

# **Water Policy Issues of China:**

Study Outcomes and Suggested Policy Interventions

## **Country Policy Support Programme (CPSP)**

Project funded by

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The Govt. of The Netherlands  
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**INTERNATIONAL COMMISSION ON IRRIGATION AND DRAINAGE (ICID)  
NEW DELHI**

**AUGUST 2005**

International Commission on Irrigation and Drainage (ICID) was established in 1950 as a Scientific, Technical, Non-commercial, Non-Governmental International Organisation (NGO) with headquarters at New Delhi, India. The Commission is dedicated to enhancing the worldwide supply of food and fiber by improving water and land management, especially the productivity of irrigated and drained lands. The mission of ICID is to stimulate and promote the development and application of the arts, sciences and techniques of engineering, agriculture, economics, ecological and social sciences in managing water and land resources for irrigation, drainage and flood management using research and development, and capacity building. ICID aims to achieve sustainable irrigated agriculture through integrated water resources development and management (IWRDM). ICID network spreads to 104 countries all over the world.

Country Policy Support Programme (CPSP) was launched by ICID in 2002 to contribute to develop effective options for water resources development and management to achieve an acceptable food security level and sustainable rural development. The programme is implemented in five countries viz. China, India, Egypt, Mexico and Pakistan and is funded by Sustainable Economic Development Department, National Policy Environment Division, The Govt. of The Netherlands as Activity No. WW138714/DDE0014311.

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ICID acknowledges the donors for reposing their confidence in ICID in assigning the challenging and complex task of exploring strategic direction for addressing water policy issues considering needs of all sectors in an integrated manner, keeping food security and rural development as the main focus.

August, 2005

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## EXECUTIVE SUMMARY

The World Water Vision on Water for Food and Rural Development (WFFRD) for year 2025, formulated through extensive consultations held in over 43 countries, was facilitated by International Commission on Irrigation and Drainage (ICID) and a few other international organisations. The Theme document presented at the 2<sup>nd</sup> World Water Forum in The Hague in 2000 projected a substantial increase in the global water withdrawal, water storage and irrigation expansion for the pre-dominant “food sector” (largely consumptive). A majority of these projections of large increases related to the developing countries. However, the integrated overview Water Vision document scaled down these requirements in an attempt to consolidate conclusions and recommendations of various other themes. It also did not reflect quantification of water needs for the “people sector” (largely non-consumptive) and the “nature sector”.

In order to analyse the supply and demand issues of all the three sectors, namely food, people and nature in an integrated manner, ICID initiated a ‘Strategy for Implementation of Sector Vision on Water for Food and Rural Development’ initiative in the year 2000. ICID also felt the need to mobilise strong international support for strategies and policies in water sector to achieve food security and reduce poverty in developing countries through independent water assessments. In line with this, ICID launched a project titled “Country Policy Support Programme (CPSP)”, with a funding support from the Government of The Netherlands.

China, Egypt, India, Mexico and Pakistan having 43% of the world population and 51% of the world irrigated areas were chosen as participating countries in the CPSP programme. The CPSP attempted a detailed assessment of the water supply-demand situation for the three sectors. To begin with a couple of representative river basins of the two most populous countries of the world, viz., China and India were taken up. This is to be followed by Egypt, Mexico and Pakistan. Multi-stakeholder consultations at the respective basin and national levels, were held and the findings from such consultations helped to identify desired interventions in the national policies related to water resources.

For carrying out detailed water assessment, two sample river basins each in China and India were selected as indicated above. In China, a water-rich basin namely the

Qiantang river basin on the south-east coast, and a water-deficit basin namely the Jiaodong Peninsula, on the east-coast, were chosen. A ‘Basin-wide Holistic Integrated Water Assessment (BHIWA)’ model evolved by ICID, was applied to these two basins. The results of the assessment for these two basins, extrapolation of the assessment and policy related issues emerging from the studies were presented in a ‘National Consultation’ held in August 2004, at Beijing. This report covers ‘Water Policy Issues of China’ and suggested policy interventions. Chapter 1 describes the state of water in China covering river basins, estimates of water resources, potential utilisable water resources, present water utilisation, food supply and demand, water quality, strategies for water management, institutional framework for water resources development, and China’s water policy (Water Law and Agricultural policy). Chapter 2 deals with water resources assessment of basins and policy issues and covers workshops and consultations organised in China, BHIWA model and its application to river basins and application of basin study results to national level and policy issues emerged from the studies.

China is the third largest country in the world in respect of geographical area (960 Mha). The drainage area of the country is divided into 9 basins. The renewable water resource of the country is 2,812 billion cubic meters. The potential utilisable water resource is 873 billion cubic meters, (751 billion cubic meters of surface water and 122 billion cubic meters of groundwater). The present population of the country is 1,276 million and the projected population in 2025 is 1,600 million. The per capita availability of water per year at present is 2,204 cum and it will be 1,875 cum in 2025. Present water utilisation is about 557 billion cubic meters and the projected requirement in 2025 is 1,138 billion cubic meters. The existing storage capacity of large and small reservoirs is 458 billion cubic meters. China has a total arable land of 139 Mha. The total irrigated area in China is 54.4 Mha and it is planned to be increased to 60.3 Mha by 2025.

The Water Law of the People’s Republic of China (CWL), which was formulated in 1988 was revised and adopted in August 2002 and made public with effect from October 2002. The CWL provides guidelines for planning, development, utilisation and protection of water resources, water bodies and water projects, and efficient utilisation of water resources.

Based on the assessment of the selected basins water scarcity/situation indicators were identified. Water situation indicators of river basin in China and basin classifications/grouping by water situation indicators are presented in the report.

The detailed hydrologic modelling and analysis of the two basins for various scenarios provided a greater insight into the understanding of the water resources. The holistic view of the assessments taken through the modelling gives a sound and much broader basis to describe the state of water availability and the likely water use under different sectors under various future scenarios at the basin / sub-basin level; source-wise - surface and groundwater separately and interaction between the two. Modelling has been used to develop a set of indicators, which help in understanding the current water scene for other basins of China. Similarly, the modelling has allowed the testing of various possible land and water use scenarios, in regard to their hydrologic implications, and allows assessment and integration of the individual water use sectors. Following is a summary of important points that have emerged, and may need to be studied further for suitable modifications in the Water Law of China adopted in 2002.

- From the perspective of the economic and social development, it would be necessary to change perception of water resource availability by promoting and improving water resources management.
- Developing harmonious coexistence between man and nature for sustainable development.
- Change in the perception that water is inexhaustible to the recognition that freshwater resources are limited.

- Paying special attention to the prevention of human damage to water while preventing water damage to mankind.
- Shifting focus on water development, utilization and management to water allocation, conservation and protection while developing, utilizing and managing water resources.
- Emphasizing water works management through strengthening non-structural measures and scientific management of water works.
- Matching water supply according to demand.
- Developing pressurized irrigation systems and promoting efficient water use.
- Realizing water as a natural gift, structural measures should be taken up for its optimum utilisation.
- Proper Management and monitoring of water quantity and quality in all uses.
- Promoting re-use of poor quality water.
- Integrating water allocation, distribution and management.

The strategy for sustainable use of country's water resources focuses on developing water resources and expanding the capacity of water supply; increasing water use efficiency and saving water; protecting water resources and improving water environment. Measures for sustainable use of water resources include – optimal allocation, effective protection and utilization, appropriate development, scientific management and increased financial input. ■

## ACRONYMS / ABBREVIATIONS

ACEO	Agricultural Collective Economic Organisation
BHIWA	Basin-wide Holistic Integrated Water Assessment
B as U	Business As Usual
BCM	Billion Cubic meters (10 <sup>3</sup> MCM)
CAPSIM	Chinese Agricultural Policy Simulation Model
CNCID	Chinese National Committee on Irrigation and Drainage
CPSP	Country Policy Support Programme
CWC	Central Water Commission
CWL	The Water Law of People's Republic of China
D&I	Domestic and Industry
EFR	Environmental Flow Requirements
ET	Evapo- transpiration
ETo	Reference Evapo-transpiration
FAO	Food and Agriculture Organisation of United Nations
G&D	Gauge and Discharge
GW	Groundwater
GIA	Gross Irrigated Area
GCA	Gross Cropped Area
GSA	Gross Sown Area
GWP	Global Water Partnership
Ha	Hectare
IAH	Indian Association of Hydrology
ICID	International Commission on Irrigation and Drainage
IEC	International Executive Council Meetings
IFPRI	International Food Policy Research Institute
IUCN	The World Conservation Union
IWMI	International Water Management Institute
IWHR	Institute of Water Resources and Hydropower Research
Km	Kilometre
LPCD	Litres Per Capita/Day
MAR	Mean Annual Runoff
MCM	Million Cubic Meters
Mha	Million hectare
MoWR	Ministry of Water Resources
MoEF	Ministry of Environment and Forest
MSL	Mean Sea Level
Mt	Million tons

NGO	Non Governmental Organisation
NIA	Net Irrigated Area
NSA	Net Sown Area
PODIUM	Policy Dialogue Model
PODIUMSim	PODIUM with Simulation Facilities
RMB	Ren Min Bi
SB	Sub-Basin
SW	Surface Water
WHO	World Health Organisation
WSI	Water Situation Indicators
WAPCOS	Water and Power Consultancy Services (India) Ltd.
WATERSIM	Water, Agriculture, technology, Environment and Resources Simulation Model
WFFRD	Water For Food and Rural Development
WWF	World Wilde Fund for Nature

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## GENESIS OF COUNTRY POLICY SUPPORT PROGRAMME (CPSP)

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## CHAPTER 1

## STATE OF WATER RESOURCES IN CHINA

## 1.0 Introduction

The geographical area of China is 960 Mha, about 1/15 of the total area of the global land surface and is the world's third largest country. It lies between latitudes 4° 15' N and 53° 31' N and longitudes 135° 5' E and 73° 40' E.

Topographically, China has distinct zones from west to east, which have pronounced influence on the distribution of precipitation and water resources. Mountainous land accounts for nearly 33% of the total area, plateaus make up 26%, hilly terrain covers 10%, inter-mountain basins occupy 19% and plains account for only 12% of the total area.

The weather across the country is extremely varied due to its vast size. All of eastern China has hot summers. While winters are warm in the southeast, they are bitterly cold in the northeast. South eastern China is subtropical. The far south region is tropical with abundant rainfall. North eastern China including Beijing experiences hot summers and cold winters, and is relatively dry. Shanghai, in east central China, has a climate intermediate between the southeast and the northeast – with mild winters and moderate precipitation (Dajun Shen and Ruiju Liang, et.al, 2003 )

## 1.1 Water Resources

China has more than 50,000 rivers each with drainage area larger than 100 km<sup>2</sup>, and about 1,500 rivers each with drainage area larger than 1,000 km<sup>2</sup>. The distribution of rivers over the country is non-uniform, as a majority of them exist in the eastern part where monsoon produces abundant rainfall, while some of them exist in the arid northwest interior, where, precipitation is deficient due to continental climate. The majority of rivers are fed by rainfall; some are fed by snowmelt in spring and rainfall in

summer and autumn. There are some rivers partly fed by glacier melting.

China has the world's largest number of mid-and low-latitude mountain glaciers. Glaciers occur extensively over the country's north western and south western regions. The total glacial area is about 58,651 km<sup>2</sup>, with glacial storage of about 5,100 billion cubic meters. The amount of mean annual glacier melt water is about 56 billion cubic meters.

Rivers of China are grouped into nine basins namely, the Songliao, Hai, Huai, Yellow, Yangtze, Pearl, Southeast Coastal, Southwest and the Inland river basins. The river basins of China and the locations of the Jiaodong Peninsula and Qiantang river basin are shown in Figure-1.

The mean annual volume of precipitation is 6188.9 billion cubic meters, and the mean annual depth of precipitation is 648 mm, 20% less than the global average precipitation and also 12% less than Asian average precipitation of 740 mm. The general tendency of the regional distribution of annual precipitation is descending from southeast to northeast. In the coastal areas of the south eastern part of the country and some regions of southwest China, the mean annual precipitation depths are higher than 2,000 mm and in some places near the eastern sector of the China-India boundary the annual precipitation depths may be higher than 5,000 mm.

Forty-four percent of the mean annual precipitation of the country i.e. 285 mm, forms the river runoff, 56% is lost in the evapo-transpiration from surface water bodies, plants and soils, and recharge to groundwater.

The drainage areas and mean annual water resources of nine river basins of China are given in Table 1. (Dajun Shen and Ruiju Liang, et.al, 2003 )

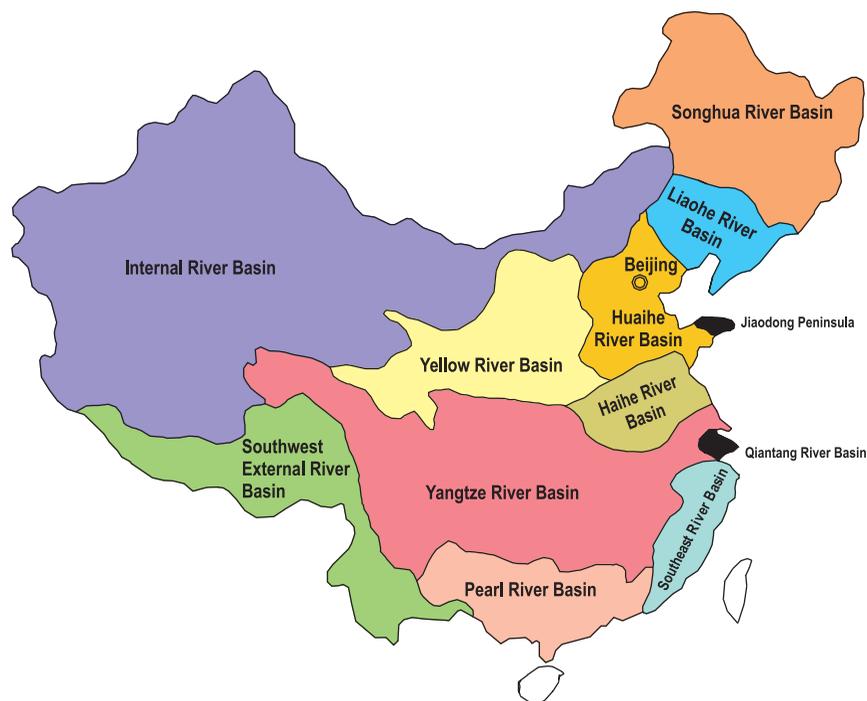


Figure 1 River Basins of China and Locations of Jiaodong Peninsula and Qiantang River Basin

Table 1.  
Basin Wise Water Resources in China (km<sup>3</sup>)

River Basin	Area (km <sup>2</sup> )	Mean Annual Precipitation	Mean Annual surface water resources	Mean Annual groundwater resources	Duplication	Mean annual water resources
Songliao	12,48,445	637.7	165.3	62.5	34.9	192.9
Haihe	3,18,161	178.1	28.8	26.5	13.2	42.1
Huaihe	3,29,211	283.0	74.1	39.3	17.3	96.1
Yellow	7,94,712	369.1	66.1	40.6	32.4	74.3
Yangtze	18,08,500	1,936.0	951.3	246.4	236.4	961.3
Pearl	5,80,641	896.7	468.5	111.6	109.2	470.8
Southeast	2,39,803	421.6	255.7	61.3	57.8	259.2
Southwest	8,51,406	934.6	585.3	154.4	154.4	585.3
Inland	33,74,443	532.1	116.4	86.2	72.3	130.4
<b>Total</b>	<b>95,45,322</b>	<b>6,188.9</b>	<b>2,711.5</b>	<b>828.8</b>	<b>727.8</b>	<b>2,812.4</b>

**Table 2.**  
**Basin wise Potentially Utilizable Water Resources (km<sup>3</sup>)**

River Basin	Surface Water Resource	Groundwater Resources	Total	Percentage of mean annual water resource (%)	Utilisation in 2001
Songliao	65.0	30.0	95	49.3	60.0
Haihe	10.0	20.0	30	71.2	39.0
Huaihe	41.5	23.5	65	73.8	60.0
Yellow	37.0	11.0	48	58.3	39.0
Yangtze	348.0	12.0	360	37.5	174.0
Pearl	123.5	6.5	130	27.6	84.0
Southeast Coastal	47.5	2.5	50	25.9	32.0
Southwest	28.0	2.0	30	5.1	10.0
Inland River Basins	50.0	15.0	65	49.9	58.0
<b>Total</b>	<b>750.5</b>	<b>122.5</b>	<b>873</b>	<b>31.8</b>	<b>556.0</b>

It is seen that out of 2,812 billion cubic meters of mean annual water resources, the rivers carry 2,711.5 billion cubic meters as surface water runoff (MAR), while 828.89 billion cubic meters constitutes natural recharge to groundwater (GW), the duplication between surface water and groundwater is 727.8 billion cubic meters.

The potential utilisable water resource in China is about 873 billion cubic meters, including 750.5 billion cubic meters of surface water and 122.5 billion cubic meters of groundwater. According to the conditions of water resources in China, the potential for future water development will be mainly in the south. Up to now, 556.0 billion cubic meters of water has been developed and there are still 317 billion cubic meters of potential for future

development and utilization. The potential utilizable water resource in the north is less than 50.0 billion cubic meters, three-fourth of which is distributed in Neijiang River, Songhuajiang River and some international rivers around the northeast and Xinjiang Autonomous Regions. Basin wise potential utilizable water resources and utilisation in 2001 is shown in Table 2. (Dajun Shen and Ruiju Liang, et.al, 2003)

In 2001, total water use in China was 556 billion cubic meters, (63% of potential utilizable water) of which 382 billion cubic meters was used for agriculture, 114 billion cubic meters was used for industry and 60 billion cubic meters for domestic use is shown in Table 3.

**Table 3.**  
**Sector wise Water Use in China (km<sup>3</sup>)**

River Basin	Agriculture	Industry	Domestic	Total
Songliao	42.0	13.0	5.0	60.0
Haihe	28.0	6.0	4.0	38.0
Huaihe	31.0	6.0	7.0	44.0
Yellow	44.0	10.0	20.0	74.0
Yangtze	102.0	42.0	4.0	148.0
Pearl	54.0	17.0	13.0	84.0
Southeast coastal	18.0	17.0	4.0	39.0
Southwest	8.0	2.0	1.0	11.0
Inland River Basin	55.0	1.0	2.0	58.0
<b>Total</b>	<b>382.0</b>	<b>114.0</b>	<b>60.0</b>	<b>556.0</b>

## 1.2 Water Resources Development

Surface water is the main water source in the river basins in the south (Yangtze river, etc). However, groundwater is the main source of water for Huang-Huai-Hai and inland river basins and surface water supply is remarkably reduced in these basins. This reflects that surface water in the north is of short supply, and groundwater will become the main water source to meet the increasing water demand, leading to over-exploitation of groundwater. The ratio of groundwater to total water supply has increased from 53.0% in 1980 to 65.7% in 2000 in Hai river basin, 24.3% to 32.1% in Huai river basin, 23.5% to 32.1% in Yellow river basin, 7.1% to 14.7% in Inland river basins and 23.9% to 43.75% in Songliao river basin. Meanwhile, viewed from inter-basin water transfer, Hai river basin transferred 3.9 billion cubic meters of water from the Yellow river basin in 2000, Huai river basin transferred 6.77 billion cubic meters and 1.60 billion cubic meters respectively from the Yangtze river and the Yellow river, the Inland river basins transferred 0.12 billion cubic meters of water from the Yellow river for inter-regional water regulation.

The degree of water development is an important index to reflect the present status of water use and its potentials for future development. It is computed as follows (CNCID, 2004,b):

$$\text{Degree of water resource development} = \frac{(\text{Actual water supply} + \text{Water transfer into the basin}) - (\text{Water transfer out of the basin} + \text{Other water supply from sea water use, sewage use and local rainwater})}{(\text{Local mean annual water resources})}$$

The degree of water development in China was 16.1% in 1980, 18.9% in 1993 and 19.7% in 2000. It has been over 50% in the Yellow River, Huai River and Hai River in the north, where the water resources are overexploited. It is over 40% in inland river basins and 32% in Songliao River Basin. The degree of water development in the south is less than 20%.

The water consumption has reduced in irrigation sector while it increased rapidly in other sectors. The total water consumption in China in 2000 was 556 billion cubic meters while it was 443.7 billion cubic meters in 1980. The annual growth rate was 1.07%, and was mainly due to the rapid growth of domestic and industrial water consumption. The total water consumption (domestic and other sectors) in urban areas was only 52.5 billion cubic meters in 1980 and

it increased to 172.3 billion cubic meters in 2000, an increase of 2.28 times, with an annual growth rate of 6.5%. Agricultural water consumption remains stable, even with a little reduction in irrigation water consumption. Agricultural water consumption reduced from 378.3 billion cubic meters in 1980 to 358.0 billion cubic meters in 2000. Industrial and domestic water consumption increased rapidly; its ratio had increased from 11.9% in 1998 to 30.8% in 2000 while agricultural water consumption reduced from 83.4% in 1980 to 69.2% in 2000. The competition of water use among irrigation, industrial and domestic sectors is becoming more and more serious and this trend will further increase with the acceleration of industrialization and urbanization process.

## 1.3 Lakes and Reservoirs

In China there are about 2,300 lakes each larger than 1 km<sup>2</sup>. The country's total lake area is about 71,787 km<sup>2</sup>, and the total lake storage is about 708.8 billion cubic meters, of which freshwater forms 31.9%.

In 1997, China had 84,387 reservoirs, of which 397 were large reservoirs each with capacity more than 100 million cubic meter and with a total capacity of 326.72 billion cubic meters; 2,634 were medium reservoirs, each with capacity between 1 to 100 million cubic meters and

with a total capacity of 72.9 billion cubic meters; 81,806 were small reservoirs each with capacity less than 1 million cubic meter and with a total capacity of 57.72 billion cubic meters. The total storage capacity of all the reservoirs in 1997 was 458 billion cubic meters. The present (2000) total storage capacity of reservoirs is 520 billion cubic meters.

## 1.4 Population

The total population in China was 1,276 million in the year 2001. China had a high population growth rate in 50s and 60s especially at the middle of 60s, reaching 2.838%. After the implementation of family planning programme in the 70s, the population growth rate gradually dropped. In 2001, it was 0.695%. The projected population for the year 2025 is 1,600 million. The water availability per capita

was 2,204 cubic meters in 2001. It is estimated that this amount will decrease to 1,875 cubic meters in the year 2025.

The cereal production of China in the year 2002 was 400 million tons and it will have to rise to 640 million tonnes to meet the needs of increased population. The food supply and demand in the year 2025 is simulated from the past trends based on the results of CAPSIM Model. The details are given in Annexure 2.

### 1.5 Water Quality

According to an analysis of river sediment data in China, about 3.5 billion tons of sediment is eroded every year on an average and transported by rivers from mountainous regions and hilly areas. Out of this sediment, approximately 1.85 billion tons reaches the sea, about 0.25 billion tons is transported outside the boundaries, 0.2 billion tons is carried away from the mountainous and hilly areas for inland rivers, and approximately 1.2 billion tons is deposited in the channels, lakes and reservoirs on the middle and lower reaches of the rivers for out flowing areas, or diverted into irrigated areas and flood diversion areas.

At present (2000), the major pollutants in the water bodies are organic pollutants, which come from high concentration organic wastewater from chemical, petrochemical, papermaking, food, leather and textile industries, and untreated urban domestic wastewater. The urban wastewater discharge increases gradually, as well as the Chemical Oxygen Demand (COD) in wastewater. The reason that aggravates the pollution in the water bodies near cities is the lower treatment rate of urban wastewater and discharge of untreated wastewater.

In large fresh lakes, widespread phosphorus and nitrogen pollution was noticed. In some lakes, mercury pollution was also noticed. Water quality in large reservoirs was good and the main pollutants were phosphorus and nitrogen. But a slight increase in organic pollution was observed.

The urban groundwater quality was good, but total hardness had slightly increased. The over-exploitation of groundwater in medium and large cities was very common. At least 14 cities experienced heavy over-exploitation of groundwater. Groundwater in the five Northern provinces and regions was mostly polluted, both in the rural and urban areas, both shallow and confined groundwater. In some localities, groundwater pollution was severe and became worse and worse gradually.

### 1.6 Environmental Sector

There are a number of issues that transcend the water sector and impact on other sectors of the environment. Soil erosion, deforestation, and damage to wetlands and grasslands have resulted in deterioration of China's national ecosystems, pose a threat to future agricultural sustainability, and contribute to the overall pollution of the water resources in China. The water and wind erosion area occupied 38% of the total territory. The drying-up of rivers in northern China is more common. The Yellow River dried up every year in the 90s, with an annual average of 107 dry days.

At present wetlands in China cover over 25 Mha, representing 2.6% of the entire country. Approximately 80 % of wetlands have fresh water. China's wetlands suffer from anthropogenic and natural effects. Of China's 217 recognized wetlands, 95 have been declared as nature reserves. Despite such efforts to protect wetlands, it is estimated that human activities and moderate to serious threats of deterioration have disturbed 40% of important wetlands. In the year 1950 there were 24,880 natural lakes of various dimensions with a total area of 83,000 km<sup>2</sup>. Over the past 30 years, lake area has decreased by more than 12,000 km<sup>2</sup>.

### 1.7 Strategies for Water Management

China's agenda 21, worked out based on the issues of population increase; insufficient resources and lack of techniques are 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.
- Increased input 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.

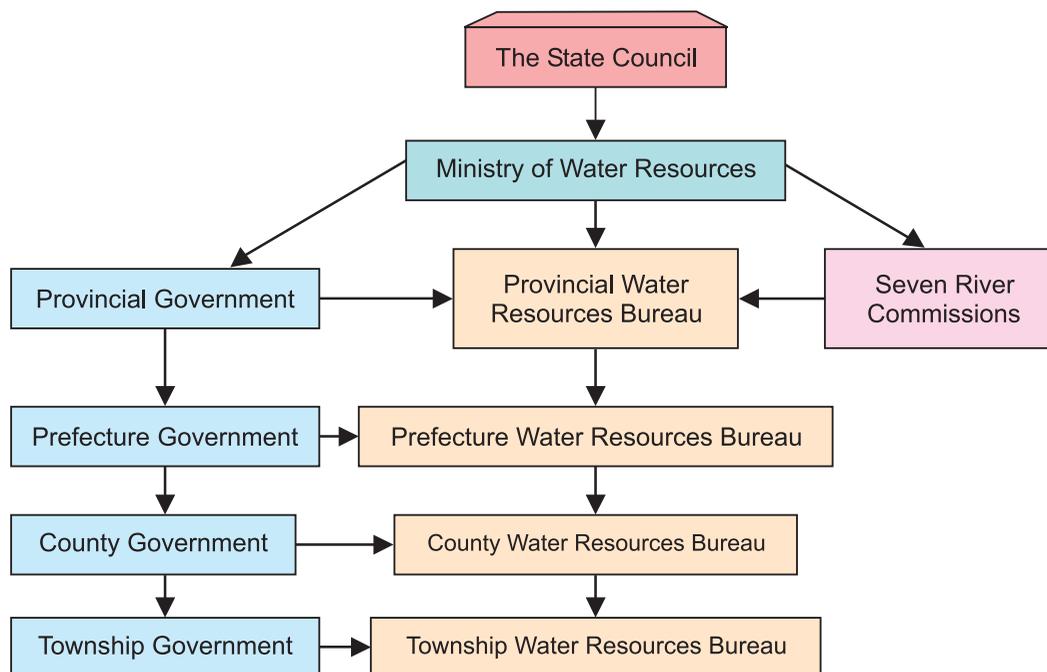


Figure 2 Institutional Structure for Water Resources Development

- Stronger research and education for sustainable agricultural development.
- Promotion of legal system establishment, public participation and international cooperation for sustainable agricultural development.

Following actions are being taken to achieve the above agenda:

- Increasing the efficiency and productivity of Irrigation water.
- Developing agriculture water saving technology system.
- Fully using rainwater to develop high efficiency dry land agriculture with low water use and yield increase.
- Developing irrigation in dry land agriculture areas.
- Inter-basin water diversion to solve the problem of irrigation water shortage in North China.
- Applying biotechnology to breed new drought enduring, high quality and high-yielding varieties to increase food production.

### 1.8 Institutional Framework for Water Resources Development

In China, water policy is created and executed primarily by the Ministry of Water Resources (MOWR). The MOWR has run most aspects of water management since China's first comprehensive Water Law was enacted in 1988, taking over the duties from its predecessor, the Ministry of Water Resources and Electrical Power. The policy role of the MOWR is to create and implement national price and allocation policy, and oversee water conservancy investments by providing technical guidance and issuing laws and regulations to the sub national agencies. The national government invests in developing the water resources from all large rivers and lakes and projects that cover more than one province. Local governments are in-charge of projects that are within their administrative districts. Figure 2 shows the vertical and horizontal structure of the Ministry of Water Resources (CNCID, 2004,b)

### 1.9 China's Water and Agriculture Policies

China is the most populous developing country in the world. Therefore, China's food security is essential to the stability of Chinese as well as the global grain market.

China is also a big irrigation country, where irrigation plays an important role in guaranteeing food grain production. However, the per capita water resources in China are much less and meanwhile it is unevenly distributed both spatially and temporally. With the rapid growth of industrial and domestic water consumption, how to rationally allocate the limited water resources while keeping the rapid development of the national economy and guaranteeing the state's food security is an important subject in formulating policies related to water resources. In recent years, in the light of the total strategy of legalized water management, the decision makers issued a number of regulations and policies, such as the "Water Law", "Policies for Water Industry", "Flood Control Law", "Water and Soil Conservation Law", "Water Pollution Prevention and Control Law" and "Regulations on Water Supply Price of Hydro Projects" to solve some serious problems such as

flood, water shortage and water pollution in water development and water use and great achievements have been made in this regard.

The Water Law of the People's Republic of China (CWL), which was formulated in 1988 was revised and adopted at the 29<sup>th</sup> Meeting of the Permanent Committee of the 9<sup>th</sup> National People's Congress on August 29, 2002 and was made public with effect from October 1, 2002. To improve the draft Water Law, the State Council solicited opinions from the National Planning Commission, the Ministry of Finance, the Ministry of Land Resources, the Ministry of Construction and the State's Environmental Protection Administration etc., 15 sectors and 10 provincial/municipal governments (Shanghai and Hebei etc.). Excerpts of relevant paras of Water Law and Agricultural Policy are given in Annexure 3.





## CHAPTER 2

## ASSESSMENT OF WATER RESOURCES AT BASIN LEVEL AND POLICY ISSUES

### 2.0 Introduction

A National Level Consultation was organized in Beijing in August 2004 in which water assessment studies carried out in two basins on the water use for nature, food and people, extrapolation of the results of assessment of these basins to other basins and policy related issues emerging from the studies were presented and discussed. The studies and other issues were updated after considering the suggestions and comments received from the participants at the Consultation. A report on “China’s Irrigation Development: Rational Allocation of Water Resources and Food Security” was presented at the special session on CPSP at the sidelines of the ICID’s 55<sup>th</sup> IEC Meetings held at Moscow in September 2004.

### 2.1 Basin-wide Holistic Integrated Water Assessment (BHIWA) Model

The Basin-wide Holistic Integrated Water Assessment (BHIWA) model developed for assessment of water resources at the basin level is a useful tool for water policy planners and other professionals who are interested in projecting the water scene at basin level under different policy options/philosophies for use of water and related resources. The model considers the entire water cycle and takes into account all types of water uses. Working at the level of land parcels, the quantum of water is integrated first at sub-basin level and then at the basin level. The model is first to be calibrated for a basin by adjusting various parameters that are assumed for the basin and sub basins and comparing the results so obtained with the actual observed data. On obtaining a satisfactory parity of results from the model, the user can simulate various scenarios of water resource development and management with respect to policy options.

Scenarios can be developed in the model in terms of changes in land use, crop areas under rainfed and/or irrigated agriculture, cropping patterns, irrigation efficiencies, imports and exports of water, surface (reservoirs) storage, source-wise (surface and groundwater) withdrawals, etc. By simulating past conditions of little or no water use in the basin, the model can also help in setting up minimum reference flows for maintenance and enhancement of river ecology and environment. Comparison of such flows with projected future river flows helps in determining indirectly limits on water withdrawals, including extent of decline in groundwater tables to meet environment flow requirements. The model takes into consideration complex interaction between numerous factors including surface and groundwater, land use and water supply, storage and water withdrawals and returns, through separate surface and groundwater and overall water balance at basin/sub basin level.

The BHIWA model has been conceived mainly to address the issues of integration of water use under the three sectors, namely, water for nature, water for people, and water for food. Figure 3 represents the Schematic diagram of BHIWA Model.

### 2.2 River Basin Studies

Water assessment studies of two sample river basins were performed Using BHIWA model,. The comparatively wet southeast coast Qiantang River flowing into the Bay of Hangzhou and the relatively dry east coast Jiaodong Peninsula flowing into the Bohai Sea were selected for the study. Maps of Jiaodong and Qiantang basins are shown in Figures 4 and 5 respectively.

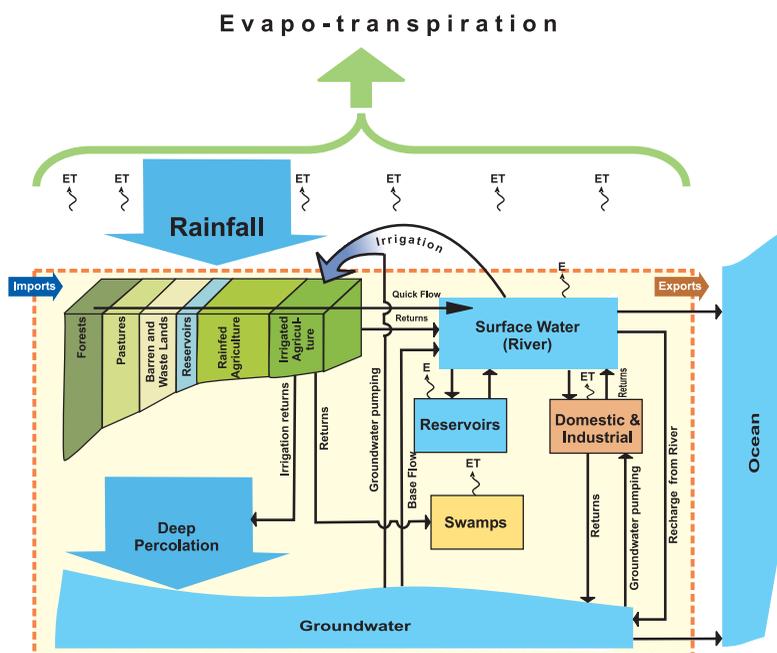


Figure 3 Schematic Diagram of BHIWA Model

**Jiaodong Peninsula basin**

The Jiaodong Peninsula Basin has a total drainage area of 19,182 km<sup>2</sup>. The river system, climate, land use, water resource and its development, water demand at present and projected water requirement in the year 2025 have been discussed in the CPSP Report 4.

The per capita annual water availability in the basin in the year 2000 was 492 cubic meter considering the estimated renewable water resources of the basin as 4394 million cubic meter per year and 8.93 million as the population of the basin. This water availability is likely to be 454 cubic meter per year per capita in the year 2025 with the projected population of 9.67 million by 2025.

The Basin Wide Holistic Integrated Water Assessment (BHIWA) Model evolved by ICID, was applied to Jiaodong Peninsula Basin to assess water use by different sectors for the present (2000) and future scenarios. The basin was divided into two sub basins, namely; Yantai and Weihai. The model was calibrated for the present conditions and applied to derive responses to the past and five future scenarios using monthly time set. Apart from Business as Usual Scenario (Future-I), other scenarios examined include:

- Without expansion of forest (Future-II)

- Better system management and reduced groundwater use (Future-III)
- Better system management and reduced groundwater use and adoption of drip irrigation (Future-IV)
- With soil and land management, import of more water and reduced groundwater use (Future-V)

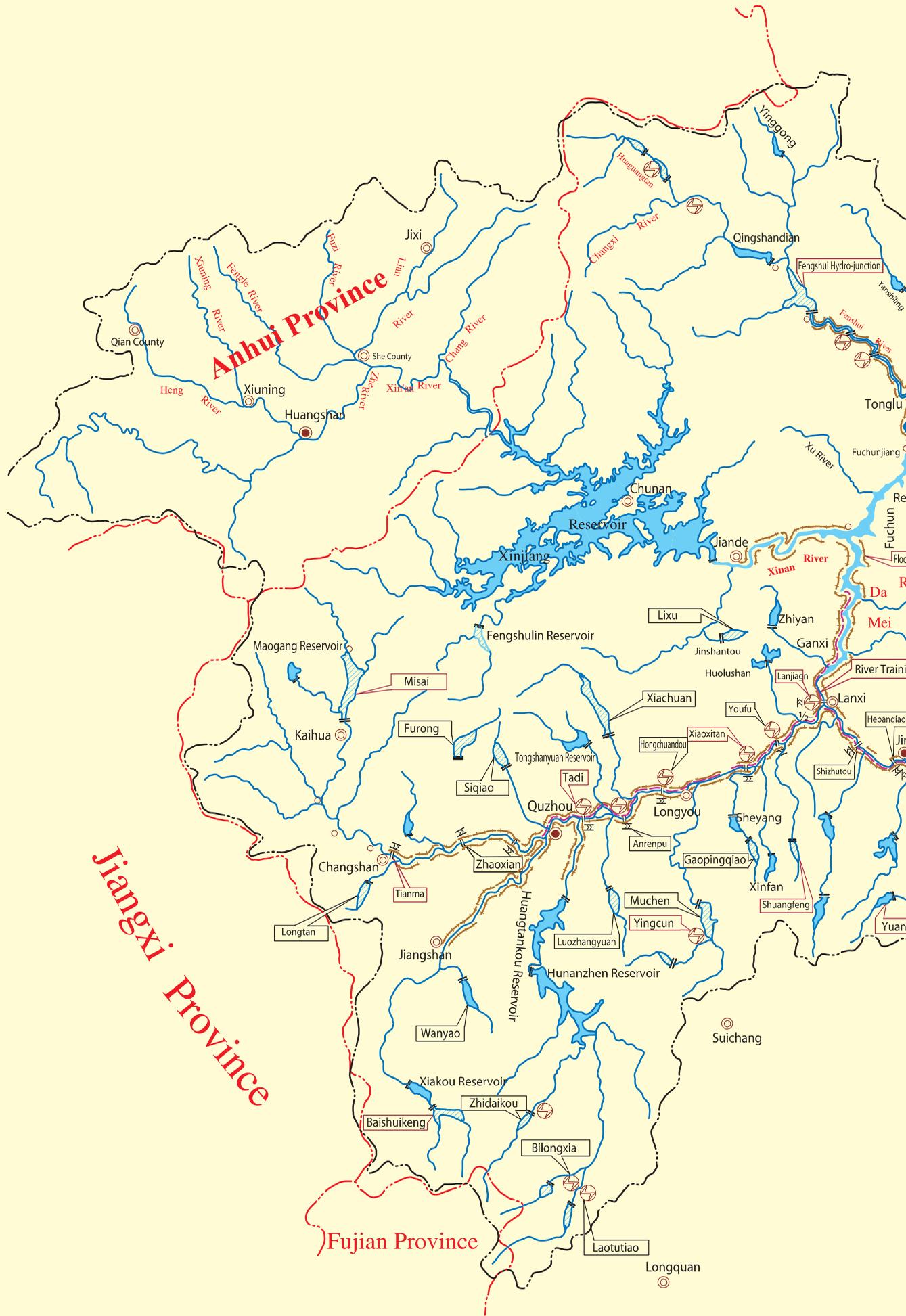
The total water input comprises rainfall and import of water. The rainfall amount in the basin is 13,748 million cubic meters. At present there is no import and hence total water input is 13,748 million cubic meters. It was found that an import of 147 million cubic meters in Bas U, Future-II, III, IV scenarios and about 295 million cubic meter in Future-V scenario may be required. The major output consists of consumptive use and river flows. There is no export of water in any scenario.

The total consumptive use (ET) at present (2000) situation is 11,821 million cubic meters comprising about 52% by nature sector (forest, pasture and barren lands), 46% by agriculture sector (rainfed and irrigated agriculture) and 2% by people sector (D&I).

The consumptive use (ET) by use sectors in different scenarios are given in Table 4.

The application of BHIWA model indicates that







**Legend**

	Province
	Municipality
	County/City/District
	Province Boundary
	Basin Boundary
	Planned Dyke
	Planned River Training
	Planned Power Station
	Planned Ship Lock
	Planned Diversion Works
	Constructed Reservoir
	Planned Reservoir

Figure 5 Map of Qiantang River Basin

consumptive use of the nature sector would increase with expanding area for forest and non-beneficial ET in agriculture would decrease. Compared with the increase in command area, the beneficial ET in the basin would considerably increase with better water management. The groundwater use is high (86%) at present and should be moderately exploited in the future. Water requirement for agriculture is likely to be increased by 40% in future. With increase in domestic and industrial (D&I) water use in future, the agriculture is likely to face serious water shortage. The expansion of forest area should be consistent with the local water resource availability and agricultural development. With increase in water use and changing water use pattern, the rate of return flows to surface water would increase, leading to risk of water pollution. Thus, measures to prevent/reduce water pollution need to be adopted.

#### ***Qiantang river basin***

Qiantang river has total drainage area of 55,558 km<sup>2</sup>. For the present study drainage area of 35,500 km<sup>2</sup> in the upstream of Hangzhou Gate has been considered. The river system, climate, land use, water resource and its development, water demand at present and projected water requirement in the year 2025 have been dealt with in the CPSP Report 5.

The per capita water availability in the basin in 2000 was 3621 cubic meters per year considering the estimated renewable water resources of the basin at 38.64 billion cubic meters per year and the population of the basin at 10.67 million. The water availability is likely to be 3389 cubic meters per year in the year 2025 with the projected population of 11.40 million by 2025.

The Basin-wide Holistic Integrated Water Assessment (BHIWA) Model has been applied to Qiantang river basin to assess water use by different sectors for the present (2000) and future scenarios. The basin was divided into two sub basins. The model was calibrated for the present conditions and applied to derive responses to past (1980) and five future (2025) scenarios using monthly time set up. Apart from Business as usual Scenario (F-I), other scenarios studied include:

- With no expansion of water infrastructure and better water management (F-II);
- With increased water infrastructure (and small import), irrigation expansion (F-III);
- With increased water infrastructure, no irrigation

expansion and more industries, export of water (F-IV);

- With increased water infrastructure, no irrigation expansion, more industries, better water management (F-V).

The total water input (rainfall and imports) to the basin is 58,014 million cubic meters. The major output consists of consumptive use, river flows and exports (only in one scenario). The total consumptive use (ET) at present situation is 25,322 cubic meters comprising about 67% by Nature sector (forest, pasture and barren lands), 29% by agriculture sector (rainfed and irrigated agriculture) and 4% by people sector (domestic and industrial).

The consumptive use (ET) by use sectors in different scenarios are given in Table 5.

The application of BHIWA Model indicates that almost entire irrigated agriculture including fisheries is presently dependent on surface water resources. The proportion of irrigation withdrawal to total withdrawal is expected to be reduced from the present 0.76 to 0.45 in the future. Surface water withdrawal constitutes only a small fraction of available supplies and seems to be constrained by availability of cultivable land. At present, a small proportion of groundwater is exploited for irrigation and D&I use, and thus there is a huge potential for increasing groundwater withdrawals in future. With the rapid growth of population and quick development of industry and urban area, withdrawals for domestic and industrial use are likely to be doubled in the future. Consumptive use under nature sector is expected to increase significantly in future due to the expansion of forest area. This in turn would tend to reduce river flow. Part of this decrease can however be restored through better soil and water management initiatives. As surface and groundwater resources are abundant in the basin, there is a scope to export water to other basins.

### **2.3 Application of the Results of the Basin Study to National Level**

The water resources assessment studies of the two basins, namely; Jiaodong Peninsula and Qiantang river basin were used for extrapolating approximately water scenarios of China's 9 basins in order to enable country wide appraisal. The river basin characteristics were compared using water situation indicators as defined below:

#### ***Water Situation Indicators (WSI)***

A survey of indicators of water stress mentioned in

**Table 5.**  
**Consumptive Use (ET) By Use Sectors in Different Scenarios, Qiantang River Basin (10<sup>6</sup>m<sup>3</sup>)**

Sectors	Past (1980)	Present (2000)	Future-I	Future-II	Future-III	Future-IV	Future-V
<b>Nature sector</b>							
Beneficial	10,126	11,128	13,908	13,910	13,910	13,910	13,126
Non-beneficial	7,102	6,003	4,075	4,241	3,936	3,850	4,435
Sub Total	17,228	17,130	17,983	18,151	17,846	17,760	17,561
<b>Agriculture sector</b>							
Beneficial	4,647	4,207	4,368	4,207	4,667	4,615	4,515
Non-beneficial	2,503	3,147	3,136	2,565	2,656	2,548	2,969
Sub Total	7,150	7,353	7,503	6,772	7,323	7,163	7,484
<b>People sector</b>							
(D&I)	535	838	1,591	1,591	1,591	2,228	2,228
<b>Total of all sectors</b>	<b>24,913</b>	<b>25,322</b>	<b>27,077</b>	<b>26,514</b>	<b>26,760</b>	<b>27,150</b>	<b>27,274</b>

International literature was made. The three main types recommended in recent years are:

- (a) The water stress indicator (WSI) used in international literature is one based on Alcamo, et.al, (2002), and is defined as

$$\text{WSI} = \text{Withdrawal} / \text{Mean Annual (natural) Runoff (MAR)}$$

- (b) Smakhtin, et.al, (2002) suggested a modification to account for water use for maintaining ecology and environment

$$\text{WSI} = \text{Withdrawal} / (\text{MAR} - \text{Environmental water requirement for aquatic Eco-system})$$

- (c) At the 3<sup>rd</sup> World Water Forum in March 2003, ICID suggested the following relationship

$$\text{WSI} = \text{Withdrawal} / (\text{MAR} - \text{Society's need for food, people and nature as evidenced by consumptive use})$$

The following indicators have been proposed in this study undertaken under CPSP in Indian basins (CPSP Reports 1 and 2, 2005)

The views of indicators is primarily aimed at abstracting the impact of human use on water availability and extend the outcome of sample basins to recommend policies on the basis of similarities and dissimilarities in the state of overall situation at the basin level. The following four indicators of the “water situation” are being used.

Indicator 1:	Withdrawals/ Total input to surface water
Indicator 2:	Returns/ Total input to surface water
Indicator 3:	Withdrawals/ Total input to groundwater
Indicator 4:	Returns/ Total input to groundwater

These indicators are considered relevant due to following reasons:

1. Whenever there is a large groundwater use, one needs indicators, which reflect water uses from both surface and groundwater sources.
2. The WSI as defined based on ‘withdrawals’; out of which a substantial part may return. Either one needs to consider the returns as an additional resource, adding to the natural runoff, or, one needs to consider the ‘net consumptive use’ rather than withdrawals.
3. The change suggested by Smakhtin, et.al presupposes that the environmental water flow requirement for aquatic eco-system has an overriding priority, and only the rest of the water flow is available for any use for terrestrial natural Eco-systems, food or people. This does not appear appropriate for many basins that are water-deficit or at a threshold level. The in-stream environmental uses is in terms of flow requirements and not have consumptive nature as in other cases and can instead be considered as one of the requirements, competing with others. It just provides a habitat and remains un-consumed till it reaches the ocean.

4. The methodology for computing the MAR by considering the withdrawals and returns has not been explained by Alcamo and Smakhtin. Since large land use changes can also affect the natural supply, this becomes more complex. Either a 'natural' land use, which does not allow for human interventions through agriculture, or a 'pseudo-natural' condition, where agriculture is allowed but irrigation is not, would have to be defined for this purpose. In case of Sabarmati basin, "past" conditions may correspond to a 'pseudo-natural' condition.

Instead of basing the indicator on gross withdrawals (numerator) and gross inputs (including human induced returns), these could also have been based on the net consumption (numerator) and the natural inputs (under the pseudo-natural conditions, without human interventions other than land use modification in the denominator).

The proposed indicators have been used to depict the water situations in Sabarmati basin in quantitative as well as qualitative terms. Indicators 1 and 3 depict the level of withdrawals as fractions of total water available in surface and groundwater system respectively, while indicators 2 and 4 depict the potential hazards to water quality in surface and groundwater systems respectively.

The indicators were sub divided into 3 to 4 classes each to represent the degree of water stress as given in the box 1.

#### ***Basin Classification / Grouping by Water Situation Indicators***

The water resource assessments made for Jiaodong Peninsular Basin and Qiantang River Basin have been used to extrapolate future water scenarios of nine basins of China namely; Songliao, Haihe, Huaihe, Yellow river and Inland rivers in the North China, and Yangtze, Zhujiang, Southeast rivers, Southwest rivers in the south China in order to enable countrywide appraisal. For this appraisal, all basins have been treated as single units, and no sub-basin working was done. Thus, the studies only considered the approximate average basin situations, neglecting local stress or surplus situation.

The surface water (natural runoff) and groundwater resources for these nine basins are based on the results of national water resources assessment from 1956 to 1979, in which the groundwater resources based on China water concept includes the recharge from rainfall and surface water, namely seepage loss from river and canal, irrigation recharge and lateral runoff recharge.

### **Box 1.** **Categories of Surface and Groundwater Indicators**

- (a) **Indicator 1 - Surface water withdrawals**
1. Very high stress – more than 0.8
  2. High stress – between 0.4 and 0.8
  3. Moderate stress – between 0.2 and 0.4
  4. Low stress – less than 0.2
- (b) **Indicator 2 - Surface water quality**
1. High threat – more than 0.2
  2. Moderate threat -between 0.05 and 0.2
  3. Low or no threat – less than 0.05
- (c) **Indicator 3 -Groundwater withdrawals**
1. Very high stress – more than 0.8
  2. High stress – between 0.4 and 0.8
  3. Moderate stress – between 0.2 and 0.4
  4. Low stress - less than 0.2
- (d) **Indicator 4 -Groundwater quality**
1. Very high threat – more than 0.8
  2. High threat - between 0.4 and 0.8
  3. Moderate threat – between 0.2 and 0.4
  4. Low threat – less than 0.2

The surface water and groundwater withdrawals take the average values from 1997 to 2001 that represent the available water use situation. These data were taken from annual report of Chinese Water Resources. The consumptive uses for three sectors, agriculture, industry and domestic are from annual report of water resources for the respective basin.

Table 6 gives a comparison of water situation for the nine basins in the present (2000) condition. Based on the concept of BHIWA model, the total inputs to groundwater are the sum of groundwater resources and return flow from well irrigation. The total inputs to surface water (river) are the sum of surface water resources and returns. The return flow from well irrigation was estimated as the total recharge to groundwater minus groundwater resources based on the groundwater assessment of plain area. The returns to surface and groundwater were estimated from the surpluses of agriculture, industry and domestic water use (water withdrawals minus consumption).

This table was prepared only to depict a generic appraisal without detailed study. Exports such as Yellow river exports water to Haihe basin, and Yellow river and Yangtze export

Table 6.  
Water Situation Indicators of River Basins in China

Basin	River Waters						Groundwaters			
	Total input (BCM)	Total returns (BCM)	Total withdrawal (BCM)	Withdrawal/ input (Indicator 1)	Returns/ input (Indicator 2)	Total input (BCM)	Total returns (BCM)	Total withdrawals (BCM)	Withdrawal/ input (Indicator 3)	Returns/ input (Indicator 4)
Songliao	175.76	10.47	34.39	0.20	0.06	64.53	16.11	27.15	0.42	0.25
Haihe	35.23	6.45	14.99	0.43	0.18	28.45	16.30	26.51	0.93	0.57
Yellow River	71.71	5.56	26.40	0.37	0.08	41.54	10.44	13.36	0.32	0.25
Huaihe	84.11	9.98	40.58	0.48	0.12	40.27	14.37	17.38	0.43	0.36
Yangtze	985.36	34.06	163.21	0.17	0.03	246.42	22.18	8.02	0.03	0.09
Zhujiang (Pearl)	492.40	23.90	79.49	0.16	0.05	111.55	12.44	4.08	0.04	0.11
Southeast Rivers	261.58	5.88	29.60	0.11	0.02	61.31	4.15	0.91	0.01	0.07
Southwest Rivers	586.36	1.05	9.01	0.02	0.00	154.38	1.93	0.23	0.00	0.01
Inland Rivers	118.63	2.26	49.27	0.42	0.02	87.88	8.15	7.44	0.08	0.09
Jiaodong Peninsula	2.68	0.28	0.58	0.22	0.10	1.03	0.35	0.88	0.86	0.34
Qiantangjiang	38.34	1.48	5.80	0.15	0.04	7.45	2.31	0.11	0.01	0.31

water to Huaihe basin have not been considered in Table 6.

Based on the Water Situation Indicators shown in Table 6, and comparing with the results of Jiaodong and Qiantang basins, the nine river basins have been classified as shown in Table 7. In regard to surface water, Yellow river (Huanghe), Huaihe, Haihe (called Huang-Huai-Hai) and inland basins all have higher stress, that is, higher development rate of surface water, if considering exports from Yellow river to other basins, the stress to surface water in the Yellow river basin would be higher than estimated values. In regard to groundwater, Songliao, Haihe and Huaihe have higher stress, especially Haihe basin; the exploitation rate of groundwater reaches 93 percent. While the four basins in the south China, Yangtze, Zhujiang, Southeast rivers and Southwest rivers basins have all low stress through surface and groundwater withdrawals, as well as low threat to surface and groundwater quality, because of higher rainfall.

Compared to the results of Jiaodong peninsular basin

studied, the policy issues regarding water use would be likely relevant to 5 basins in the north China, but the dissimilarities also exist. For example, the stress of groundwater withdrawals in Haihe basin is similar to Jiaodong, but the stress of surface withdrawals is higher for the Huaihe basin than Jiaodong Peninsula basin, the water shortage is more serious in Haihe. In addition, the surface water withdrawals in Huang-Huai-Hai and Inland river basins are highly stressed than in Jiaodong basin. While the WSI values four basins in the south China are similar to those of Qiantang river basin, especially Yangtze and Zhujiang basins, where policies to increase groundwater withdrawals, in future, might be necessary.

#### 2.4 Policy Interventions Emerging from the Studies

The detailed hydrologic modelling and analysis of the two basins for various scenarios provided a greater insight into the understanding of the water resources of the basins. The holistic view of the assessments taken through the modelling gives a sound and much broader basis to describe the state of water availability and the likely water use under

**Table 7.**  
**Basin Classification/Grouping Based on Water Situation Indicators**

Indicator	Water source and type	Category	Value	Basins
1	Surface water withdrawal	Very highly stressed	>0.8	None
		Highly stressed	0.4 – 0.8	Haihe, Huaihe, Inland rivers
		Moderately stressed	0.2 – 0.4	Songliao, Yellow River, Jiaodong Peninsula
		Low stress	<0.2	Yangtze, Zhujiang, Southeast, Southwest, Qiantangjiang
2	Surface water quality	Low threat	<0.05	Yangtze, Zhujiang, Southeast, Southwest, Inland, Qiantangjiang
		Moderate threat	0.05 – 0.2	Songliao, Yellow River
		High threat	0.1 – 0.20	Haihe, Huaihe, Jiaodong Peninsula
3	Groundwater withdrawal	Very highly stressed	>0.8	Haihe, Jiaodong Peninsula
		Highly stressed	0.4 – 0.8	Songliao, Huaihe
		Moderately stressed	0.2 – 0.4	Yellow River
		Low stressed	<0.2	Yangtze, Zhujiang, Southeast, Southwest, Inland, Qiantangjiang
4	Groundwater quality	Very high threat	>0.8	None
		High threat	0.4 – 0.8	Haihe
		Moderate threat	0.2 – 0.4	Songliao, Yellow River, Huaihe, Jiaodong Peninsula, Qiantangjiang
		Low threat	<0.2	Yangtze, Zhujiang, Southeast, Southwest, Inland

different sectors under various future scenarios at the basin / sub-basin level; source-wise - surface and groundwater separately and interaction between the two. Modelling has been used to develop a set of indicators, which help in understanding the current water scene for other basins of China. Similarly, the modelling has allowed the testing of various possible land and water use scenarios, in regard to their hydrologic implications, and allows assessment and integration of the individual water use sectors. Following is a summary of important points that have emerged, and may need to be studied further for suitable modifications in the Water Law of China adopted in 2002.

## 2.5 Summary of Findings

### 2.5.1 Change in the perception of water resources

Improvement of water management has become a common concern of all people in China. From the perspective of the economic and social development, it would be necessary to change perception of water resource availability by promoting water resources management at a better level. The following important aspects need to be considered for better water management.

- Developing harmonious coexistence between man and nature for sustainable development;
- Change in the perception that water is inexhaustible to the recognition that freshwater resources are limited;
- Paying special attention to the prevention of human damage to water while preventing water damage to mankind;
- Shifting focus on water development, utilization and management to water allocation, conservation and protection while developing, utilizing and managing water resources;
- Emphasizing water works management through strengthening non-structural measures and scientific management of water works;
- Matching water supply according to demand;
- Developing pressurized irrigation systems and promoting efficient water use.
- Realizing water as a natural gift, structural measures should be taken up for its optimum utilisation.
- Proper Management and monitoring of water quantity and quality in all uses.
- Promoting re-use of poor quality water.
- Integrating water allocation, distribution and management.

### 2.5.2 Areas of Sustainable Use of Water Resources

*Developing water resources and expanding the capacity of water supply*

- Optimizing regional and sectoral allocation of water resources
- Strengthening evaluation of water resources development and utilization
- Constructing number of water resources development and utilization projects
- Promoting the comprehensive use and multi-purpose development of water resources
- Developing alternative water resources

*Increasing the water use efficiency and saving water*

- Strengthening water conservation and management
- Formulating national and local, middle and long term plan for water supply and demand
- Extending water saving in irrigation with enhanced vigour
- Promoting water saving practice in industry
- Promoting water saving in municipal use
- Publicizing vigorously water saving practices through news media like radios, television and newspapers, mobilizing the public participation.

*Protecting water resources and improving water environment*

- Drawing up overall plans for the protection of water resources and water environment in all the river basins
- Strengthening the water environment monitoring
- Strengthening water environment protection in urban and rural areas
- Strengthening scientific research for the protection of water resources and improvement of water environment, popularising new technologies of water environment control through experiments and demonstrations.
- Publicizing the importance of water resources protection and water environment improvement, mobilizing the public support and participation.

### 2.5.3 Measures for Sustainable Use of Water Resources

*Optimal allocation*

- Formulate water resources planning, specify water resources macro control index.
- Formulate water allocation schemes and indices as well as reliable measures for Provinces, river basins and the whole country;

- Coordinate water use for nature, food and people sectors based on total allocated water amount,
- Implement water-drawing permit; formulate contingency water supply plan during dry seasons and prioritise water uses,
- Development of contingency policies and measures to guarantee water use safety;
- Optimise inter-river basin and inter-region water allocation on the basis of scientific research and analysis;
- Formulate water rights and rotation systems suitable for the country's situation and market economy.

#### *Effective Protection*

- Formulate water resources protection program of major rivers,
- Divide water function areas, specify amount of waste and total discharge of various pollutants in the river system so as to realize total amount of control for waste discharge;
- Establish an economic compensation system for water resources protection and eco-system rehabilitation
- Formulate GDP statistics index for pollution control
- Specify water source protection zones for providing safe drinking water for urban and rural population over 200,000;
- Readjust industrial structure to encourage clean production so as to control pollution at the source;
- Implement wastewater discharge permit.

#### *Effective utilization*

- Formulate national policies on water saving,
- Designate micro water use quota for different areas, different sectors and different products specifying water use index of 10,000 Yuan GDP of various sectors, and water-saving evaluation index,
- Develop and utilize water-saving technology and equipment,
- Increase waste treatment and reuse of industrial water.
- Develop water-saving in industry,
- Establish water saving societies in cities to improve water use efficiency

#### *Appropriate development*

- Develop new sources appropriately to improve distribution and water supply safely for conserving water.

- Solve drinking water problem to poor people and guarantee water supply for economic and social development.
- Construct storage projects to make full use of local water resources;
- Develop inter-river basin and inter-regional water transfer projects after overall planning and scientific research;
- Rationally utilize groundwater resources in areas with potential;
- Increase utilization of rain and floodwater, speed up wastewater treatment and reuse of industrial and domestic water, seawater desalination and direct use, and other unconventional water utilization.

#### *Scientific management*

- Revise “Water Law” and formulate “River Basin Law”, “Water-Saving Law” to establish and improve the legal system for water resources management.
- Promote the water management system with integrated urban and rural water management;
- Establish an integrated, authoritative and efficient water resources management system for major rivers and develop sound water project operation mechanism to realize effective combination of river basin management and regional management;
- Coordinate the use of surface water and groundwater, as well as the use of local water resources and water transferred from other areas to achieve effective and efficient uses;
- Establish water resources real-time monitoring system, distribution system and management information system.

#### *Increased financial input*

- Divide the rights and responsibilities between the central and local government and among the government, market, beneficiaries; and investors of water projects.
- Implement active fiscal policies to increase government input in water resources development and utilization.
- Establish a rational water pricing mechanism and make full use of the market system to raise funds for water projects;
- Mobilize the public to participate in water development through policies and measures.



## ANNEXURES

### ANNEXURE 1

#### A BRIEF OF VARIOUS WORKSHOPS, CONSULTATIONS AND MEETINGS ORGANIZED FOR CPSP STUDY, CHINA

##### **Preparatory workshop, 11-12 November 2002, Beijing**

A preliminary workshop organized by the secretariat of Chinese National Committee on Irrigation and Drainage (CNCID) was held in November 2002 and a Project Lead Team consisting of Director Generals from the Ministry of Water Resources (MOWR) and from Provincial Water Conservancy Departments, a Project Work Team composing of specialists from MOWR, China Institute of Water Resources and Hydropower Research (IWHR), CNCID and Zhejiang and Shandong provincial water conservancy departments, and a Consultant Team were established and the detailed program for this project was made (CNCID, 2002). The workshop considered that the CPSP project is of great significance to China's irrigation development, rational allocation of water resources, and food security. More than fifty professionals from Govt. Departments, academic and research institutions participated in the workshop and launched basin water assessment studies.

##### **ICID Session in Third World Water Forum, Kyoto, Japan on 11-12 March 2003**

Status report of the CPSP studies in India and China were presented in the Special Session for apprising the office bearers of ICID and other delegates attending the Third Water Forum.

##### **Basin Level Consultation, July 2003, Beijing**

After over half year of data collection and model study,

a draft general report about the water availability assessment for the present status and projection for water balance and food security for future scenarios in the two selected basins was prepared and a basin level consultation was subsequently held in July 2003 at Beijing. After soliciting opinions and comments from the Central Office (ICID) and domestic specialists, this report was revised and a national level water and food assessment was made that involved nine major river basins of China.

##### **Presentation of CPSP studies in a Special Session, 17 September 2003, Montpellier, France.**

Status report of the CPSP studies in India and China was presented by the Secretary General, ICID, at the Special Session for apprising the office bearers of ICID and other delegates who attended the 54<sup>th</sup> meeting of International Executive Council of ICID.

##### **Orientation Workshop on PODIUMSim, 19-20 November 2003, New Delhi.**

Over 20 professionals, modellers and resource persons both from China and India participated in the workshop. Key presentations were made by IWMI team and modellers from Central Water Commission (CWC), India, Chinese National Committee on Irrigation and Drainage (CNCID) and CPSP Central Team. An introductory presentation on WATERSim was made by Dr. Upali Amarasinghe of IWMI. It was felt that objectives of WATERSim as conceived were far beyond the scope of the CPSP.

### **Preparatory meeting for National Consultation of CNCID, 17-18 February 2004, Beijing, China**

Chinese National Committee (CNCID) organized this meeting. The meeting was attended by about 20 participants comprising professionals from CPSP China study team and officers of Ministry of Water Resources, Govt. of China. A four-member delegation from India comprising Er. M Gopalakrishnan, Secretary-General, ICID, Er. A D Mohile, CPSP Study Team Leader, Er. L N Gupta, CPSP Central Team Leader and Dr. S A Kulkarni, Director, ICID attended the meeting.

Dr. Liao Yongsong made a presentation on Chinese basin studies. He highlighted the future water and grain demand using PODIUM approach. Mr. Mohile and Mr. Gupta made detailed presentations on the BHIWA model and explained the results obtained by its application to two Indian River basins, Sabarmati and Brahmani. The participants took note of the model and opined it as a very useful tool for assessment of water needs for various scenarios of land use, industrial and agricultural growth at basin scale.

### **Chinese National Consultation, 7 August 2004, Beijing, China**

About 30 professionals including policy makers participated in the consultation. President-ICID, Ir. Keizrul bin Abdullah, Secretary-General, ICID, Mr. M Gopalakrishnan, Mrs. Qing Liyi, China Program Leader of IUCN and Dr. Shahbaz Khan, Research Director attended the consultation. President ICID, Keizrul bin Abdullah gave a talk briefing the circumstances under which ICID launched CPSP studies after Second World Water Forum. Secretary-General ICID in his address covered the background of CPSP and outcome of Indian National Consultation held in November 2003. Prof. Pei Yuansheng, Consultant of CPSP China Program presented Water Resources Development and Management Policies of China. The application of BHIWA model to Qiantang and Jiaodong basins for assessment of water use for Nature, Food and People, and extrapolation of assessment of these

basins to other basins were presented by Mrs. Mu Jianxin and Mrs. Wang Shaoli, respectively. Mr. Li Daixin, Chairman CINCID highlighted the findings of the studies and their usefulness for policy intervention in the Water Resources Development during Eleventh Five Year Plan.

### **IWMI/ICID Scenario Development Orientation Workshop for India and China, 3-4 September, 2004, Moscow**

The workshop was attended by 24 professionals comprising a wide array of relevant disciplines like engineers, economists, environmentalists, sociologists, policy makers/planners, and agronomists from China and India besides experts from ICID, IWMI, IUCN and WWF. Applications of BHIWA model to selected river basins of India and China and relevance of findings to the national level were presented in the workshop. The scenario development and the key drivers of the PODIUMSIM were also discussed.

### **ICID Special Session on CPSP, 5 September, 2004, Moscow**

The purpose of the special session was to apprise ICID family about CPCP work carried out so far. The session was attended by office bearers of ICID, professionals from National Committees of CPSP participating countries, besides ICID and IWMI professionals. ICID President Ir. Keizrul bin Abdullah said that it was possible to bring together individuals and groups of diverse views to discuss future water policies to CPSP. The detailed presentation of the BHIWA model and major findings at the selected river basin assessments were made by CPSP India and China team. Dr. Molden provided feedback on the outcome of IWMI/ICID workshop held on 3-4 September 2004 in Moscow. President Hon' Prof. Bart Schultz said that there was a need to shift the focus to other three participating countries namely; Egypt, Mexico and Pakistan and also on developing broad based scenario through a consultative process at the national level involving all stake holders. ■

## ANNEXURE 2

### A NOTE ON FOOD SUPPLY AND DEMAND IN CHINA USING CAPSIM MODEL

China is the most populous country of the world. The rapid growth of population needs increased food supply in the future, which also requires more water for irrigation. The trends of food consumption and production at the national level in the past are firstly analysed; secondly, the per capita food consumption and grain yield in year 2025 is simulated according to the past trends especially based on the results of Chinese Agricultural Policy Simulation Model (CAPSIM). Finally, food demand and supply at the two basins in 2025 is projected.

#### Past trends of grain consumption since 1980

Thanks to the sustainable economic growth and per capita income increase, the total grain consumption has steadily increased since 1980, when the economic reformation policies were adopted in China. The major characteristics of food consumption in the past two decades are that feed grain (animal feed) consumption has increased rapidly, miscellaneous grain consumption has remained steady and the consumption of food grain has increased periodically. The total grain consumption has increased by 139 million tons (Mt) from 273Mt in 1980 to 412 Mt in 2000, with an average growth rate of 2.08%. Out of which, the feed grain consumption has doubled, increasing from 38.74Mt in 1980 to 117Mt in 2000, with an average growth rate of 5.67% and food grain consumption has increased from 185 Mt in 1980 to 238 Mt in 2000, with 1.27% growth rate.

There were three significant periods of food grain consumption in the past two decades. The first period was from 1980 to 1984, when the total food grain consumption increased remarkably. With the implementation of the household contract responsibility system in the rural areas in 1978, farmer's enthusiasm for grain production was greatly encouraged than ever before. Grain and other agricultural production dramatically increased. Problems such as food scarcity and malnutrition were alleviated gradually; most people can have basic food to eat and cloth to wear at the end of this period. It is worth noting that the farmer's per capita food grain consumption increased by 32 kg within 5 years. The per capita food grain consumption in urban centres almost did not change due to increased consumption of miscellaneous food. The per capita food grain consumption reached the peak in

1984. The second period is from 1984 to 1996, when the per capita food grain consumption in both rural areas and urban centres began to decrease due to further development of rural economy and more plentiful agricultural production. The per capita food grain consumption in urban centres decreased from 141kg in 1984 to 114kg in 1996. Moreover, the per capita food grain consumption of farmers also decreased by 13 kg. The total grain consumption still increased due to the growth of total population in this period. However, the total food grain consumption began to decrease since 1996. The price of most agricultural produce in the market began to decrease owing to the excess supply of agricultural produce over demand. Consumers began to pay more attention to the quality of food.

The consumption demand of milled rice, wheat and maize etc., and staple food crops have its salient features respectively. Milled rice is mainly used as food. The food consumption of milled rice accounted for 85% in 2000. The total rice consumption increased by 34.4Mt in the past two decades, among which 7.67Mt is for urban people. The per capita rice consumption of urban people decreased by 20 kg from 77.5 kg in 1980 to 57.3 kg in 2000. The farmers' rice consumption increased by 20 kg from 80.5 kg in 1980 to 103.9kg in 2000. The ratio of wheat consumption for food to the total wheat consumption in 2000 accounted for 82%, an increase of 41.45 Mt. The per capita wheat consumption of urban people decreased from 61.4kg in 1980 to 44.3 kg in 2000 and the farmers' wheat consumption increased from 48.8 kg in 1980 to 85.4 kg in 2000. The maize consumption for food accounted for 44.8% of the total maize consumption while the maize consumption for feed was just 42.7% of the total in 1980. However, in 2000, the maize consumption for food dramatically decreased by 9.5% and the maize consumption for feed increased to 81.2%. Rapid feed demand of maize is the main result for the rapid increase of total maize consumption.

#### Projection of grain demand

The total grain demand depends on the amount of population and per capita grain consumption, which is affected by the income, urbanization level, development of agricultural production market and grain consumption

policies. The projection of the national grain demand includes the projections of food grain, feed grain, seed grain, grain for industry and wastes. The projection of food grain demand includes the demand for milled rice and other grains. The projection of feed grain demand is done through the projection of pork, beef, mutton, chicken, fish, egg and milk and the conversion ratio of meat demand to feed grain. All of these projections of grain demand are divided into two parts, viz., grain demand for urban and rural people.

CAPSIM Model simulates the grain demand in 2020 on the following assumptions:

- Population Growth: Total population of China will be 1.445 billion by 2020.
- Urbanization level: The ratio of the population in urban centres to the total population will increase to 50.9%
- Per capita income: The per capita income of urban people will increase from RMB 6,321 Yuan in 2000 to RMB 15,130 Yuan in 2020 (reference: 2000 prices) and rural people's income will increase from RMB 2290 Yuan in 2000 to RMB 4200 Yuan in 2020.

Grain demand will still dramatically increase in the coming two decades due to the huge increase of feed grain demand such as maize. The growth of total population is

the major driving forces for the growth of grain demand in the future. It is estimated that the grain demand in 2020 will amount to 507Mt. The marginal growth of population will be more than over the marginal growth of grain demand after 2010. The per capita grain demand will slowly decrease due to urbanization and agricultural market development. The per capita grain demand in 2020 will be about 169 kg and the per capita income will keep on increasing in the next 20 years. However, the non-grain demand such as livestock and aquatic demand will increase rapidly and will indirectly result in the increased demand of feed grain especially maize. The total feed grain demand will reach 199.1 million tonnes and the ratio of feed grain demand to the total grain demand will increase from 37.4% in 2000 to 39.2% in 2020.

#### Past trends of grain yield growth

Grain yield has increased rapidly since 1980 (Figure 6 shown below). In 1980, the average grain yield was just about 2.86 ton/ha, but it has increased to 4.6 ton/ha in 2000 with an average growth rate of 2.4% per year. The period of grain yield growth may be divided into three stages according to its growth characteristics. The first period is from 1980-1984, when grain yield rapidly increased. Grain yield almost increased by 900kg just in 5 years with a peak growth rate of 5.7%. The second period is from 1984 to 1995 during which grain yield steadily increased with about 1.4% growth rate. The last period is after 1995. The growth rate of grain yield is at a comparatively lower

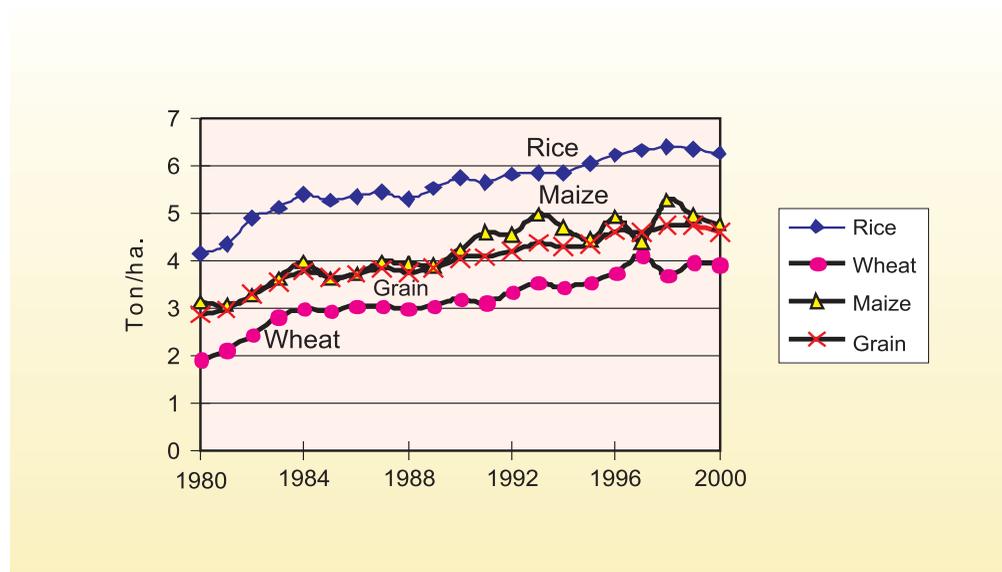


Figure 6 Grain Yield Growth in China

**Table A2-1.**  
**Projections on Grain Yield (Ton/ha)**

Year	Rice	Wheat	Maize	Other cereals	Sweet potatoes	Potatoes
1980	4.13	1.91	3.12	1.65	2.99	1.86
1990	5.73	3.19	4.21	2.00	3.32	2.41
2000	6.26	3.9	4.75	2.18	4.04	2.78
2010	6.63	4.35	5.35	2.35	4.34	3.06
2020	6.84	4.59	5.88	2.43	4.64	3.29

level of 1.1% and the average grain yield is at high level compared to the whole world.

#### **Simulations on grain yield and grain production growth of China**

Various factors exert influence on crop production as shown by past studies. Economic system reform in rural areas and advanced technology induced the growth of grain production at the earlier stages (Lin, Justin Yifu, 1992). However, some other experts argued that technology played a key role in the growth of grain yield even in the earlier period (Huan, et al., 1995, 1996). Advanced technology played a decisive role in the growth of grain yield (Zhu Xigang, 1997). In general, arable land area, domestic and

international prices of agricultural inputs and outputs, and cropping intensity are the major factors influencing the crop area under food grains. With time as the independent variable, to explain the yield growth of rice, wheat, maize, it is almost as a dull-log function. Projections on grain yield are based on the results of CAPSIM model. The results of simulation are summarized in Table A2-1.

If the total crop area remains at 153 million ha in the next two decades, the crop area of grain will be about 85 million ha in 2020. The crop area of most of the crops will decrease in the future except some vegetables and fruits with comparative advantages. It is estimated that the total cereal and grain production will amount to 520 million tons and 600 million tons by 2025 respectively. ■

## ANNEXURE 3

## EXCERPTS FROM WATER LAW AND AGRICULTURE POLICY OF CHINA

**1. General Provisions**

- 1.1. This law is formulated for the purposes of rational development, utilization, conservation and protection of water resources, control of water disasters, sustainable use of water resources and meeting the needs of national economic and social development.
- 1.2. This law is applied in developing, utilizing, saving, protecting and managing resources and controlling water disasters within the territory of the People's Republic of China. For the purpose of this law, "water resources" include surface water and groundwater.
- 1.3. Water resources are owned by the State. The State Council exercises the property of water resources on behalf of the State. The water in ponds possessed by Agricultural Collective Economic Organizations (ACEO) and the water in reservoirs constructed and managed by ACEOs are used by the respective agricultural collective economic organizations.
- 1.4. In developing, utilizing, saving and protecting water resources and controlling water disasters, overall planning should be performed in a comprehensive and systematic way with all aspects taken into account and with emphasis on multiple purpose uses and achieving maximum benefits so as to allow full play to the multiple functions of water resources and rationally allocate the water used by livelihood, production and operation, and ecological environment.
- 1.5. The people's government above county level should strengthen construction of water infrastructures and bring this into its national economy and social development plan.
- 1.6. The State shall encourage units and individuals to develop and utilize water resources under conditions prescribed by the law and protect their legal rights and interests. The units and individuals developing and utilizing water resources have the duty to protect water resources.
- 1.7. The State shall exercise water-drawing permit system and paid water use system under conditions prescribed by the law except the water in ponds and reservoirs owned and used by ACEOs and their members. The department of water administration under the State Council shall be in charge of the organization and implementation of water-drawing permit system and paid water use system at national level.
- 1.8. The State shall strictly enforce water savings and devote major efforts to pursuing water saving measures, extending up-to-date water saving techniques and arts, developing water saving industry, agriculture and services and setting up water saving society.  
  
The people's governments at various levels should adopt measures to strengthen administration to water savings, establish the development and extension system for water saving technology, and nurturing, educating and developing water saving industry.  
  
The units and individuals have the duties to save water.
- 1.9. The State shall take effective measures to protect water resources and improve ecological environment, including planting trees and grass to protect vegetation, conserve water source and prevent soil and water loss and water pollution.
- 1.10. The State stimulates and gives support to the study, extension and application of advanced science and technology in developing, utilizing, conserving, protecting and managing water resources and controlling water disasters.
- 1.11. The units and individuals that have made outstanding achievements in developing, utilizing, conserving, protecting and managing water resources and controlling water disasters shall be rewarded by the people's governments at various levels.
- 1.12. The State shall exercise a management system associated with river basin management and administrative management. The department of water administration under the State Council shall be in charge of the unified administration and supervision of water resources throughout the entire

country. The river basin management institutions of some major rivers and lakes designated by the department of water administration under the State Council shall exercise the responsibility of water administration and supervision prescribed by the law and administrative regulations and authorized by the department of water administration under the State Council within their jurisdictions. The water administrative departments of local people's governments at or above the county level shall be in charge of the unified administration and supervision of water resources within their administrative regions in conformity with the assigned limits of authority.

- 1.13. The relevant departments under the State Council shall be in charge of corresponding development, utilization, conservation and protection of water resources in conformity with the respective responsibility. The relevant departments of local people's governments at or above the county level shall be in charge of corresponding development, utilization, conservation and protection of water resources within their administrative regions.

## 2. Water Resources Planning

- 2.1. The State shall make the national strategic water resources plans. In the development, utilization, conservation and protection of water resources as well as in control of water disasters, overall planning shall be undertaken with river basin or region as basic units. Plans are classified into river basin plans and regional plans. River basin plans include comprehensive river basin plans and professional river basin plans and regional plans include comprehensive regional plans and professional regional plans. The above-mentioned comprehensive plans refer to the overall plans made for the development, utilization, conservation and protection of water resources and control of water disasters in the light of the needs for economic and social development and status quo of water resources development and utilization. The above-mentioned professional plans refer to planning for flood control, water logging control, irrigation, navigation, water supply, hydro-electric power generation, bamboo and log rafting, fishery, water resources protection, soil and water conservation, erosion prevention and control, and water savings etc.
- 2.2. The regional plans within the river basin should be

subordinated to basin plans and professional plans should be subordinated to comprehensive plans. The comprehensive river basin plans and comprehensive regional plans as well as professional plans closely related with land use should be in coordination with the plans for national economy and social development, the overall plans for land use, the overall plans for urban development and the plans for environmental protection with the demand of various regions and various sectors taken into account.

- 2.3. For the formulation of water resources planning, comprehensive scientific investigation, survey and assessment must be undertaken. The comprehensive scientific investigation, survey and assessment of water resources shall be performed by the water administrative departments of local people's governments at or above the county level jointly with relevant departments concerned at the same level. The people's governments at or above the county level should strengthen the development of information system for hydrology and water resources. The water administrative departments of local people's governments at or above the county and river basin administration institutions should strengthen the dynamic monitoring to water resources. The basic hydrologic data should be made public in accordance with relevant regulations of the State.
- 2.4. Comprehensive plans for the basins of major rivers and lakes so designated by the State shall be formulated by the department of water administration under the State Council in conjunction with relevant departments under the State Council and relevant people's governments of provinces, autonomous regions and municipalities directly under the Central Government. These plans shall be submitted to the State Council for approval. Comprehensive plans for the river basins and lakes of other inter-provincial, inter-autonomous regions and inter-municipalities directly under the Central Government shall be formulated by river basin administration institutions in conjunction with the water administrative department and relevant departments of provinces, autonomous regions and municipalities directly under the Central Government in which the rivers and lakes are located. These plans shall be submitted to the people's

government of provinces, autonomous regions and municipalities directly under the Central Government for overview and comments, then submitted to the department of water administration under the State Council for overview and lastly submitted to the State Council or department authorized by the State Council for approval. The comprehensive plans for the basins and for the regions of other rivers and lakes beyond the above-mentioned authorities shall be formulated by the water administrative departments of local people's governments at or above the county in conjunction with relevant departments at the corresponding level and relevant local people's governments. These plans shall be submitted to the people's government at the corresponding level or department authorized by the people's government at the corresponding level for approval and to the water administrative department at the next higher level for record. Professional plans shall be formulated by relevant departments of the people's governments at or above the county level. These plans shall be submitted to the people's government at the corresponding level for approval after soliciting opinions from other relevant departments at the corresponding level. Of these, the formulation and approval of plans for flood control and soil and water conservation shall be performed according to the Flood Control Law and Soil and Water Conservation Law.

- 2.5. The plans shall be strictly implemented once they are approved. Any modification on an approved plan must be submitted to the authority that originally approved the plan for approval in the light of the procedure for plan formulation.

### 3. Water Resources Development and Utilization

- 3.1. The development and utilization of water resources shall follow the policy of deriving benefits while mitigating damages, take into account the interests of both upstream and downstream, both left and right bank as well as all involved regions so as to fully realize the comprehensive benefits of water resources and shall also conform to the overall arrangement for flood control.
- 3.2. In the development and utilization of water resources, the domestic water demands of urban and rural inhabitants shall be satisfied first, while agricultural and industrial water demands as well as

ecological environmental and navigation requirements shall also be considered and taken care of. In arid and semiarid areas, the development and utilization of water resources should give full consideration to the water requirement of ecological environment.

- 3.3. For any inter-basin water transfer projects, overall planning and scientific justification must be undertaken, water demands of both the export and import basins must be considered, and any damage to the ecological environment must be averted.
- 3.4. Local people's governments at various levels shall rationally organize the development and comprehensive utilization of water resources in the light of the actual conditions of local water resources and in the principle of conjunctive development and use of surface water and groundwater, giving priority to water savings, and sewage treatment and reuse. Formulation for the plan of the national economic and social development as well as the overall plan for urban development and the layout of significant construction projects shall conform to local water resources conditions and flood control requirement. Meanwhile, scientific justification shall be undertaken; in areas deficient in water. Urban growth and the development of high water consumption industries, agriculture and services shall be restricted.
- 3.5. In areas deficient in water, the State encourages the harvesting, development and utilization of rainwater and saline water and use and desalination of seawater.
- 3.6. Local governments at various levels should strengthen the lead to irrigation, draining of water logged areas and soil and water conservation and promote the development of agricultural production. In areas prone to salinization-alkalization and water-logging, measures shall be taken to control and lower groundwater table. The agricultural collective economic organizations or their members who invest and construct water infrastructures in the collective land or contracted land owned by the agricultural collective economic organizations shall manage and rationally use the water infrastructures and water storage according to the principle that those who invest construct and manage the systems benefited. Any ACEO that plans to construct reservoir shall submit to the water

administrative department of local people's government at or above the county level for approval.

- 3.7. The State shall encourage the development and utilization of hydropower potential. On rivers rich in hydropower potential, multiple-purpose cascade development in a planned way shall be practiced. In the construction of hydropower stations, the ecological environment shall be protected, and the requirements of flood control, water supply, irrigation, navigation, bamboo and log rafting, fishery, etc., shall be taken into account.

- 3.8. The State shall safeguard and encourage the development of navigation potential. When building permanent dams and sluice gate structure on migration route of aquatic organisms and navigable or bamboo and log rafting streams, the construction unit must simultaneously build facilities for fish, ship or log passage or, after being approved by departments authorized by the State Council, take other remedial measures and also make adequate arrangements for aquatic organisms protection, navigation and bamboo and log rafting during the construction period and the initial filling period, and bear the expenses thereby incurred.

In case a non-navigable stream or man-made waterway becomes navigable after a dam or sluice gate structure is built, the construction unit shall simultaneously build ship passage facilities or reserve sites for such facilities.

- 3.9. Neither unit nor individual, while diverting, storing or draining water, shall infringe upon public interests and lawful rights and interests of others.
- 3.10. The State shall pursue open policies to resettlement due to construction of water projects and shall make proper arrangement for the livelihood and production and safeguard the lawful rights and interests of relocates. Resettlement shall be conducted together with the construction of project. The construction unit shall make plan for resettlement according to the environmental capacity of resettled areas and local conditions and in the principle of sustainable development. The local people's government shall be responsible for the organization and implementation of the resettlement after approval. The funds needed for the resettlement of the relocates shall be included in the investment plan of the project.

#### 4. Protection of Water Resources, Water Bodies and Water Projects

- 4.1. The water administrative departments of people's government at or above the county level, river basin administrative agencies and other concerned departments shall pay attention to keeping the reasonable flow of rivers and the rational water table of lakes, reservoirs and groundwater and maintaining the natural purification capabilities of water bodies.

- 4.2. Any water activity involved with the development, utilization, conservation and protection of water resources and control of water disasters shall abide by the approved plan; and they shall bear the responsibility for improvement due to violation of plan resulting in the reduction of the functions of rivers and lakes etc., water bodies, groundwater overexploitation, ground settlement and water pollution. In mining operations or the construction of underground projects, when water drainage results in cutting down of the groundwater table, groundwater depletion, ground subsidence or cave-ins, the mining unit or the construction unit shall take remedial measures, and compensate for the losses to the livelihood and production of other units or individuals,

- 4.3. The department of water administration under the State Council in conjunction with the department of environmental protection administration under the State Council and relevant people's governments of provinces, autonomous regions and municipalities directly under the Central Government shall formulate the water function zonation of some major rivers and lakes so designated by the State and submit to the State Council for approval.

The water zonation of rivers and lakes of other inter-provincial, inter-autonomous region and inter-municipalities directly under the Central Government rivers and lakes shall be formulated by river basin administration institutions in conjunction with the water administrative department, environmental protection administration department and relevant departments of provinces, autonomous regions and municipalities directly under the Central Government in which the rivers and lakes located. These plans shall be submitted to the people's government of provinces, autonomous regions and municipalities directly under the Central Government for review and comments, then

- submitted to the department of water administration under the State Council and department of environmental protection administration under the State Council for review and lastly submitted to the State Council or department authorized by the State Council for approval. The water zonation of other rivers and lakes beyond the above-mentioned authorities shall be formulated by the water administrative departments of local people's governments at or above the county level in conjunction with the environmental protection administrative departments of local people's governments at the corresponding level and relevant departments. The zonation shall be submitted to the people's government at the corresponding level or department authorized by the people's government at the corresponding level for approval and to the water administrative department and environmental protection administration department at the next higher level for record. The water administrative department of local people's government at or above the county level and river basin administration institutions shall monitor the water quality of the water zones and immediately report to the relevant people's government to take treatment measures and circulate to the environmental protection administrative department as long as the discharged amount of some major pollutants has exceeded the control index or the water quality in the water zones can not meet the requirement.
- 4.4. The State shall establish the system of drinking water source protection areas. The people's governments of provinces, autonomous regions and municipalities directly under the Central Government shall delimit the protection areas of drinking water source and take measures to prevent water source depletion and water body pollution so as to safeguard the drinking water security of urban and rural residents.
- 4.5. Discharging sewage in the drinking water source protection areas is prohibited. Any new construction, rehabilitation and extension of sewage outlet shall be approved by the water administrative departments with jurisdiction or river basin administration institutions. The report for environmental impact of the construction project shall be submitted to the environmental protection administrative department for approval.
- 4.6. As to the construction of projects that occupied irrigation water sources or irrigation and drainage facilities or, exert adverse impact to the original irrigation water source and water supply source, the construction unit shall take corresponding remedial measures and compensate for any incurred loss.
- 4.7. In groundwater overexploitation areas, local people's governments at or above the county level shall take measures to strictly control groundwater overexploitation. In severe groundwater overexploitation areas, and non-groundwater exploitation areas or limited groundwater exploitation areas can be delimited after approval from provinces, autonomous regions and municipalities directly under the Central Government. Scientific justification shall be undertaken to groundwater exploitation in coastal areas and measures shall be taken to prevent ground subsidence and seawater ingress.
- 4.8. In any river, lake, reservoir and canal, discarding or piling objects, or planting trees and growing crops of long stalk variety impedimental to flood passage is prohibited. In any river channel, constructing structure impedimental to flood passage and any activity influencing the stability of river or endangering the safety of river banks or any activity impedimental to flood passage is prohibited.
- 4.9. Building of bridge, wharf and other structures blocking, crossing or bordering a river channel; laying pipelines or cables across a river, must comply with State-specified standards for flood control and navigation as well as other related technical requirements. The project construction plan shall be submitted to the water administrative departments for review and approval in the light of the relevant regulations of the Flood Control Law.
- When existing structures or facilities require extension, modification and removal, or suffer damage because of the building of the structures or facilities listed in the foregoing clause, the construction unit of the subsequent projects shall bear the expenses for the extension and modification as well as the expenses for the compensation of losses, except when the existing structures or facilities violate relevant regulations.
- 4.10. In river channel, the State shall pursue sand mining permit system. The detailed regulations for sand mining permit system shall be stipulated by the State Council.

Any sand mining activity in river channels that influence the stability of river or endanger the safety of river banks, the water administrative department of local people's government at or above the county level should delimit mining prohibited area and stipulate mining prohibited period and announce it to the public.

- 4.11. Reclaiming parts of lakes for farmland is prohibited. The reclaimed parts shall be returned to the lake in a planned way according to the flood control standards stipulated by the State.

Reclaiming river beaches for farmland is also prohibited, in case of definite necessity; scientific justification is mandatory and must be approved by the people's government at the corresponding level after approval by the water administrative departments of people's governments of province, autonomous region, or municipality directly under the Central Government or the water administrative department under the State Council

- 4.12. Any unit and individual has the duty to protect water projects and no one shall encroach upon or damage the facilities such as dykes, bank revetments, flood control facilities, hydrologic monitoring facilities, hydro geological monitoring facilities etc.
- 4.13. Local people's government at or above the county level shall take measures to safeguard the safety of water projects especially the safety of dams and dikes within its jurisdiction and eliminate dangerous state of situation within prescribed time limit. The water administrative department shall strengthen supervision and administration to the safety of water projects.
- 4.14. The State shall safeguard the water projects. For each State-owned water project, a management and safeguard zone shall be delineated based upon the State Council's provisions.

For any water project owned by the water administrative department under the State Council or river basin administration institutions, a management and safeguard zone shall be delineated by concerned departments or river basin administration institutions after consultation with people's government of the corresponding province, autonomous region, and municipality directly under the Central Government.

For any other water project beyond the above-mentioned, a management and safeguard zone shall be delineated according to the stipulations of people's government of the corresponding province, autonomous region, and municipality directly under the Central Government.

Within the safeguard zone of a water project, activities such as blasting, well sinking, rock quarrying, earth borrowing, etc., which influence the operation and endanger the safety of the water project are prohibited.

## 5. Allocation and Economical Utilization of Water Resources

- 5.1. The development and planning department under the State Council and the department of water administration under the State Council are responsible for the macro dispatching and allocation of water resources of the entire country. The middle and long-term plan on water demand and supply of the entire country and those of different provinces or autonomous regions and municipalities directly under the Central Government shall be formulated by the department of water administration under the State Council in cooperation with other relevant departments and shall be executed upon approval from the competent development and planning department under the State Council. Local middle long-term plans on water demand and supply shall be formulated, based upon the middle and long-term plan on water demand and supply formulated by the competent department of the people's government at the next higher level based on actual local conditions, by the water administrative department of the local people's government at or above the county level in cooperation with other relevant departments at the corresponding level, and shall be executed upon approval from the competent development and planning department of the people's government at the corresponding level. The middle and long-term plans on water demand and supply shall be formulated according to the status quo of water supply, the plan for national economic and social development, the plan of river basins and the plan of regions and in the principle of coordination between water supply and demand, integrated balance, ecological protection, water savings and rational development of water resources.

- 5.2. The water allocation plans shall be formulated in the light of the plans of river basins and the middle and long-term plans on water demand and supply with river basin as the unit. Water allocation plans and water releasing plans under drought situations of different provinces or autonomous regions and municipalities directly under the Central Government shall be formulated by the river basin administration institutions in consultation with the people's government of provinces, autonomous regions and municipalities directly under the Central Government and shall be executed upon approval from the State Council or department authorized by the State Council. The other water allocation plans and water releasing plan under drought situations covering different administrative divisions shall be formulated by the water administrative department of the people's government at the next higher level after consulting with the concerned local people's governments, and shall be implemented after approval is granted by the people's government at the corresponding level. The water allocation plans and water releasing plans under drought situations must be strictly executed by relevant local people's government after approval. Any project for the development and utilization of water resources constructed on the boundary rivers of different administrative divisions shall conform to the approved water allocation plan in this river basin and shall be submitted by local people's government at or above the county level to the water administrative department of people's government at the next higher level for approval.
- 5.3. The water administrative department of local people's government at or above the county level or river basin administration institutions shall formulate the annual water allocation plan and annual water releases plan based on the approved water allocation plans and the predicted annual water inflow and shall perform integrated water release. Relevant local people's government must obey. The annual water allocation plans of major rivers and lakes designated by the State shall be brought into the annual plan for the national economic and social development.
- 5.4. In water use, the State shall pursue a system of integration between total amount controls with quota management. The sector administrative departments of the people's government of provinces, autonomous regions and municipalities directly under the Central Government shall formulate the sectoral water use quota within its administrative regions and submit to the water administrative department and quality supervision and check administrative department at the corresponding level for review and approval. The people's government of provinces, autonomous regions and municipalities directly under the Central Government shall publish the sectoral water use quota and submit to the department of water administration under the State Council and the department of quality supervision and check administration under the State Council for record. The development and planning administrative department at or above the county level in conjunction with the water administrative department at the corresponding level shall formulate the annual water use plan according to the water availability determined from the water use quota, economic and technical conditions and the water allocation plan and carry out total amount control of the annual water use within the administrative region.
- 5.5. The units and individuals who draw water directly from rivers, lakes or aquifers, shall apply forthwith water-drawing permit license from the water administrative department or river basin administrative institutions based upon the provisions of the State's water-drawing permit system and paid water use system and shall pay the water resources fees so as to get water drawing rights. For units and individuals who draw water for household use and for livestock and poultry drinking, and also for other small quantity water drawings, it is not necessary to apply for water-drawing permit license. The measures for the implementation of water drawing permit system and collection of water resources fees shall be stipulated by the State Council.
- 5.6. Water volume should be measured and used with the approvals. In water use, volumetric water use and successive accumulation system for extra water use shall be carried out.
- 5.7. The people's government at various levels shall pursue efficient irrigation methods and water saving technologies and seepage and percolation control measures shall be adopted in agricultural water storage works and water delivery works to increase agricultural water use efficiency.

- 5.8. Advanced technologies, arts and facilities shall be used in industrial water use and the recycled use times and water reuse rate shall be increased.
- 5.9. The people's government at various levels shall take effective measures to improve the drinking water conditions in urban and rural areas.
- 5.10. Those who use water provided by water-supply project shall pay water charge to the supplying unit in accordance with the State's stipulations. The water supply price shall be determined according to the principles of compensation for the cost, reasonable benefit, and high quality high price and fair share. The detailed measures shall be determined by the competent department of people's government at or above provincial level in conjunction with water administrative department or other water supply administrative department at the corresponding level within the jurisdiction.

#### **Policies for Agriculture and Rural Development in China**

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 directions of on significant policies and measures as follows:

- Stabilizing the contracted responsibility system with remuneration linked to output, improving the management system with integration of the whole and the part, prolonging the land contracted period to be unchanged within 30 years and establishing the lawful status of rural basic management system;
- Increasing the purchasing price of cereal and cotton and reforming the purchasing and selling system of cereal and cotton and major agricultural products and the circulating system of fertilizer;

- Controlling capital construction scale, adjusting investment structure and increasing agricultural income through various channels;
- Implementing the strategy of vitalizing agriculture with science and education, deepening the reform of educational system and popularizing practical agricultural techniques;
- Carrying out the provincial governor and mayor responsibilities system of "cereal bag" and "vegetable basket" and mobilizing local government's initiatives in developing agriculture;
- Facilitating the stock cooperation system actively, implementing cooperative projects between the east and the west and improving the development qualities of town and township enterprises;
- Carrying out preferential policies in poorer regions, increasing investment in poverty elimination, carrying out provincial governor responsibility system of poverty elimination, carrying out providing work as a way of relief and dressing warmly and eating to one's fill etc. large scale special poverty elimination plans and arousing the whole social strength to help the development and construction of poorer regions;
- Lightening the burden on farmers conscientiously and safeguarding the farmer's interests and initiatives;
- Conserving agricultural resources, accelerating the construction of ecological agriculture and carrying out the strategy of sustainable agricultural development;
- Strengthening the construction of rural primary organizations and solving the weakness and slackness issues in rural primary organizations. ■

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## EXPLANATORY NOTES/GLOSSARY

**Basin:** Area drained by a river including its tributaries upto its common terminus.

**Drainage area, Catchment area:** The area from which a lake, stream or waterway and reservoir receives surface flow which originates as precipitation. Also called 'watershed' in American usage.

**Drainage:** The natural or artificial removal of excess surface and ground water from any area into streams and rivers or outlets.

**Evapo-transpiration, or Consumptive use of water:** The quantity of water used by the vegetative growth of a given area in transpiration or building of plant tissue and that evaporated from the soil or from intercepted precipitation on the area in any specified time. It is expressed in water-depth units or depth-area units per unit area.

**Freshwater:** Water with salinity less than 0.5 parts per thousand.

**Groundwater:** The water that occurs in the zone of saturation, from which wells and springs or open channels area fed. This term is sometimes used to also include the suspended water and as loosely synonymous with subsurface water, underground water or subterranean water.

**Land-use pattern:** The area design or arrangement of land uses, major and minor, and of operation units convenient for cultivation.

**Mean annual precipitation:** The average over a period of years of the annual amounts of precipitation.

**Natural recharge:** It is that portion of water, which gravitates to the zone of saturation under natural conditions.

**Precipitation:** The total measurable supply of water of

all forms of falling moisture, including dew, rain, mist, snow, hail and sleet; usually expressed as depth of liquid water on a horizontal surface in a day, month, or year, and designated so daily, monthly or annual precipitation.

**Rain:** Precipitation in the form of liquid water drops greater than 0.5 mm.

**Reference evapo-transpiration (ET<sub>o</sub>):** The evapo-transpiration rate from a reference surface, not short of water is the reference crop evapo-transpiration or reference evapo-transpiration and is denoted as ET<sub>o</sub>. The ET<sub>o</sub> is climatic parameters and can be computed from weather data. ET<sub>o</sub> expresses evaporating power of the atmosphere at a specific location and time of the year and does not consider crop characteristics and soil factors.

**Runoff:** 1- Portion of the total precipitation from a given area that appears in natural or artificial surface streams. 2- Also the total quantity of runoff during a specified period. 3- The discharge of water in surface streams above a particular point. 3. Runoff is the surface and subsurface flow of water.

**Saline water:** Water which contains moderate concentration of total dissolved salts.

**Water resources:** 1- Water available, or capable of being made available, for use in sufficient quantity and quality at a location and over a period of time appropriate for an identifiable demand. 2- Supply of water in a given area or basin interpreted in terms of availability of surface and underground water.

**Water table:** The upper surface of a zone of saturation, where the body of groundwater is not confined by an overlying impermeable formation.



