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 ($10^9 m^3$/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 ($10^9 m^3$/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 ($10^9 m^3$/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.