

Water Resources and Sustainable Development in China

Recursos hidráulicos y desarrollo sostenible en China

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Resumen: El artículo, que fue la conferencia de clausura del V Congreso de Ingeniería Civil, recoge la situación actual de la política hidráulica en China, estudiando los recursos disponibles y la utilización de los mismos en un país cuyos avances en todos los sectores tanto están asombrando al resto del mundo. En esta comunicación, el autor plantea las soluciones que desde esa óptica se están llevando a cabo para contribuir a un desarrollo económico y social sostenible, describiendo algunas de ellas y, en especial, los tres diferentes trasvases de gran longitud (uno todavía en fase de planificación, los otros dos ya en construcción), con los que se pretende equilibrar los diferentes aportes hidráulicos.

Palabras Clave: China; Recursos hidráulicos; Trasvases

Abstract: This article formed the closing conference of the V Civil Engineering Congress and outlines the current state of water policy in China, studying the available resources and employment of the same in a country whose rampant development in all areas is taking the world by surprise. In this paper, the author describes the solutions being taken in this area to contribute to sustainable economic and social development, outlining some of the plans and making particular reference to the three different large scale water transfers (one still in the planning stage and the other two already under construction) by which the country aims to balance out its different water resources.

Keywords: China; Water resources; Large water transfers

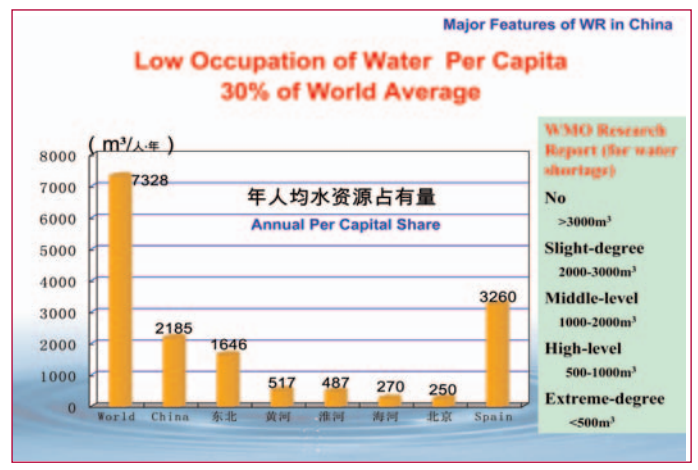
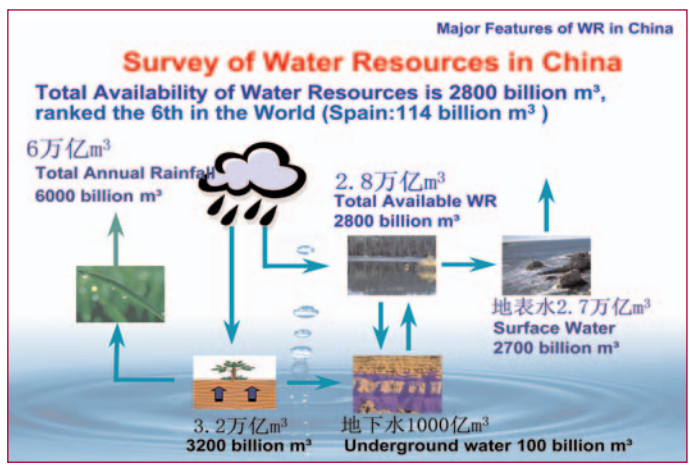
Outlines

- 1、 Basic Situation of Water Resources
- 2、 Major Challenges of Water Resources
- 3、 Globe Warming & Its Impacts on Water
- 4、 Strategies of Sustainable Utilization of Water Resources

Major Features of WR in China

- Low Occupation Per Capita
- Extremely Uneven Temporal and Spatial Distribution
- Geographic Mismatch between Water Resources and population and Economic Development
- Marked Decrease Tendency of Water Volume in North Rivers

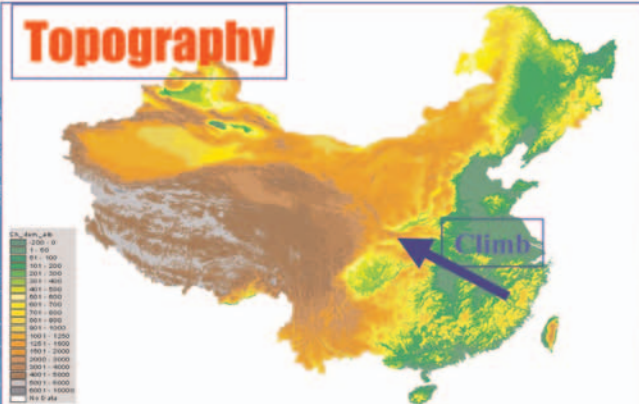
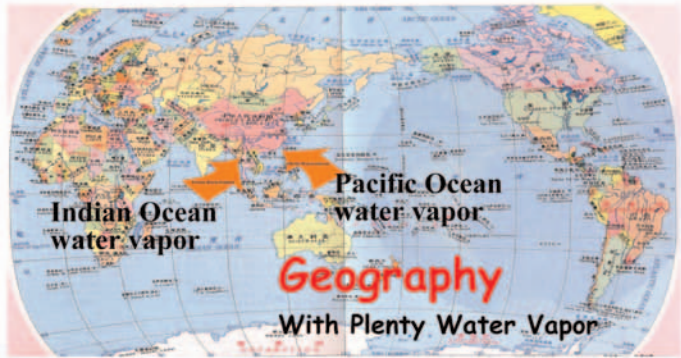
Basic Situation of WR in China



Se admiten comentarios a este artículo, que deberán ser remitidos a la Redacción de la ROP antes del 30 de abril de 2008.

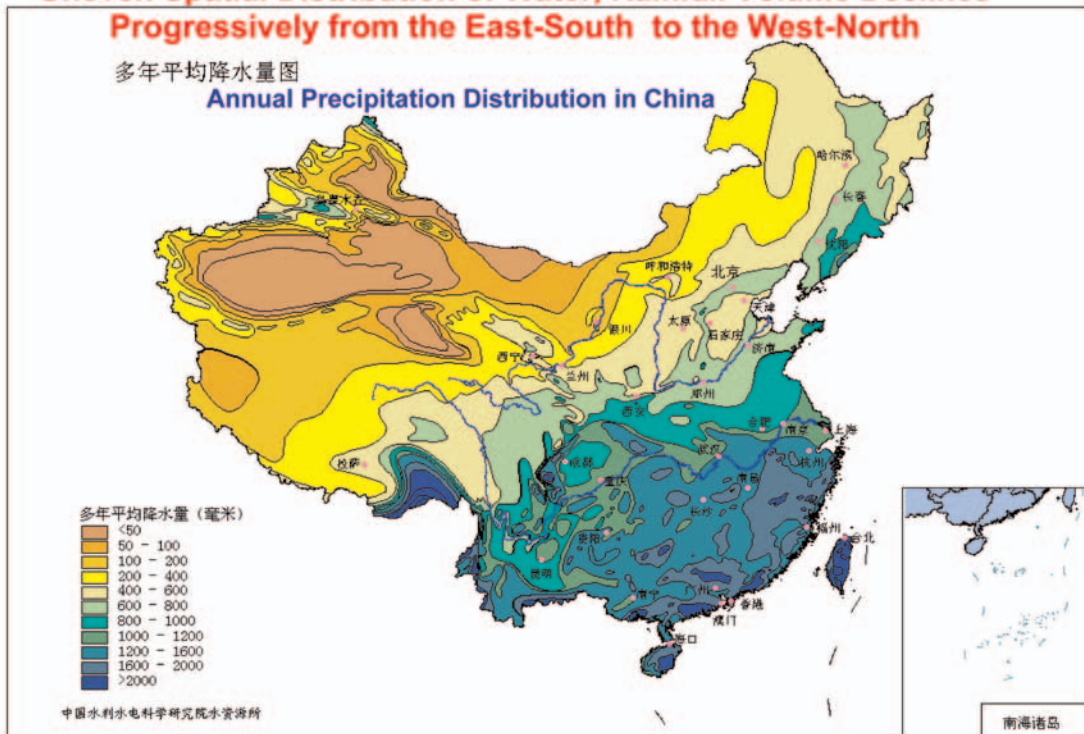
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Geography
Topography
Climate



Uneven Spatial Distribution of Water, Rainfall Volume Declines Progressively from the East-South to the West-North

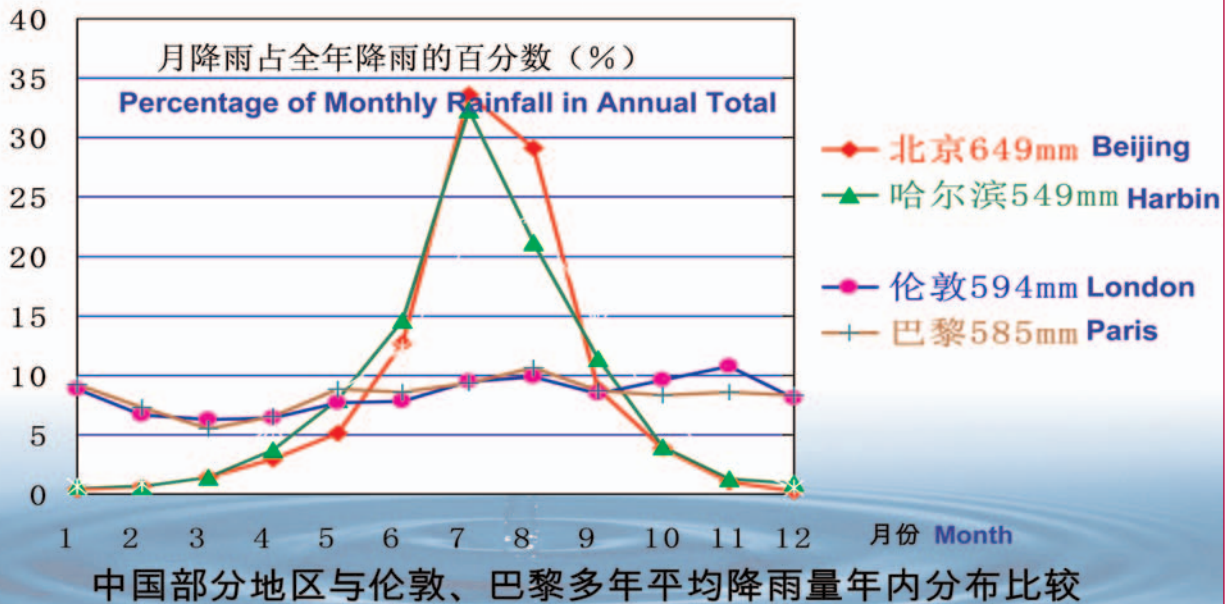
多年平均降水量图
Annual Precipitation Distribution in China



中国多年平均降水648mm，低于全球陆地平均降水量约20%，年降水总量61900亿m³。

Major Features of WR in China

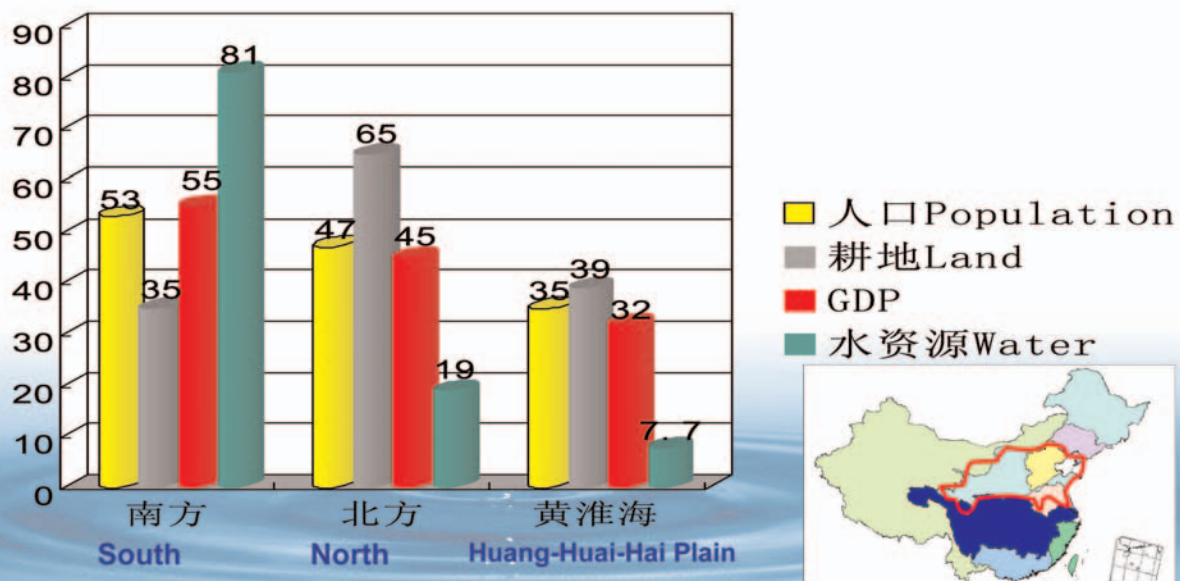
Extreme Uneven Temporal Distribution



Major Features of WR in China

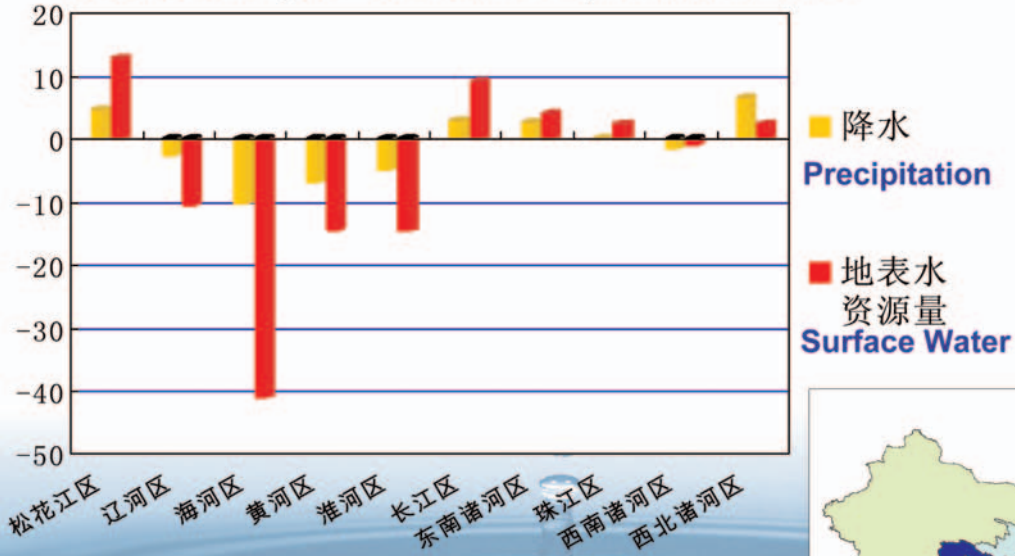
Mismatch between Water Resources and Population, Arable Land Distribution and Economic Development

占全国的比例 (%) Percentage of National Total

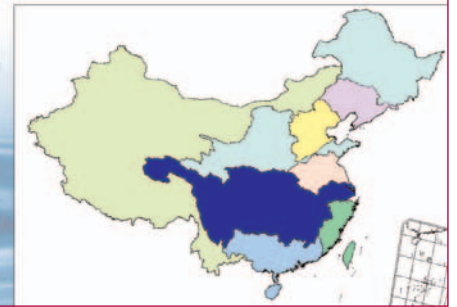


Marked Decline of Water Resources in Northern China in Recent Years

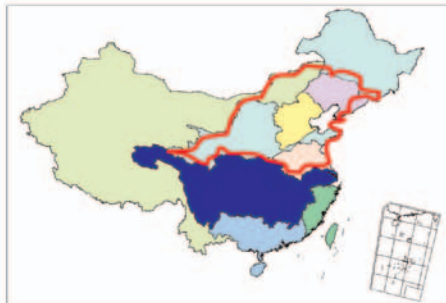
1980-2000年(第二次水资源普查)与
1956-1979年(第一次水资源普查)水资源数量比较



The 2nd water survey(2006) versus
the first water survey(1984)



Major Features of WR in China



Marked Decline of WR in Northern China

(units:100.000.000m³)

Basin	1956—79	1980—99	1980s	1990s
Haihe Basin	288	177	155	200
Yellow river	661	542	607	476
Huai river basin	622	568	567	570
HYH+SanDong	1690	1373	1415	1332
Comparing with the series of 56—79	0	-317	-275	-356
		-18.5%	-16.3%	-21.2%

Outlines

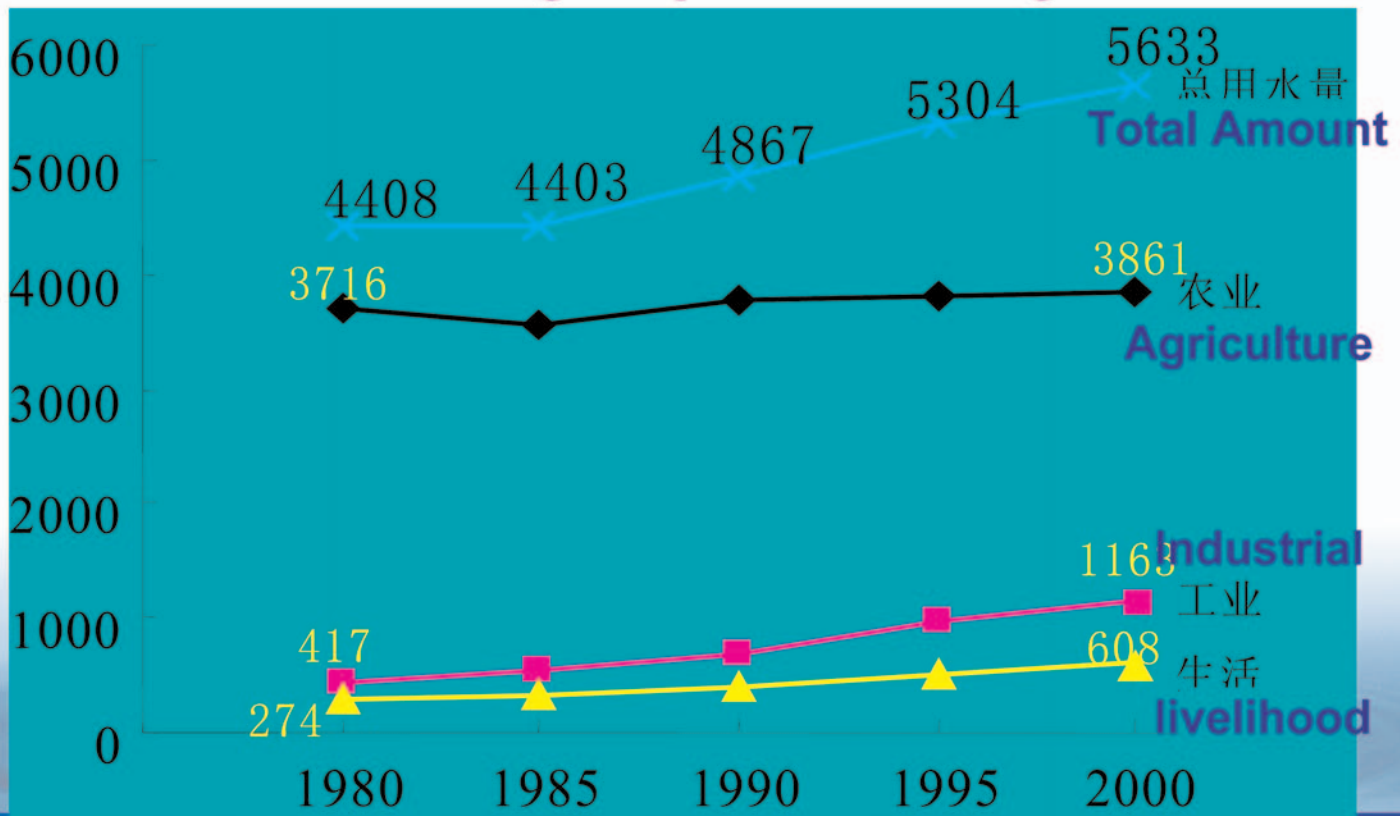
- 1、 Basic Situation of Water Resources
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- 4、 Strategies of Sustainable Utilization of Water Resources

Major Challenges of Water Resources

- (1) Sharp Conflict Between Water Supply and Demand
- (2) Low Efficiency of Water Utilization
- (3) Marked Water Pollution Problems
- (4) Increasing Degradation of Eco-Environment

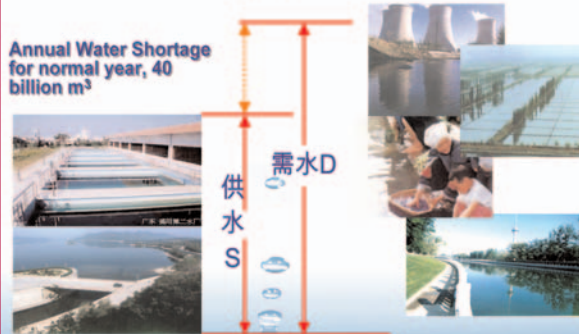
Major Challenges of Water Resources

全国城乡用水急剧增加
Water Usage Rapid Increasing



Major Challenges of Water Resources

1. Sharp Conflict Between Water Supply and Demand



There are more than 400 cities short of water supply in China, among which about 110 cities are extremely short of water supply. Sharp conflict between supply and demand

Major Challenges of Water Resources

The Sharp Conflict Between Water Supply and Demand has Caused:

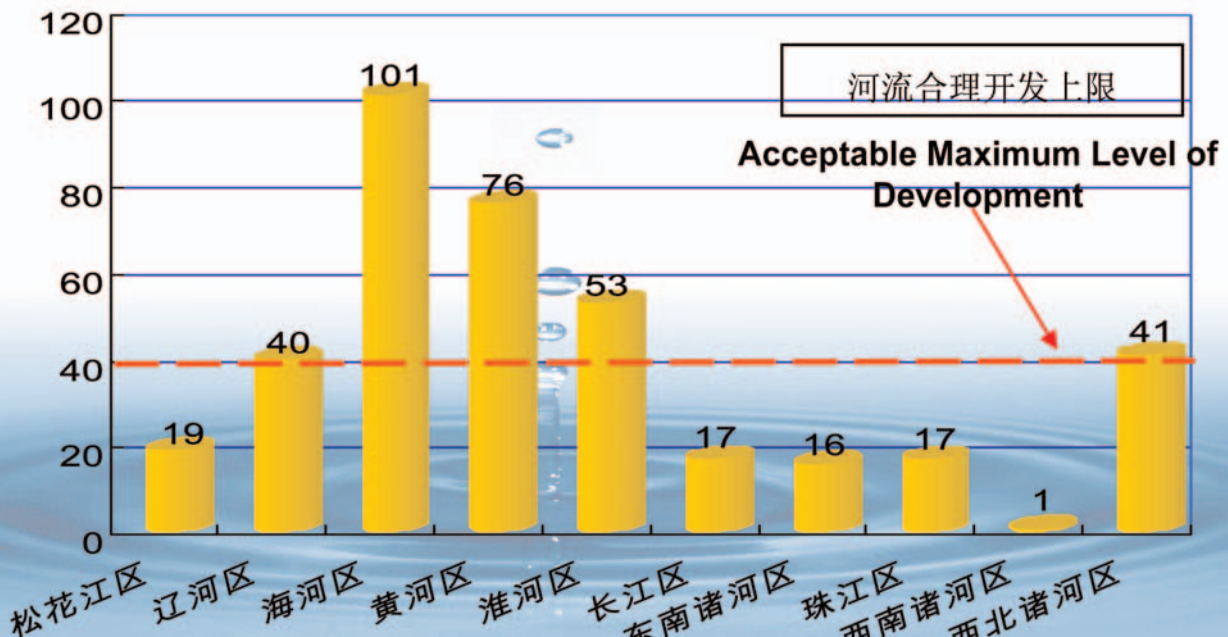
- Rising serious eco-environment problem with over-development of surface water and underground water
- Restrict the economic development with limited water supply
- Effect public live (more than 400 cities short of water, some of these cities supply water only few hrs per day)

Sharp conflict between supply and demand

Major Challenges of Water Resources

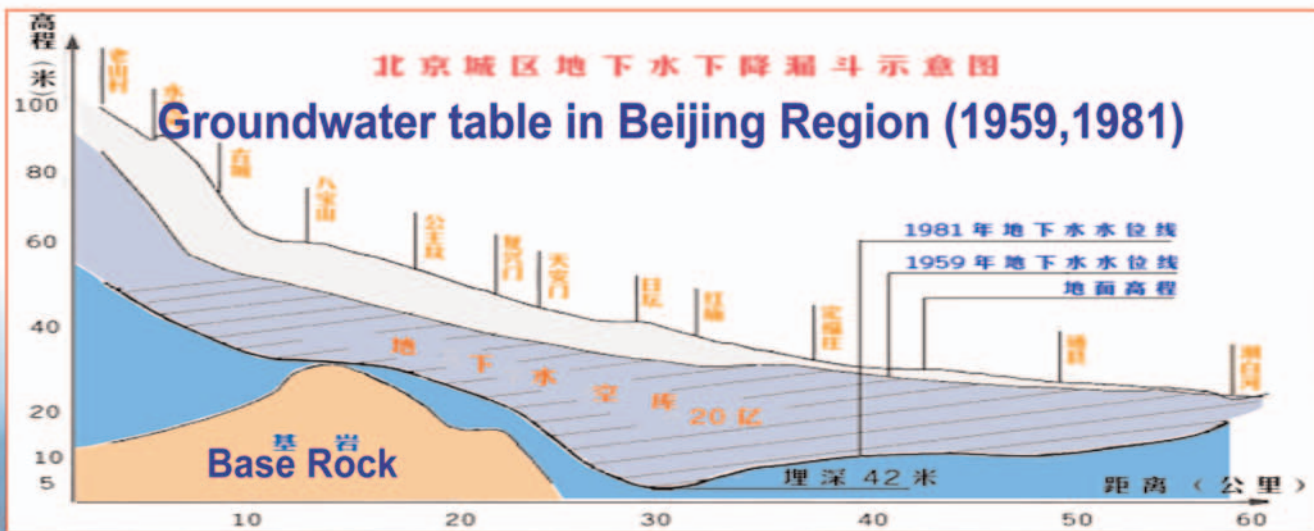
- River flow development over its potentials;
- Haihe river (101%) , Yellow river(76%), Huaihe river (53);
- The acceptable max level of development for river flow is 40%(WMO)

% Actual Level of Development of river flow in China



Major Challenges of Water Resources

- Groundwater over-drawn 7.4 billion m³ annually
- 164 areas with marked over-drawn of groundwater & caused eco-environmental problems, most locate in north parts.



Sharp conflict between supply and demand

Major Challenges of Water Resources

1.6 billion people by 2030

用水总量为 7000 ~ 8000 亿 m³

Demand 700-800 billion m³

全国实际可利用的水资源量 约为 8000 ~ 9000 亿 m³

Exploitable Resources 800-900 billion m³

Along with population and economic growth, the combined water demand, industrial and domestic demand in particular, will further increase, which will rise more serious conflicts between supply and demand of water.

Sharp conflict between supply and demand

Major Challenges of Water Resources

2. Low Efficiency of Water Management & Utilization in China

Index of water usage	China	Developed Countries
Consumed Water/10000GDP(RMB)	537 m ³	4×世界均值
The effective-utilization coefficient of agricultural irrigation water	0.4~0.5	0.7~0.8
Consumed water/10000RMB industrial added production	137 m ³	50 m ³
The rate of the recycling use of industrial water	50%	85%

Major Challenges of Water Resources

3. Water pollution becomes more serious issue in China.

In 2006, Sewage discharged into rivers and lakes was 73.1 billion Tons , 11.1 billion Tons more than year 2000.



Increasing Degradation of Eco-Environment

- 3.56 million km² territory affected by erosion
- Serious desertification of the grassland in pastoral areas. 90% the total 225 million hectares available grassland are experiencing serious degradation.
- Rivers stop flowing, lakes shrink, flood plains disappear, natural wet lands become dry. The water conservation capacity and regulation capacity of headwaters has decreased.
- The ground water level decreases in some areas causing the sink of ground surface and sea water intrusion

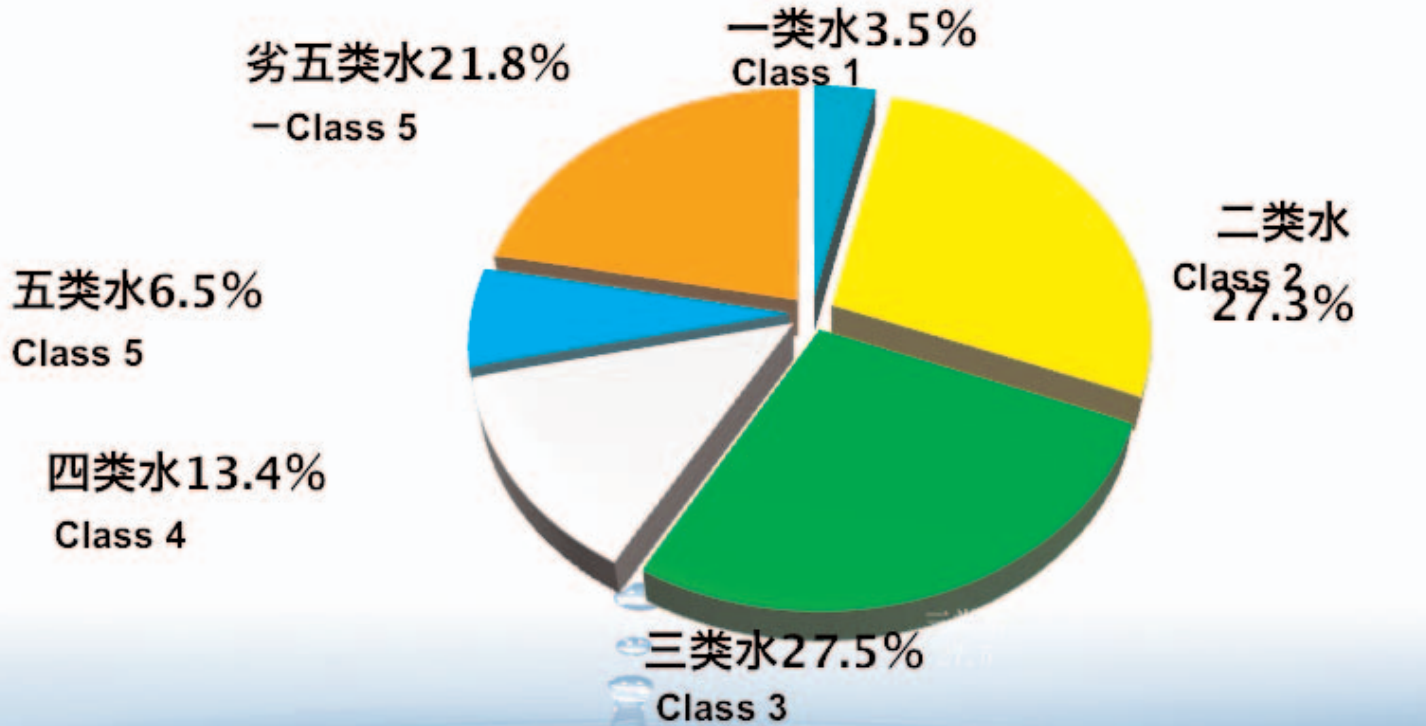


Grassland desertification



Yongdin River, beside of Beijing

Major Challenges of Water Resources



2006年13.8万公里评价河长水质评价结果

The result of the water quality assessment in 2006 with regard to a total river length of 138,000 km.

Outlines

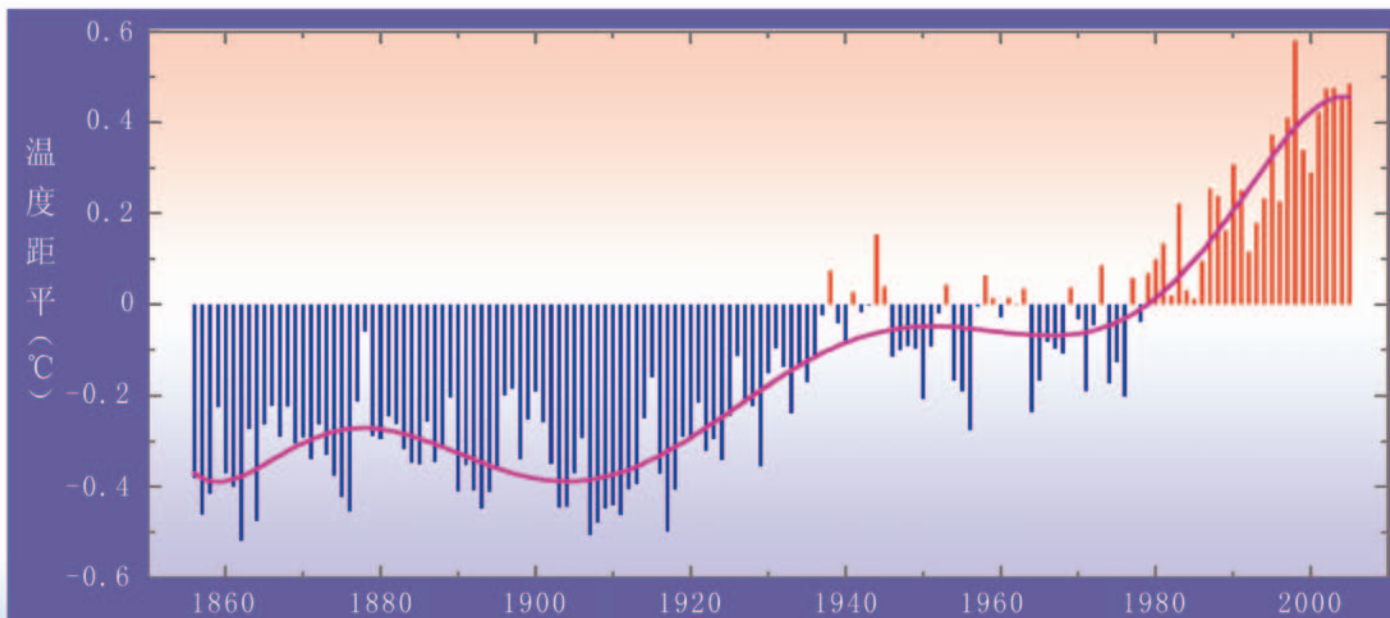
- 1、 Basic Situation of Water Resources
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- 3、 **Globe Warming & Its Impacts on Water**
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Global warming and its impacts are the current hot research issues in the world.

Apr. 2007, the Intergovernmental Panel on Climate Change (IPCC) released a report of *Climate Change 2007: Impacts, Adaptation and Vulnerability*.

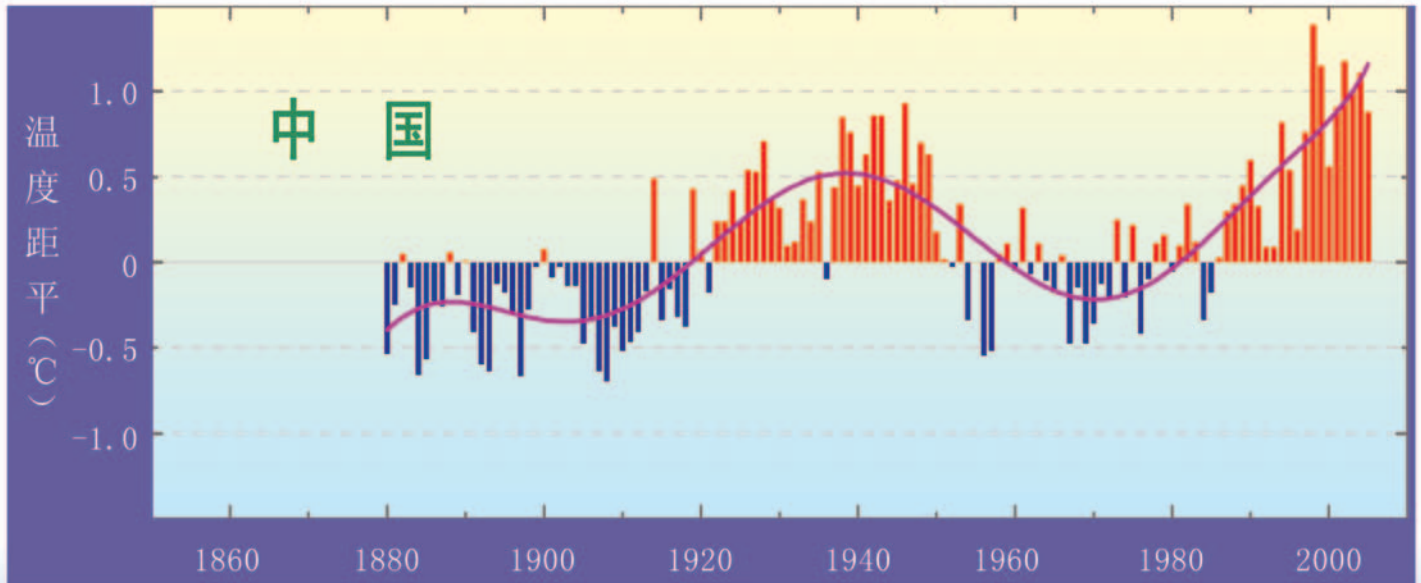
Report: Global warming will make billions of population in the Earth face the challenge of water and food shortage, and increase of natural disasters like floods, droughts and typhoons.

Global Temperature Changed in Recent 100 Years



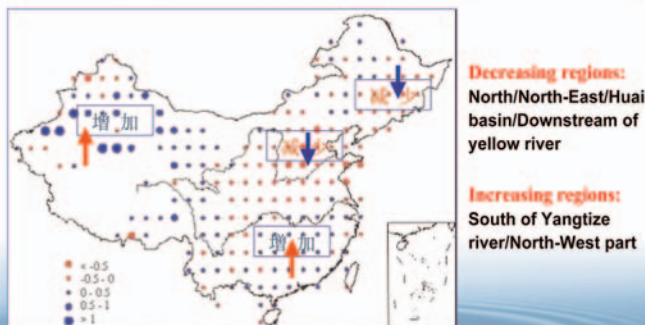
- From 1861 to 2000, Global surface temperature raised $0.6 \pm 0.2^{\circ}\text{C}$
- 1990s may be the warmest period in last century
- Comparing with 1850-1899, the mean ST in the period of 2001-2005 raised 0.76°C in total.

Temperature Changed in Recent 100 Years in China



In China, ST raised 0.5—0.8°C in recent 100 years; the raising rate in last 50 years was about 0.22°C/10a, it was little bit higher than the world

Precipitation Changed during 1951-2002 in China



1951-2002年中国年降水量变化率(‰/年, 潘家华, 2002)

Chinese Government: National Assessment Report on Climate Change (2007)



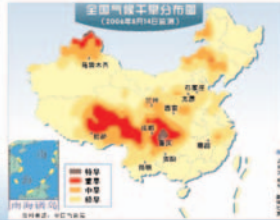
The global warming will speed hydrological cycle, the rate of evaporation and precipitation may be increased, and it may cause more extreme weather events, such as heat-wave, storm, while the cold-weather probably become less

Chinese Government: National Assessment Report on Climate Change (2007)

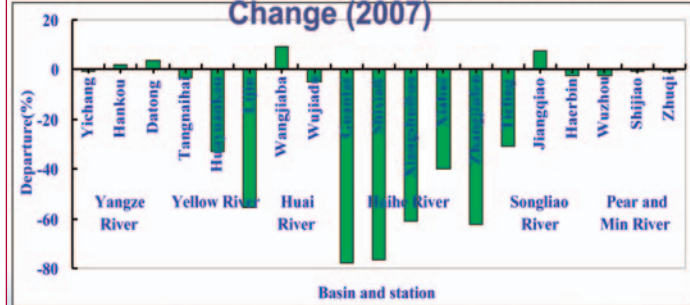
Global warming may cause more high-temperature weather and heat-wave, more frequent and wider scope of droughts

An extreme drought events experienced 2006, in China.

- Duration of more than 60 days
- High temperature ranges from 35 to 44.5 °C
- Wide-ranging Impacts



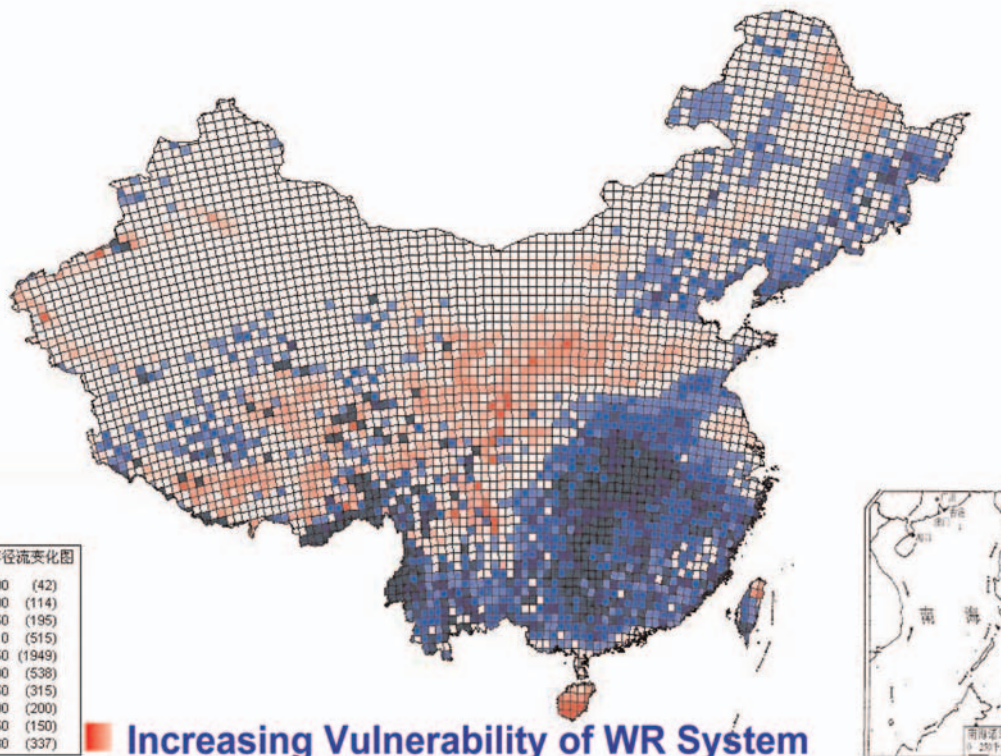
Chinese Government: National Assessment Report on Climate Change (2007)



- River Runoff Changing
- ✓ Generally, the runoff decreasing in most rivers, especially in north part rivers
- ✓ The declining trend of runoff resulted both from CC and human activities

Runoff Distribution Simulated by the A2-Scenario UK Hadley Center's RCM-PRECIS – 50km × 50km-SRES

A2情景



2071-2079年多年径流变化图

-850 to -200	(42)
-200 to -100	(114)
-100 to -50	(195)
-50 to 0	(515)
0 to 50	(1949)
50 to 100	(538)
100 to 150	(315)
150 to 200	(200)
200 to 250	(150)
250 to 3,030	(337)

Increasing Vulnerability of WR System

May cause: drier in north while wetter in south,
which will make more sharp of water issue in China

Outlines

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4.1 Building a Water-Saving Society

To build a water-saving society, to improve the efficiency and effectiveness of water use, it is the fundamental resolution to China's water scarcity.

建设节水型社会是解决我国水资源短缺问题最根本、最有效的战略举措。主要思路是：

How to establish a water-saving society

- ✦ Identify the initial water right.
- ✦ To establish two index systems:
Total Quantity at macro level (for regions) and Quota at micro level (for each water-user).
- ✦ Implement the water right trading system to realize high-efficiency allocation of water resources.
- ✦ Combining governmental regulation, market orientation and public participation.



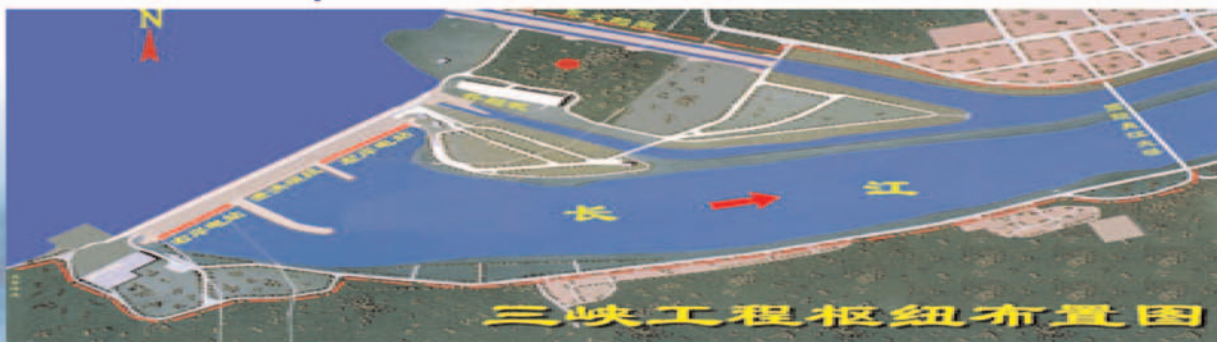
4.2 Developing and Utilizing Non-Traditional Water Resources

- Maximizing utilization of flood water (precipitation)
1.35 trillion m³ flood water, be difficult to be used for normal years
enhance flood controlling engineer and no-construction measures
- Utilization of waste water (an important resources to be utilized)
Discharged waster water reached to 73 billion tons in 2006 in China,
and will reach to 110 ~ 150 billion tons in 2050.
- Utilization of sea water
small amount has been utilized, as high-cost for the desalination



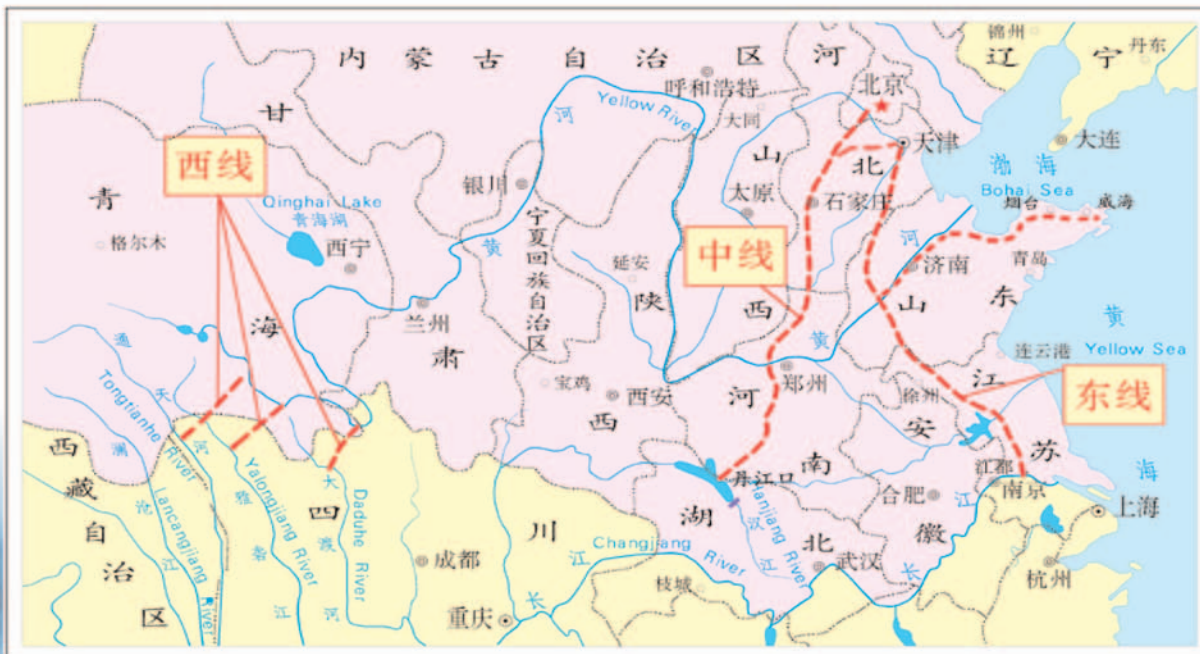
4.3 To Enhance the Construction of Water Controlling Projects

- To construct reservoirs, river dikes and flood retention areas to improve the capability to withstand natural disasters and increasing the water supply capacity
- To construct water transfer projects between basins, to realize the optimal allocation and utilization of water

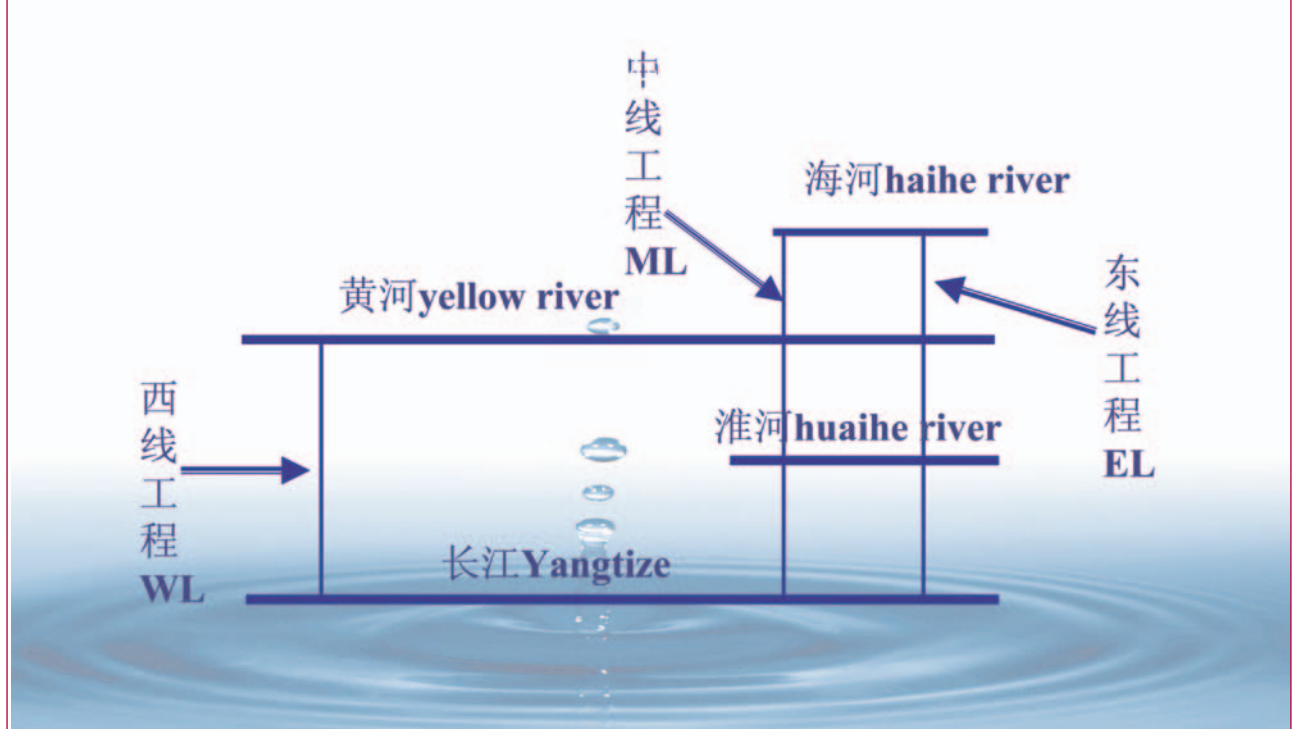


South-to-North water transfer project

3-line: East, Middle, West (W&M started to be constructed 2002)



Covers 4 basins: Yangtze, Huaihe river, yellow river and haihe river,



南水北调东线位置图
The East Route scheme of the South-to-North Water Transfer Project



East Route

- ❖ draw water from downstream of Yangtze
- ❖ Water supply to: Tianjin city, Shandong and Hebei provinces
- ❖ Route length: 1150km
- ❖ Operation: 13 pumping stations, with total pumping height 65m
- ❖ Transferring capacity:
 - Recently: 400 m³/s (water transfer 6-7 billion m³ per years, cost 5 billion RMB)
 - Middle-term : 600 m³/s
 - Long-term: 1000 m³/s



南水北调中线位置图

The Middle Route Scheme of the South-to-North Water Transfer Project

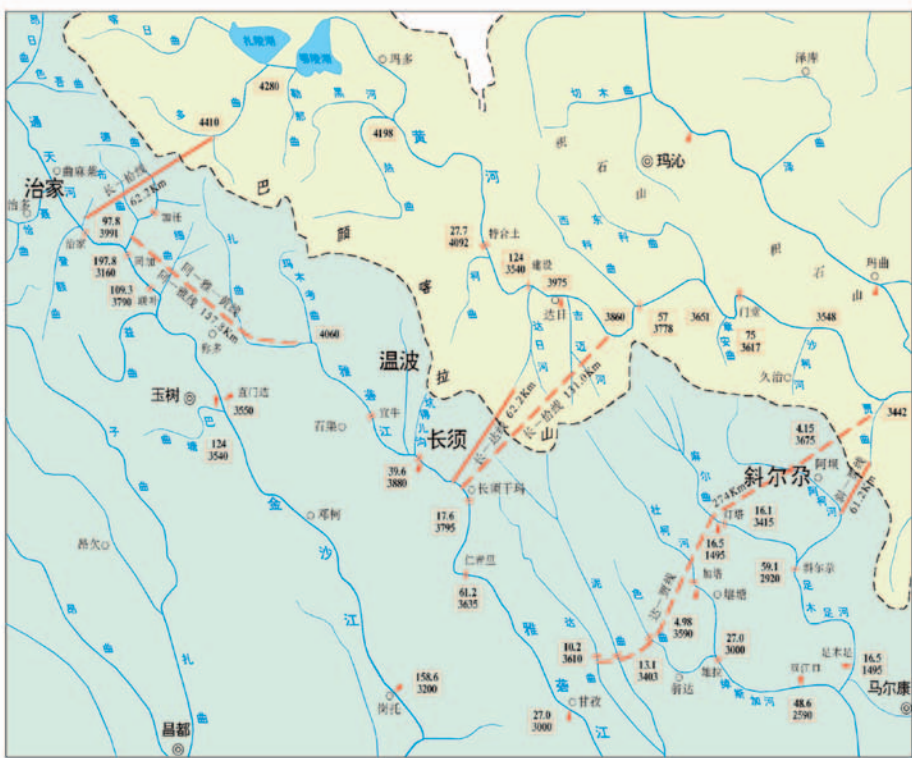


Middle route

- ❖ Discharge water from middle of Yangtze
- ❖ Water supply to: Beijing and Tianjin cities, and Hebei provinces
- ❖ Route length : 1246km
- ❖ Transferring capacity: Recently: 350 m3/s (8-9 billion m3 water transfer to north per year, cost 78 billion RMB)

West Route

Discharge water From the upstream of Yangtze river, only in the phase of planning and survey



4.4 Perfecting Policies, Regulations and Strengthening Integrated Management of Water Resources

- New Water resources assessment and planning for integrated utilization will be issued soon (2002-2007)
- Laws and regulations
 - water law
 - water resources protection law
 - water intake license
 - laws or regulations for water resources management for each river basin



Conclusions

Water resources is a fundamental natural resources and strategic economic resources, providing an important basis for economic and social sustainable development, maintenance of ecological balance and nice environment. The present problems of water resources in China have become the serious constraints of economic and social development and eco-environmental construction. With population growth, fast development of economy, rapid urbanization and gradual improvement of livelihood standard, higher requirement on safeguarding water resources safety is put forward, which makes water problems in China more prominent.

Global warming is an indisputable fact recognized by the public. Under the background of global warming, climate in China in recent 100 years changed obviously

with temperature increase and the average increase rate slightly higher than those of the globe. Influenced by climate change, the global hydrological circulation will be fastened with frequent occurrence and increasing intensity of extreme weather disasters like storms, droughts, high temperatures and strong typhoons, directly frightening water safety in China.

In view of features and existing problems of development, utilization and management of water resources in China, measures of building a water-saving society, developing and utilizing of non-traditional water resources, construct water controlling projects and enhance the integrated management of water resources are of great significance to safeguard the sustainable utilization of water resources and sustainable development of social and economic development in China.