data of the Ukrainian Institute of Water-Ecological Problems the level of pollution surface waters of Ukraine has exceed all reasonable limits and as such untreated waters can not be used for consumption.

Recently, the situation with chemical pollution of surface waters has worsened due to arises in economy and fall in production which led to decrease of water intake and offtake. Examination of Dnieper river from Kiev water reservoir up to mouth part of the river being conducted in 1997-1998 years, has shown, that hydrochemical water indexes in Dnieper reservoirs are much better than in rivers - inflows of Dnieper.

Effectiveness of water use in Ukraine is unsatisfactory. It is necessary to replace existing industrial technologies and promote recycling which have note yet been used because of their high cost. Due to insufficient electric power supply already built treatment works also stop functioning, resulting in increase of water wastes.

2.3 WATER MANAGEMENT

The management of water is partly done through water resources users committees and partly by canal Administration.

It is necessary to perfect the legal and economic mechanisms as to the payment for water use generates resources for the protection of water sources. The enlisting of public organizations for the object of water protection holds much promise. Water economy and water ecology situation in Ukraine may develop on two main scenarios.

The first is passive and envisions further fall in production that will lead to decrease of water intake as much as two times and this will not exceed of ecology permissible limit of 10%. Water offtake will lowered two times too and this does not significantly exceed surface and underground flow. On the whole the effect will be favorable concerning to surface waters, first of all it relates to Dnieper river.

Second is active and it will lead to the same results with lower expenses but not so quickly, since it envisions basic changes in technology of production. It is most likely that the second scenario will gradually replace the first one.

3. CONTEMPORARY STATE OF WATER RESOURCES AND THEIR USE

The area of Ukraine is equal to 603.7 thousand km2. About 434 thousand km2 (72,2 %) is used in agriculture, 80% of the lands being plowed every year. Pastures and hayfields occupy 17% and perennial herbs -3% of all area. Ukrainian territories can be divided into four agro-climatic zones (Figure 1): humid, moderate wan-n (1), insufficient humid (2), arid, very warm (3), very arid and moderate hot (4). As usual, the lands in the first zone are overwetted and require artificial drainage application. That is why, draining and irrigating land reclamation systems are spread over an area of 2.9 million ha. Almost on all arable, lands one can meet the soil salinity (more than 8 million ha) or alkaline reaction and require liming or gypsum application. The area of alkaline lands makes up approximately 4 million ha. Mainly, they are spread over left side of forest-steppe and steppe. High degree agricultural development of lands in Ukraine has led to impoverishing of natural landscapes at the expense of plants and decrease of soil resistance to wind and water erosion. Total area of eroded lands has reached 12.2 million ha, that is it constitutes one third over the last 25 years. Every year about 20 million tones of humus are washed out and damage being estimated as 3 million dollars.

4. CURRENT STATE IN AGRICULTURAL DEVELOPMENT

More than one third of black soils reserves which are the natural basis for the efficient development in agriculture are concentrated in the Ukraine. The absence of the market is the main obstacle in such development.

The land reform are being started in the Ukraine and providing non-state forms for land property including private was completed as of November 1, 1997.

As a result of economic reform the collective and state agricultural enterprises have 33mln hectares of lands, farmers - 0.8mln hectares, 6.4mln of hectares are in the private people's property.

An inconsistent village's reforming have produced the following negative demographic phenomena: unemployment, social structure disintegration, drastic decrease of a real income of country-people.

The natural reduction in the number of countrymen has ranged up to 8.7 humans per 1000 of inhabitants, 2.6 more than of townsmen. As a consequence for each 1000 able-bodied humans in the village there are 1037 pensioners. Migration was intensified.. Countrymen searching for the work are moving to the cities. As a result the average number of inhabitants in settlements decreased on 17%.

Average monthly wages in countrymen constitute 25$ and among economy branches occupies 20-th place. In so doing the payment of wages is performed irregularly.

Within 1990-1997 the level of capital investments into the social infrastructure of the village was reduced in 4.7. 22.5% of villages has the water-piping, 22%- natural gas, 3,1 %- sewerage system. The palaces of culture, kindergartens and even shops a-re closing in every place.

The power availability in agriculture is for more than 4 times lesser than in industry, though the share of energy-expenditures in the structure of general branches constitutes 37-41%. It can be explained by the low efficiency of agricultural techniques. Nearly the half of available agricultural machines are inoperative through the lack adequate quantity of combustible-lubricant materials and spare parts.

Under conditions of transitive market economy the domestic agriculture is not in a condition to compete with industry, energetic and import. One ton of petroleum is twice/triple more expensive than the ton of milk or the ton of the top-quality wheat. The cost of domestic agricultural technique exceeds the real possibilities of rural commodity producer.

By the most conservative estimate the food market is formed on 60% from import products and it is assisted by the banks' policy as 80% of its' investments are directed towards import supporting. The investments to the industry were restricted in 2.3 times comparing to 1991 and to the agricultural complex - in 4 times.

The agriculture of the Ukraine is gradually transferring to the raw materials appendage for the Western Europe which readily invests plant growing, undermining the potential fertility of its own soils. Above all it is a sunflower and the other oil cultures.

The drop in agricultural production is determined as well by the lowering in food products consumption by the population because of its impoverishment and the loss of its purchasing power.

In 1996 the Institutes of the UAAS were grouped together into 22 Centers, which received financial support. It enabled to concentrate monetary and material resources for the decision of the most important problems.

5. THE PROSPECTS AND OBJECTIVES

The creation of the conditions for the provision of the population by the food products under established medical norms is the immediate task of the economic development in the Ukraine, namely: meat - 85, milk - 420, grain - 148kg, eggs - 304 per capita. With consideration for this it should be annually produced 5,6mln tons of meat in preslaughter weight, 25,2mln tons of milk ad 18,4 blrd eggs.

At the governmental level the scientists propose and find support to transfer 10mln of arable lands into forage lands which are at the most approached to natural to perform forestation of no less than of 1mln hectares of lands first and foremost eroded and scab lands, to create in river flood-lands the water-protective zones. Under transformation the area of arable lands would reduce from 32,3 to 22,3mln hectares and the area of natural forage lands would increase from 7,3 to 16 .3mln hectares. For the population needs it is quite enough to sew cereals over the area of 7,15- 8,llmln hectares. The general group of cereals must include wheat (6mln hectares), spring and winter barley (3,5), oats (0,8). maize (1, l), pea (1,6), groats (0,6). Two main objectives are accomplished by reducing the areas of arable lands: The energy expenditures and material resources are reducing as well the natural landscapes are restoring having a beneficial effect on surroundings. In essence the all lands being in agricultural use must be constantly subjected to the complex reclamation.

Irrigated and drainage lands plays a leading role in the guaranteed provision by the food products. In recent years the level of these lands use was considerably reduced due to the energy deficiency, physical out-dating of reclamation systems. It is necessary to reconstruct 30-40 thousand hectares of irrigative and 10-15 thousand hectares of drainage-moistening systems for the restoration of the former technical state.

6. DISCUSSION ABOUT THE FUTURE PROSPECTS

The development of agriculture have to go on in the direction of arable area reduction on the account of re-naturalization of low-productive lands, raise of natural landscape diversity, universal spreading of the systems of reclamation agriculture.

The re-naturalization of the landscapes of Ukraine will have a beneficial effect on the ecology of the European states, above all through the cleaning of air basin, increasing of the total area's water content on the account of precipitation of connective origin, reducing of Black Sea aqua-territory contamination.

The Ukraine with its fund of fertile soils and not contaminated yet is able to be for the Europe the source of ecologically clean products. Taking into account an inevitable integration of European states, the fertile lands of the Ukraine will be in somewhat distant future the reserve for the extended reproduction of food products.

Water economy have to be developed in the direction of essential reducing of water-shed at simultaneous increasing the share of irretrievable water-consumption due to the introduction of water-saving technologies in, production.

The integration of efforts of the scientists and specialists from European countries is of great importance for problems connected with sustainable agricultural development.

It is very important for the Ukraine to participate in decision of general European problems and more fight cooperation with International organizations FAO, ICID etc.

VIETNAM

Food security should be linked closely with sustainable agricultural production. In agricultural production, water always plays the most important role, guaranteeing whether there is a good or poor crop. Through many generations, the four factors which have the greatest effects on agricultural production have been summarized and ranked by Vietnamese farmers as: "Water is first, fertilizer second, hard work third, and variety forth". The Agriculture and Food Organization of the United Nations (FAO) also confirms that "Sustainable agricultural development depends on sustainable water use". According to the review of FAO two thirds (many studies show 90%) of the world's water resources coming from rivers, lakes and underground resources are used for irrigation, the rest for domestic and industrial use. In Vietnam, agriculture now uses over 90% of the total water resources available for domestic and industry.

Recently, the need for food has increased rapidly due to population growth. In order to produce more food, farmers have had to diversify their crops, increase productivity and expand cultivated land. Therefore an increase in the need for agricultural water has been inevitable. People have been more and more aware that their water resources are not abundant. Water is limited even if it can be reused. However it is very sensitive to environmental changes and easily polluted and deteriorated. Population growth and urbanization, strong industrial development and inappropriate exploitation and use of water are now the main causes leading to the deterioration of this important resource. Agricultural production uses more water than any other industry and will have to burden any negative impacts of this situation. FAO warns that the number of nations with a shortage of water will increase more and more and, by the year 2000, over 40 countries will be at risk of water deterioration. Therefore management activities should focus on exploitation, use and preservation of water.

At present, Vietnam is considered a country with plenty of water, having a total surface water capacity of over 2360 rivers and lakes estimated at $8.5x10^{11}$ m^3. With a population of 7.5 $x10^7$ there are $1.1x10^4$ m^3 per capita per year. According to world standards, our country ranks in the middle in terms of water resources ($1x10^4 m^3$ per capita per year). As estimated, by 2010 our population will reach $9.334x10^7$ then the average volume of water per person per year. It will only be $9.1x10^3$ m^3 and we will be at the threshold of nations with a shortage of water. Another factor in Vietnam comes from our neighbors. Vietnam is located downstream in nine international rivers. We have shared water with surrounding nations such as the China, Myanmar, Thailand, Lao and Cambodia. Accordingly, our water resource is materially affected by the water use of upstream nations.

Vietnam is now an agricultural nation. Our cultivated land is potentially about 1.1 to 1.2 $x10^7$ ha. Presently we are using 7.5 $x10^6$ ha most of which is to cultivate for rice. Water for agriculture in Vietnam now takes up over 90 % of the water for all purposes. In the near future, by 2010, water for agricultural production in Vietnam will still take over 80% of its water. So the sustainable use and management of water is important for national food security. The following statistics (Tables1 and 2) show that water still plays an important role in agricultural development in Vietnam.

Table 1. The situation and forecast of water and land use in Vietnam by 2010

Year	1995	2000	2010
Types of land			
Country natural land area (ha)	33,000,000	33,000,000	33,000,000
Agricultural land	7,348,500	7,790,000	9,409,600
- Paddy rice	4,252,000	9,409,600	4,378,000
- Other cropping	3,596,500	4,240,000	5,031,600
Forestry land of all types	9,500,000	14,300,000	15,900,000
Other land	16.151.500	10,110,000	7,690,400

Source: The strategy of management and protection of water resource in Vietnam - The Water Resource and Hydraulic Works Department.

Table 2. Water requirement for agriculture and other economic industries by the year 2010

Year	1990		2000		2010	
Sectors using water	Water requirement	%	Water requirement	%	Water requirement	%
Agriculture	46,976	91	60,929	85	74,035	82
Industry and domestic use	4,659	9	10,96	15	15,918	18
Total	51,635	100	71,926	100	89,953	100

Source: The strategy of management and protection of water resource in Vietnam - The Water Resource and Hydraulic Works Department 6/96.

However, it is not easy to define the difficulties in the use of agricultural water if we only depend on the statistics mentioned above. In fact, because of the large difference between dry and rainy seasons, flows in dry seasons, depending on the area, is only about 15 to 25% of the total annual flow. With the aim to provide enough irrigation water for most cultivated land (except for land irrigated by rain water), we have to build thousands of works to control and regulate water with different scales. According to the statistics of 1996 from the Water Resource and Hydraulic Works Department of MARD, Vietnam has 75 large and medium irrigation systems, 743 large and medium reservoirs, 1017 dams, 4712 sluices, 1793 pumping stations and thousands of water canals with different lengths. In the Mekong delta, one of the two biggest rice producers of the country, there are thousands of kilometers of large canals, flood protection levies and more than $1x10^{4}$ small pumping stations. According to the report of the water sector, (relatively though), the value of this property reached over VND $2.5803 x10^{13}$ (according to the1993 price level). During the past 25 years, the water resource sector has made significant contributions to the increase of food in the half century from $1.45 x10^{7}$ tons in1975 to over $2.9x10^{7}$ tons in1996 thus guaranteeing national food security.

Water is one of the important factors guaranteeing sustainable agricultural development. However, floods and droughts are natural disasters threatening people's life, poverty and the economic development especially agricultural production. Protecting and mitigating damages caused by disasters is one of the main interests of water resource management in our country. Along with the construction of a range of irrigation, drainage and flood protection works as mentioned above, through many generations, Vietnamese people have set up over $5.6x10^{3}$ km of river embankments, more than $2x10^{3}$ km of sea dikes, $8x10^{3}$ km of flood protection levies, $5.9x10^{2}$ banks, $2.9x10^{3}$ sluices under dikes to control floods and protect people's life and poverty, stabilized agricultural production on great deltas thus contributing to food security both nationally and globally.

The use and management of water for sustainable agricultural production and national food security have made progress. Vietnam has had a lot of good policies, strategies and much assistance from professional organizations, countries in the region and the world (FAO, ADB, WB, ICID..). From a nation with a shortage of food, Vietnam has provided itself with food and become one of the world's leading rice exporters.

However, it is not correct that all problems of sustainable water resource management and development have been settled successfully. We still have to face drought in dry seasons and floods in rainy seasons. Water resources continues to be polluted and deteriorated by the pressure of population growth and economic development. These challenges will become more severe in the future, causing instability and unsustainability in agricultural production thus affecting directly policies on national food security.

Learning from the experiences of many other countries and based on the practical situation in Vietnam, we find that it is necessary to improve and complete strategies and policies on sustainable water use and management contributing to agricultural development and national food security in the long term as follows:

a. Institutional strengthening will help to ensure integrated management of our national water resources. It is important that the Government has approved and issued water laws. This is the most important legal framework that controls the use, management and protection of this precious resource. Along with the completion of legal documents on water resources, we should establish an appropriate organizational structure guaranteeing the integration and efficiency of state management of water laws. Disintegrated management of water law has a great impact on society and the economy. This is now a great concern of many countries in the region and the world such as

Thailand and Bangladesh. Establishment of basin water resource management agencies is one of the advanced organizational models that needs studying.

b. Vietnam is located downstream on many international rivers in which the Red and Mekong Rivers are especially important. Participation in the international basin organization (Mekong Committee) and cooperation with upstream countries to develop and protect the water resources of these rivers is important in order to protect our rights.

c. Upgrading and rehabilitating the existing water and flood protection works is aimed to use most efficiently their design capacity. This economic resolution is suitable with our economic conditions and also used by many countries in order to avoid wasting water. (At present, our works only use around 60% of their design capacity and waste water. For instance, the irrigation coefficient is 1.5 to1.7 times higher than design level). The hydraulic water works are nationally in great poverty, being built through many periods. Many were built at the beginning of the 20th century (Bai Thuong, Do luong, Yen Son), and most of the rest in the 60s and 70s. Due to their life expectation, exploitation as well as wars and lack of capital for O&M many are severely degraded.

d. Investment in rehabilitating and upgrading the hydraulic and flood protection requires a large fund. Each year the state spends hundreds of billions of dong on these activities. Only in the period of 1994 - 2000, has our government signed treaties to borrow from the WB to upgrade and rehabilitate a small number of hydraulic water works in the north and the central part of our country. The capital borrowed is up to $3x10^{12}$ dong because these activities needed carrying out efficiently, guaranteeing their duration.

e. Continue studying and applying advanced, efficient exploitation and management methods of hydraulic works of various countries. These methods include policy, organization, participatory management and protection.

f. Continue with investment in building new works to serve the current needs and expand cultivated areas and flood control in order to meet increasing needs for water, food and energy. It is necessary to build water works in mountainous and isolated areas, in order to contribute to the reduction of poverty and alleviate hunger thus creating general food security. However, new works need studying carefully to avoid and minimize negative environmental and ecological influences. At the same time, they must be economically viable and of high quality and beauty, meeting regional and international standards and generating work for the future.

g. Improve the capacity of staff and agencies in charge of water management, creating conditions to support our water management activities to catch up with the world standard.

h. A well-known world expert in water management said that: “Water is an import factor making contributions to social stability and economic development of any community, any nation or any civilization.” Accordingly, sustainable water management in terms of economics, a society and the environment will be an important part in developing sustainable agriculture in our country and guaranteeing national food security.

i. Strategy for development of irrigation schemes and water resources management in Vietnam to the year 2010 will include the following:

1. Challenges:

a. Low initial investment (1,000 - 2,000) uncompleted constructions;

b. Degraded constructions, some only reach 60% of designed capacity;.

c. Lack of water, security of construction not ensured;

d. Management of irrigation construction at local levels are not in line with market mechanisms.

e. One million upland people lack clean water. Only 30% of rural people have access to clean water.

f. Planning for protection and utilization of water resources is not comprehensive.

g. There are exhausted water resources in many places.

h. Scattered and overlapping management of water resources between Ministries, Sectors and local level management by river basins has not yet been implemented.

2. Objectives for the year 2010.

a. Ensure a clean water supply of $7.2x10^{10}$ m^3 by the year 2000 (agriculture $6.1x10^{10}$ m^3; industry and domestic use $1.1x10^{10}$ m^3) and $9x10^{10}$ m^3 by the year 2010 (agriculture 7.4 $x10^{10}$ m^3; industry and domestic use $1.6x10^{10}$ m^3).
b. Ensure drainage for flooded areas; improve the environment and ecology.
c. Red River dike system to ensure a stable flow of water and prevent flooding at high water.
d. Create a sea dike system to withstand storms of 11-12 Beaufort and developed to prevent coastal areas from salt water intrusion.
e. Ensure security from flooding of the Mekong River Delta areas.
f. Establish irrigation from large river basins.
g. Overcome water shortages in the HCM city - Dong Nai- Vung Tau triangle.
h. Develop small and medium scale construction in mountainous areas and the Central Highlands.
i. Complete construction to prevent salt intrusion and regulate the water level in the Mekong delta areas.
j. Provide a basic water supply for $1x10^6$ people in upland areas.
k. Strengthen scientific research, water resources management, and the capacities for planning, design and building of irrigation construction and the application of new construction materials.
l. Complete the legal document system under the Law on Water Resources.

Priorities to strengthen the capacities for water resources management and irrigation schemes.

a. Establish national strategies for water resources.

b. Plan and construct river basin and irrigation systems towards to integrat the use and management by watershed.

c. Establishing legal documentation.
   i) Implement the Law on Water Resources.
   ii) Decree on administrative sanctions in the water resources sector.
   iii) Decree on the pricing of water.
   iv) Revise the law on exploitation and protection of irrigation schemes and the laws on dikes, flood and storm prevention to make them compatible with the Law on Water Resources.
   v) Prepare inter-ministerial circulars and regulations on water resource management and loss prevention.

c. Establish water resource councils, management and planning agencies for river basins to investigate water resources.

d. Investigate water resources in order to establish a data base.

f. Train human resources.

g. Issue licenses for the exploitation and use of water and emission of waste water.

3. Priorities for investment

a. Construct multi-purpose irrigation schemes.
b. Construction for flood regulation and reduction of losses by natural calamities.

c. Construction to prevent salt intrusion
d. Construction for waste water treatment.
e. Construction for drainage of flooded areas.
f. Improvement of existing irrigation constructions.
g. Consolidation of systems of dikes and canals.
h. Improvement of irrigation control system.
i. Improvement of weather forecasts and information of natural calamities.
j. Strengthen capacities to manage reservoirs.
k. Establish to manage networks for waste water treatment.
l. Provide clean water and hygiene in rural areas.

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ICID STRATEGY FOR IMPLEMENTING THE SECTOR VISION OF 'WATER FOR FOOD AND RURAL DEVELOPMENT"

CONTENTS

Strategy for implementation of issues of ICID concern emanating from the sector vision of

'WATER FOR FOOD AND RURAL DEVELOPMENT'

(Draft, October 2000)

PREAMBLE

The International Commission on Irrigation and Drainage (ICID) is a constituent member of the World Water Council (WWC). The WWC presented a global "Long Term Vision for Water, Life and Environment in the 21st century" to the world community at the Second World Water Forum held at The Hague, The Netherlands from 17 to 22 March 2000. In the framework of the vision preparation process, three major sector visions were developed: Water for People, Water and Nature and Water for Food and Rural Development. ICID has made a significant contribution to the Sector Vision on Water for Food and Rural Development.

A proposal to prepare an ICID "Strategy for Implementation of Sector Vision", based on the discussion in the Task Force set up for the purpose, was vetted in the Permanent Committee for Strategy Planning and Organisational Affairs (PCSPOA) and the Permanent Committee for Technical Activities (PCTA), among others through the preparation of 41 Country Position Papers and the hosting of regional meetings in the Americas, Europe, South Asia and South-East Asia. It was further considered and adopted by the International Executive Council of ICID at Granada. The draft strategy to reflect ICID's specific ideas, positions and plans as a key association of professionals in the Sector was prepared in the Central Office, was vetted by the Task Force and then circulated to ICID's National Committees for concurrence. Suggestions received were incorporated and the draft "Strategy Paper" was finalised for presentation at the Second World Water Forum. It consisted of the following:

- steps to disseminate the country position papers widely within each country;
- actions to fill up the gaps in the position papers;
- identification of what ICID would undertake on its own and what would be done in co-operation with other institutions or organisations;
- allocation of various actions to different Work Bodies within ICID;
- selection of topics from identified actions for future workshops, conferences and congresses of ICID;
- help in mobilisation of funding for implementing actions;
- establishment of mechanisms to monitor and evaluate progress on implementation of actions;
- establishment of awards/prizes to recognise National Committees making significant progress on implementation under this Strategy;
- promotion of ICID's WatSave Awards and wide dissemination of the information contributed.

The draft strategy was presented by the President ICID during the subject session at The Hague. A 500-page ICID publication comprising the "Draft Strategy" and the Country Position Papers was released at that time, when very useful discussions took place during the session. The Central Office of ICID, many of the ICID office bearers and representatives of National Committees and experts made significant contributions to the whole process of formulation of the Vision during the earlier 6 months. During the Second World Water Forum, discussions relevant to ICID concerns were held in several other sessions as well. After the Second World Water Forum, the Central Office of ICID accessed/procured several proceedings of these sessions and culled out issues for consideration of ICID work bodies at Cape Town in consultation with their Chairs. Some of the critical issues have been included in the revised "Strategy". As a result of deliberations in the

Work Bodies at Cape Town, the draft Strategy will be improved and presented to IEC for adoption.

In parallel with the preparation of the revised Strategy for Implementing the Sector Vision, the Country Position Papers were edited. Vice President Hon Tom Anstey readily and enthusiastically helped Central Office with meticulous editing of several of the Country Position Papers. The National Committees also responded to the request call and sent the revised versions of their papers wherever necessary. The revised Country Position Papers have been published separately on a CD-ROM. Remaining copies of the printed draft publication released at The Hague have been made available to those interested, by the Central Office.

During the process of development of the Country Position Papers, the Policy Dialogue Model (PODIUM) developed by the International Water Management Institute (IWMI), Colombo, Sri Lanka was presented. It was deployed by a few National Committees. Discussions held earlier about PODIUM in Granada led to the organisation of a special workshop at New Delhi, India by ICID in collaboration with the Indian National Committee on Irrigation and Drainage (INCID) during December 1999 to verify the country data, the basin wide irrigation efficiency and the problems experienced while using the PODIUM. For this purpose, representatives of five National Committees accounting together about 60% of the world's irrigated area, viz. China, Egypt, India, Mexico, and Pakistan were invited. A group of PODIUM experts from IWMI interacted with the representatives of the National Committees as well as a few independent experts in the field of hydrology, ground water, irrigation and agriculture from India. Mr. Fernando Gonzalez from the World Bank participated and guided the proceedings. As a result of this workshop, IWMI took up for modification of the PODIUM so as to enable its use by the large countries like China and India. Both these countries plan to use the revised version and sharpen their focus on the Sector Vision. The contributions made by INCID for fine-tuning of PODIUM in association with IWMI experts are indeed noteworthy. A follow up to the New Delhi workshop was held at HR Wallingford UK during February 2000 where presentations about PODIUM were made by Dr. David Seckler and Dr. Upali Amarsinghe of IWMI for the designated experts of ICID viz. Mr. Bob Rangeley, Dr. M.G. Bos and Mr. Frederiksen.

The Strategy depicts what, ICID considers of importance, for the implementation of the vision by all the actors in the sector. ICID's input in this integrated process is formulated in line with this background. It is clear that especially in the developing countries, huge efforts are required to:

- feed the still growing population;
- improve the standard of living in the rural area;
- develop and manage land and water in a sustainable way during the coming decades.

In respect to this process, ICID recognises basically three climatic zones, viz. temperate humid, arid/semi-arid and humid tropics. In addition, in principle, four cultivation practices are distinguished, viz. rainfed area with or without drainage, and irrigated area with or without drainage. Dependent on local conditions, different types of water management with different levels of service will be appropriate.

ICID has participated in the whole vision process with keenness and realises its responsible position as an international apex body in the sector that is responsible for about 70% of the water use in the world. ICID therefore appreciates the necessity to support full but justified water use in the sector. As enunciated in the GRANADA statement, "ICID encourages all stakeholders to irrigate and drain arable lands to their optimum efficiency, maximise food production and assure that *water not used is recycled to the extent that is reasonably possible. Basin wide, the use of water will be optimised. Where applicable it will be shared amongst States and regions and pollution affecting water quality for use in irrigation, will be controlled to an acceptable level*".

The document lays down a strategy for implementation of ICID's findings from the Sector Vision. The "Strategy" basically charts out its own Agenda for the future. The compilation of Country Position Papers will help a reader to get a good overview of the developments and positions in irrigation and drainage at country level amongst ICID membership. The Strategy includes in brief ICID's concerns on various issues that have become more apparent due to the vision process. It does not necessarily agree with the findings of the 'Vision" which are summarised. Some of the ICID concerns which are not included in the Vision are brought up in the `strategy'. In fact the document clearly spells out what ICID believes as necessary and important for future water management, to support the required increase in food production, in light of sustainable and equitable rural development with efficiency and economy.

Aly M. Shady	C.D. Thatte	Bart Schultz
Chairman, Task Force	Secretary General, ICID	President, ICID

CAPE TOWN, OCTOBER 2000.

STRATEGY FOR IMPLEMENTATION OF ISSUES OF ICID CONCERN EMANATING FROM THE SECTOR VISION OF

'WATER FOR FOOD AND RURAL DEVELOPMENT'

(DRAFT, OCTOBER, 2000)

I. INTRODUCTION

Human habitats spread out on the earth's surface initially wherever food could be gathered and later where it could be produced. Survival and growth of mankind in the face of adverse environment was due to man's ingenuity in meeting with the food requirements. Forests were cut, lands were protected and reclaimed, and cultivation was started. Early civilizations grew along major rivers of the world, with agriculture as the focal point around which, the nomadic mankind gravitated. But towns, cities, metros and mega-cities grew out of needs of people for more organised life through co-ordination, defence, governance, and later with the industrial revolution. The original small habitats remained 'rural'. Rural populations remained agriculture-centric though benefiting from the industrial revolution. The urban ones got differentiated according to the needs of centralisation. The rural areas continued to grow food and feed the urbanites. Collection, process, storage to take care of lean seasons, transport, distribution, trade, market etc. for food gradually got centralised and concentrated in urban areas. But the process triggered infrastructure development in rural areas. Such activities with spread at both locales together, constitute rural development and well being.

Up to the 19th century, the rural folks remained employed on agriculture related activities, the urbanites getting employed more and more in manufacturing and services sectors catering to production of consumer goods of higher value. Agriculture production remained farm and family oriented in many countries, under-organised, lowly valued, contributing a lower proportion to the Gross Domestic Product (GDP) of a nation, as compared to a smaller population remaining engaged in other sectors producing a larger share of GDP. The rural populations largely remained relatively poorer as compared to the urban people. Due to increasing pressure on land, landless people grew in numbers. Due to lack of jobs and deficit in availability of water and food for the growing populations, migration towards urban habitats grew, providing labour force but also causing growth of impoverished pockets in urban areas. Poverty, hunger, malnutrition and unemployment both in rural and urban areas got intricately associated. A poor person often remained unemployed, hungry, undernourished and unhappy, even when at times adequate food was available globally, simply for want of buying capacity and accessibility to food. But due to extreme variability in availability of water, people continued to suffer hunger and at times starvation due to famines. This picture changed significantly during the 20th century due to rapid spread of irrigation, drainage of water logged farmlands and improved flood management in cropped areas. The ill effects of landlessness, unemployment, malnutrition and poverty were reversed. They, however continue to stalk many societies even at the beginning of the 21st century, where irrigation and drainage are neither developed nor managed adequately.

Food consumed by mankind comes from agricultural crops or from birds, fish and animals - meat and milk, which constitute livestock products. Crops are used for providing cattle feed mostly by way of using grains in case of developed countries and/or mainly crop residue itself in case of developing countries. Cropped foods are relatively economical and are mostly poor peoples' foods. Meat and dairy foods are secondary, derived from products of crop foods; they consume more water and are on the whole more expensive. Proportion of consumption of meat and milk, normally grows with economic well being i.e. affordability. But growth of both types of food requires proper water management, especially during the critical growth period of crops, by either water application in the right dose and at the right time through irrigation where necessary, or by removal of excess water by drainage.

Irrigation increases productivity and value of land, which brings prosperity, which in turn facilitates installation of infrastructure. But conversely, good infrastructure helps improve the land productivity. Not long ago, the Green Revolution increased the global food production dramatically. Water availability being variable in space and time; the rural well being is intimately dependent on its supply, use, disposal and reuse. Like any socio-economic activity utilising finite natural resources, growth and sustained yield from agriculture per unit of water and land, calls for adequate financial and human investments. At the same time, a farmer is encouraged to invest in farming if he is assured of irrigation to overcome vagaries of natural availability of water. Survival, development, growth of rural economy and well being thus become synonymous with water, food and agriculture. Besides planning another green revolution or an evergreen revolution to increase land productivity and impart sustainability, a blue revolution tied up with maximising crop production while minimising water consumption is now advocated. Irrigation and drainage coupled with flood management indeed can promote sustainable rural development. A balance however is to be found between the requirements of the society, and acceptable side effects while aiming at sustainable development.

Water in the form of rain and snow is made available by nature in the yearly hydrological cycle. An appreciable part of it gets lodged in snowcaps and natural lakes and is utilisable subsequently in case of the former, through snowmelt reaching a river system. A sizeable part is retained in surface soils and used up through evapotranspiration for biomass generation. Another part seeps into the ground feeding natural aquifers. A major part appears in the river system downstream and is drained through streams and rivers into seas, unless captured in man-made storages or artificially diverted from natural streams. Water is recycled continuously through transpiration through biomass and evaporation from land, river systems and oceans, besides precipitation through condensation, rain and snow. A river basin is a natural entity for planning beneficial uses of available waters from precipitation, which are highly variable in space and time. Where available precipitation is excessive, land has to be drained to get beneficial uses out of it.

Often, some parts of a basin are surplus in availability, while some others face deficit. Intra and inter-basin transfer of water to remedy such imbalances has been practiced by mankind for a long time. It may involve construction of storages for impounding runoff of floodwaters generated over a few storms sometimes spanning a few days in a year, enabling its use round the year. Diversion structures involving little or no storage may be constructed for withdrawals through canals and by pumping, where the river flow quantum is adequate. Storages wherever constructed always absorb and reduce flood peaks downstream, enabling better flood management.

Presently, irrigation covers more than 250 million hectares (M ha) i.e. about 17% of world's arable land, but is responsible for around 40% of crop output and employs nearly 30% of population spread over rural areas. It uses about 70% of waters withdrawn from global river systems, 60% of which gets used consumptively, the rest predominantly returning to the river systems enabling its reuse downstream. Thus 30% of water withdrawn is put to other uses like drinking, municipal, industrial, hydropower generation, and recreation. Only a small part of this quantity is used up consumptively, while a large unconsumed part either treated or untreated is returned to the river systems and reused. Drainage systems cover about 150 M ha i.e. about 10% of world's arable land, of which 100 M ha is rainfed and the rest irrigated. As river basin boundaries normally don't match with national or State administrative boundaries, basin wide development may be affected by conflicts and competing demands for sharing of available waters between regions or peoples for various beneficial uses. Plans would therefore invariably have to aim at integration of uses, demands, supplies, size of structures required, other available resources and institutional arrangements.

The world population is likely to grow for another 50 - 60 years and will then probably stabilise. However, the growth in population will be mainly in developing countries especially in Africa, South America, Central Asia, while population of the developed world may continue to decrease. So will the food demands. The mix of foods consumed - cereals, pulses, oils, fruits, vegetables, nuts, meat, dairy products, fish - and the level of calorie intake with a balanced nutritional diet is expected to undergo change with increase in the standard of living. Food needs will exceed projections, which are in proportion of growth in population alone. It is estimated that while the population will grow from 6 billion to 8 billion in next 25 years, the present food production shall have to be doubled. Demands for water for growing more food will increase causing shortages in regions, which are hitherto comfortable with availability. The growth in shortage could be avoided only by developing the unharnessed potential or by decreasing the withdrawals and simultaneously increasing water use efficiency. Large populous countries would continue to strive for maintaining self-sufficiency in food production, because their shortfalls in case of droughts, will be too large to be covered by world trade which remains at around 10% of total production and which shows signs of reduction. As developed world only has surplus food for trade. There is also a possibility that producers in developed world will move away from food production. Nevertheless every country would attempt to increase productivity of cropped lands with water that could be made available by improving water use efficiency and by bringing additional lands under irrigation employing better irrigation technology and through increased withdrawals where potential is yet available.

Such effort should lead to maintaining or achieving food security. The concept of security encompasses not only food production, but relates to its storage, preservation, supply at reasonable and affordable prices, and adequate size of buffer stocks to take care of natural disasters. The aim of food security for Governments means co-ordination of effort of several Ministries/Departments, which include: water resources, irrigation, public works, agriculture, rural development, environment, health, commerce and trade, industry, chemicals and fertilisers. Realisation of targeting of food security round the world would call for commitment of stakeholders and political will of the country's leadership.

It is expected that more people either landless or otherwise would move away from the agriculture sector to the manufacturing and services sector to escape unemployment and poverty in rural areas. This shift could trigger consolidation of land holdings, and improved productivity from the landmass, which in turn could cause faster economic growth. Increased productivity could mean growing required cereal food from lesser area, release some of the area for higher value crops thus ensuring poverty alleviation for poor and marginal farmers. Making water available to achieve food sufficiency and security will also lead to rural well being through better livelihood, health, employment, stabilisation of rural populations, education, transportation, communications and human productivity. It will help insure societies against natural disasters and provide a more sustainable livelihood. Irrigation, drainage and flood management will no longer remain options but will fulfill the core needs of society as well as ensuring protection of environment. As everybody lives downstream of somebody, the national planning shall, nevertheless, have to ensure availability of requisite quantities of water with right quality, down the streams in a river basin.

II SUMMARY OF THE WORLD WATER VISION, SECTOR VISION OF WATER FOR FOOD AND RURAL DEVELOPMENT AND DELIBERATIONS IN THE SECOND WORLD WATER FORUM, THE HAGUE, MARCH 2000

II.1 VISION COMPONENTS AND THE SECOND WORLD WATER FORUM

The World Water Council (WWC) had appointed the World Commission on Water (WCW) to advise the Vision Management Unit (VMU) of the WWC about formulation of the vision through mobilisation of global effort. The VMU prepared a Staff Report comprising background information and analysis of the three main sector reports, viz. Water for Food and Rural Development (WFFRD)., Water for People, and Water and Nature. ICID was deeply involved with the first sector vision, which looked into food needs and production through irrigated and rainfed areas leading to sustainable rural development The second sector vision related to water for drinking, domestic and industrial needs besides that for sanitation. The third sector vision was related to water for ecological purposes including flora, fauna, forests, biodiversity, wetlands, etc. The WCW considered the Staff Report and made a Vision Report. All these reports record the views of the authors, which are not necessarily leading from one to the other, nor shared by all the participants in the effort. What is reported, for example, in WFFRD is not necessarily the position of each of the participating organisations say like ICID. Also WFFRD conclusions are not necessarily accepted in the Staff Report and in turn what is said in the Staff Report is not completely recorded and summarised in the WCW report. To some extent therefore, a reader of one report gets only a partial glimpse of the vision. The Central Office is taking up with the WWC, such important deviations of concern to ICID. They are reflected in the succeeding paragraphs.

All these reports were presented and discussed in mainly four groups of sessions viz. Water Use Presentations, Regional Presentations, Special Subjects and Major Groups. In each of these groups, there were 11, 22, 29 and 22 sessions on wide ranging issues. The presentations and discussions at these sessions covered ground much beyond what is reported in the sector vision reports. Some conclusions were attempted in the sessions, but they were not necessarily discussed and agreed to by the participants. The following paragraphs attempt to draw and present from the Vision Reports and from the Second World Water Forum deliberations, what is useful for ICID. Essentially the Forum provided a platform for all the stakeholders to air their views, to meet with, listen to, convince them or get convinced from people with different shades of opinion.

II.2 FINDINGS OF THE SECTOR VISIONS FOR ICID

The sector vision WFFRD comprises: a world of healthy people with adequate nutrition and secure livelihoods through agriculture in irrigated, rainfed and drained areas operating on a sustainable basis with an equitable access to resources in a fair price environment, using water efficiently; vibrant rural communities living in a secure environment for education, social services, employment, access to food, transportation and communication, market and economy. The formulation of the vision took into account the driving forces of growing population, shift in composition of cropped and livestock based foods, urbanisation and industrialisation, falling energy costs, advancements due to biotechnology, genetically modified foods, remote sensing, information technology, market based economies, world trade, ecosystem approach, and impacts of likely climate change.

The sector vision for 2025 envisages decline in the rate of increase of cereal yield by 1%, increase in cereal area annually by 0.25%, additional water supply for agriculture by 15 to 20% from investments on new large and small besides ground water storages, special strategy for rainfed areas. It also envisages improved water management practices, improved water and power pricing, utilisation of return flows, increase in water productivity, better management of shared river basins, setting up of basin organisations, agro-processing industry in high yield agricultural areas; research and development support for use of poor quality waters - productivity - improved crops to resist drought, salinity, impacts of agricultural chemicals, etc.

The sector vision for people dwells upon harnessing peoples' energy and creativity, advocates a holistic approach, environmental sustainability, governance and leadership. The sector vision for nature dwells upon economic security through environmental and social security; highlights ensuring survival and continuance of intrinsic values of eco-systems, by way of providing goods and functions which are difficult to replace, envisages reversal of degradation indicated by desertification, drying of rivers, falling ground waters, loss of wetlands and biodiversity. It also advocates an ecosystem based approach, empowerment of people, raising of awareness and good governance.

Findings such as these, from the sector visions have been included in the Agenda for meetings of Work-Bodies of ICID at Cape Town.

II.3 ANOMALIES BETWEEN WATER FOR FOOD AND RURAL DEVELOPMENT REPORT AND WORLD COMMISSION ON WATER AND STAFF REPORTS

The WFFRD and WCW reports recognise at philosophical level, freshwater as a scarce commodity, a basic need with access to the poor; advocate a holistic, systemic, integrated approach for Water Resources Management (WRM) while accounting for ecosystems integrity; emphasise need for participatory, innovative institutional mechanisms involving youth and women; full cost pricing, new subsidy programs and bridge financing; suggest role for Governments as facilitators or enablers; and need for strong and quality databases.

On detail however, the WCW report inexplicably reverses WFFRD findings and envisages: -limit on expansion of irrigated agriculture, -full cost pricing, -scales down need for additional withdrawals from sector vision figures from 15 - 20 to 6 - 9%, storages from 13 to nil % and additional irrigated area from 31 and 17.5 to nil %, -pegs annual funding requirement for agriculture at the level of US$ 30 billion at both 2000 and 2025 while sector vision WFFRD would need much higher level of funding.

The scale of investment on water for agriculture is brought down in the WCW report from present 45 to 18% only in 2025 without explaining the logic. The reasons for the reversal of findings of sector WFFRD are not mentioned. ICID has been a party to the WFFRD process and largely supports its findings but does not understand and hence can't support the watering down of those findings by the WCW.

II.4 FINDINGS OF INTEREST FROM DELIBERATIONS DURING THE SECOND WORLD WATER FORUM

The more than 80 sessions held in the Forum covered vast ground related to all facets of water. Although ICID is not directly dealing with some of these subjects, following issues of consensus which emerged are of importance to ICID for future charting of the course of actions and hence are recapitulated:

- assessment, monitoring and preparations for facing likely impacts of climate change on water availability - increase in floods and droughts - sea level rise - melting of snow and glaciers - desertification; water scarcity indicators as recently expounded by IWMI;

- need for integration of water resources development and management; need for both supply and demand management according to level of development - growing needs due to economic development and population growth of countries; need for different sizes of dams in a basin and in case of very large river basins - a sub-basin approach; scheme efficiency vis-à-vis basin efficiency and its optimisation;

- basinwide ecosystem approach; ensuring sustainability of human systems with ecosystems; sustainability is equivalent to durability and or resilience in face of natural vagaries and disasters; reclamation of waste lands; increasing water and land productivity by structural and non-structural measures;

- the crucial role played by large dams; critical role of dams in generation of hydro power and flood control; besides regeneration of ecosystems in hostile environment; need for inter-basin transfer of waters; need for resolution of problems related to water sharing within countries and between countries sharing rivers, interdependence of surface and ground waters and need to harness them optimally and conjunctively; artificial recharge of ground water where cost-effective;

- need to improve both surface and groundwater quality from both point and non-point sources of pollution; adoption of 'user pays', 'polluter cleans or pays' and 'equitable cost allocations' principles according to level of economic development and poverty level;

- level of cost recovery, balancing of prices of food- subsidies- water pricing keeping in view the need to support poor and marginal farmers; Integrated Water Resources Development and Management (IWRDM) and linkage with poverty alleviation; need for social audit;

- disallowing diversion of water from food crops to high value crops at the cost of food self sufficiency; limits of world trade in food; stakeholder participation, involvement of youth and women, lesser role for Governments as providers.

III. ICID'S CONCERNS

ICID's mission comprises 'Managing Water for Sustainable Agriculture' and ICID is dedicated to enhancing the worldwide supply of food and fibre for all people and productivity of irrigated and drained lands, by improving water and land management besides management and control of flood affected lands. The WFFRD and the entire vision process went far beyond ICID's field of work and hence everything that has been summarised in Section II does not necessarily fall in the ambit of ICID's concerns. For instance 'Rural Development' encompasses a very large scope, of which 'Water for Agriculture' is no doubt a core concern. Similarly 'Poverty Alleviation of Rural People' is a vast subject but everybody agrees that the contribution of sustainable agriculture through irrigation and drainage to poverty reduction is substantial. The Section III therefore attempts to focus attention through following sub-sections on ICID's concerns as distinct from Vision outputs and provides a brief list of issues at the end of each sub-section.

III.1 WATER AVAILABILITY

Fresh-water is a finite, naturally renewable resource received by way of precipitation, but is significantly unevenly distributed in time and space. Hydro-climatological conditions of a region therefore set the limits for its availability. Countries or regions are broadly considered water stressed when the annual per capita availability is between 1000 - 2000 m^3. With availability below 1000 m^3, a country is deemed ‘water scarce’. In 1990, eighteen countries in the world were ‘water scarce’, a number that could swell to 30 by the year 2025. Most of these are located in Asia and Africa, and are already facing food shortage. Further, there are 12 countries with availability less than 500 m^3. This number too is likely to increase to 19 by 2025. More than 1 billion people including one third of the population of China and India live in arid regions facing water scarcity. Similarly, 350 million people mostly in Sub-Saharan Africa face severe scarcity, and can't do without embarking upon massive water development projects to meet with their water needs.

These criteria of classification are however based on water quantity flowing down in rivers. Such bases indicate the potential availability. But they don’t consider how much proportion of the potential is useable, developed and how much is put to beneficial use, especially due to inability of some countries to impound it. If such quantum is considered and developed, the present assessment would change significantly.

IWMI had for the first time in 1998, studied water requirements and withdrawals anticipated in 2025, against the availability status, for a sample of 116 countries. Assuming significant increase in water use efficiency in irrigation, the study computed the need for facilities enabling additional withdrawal of water resources for these countries, which were clubbed into five groups. The study indicated significant need for additional withdrawal of waters in country groups I to IV, while indicating a need for attending to water management for all the groups. China and India, together accounting for the world’s 40% of population were not included in this grouping. They being very large and having highly variable water availability in time and space, were planned to be studied by IWMI in greater detail.

In a subsequent study, IWMI considered 45 selected countries and grouped them into 3 basic categories of projected water scarcity.

Group I : Consists of countries that face physical water scarcity, i.e. these countries do not have sufficient water resources to meet their agricultural, domestic, industrial and environmental needs in 2025, even if highest feasible efficiency and productivity of water use is ensured. Indeed, many of these countries can not even meet their present needs. This category includes countries in Middle East, South Africa, and drier regions of western and southern India, and north China, covering 33% of total population. The only option available for these countries is to invest in expensive desalinisation plants/or reduce the amount of water used in agriculture transfer to other sectors and import more food.

Group II : Represents countries that do have sufficient water resources to meet 2025 needs, but which will have to increase water supplies through additional storage, conveyance and regulation systems, by 25% or more over their 1995 levels to meet their 2025 needs. 45% of the total population live(s) in these countries.

The countries of Groups I and II together will account for 78% of the world population in the year 2025.

Group III : Consists of countries that need to develop less than 25% more water supplies to meet their 2025 needs, which will not be a problem as most of these countries are developed countries and cover 22% of the population.

Asia has a large variability in water availability due to the monsoon climate, which creates significant seasonal and spatial variations. Mongolia, Northern China, and Northwest and South India are some of the most water short regions of the world. Though some countries like Laos, Myanmar are water rich, on ‘per capita’ basis, many regions of Asia are already experiencing water stress. Central Asia is already using 85%. South Asia 48%, Northern China and Mongolia 25% of available water resources. Groundwater is also being used at places excessively both for drinking water and irrigation. Dependence on ground water supplies has reached about 35% in Bangladesh, 32% in India, 30% in Pakistan, and 11% in China.

In case of East and South Africa, the region’s withdrawal is only 4% of its total renewable water resources. The rainfall is highly unreliable due to its spatial and temporal variability resulting in frequent crop failure. The entire region can be classified as economically water scarce with the exception of South Africa, which is physically water scarce. The region has number of important shared rivers, which would require massive investment for development with international cooperation. The West African region also be classified as economically water scarce, suffering from extreme variability of availability which is getting reduced on per capita basis, due to rising population.

Most of the Middle East and North African countries have an arid or semi arid climate. Availability of fresh water per capita is decreasing as population grows and water resource development has reached a ceiling in many countries. Fresh water resources vary from a low of 220 m^3 per capita in Jordan and 330 m^3 per capita in Palestine to 2000 m^3 for Turkey and Iran. The last two countries, however, contain regions with severe shortage. The region has four major international rivers – The Nile, Euphrates, Tigris and Jordan, on which major irrigation development is based. International cooperation shall be required for equitable development and sustainable management.

Europe has, in general, sufficient water resources to satisfy the needs of different users. The major part of the European continent is situated in the temperate humid zone. The mainland of Europe is blessed with precipitation throughout the year, although with decreasing quantities from west to east. However, far North and South do show a negative water balance. Irrigation management in South, Central and East Europe holds a dominant role within the group of water users.

The Americas contain some of the world's largest rivers and the countries sharing these rivers are generally "Water rich". Canada, USA, and a few other countries of the Americas as per IWMI, belong to the group, where available water resources are adequate. However, regional and temporal variations make even parts of these countries suffer from droughts, while on an annual basis, only 1% of the total volume of water is withdrawn in South America.

United States has some of the highly productive rainfed lands in East and Mid West. Irrigation is extensively practiced in the three regions – California, the Pacific Northwest and the Great Plains. While the 1st two regions depend upon surface water withdrawals from rivers, the Great Plains are underlain with vast reserves of groundwater, which have been extensively exploited for extending irrigation. Throughout North America, ground water accounts for a significant portion of freshwater withdrawals. Mexico and USA are particularly reliant on ground water, which accounts respectively for one third and one fifth of freshwater abstractions. However, over exploitation of ground water in United States, is now giving rise to some concern as well.

The increase in population and continuous change in water use patterns causes increase in demand for water, resulting in decreased per capita annual water availability. While per capita availability indicates a country's potential, the state of its utilisation indicates the level of development achieved and efficacy in its use. Even where water is available, the level of withdrawal depends upon the technological capability, the state of economy and the level of investment in the water sector. Most countries with limited availability, suffer from serious handicaps of economic development in general and food production in particular, making them dependent on import of food to feed the often large and rapidly growing population. Demands by rapidly growing industry and urban sectors, on the other hand, are causing reduction in availability for agriculture. This is particularly true for countries of East and South Asia where urban population is likely to increase by 50% by 2025. These countries have a climate dictated by monsoons, where significantly high and intense precipitation during limited rainy days in a year, results into heavy runoff, which can't be used. The global climate change is being studied by the Intergovernmental Panel for Climate Change (IPCC). The UN agencies are also keeping track of desertification processes and ways to combat them. The likely increase in variability in precipitation will cause increased need for storages - large and small. Also the possible increased snow melt and sea level rise will need close monitoring and call for simultaneous advance plans for mitigation.

SUMMARY: Water Availability

Regionwise estimate of water availability is to be fine-tuned in light of the latest work by IWMI through PODIUM. Ideally basin approach would be desirable. Inter-basin transfer will ease regional shortages in several cases. Surface and ground waters are inter-dependent and constitute total water availability. They have to be assessed and planned for conjunctive use. Artificial recharge of depleting groundwater storage is required where surface availability exists and where it is cost-effective. Likely changes in global climate could affect availability in different regions. Also they could affect variability in availability and incidence of floods and droughts. Preparations to meet with such eventualities are necessary.

III.2 NEED FOR INCREASING WITHDRAWALS TO BRIDGE MISMATCH BETWEEN DEMAND AND SUPPLY

The present global water use for agriculture is about 70% of the total. As demands rise in all the sectors, the proportion would change. The potential water resource available in various regions and countries to meet the requirement of 2025 is extremely varied. Many people argue for transfer of irrigation water to other sectors by improving water use efficiency. They also claim that demand management instead of supply management will solve the problems. What has become apparent during the vision study for WFFRD is that supply and demand management has to go hand in hand for removing the mismatch.

According to IWMI, as compared to 1995, 31% more gross irrigated area would have to be brought under cereal cultivation. The IWMI study quantifies as indicated in the previous section perhaps for the first time, the need for increasing withdrawals ranging from 20% - 25% for most of the countries of the developing world. Globally, water supplies used in agricultural would have to be augmented by 15 - 20% over the next 25 years, even under favourable assumptions regarding improvements in irrigation efficiency and agronomic potential to meet food requirements. Such withdrawals with the help of storages, basin by basin, could help remove the mismatch between variable in-stream availability and demand besides meeting soil moisture crop requirement for crops round the year. Links may have to be provided between reservoirs to transfer water to cater to needs of deficit areas within a basin or across the basin boundaries.

Though considerable scope for exploitation of ground water still exists especially in surplus surface water areas, it would need substantial investments on energy. A large component of groundwater is derived from surface water and hence both need to be considered conjunctively as renewable resource for optimising availability and use. Where surplus surface water which can't be stored runs off to seas, catching it and using it for artificial recharge of ground waters can be adopted in cases where such a storage is required and reasonably possible. Watershed development is a relatively economic option, but its efficacy about quantities of water that can be recharged is severely limited.

A discrete mix of mega to micro-scale surface water storages in addition to insitu conservation measures are called for to augment availability in a cost-effective manner. The in-stream availability and need for storages varies for countries within a climatic zone viz. arid/semi-arid, temperate humid and humid tropical. In each of these zones the strategy has to be different for rainfed and irrigated areas.

Besides developing storages, augmentation of availability has to be achieved by improving efficiency of application in irrigated agriculture. Availability can also be augmented by recycling the used and wastewaters after due treatment.

SUMMARY: Need for increasing withdrawal.

There is an expected need for global increase of withdrawal of 15 - 20% of waters from surface and ground for providing irrigation to larger areas during the next 25 years. Assessments for regions and basins based on water and salt balance approaches are required. Availability is to be augmented by new storages, by increasing water use efficiency, by recycling otherwise wasted waters and by deploying poor quality waters. For rainfed areas, better watershed management may assist augmentation, but the effects are expected to be only marginal.

III.3 FOOD SECURITY, RURAL DEVELOPMENT AND LIVELIHOOD THROUGH IRRIGATION, DRAINAGE AND FLOOD MANAGEMENT

The rise in population in developing countries is much more rapid as compared to the developed world. For instance in 1960, out of the world's 3 billion populations, 67% was concentrated in the developing world. The rising trend has been maintained as more than 80% are expected to live in developing world in 2025. The majority of these people will live in flood prone areas. This has critical implications for food requirements, labour supply, and per capita land availability besides fresh water availability. With nearly the same water and land resources base, we shall have to grow enough food to additionally feed 2 billion people, considering the increased demand resulting from expected increase in the standard of living, there will be need to double the level of food production. In addition, this calls for flood control, flood protection and drainage measures to a significant extent.

Bulk of the population in the developing world lives in rural areas. The proportion is reducing gradually. Also, the proportion of population employed in agriculture will gradually reduce due to its shift to the manufacturing and services sector. This also would cause greying of people engaged in agriculture. Still, the thrust of these sectors will continue to be towards agriculture. A small minority of the rural people in the developing world owns large farms. Majority has small land holdings. Others are landless and work as labourers in farm related activities. But the rural population is predominantly poor, unlike in the developed world, where the rural areas have developed fast by adoption of advanced technology in agriculture early on due to the industrial revolution and provision of irrigation and/or drainage facilities wherever needed and possible. Many countries equate poverty only with calorie intake through food for adequate nutrition. Rural development and a secured livelihood for rural populations of today, therefore, are synonymous with eradication of poverty through employment generated from agriculture and related activities. Extension and modernisation with replacement of ageing systems to maintain sustainability of irrigation, drainage and flood protection alongwith other concomitant inputs are essential for this purpose.

Agriculture needs water, which is provided by rainfall fully at some places or in excess in some lands. In these cases, drainage of land is required to enable agriculture. In the latter cases where needs are partially met with by rainfall, supplemental irrigation would have to be provided through wells, canals, ponds, and tanks either by gravity flow or by pumping. Moisture in the soil profile being essential for dry food crop production, its availability has to be maintained at a desired level by replenishment either through local conservation measures or by irrigation, otherwise moisture stress leads to not only reduction in yield but sometime even to complete loss. For paddy cultivation generally a water layer of certain depth has to be maintained on the field. For rainfed agriculture, where failure of rainfall or long gaps between consecutive spells of rain ruin a crop, measures to increase moisture retention capability like tillage, mulching, etc. are often deployed. Supplemental irrigation however becomes necessary for survival of crops even in humid tropics in winter and summer if rains fail. For the arid and semi arid areas, irrigation is an essential input for farming, even during the rainy season. The provision of irrigation facilities which can make all the difference to a good harvest and watershed development of rainfed areas, together make the agriculture in a river basin sustainable and productive.

Irrigated agriculture provides 40% of world’s food production from 17% of cultivated land. In regions of water shortage, yield of irrigated land often is more than 2 to 3 times that of rainfed agriculture. The critical role of irrigation for food security in arid and semi arid areas is evident from the fact that almost one third of the globe area is accounted by arid and semi arid areas and yet the world has been able to largely feed its billions. Even in temperate and humid zones, although crops can be grown, timely irrigation during critical periods of growth, when plant is most sensitive to soil moisture deficit, yield of crops may double or even treble. In case of rainfed cropped areas, if assured or even supplemental irrigation is provided, it can make significant contribution to food production. The World Food Summit in 1996, estimated that 60% of extra food required to sustain the world in future must come from irrigated agriculture, which needs more investments and sustained efforts at expansion and improvements. The vision WFFRD also has similarly estimated increase in irrigated area even after assuming significant increase in water use efficiency. The challenge of improving the lot of poor rural population hinges on the success of these efforts. Rainfed areas with favourable soil moisture regime are already producing good yield of food crops. Rainfed areas which are water rich can grow additional food crops only with installation and improvement of drainage systems. Water deficit rainfed areas need exogenous water supplemented to a possible extent by rainwater harvesting.

While water is an essential input for agriculture, it also needs other inputs like fertilisers, pesticides, seeds, cold-storage, animal power, animal husbandry services, market, transportation, electric power, credit, agricultural implements and services for maintenance. Even when productivity is enhanced by different inputs such as mechanization, fertilizers and pest control, the potential benefits can not be attained under excess moisture or salt concentration in the root zone. Thus investment in drainage not only has its direct impact of increasing crop yield but also maximizes the benefits from other inputs. The irrigation and drainage schemes therefore not only play a critical role in increasing crop yield and improving rural household income, but also help in accelerating the pace of development of rural infrastructure through improved communications and road systems, better healthcare, education facilities for rural communities. Irrigation canals often serve as the only source of potable drinking water for the rural areas of the developing world. Properly functioning drainage channels may improve sanitation and disposal of wastewater in rural areas, where applicable.

The planning for achieving the objective of food security in several countries must also focus on rural poverty alleviation, and generation of employment opportunities. Both have contributed to economic growth of such societies. Irrigation has played a major role in poverty alleviation and protection of rural people from natural disasters like droughts and famines. The poor landless segments have better employment opportunities in construction and maintenance works of irrigation schemes. The increased agricultural production mostly from irrigated areas and overall infrastructural improvements act as powerful magnets to attract investments in rural agro-based industries. The rural development has become synonymous with agricultural development. The close linkage becomes apparent every time drought strikes an agriculturally predominant area or a State, when the whole rural economy comes to a grinding halt due to set back in agricultural production. It has also been experienced that the lack of assured irrigation leading to unsatisfactory returns from agriculture, coupled with other handicaps, has caused growing tendency for switch over to non-agricultural occupations and migration from the rural to urban areas in search of better employment. The multiplier effect of irrigation arrests this tendency and helps improve even the urban environment because of reduction in pressure there, on the already dwindling water supply and other infrastructural facilities and helps maintain the ecological balance. In some water scarce areas, the available potential of water resources has still not been tapped due to several reasons including financial weakness. These causes have to be obviated. The absence of appropriate measures makes such areas more vulnerable to scarcity and growing demands due to population growth.

Among the world's poor, more than 800 million people do not have adequate access to enough food. This number would increase as the world population is set to reach 8 billions by 2025. With most of the increase occurring in developing countries, food needs in these countries would result in great pressure on the agricultural sector to increase overall production and yield. Though advances in bio-technology and genetic engineering may help to increase food production from available land and water resources, the irrigation and drainage expansion and modernisation shall have to play the pivotal role in increasing the food productivity per unit of land and water, as in past especially in the latter half of the 20th century. It is however necessary to ensure that irrigated agriculture remains a sustainable endeavour by addressing the problems of salinity, waterlogging, institutional deficiencies in ensuring equitable distribution of available water amongst all users and environmental sustainability. Such strategy would ensure that the production in food grains is not outpaced by the population growth. To maintain food security, sustainability or durability or resilience has to be ensured. One can look at sustainability: of infrastructure created; of resource base of land soil and water; of institutions created; of ecosystems and most importantly of people and their capacity to carry poverty or poverty alleviation.

SUMMARY: Food security, rural development and livelihood through irrigation, drainage and flood management

Ensuring global food security calls for priority for increased production at already cultivated land and to a significant extent for increase in withdrawals besides increase in water use efficiency, improved irrigation management, etc. The objective of 'Food self-sufficiency' is dominating planning and will continue to dominate it in the developing world for rural development. Ensuring sustainability of resources, facilities created, product of IWRDM, is central to the food security and in turn to poverty alleviation and protection from famines, etc. Adequate operation and maintenance, modernisation and where required replacement of old schemes and most importantly addition of infrastructure constitutes the core programme for the future.

III.4 STRATEGIES FOR IMPROVING WATER PRODUCTIVITY IN IRRIGATION

In the developing countries, while significant efforts are directed towards facilitating expansion of irrigated area through additional withdrawals by building storages and or diversion structures where practicable and through optimised use of ground water, attention is to be paid for improving the on-farm water management between desired water use efficiency and the one actually realised by improved technological interventions. Strategies have to be developed not only for ensuring maximum productivity per unit of water and unit of land but also to reduce the substantial gap between irrigation potential so far developed and utilised.

Some claim that water scarce countries should aim at only high value crops for export while importing low value food crops, thus meaning import of virtual water. On the face of it, the concept sounds good but it has to be considered in depth in context of poverty incidence in such countries.

Whereas increasing water productivity calls for considerable changes in crop varieties, adequate steps are necessary to transfer the already developed and tested irrigation and drainage technologies from the developed world to the developing countries. An IWMI study of 50 irrigation systems round the world shows a wide variance in productivity. Considerable improvement in productivity is possible in some large systems with well-designed inputs. For example, in India an average increase of yield from 2 to 4 ton/ha is achievable and would have to be achieved. It could make vast difference to the status of food sufficiency.

Some of the available options for improving the productivity of irrigated lands are listed below:

- establishing water users organisations for better involvement of farmers in management and collection of fees, reducing irrigation subsidies and/or introducing conservation oriented pricing, strengthening the training and extension services for dissemination of efficient technologies; in short deployment of technologies involving a discrete combination of structural and non structural measures is essential;

- improved operation and maintenance of irrigation and drainage systems. Using controlled groundwater table management to conserve water and improve the quality of drainage effluent;

- employing better techniques of water application like furrow irrigation instead of traditional flooding. Furrow diking techniques help promote soil infiltration and reduce runoff. Employing surge irrigation techniques even in furrows gives better results;

- adopting water conservation methods like tillage, to reduce evaporation from land or changing the planting dates to match with periods of low evaporation rates and improving drainage by surface or sub surface methods and recycling of drainage and tail water;

- increasing use of pressurised irrigation, sprinkler and micro irrigation systems, instead of open gravity flow to apply water more uniformly, taking advantage of already developed low energy - precision application – systems to cut evaporation and wind-drift losses. Adopting better irrigation scheduling and improved canal operation to ensure supply, when it is most crucial to crop's yield;

- involving private sector companies in developing cost effective technologies and their promotion particularly in developing countries;

- promoting and adopting results of agronomic researches like:

    * selecting crop varieties with high yield per unit of water;
    * switching from crops consuming more water to those consuming less i.e. better matching crops to climate conditions and to quantity of water available;
    * sequencing crops to maximise output under conditions of soil and water salinity;
    * introducing water efficient crop varieties.

SUMMARY: Strategies for improving water productivity in irrigation

More crop per drop and per unit of land has to be the joint strategy. The gap between potential created and that utilised is to be narrowed down urgently through structural and non-structural measures. Shift from food crops to high value crops depends upon self-sufficiency needs of a country. It will be gradual with increase in productivity in cereal production. World trade in food is barely 10% of the total production and is showing signs of reduction. Achieving domestic higher productivity by shifting agricultural labour force to other sectors, by modernisation of agriculture and by land reforms is necessary. Establishment of Water Users' Associations and transfer of the operation and maintenance of distribution systems to them is necessary on a large scale.

III.5 BASIN PLANNING FOR INTEGRATED DEVELOPMENT AND MANAGEMENT OF WATER RESOURCES (IWRDM)

Water flows through river systems across political boundaries. There are several countries relying on flows arriving from upstream countries. For example Bangladesh, Egypt, Iraq, The Netherlands, Syria, Turkmenistan, and Uzbekistan depend on upstream countries for two thirds or more for their surface waters. Conflict often arises if water sharing between upstream and downstream user countries is not agreed to jointly and if excessive withdrawals are effected. In a growing number of shared basins, enough water to meet demands from basin countries is not available. In such situations, the option for them is to aim at integrated development on techno-economic and social considerations through dialogue both at governmental and non-government level. Similar situations do occur even in shared basins within countries. River basin conflicts in such cases can be tackled by the IWRDM approach through river basin authorities charged with adequate powers to adjudicate and implement decisions. For large basins, the approach can be even applied for sub-basins as has been shown successfully in countries like India and China. For the integrated development of water resources, a perspective plan for diverse uses of water at the river basin as well as sub-basin levels needs to be prepared. The plan would have to indicate availability of water on a short, medium and long term basis, and the allocations for various uses as per inter-sectoral priority within a political region.

The question of low water use efficiency for individual schemes arises. The IWMI study has recently shown that maximisation of basin level water use efficiency is more important, because it varies scheme to scheme due to various reasons and as long as the excess water is reused in the basin, the objective is achieved. In a water short basin, a joint strategy has to be agreed upon for using water more efficiently, increasing its productivity, for adding high value crops to the crop pattern, and providing additional water for other non-consumptive sectors. Many in-basin or inter-country differences on sharing of water have caused problems in development of water resources. There are however several developments round the world in recent times, such as in the Danube, Indus, Nile, Mekong, Rhine and Ganges-Brahmaputra- and Meghana basins, which are encouraging. A recent UN convention on international watercourses, which is enshrined on the principles of equity, is under ratification.

While allocating requisite quantities of water, the basin authorities have to ensure that the quality is also of desired level. Where degraded, it is to be made good through identification and treatment of flows emanating from point and non-point pollution sources. Where practicable, beneficiation of low quality waters by means of fresh waters would have to be implemented. Most of the non-consumptive uses are amenable to treatment, recycling and reuse. The twin principles viz. "**polluter cleans or pays**" and "**user pays in one form or the other**" if adopted, often pay rich dividends. Most of the pollutants eventually travel into the estuarine regions and often result into the demand for freshwater releases to flush them and take care of local eco-systems. Such releases often prove more expensive than treatment of pollutants at source. Also if done by depriving established utilities, social tensions develop. The pollutants sometimes degrade the ground water. These issues are best tackled through judicious basin plans. Along with IWRDM an eco-system based basin approach often helps.

Surface and groundwater basin boundaries in plains do not usually match. The groundwater resources have multiple tapping points, require pumping, are not transported over long distances like the former and hence are locally used. They however are interdependent and ought to be planned for use conjunctively in a surface basin. Over withdrawals of ground waters exceeding the natural recharge are unsustainable and may cause salinity ingress in coastal areas. In ultimate sense, ground water is expensive, as it requires energy inputs for pumping for supply at demand locations. Basin wide planning alone helps in judicious use of both these water resources.

Cultivated lands and standing crops in several countries round the world suffer damages because of floods arriving from upstream river basin areas, largely due to absence of adequate regulation facilities, by way of storages, lack or failure of flood embankments etc. Deltas and coastal lowlands of many countries face flooding, inundation and or congestion at outfalls into the sea. Some countries also face the fury of cyclones in the coastal areas. They would have to be protected where feasible and politically and environmentally acceptable. In many countries, reclamation of such lowlands has become necessary in view of shortage of arable lands. The schemes for construction of structural measures like dikes and drainage works, their modernisation, raising and strengthening where required would have to be implemented as an integral part of a comprehensive master plan which also provides for non-structural measures wherever feasible to reduce damage potential. The implementation of such plans would ensure integration of basin-wide flood control and drainage to protect the delta zones and coastal area against inundation and congestion of drains.

IWRDM like any other socio-economic activity has positive impacts and may have adverse impacts on the ecosystems. Basin plans would have to ensure that the positive impacts are maximised and negative ones minimised and have to strive for a proper balance between human and environmental/ecological needs. Such balance ensures sustainability of the IWRDM. Environmental issues related with ‘water for food’ are of recent origin. Adverse impacts on environment were there all through. But until recent past, the impacts were not projected. The concerns are many, for which a whole range of acts, laws, guidelines and policies have been or are being formulated and put in practice. They are still evolving and will evolve further during the next 25 years, as the impacts become more critical in some regions.

Lastly, where a mismatch between demand and supply can not be removed by basin approach, interbasin transfers may be adopted. There were many such efforts made in the past and many more will be in pipeline, as within basin development reaches an optimum. In fact at several places, inter-basin transfers of water have been made for a long time, within sovereign countries and sometimes with co-operation between two countries. Such co-operative efforts will all the more be necessary in future.

SUMMARY: Basin planning for IWRDM

IWRDM within a basin in consultation with and with participation of stakeholders ensures speedy realisation of objectives of adequacy of water supplies in requisite quantity and quality. Conflicts on sharing of waters, costs and benefits of facilities also reduce. Maximisation of basin level water use efficiency is important. Integration of mega to micro level facilities, surface and ground waters, of consumptive and non-consumptive uses, of demands and supply is required at basin level and where necessary across basin boundaries. Basin authorities would have to be set up to deal with total IWRDM.

III.6 GOVERNANCE, LEGAL AND INSTITUTIONAL ISSUES

Traditionally, the planning, development, withdrawal, uses and disposal of waters has mostly rested with governments of the individual countries particularly in the developing world. Irrigation of farms by means of water drawn through dams, canals and wells or drainage of waterlogged lands grew with active involvement of institutions and legal procedures set up on drainage by the governments. Functionaries of governments or institutions charged fees for the water supply and recovered them by way of land revenue or in kind, by way of levy in form of farm produce. Water disputes were heard by government or institution functionaries and resolved as per law of the land.

Irrigation, drainage and flood control of agricultural lands, which are all intricately related with ‘water for food’ are likely to be continued to be governed by governments in the countries of the developing world. Legal positions also might not undergo much change, excepting that the concepts of water rights will be debated along-with other rights on natural resources. But the main likely change will relate to basic human rights like right to food, water, employment and livelihood. All required changes in the institutions will flow from these changes. An overall change in complexion of the sector will occur as all shades of rural development activities are woven around ‘water’. While centralisation at apex level because of the scale and range of activities involved will continue, there will be much more decentralisation lower down to facilitate the final use of water for rural development. Even in case of environmental concerns, a holistic view will be possible, if centralisation at national level exists. But it will need complete decentralisation, as one goes to local ground level. On the whole, a much more participatory process involving stakeholders will evolve, for not only the decision making, but also for implementation, operation and maintenance.

‘Water for food’ is a socio-economic proposition after its technological complexities are unravelled and accommodated in the vision. But in many cases, the complexities have hindered economical and efficient use of water. Therefore, institutional reform has become a central issue in the water sector in most of the countries. Following institutional and legal aspects are under debate:

- absence of a comprehensive water policy covering all types of consumptive and non-consumptive uses and institutional arrangements for implementation. A number of countries have accumulated a body of legislations, either in the form of comprehensive water codes or sector by sector legislations like irrigation acts drainage acts, etc. There is urgent need to enact a comprehensive water related land legislation, clarifying surface, and groundwater rights of land cultivators, establishing an appropriate administrative machinery for implementation, etc. This type of legislation is necessary for providing a framework for sound decision making;

- the need for the irrigation sector to not only overcome and face sectoral competition for water, but also to address social and environmental issues. For this purpose, it has to devise a viable policy, adopt appropriate technology packages and project management system and carry out institutional changes and reforms;

- putting in place an appropriate mechanism for conflict resolution both for intra basin and inter basin water sharing and transfers. Tackling equity issues providing for consideration of environmental impacts.

SUMMARY: Governance, legal and institutional issues

Reduction of governmental role in IWRDM from being a provider to be a facilitator, from planning to operation and maintenance, changing complexion of 'Water' as a social good gradually to an economic good. Water rights of people for both surface and ground water use; private or public good. Setting up of viable basin authorities, water users' associations, conflict resolution mechanisms, evolution of guidelines for equitable allocations - sharing of resources - costs and benefits of IWRDM. Water quality preservation acts, laws and guidelines covering policies like 'polluters clean or else pay for polluting waters', 'users in one form or the other', 'recycling and reuse'.

III.7 STAKEHOLDER INVOLVEMENT, YOUTH AND WOMEN'S PARTICIPATION

Irrigation, drainage and flood management works, were undertaken in many developing countries by the governments of the nations as public welfare activities. In many instances, they were started as famine and drought proofing protective measures and were considered as most important duties of the State. Due to this background and due to the complex nature of the issues involved, most of the water development projects in these countries have a 'top-down' planning process at present. In recent past, however, efforts have been made to introduce water management with involvement of the stakeholders in decision making. It is recognised that it will be necessary to strive for creating an environment, where the users are 'empowered' in management of water for the right level of productivity, through the most desired mix of crops, for the well being of the society. Stakeholders basically will be increasingly involved in decision-making processes, so that they also feel and can be responsible for the operation and maintenance of a system.

Women generally are not participating in the management of irrigation schemes, while they are equally dependent on irrigation water for their farms, where they put in lot of labour. They manage the domestic requirement of water including that for vegetable gardens as well as tending of livestock. They have to be provided a big say in water management through water users associations along-with other stakeholders.

User participation should be a central principle. Water users including women need to be involved in identification, planning, implementation, operation and maintenance, as well as monitoring and evaluation. User participation would need activating existing and setting up of necessary community based institutions. NGOs and women groups can be instrumental in organising water users in the process and ensure that they all share costs and benefits. User organisations, when formed, have to be strengthened by legal backing of 'Establishment' to permit transfer of functions as well as assets, and defined water rights.

SUMMARY: Stakeholder involvement, youth and womens' participation

Evolution of guidelines for stakeholder involvement from basin down to a village level. Mobilisation of youth organisations from data gathering to acting as watchdogs or from acting as bare-foot engineers to creators of public awareness. Proportionate reservation for women at all levels of administration, policy formulation and financial management.

III.8. FINANCING INTEGRATED WATER RESOURCES DEVELOPMENT AND MANAGEMENT, MODERNISATION, REHABILITATION AND REPLACEMENT

Basin wide IWRDM calls for correct assessment of both surface and ground water resources at basin and sub-basin level, in terms of quantity as well as quality, their sharing, development, conservation, abstraction, recycling and reuse, in context of equity for users. The IWRDM thus encompasses formulation of a financing policy, from development of 'water master plans' to ensure optimum utilisation and implementation, to pricing, cost recovery, and ensuring adequate finances for operation and maintenance, safety, modernisation, and replacement. Financing is required at all stages of IWRDM. It covers institution building, capacity building, decision support systems, information technology, automation, research and development, economic analysis, risk analysis and other aspects.

All these issues call for provision of adequate resources in the overall planning and be considered as an investment in future prosperity for which besides the national Governments, public participation and well-designed privatisation will help. Multilateral and bilateral funding although it concerns less than 10% of total investment may act as catalytic agent for resource mobilisation. While it is desirable that the whole irrigation and drainage sector be run as far as reasonably possible on economic lines, by way of generating revenue from the services provided to sustain the services and future development needs, this is not easily possible in developing countries due to prevailing socio-economic conditions. It is also necessary to note that most of the developed world has been blessed with favourable climatic conditions which allows them to grow crops under rainfed conditions. Further agriculture is also highly subsidised. As such the production from irrigated agriculture in developing countries if subjected to full cost recovery principles will be much costlier. The predominance of small landholders and a large force of unemployed landless make the problems more difficult to handle. There is a widespread fear that treating water as an economic good in these countries can result in cash-rich industrial sector purchasing as much water as possible regardless of the price of water, reducing its availability for agriculture and thus endangering food security. The issue of cost recovery or pricing is to a certain extent linked to the economic status of a country, though partial or preferably full recovery of the operation and maintenance component will have to be the objective. The concept of full cost pricing or recovery is to be seen also from the point of view of subsidised global food prices, their impact on poor and marginal farmers of developing countries and food sufficiency - security concerns of large countries. The approach will have to be extremely cautious.

Large scale funding is required to provide for projected additional withdrawals of water as well as for the requirements regarding drainage and flood protection. But on the water management side, again lot remains to be done. Lack of regular annual maintenance results in systems falling into disrepair, increasing thereby the likelihood of breaches, and silting of distribution channels and congestion of drains. There is urgent need for modernisation of several large irrigation schemes in Asia besides replacement of old schemes, which will not only improve efficiency of performance, but also result in water savings which can be used for bringing more areas under irrigation which were uncommanded earlier. Financing of such schemes has a great potential to increase agricultural production. Sometimes, relatively small outlays on modernisation for instance on head-works, distribution structures and drainage outlets, can help raise production substantially even in small irrigation schemes. Participatory approach whereby farmers get motivated to offer their services in kind, if not in cash, helps greatly in modernisation efforts and have to be attempted in a big way in future.

The vision WFFRD envisages need for a higher level of funding for the irrigation, drainage and flood protection sector in the next 25 years. One estimate calls for enhancement of present level of funding for irrigation by at least 40%, not only for new infrastructure but also for replacement, modernisation of ageing systems and imparting sustainability to them.

SUMMARY: Financing IWRDM, modernisation, rehabilitation and replacement

The water for food sector needs to enlarge withdrawals within the next 25 years by 15 - 20%. This calls for massive increase in investments from government and non-government sectors. Where high value crops are possible, private investment also will be viable. Basinwise assessment of requirement of funds needs to be made, especially for operation and maintenance, safety and sustaining serviceability of infrastructure. Especially in developing technologies, transition may be expected from government funding to stakeholder funding for operation and maintenance. However, for modernisation, replacements and new construction, a significant part of funding will still have to come from governments. Donor funding would have to be directed towards the support of these processes and developments.

III.9 EQUITY, EFFICIENCY AND ECONOMY

For IWRDM to become sustainable, it ought to have three important components, viz. equity, efficiency and economy in services provided. The three are interdependent. They bring in optimisation in use of natural resources, increase productivity per unit of land and per unit of water. They ensure that the fruits of IWRDM reach all stakeholders in an equitable manner when needed through supply of water when, where and in right quantity.

Low water use efficiency can be attributed to low level of on-farm irrigation technology, land management as well as deficiency of operation and maintenance. Lining of canals and distribution system or use of low pressure pipes for distribution wherever feasible as well as introduction of efficient on-farm facilities and practices can help achieve better efficiency. Adequate and efficient drainage is necessary to sustain high crop productivity and conserve land resources. It is also necessary to set up a system of real time monitoring of flows and water demand. Adoption of water saving sprinkler and drip irrigation systems may help to achieve not only better utilisation of scarce water resources, but also better output of crops due to application of the correct quantum of water at the critical stages of growth. Utmost economy in deployment of financial resources will therefore be a key word in the future. It would mean need for enhancement of productivity, water use efficiency, reversal of degradation of land and water resources already deployed. It also would mean enhancement of standards for new areas of irrigation and drainage and sustainable development of the rural area, for which financial resources ought to be earmarked.

IV ICID’s STRATEGY FOR ACTION

Summaries provided at the end of each sub-section under Section III, have brought out issues which are close to ICID's concerns. The following paragraphs lay down what will be the strategy of ICID for enabling action on the issues identified.

IV.1 ICID’s GOALS AND OBJECTIVES

ICID was established in 1950 as a scientific, technical, voluntary, non-profit, non-governmental, international professional organisation, dedicated to enhancing world-wide supply of food and fibre for all people by improving water and land management. It encompasses assessment and deployment of appropriate techniques for irrigation, drainage and flood control/management for increasing productivity through natural resources, while taking care of environmental concerns. The activities are pursued in accordance with the ICID constitution and bye-laws last revised in 1996. The ICID mission comprises stimulating and developing application of arts, sciences and techniques of engineering, agriculture, economics, ecological and social sciences including research and development alongside capacity building for achieving sustainable irrigated agriculture.

ICID operates through over 86 strong membership of National Committees, each having its own independent autonomous set-up. They make up the International Executive Council (IEC) which elects one President and nine Vice Presidents as honorary office bearers, besides the Secretary General who is a full time office bearer of the ICID. The business of the ICID is conducted by the Central Office located in New Delhi, India under the supervision, direction and control of the Secretary General. ICID’s work is carried out through Permanent Committees,

Committees, Working Groups, Task Forces etc. as authorised by the IEC. The Central Office facilitates work of the Work Bodies and National Committees, in organising international meetings - conferences - congresses, seminars etc., and brings out various relevant publications.

IV.2 DISSEMINATION OF COUNTRY POSITION PAPERS IN EACH COUNTRY

Preparation of a global vision for water in the sector WFFRD was entrusted to a group of institutions viz. ICID, IWMI, IFPRI, IPTRID, ICARDA, FAO and others. ICID with its global network of National Committees undertook to build the global vision based on building blocks of country position papers, which were synthesised in eight regional visions. A Task Force led by Mr. Aly Shady, evolved guidelines to be used by National Committees for framing the Country Position Papers. About 41 countries accounting for about 75% of cropped area of the world, produced such documents on the basis of a consultation process evolved by the Task Force.

As most of the Country Position Papers were the best drafts that could be made in limited time frame that was available, further elaboration and local consultations would be required to bring the papers to such a level that they could be used as a basis for policy making. They will also need to be updated from time to time taking into consideration the changing local scenarios in IWRDM.

IV.3 CONSIDERATION OF SECTOR VISION AND FRAMEWORK FOR ACTION IN WORK-BODIES OF ICID

Some of the ICID work bodies are working on these aspects of the Sector Vision. They will be regionally holding consultations, based on the feedback received from the Country Position Papers and arrive at appropriate strategy for dissemination of experiences and information.

Based on the prepared visions, and discussions held during the Second World Water Forum, the following guiding principles emerge which have relevance for further policy development and implementation of action points during the next 25 years:

- to cater to the projected rise in the worlds population from 6 to 8 billion, which will mostly be in the developing countries, food production shall have to be doubled in the next 25 years. As brought out in Section III, bulk of this increase will come from expansion and intensification of irrigated agriculture, which calls for sustained efforts;

- development and management of irrigation and drainage systems as well as flood management strategy must form an integral component of the rural development strategy within the parameters of the concept of IWRDM. This will not only result in a viable rural development model, but also will help achieve poverty reduction in the rural areas;

- institutional reforms aimed at stakeholder controlled operation and maintenance are necessary, not only to achieve the required increase in food production but also to enable the habitants of rural areas to have an humanly acceptable standard of living to prevent deprivation due to poverty and involuntary migration to urban areas or switch over to non farming vocations.

The workbodies of ICID will integrate the guiding principles, policies and action points in their rolling plans for implementation.

IV.4 WIDE DISSEMINATION OF WORK ALREADY DONE BY ICID

ICID, through its sustained efforts during the last 50 years, has brought out several publications, which do cover many of the issue highlighted/identified through the vision process. These publications can serve as valuable source of background material, on different aspects, some of which might even have been missed during the hectic vision process. These reports will enable stakeholders in the National Committees to understand the importance and scope of work done. ICID's own webpage has been operationalised during this year for dissemination of all such useful information. A Text Delivery Service (TDS) has also been transferred to the Central Office by the International Program on Technology and Research in Irrigation and Drainage (IPTRID). It is being strengthened presently. ICID has also planned to promote the information network for its National Committees, along with installation of complementary TDS facilities. It is hoped that the information and communication technology advances that would be available during the coming years, will greatly enhance the availability of relevant information for the stakeholders in the ICID associates.

IV.5 PROPOSALS TO MOBILISE FUNDING

It is planned to approach the multilateral and bilateral funding agencies around the globe for promoting activities through the National Committees, the Work Bodies and the Central Office. It is proposed to build strong linkages with the UN sister organisations, CGIAR Institutions and water and agriculture related governmental institutions, especially in the developing world. There are several regional outfits/groupings of countries for addressing socio-economic issues of different continents, which also will be able to support activities to be taken up by ICID. Several proactive steps are being initiated for technology information transfer, capacity building and information dissemination.

IV.6 MONITORING, REPORTING AND REVIEW OF PROGRESS ON PROPOSED ACTIONS

After conclusion of the Second World Water Forum, the Central Office is trying to facilitate organisation of several activities with the help of Work Bodies and the National Committees. It is proposed to set up appropriate committees with representation from the participating institutions and organisations for monitoring, reviewing and guidance of the various "Initiatives". Reports will be made to the Work Bodies through the annual meetings. Efforts are in hand to arrange for the organisation of one international workshop and three regional workshops in different continents to chalk out a detailed strategy for action in the immediate future. ICID is represented on the WWC Board of Governors by the Secretary General. President Hon. Aly Shady is serving as Vice President of the WWC. The outcome of the ICID activities would also be reported to the WWC, who is going to monitor activities through their Program Committee.

IV.7 INCREASE IN WATSAVE ACTIVITIES AND RECOGNITION OF EXEMPLARY WORK THROUGH WATSAVE AWARDS

With the highlighting of scarcity of water in many countries during the vision exercise, it is expected that the WatSave activities will get tremendous boost from the multilateral as well as bilateral funding agencies. It is seen during the last 3 years that countries and National Committees have been volunteering and willing to support the ICID WatSave awards. It is expected that not only the amount of award money will be enhanced, but also the coverage of watsave programme promoting new water efficient technologies and management approaches will be expanded. ICID plans to publicise around the world, in a big way, the work of individuals which has merited awards through various fora including ICID's own publications and through ICID's website, which is presently considerably strengthened.

The publication 'WatSave Scenario' brought out during 1998 has generated considerable interest in the global community. The second part covering activities of remaining countries is proposed to be brought out during the near future. The Workshop on WatSave liberally funded by CIDA and being held at Cape Town with the 51st IEC, hopefully will set the tone for promotion of these activities.

IV.8 IDENTIFICATION OF TOPICS FOR FUTURE CONFERENCES

The Second World Water Forum has provided indicators of the concerns of the world community about regions and countries which are likely to be water stressed because of decreasing per capita availability of water, or which are likely to get into a crisis situation during the coming 25 years. It has now become necessary to shift the thrust of ICID from exchange of information and technology to a more proactive and advocacy mode during the next few years.

A very good start has been made during the last two years, about preparation of position papers by ICID's National Committees. The subject of 'dams' and 'water for food' sector vision are two instances in this connection. It is expected that the ICID will be organising conferences, symposia, seminars dealing with more actions on such issues in the areas of irrigation, drainage and flood management. This action-oriented approach will also require more participatory consultations and roundtable conferences, with other allied sectors who participated in the vision process.

IV.9 CO-SPONSORING OF ACTIVITIES FOR IMPLEMENTATION

ICID has always actively collaborated with other water related international organisation and is providing secretarial services for the International Water-related Associations Liaison Committee (IWALC), which is now headed by Dr Chris George of the International Association of Hydraulic Research (IAHR). As a result of the Forum, IWALC is expected to provide a new direction to the Associations. ICID is presently effectively participating in the WWC and GWP, and most of the water related UN organisations. These linkages are expected to be strengthened during the coming years. There is tremendous scope for joining hands with all these organisations and co-sponsoring various activities including those, which focus more on collection of the experiences of various stakeholders and build such database through our National Committees for identifying further line of actions.

IV.10 ACCORDING RECOGNITION TO THE GOOD WORK DONE BY THE NATIONAL COMMITTEES

Several National Committees (NCs) of ICID especially in developing countries are strongly supported by their Governments. The Governments themselves are in the process of reduction of their own role and promoting public participation in the irrigation sector. It is expected that these Governments dealing with the WWFRD sector will play a crucial role with the support of ICID through their National Committees. ICID has set up a Task Force to examine how the broad basing of the National Committees could be achieved. Recommendations of the Committee will be adopted by the IEC after modifications. It is expected, that the broad basing already initiated by several National Committees will form the basis for the recommendations of the TF and hence the new policy will generate active interest in ICID activities by all the National Committees. The broad based National Committees will be motivated to critically examine all the issues brought out in this document and provide inputs to IEC for mid-course corrections in the Strategy. A series of workshops will be planned through the regional working groups of ICID for brainstorming to include all stakeholders, particularly the irrigation water users' and drainage organisations on these issues. The National Committees who provide a lead in this direction will be identified for recognising their role and encouraging such activities amongst other National Committees.

IV.11 MECHANISM TO MONITOR AND EVALUATE IMPLEMENTATION OF THE STRATEGY

The permanent committees namely, the PCTA and PCSPOA will be providing the thrust for actions as identified in this document. They will be setting up a monitoring and evaluating mechanism for implementation of the strategy. The Central Office will provide a much strengthened support role for the 'Strategy for Implementing Sector Vision for Food and Rural Development' for which a mechanism will be put in place soon.

IV.12 TOWARDS THE THIRD WORLD WATER FORUM, 2003 JAPAN

It has been agreed that the Third World Water Forum will be held in the year 2003 in Japan. Issues that in all probability will play a prominent role then will be : how to achieve the required enhancement/doubling of the food production in light of sustainable rural development; and how to identify reasonable mechanisms to attain financial sustainability in irrigation drainage and flood protection;

ICID has already planned the following activities having a direct bearing on these issues.

- the 1st Asian Regional Conference on Agriculture, Water and Environment and related workshops to be held in Seoul, South Korea, 16 - 21 September 2001;

- two events during the 18th ICID Congress in Montreal, Canada, 21 - 28 July 2002, viz.

    * special events regarding the progress that has been made by ICID after the Second World Water Forum;
    * the Symposium on Private sector participation in irrigation and drainage.

In light of this, it is proposed to reconstitute the existing Task Force established to prepare ICID's input in the vision process into a Task Force to guide ICID's preparations for the Third World Water Forum. The Task Force will operate in close consultation with the Japanese National Committee.

Further taking into consideration the trend of discussions during the Hague Forum meeting followed by exchange of views amongst the membership, ICID proposes to set up the following two Task Forces-

(1) Task Force to develop an ICID position paper on global issues related to food production, security and food trade.

(2) Task Force to prepare position paper on the issues of financial and socio-economic sustainability of services provided by irrigation sector.

On approval of the proposal and this strategy document by IEC at Cape Town, the President, ICID will set out the composition, terms of reference and time frames for the activities of these 3 Task Forces.

An important milestone event that will be taking place between the second and third World Water Forum is the UNCSD 10-year review of Agenda 21 adopted in Rio in 1992. Chapter 18 of Agenda 21 is related to freshwater issues with which ICID is closely concerned. It is proposed that the reconstituted Task Force will undertake preparatory work of ICID's concerns and utilise the outputs of the Rio+10 review to feed forward activities of third World Water Forum.

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