

Development and utilization of water resources in China

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Outline

- Water Resources and its Distribution in China
- Water Requirements
- Confronting Problems
- Solutions to the Problems
- Conclusion

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1. Water Resources and its Distribution in China

CHINA



MAP OF CHINA

9,600,000km²
34 provinces
1.339 billion

圖一 兩岸中國行政區地圖的差異

1. Water Resources and its Distribution in China

CHINA



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1.339 billion

Northeast China

圖一 中國大陸行政區地圖的差異

1. Water Resources and its Distribution in China

CHINA



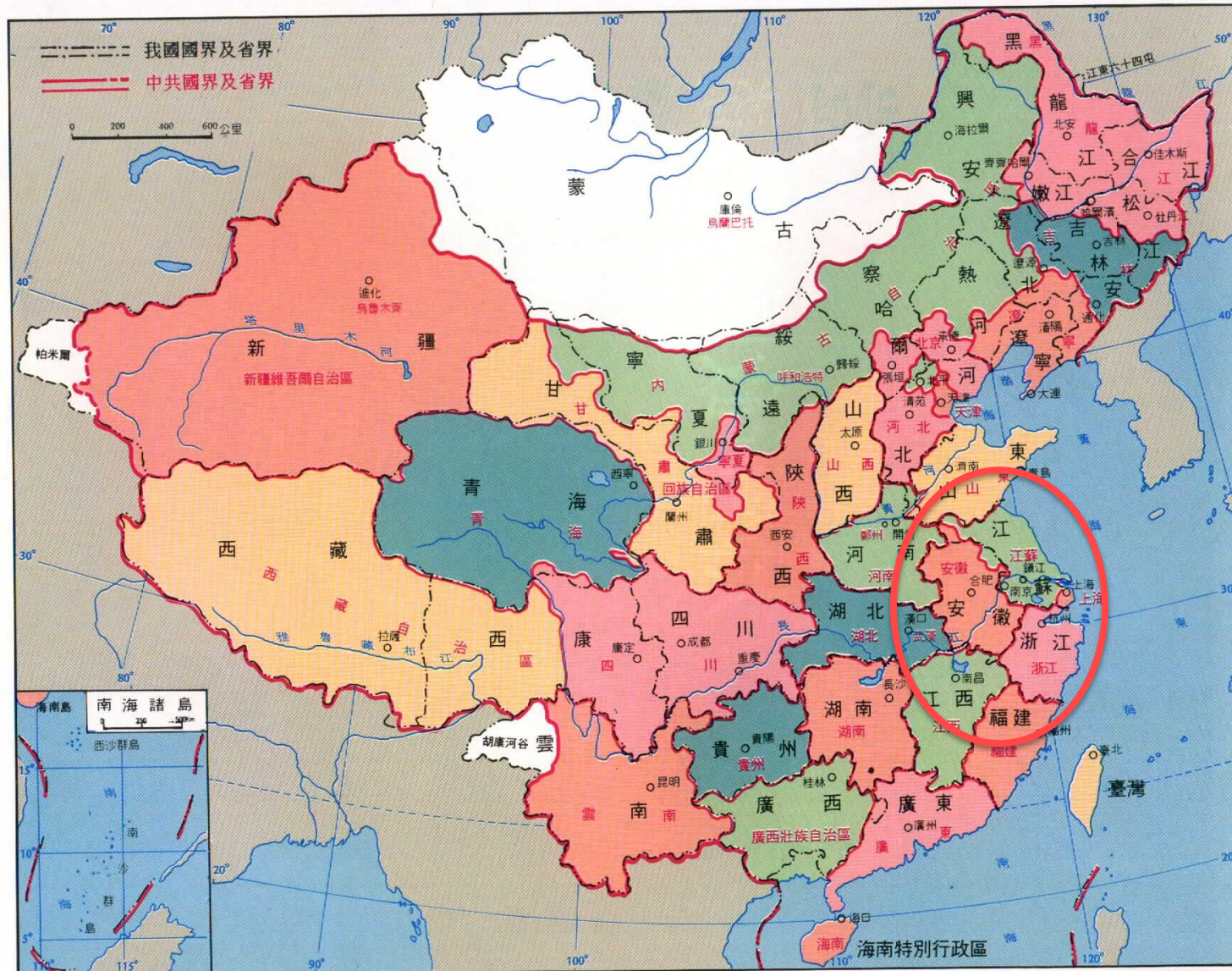
MAP OF CHINA

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North China

1. Water Resources and its Distribution in China

CHINA



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East China

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South China

1. Water Resources and its Distribution in China

CHINA



MAP OF CHINA

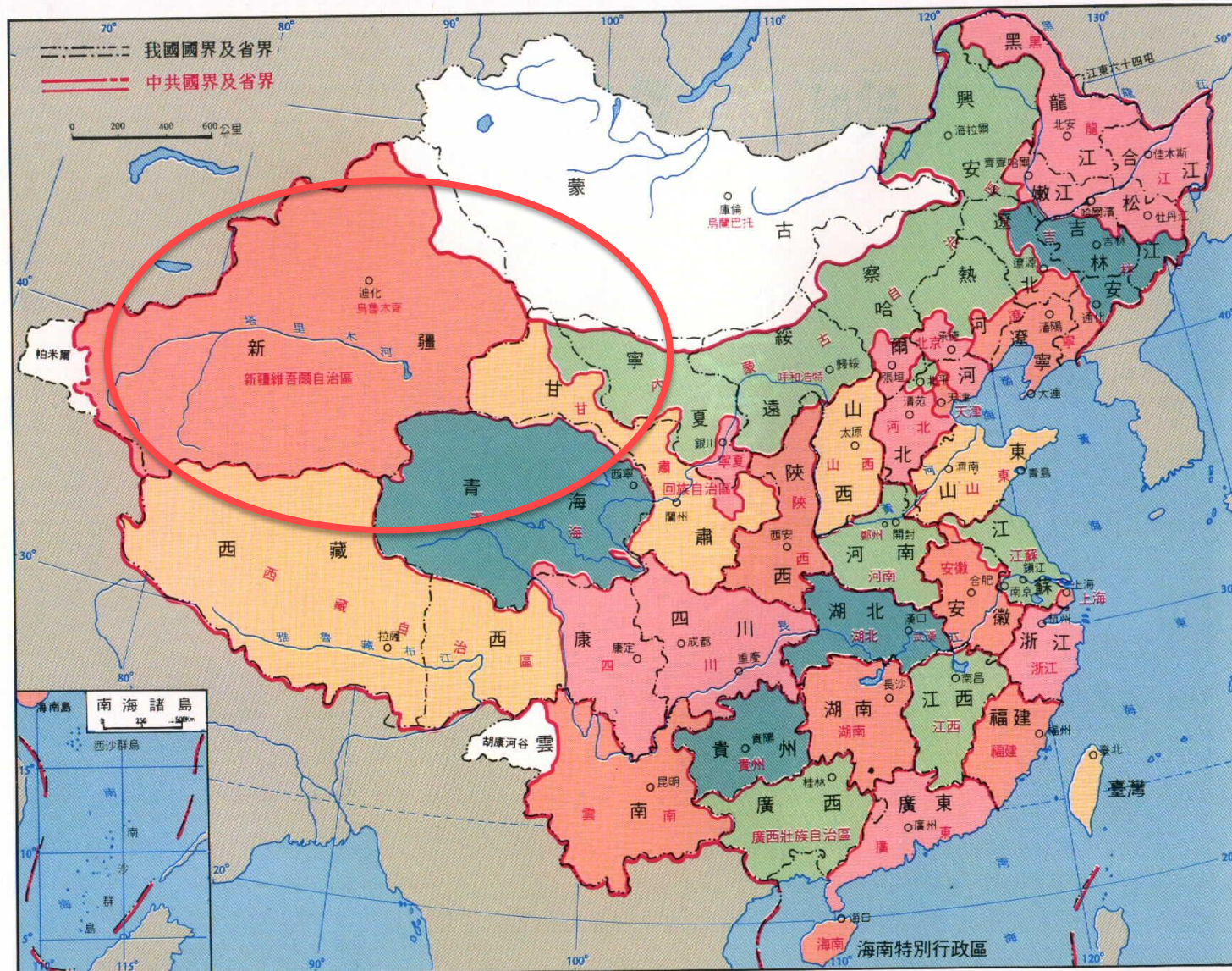
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Southwest

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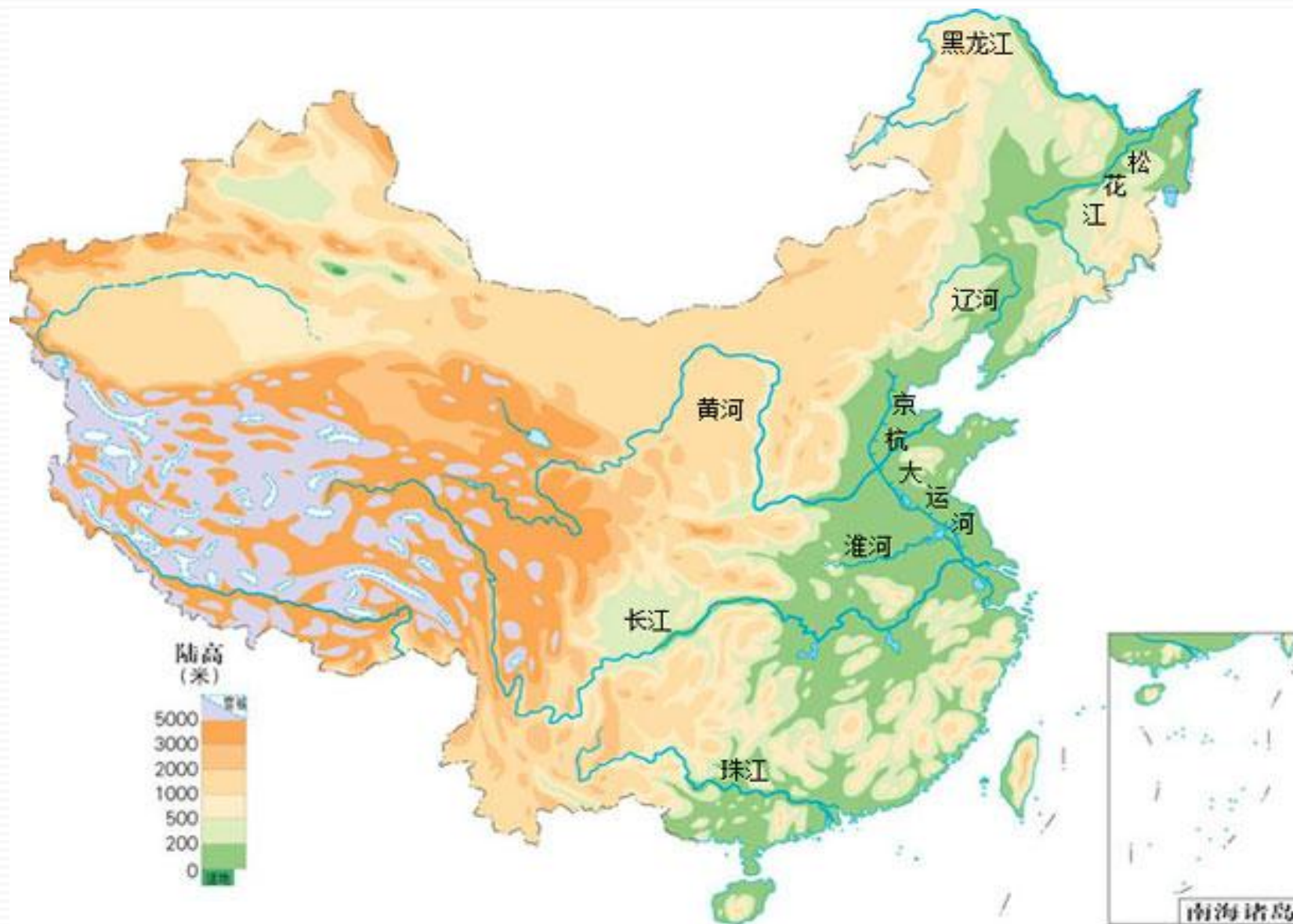
MAP OF CHINA

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Northwest

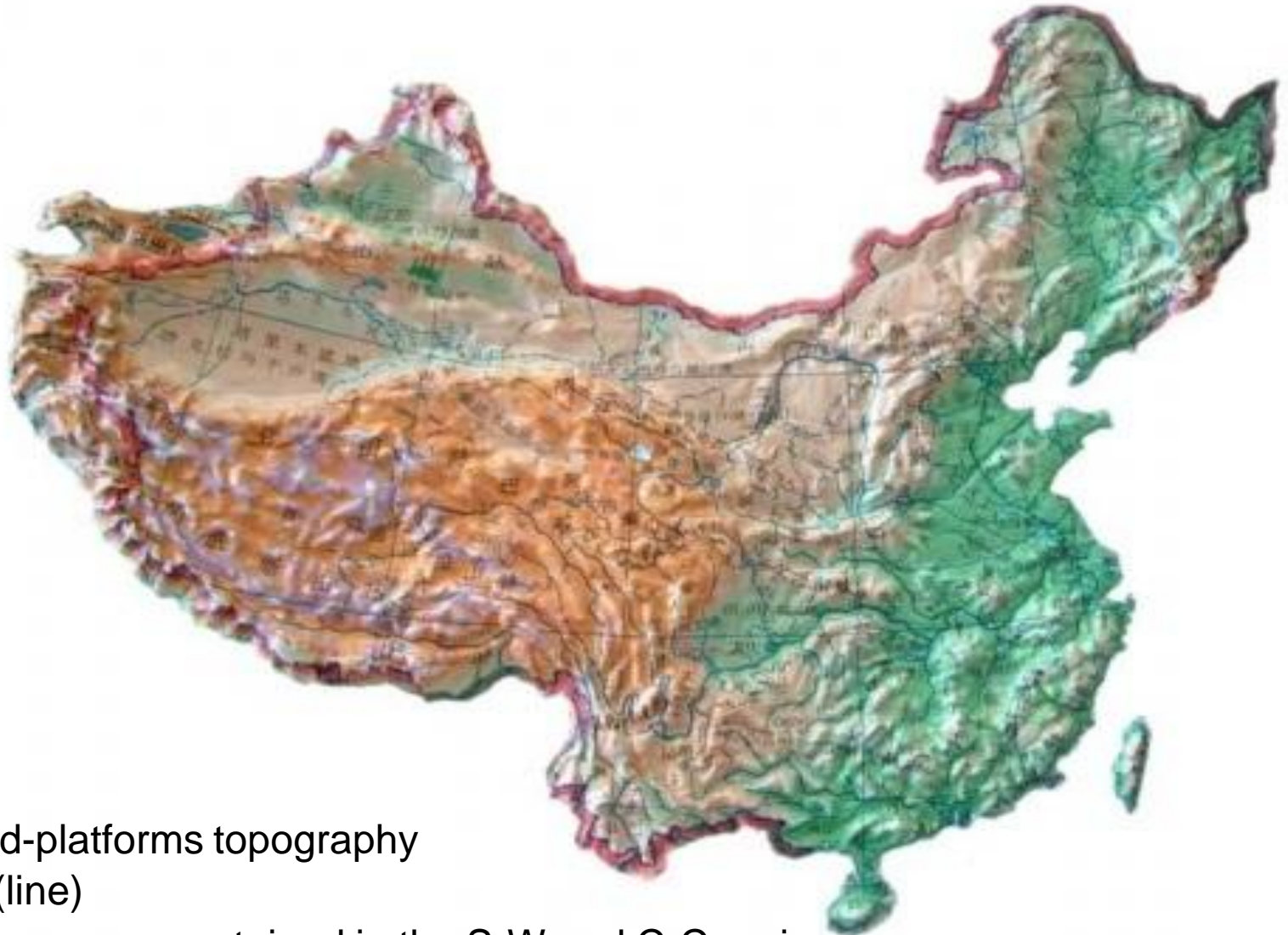
1. Water Resources and its Distribution in China

River Basin



1. Water Resources and its Distribution in China

Terrain



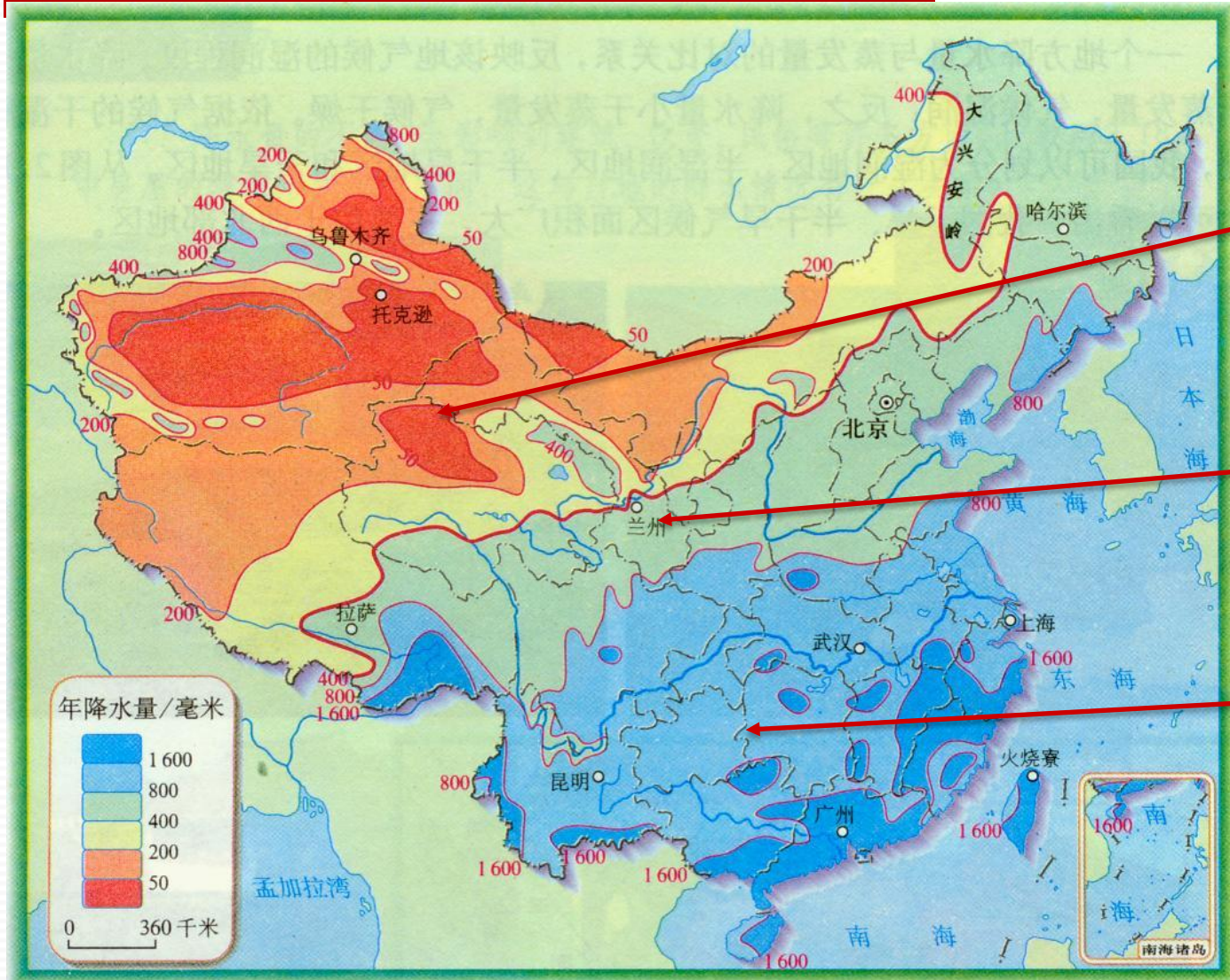
Three step-and-platforms topography

Turning point (line)

Hydropower resources contained in the S-W and C-C regions.

1. Water Resources and its Distribution in China

Climatic Zone



Arid Region

Semi-humid region

humid region

Annual Precipitation (mm)

◆ **Total freshwater resources (2011 data from world factbook):**

- 2.8 trillion m³, accounting for 6% of global water resources
- Ranked 5th in the world, following Brazil, Russia, United States and Canada
- 98% of surface water is recharged by precipitation (from Ministry of Water Resources, MWR)

◆ **Per capita freshwater resources (2014 data from FAO):**

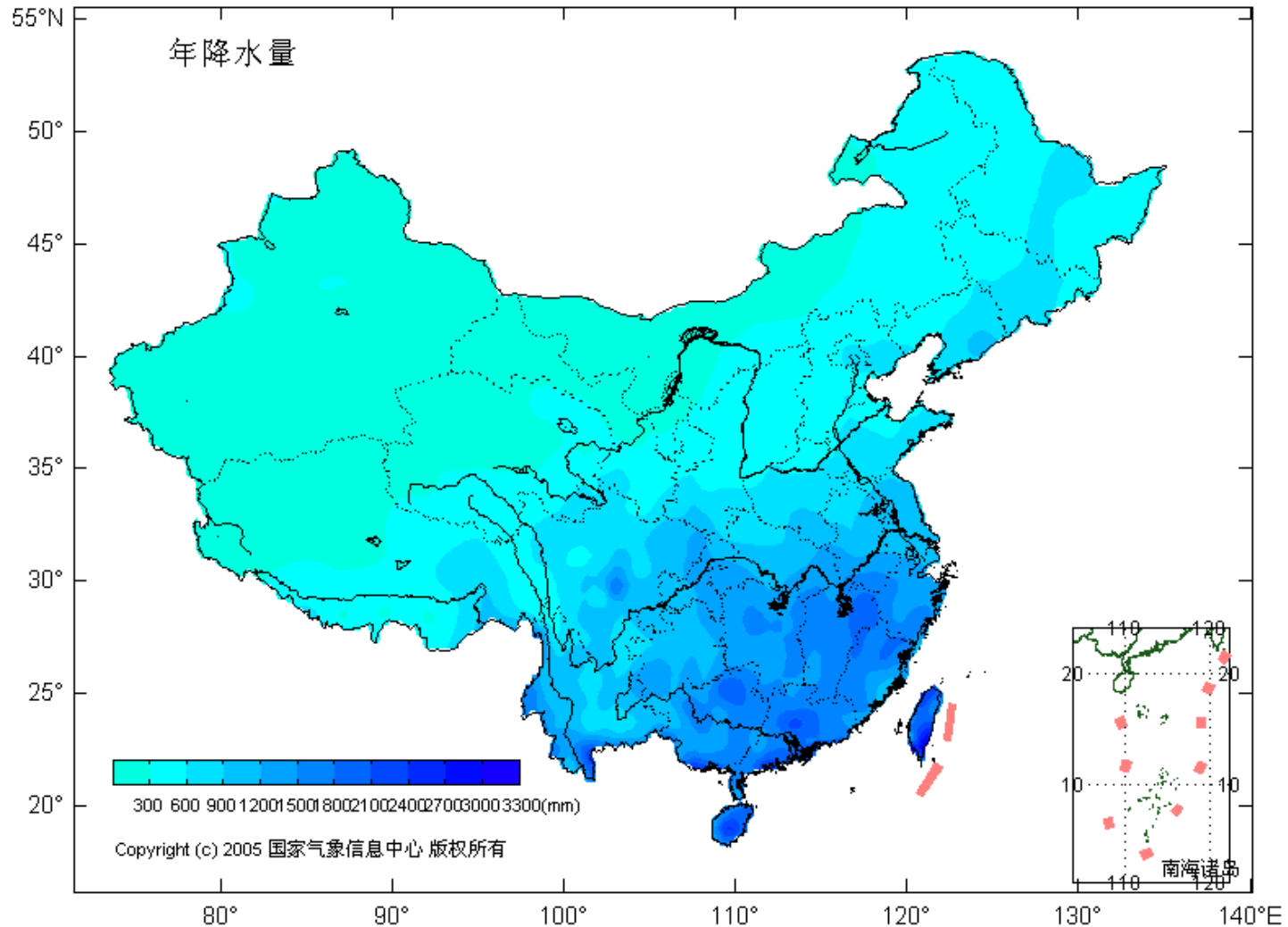
- Only 2062 m³, a quarter of the world average value
- Ranked 104th in the world

◆ **Distribution of freshwater resources:**

- Uneven distribution of freshwater resources in terms of time and space all over China due to climate variation

1. Water Resources and its Distribution in China

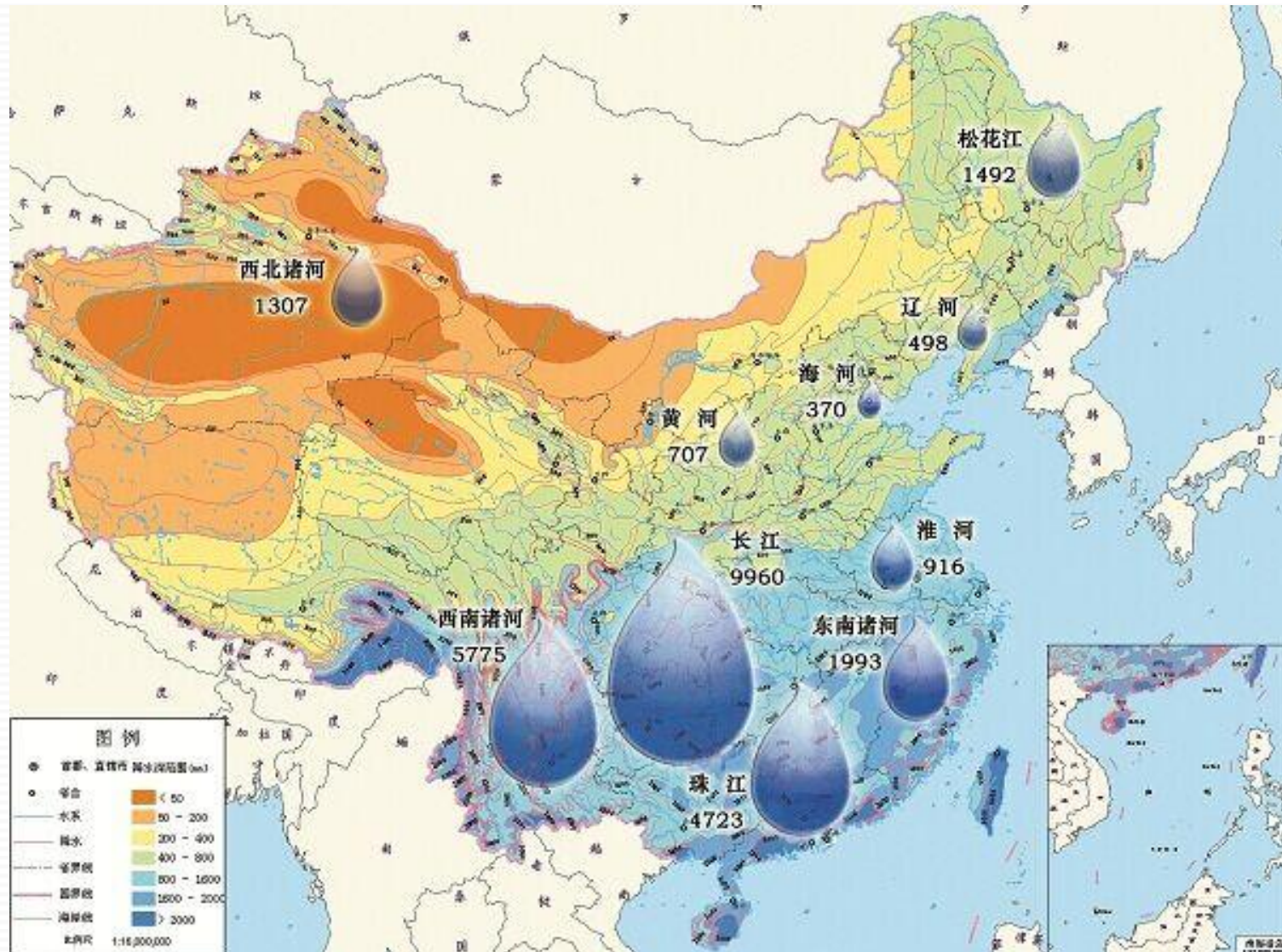
Climatology Annual Precipitation (1971-2000)



From China Meteorological Administration

1. Water Resources and its Distribution in China

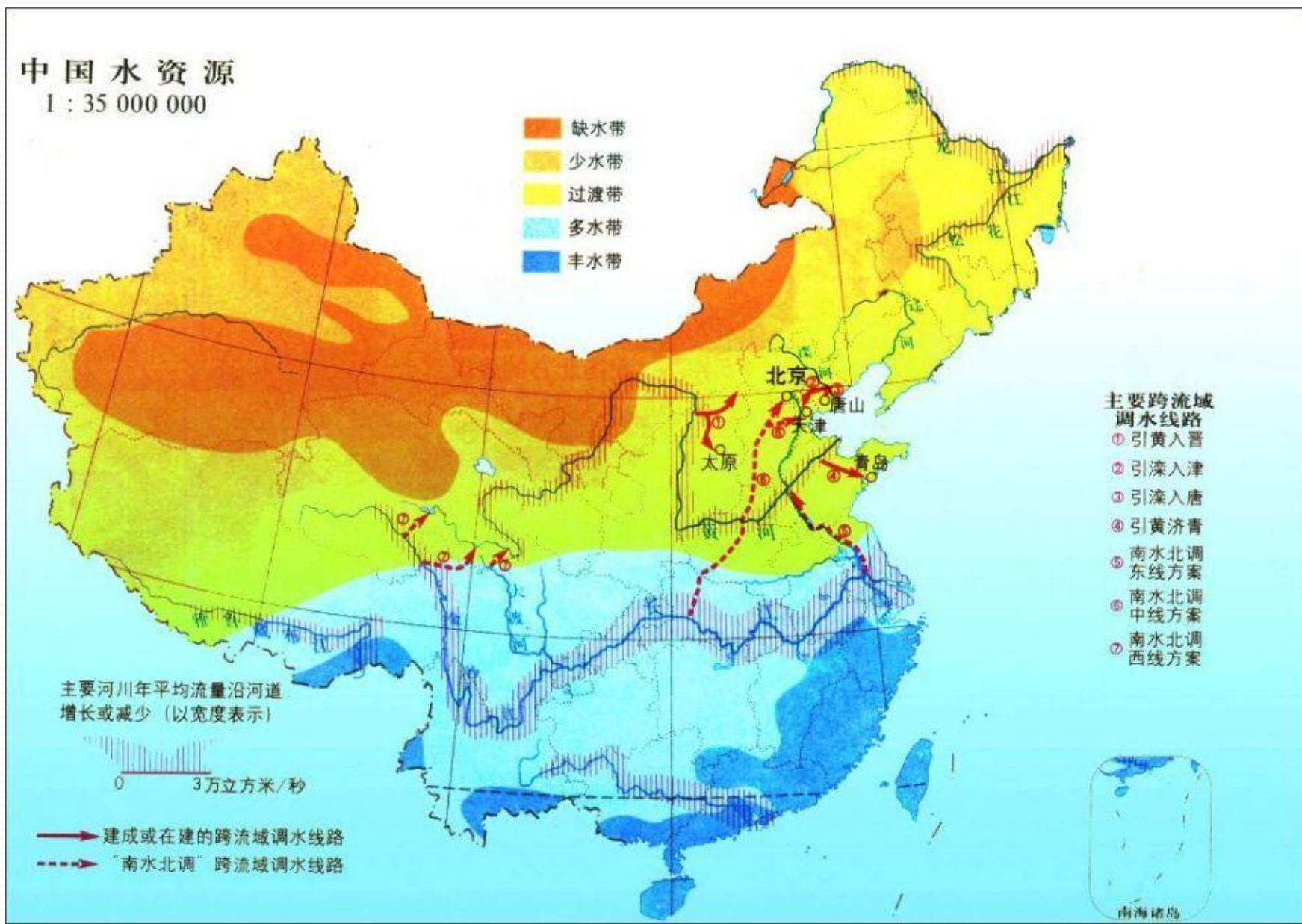
Distribution of Freshwater Resources



A large number of freshwater resources are located in the south region, about 4 times more than that of the north region

1. Water Resources and its Distribution in China

Total Freshwater Resources by topography

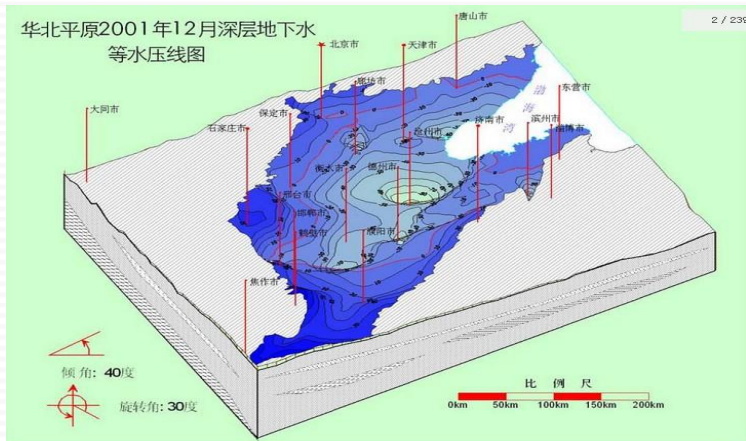


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- **Water Requirements**
- Confronting Problems
- Solutions to the Problems
- Conclusion

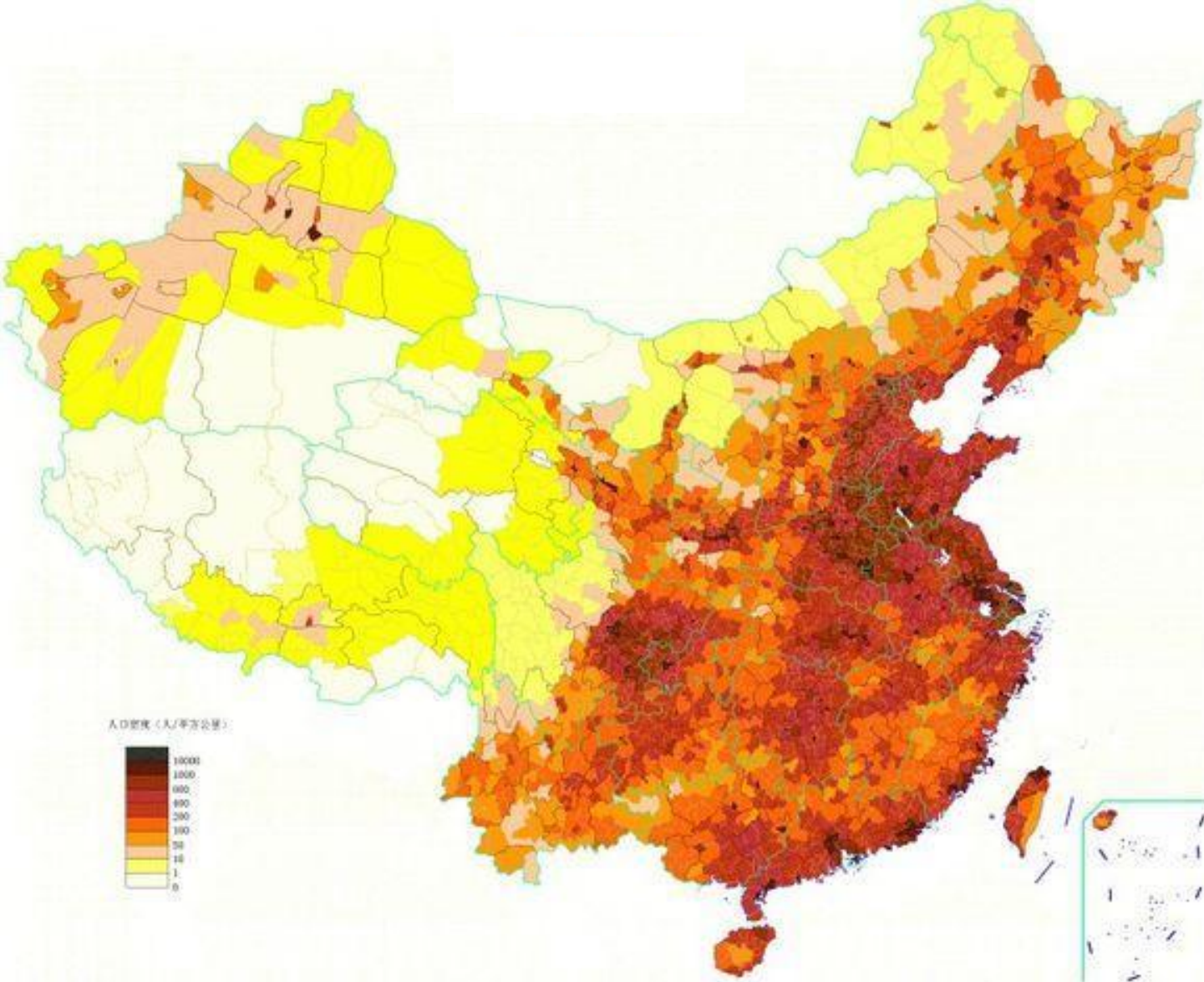
2. Water Requirements

- **SUPPLY:** Water supply in China is from both **surface water and groundwater**. Some cities, especially those located in North China Plain, **are suffering from overexploitation** of groundwater, which results in severe groundwater table decline and even groundwater **depression cone**.
- **CONSUMPTION:** Annual consumption of freshwater resources is **609.5 billion m³ in 2014**, **approximately 13% of the world's annual consumption value**. Total water shortage is estimated to be **30–40 billion m³ per year**.



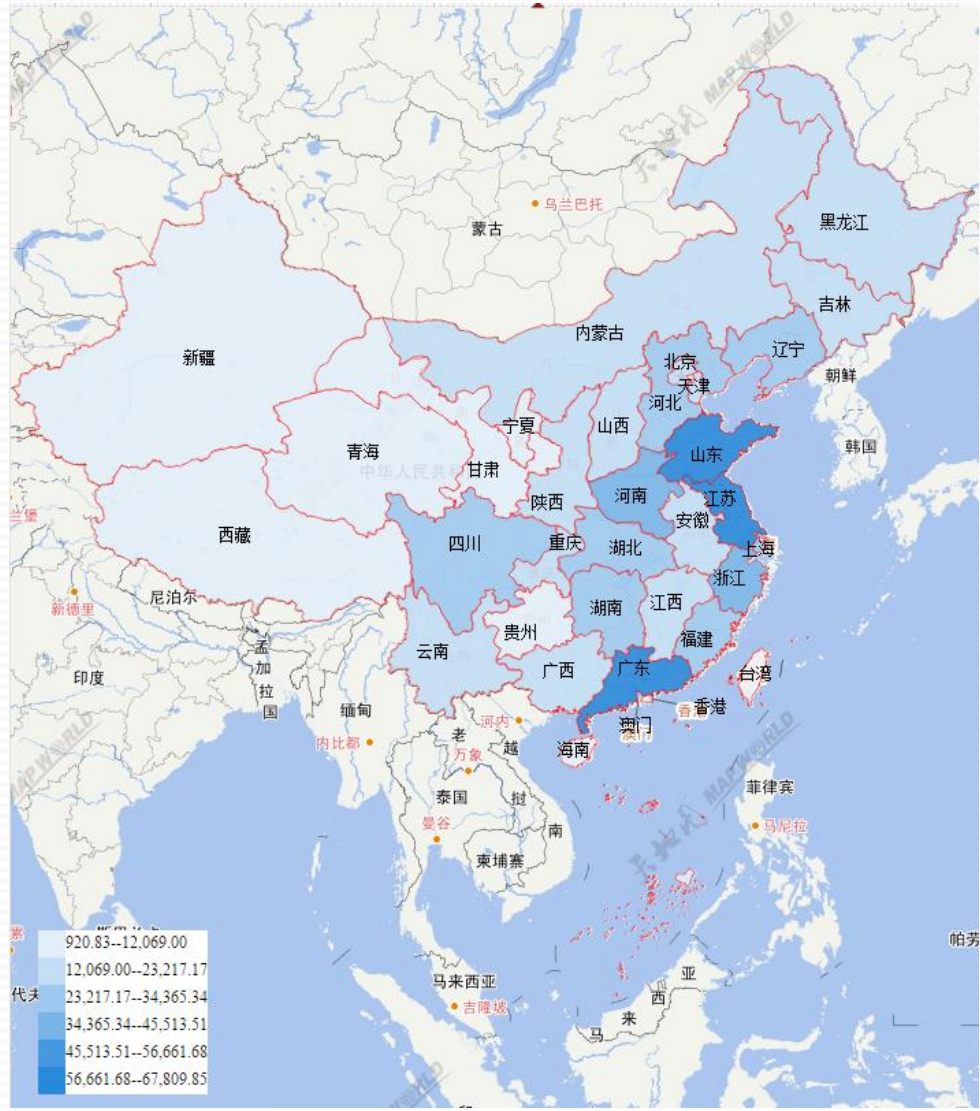
2. Water Requirements

Population Density and Spatial Distribution



2. Water Requirements

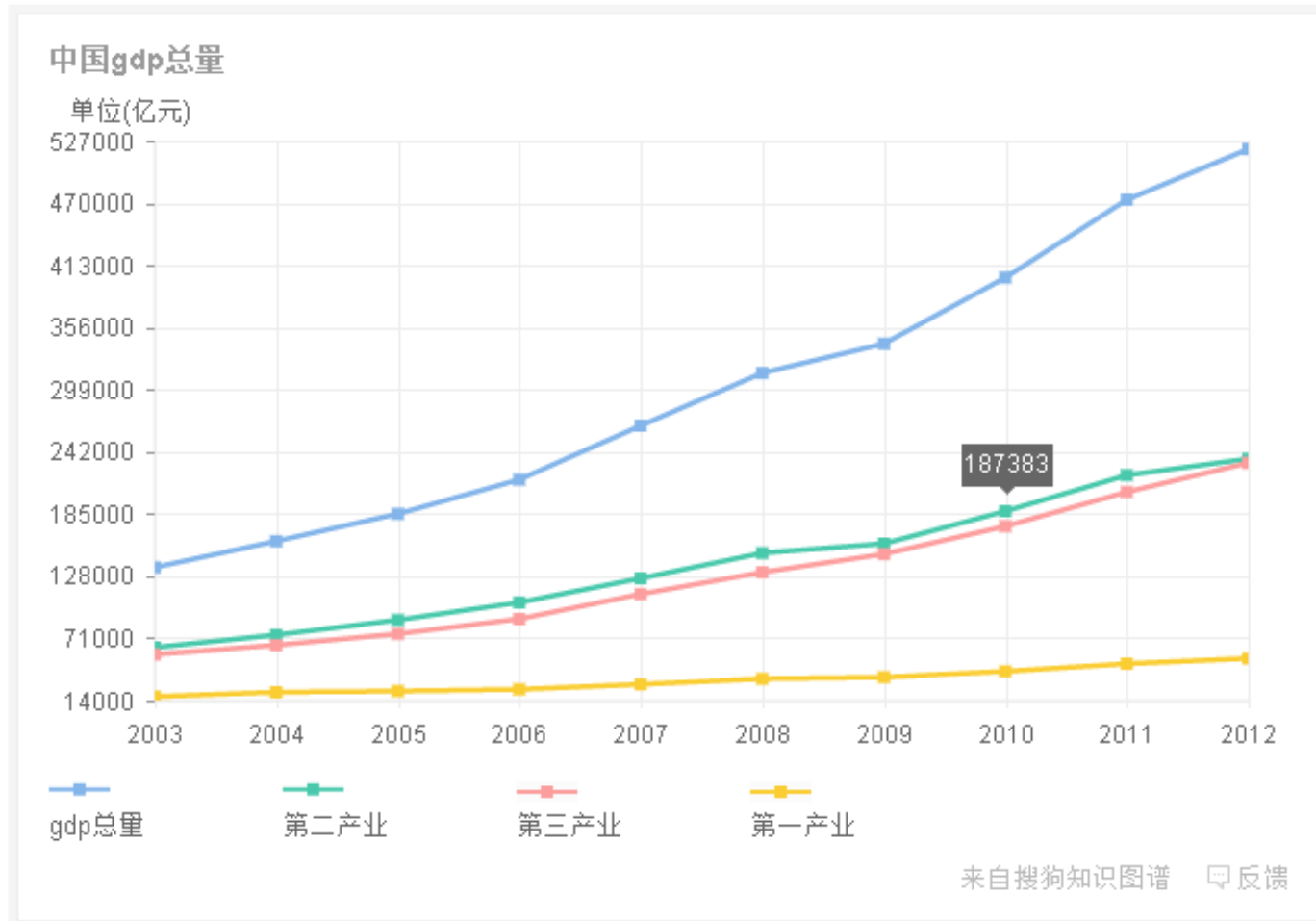
GDP by Province



From National Bureau of Statistics of China (2014)

2. Water Requirements

GDP Increasing



2. Water Requirements

Annual Freshwater Consumption by Province

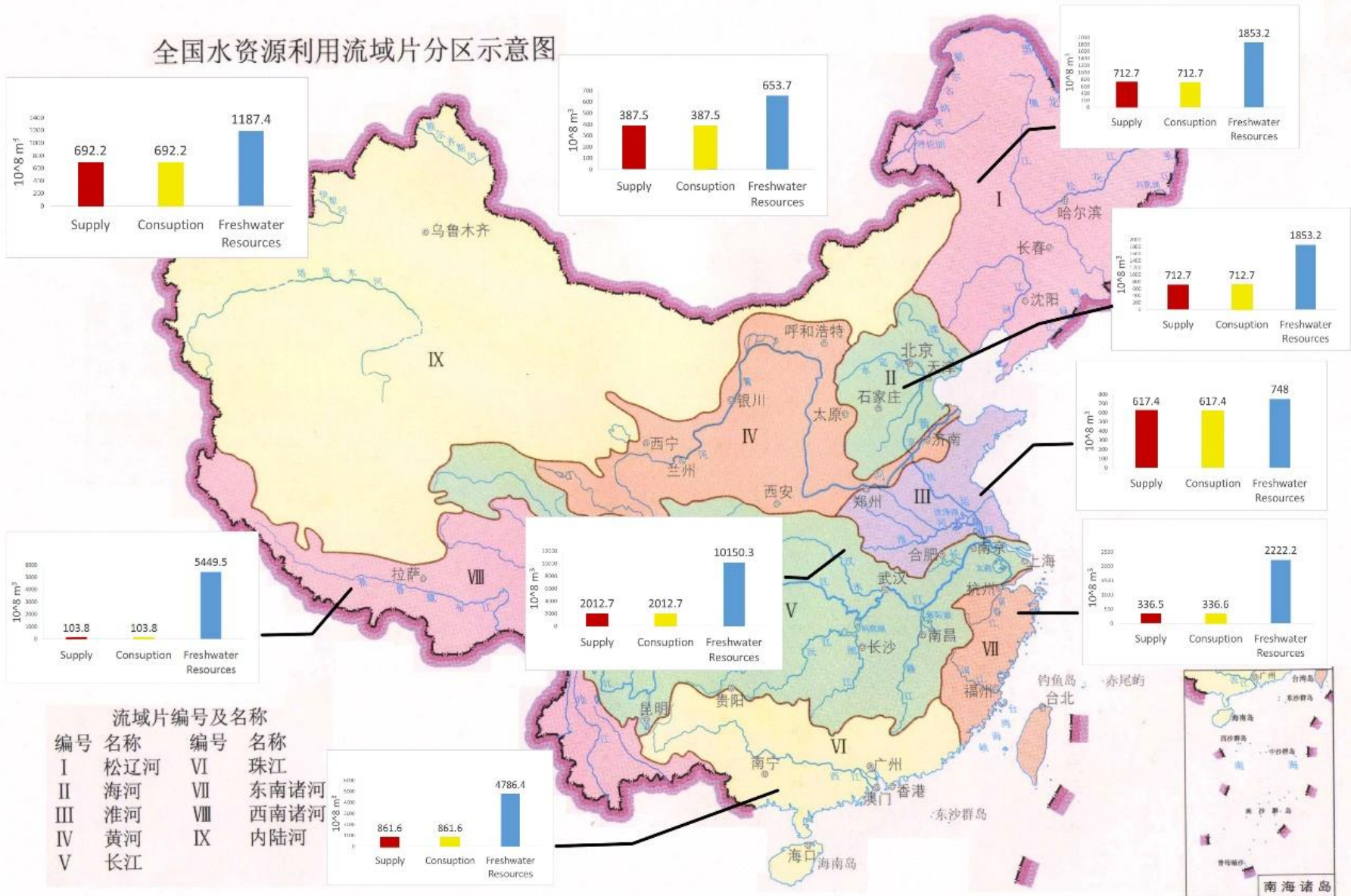


From National Bureau of Statistics of China (2014)

2. Water Requirements

Freshwater, supply, Consumption for each one-grade district division of water resources

全国水资源利用流域片分区示意图



2. Water Requirements

Freshwater, supply, Consumption for each one-grade district division of water resources

Water resources of one-grade district division(2014)

unit:10⁸m³

Level-1 Region	Precipitation (mm)	Surface water resources	Groundwater resources	Non-overlapping surface water and groundwater	Total water resources
Songhuajiang	511.9	1405.5	486.3	207.9	1613.5
Liaohe	425.5	167	161.8	72.7	239.7
Haihe	427.4	98	184.5	118.3	216.2
Huanghe	487.4	539	378.4	114.7	653.7
Huaihe	784	510.1	355.9	237.9	748
Changjiang	1100.6	10020.3	2542.1	130	10150.3
Southeastern Rivers	1779.1	2212.4	520.9	9.8	2222.2
Zhujiang	1567.1	4770.9	1092.6	15.5	4786.4
Southwestern Rivers	1036.8	5449.5	1286.9	0	5449.5
Northwestern Rivers	155.8	1091.1	735.6	96.3	1187.4

2. Water Requirements

Freshwater, supply, Consumption for each one-grade district division of water resources

Water supply and demand of one-grade district divisions(2014) unit:10⁸m³

Level-1 Region	Water Supply				Water Consumption				
	Surface water	Groundwater	Other	Sum	Demestic	Industry	Agriculture	Environment	Sum
Songhuajiang	288.5	218.6	0.9	507.9	29.8	54.7	414.7	8.8	507.9
Liaohe	97.7	103.7	3.4	204.8	30.2	32.6	135.7	6.3	204.8
Haihe	132.9	219.7	17.8	370.4	59.3	54	239.5	17.6	370.4
Huanghe	254.6	124.7	8.2	387.5	43.1	58.6	274.5	11.3	387.5
Huaihe	452.6	156.4	8.3	617.4	81.2	105.9	421	9.3	617.4
Changjiang	1919.7	81.3	11.7	2012.7	282.2	708.2	1002.6	19.7	2012.7
Southeastern Rivers	326.9	8.3	1.4	336.5	63.9	115.1	150.2	7.3	336.6
Zhujiang	824.6	33.1	3.9	861.6	152.6	196.1	504.6	8.3	861.6
Southwestern Rivers	98.7	5	0.1	103.8	8.6	10	84.6	0.7	103.8
Northwestern Rivers	524.4	166.3	1.6	692.2	15.8	21	641.5	13.8	692.2

Outline

- Water Resources and its Distribution in China
- Water Requirements
- **Confronting Problems**
- Solutions to the Problems
- Conclusion

3. Confronting Problems

(1) Contradiction between water resources demand and supply

- Total freshwater resources available in China are approximately 2.8 trillion m³, by comparison, per capita freshwater resources are only 2062 m³, a quarter of the world average. China is regarded as one of the 13 most water-stressed countries with annual water resources deficit being 40 million m³.
- More than 2 million ha cropland in China suffers from water shortage.



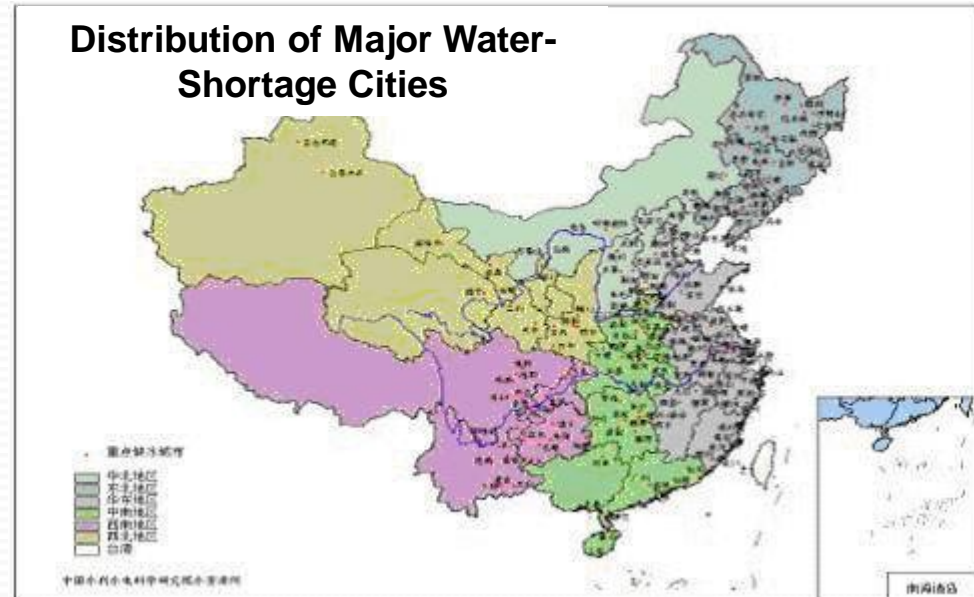
3. Confronting Problems



3. Confronting Problems

(1) Contradiction between water resources demand and supply

- In normal water years, more than 300 cities have insufficient water supplies among 662. About 110 experience severe water shortages. Especially, about 30 out of 32 metropolitan areas with tens of millions of people are struggling to meet water demands.



3. Confronting Problems

(2) Uneven distribution in the time and space

- Uneven **spatial distribution** of freshwater resources dose not match the socio-economic development.

	area	population	cropland	GDP	water res.
Southern C:	36%	54%	40%	56%	81%
Northern C:	64%	46%	60%	44%	19%

- In most regions, 60%~80% of the precipitation is concentrated in consecutive month in summer. Therefore, **runoff accounts for 2/3 freshwater resources in summer** not only impose great pressure to flood control, but also intensifies the contradiction between water resources demand and supply.

3. Confronting Problems

(3) Serious water pollution

- A lot of major rivers in China have been **widespread polluted**, among which Hai He and Liao He suffer from the heaviest pollution. 90% of the urban waterbody has been polluted which affects the safety of drinking water, only 23% of the drinking water in 35 focus cities meets the standard.

3. Confronting Problems

(4) Over-development of freshwater resources

- Nearly **half of the freshwater resources** in China have been developed. The development rate of Hai He is almost 100%, far exceeding the internationally recognized limit of 30% to 40%.

(5) Low efficiency and serious waste

- Agricultural, industrial and city life use water are 3 major consumers of freshwater resources, however, their utilization **efficiency is quite low comparing with other countries**. For example, 972 m³ water resources are needed for 1t food production in China while the value of Israel is only 280 m³. The water consumption for Industrial output value of ten thousand yuan is 103 m³ in China, but 8 m³ and 6 m³ in US and Japan respectively.

3. Confronting Problems

(6) Imperfect legal system and poor management

- Although a series of laws and policies including “water law” have been promulgated to protect water resources, the potential side effects of water resources development are not fully considered before developing, which results in more serious damage to the freshwater resources.
- The management system under its specific historical conditions can not match the requirement of environmental conservation in new pattern of cross-department and cross-industry cooperation.
- Confusion about duties, responsibilities, rights and interests among different administrative departments lead to Inefficient and chaotic management.

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4. Solutions to the Problems

- Comprehensive Planning
- Water Conservation
- Construction of Water Conservancy Projects
- Strengthen Management

COMPREHANSIVE PLANNING is the basic and important reference for freshwater development, utilization, conservation, protection and management in China. It is one of the state macro-strategies.

- Investigation and assessment of freshwater resources
- Demand prediction
- Supply prediction
- Balance analysis between supply and demand
- Reasonable allocation of freshwater resources
- Planning of Water Conservancy Projects
-

Investigation and assessment of freshwater resources

- **Extension and assessment of data series:** to extend the coverage of existed **data series** and analyze its **representativeness as well as rationality**; to assess the **quantity and quality** of freshwater resources under current conditions, including but not limit to the spatiotemporal characteristics of freshwater resources and chemical status of rivers and lakes.
- **Estimation of available freshwater resources:** to determine the **control indices** of freshwater resources development (involved considering the ecological water demand), which serve as the basis to estimate the **quantity and distribution** of freshwater resources under current conditions

Investigation and assessment of freshwater resources

- **Evolution analysis of freshwater resources:** to analyze and predict the **potential variation** of freshwater resources by investigating the variation of dominant factors that influence the evolution of the freshwater resources.

Demand prediction

- **Investigation on the freshwater resources demand on the basis of economic and social development:** based on the local freshwater resources characteristics, to investigate the freshwater resources demanded **by different aspects including economic, social, industry, agriculture and ecology under different conditions.**
- **Prediction of industry, agriculture and daily Life demand:** to fully consider the impact of Industrial and economic **restructuring, water price adjustment, population control, and technology advances, etc.**

Demand prediction

- Prediction of ecology and environment demand: to consider the well-being of ecology and environment, including sediment scour in flood season, the minimum water to sustain rivers in dry season, water recharge to keep the coverage of lake and marshland, water used for tourism landscape, etc.

Supply prediction

- To estimate the **water supply capacity under various development scenarios** by considering the economic restructuring and the local pattern and potentiality of freshwater resources development.

Balance analysis between supply and demand

- Based on the economic and social development targets as well as freshwater resources conditions in planning level year, **to determine the potential schemes and their combinations for the future freshwater resources development**, which serve as the basis for dynamic balance analysis of water supply and demand.

Reasonable allocation of freshwater resources

- Following **the efficient, equitable and sustainable principles** in given region, reasonable allocation refers to the activities that control the water demand, increase water supply and protect environment, coordinates of water demand among the water-consumers in time and space **by neither engineering or non-engineering approaches.**

By the implementing Comprehensive Planning:

● By the end of 2020:

- National total water consumption $< 6700 \times 10^8 \text{ m}^3$
- $\text{¥} 10000$ GDP water consumption $\approx 120 \text{ m}^3$
- $\text{¥} 10000$ industrial added value water consumption $\approx 65 \text{ m}^3$
- Utilization efficiency coefficient of agriculture irrigation ≈ 0.55
- Quality of urban drinking water source is generally up to standard
- Quality of $\sim 80\%$ of the major water function areas is generally up to standard

● By the end of 2030:

- National water consumption $< 7000 \times 10^8 \text{ m}^3$
- $\text{¥} 10000$ GDP water consumption $\approx 70 \text{ m}^3$
- $\text{¥} 10000$ industrial added value water consumption $\approx 40 \text{ m}^3$
- Utilization efficiency coefficient of agriculture irrigation ≈ 0.60
- Quality in the major water function areas of the lakes and rivers is generally up to standard

4. Solutions to the Problems

Water Conservation

- Agricultural water conservation
- Industrial water conservation
- Domestic water conservation

4. Solutions to the Problems

Water Conservation

Agricultural water conservation

In China, agriculture is the biggest water consumer, **accounting for 80% of national annual water consumption, however, only 30% is utilized by crop**. For this reason, agricultural water conservation is urgent. Agricultural water conservation is a systematic project which involves a lot of professional fields including agriculture, water resource, ecology, environment, engineering, etc.

- **Engineering technology:**

Canal prevention, Sprinkling irrigation, Drip irrigation, Infiltrating irrigation, Rainfall collection and utilization

- **Agronomic technology:**

Regulated deficit irrigation, Controlled alternative partial root-zone irrigation, Improved surface irrigation, “Thin-shallow-wet-dry” irrigation, Saline water irrigation



Industrial water conservation

Industrial water conservation technologies refers to **increasing industrial water use efficiency, reducing the water loss, and replacing the ordinary water resources.** They include both direct and indirect approach.

- **Water recycling system:** It can be used to increase water use efficiency by recycling of industrial water use. The recycling system can also help reducing environmental pollution by producing less sewage.
- **Improved production processes:** (1) new water-saving processes, (2) non-polluting or less polluting processes and (3) promotion of new water-saving devices.

Domestic water conservation

Domestic water conservation refers to reduce the water use for everyday life, including urban and rural domestic water conservation.

- Promotion of water-saving appliances and kitchen & sanitary equipment which are able to satisfy the same purpose with less water.
- Focus on water reuse for flushing and watering, etc.

4. Solutions to the Problems

Construction of Water Conservancy Projects

- Reservoirs
- Water diversion projects
- Small water projects

4. Solutions to the Problems

Construction of Water Conservancy Projects

Distribution of Key Water Conservancy Projects in China



4. Solutions to the Problems

Construction of Water Conservancy Projects

Reservoirs

Distribution of Large and Medium-Sized Reservoirs



4. Solutions to the Problems

Construction of Water Conservancy Projects

Reservoirs

Three Gorges Project (TGP) is **the most famous project all over the world**.

- The dam is 2335m long and the top of the dam is 185m above sea level
- The normal high water level is 175 m
- total capacity of reservoir is 39.3 billions m^3
- Installed capacity of power station is 22,500 MW

Major function of TGP includes flood control, power, navigation, etc. It's also crucial to the water supply of downstream area in dry season by releasing stored water.



4. Solutions to the Problems

Construction of Water Conservancy Projects

Reservoirs

- Qingcaosha Reservoir of Shanghai was completed in 2010
- Its water quality meets the requirements of national II class standard
- Water supply capacity is more than 7190 thousand m³/d, 50% of total water supply in Shanghai
- More than 11 million peoples are benefited



4. Solutions to the Problems

Construction of Water Conservancy Projects

Water Diversion Project

To divert water from water source areas to other water-stresses regions through a series of intake and diversion infrastructures.

- South-to-North water diversion project
 - Luanhe-Tianjin water diversion project
 - Luanhe-Tangshan water diversion project
 - Huanghe-Qingdao water diversion project
 - Huanghe-Shanxi water diversion project
 - Qiantangjiang-Taihu water diversion project
 - Datonghe-Qinwangchuan water diversion project
 -
- Inter-basin water transfer project
In the basin water transfer project
Inter-administrative region water transfer project

4. SOLUTIONS TO THE PROBLEMS

Construction of Water Conservancy Projects

Water Diversion Project

South-to-North Water Transfer Project is the most famous and biggest one in China, which consists of 3 diversion routes, i.e. eastern route, middle route and western route. The middle route and phase 1 of eastern route have been in operation.



Routes of South-to-North Water Transfer Project

4. Solutions to the Problems

Construction of Water Conservancy Projects

Water Diversion Project

- **South-to-North Water Transfer Project** is to solve the water stress in northern China, especially Huanghe, Huaihe and Haihe river basin. The designed water diversion capacity is $448 \times 10^8 \text{ m}^3$, benefiting 0.438 billion people in these areas.
- Total length of 3 routes is 4350 km, of which 2899 km belongs to middle route and phase 1 of eastern route. There are another 2700 km supporting channels along with the routes.
- 4 large river basins including Changjiang, Huanghe, Huaihe and Haihe are connected through 3 water diversion routes, constituting the backbone of **national water diversion network** (3 vertical and 4 horizontal routes) which is designed for rational allocation of water resources all over the country.

4. Solutions to the Problems

Construction of Water Conservancy Projects

Small Dam: A small project to store the natural rainfall through dam.

- The most representative projects are “5 small projects” in southwestern China, including small cellar, small pool, small pumping stations, small ponds and small canals.
- A shocked event: Yunnan, Guizhou, Sichuan, Chongqing and Guangxi provinces suffered from serious drought for 240 days from September 2009 to March 2010, there was hardly no rainfall over these 5 provinces. This drought event lasted long and influenced large areas and A large number of people.



4. Solutions to the Problems

Strengthen Management

- Policy, Law and Regulations
- Management system
- Citizenship education

4. Solutions to the Problems

Strengthen Management

Policy, Law and Regulations

Chinese government has been making several policy, law and regulations regarding water resources, for example, “Water Law”, “Environmental Protection Law”, “Water Pollution Prevention Law,” “Standards for surface water environmental quality”, “Healthy standards for drinking water, etc.

The State Council also issued "on the implementation of the most stringent water management", clearly proposing the 3 “red lines” to constrain (1) upper limit of water resources allocation, (2) the baseline of utilization efficiency of water resources and (3) the upper limit of sewage discharge. The target of these 3 “red lines” is to balance the development of society and carrying capacity of water resources and to achieve objectives of the Comprehensive Planning.

Management System

Management systems are used to support the implementation of policy, law and regulations . For example, a project named “**Construction of the National Monitoring and Control Capability of Water Resources** ”is being carried out at present.

- **Functions**: Obtainning the real time dynamic data of water recharge, withdraw, consumption, drainage and so on, ensuring the accuracy, scientificalness and comprehensiveness of the data.
- **Overall objectives** : Completing the Phase-1 construction in 3 years starting from 2012, which consists of 3 monitor systems corresponding to “3 red lines” for major water consumers, water quality in water function areas and In the section between the different provinces. Basically it is to establish the national system framework and monitoring capability of freshwater resources management. Gradually it is to increase the capability of scientific management of water resources and evaluation of "3 red lines".

Management System

The core of “Construct of the National Monitoring and Control Capability of Water Resources ” is real time freshwater resources **monitoring and management system**.

Based on the modern theory of water resources management and information technology, the various high-tech approaches are adopted in the system development to **collect, transport and manage the real time data** regarding water resources at given region. In light of these real time data, the system is then used to allocate and dispatch the water resources among different sectors and water-consumer.

Some key features of the systems:

- Real time monitoring of water resources
- Integrating a variety of water-related information using GIS, for example, hydrology, weather, water resources, soil moisture, etc.
- Real time allocate and dispatch based on scientific model library and real time data.

4. Solutions to the Problems

Strengthen Management



Interface of the System (example)

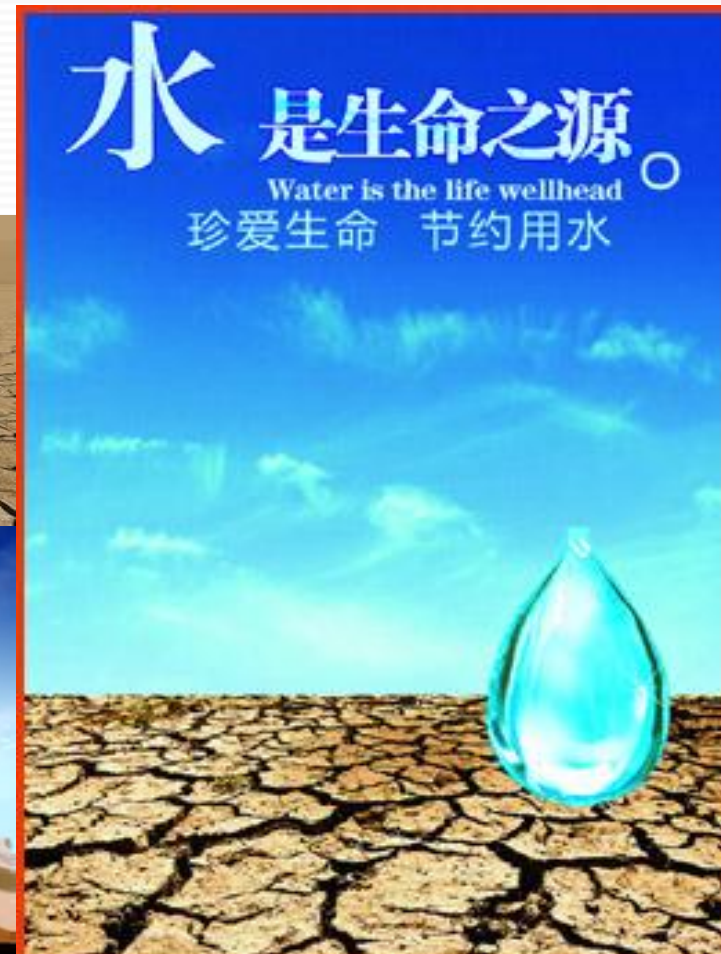
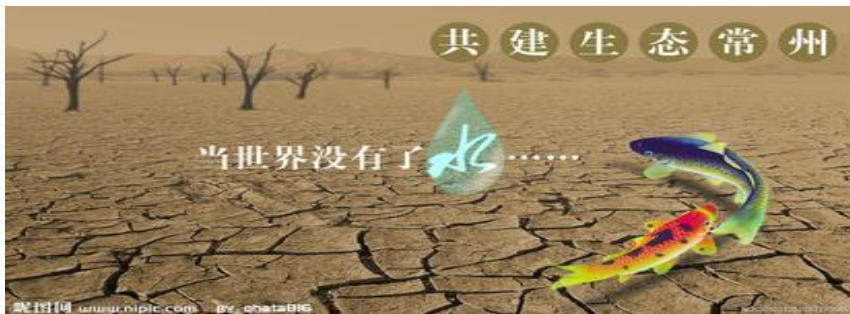


4. Solutions to the Problems

Strengthen Management

Citizenship Education

- The Importance of freshwater resources as well as the severity of confronting problems
- Preach of laws and regulations
- Awareness of water conservation



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4. Summary

- **China is poor in water resources, not only in the gross amount, but also in the Space-time distribution**
- **The imbalances are between supply and demand are very outstanding**
- **Water Conservation, Water Conservancy Projects, scientific management are the main approaches to solve problems that we are facing**
- **Water ecological and environmental are taken very seriously in the development of water resources**
- **The national Status of water resources is being better and better**

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Thanks for your attention.

