

LID workshop ,Taiwan, on May 4-5,2012

Adaptive Water Management in Changing Environment: *Opportunity and Challenges for Solution in China*

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Outline

- *Emergency water issues*
- *Screening climate change*
- *A new study on Climate change & water*
- *Adaptive water management*

1. **Water** is central to all our development goals



**UN Secretary-General
Ban Ki-moon**

“Without water there is no dignity and no escape from poverty.

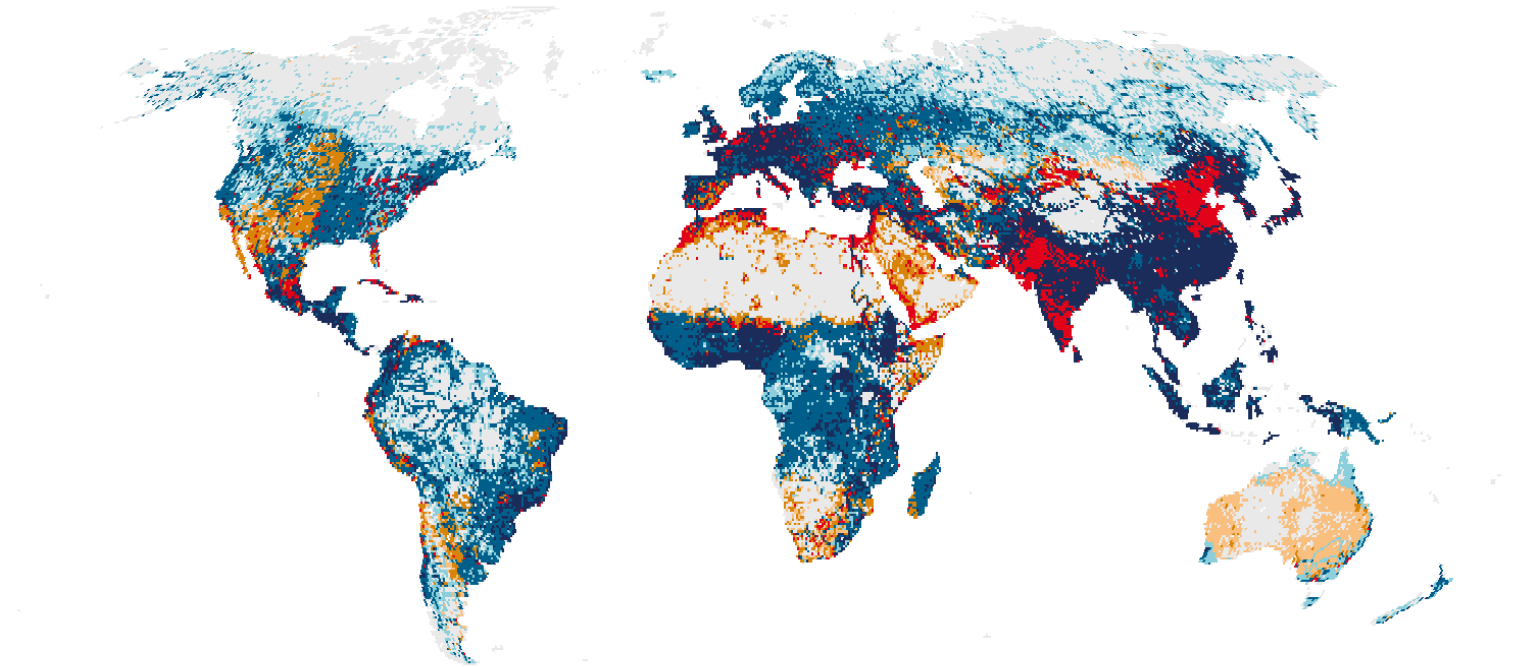
Water challenges go beyond questions of access....

Safe drinking water and basic sanitation are intrinsic to human survival, well-being and dignity”

**World Water Day
22 March 2011**

**Water for cities:
responding to the
urban challenge.**

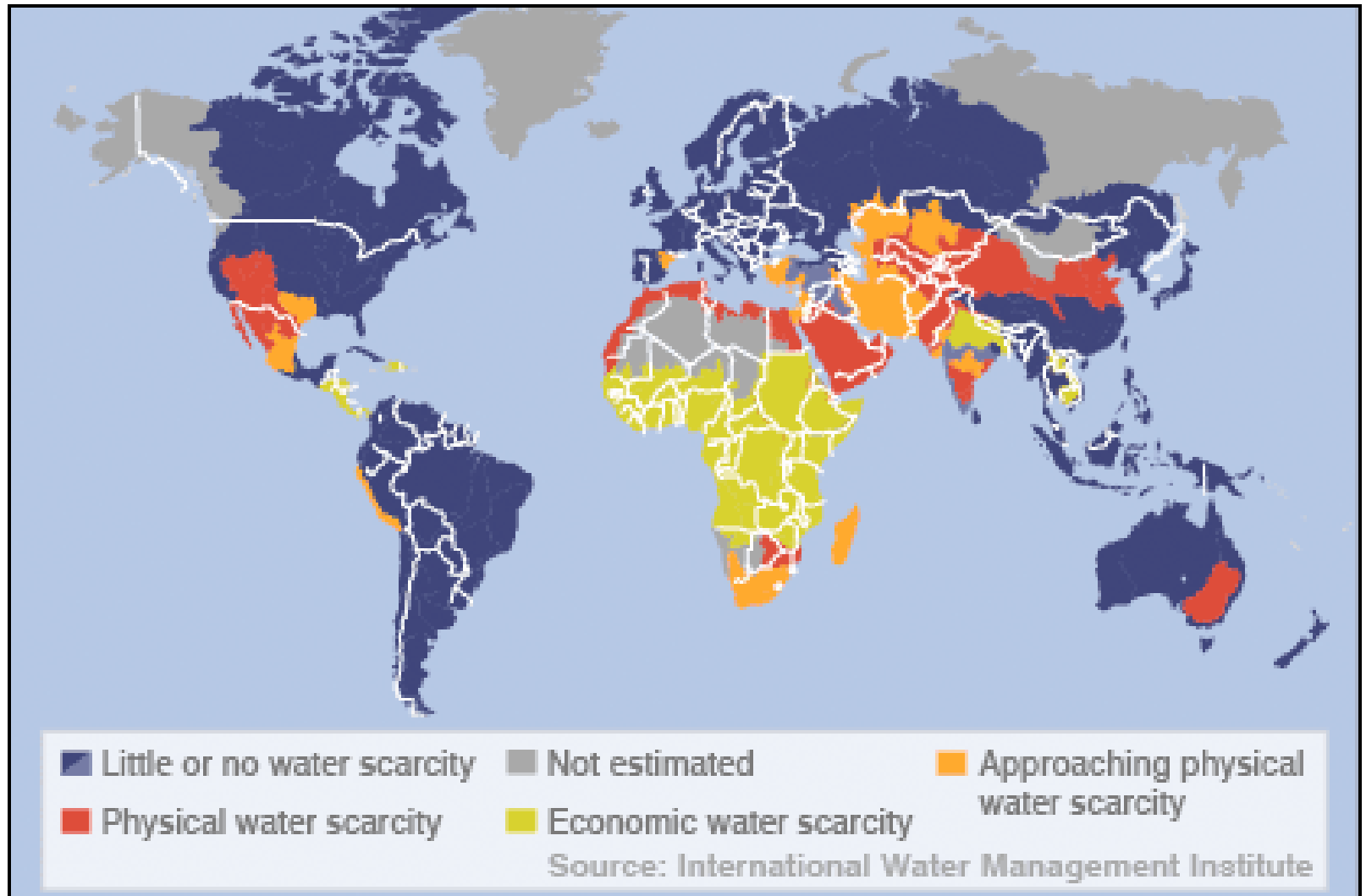
RELATIVE WATER STRESS INDEX (WWAP,2006)



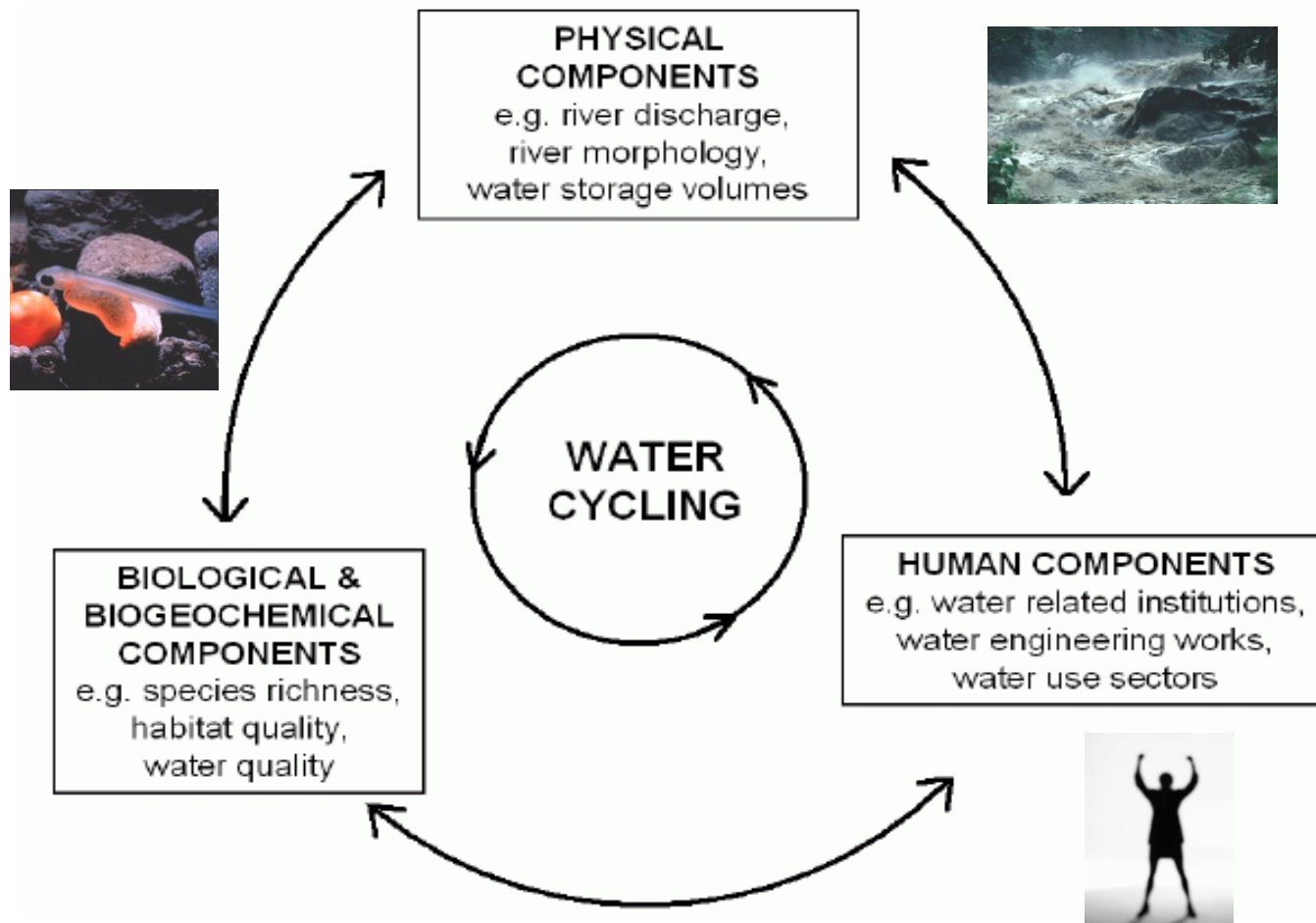
The map shows populations living in **water-stressed (red, population > 100 thousands)** and **relatively unstressed (blue)** conditions. *Higher stress occurs when water availability is less than water demand; lower stress occurs when water availability is higher than demand.*

Map details global water stress

(IWMI,2011)

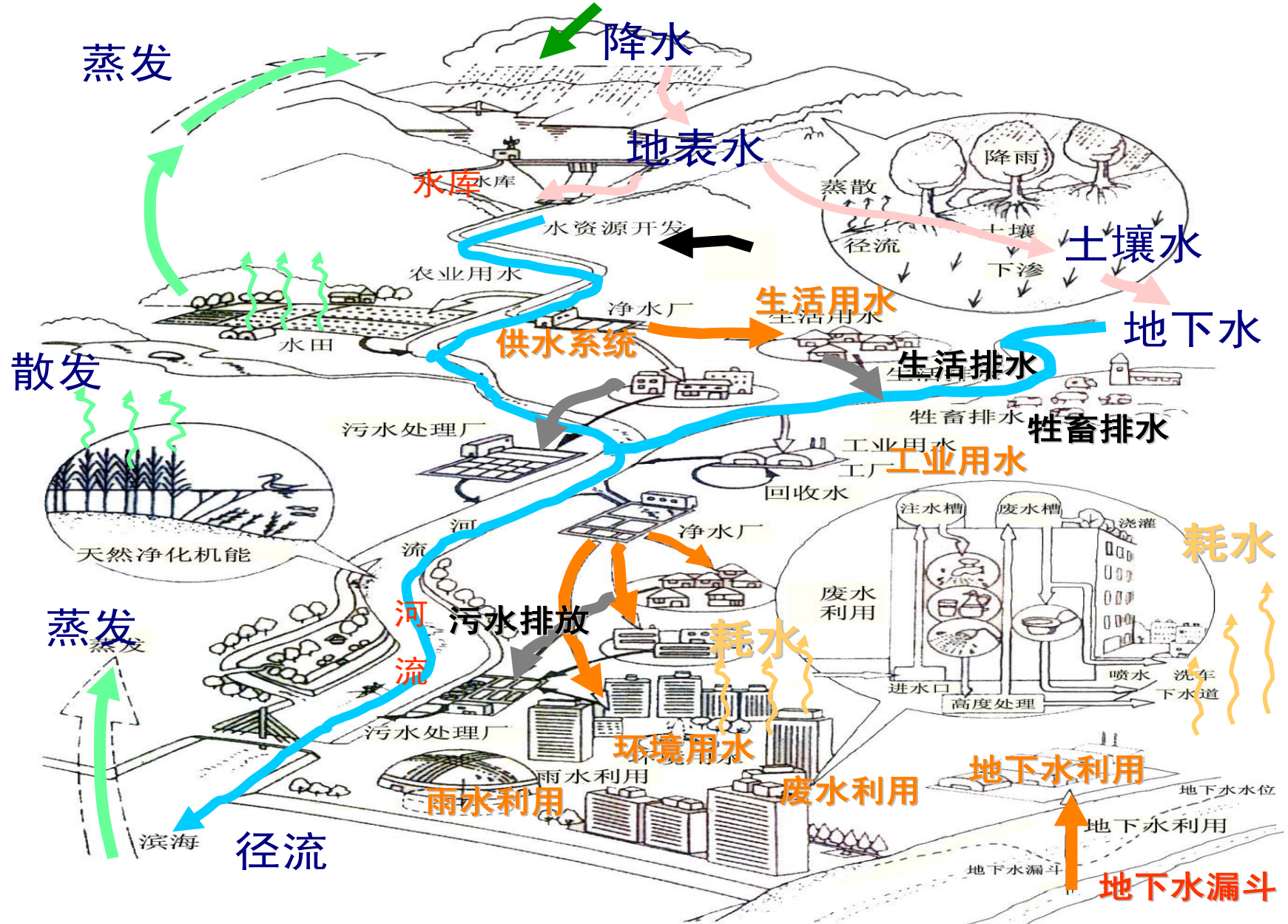


2. Water issue is also rather complex due to its system behaviors



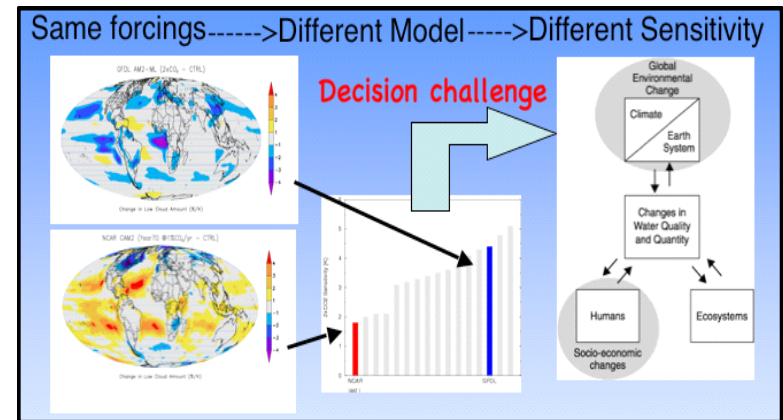
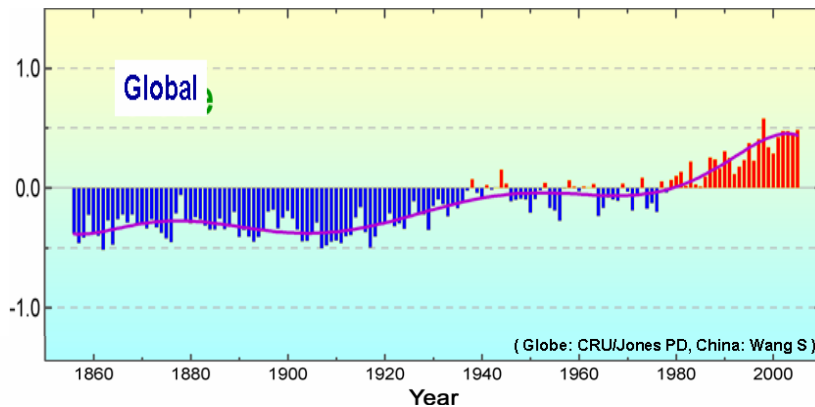
WATER SYSTEM

Basin/Urban Water System



There are multiple impacts & challenges

(1).Climate change impact



It is quite possible to

- **change water's time-space distribution**

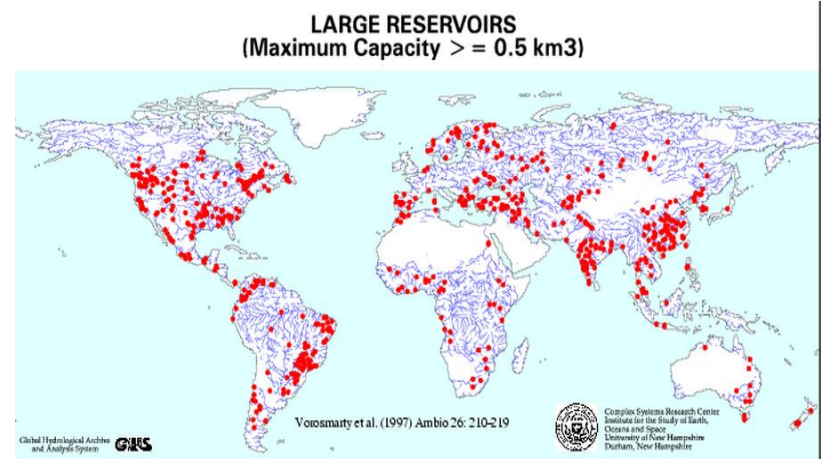
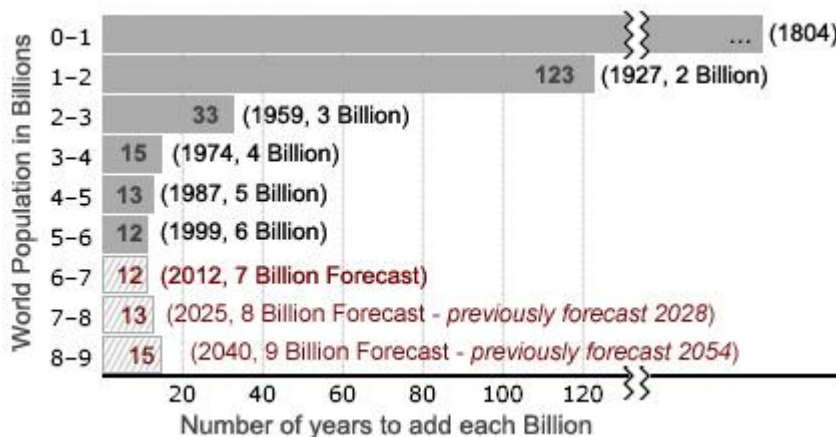
- **increase risks on floods & droughts in water stress regions**

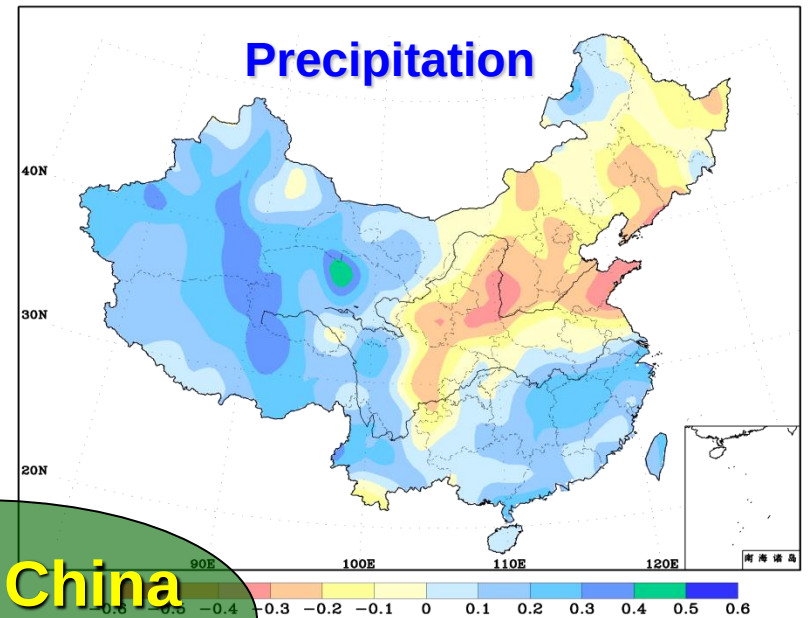
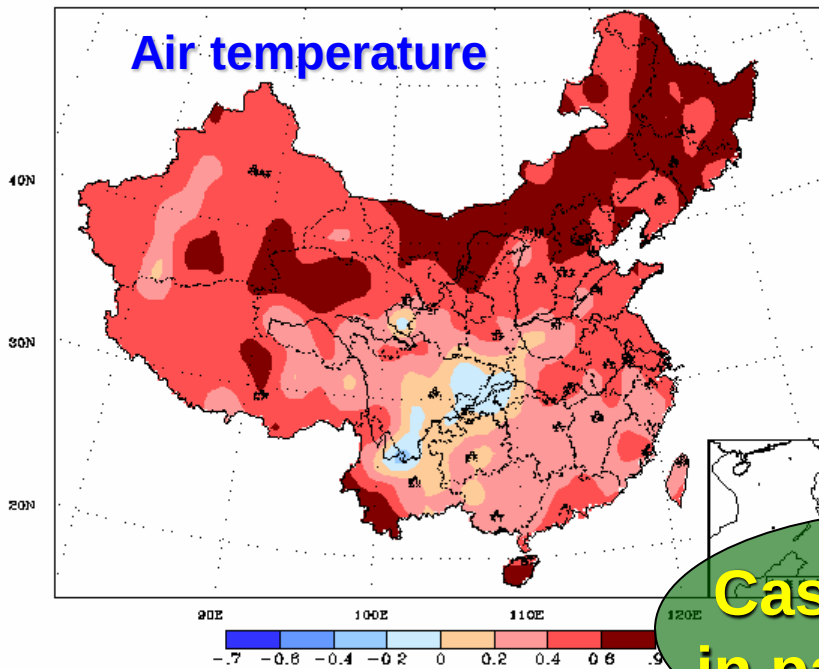
IPCC AR4 (2009)

There are multiple major challenges

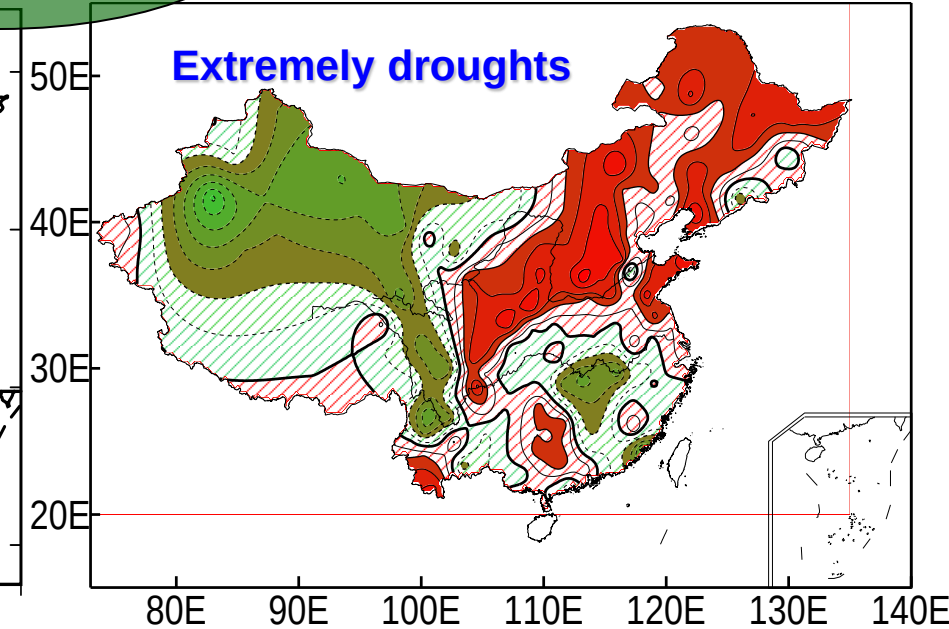
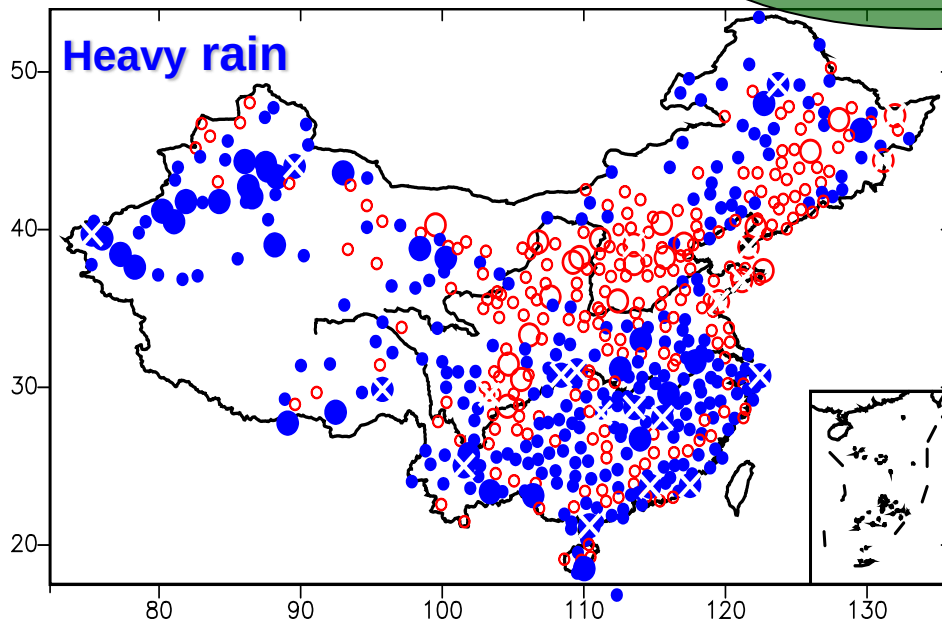
(2). Human activities impact

- **Remarkable LUCC** due to rapidly urbanization, agricultural & energy developments
- These also **significant impact sustainable utilization of water for life etc.**



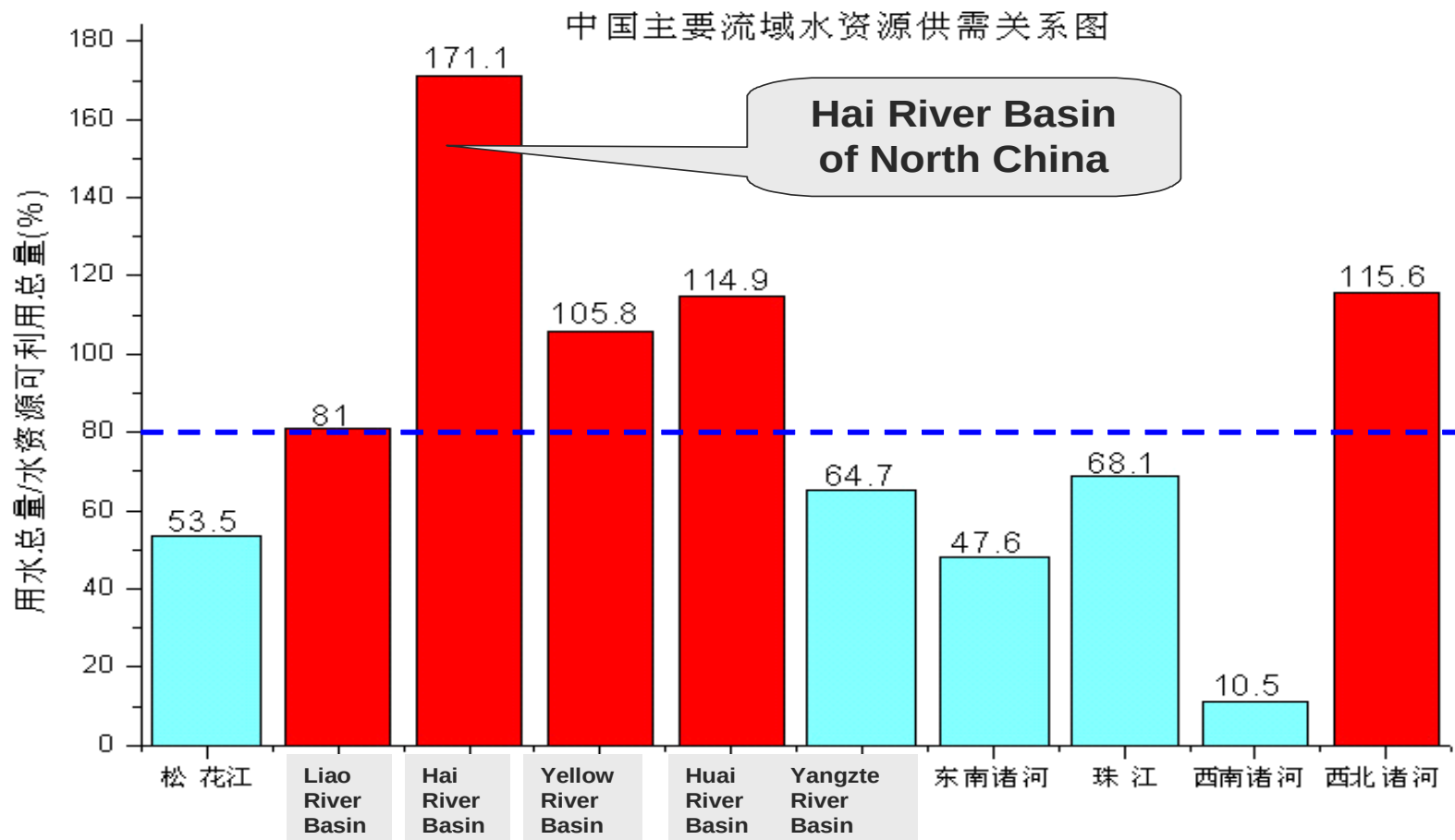


**Case of China
in past 50 years**

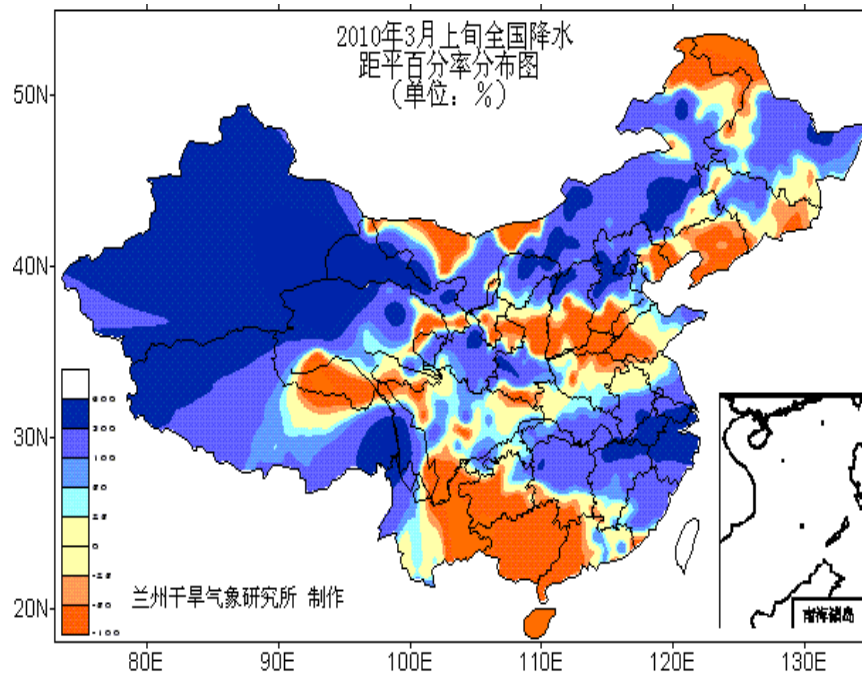


Water scarcity in China

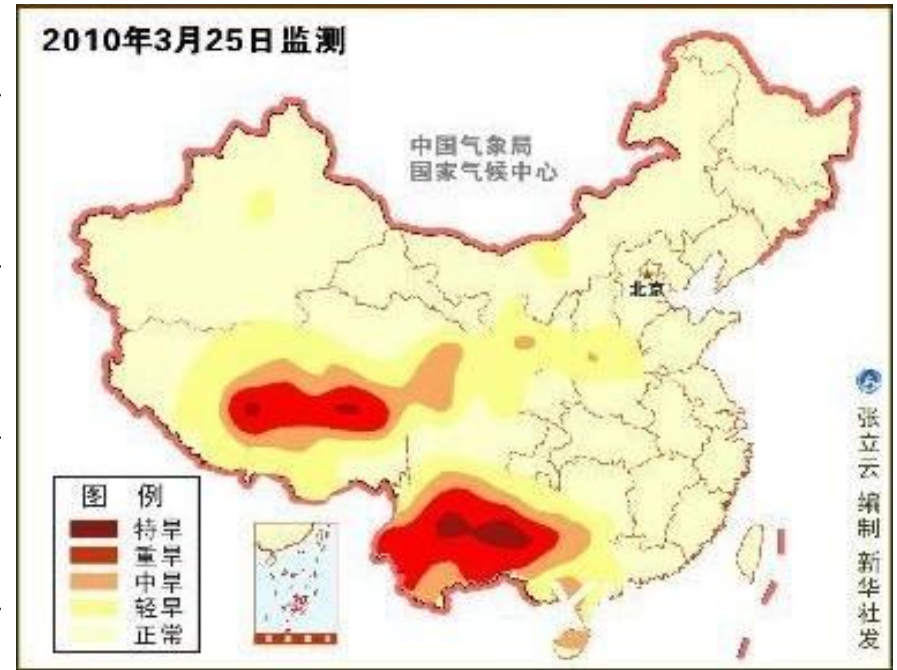
Total water use / usable water resources in China



2010's Extremely Droughts during Spring, South-West China



Precipitation change on March in China

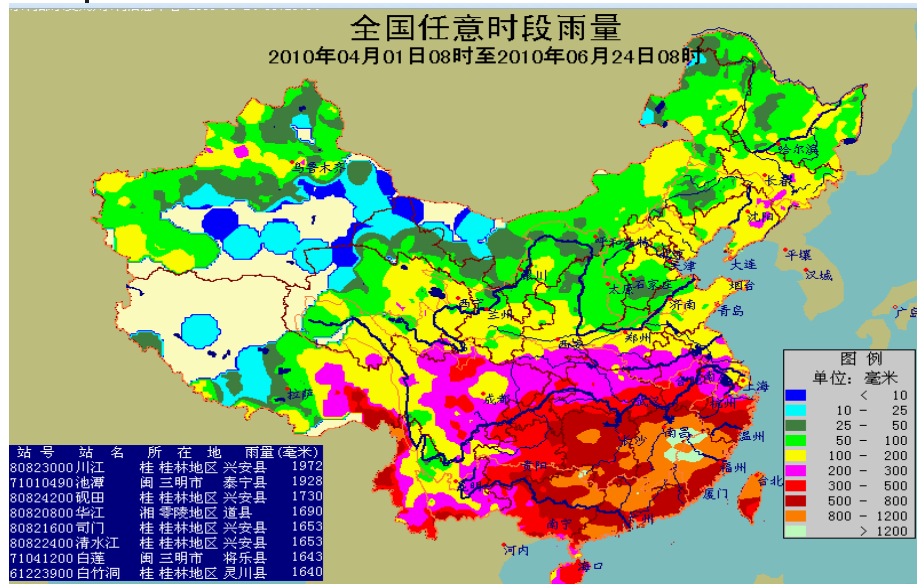


Drought monitory on March in China



2010's *Big Floods* on June in South China

Rainfall from April 1 - June 24, 2010



(Li K G, MWR,2010)

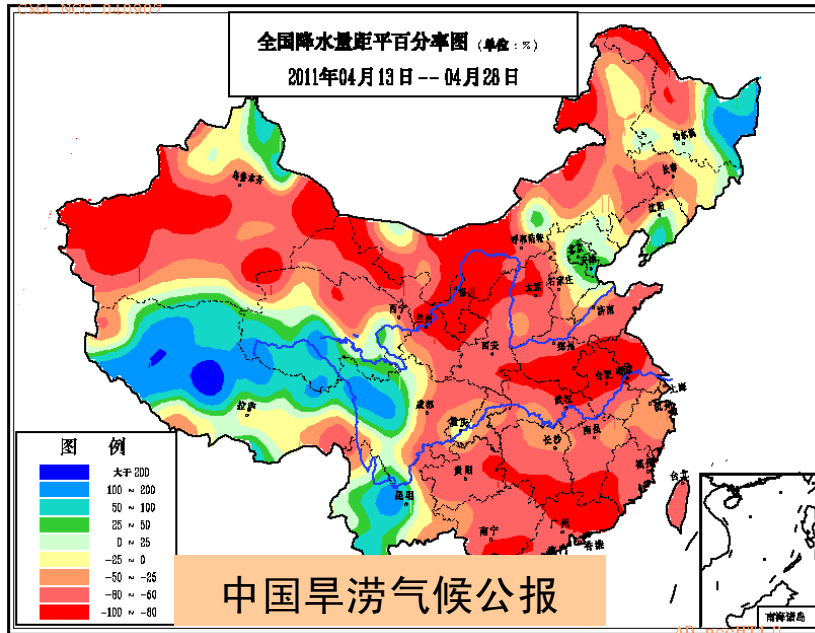
Flood Happened in Many Rivers of South China during April to June,2010



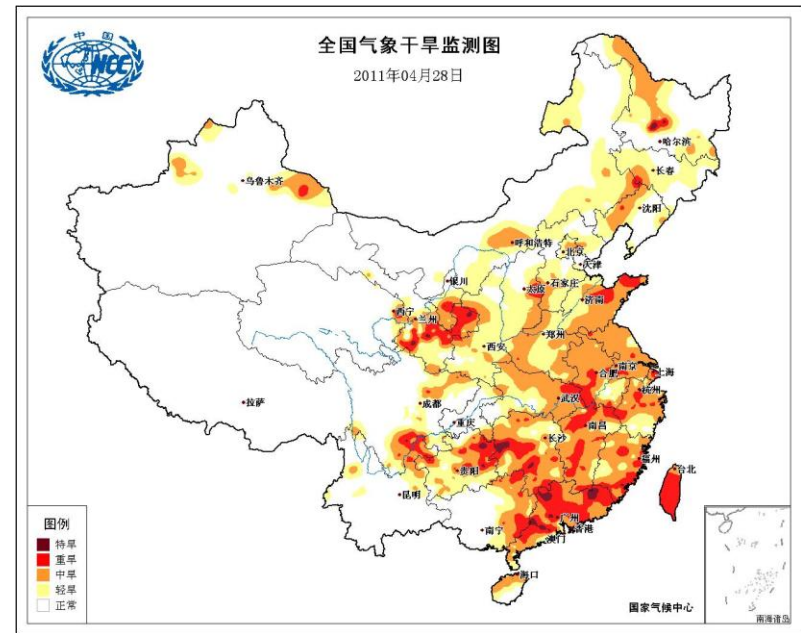
(Li K G, MWR,2010)



2011's Extremely Droughts during April in southern China



Precipitation change on April in China



Drought monitory on April in China



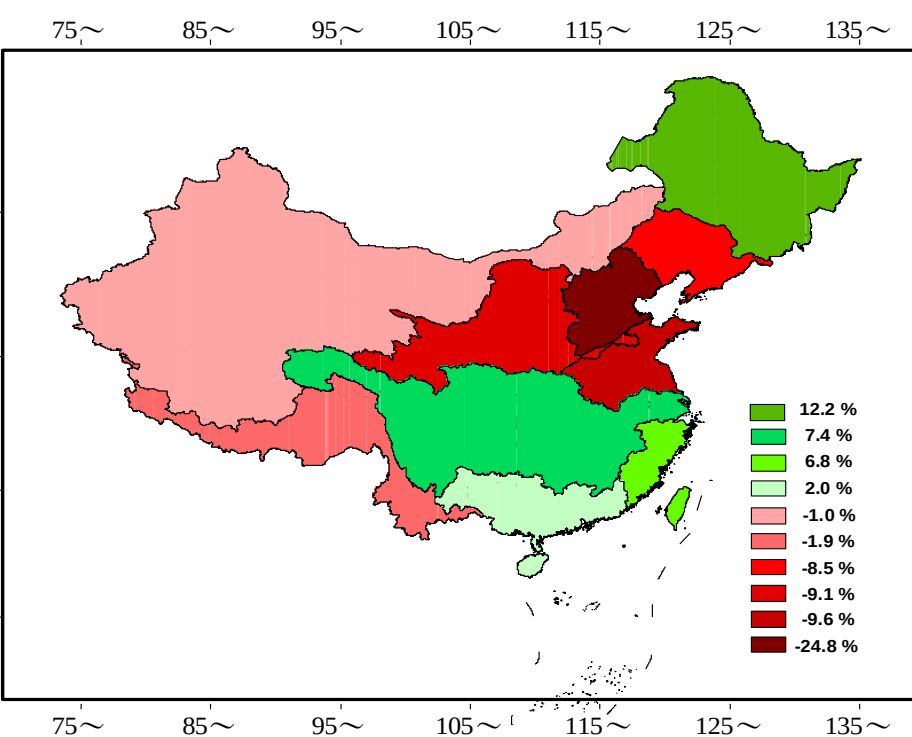
江西土地龟裂(张俊 摄)



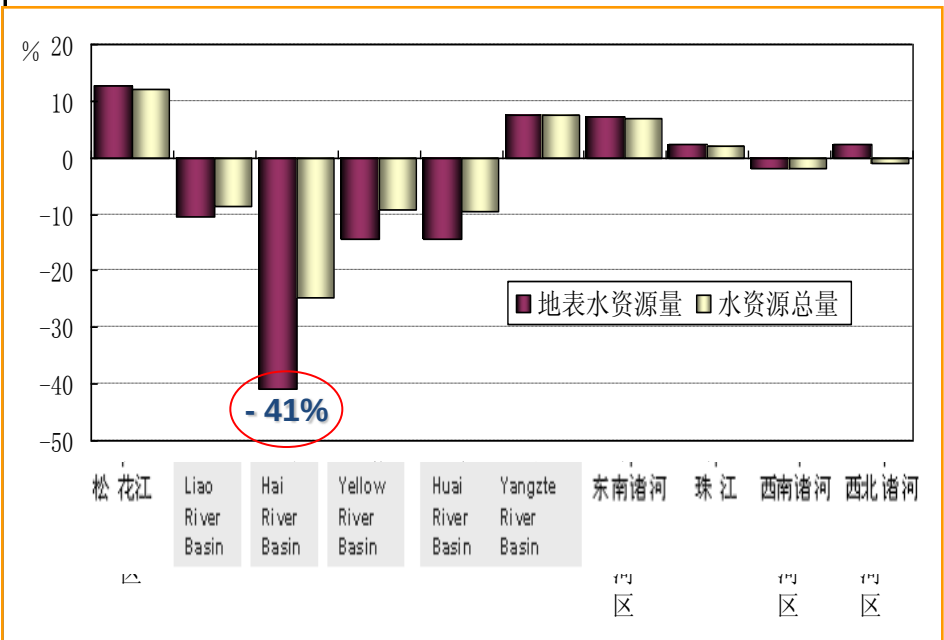
淮河河床干裂(现代快报)

Runoff change by two period comparison (1980-2000 with 1956-1979) in China

1980-2000 1956-1979 2004

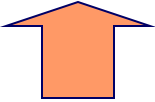
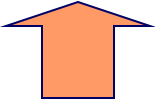


中国水资源总量变化（1980-2000年与1956-1979年的比较，水利部 2004）



中国地表水资源量变化（1980-2000年与1956-1979年的比较，水利部 2004）

Along with social & economic growth and impact of environment change, usable water resources will decline, water vulnerability will increase.

Year	Population (Billion)	Total Actual Water Use (Billion M ³)	Useable Water Res. per capita in North (M ³ /p)	Useable Water Res. per capita (M ³ /p)
2000	1.3	563.2	359	628
2030	1.6 	710.1 	292 	508 

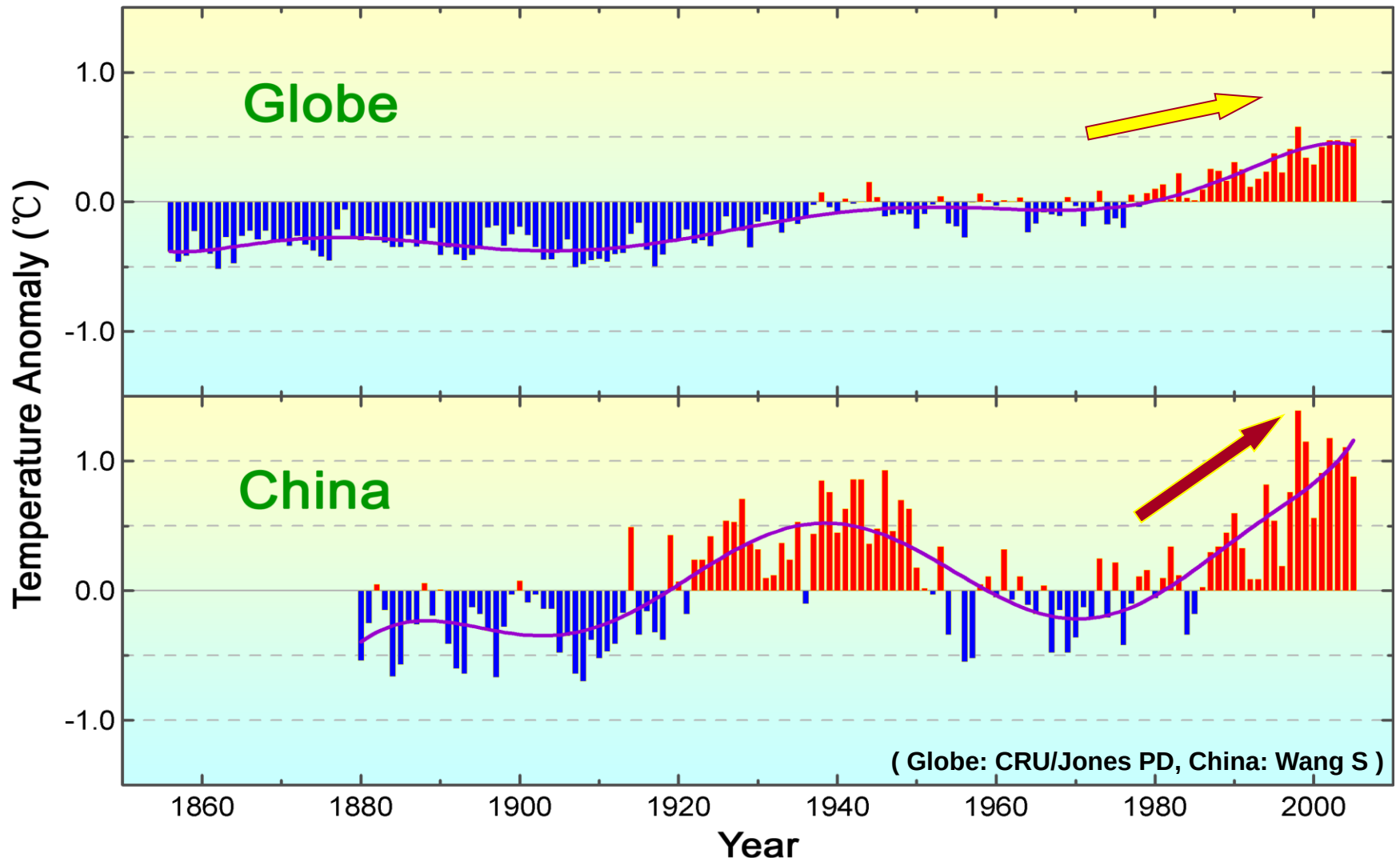
Critical Water Issues

- **Drinking Water** (Surface/Ground Water)
- **Agricultural Water** (flood security etc.)
- **Urban Water** (recycling water etc.)
- **Eco-water** (river, lake, wetland, land & coast eco-system etc.)
- **Water & Energy** (the demands for both resources are increasing faster than ever)
- ...

Aspect: water quality & quantity

Scale: global & regional

There are still arguments on climate natural variation and due to global warming



Questions related climate change impact to water sector

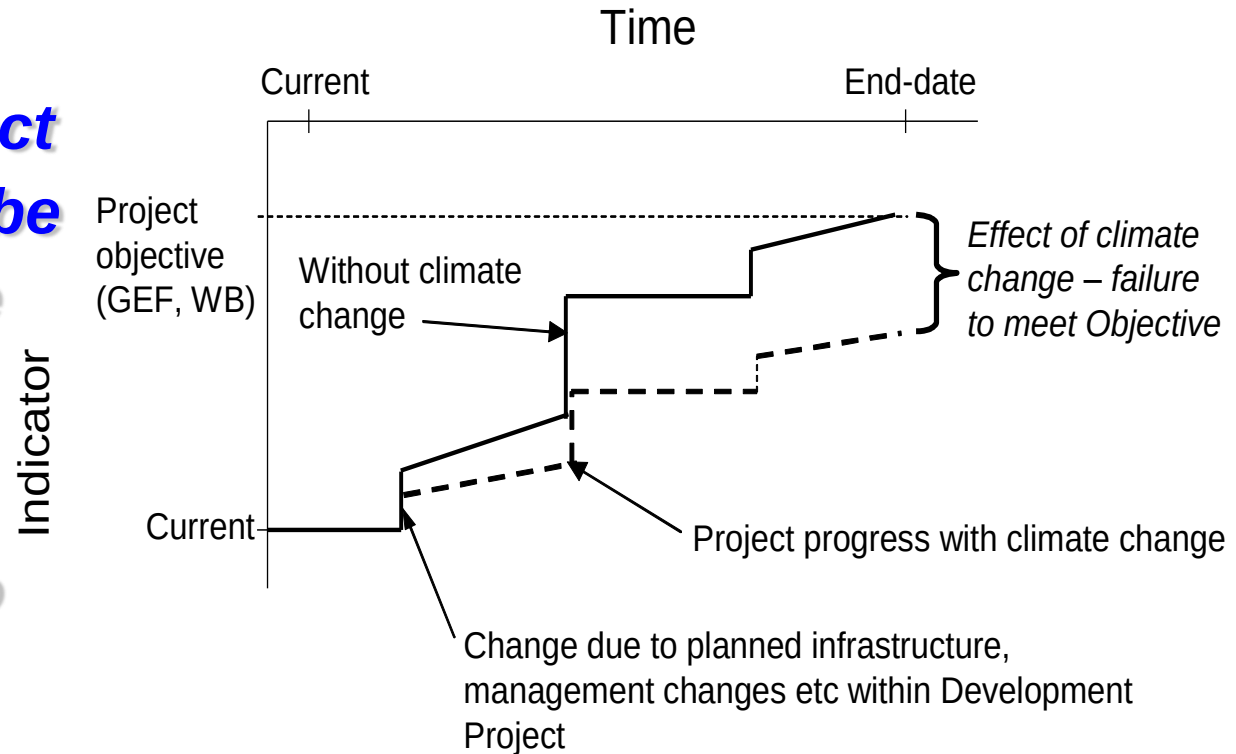
- Would changes on *time-space variability of water resources and extremely events*, such as *floods & droughts* in China, get more worse in the future?
- How to *take adaptation for climate change & wisely manage water* related to Low Impact Development (LID) on both urban & basin system?

It is a key issue to screen climate change

Screening Climate Change Impact to Water Sector

What is climate screening?

- ***It is a process to assess how project objectives might be affected by future climate-related impacts, and***
- ***identify options to manage impacts and exploit opportunities.***



A Screening Process for Climate Impacts

➤ **Key questions for the process**

- *What is impact of climate change on the project?*
- *Options for how to manage the impacts?*
- *Whether to manage the impacts?*

➤ **Economic analysis compares costs & benefits of options**

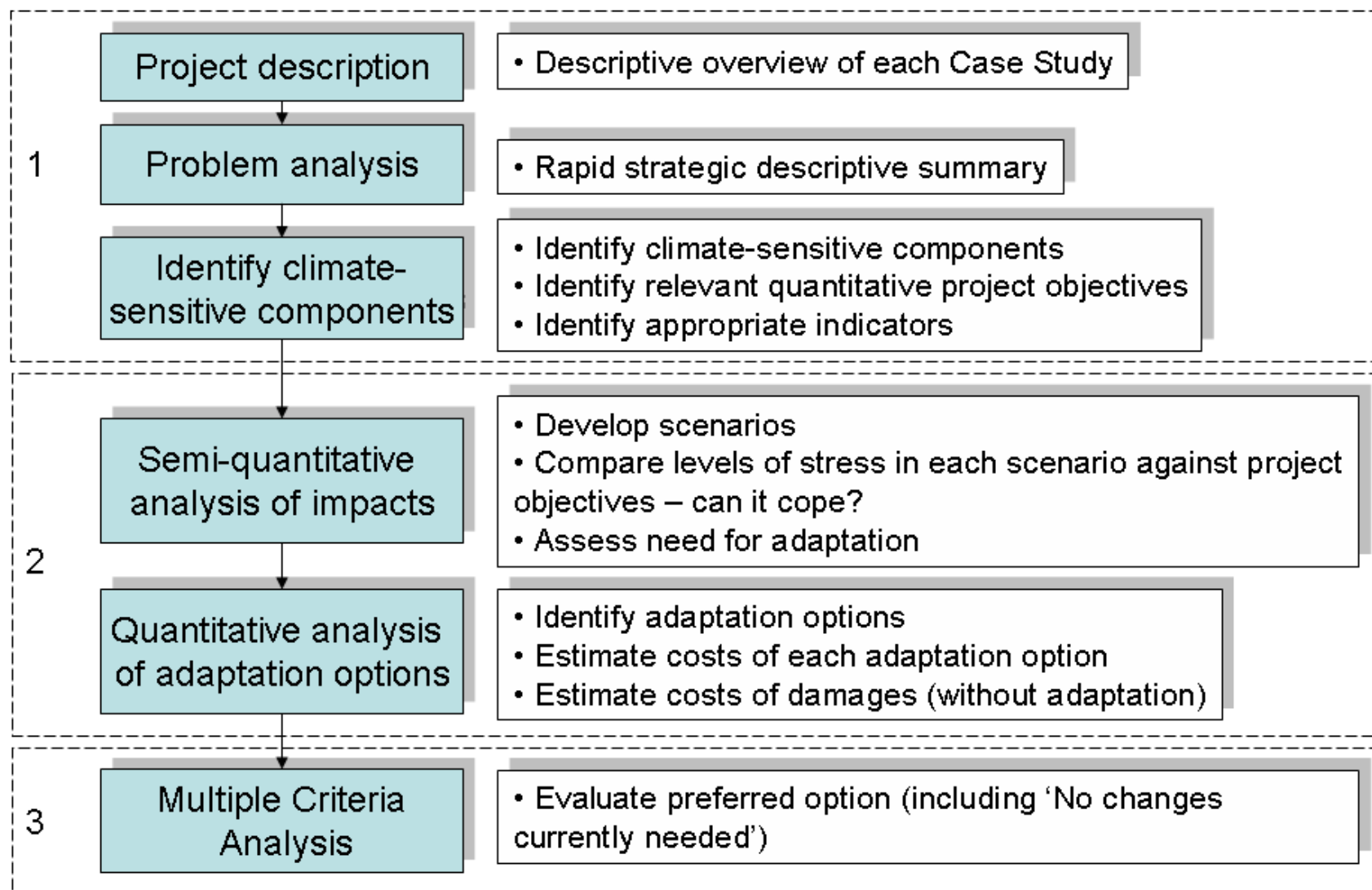
➤ **Decision on options for managing impacts is aided by a multi criteria analysis**

- *Recognises factors other than economic cost are important in decision making*

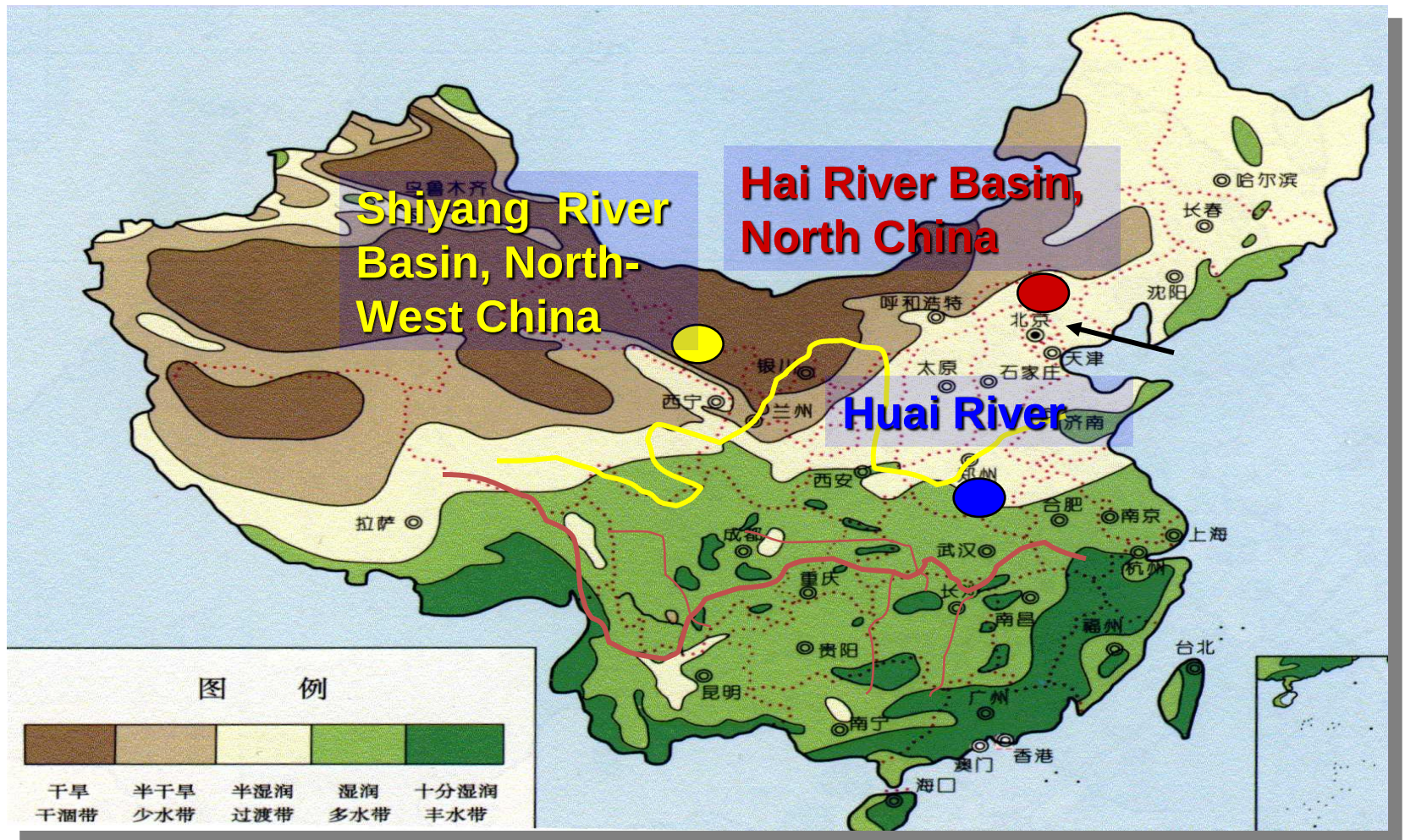
Framework of screening climate change impact

Phase

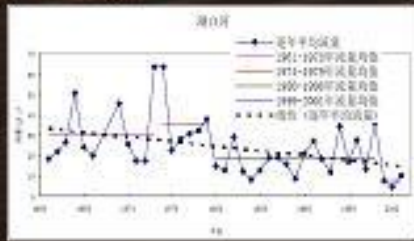
Steps



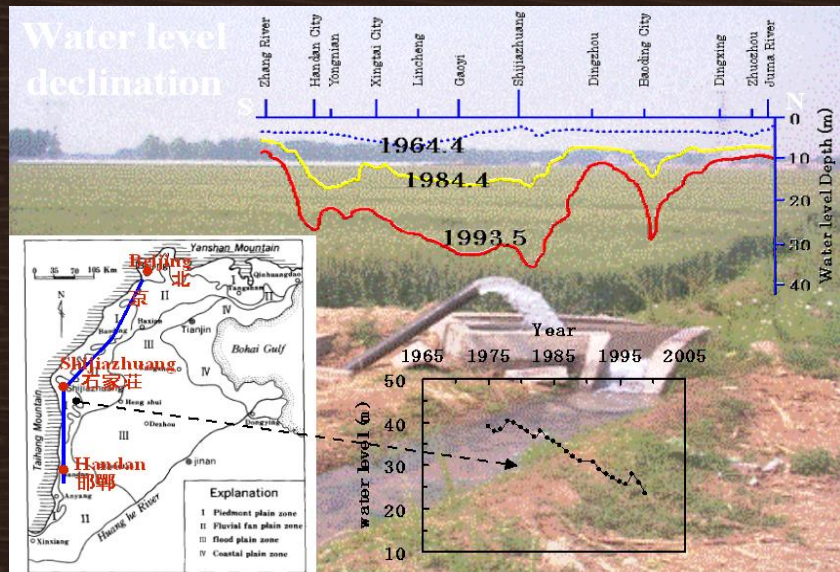
Four case studies in three representative regions were selected in China



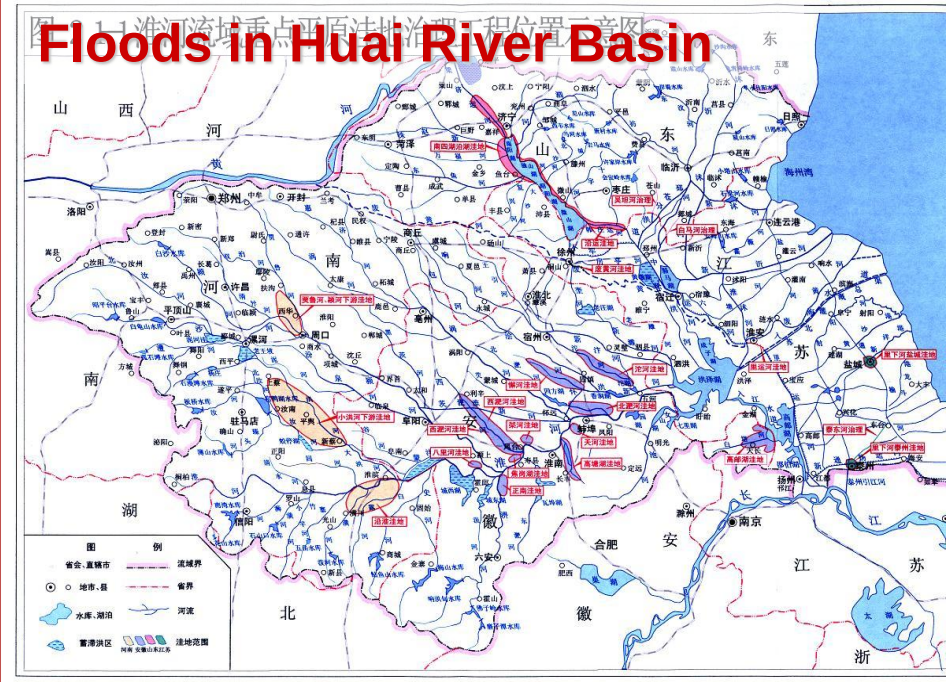
Urban Water Supply of Miyun Reservoir



Water use in agriculture and ground water change in North China.



Floods in Huai River Basin

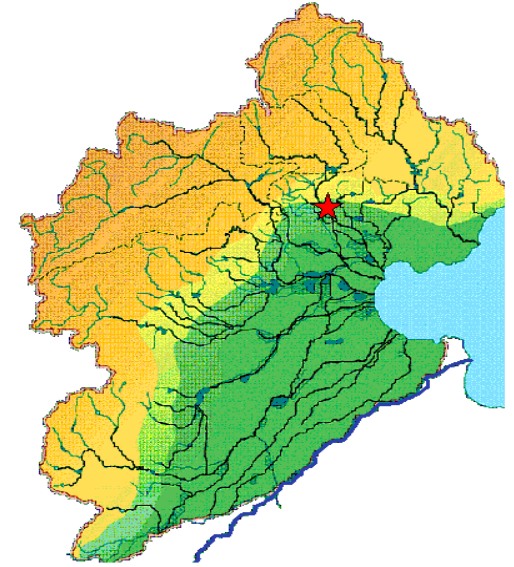


Integrated Water Management for Shiyang River Basin in West China



The Case in Beijing & Hai River Basin

Basin area: 320,000 km²
Center for policy, culture & economic in North China



Indexes	Beginning of 1950s		Present
Population	55 Million	→	126 Million
Urbanization	16%	→	30%
GDP	30 Billion	→	100 Billion
Water resources per capita	750m ³	→	276 m ³

Beijing Capital, China



The population growth and economic developing in the city are very significantly:

- **Population in 2010 has reaching to 20 Million**
- **GDP in 2010 has come up to 1380 Billion CNY**



2010年北京常住人口已接近2000万，GDP达1.38万亿元



It is also the most seriously for eco-system degradation due to water shortage and droughts

- **Water resources per capita in the city only 120 m³**
- **Yongding River sector in Beijing has drying up for 30 years**

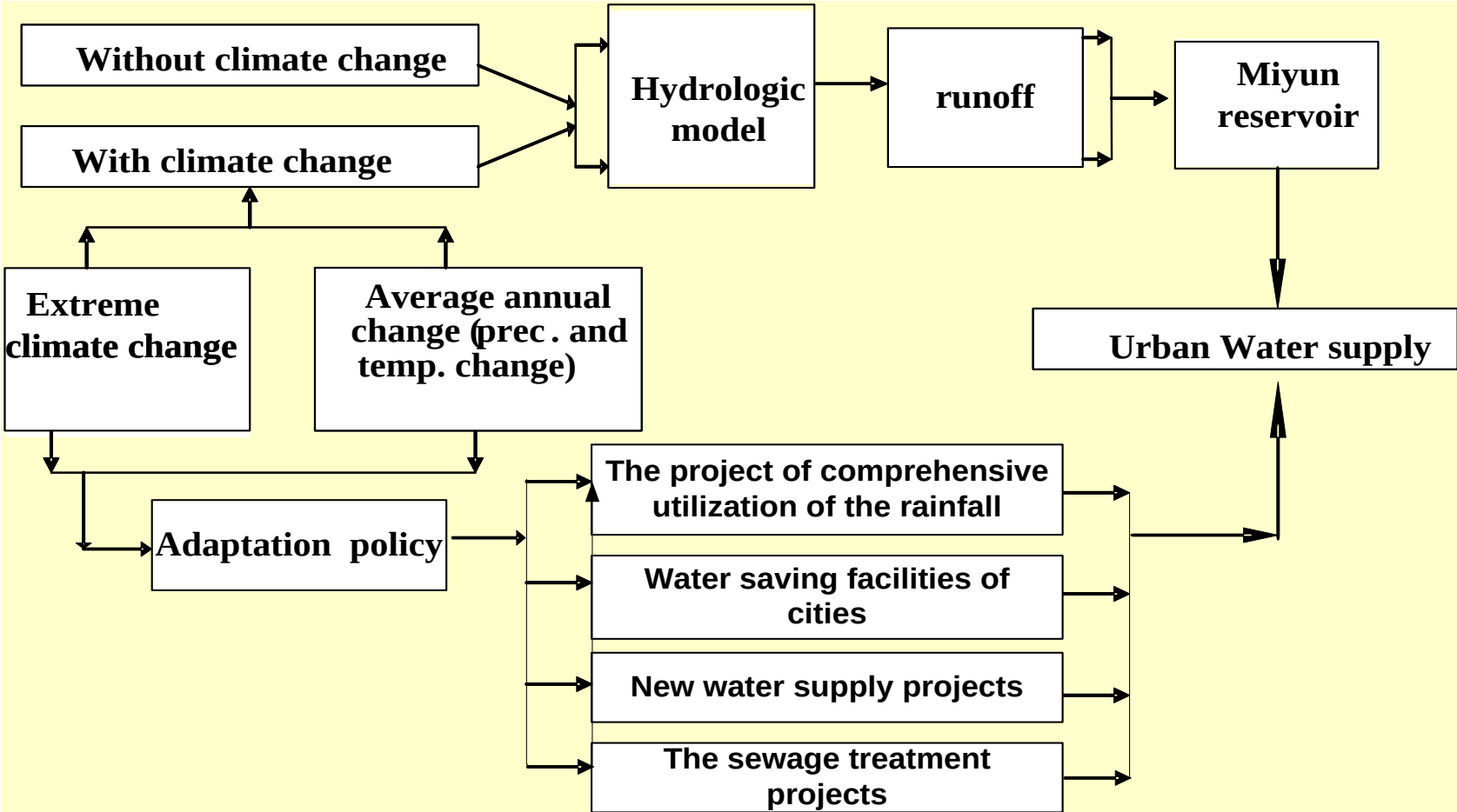


北京人均水资源量仅120m³，永定河北京段持续干涸30多年

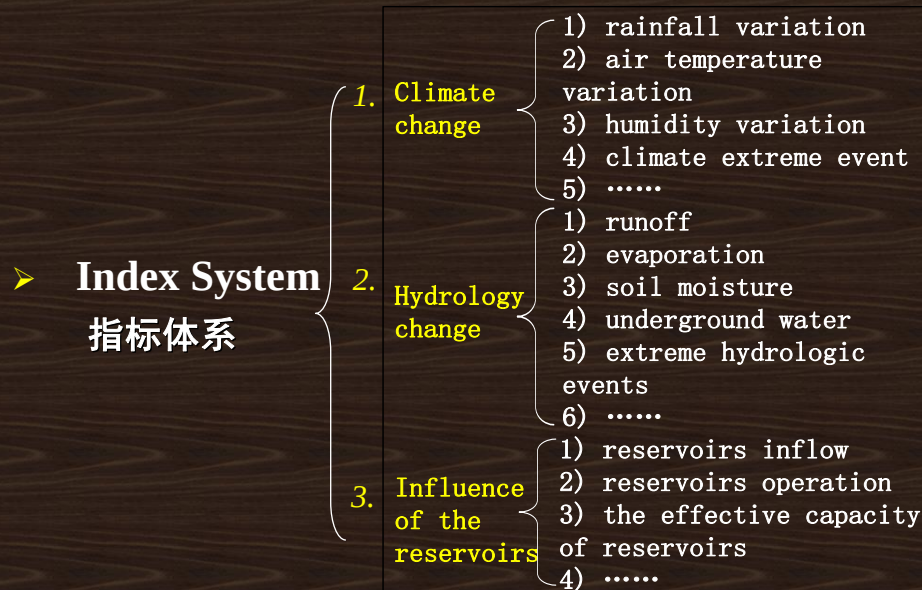


Semi quantitative and quantitative analysis

applied to Case study in Miyun Reservoir Basin, Beijing Capital



Index System



• **Climate change**

• **Hydrological change**

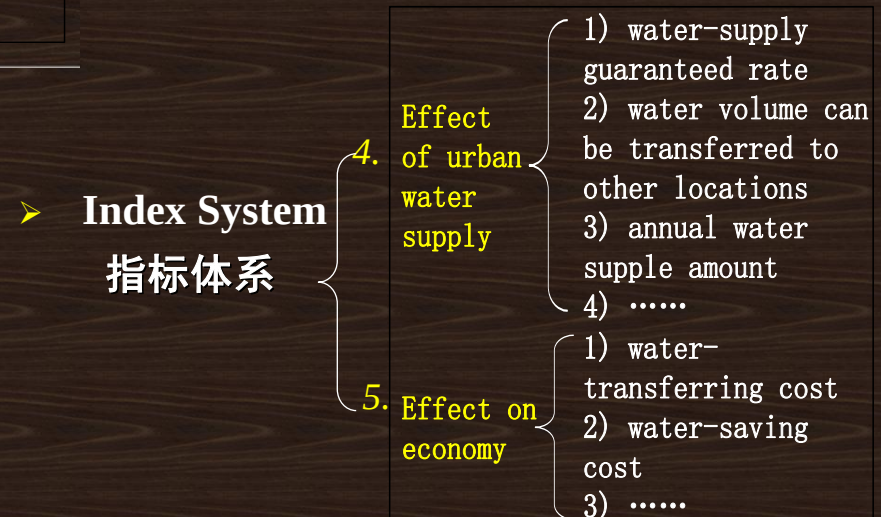
• **Influence of reservoir operation**

• **Urban water demand**

• **Urban water supply**

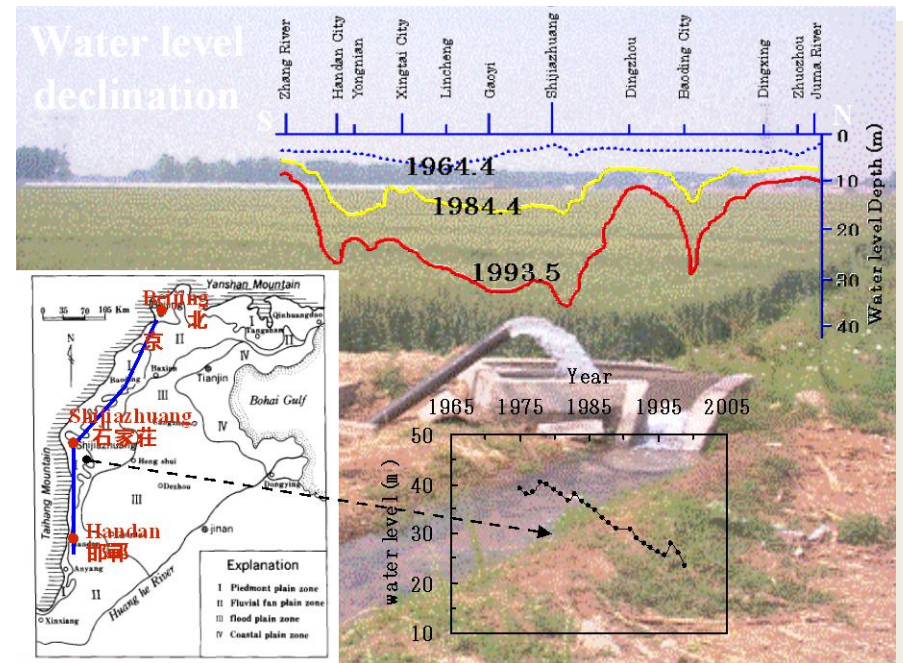
• **Economic analysis**

• **Adaptaions**



Vision I : Human activity is a major reason to result in water stress

- *Water use in agricultural irrigation is almost 70% of total water use amount.*
- *Over use of ground water is also one of major causes to reduce ground water resource.*



Urban development & over use of ground water

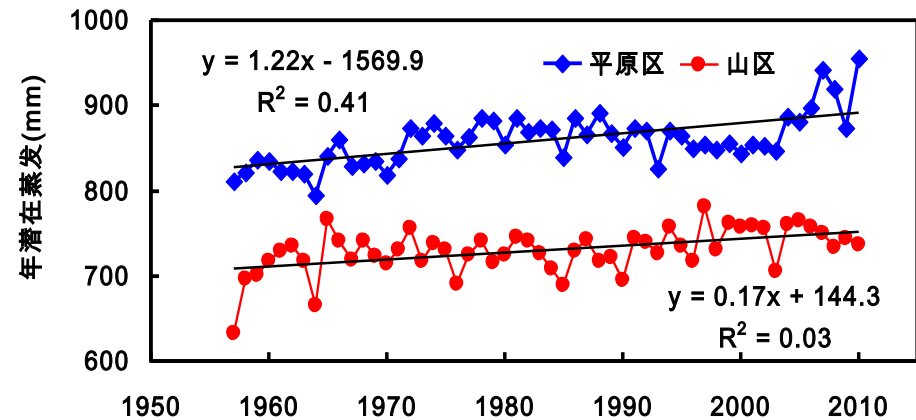


- **Big depth of ground water** concerted in urban area due to continue water using behavior in the cities

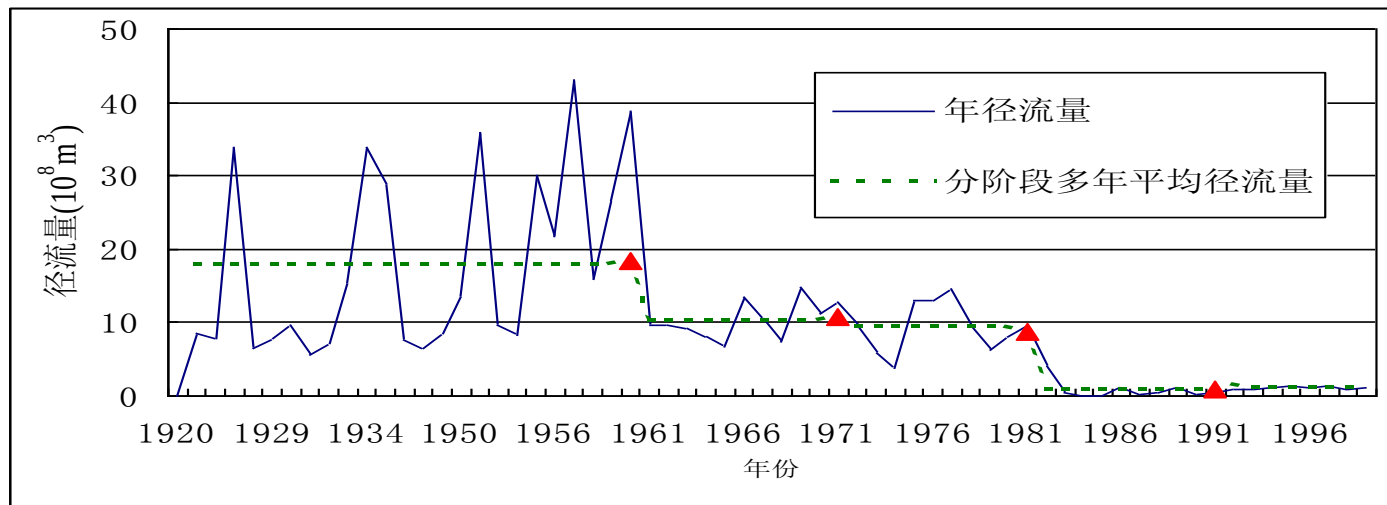


Vision II: Climate change has still an impact to regional hydrological process

1. Air Temperature increase result in ET change



2. Runoff change



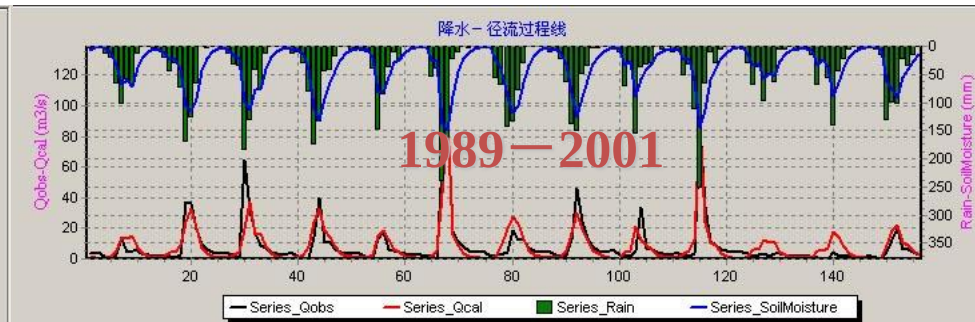
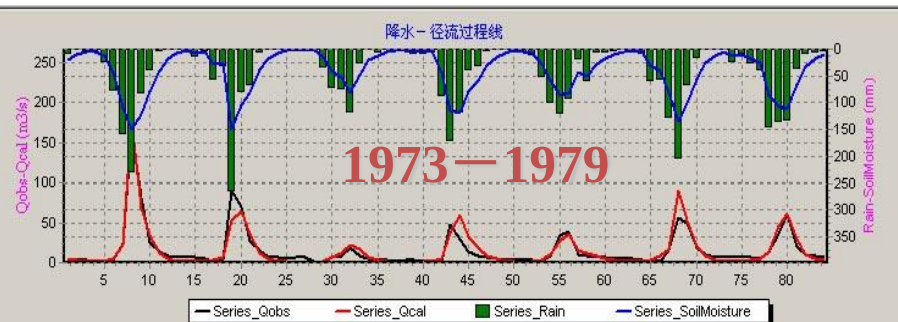
潮白河径流演化的阶段性

Five Periods of Annual Runoff in Chaobaihe River, Beijing

Case study on Climate change contribution in Chao Bai River, Hai River Basin

Comparison of runoff change in 1970s with 1990s

		Climate change		Human activity		
		DataC70 ParaC70	DataC90 ParaC70	DataC70 ParaC90	DataC90 ParaC90	变化/余额
Yearly precipitation (mm)		526.27	—————→		521.74	-0.86%
Yearly runoff (mm)	实测	79.57			52.81	-33.63%
	模拟	79.51	72.88	60.02	52.81	
Modeling change (mm)			-6.63	-19.49	-26.70	-0.58
Contribution (%) (贡献率%)			-24.82	-73.01	-100	-2.17
影响			Runoff decline	Runoff decline		

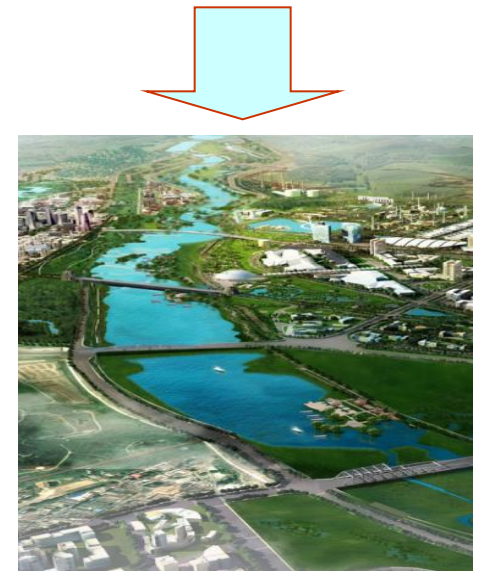


Vision III: Urban Water Management is one of key issues for sustainability of Beijing City

■ **Low Impact Development (LID) and River System Restoration (RSR) in Mega City are two very important and relative issues**



■ **Yongding River sector in Beijing Capital is such a challenges how LID and RSR could be processed in new eco-system restoration under the stress of climate change and city development.**



Research shown

1. *Climate change impact* is a big issue to water sustainable use in China due to *existing or planning water projects and programming* do not fully consider potential impact on climate change , particular on possibility of increasing extremely events (floods & droughts) .

It is possible to increase probability on the risk of both low water in North & South for the WDPSN with 2.6-8.2%



2. Basic research & adaptive management should be emphasized due to much water stress & uncertainty related to climate change:

- How to change *in the past* ?
- How to change *in the future*, particular to coming 20-50 years ?
- What's the *mechanism* for such changes ?
- How to *adapt* climate change & wisely *manage water* ?

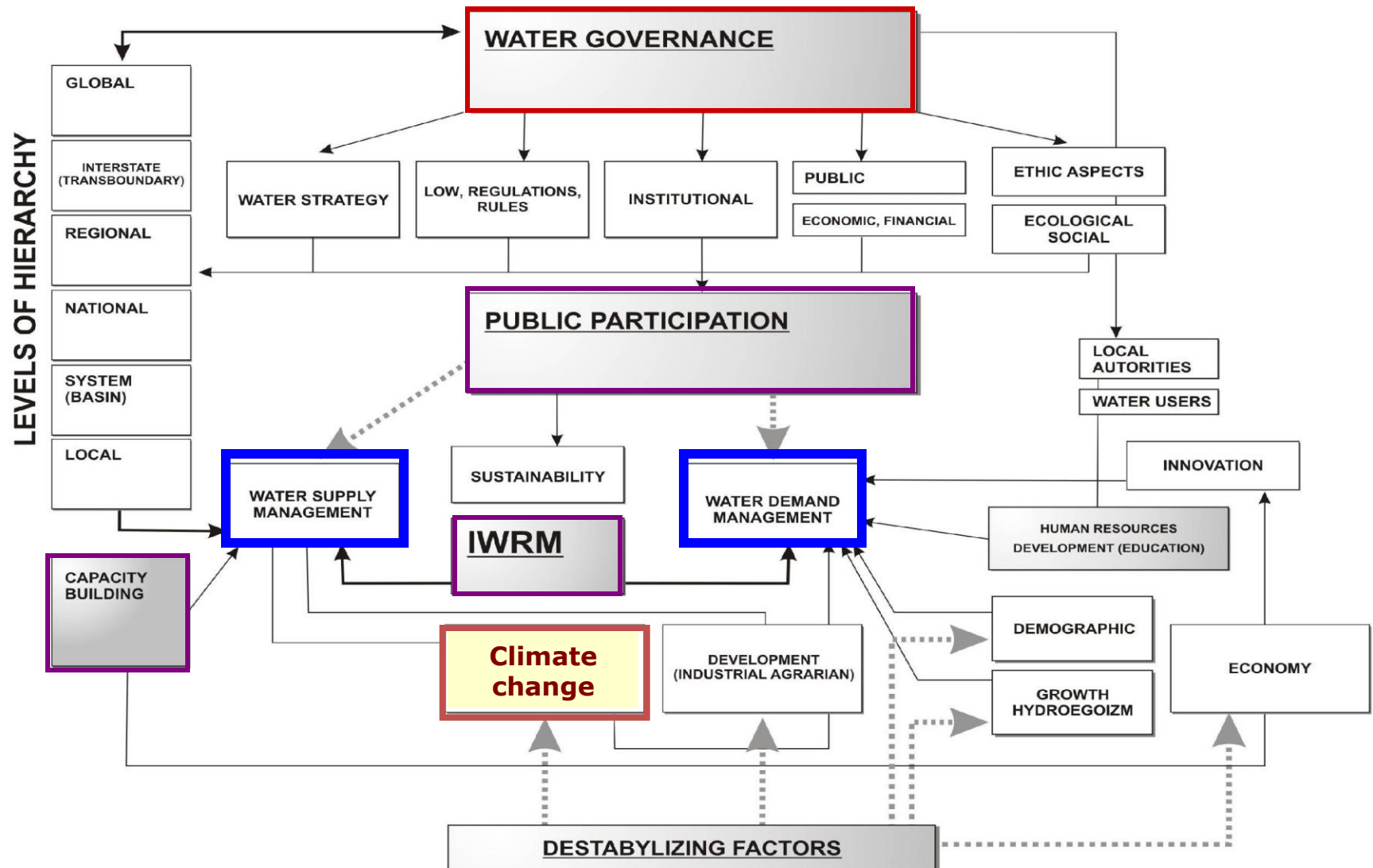
3. Improving Water Governance to changing environment will be a priority issue for adaptive management.

A Good Water Governance

is the process in which government and society get organized to use water resources sustainably to meet needs within a legal and ethical framework in accordance to the water availability at any given time with equity and dignity.

(Kick-Off Meeting of the 6th WWF in Marseilles, June 2-5,2010)

Framework of Water Governance with Changing Environment and adaptation (IWRA, 2010)

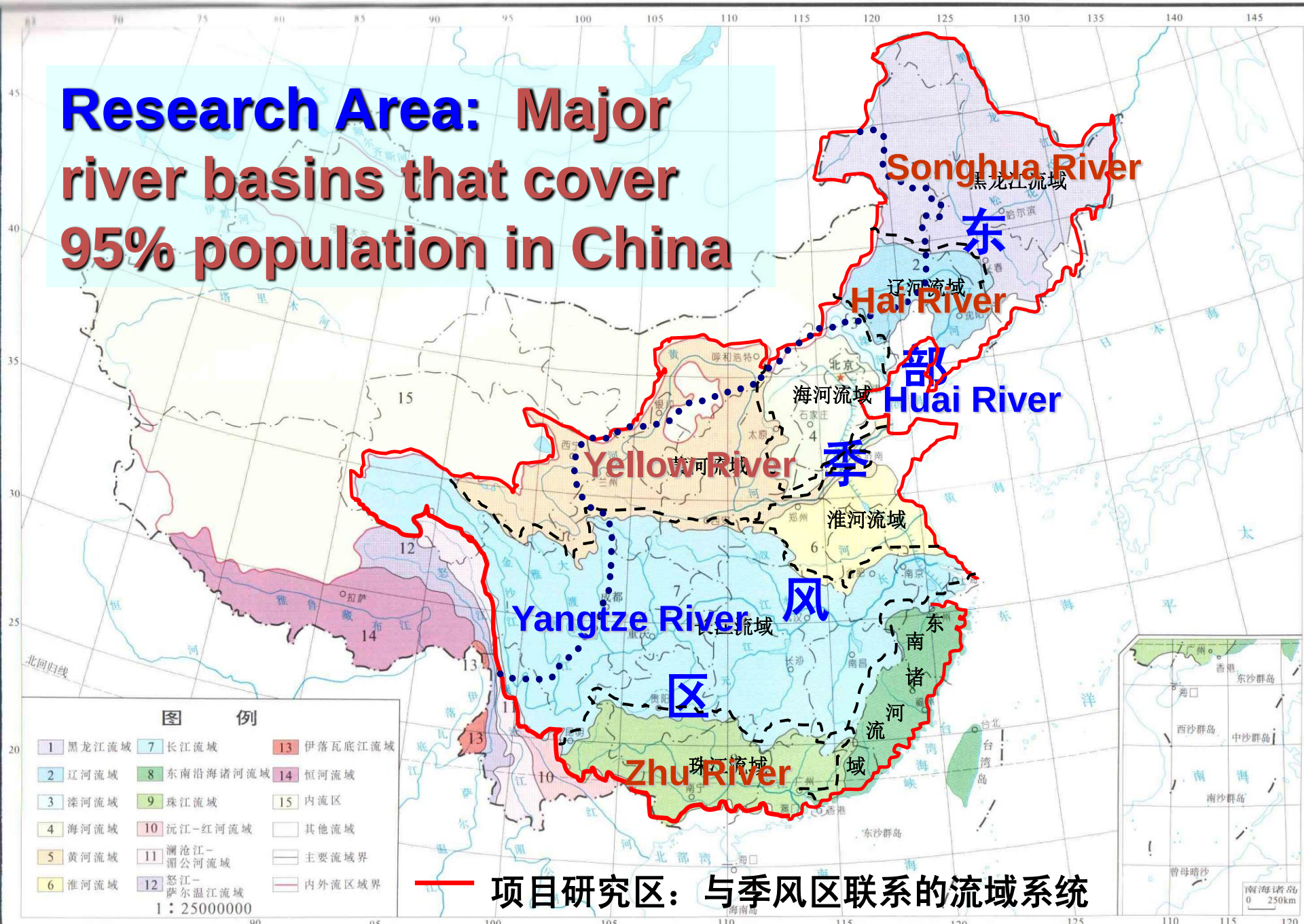


A New Study on Climate Chang & Water

MOST- China, support a National Basic Research Project (973) on *Climate Change Impact to Water Cycle & Water Security in China*, 2010-2014, with 32 Million RMB, lead by J.Xia



Research Area: Major river basins that cover 95% population in China



Key Research Issues

1. **Time-space variability** of water cycle & its **uncertainty** to climate change & human activities
2. **Land & atmosphere interaction and feedback mechanism** by building coupled hydro-climate models etc.
3. **Vulnerability and adaptation** of regional water resources impact by climate change

MAJOR RESERACH

➤ **Detection & Attribution** of non-stationary hydrological processes for past 50-100 years

➤ Reduced **uncertainty of future different climate-hydrological scenarios** (GCMS) & downscaling

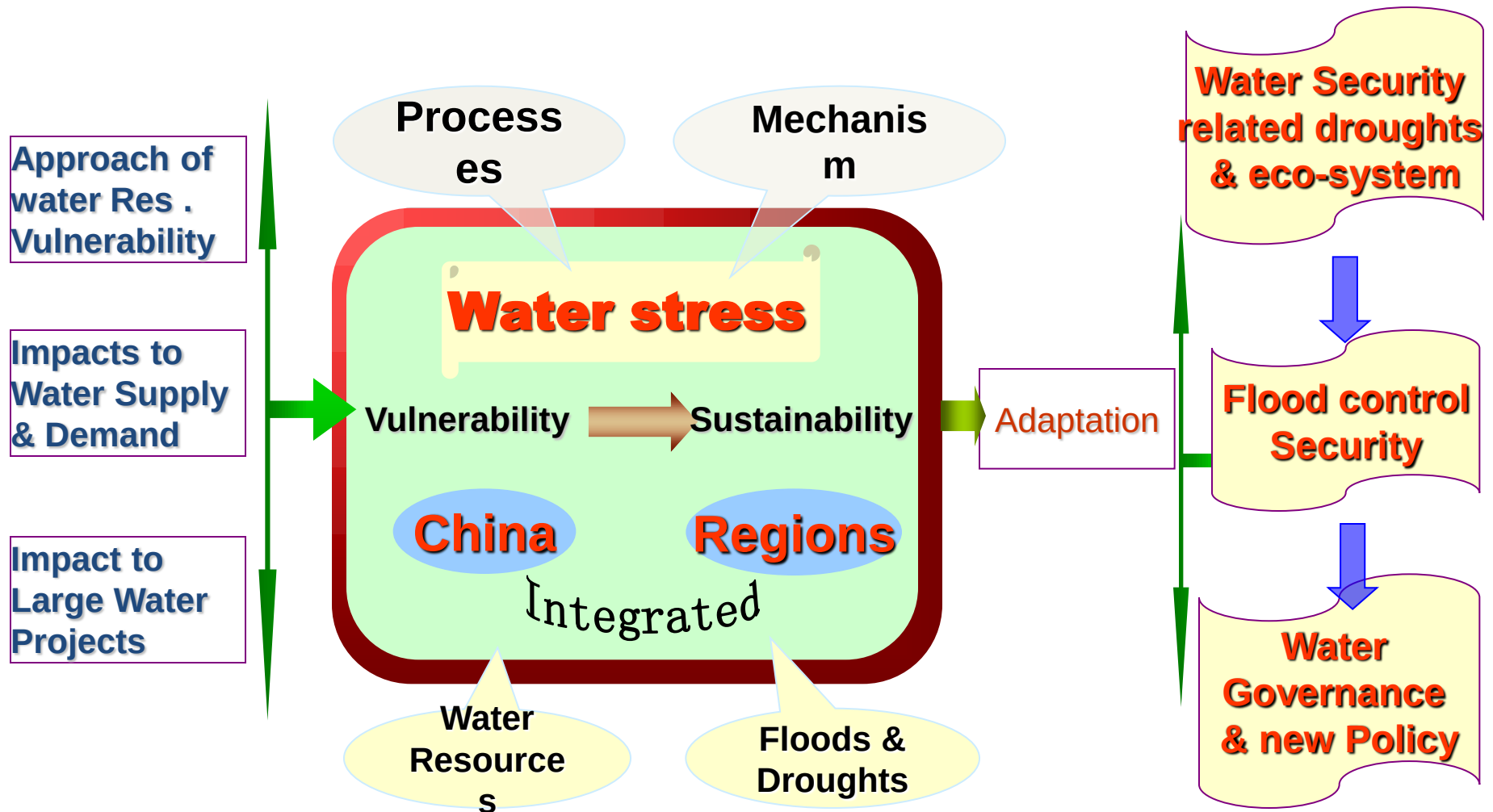
➤ **Coupling Land hydrological process models with Regional climate models**

➤ Impact of climate change on **Drought & water security related to food security & eco-system** in North China

➤ Impact of climate change on **floods control security** related to South China (Huai River/Zhu River etc,,)

➤ **Water resources vulnerability & adaptation management**

Framework of Adaptation Evaluation to Water Sector in China



Water Resource Vulnerability

- It could be linkaged with water stress indicator (**resilience**) , $C(t)$ & **sensitivity**, S .

- New study:

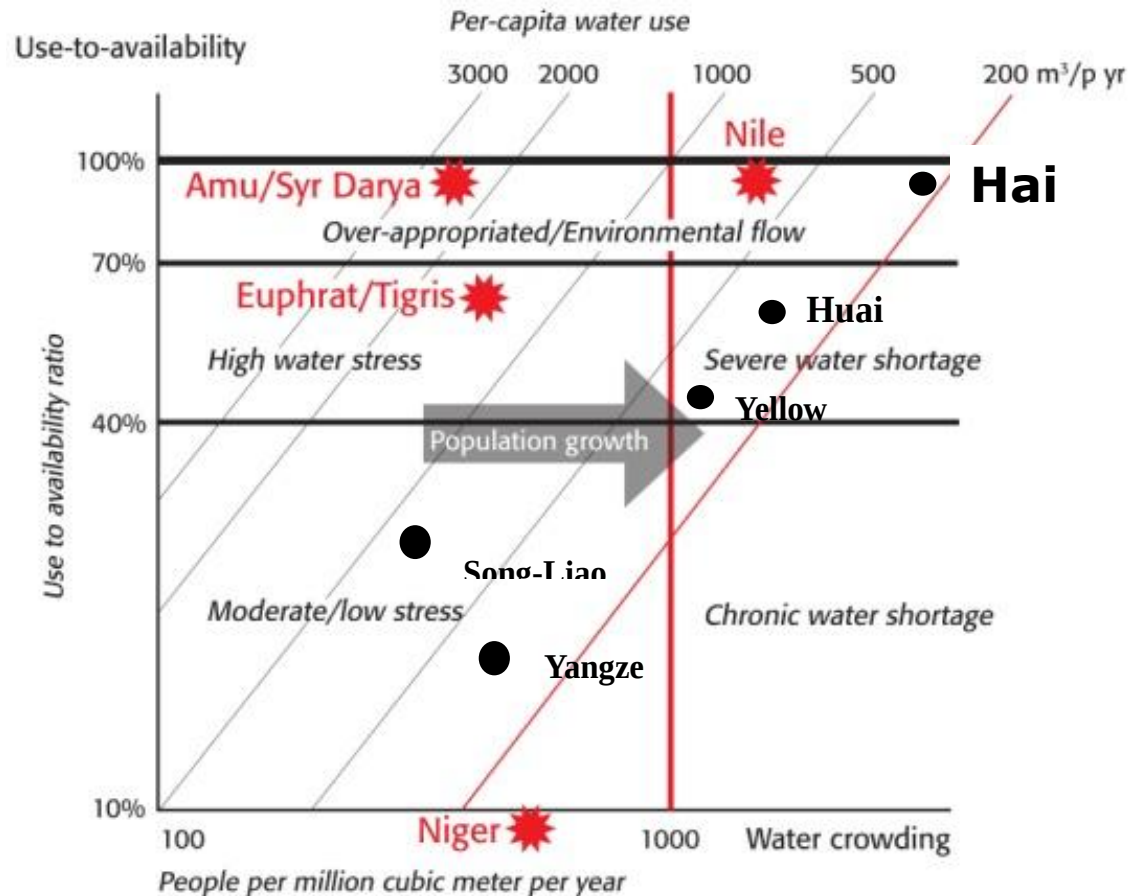
$$V(t) = \frac{S}{C(t)}$$

$$C(t) = f_1(r) \cdot f_2\left(1/\left(\frac{P}{Q} \cdot \frac{W_D}{P}\right)\right)$$

- r – Use to availability ratio (%)
 P/Q - water crowding (p / Million m^3 / yr)
 W_D/P - per capita water use (m^3 /p yr)

Malin Falkenmark & Molden (2008) developed these indicators to show demand-driven water stress and population-driven water shortage.

Late, *Malin Falkenmark & Jun Xia* developed case study in China to address Water Security in watershort basins (2010)



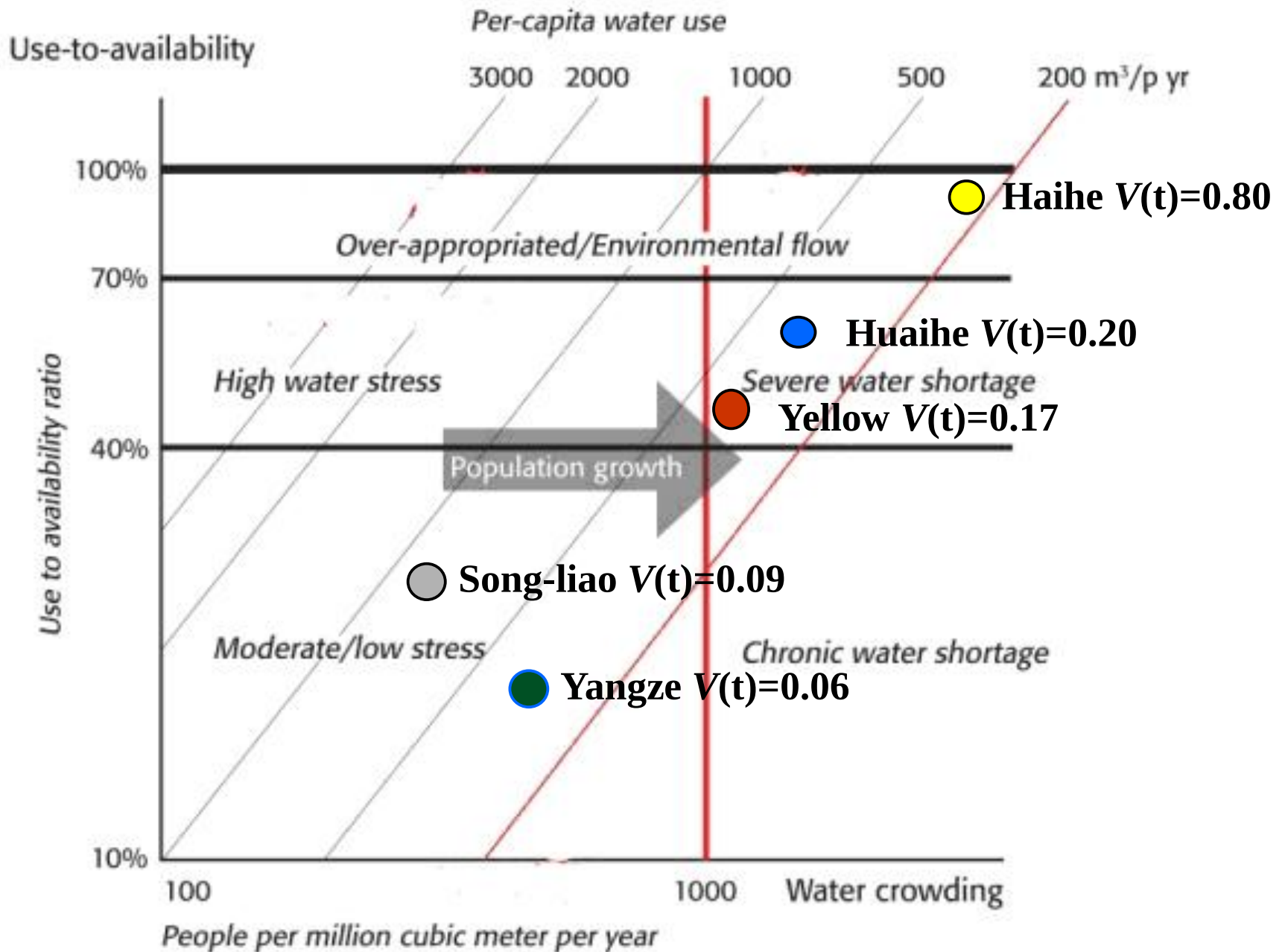
New study on quantifying **Water Resource Vulnerability**

$$C(t) = C\left\{r \cdot \frac{Q}{W_D}\right\} = \exp_1(-r \cdot k) \exp\left(-\frac{P}{Q} \cdot \frac{W_D}{P}\right)$$

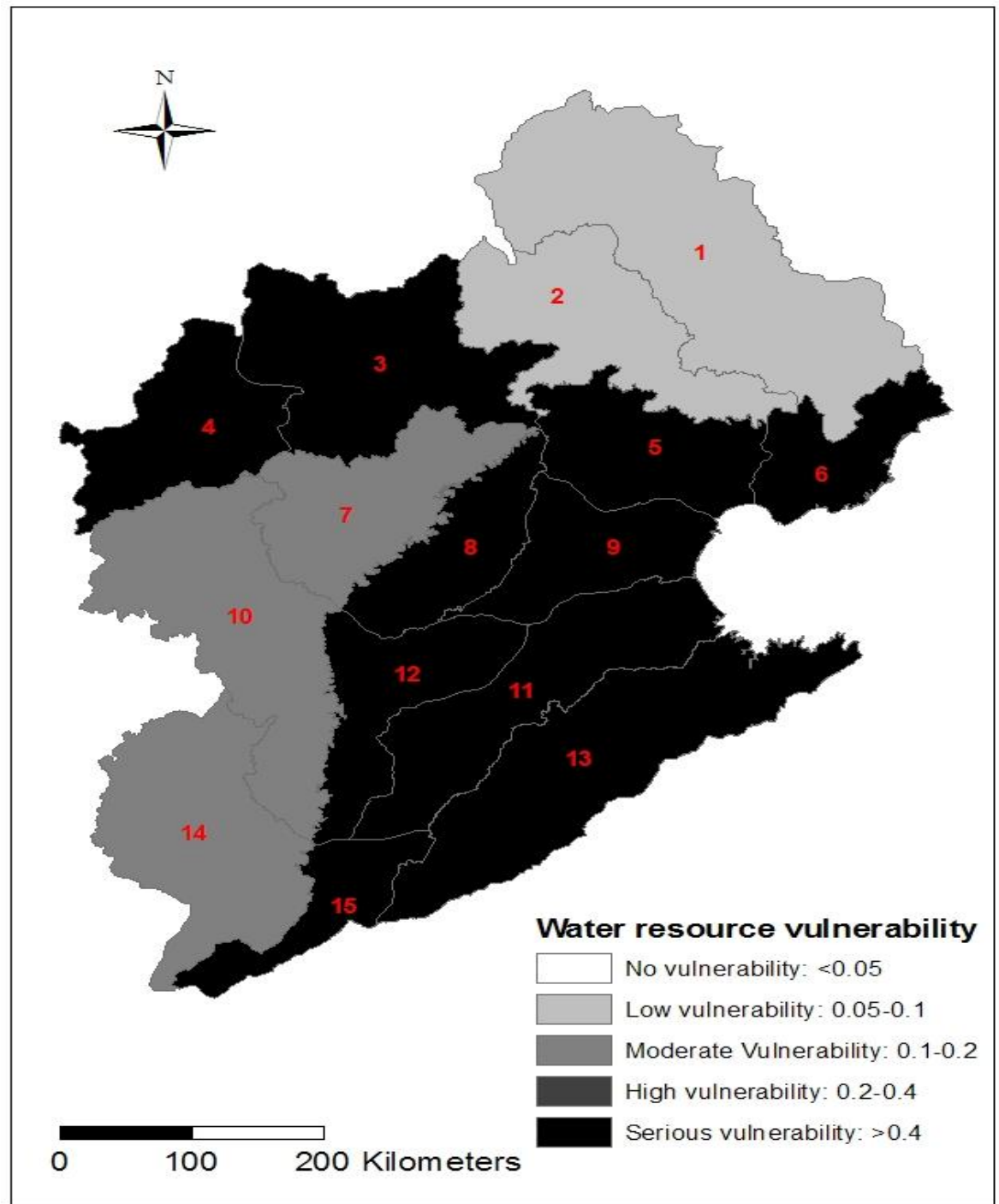
r – Use to availability ratio (%)
 P/Q – water crowding (p / Million m³/ yr)
 W_D/P – per capita water use (m³/p yr)

Categories of water resource vulnerability

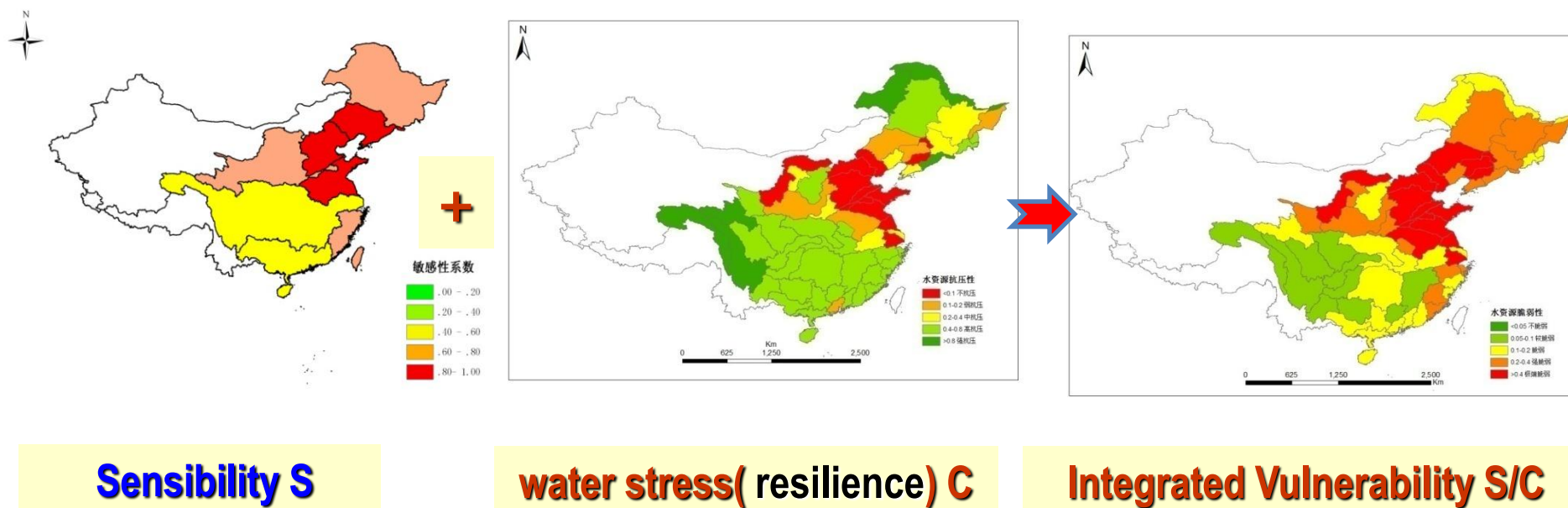
no vulnerability	low vulnerability	moderate vulnerability	high vulnerability	Serious vulnerability
<0.05	0.05-0.1	0.1-0.2	0.2-0.4	>0.4



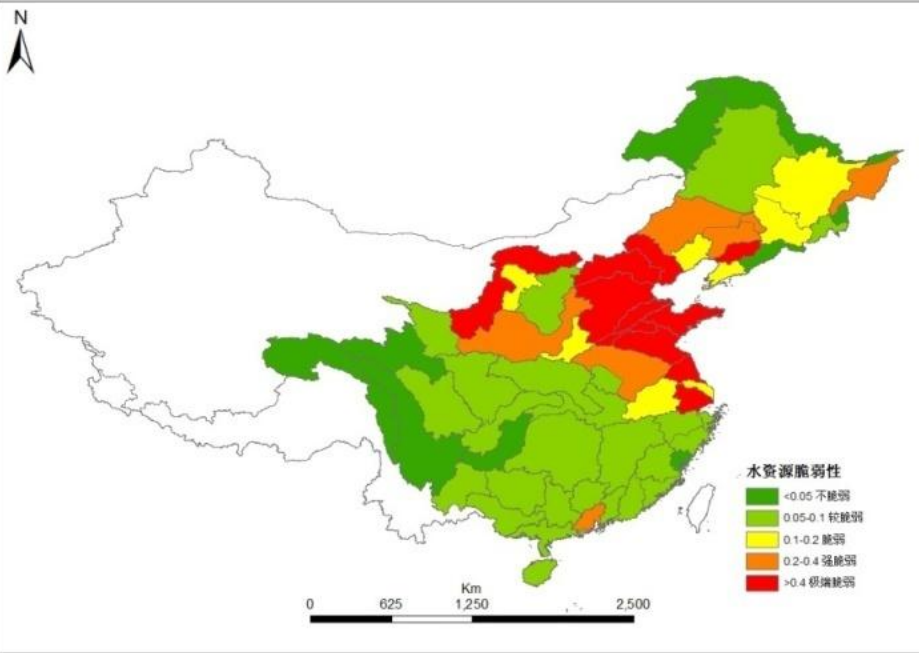
Water Resource Vulnerability in Hai River



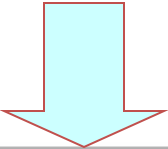
New Study on mapping vulnerability



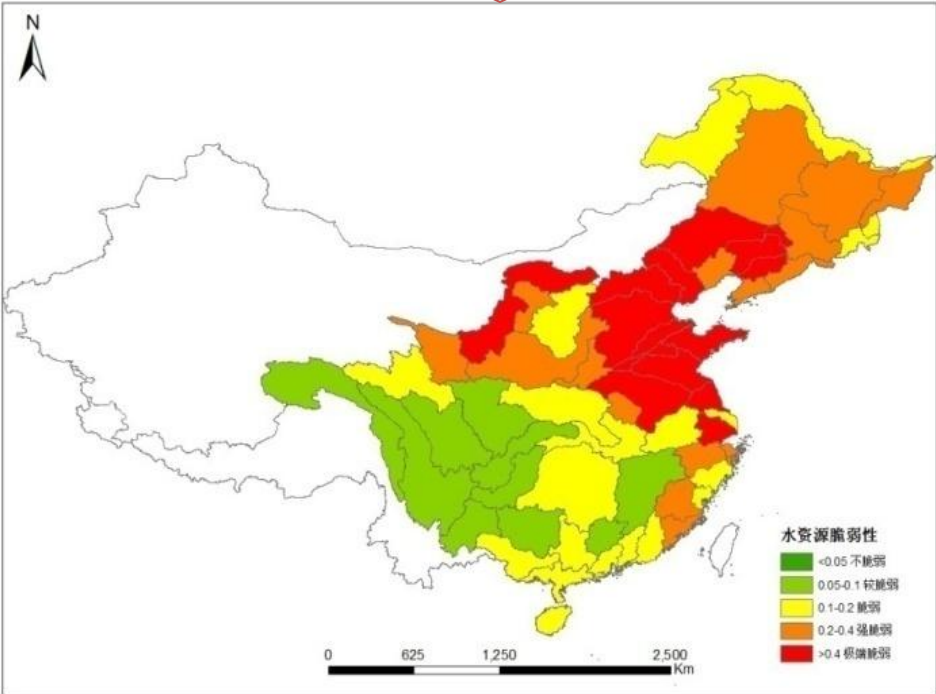
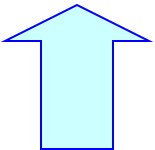
2000年代表年（1980–2000年序列）



**Vulnerability
S/C**



**Vulnerability
1/C without S**



Water Resource Vulnerability to climate change in Hai River

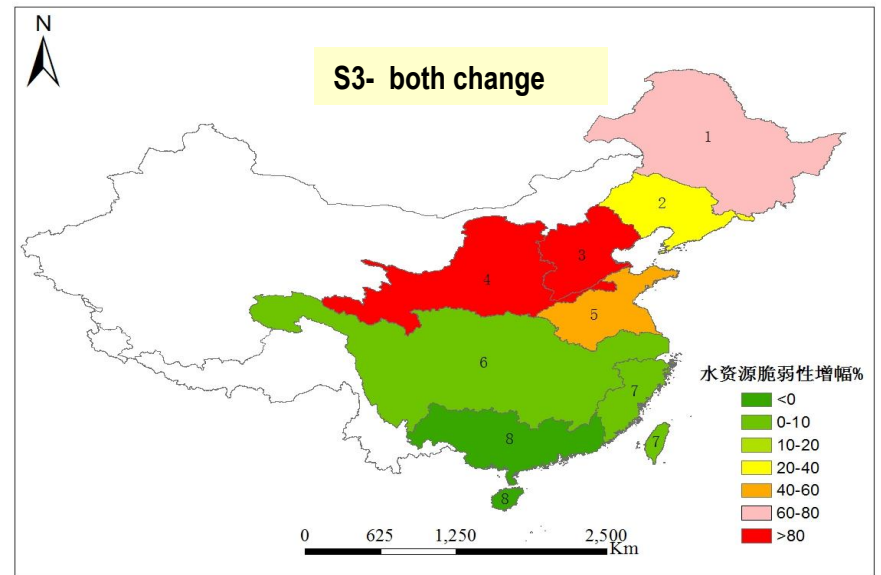
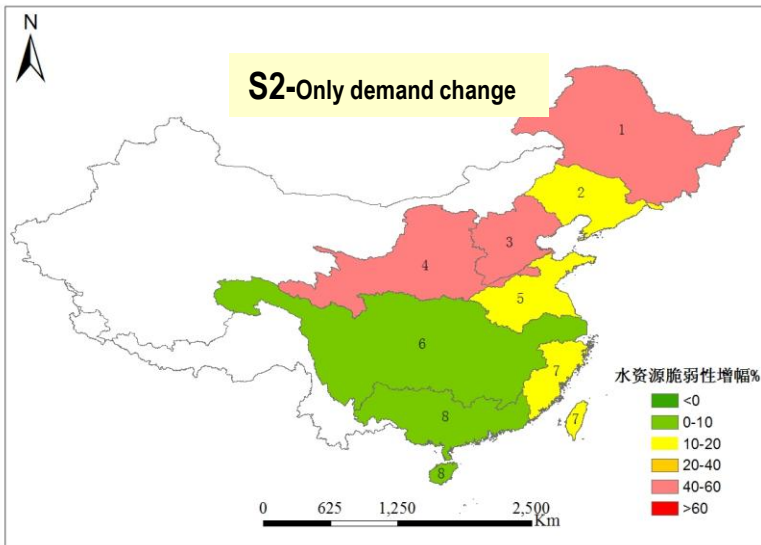
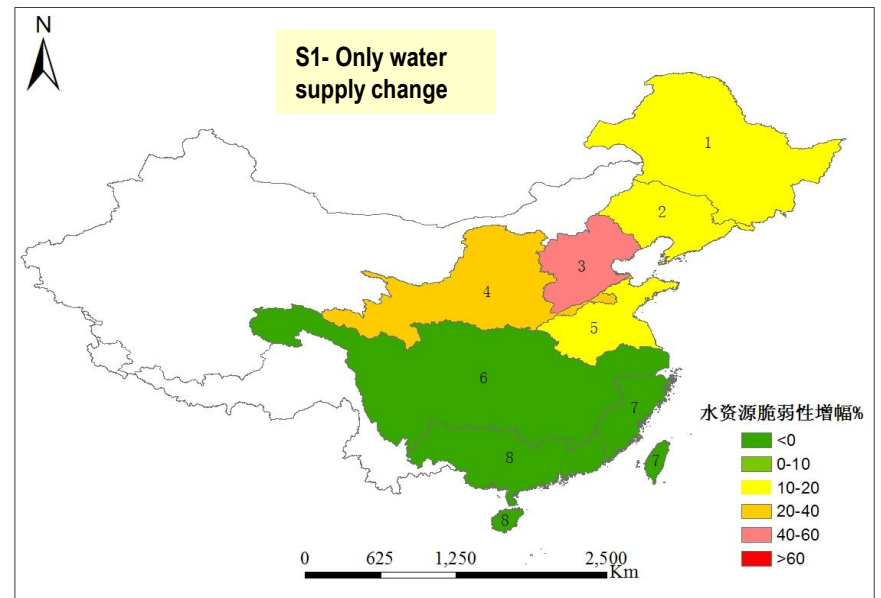
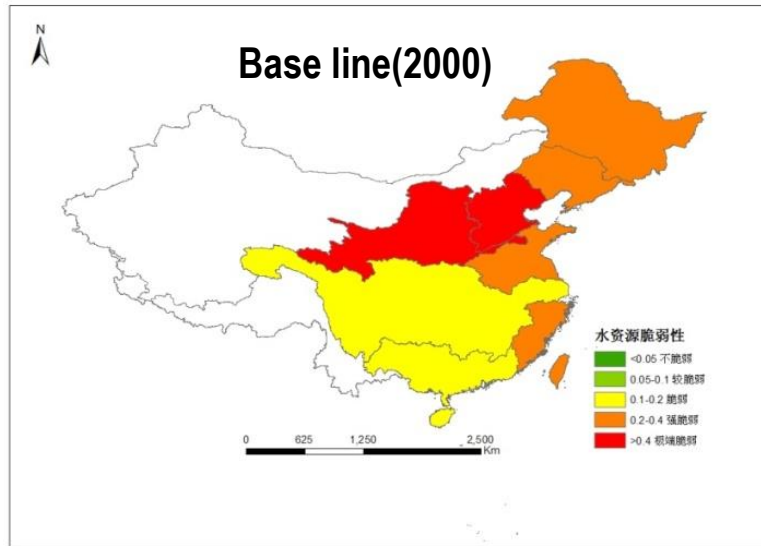
scenarios	$\Delta P/Q$ ($\text{人}/10^6 \text{m}^3/\text{y}$)	$\Delta W_D/P$ ($\text{m}^3/\text{p y}$)	Δr (%)	$\Delta V(t)$
Sc1	-337	0	-8.5	-0.18
Sc2	869	10	26	0.85
Sc3	452	10	15	0.57

Sc1 – only available water resources change to global warming

Sc2 – only water demand change

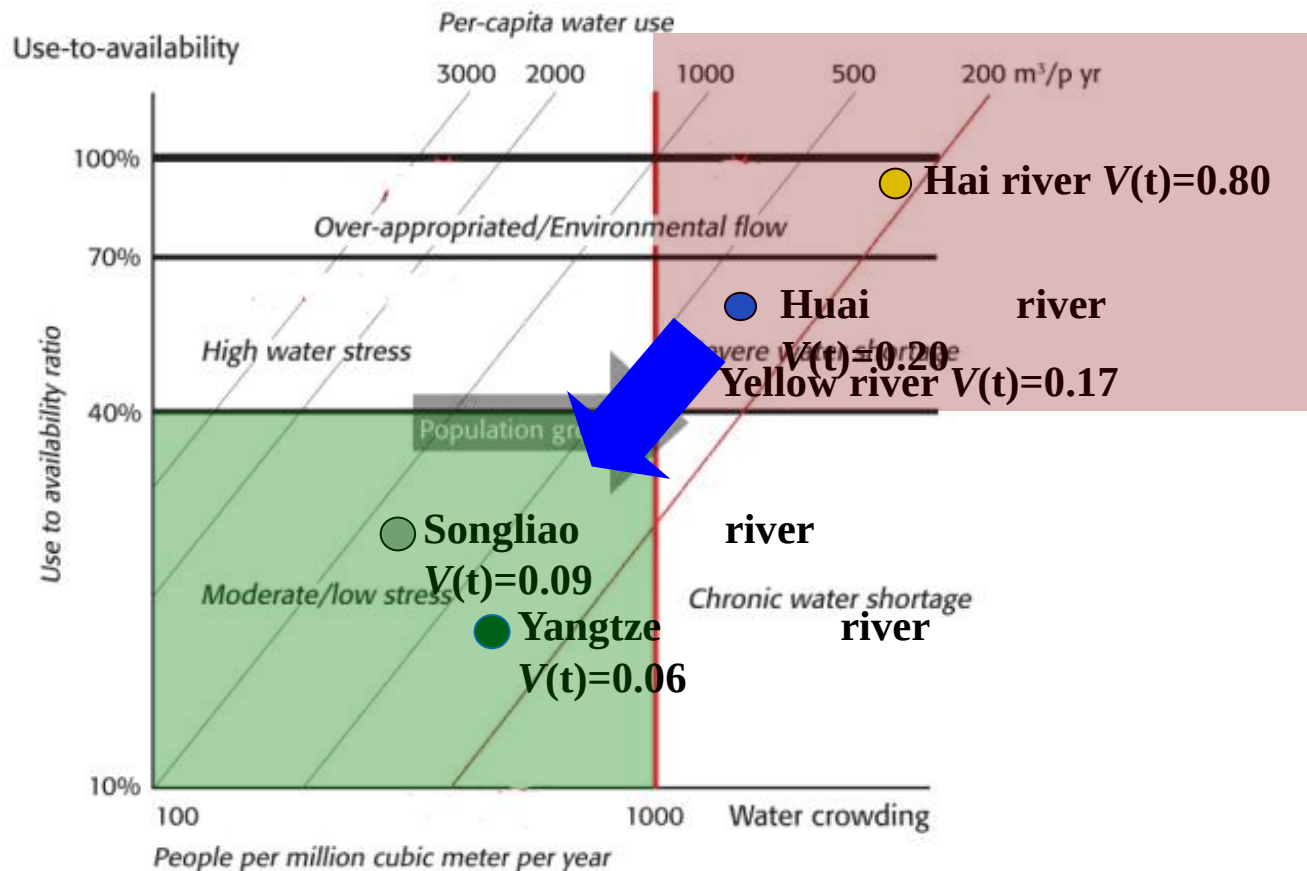
Sc3 – considering both change

Vulnerability change $\Delta V(t)$ to different scenarios



Adaption to climate change and both human activities:

Shifting from higher vulnerable into blue by adaptive management, particular good water governance, i.e. changing the rate of water developing & using water crowding & per capita water use etc.



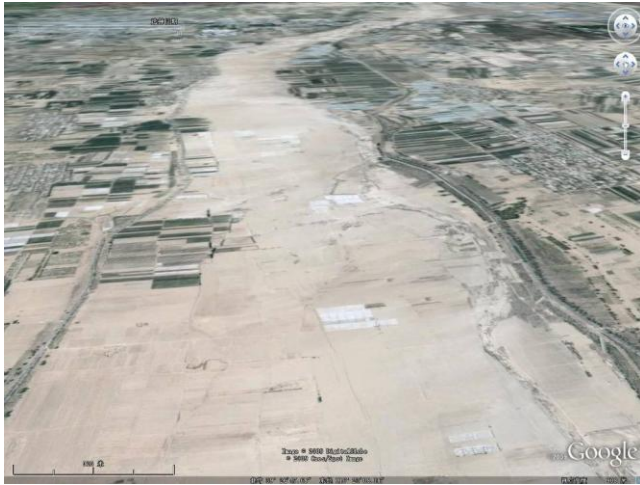
Adapted policies

- *Water saving policy*
- *Managing water wisely*
- *Infrastructure Building: South-to-North Water Diversion Project etc.*



Goal: Enhancing ability to adapt climate change

A case study in Beijing for Yongding River Restoration



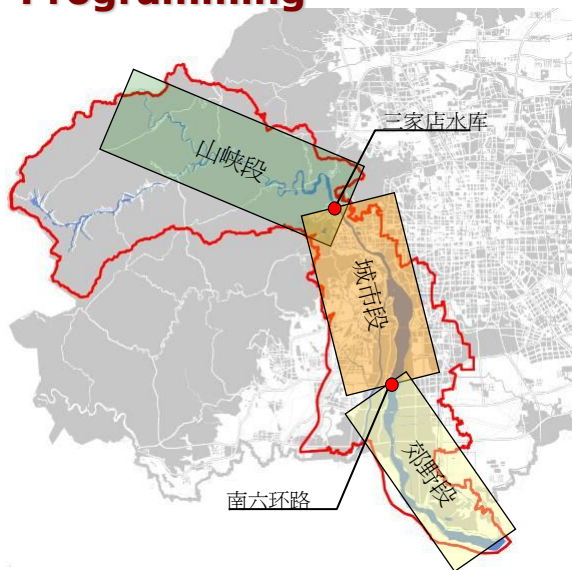
挽救母亲河

我们在**行动**

规划治理布局

- 按照“以流域为整体，河系为单元，山区保护，平原修复”的方针，山区河流以河道生态基流和水源地保护为主线，平原河流实施“四治一蓄”（治砂坑、治污水、治垃圾、治违章、蓄雨洪）。

Planning and Programming



山峡段——源于自然

Keeping nature in upstream

- 采用“维护保护型”的治理模式，维护生态水环境和生物多样性，治理水土流失面积**500**平方公里；建设景观湿地**6**处，面积**180**公顷，源保护天然河道，水质保持II~III类；
- 挖掘门头沟区特有的自然山水文化资源，增加市民旅游休闲场所，发展旅游经济。



自然景观河道

平原城市段——融入自然

- 采用“生态补水型”的治理模式，治污蓄清，增加河道蓄水，形成溪流，重点区域和交通节点形成水面，修复河流自然形态，建成良好的城市生态水景观。
- 规划形成由溪流串联的**6**处湖泊，面积**680**公顷。溪流长**50**公里，水面面积**270**公顷。
- 河道水质保持III~IV类

LID & RSR in city area



城市景观河道

平原郊野段——回归自然

LID & RSR in city area

- 采用“以绿代水”的治理模式，加固堤防，彻底消除防洪安全隐患。修复已退化的河流生态系统，打造田园生态景观
- 河道及两侧**200~500**米建成滩地修复保护带。有水则清、无水则绿，滩地修复压尘。形成溪流，水面面积**50**公顷
- 恢复金门闸、龙王庙等历史人文景观。



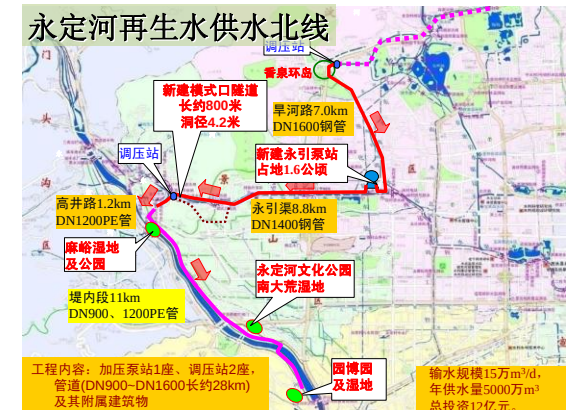
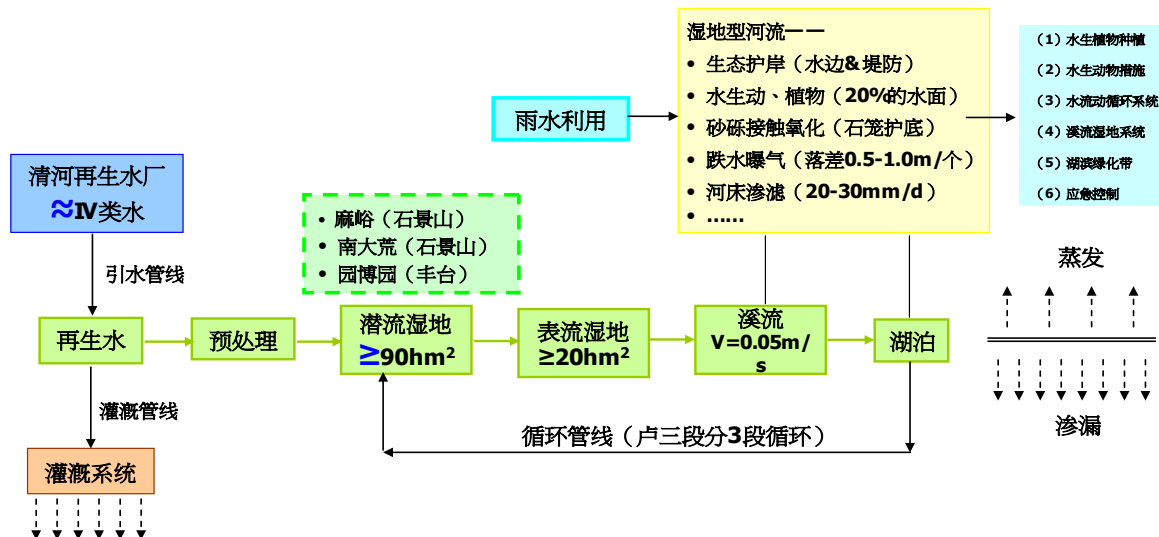
田园景观河道

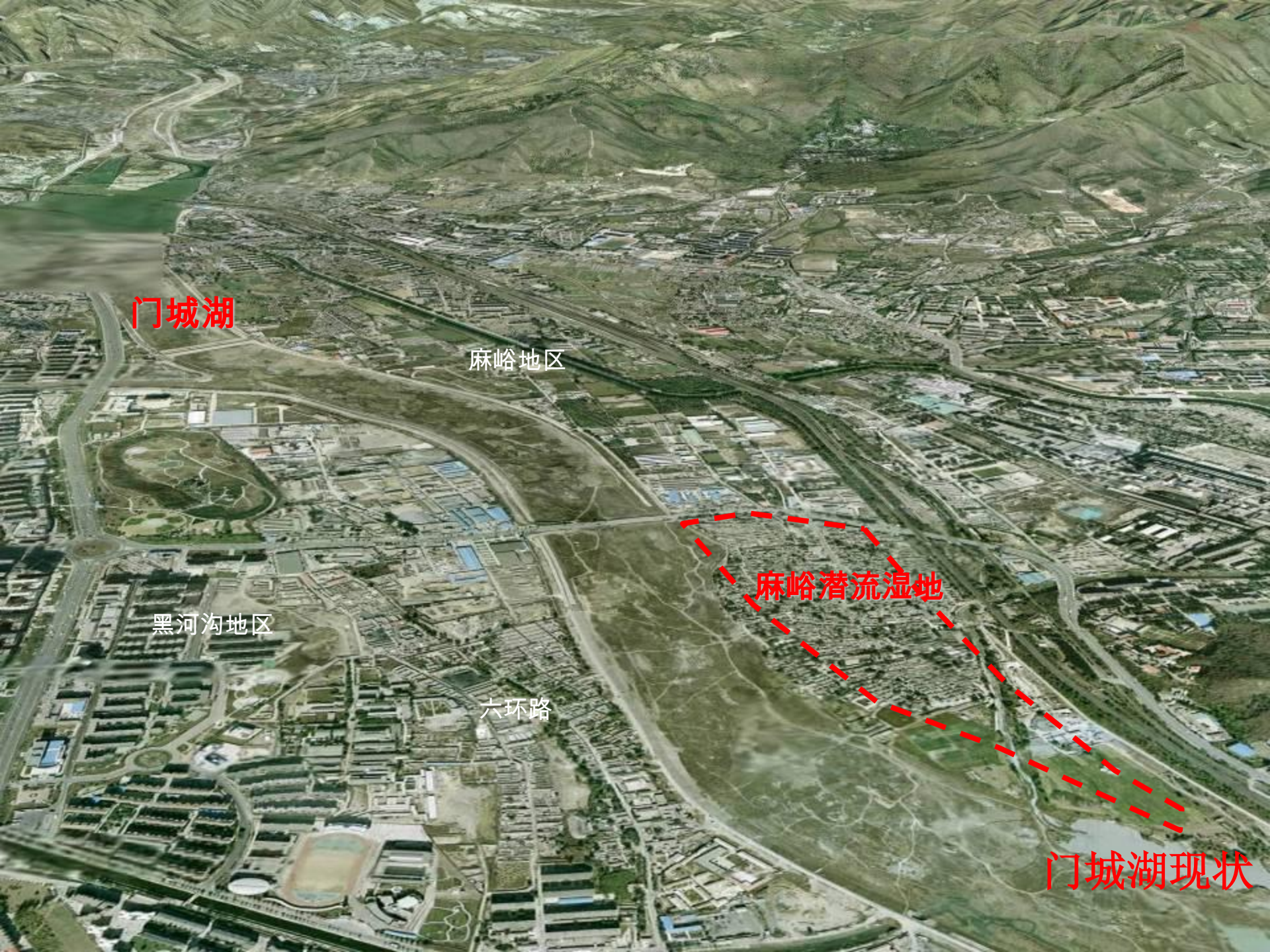
Major Ways

- **Balancing multiple use of water**
 - Multiple uses from Rain water, recycling water,
 - Waste water treatments
 - Wetland use
- **Urban water management**(LID, Green BMP ...)

水质净化工艺流程

Process Flow Chart of
Water Supply, Circulating , Purification and Maintenance





门城湖

麻峪地区

黑河沟地区

六环路

麻峪潜流湿地

门城湖现状



门城湖

麻峪地区

黑河沟地区

六环路

麻峪潜流湿地

门城湖

Conclusions

1. **Climate change** and **human activity** are two big issue to water sustainable use. **Science & technology** will play a key role on understanding & reduce risk

Roles of Sciences & Technology

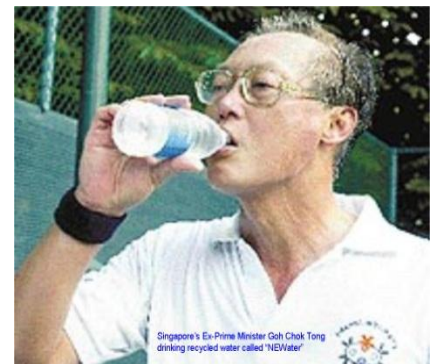
● *Addressing Water Problems*

– Success story

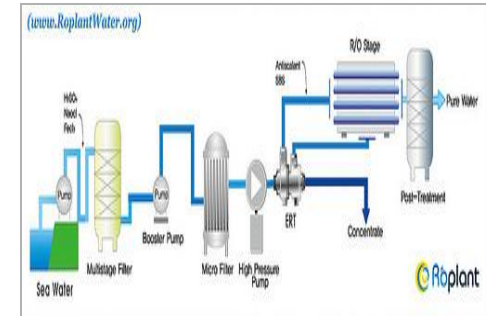
such as water management in Singapore,

- Large-scale storm water harvesting
- recycling of water (low cost membranes)
- Desalination
- Water Demand Management (engaging consumers)

and Lessons in the world

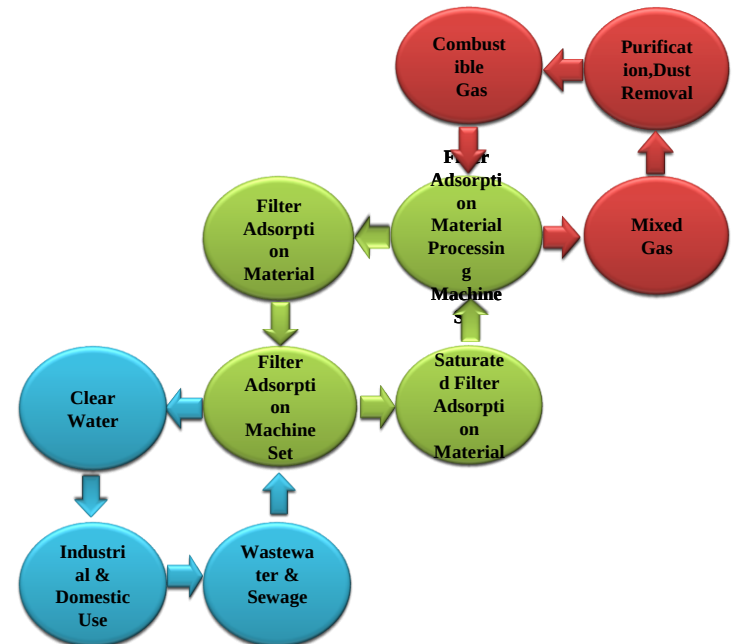
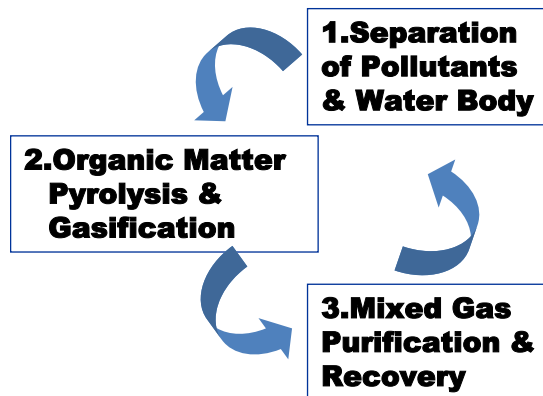


- **Innovations on Knowledge & Technology** – such as on Pollution Control & Treatment, Sea water desalination, Agriculture, Water Storage...



e.g., a new filter adsorption

Method: Wastewater advanced treatment process



Filter Adsorption Wastewater Purification Treatment Results

Wastewater Type	Influent COD	Effluent COD	Treatment Cost
	mg/l	mg/l	RMB/ton
Municipal Water Supply Water Source Pre-Treatment (CODmn)	Category IV Surface Water	1.15	0.08
Municipal Wastewater Purification Treatment (Gaobeidian)	47.43	17.22	0.5
Municipal Wastewater Advanced Treatment (Beijing Capital Group)	253	15.2	0.8
MSW Leachate Advanced Treatment (China Everbright)	816	56	3.8
Paper Mid-Section Wastewater Advanced Treatment (Shandong Zibo)	734	18	1.2
5 Metal Electroplating Wastewater Advanced Treatment (Shenzhen)	480	32	1.2
Pharmaceutical Wastewater Advanced Treatment (North China Pharma Group)	320	22	1.2
PCB Wastewater Advanced Treatment (Shenzhen)	207	31	1.1

ROLE OF SCIENCE

● ***Social Sciences*** in ***Environmental Management & Integrated Water Management***

- **Environmental Humanities Approach**
- **Relevance of EH to provide effective solutions to environmental disasters etc.**
- **Changing Behavior (New Water Policy “Building Society of Saving Water” in China)**



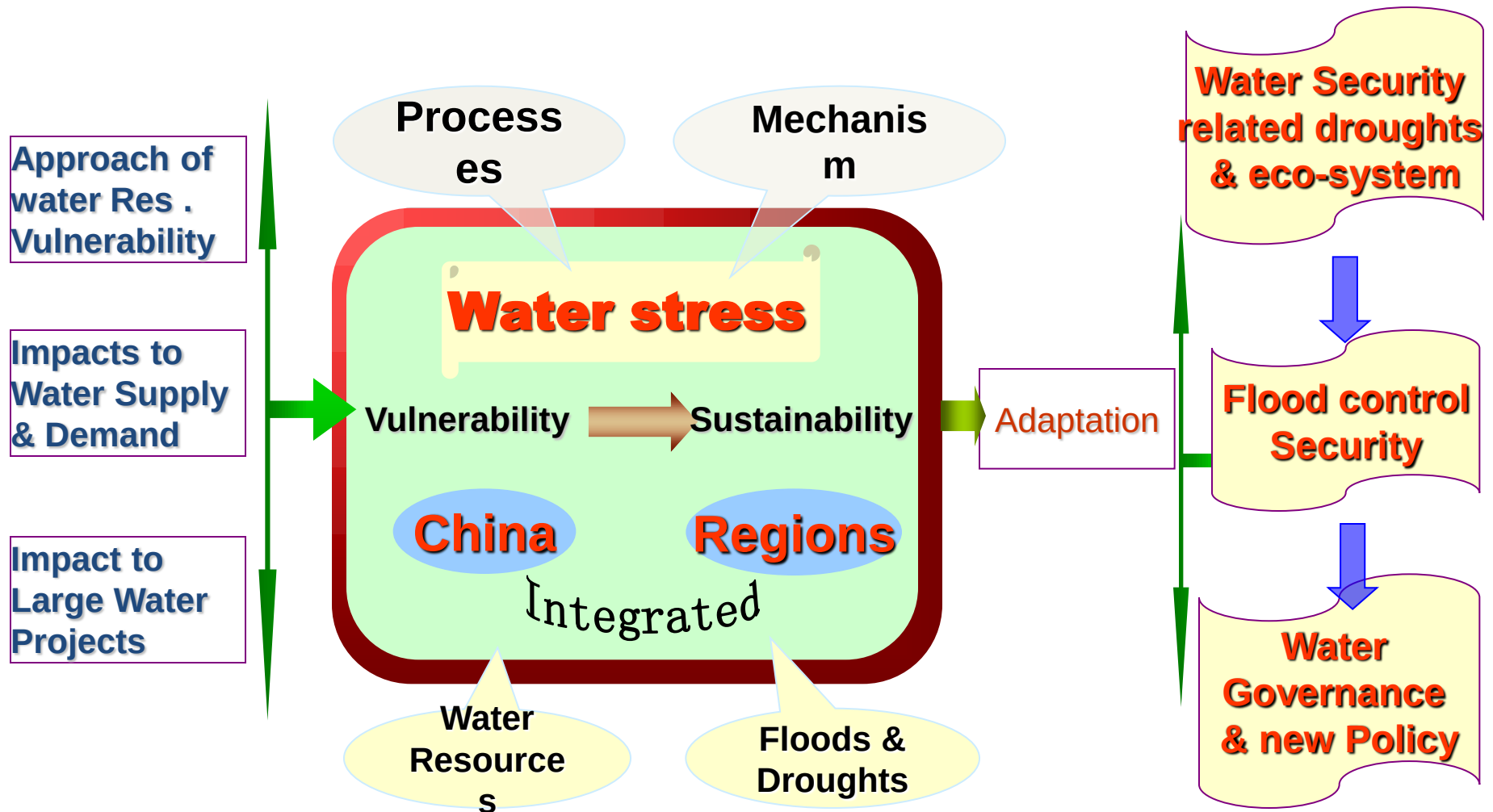
- ...

2. Water policy, in China will had to shift from
Water Quantity Management → ***Water Quality Management***
Water Supply Management → ***Water Demand Management***
-

MWR in China is processing a new water strategy based on three red lines control

- *The red line I :* the control of total water use by *Total Water Resources Allocation.*
- *The red line II :* the control of lower water use efficiency by *Water Demand Management.*
- *The red line III:* the control of total waste water load by *Water Quality Management.*

Adaptive water management will face to new opportunity & challenges on global and regional.





XIVth IWRA World Water CONGRESS

September 25 to 29, 2011
Porto de Galinhas * Brazil

Adaptive Water Management: Looking to the Future

www.worldwatercongress.com

Congress themes

Adaptive water management
Water resources and global change
Governance and water law
Knowledge systems

Dates

Nov. 1, 2010:
Deadline for submission of abstracts
Dec. 2010:
Inform authors of accepted
presentations / posters
May 2011:
Deadline for submission
of final presentations
Sept. 25 - 28, 2011:
Congress
Sept. 29 - Oct. 1, 2011:
Optional trips



PROMOTION



WELCOME MESSAGE

DATES

TIMELINE

VENUE

GOALS

REGISTRATION

OBJECTIVES

THEMES

ABSTRACT SUBMISSION

SPECIAL SESSIONS

INTERNATIONAL SCIENTIFIC COMMITTEE

OFFICIAL TRAVEL AGENCY

VISAS AND TRAVEL TO BRAZIL

LINKS

PROMOTION

INFORMATION



International Water
Resources Association



Energy and Water Resources Secretariat –
State of Pernambuco



International
Association for
Water Law



Federal
University of
Pernambuco



VERSeau
Développement



Portuguese
Water Resources
Association



The University
of Arizona



International Development
Research Centre



Brazilian Water
Resources Association

WELCOME MESSAGE

The XIV World Water Congress continues a tradition of meetings designed specifically for water resources professionals - practitioners, researchers, decision-

- 1) adaptive water management
- 2) water resources and global change
- 3) governance and water law
- 4) knowledge systems.

Plenary sessions and keynote speakers will set the broader context to frame individual, more detailed sessions.

We look forward to your participation and encourage you to continue checking the Congress website for updates over the coming months leading up to the Congress.



Prof. Jun Xia
President, IWRA



Prof. Christopher Scott
Chair, ISC



Dr. José Almir Cirilo
Executive Secretary,
SRHE

XIVth World Water Congress

25-29 Sept., 2011, Recife, Brazil





TOWARDS WORLD WATER SOLUTIONS

WWC 49th BoG – SAN FRANCISCO, CA 14 OCTOBER 2010



6th World Water Forum

March 2012, Marseille



DRAFT THEMATIC FRAMEWORK

CREATING A BLUE MOVEMENT !

3 strategic directions

12 key priorities for water action:



Ensure everyone's well-being

Contribute to economic development

Keep the planet blue

Conditions for success

Guarantee access to water services for all and the Right to Water

Guarantee access to integrated sanitation services for all

Contribute to improved hygiene and health through water

Protect populations and economies from risks

Contribute to cooperation and peace

Balance multiple uses

Ensure food security

Harmonize energy and water

Protect and value ecosystem services and green growth

Improve the quality of water resources and ecosystems

Adjust pressures and footprints of human activities on water

Respond to climate and global changes in an urbanizing world

Good governance

Finance water for all

Enabling environment

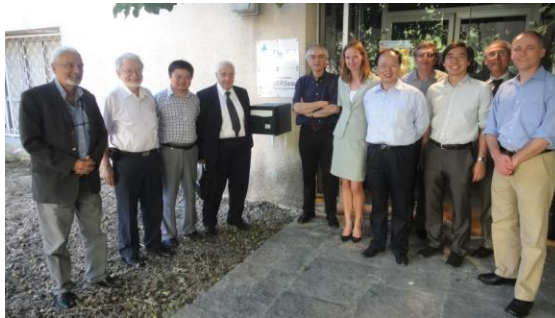
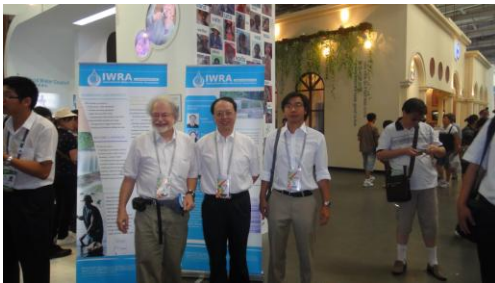




International Water Resources Association (IWRA)

IWRA, as a well-known international water resources organization, provides a global forum to bring together disciplines and geographies by connecting professionals in and out of academe, students, and all other individuals who are concerned with the sustainable use of the world's water resources.

Improving Water Governance is one of key issues for IWRA strategies in coming years.





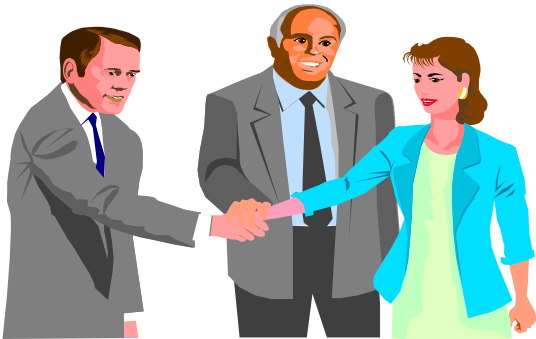
International Water Resources Association (IWRA)

IWRA, as one of major Governors in the Board of *World Water Council (WWC)*, and the member of *UN Water* and others, plays key roles in developing *water strategies in 2020 and beyond*, such as

- ***Water Supply Management (WSM) & Water Demand Management (WDM), a global water policy & strategies to balance regional development & water stress***
- ***Adaptive management for climate change***
- ***Balancing multiple use of water***
- ***Integrated Water resources Management***
- ...



***International & regional
cooperation are welcome !***



Thank you !

Prof. Xia Jun,
E-mail: xiaj@igsnrr.ac.cn