Water: Challenges and Opportunities in China

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- Water resource position: Shandong Province
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Water resource position: in China

Serious water scarcity

- **Water quantity**
- **Water quality**

China's water resource challenge consists of both water quantity and quality issues, both of which present distinctive challenges for Chinese policy.

Water resource characteristics in China

- **Rich in volume , less than world average per capita**

Total water resources	2,800 $\times 10^9$ m^3
Surface water runoff	2,669 $\times 10^9$ m^3
Groundwater storages	809 $\times 10^9$ m^3
Ice melt water	50 $\times 10^9$ m^3

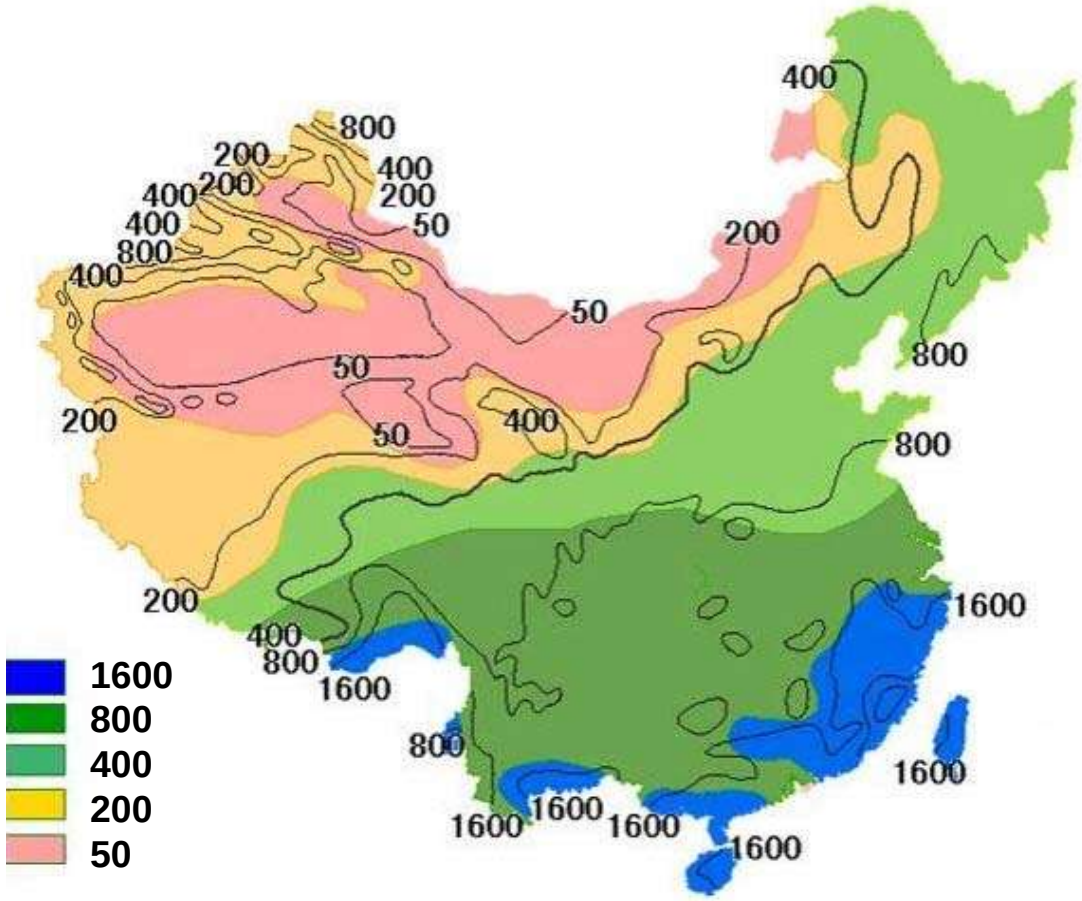
✓ The sixth in the countries of the world

✓Per-capita share of 2,200 m^3 per annum (World Bank forecast);

One fourth of the world's average at present

Water resource characteristics in China

- **Uneven regional distribution**



Annual precipitation of China (mm)

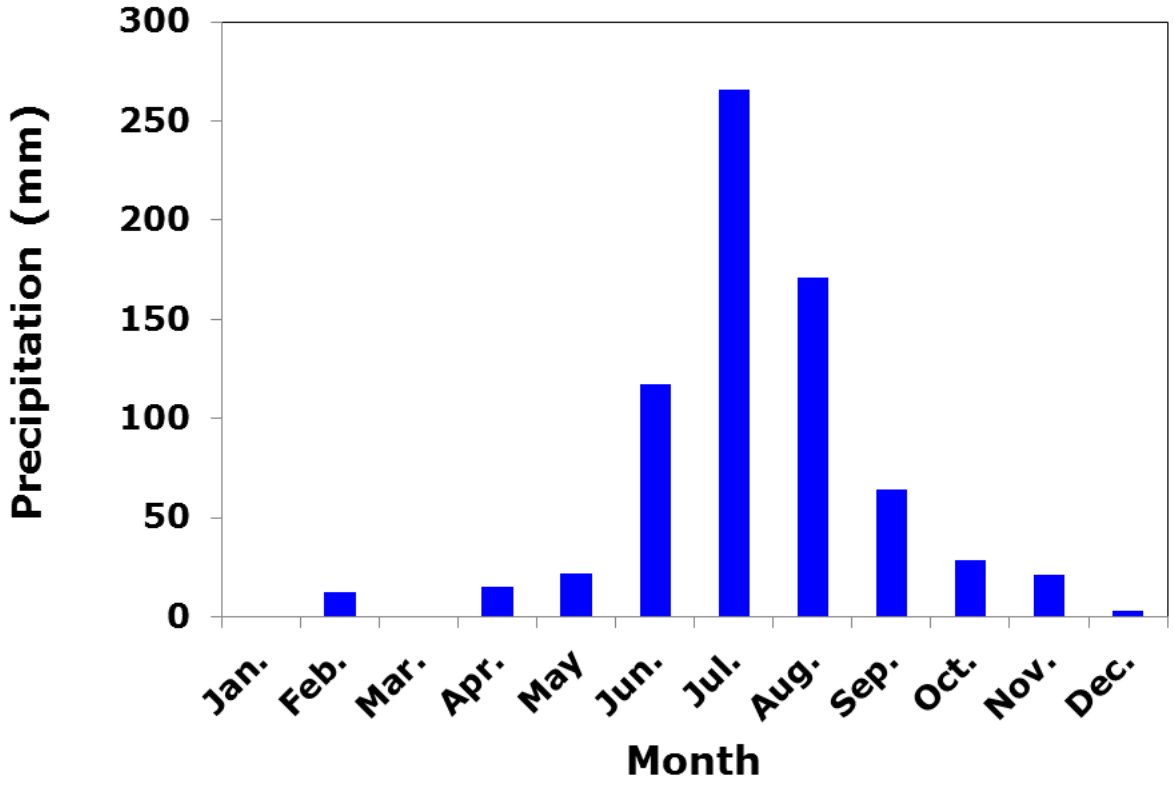
East > West

South > North

60.3% cultivated area is in the North China, where the runoff is only 14.7% of total runoff of China.

Water resource characteristics in China

- **Great annual variation**



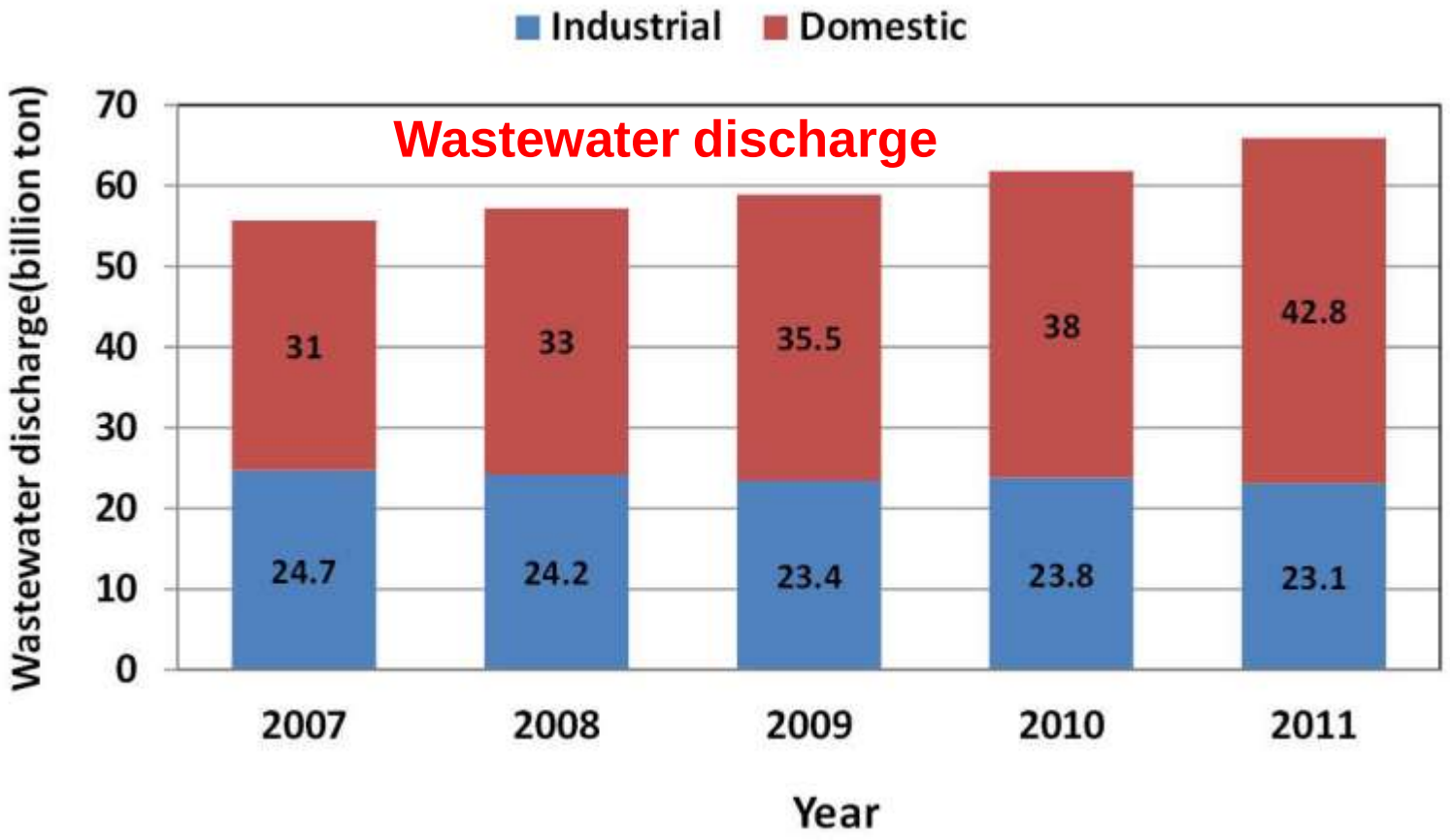
Precipitation variety of Beijing (2011)

✓ **Annual variation**

Affected by the monsoon, the flood season, accounting for 70% of annual rainfall, is about four months in summer and autumn.

Water resource characteristics in China

- **Severe water pollution**

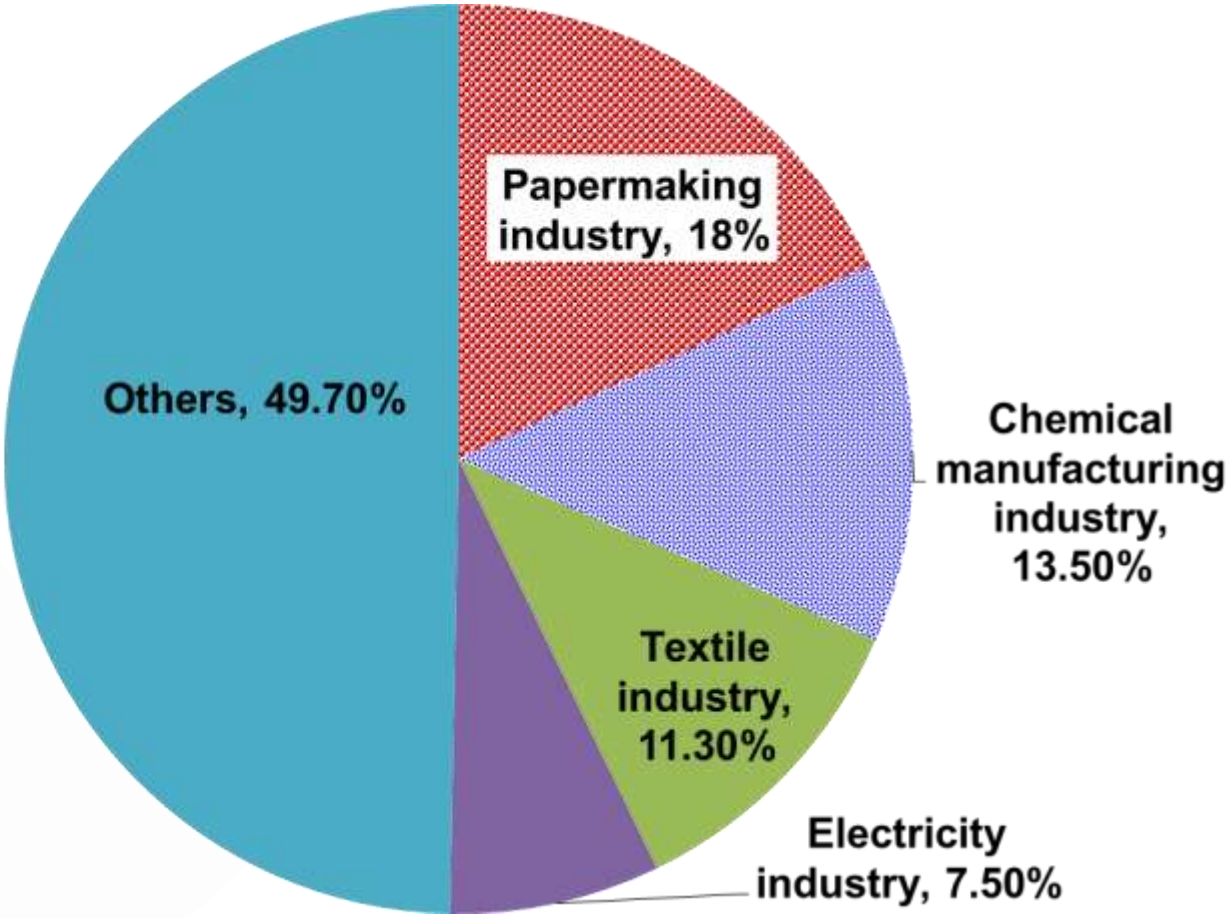


✓ **2010, China's first pollution census revealed farm fertilizer was a bigger source of water contamination than factory effluent.**

Dates based on "Report on the state of the environment in China (2007-2011)"

Wastewater discharge of 41 industries (2011)

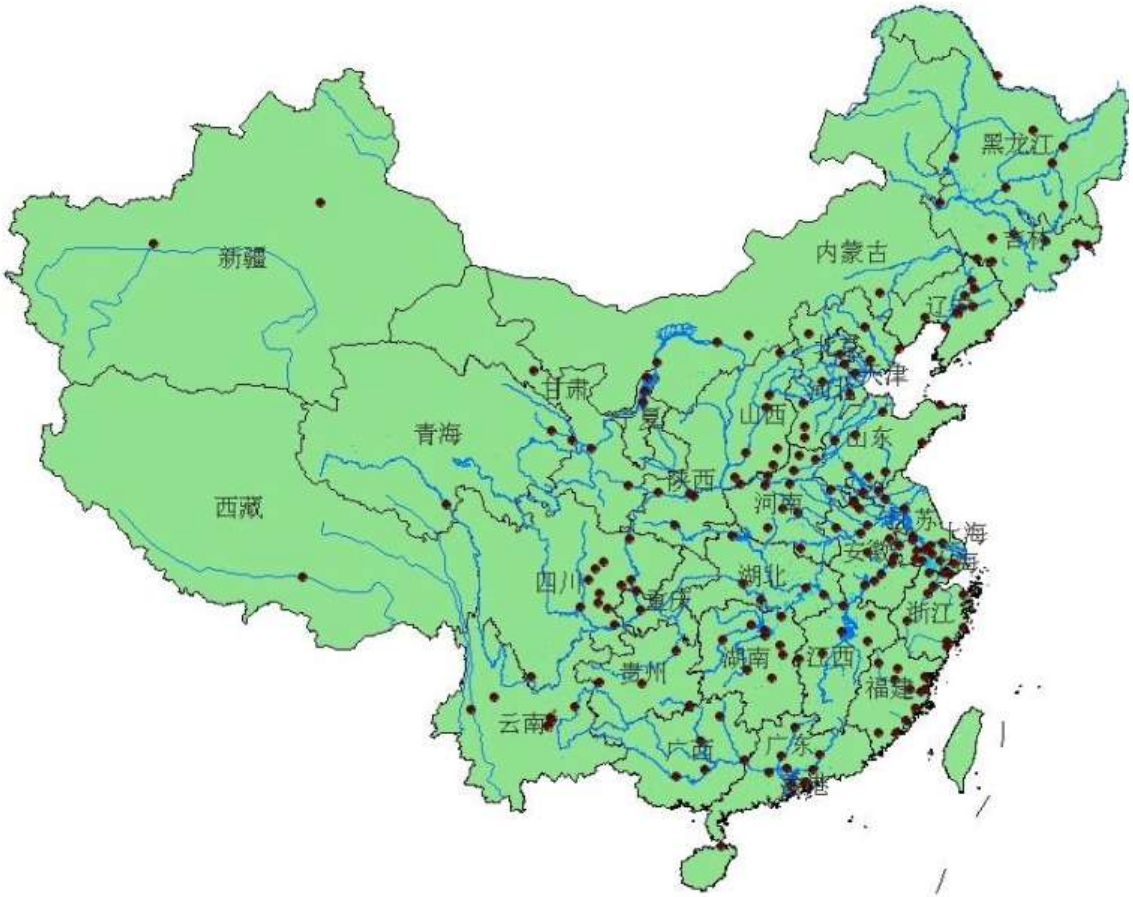
The top four industries: 10.7 billion tons, account for 50.3% of the total.



Wastewater discharge of Key industries

Water resource characteristics in China

- **Severe water pollution**



State-monitored sections:

759 monitoring sections

✓**469 rivers sections (318 rivers) of 10 big water systems**

✓**290 sections of 26 lakes and reservoirs**

Water resource characteristics in China

The standard of surface water quality (mg/L)

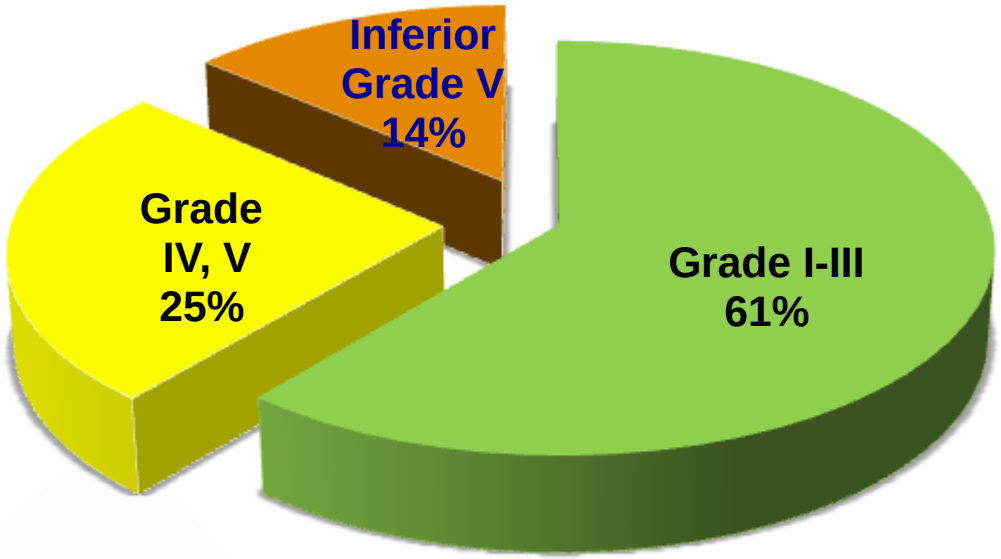
Main pollutant		Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ
COD		15	15	20	30	40
NH_3-N		0.015	0.5	1.0	1.5	2.0
TN		0.2	0.5	1.0	1.5	2.0
TP	Rivers	0.02	0.1	0.2	0.3	0.4
	Lakes/reservoirs	0.01	0.025	0.05	0.1	0.2

Grade Ⅰ, Ⅱ and Ⅲ: water quality is good;

Grade Ⅳ and Ⅴ: water quality is poor, unsuitable for drinking and swimming.

Water resource characteristics in China

- **Severe water pollution**



Rivers and lakes water quality of 759 state-monitored sections

The main pollution indicators:
COD, TP

Dates based on "Report on the state of the environment in China (2011)"

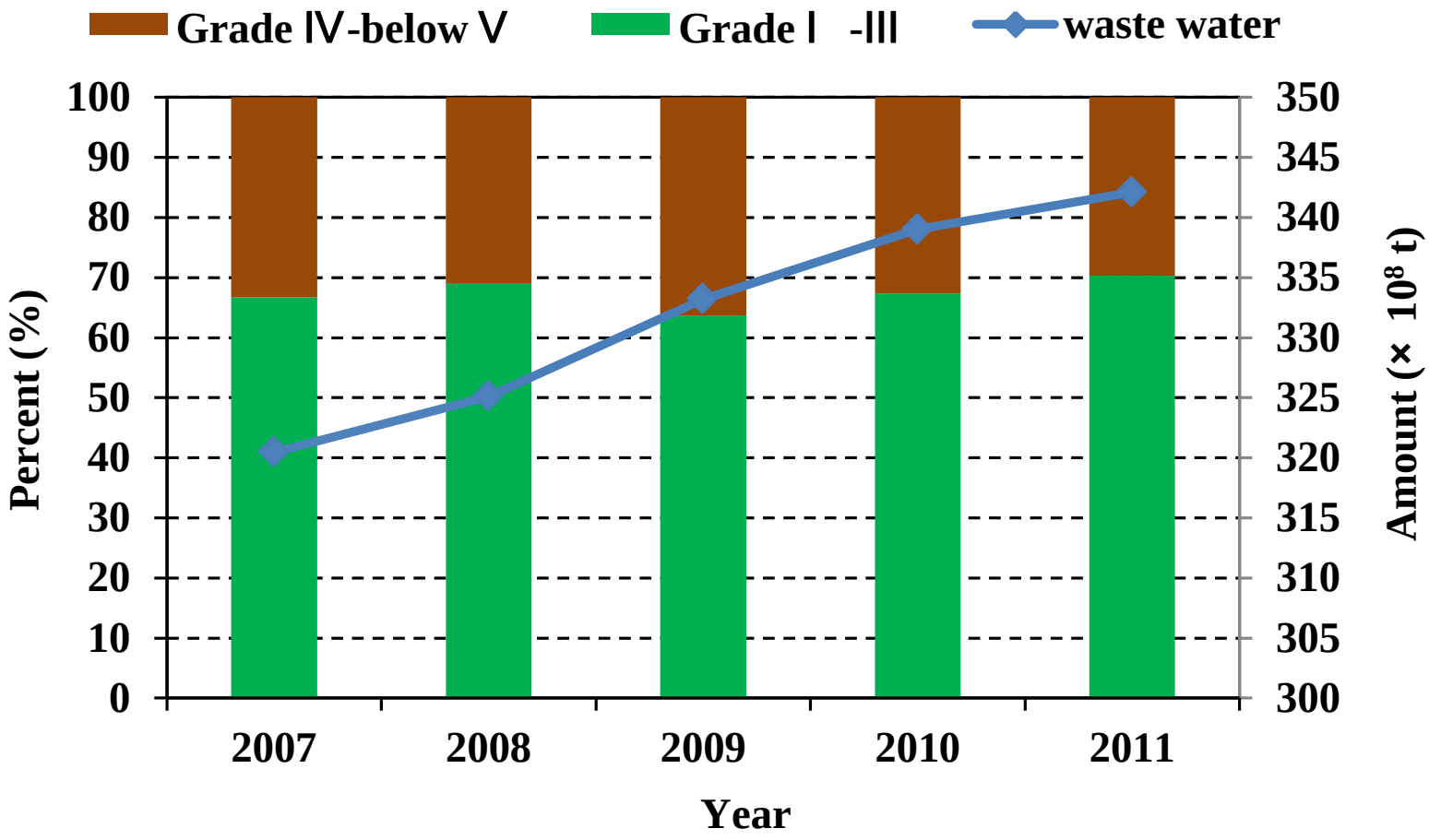
Yangtze River pollution

Length: 6,380 km; Basin area: 1,808,500 km^2

- **Half of China's 20,000 petrochemical factories lie on its banks.**
- **About 40 percent of all wastewater produced in China—about 34 billion tons—flows into the Yangtze River.**

Yangtze River pollution

The quality of Yangtze River and amount of waste water over the years



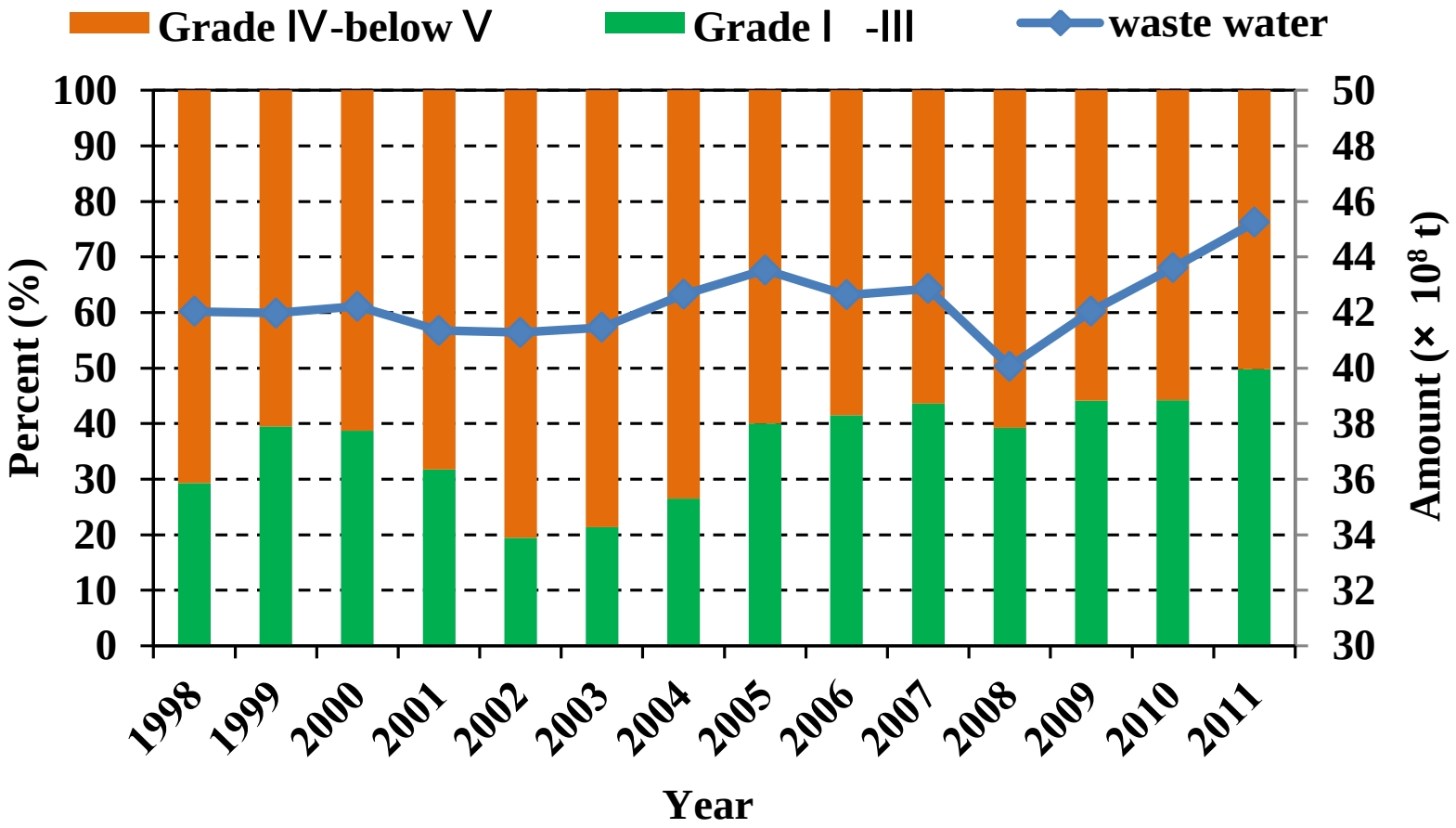
Yellow River pollution

Length: 5,600 km; Basin area: 752,443 km^2

- **4,000 of China's 20,000 petrochemical factories are on the Yellow River.**
- **A third of all fish species once found in the Yellow River have become extinct because of dams, falling water levels, pollution and over fishing.**

Yellow River pollution

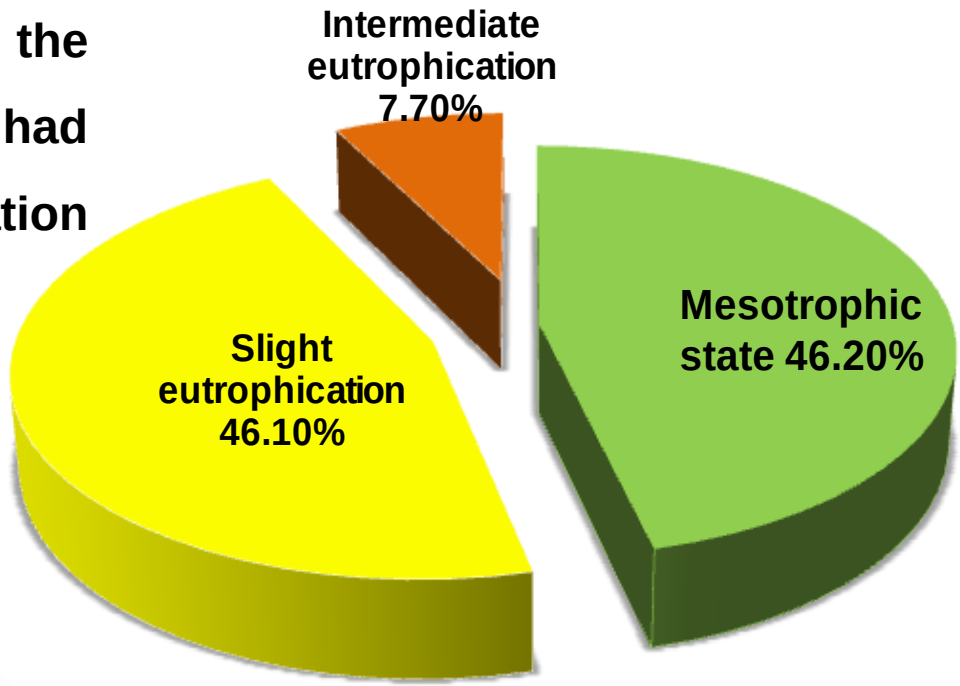
The quality of Yellow River and amount of waste water over the years



Water resource characteristics in China

- **Eutrophication of lakes and reservoirs**

Compared with that of 2010, the water quality of Dianchi Lake had turned from heavy eutrophication into intermediate eutrophication.



Eutrophication state of 26 lakes and reservoirs (2011)

- **Eutrophication of lakes**

algae blooms

Lake Tai, China's third largest freshwater lake, occurred algae bloom since 2007 as a result of nitrogen and phosphate pollution.

That made the water undrinkable and produced terrible stench.

Water resource in Shandong

- **Area:**

  157,100 km²
- **Population:**

  90,793,100
- **Precipitation:**

  850 mm (southeast)

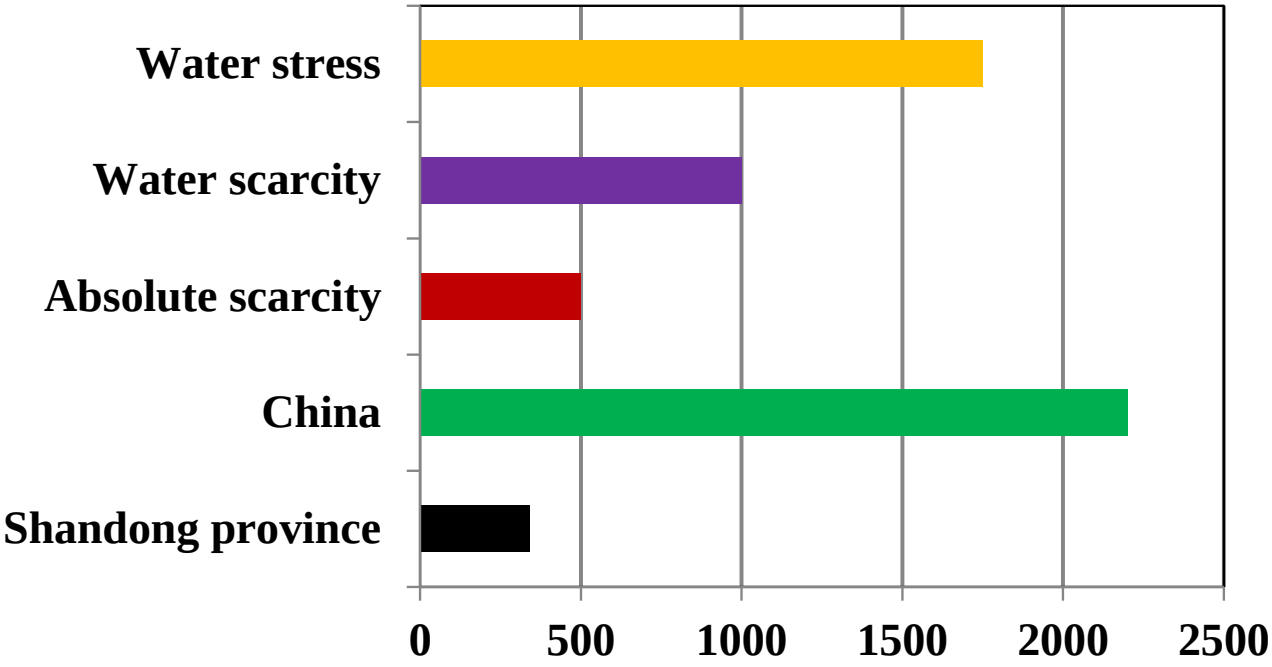
  550 mm (northwest)
- **Total water resources:**

  309.12 billion m³

Characteristics of Water Resource

Shandong province

- **Water deficiency**



The Falkenmark indicator of Shandong and China (m^3 p^{-1} $year^{-1}$)

- The per capita water resource: 340 m^3, less than 1/6 of the national average in China

Characteristics of Water Resource

Shandong province

- The wastewater discharge of major polluting industries (2011)

Industries	Wastewater discharge (million ton)
Paper making	362.22
Chemical manufacturing	268.56
Textile	195.10
Agriculture non-staple food processing	186.52
Total	1,012

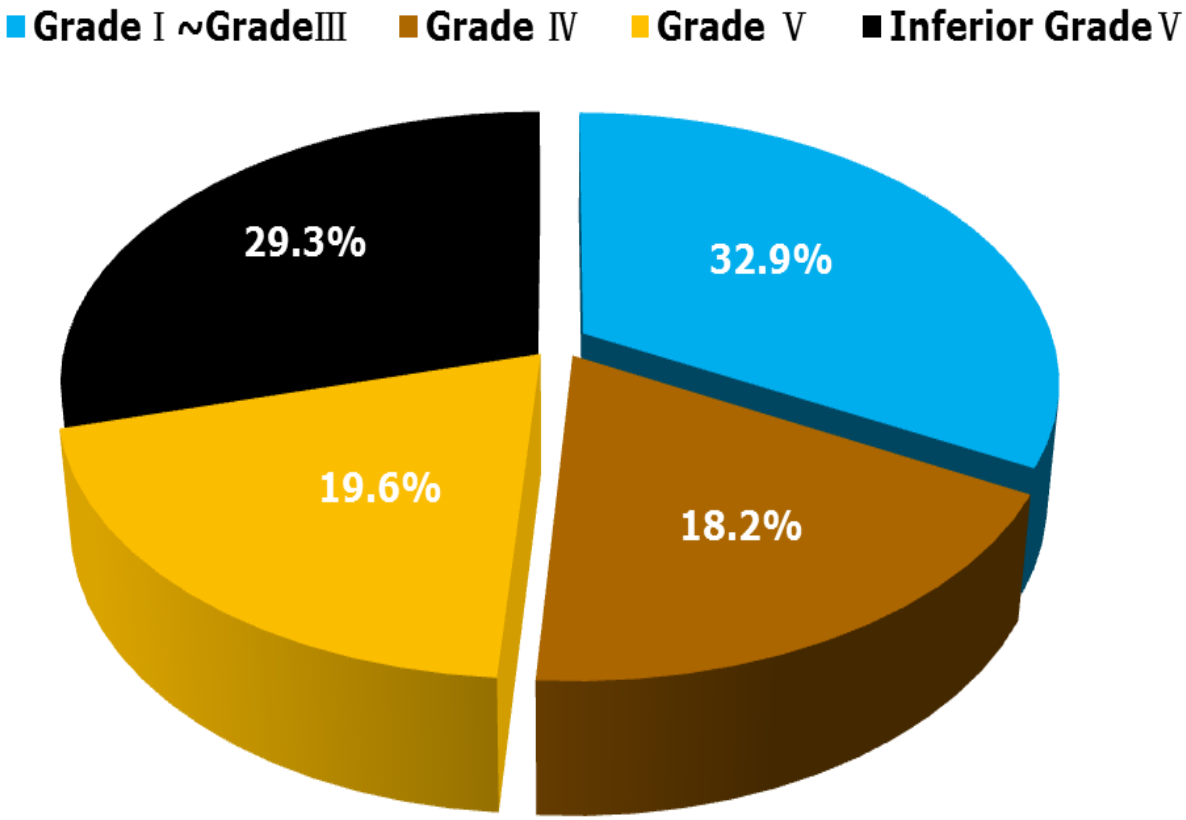
Water quality of rivers and lakes

Shandong province

Rivers: 1500

Lakes: 11

Reservoirs: 6424



Water quality at 143 monitoring sections of 67 rivers in Shandong province

Actions in China

"Only when the last tree has died and the last river has been poisoned and the last fish been caught will we realise we cannot eat money."

Cree Indian saying

Actions in China

The Chinese government recognizes the water resource issues and has been taking steps to promote sustainable water use.

- **China has set up a series of policy goals and priorities for water resource management in its 11th Five-Year plan (2006-2010) for Social and Economic Development. The general goals and guiding principles:**

"scientific development"

"harmonious society"

Actions in China

Uneven regional distribution

- Water transfer projects

Great annual and inter-annual variety

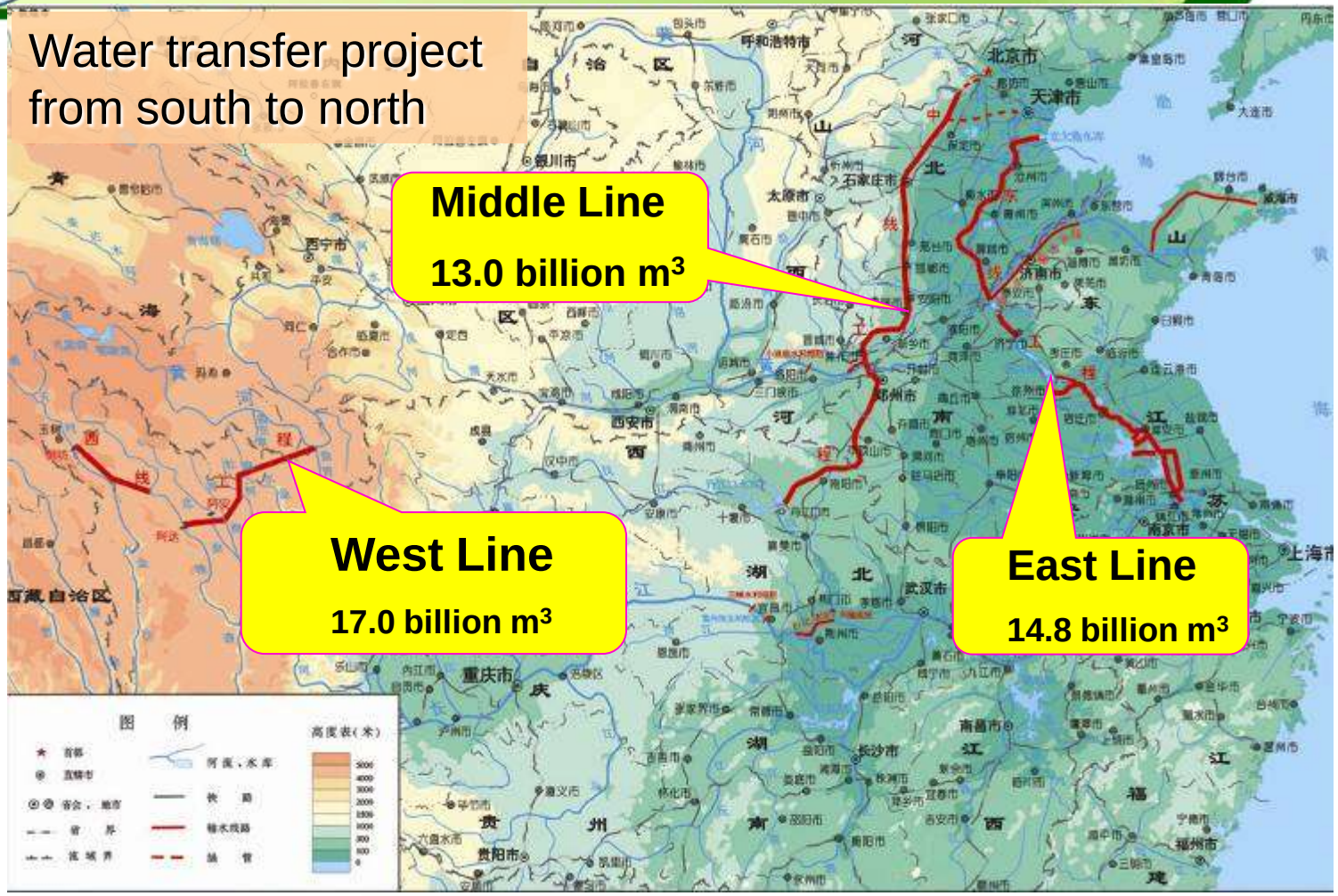
- Build reservoirs

Water pollution

- Develop new water use technology
- Exploit new advanced waste water treatment technology
- Establish water-saving policy against water wasting and water pollution

Actions in China

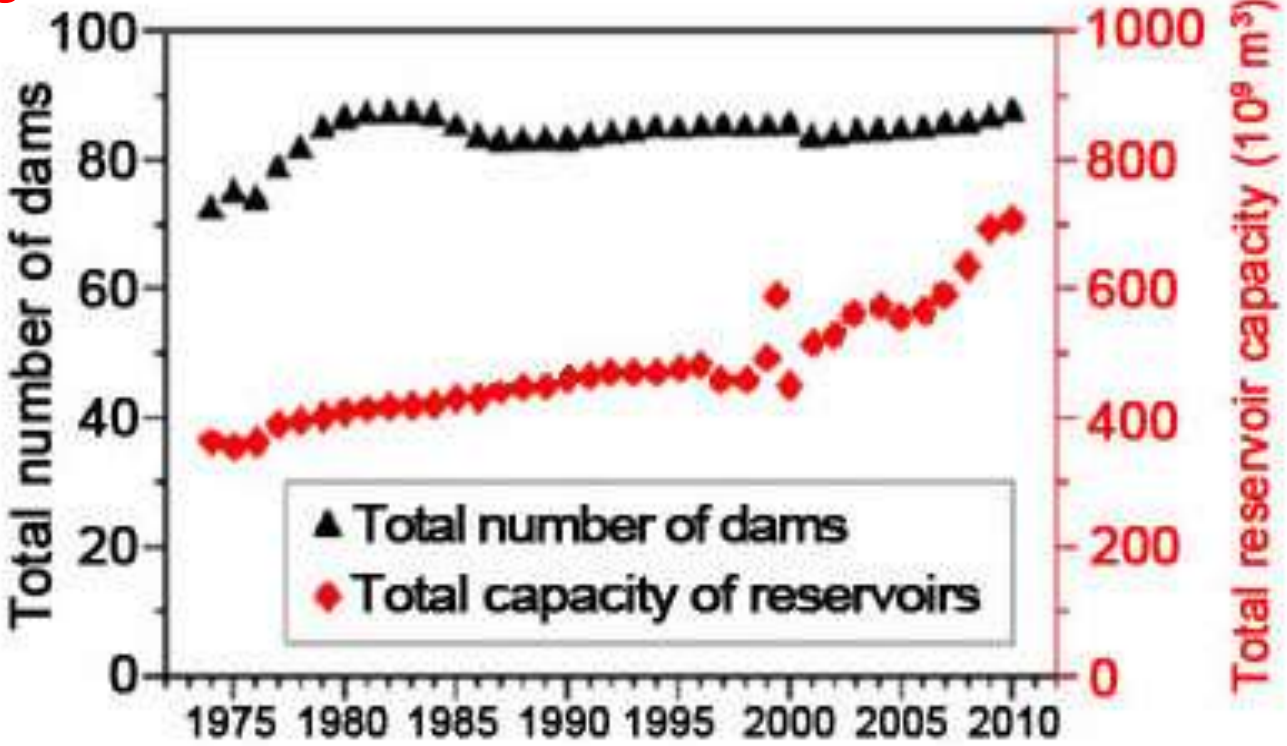
Water transfer project from south to north



At time of completion, the three-route project will channel 44.8 billion m^3 of water from the Yangtze River to the drought-stricken north of China.

Actions in China

Dams and reservoirs



Development of dams/reservoirs in China since the 1970s

- ✓ China has built about **87,873** dams and reservoirs of all sizes.
- ✓ The total storage capacity of reservoirs was **716.2 billion m^3** in 2010.

Ministry of Water Resources of China ((MWR, 2010a)

Desalination of sea water

Shandong province

- ✓ Coastline of 3,345 km
- ✓ One sixth of the whole country's mainland coastline
- ✓ Marine area of 170,000 km^2

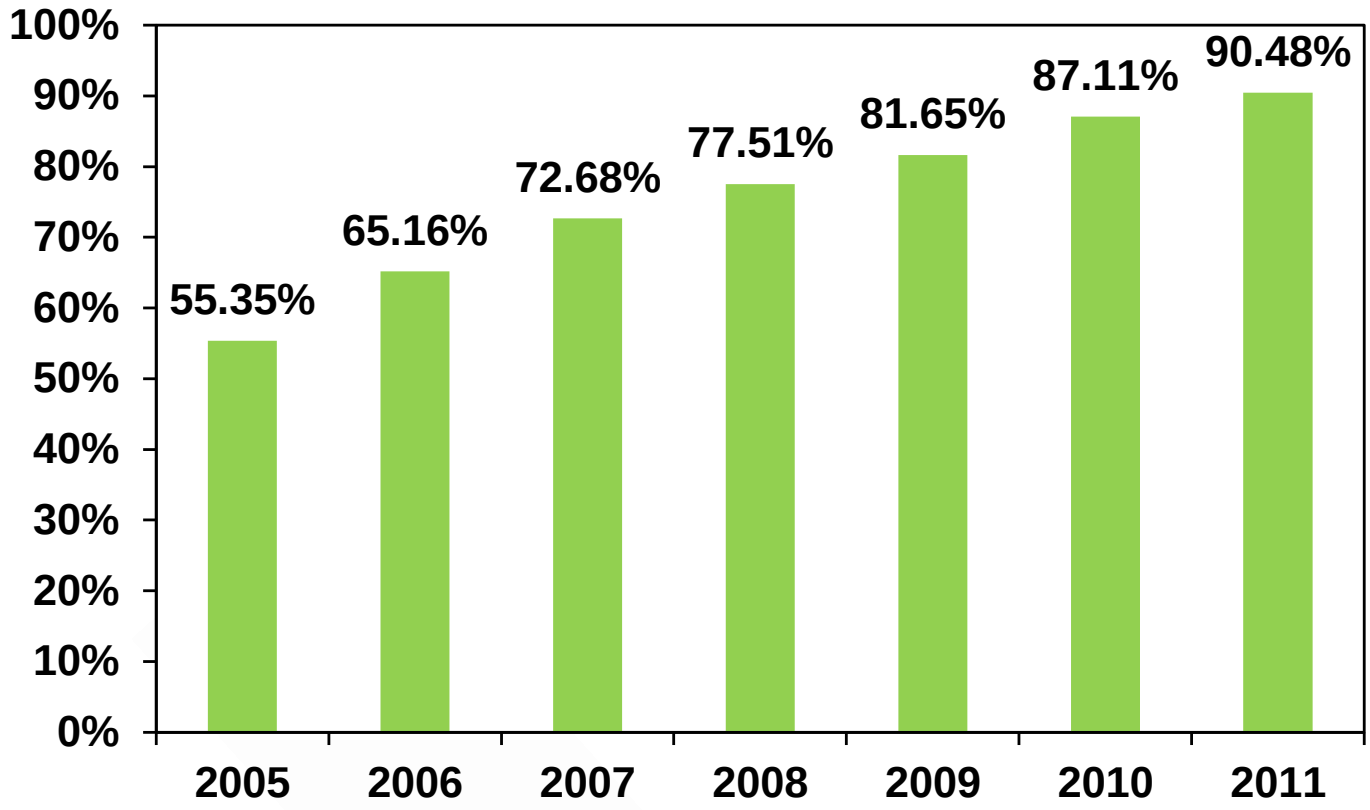
- ◆ Marine water desalination plants:18
- ◆ Desalination of sea water capacity: 295×10^3 m^3/d.

Technology	Cost (Yuan/t)	Ratio
Reverse osmosis(RO)	4.16-5.19	65.6%
Multi-efficient distillation (MED)	4.88-6.70	33.5%

Actions in China

Shandong province

- Municipal domestic wastewater



Sewage treatment rate during the period 2005-2011

Actions in China

During the “12th Five-Year Plan” (2011-2015)

Strengthen major work on environmental protection

Water quality issues:

- ✓ **Reduction of total discharge of major pollutants**

- ➢ **8% reduction of COD ” (compared with that of 2010)**
- ➢ **10% reduction of ammonia nitrogen.**

- ✓ **Continuous enhancement of prevention and control of pollution of key river basins and regions**

- ✓ **Comprehensive prevention and control of heavy metal pollution**

Opportunities in China

Projects (in this conference) that would be prosperous in China for pollutants reduction aims

- **Nutrient removal –algae & fibre optics**
- **Phosphorus removal & recovery**
- **Novel integrated photocatalytic adsorbent-organic removal**
- **Low carbon anaerobic wastewater treatment**
- **……..**

Shandong University

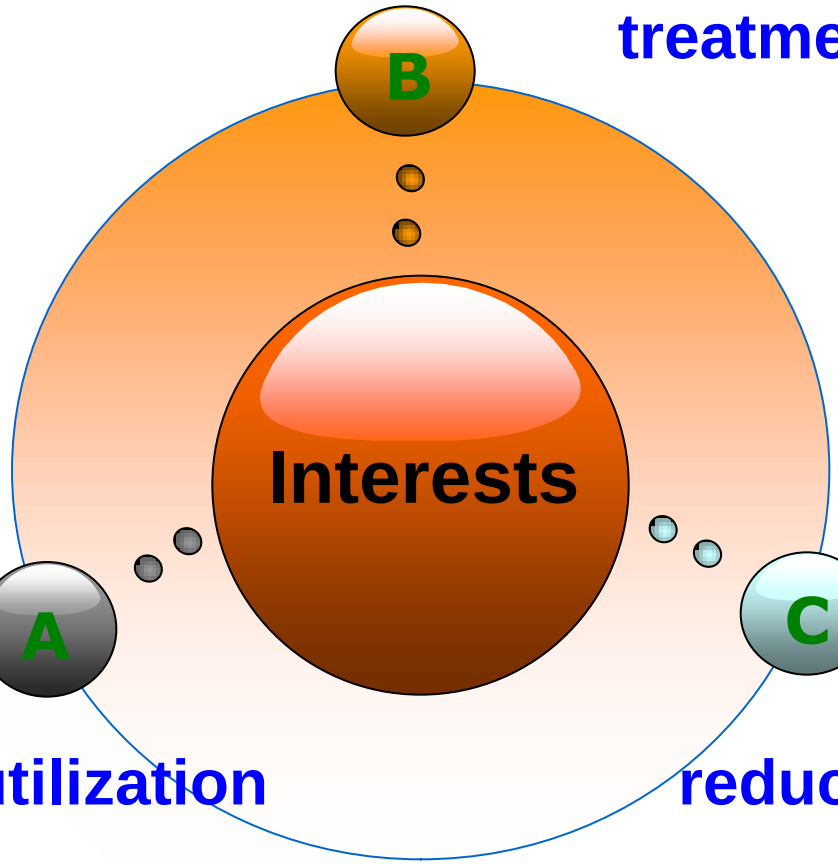
- **Established in 1901.**
- **Schools:**
  - 6 campuses
  - 31 schools
- **Staff**
  - 10,200 staff
  - 1,046 professors
- **Students**
  - 60,000 full-time students, including
  - 43,000 undergraduates
  - 15,000 postgraduates
  - 1,600 international students

Shandong Provincial Engineering Centre on Environmental Science & Technology

2 professors, 1 associate professor

10 PhD students, 10 Master students

Research Interests



treatment and reuse

Algae

Sludge

control and utilization

reduction and dewatering

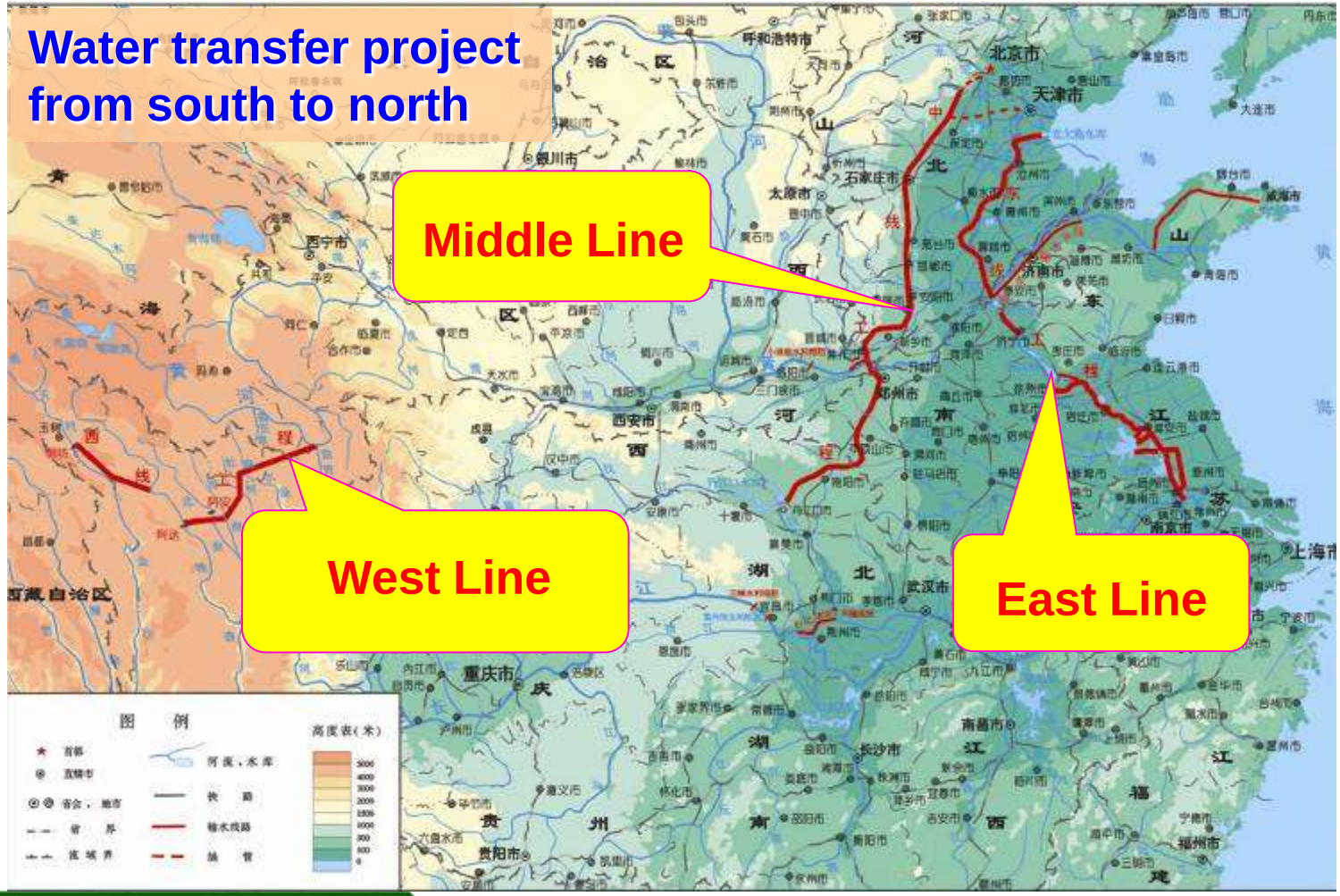
Current research

----Algae

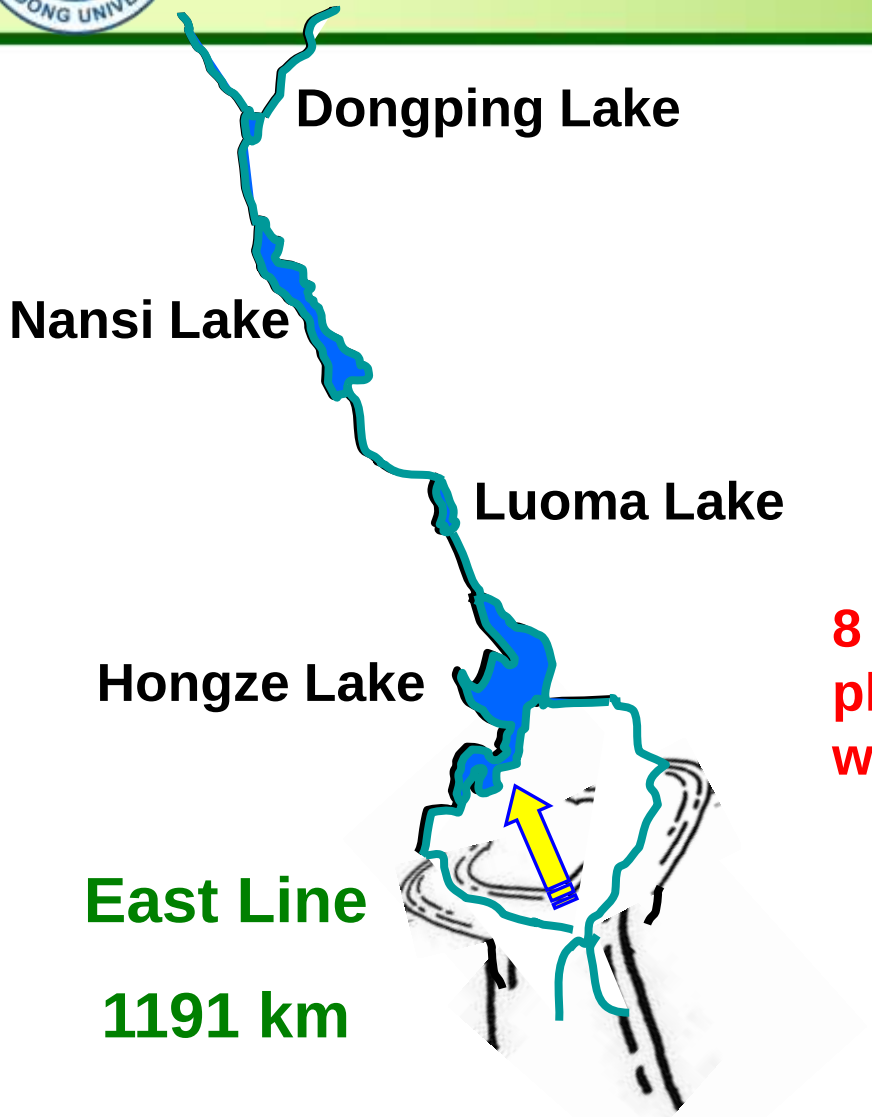
- Community characteristics of algae
- Algae removal methods
- Development and utilization of algae resources

The community characteristics of algae

Target on water transfer project from South to North



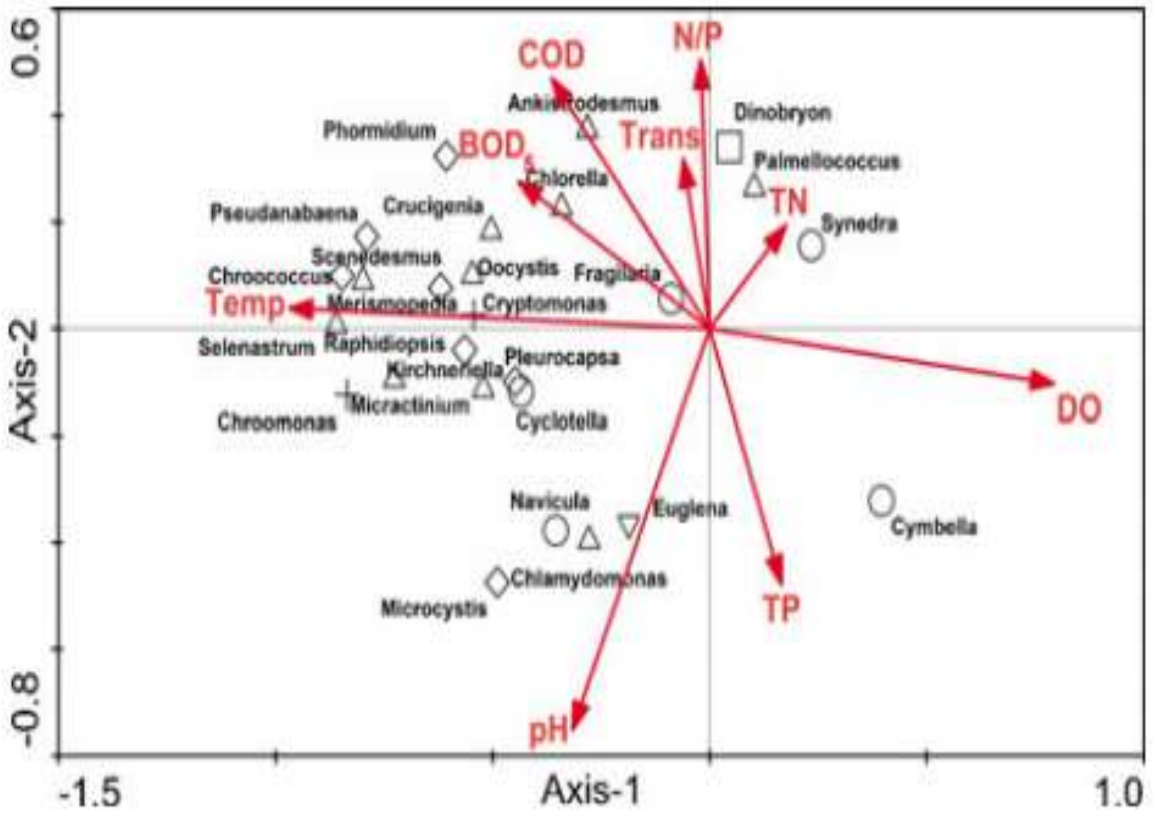
The community characteristics of algae



- Phytoplankton community
- Dominant species

8 phyla, 122 genera and 297 species of phytoplankton community in the waters were identified.

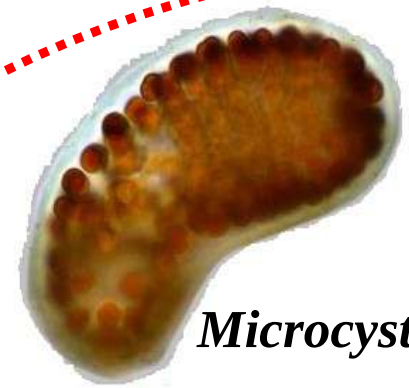
The community characteristics of algae



- phytoplankton distribution and composition
- Environmental drivers
- Blue algae distribution and control

The relationship between phytoplankton community structure and environmental variables.

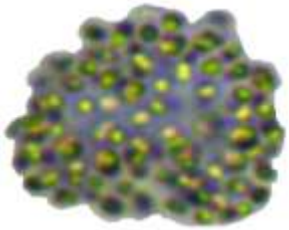
The distribution of toxic blue algae in the four lakes



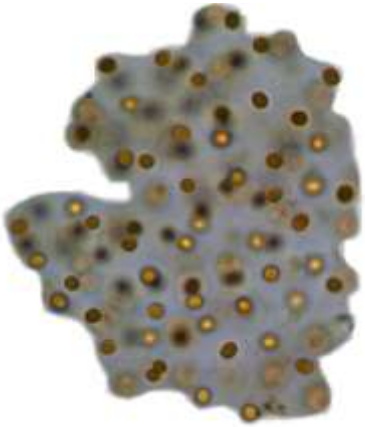
Microcystis wesenbergii

Anabaena circinalis Rab.

Aphanizomenon issatschenkoi



Microcystis incerta Lemm.



Microcystis aeruginosa Kütz.

The community characteristics of algae

- “Investigation on Distributed Characteristic of Phytoplanktons and Control Measures to Prevent Water Bloom in Nansi Lake” granted the 1st rank award for provincial Scientific and Technological Progress in 2009.

山东省科学技术奖

证 书

为表彰山东省科学技术奖获得者，特颁发此证书。

项目名称：南四湖藻类种群构成特征及其水华预防控制技术

奖励等级：壹等

获 奖 者：裴海燕(第壹位)

类　　别：科技进步奖

山东省人民政府

2010年01月18日

证书号：JB2009-1-17-1

The community characteristics of algae

Further areas for research:

- **The influences of water transfer from South to North on algae distribution and composition**

Research projects supported by Policy and Technology Research Center of South-to-North Diversion Project Office, State Council.

Algae removal methods

Target on the reservoirs of the drinking water sources

Algae removal methods

Projects carrying on

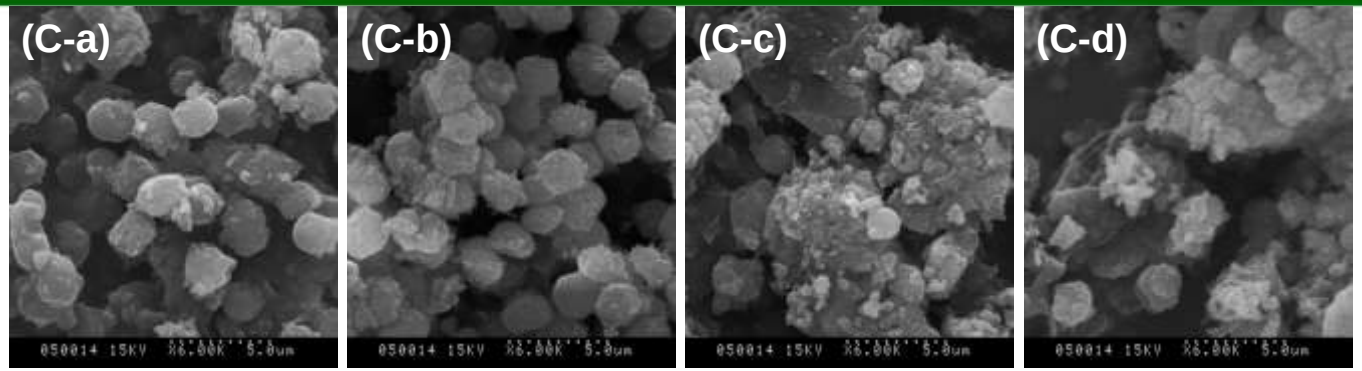
The breakage mechanism and highly effective removal of Cyanobacterial biomass

The international science & technology cooperation program

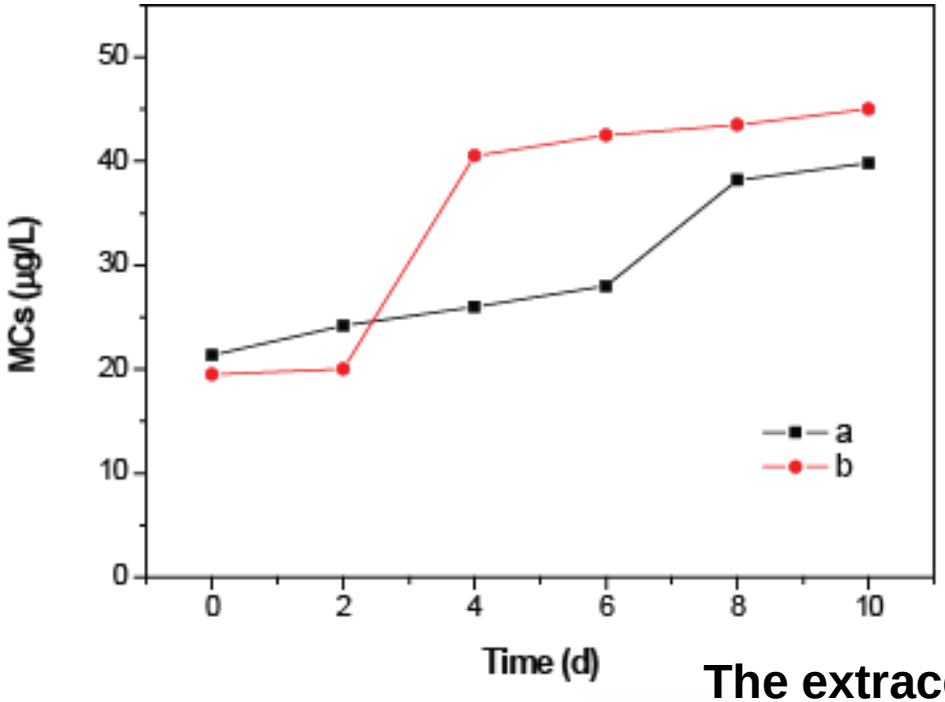
The effect of different coagulants on Cyanobacterial cells

- ✓ **Traditional coagulant**
- ✓ **Bio-flocculant**

Algae removal methods



SEM micrographs of *M. aeruginosa* after coagulation.
The cells stacked for (a) 0d, (b) 2d, (c) 4d, (d) 6d.



- **All cells were removed intactly by the surface charge neutralization with coagulant.**
- **In the floc sedimentation process, coagulant caused obvious damage to the cells and led to a large amount of MCs release above background.**

The extracellular MCs of systems without (a) and with (b) coagulant in different floc storage times.

Algae removal methods

Main research concerns for algae removal from drinking water

- ✓ **The breakage and toxin release of Cyanobacterial cells in drinking water sludge**
- ✓ **The effective methods of toxin degradation of drinking water sludge**

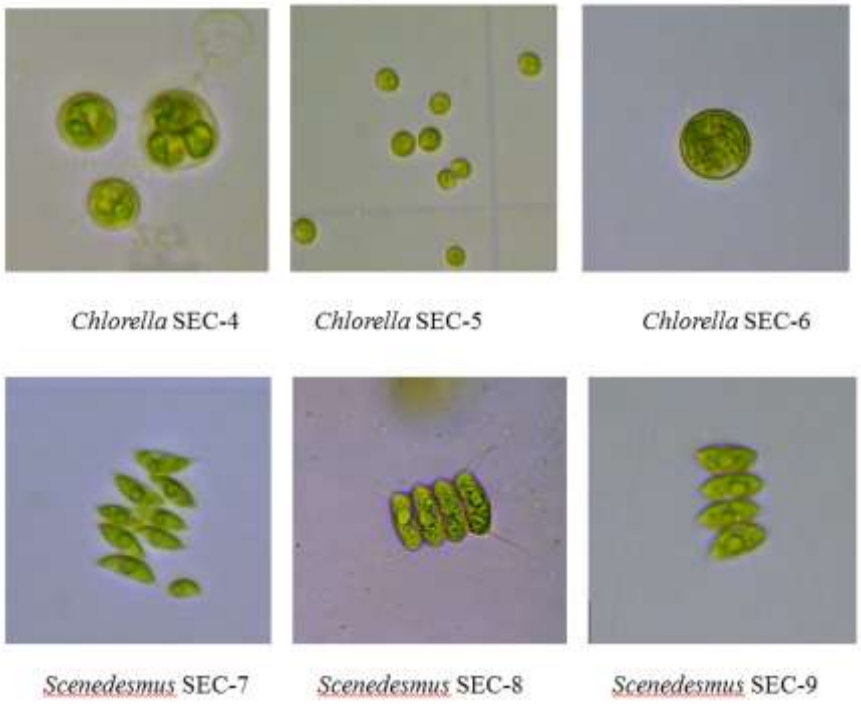
Development and utilization of algae resources

Target on the pollution of nitrogen and phosphorus in wastewater

- **Screen algae**
  - desirable biodiesel quality,
  - high biomass
  - lipid productivity
- **Nitrogen and phosphorous removal effect**

Development and utilization of algae resources

Microalgae strains



- ✓ **Biomass production: 0.10 – 0.23 g/L**
- ✓ **Total Lipid content: 19.4 - 42.6%**
- ✓ **Desirable saturated and monounsaturated fatty acids: 89.09 - 100%**

Development and utilization of algae resources

Projects carrying on

- The nitrogen and phosphorus removal effect and environmental adaptive mechanism of energy microalgae

  National science foundation

Main research concerns

- ✓ The coordinate mechanism of carbon and nitrogen on lipid accumulation
- ✓ Favorite reactors for algae growing and harvest
- ✓ Waste sources for algae feeding

Thanks for your attention