

Climate Change Impact & Adaptive Water Management for Major Basins in China

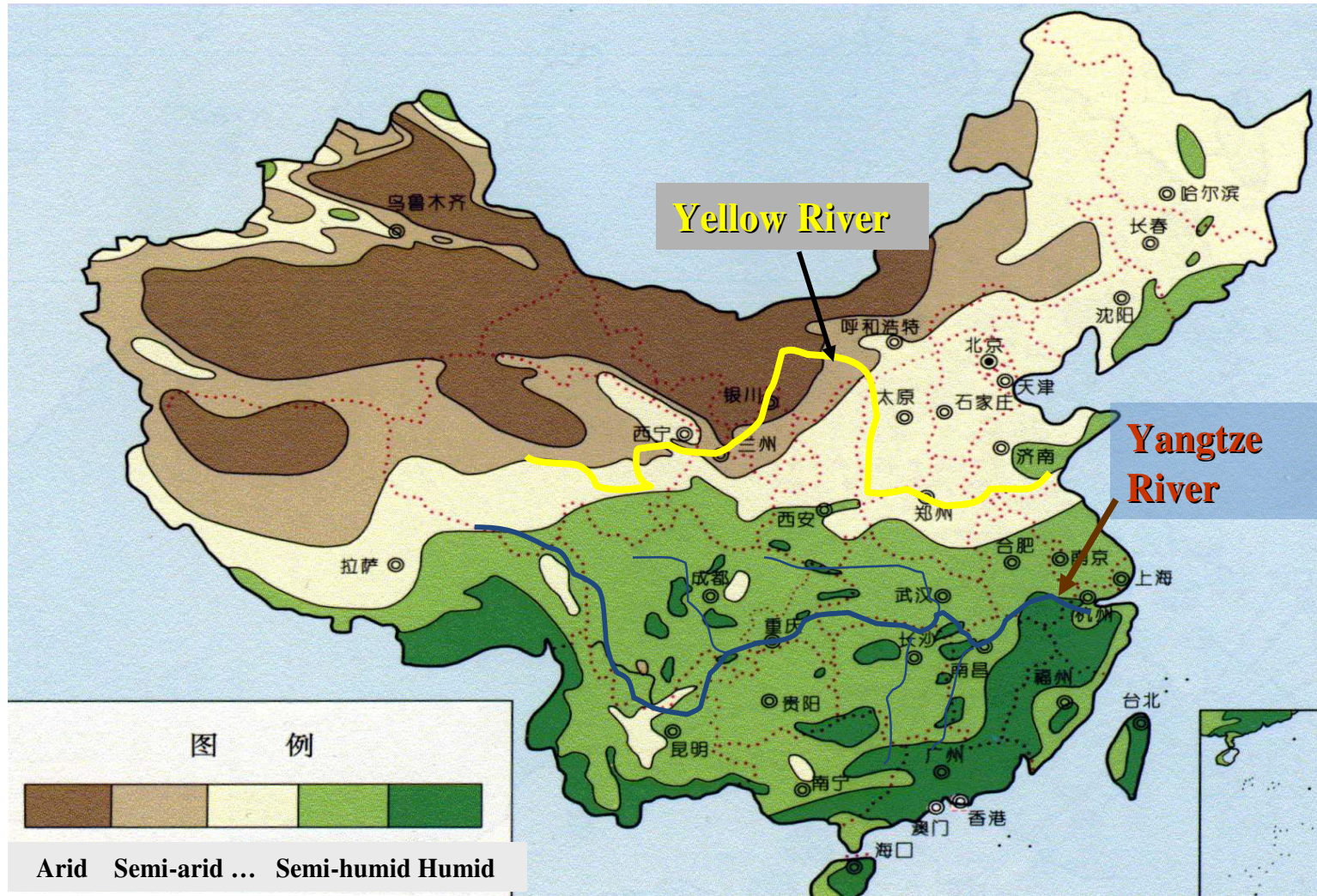
Jun XIA

Past President, IWRA

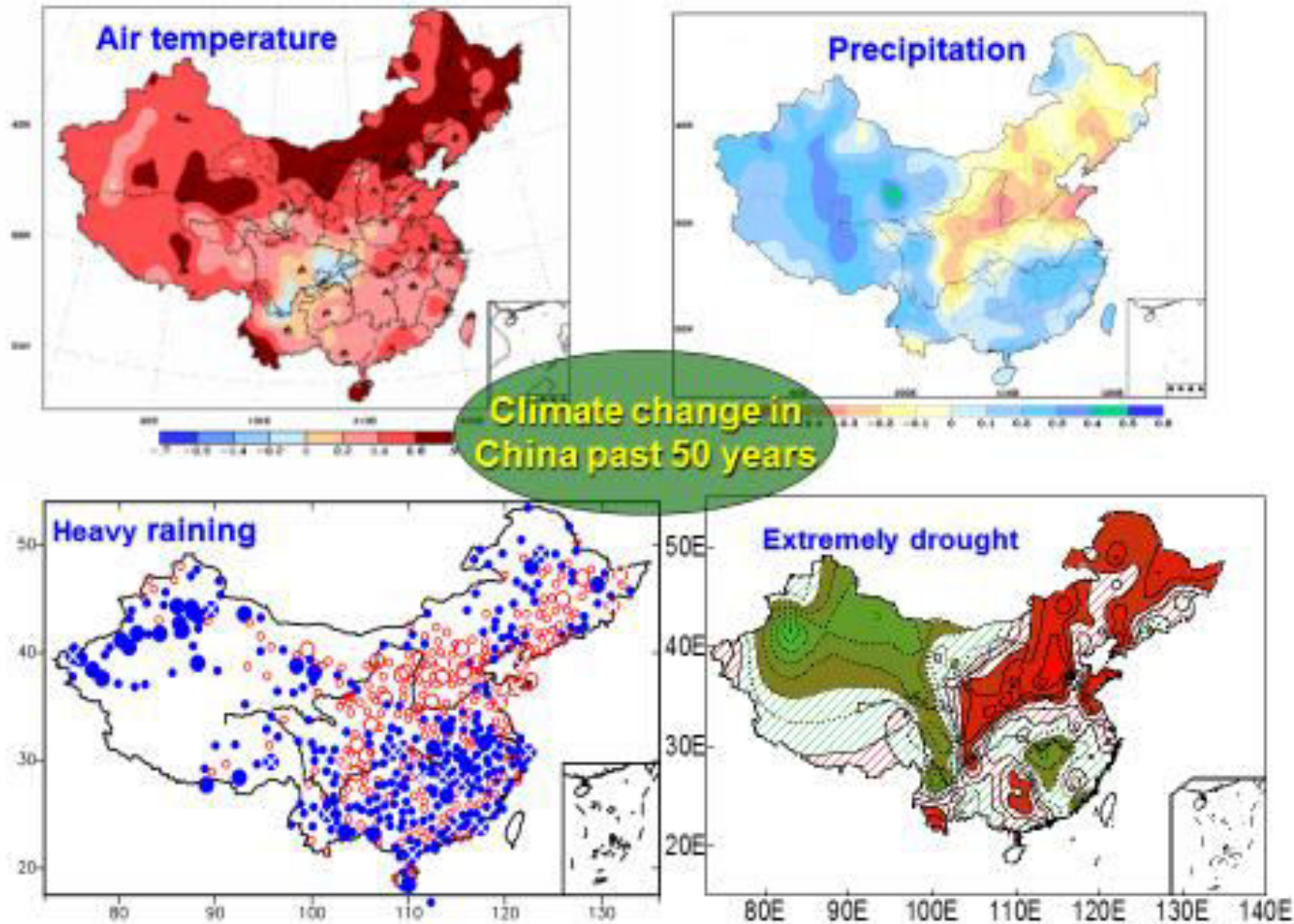
***Chair Professor & Dean, The Research Institute for
Water Security (RIWS), [Wuhan University](#)***

***Distinguished Professor, Key Lab. of Water Cycle &
Related Land Surface Processes,
[Chinese Academy of Sciences \(CAS\)](#)***

1. China is such a country with a variety of climate & much stress from its *population & economic development*

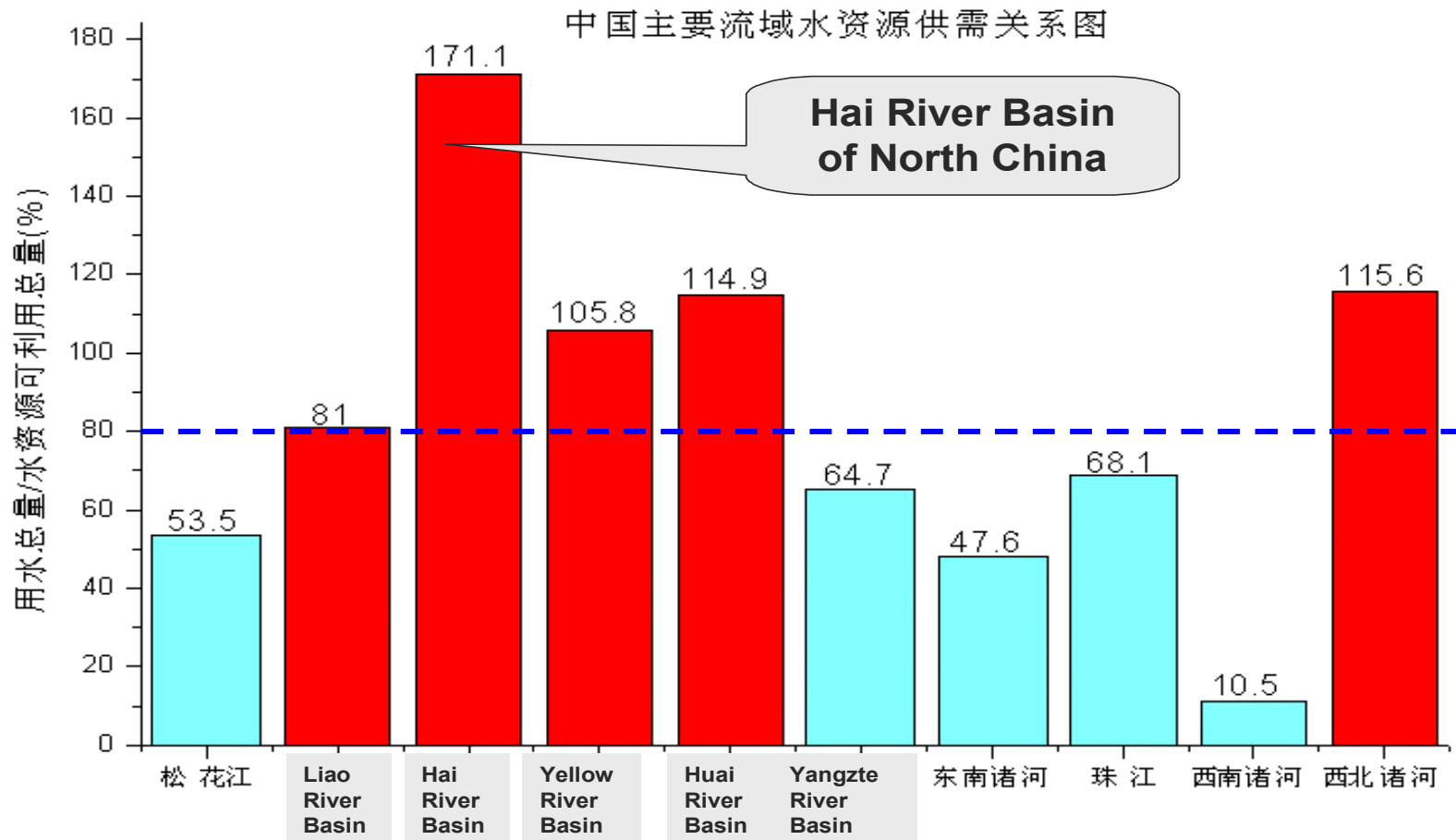


Climate change impact on water resources will be an important issue for China development


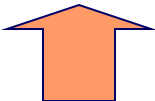




e.g., Water scarcity in China

Total water use / usable water resources in China



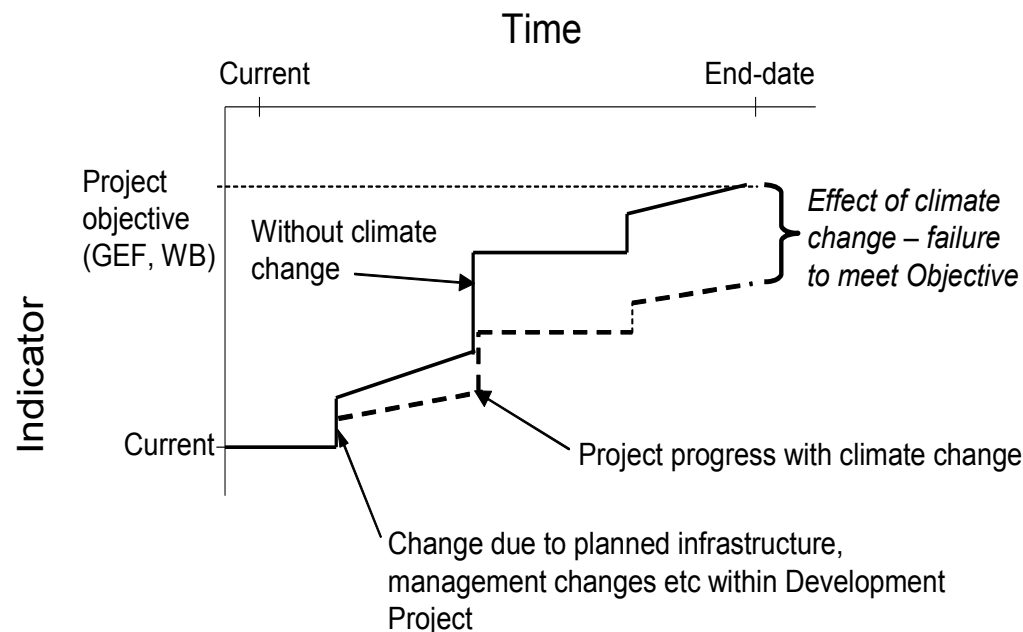
Along with social & economic growth, available water resources per capita in China will be declining

Year	Population (Billion)	Total Actual Water Use (Billion M³)	Available Water Res. per capita in North (M³/p)	Available Water Res. per capita (M³/p)
2000	1.3	563.2	359	628
2030	1.6 	710.1 	292 	508 

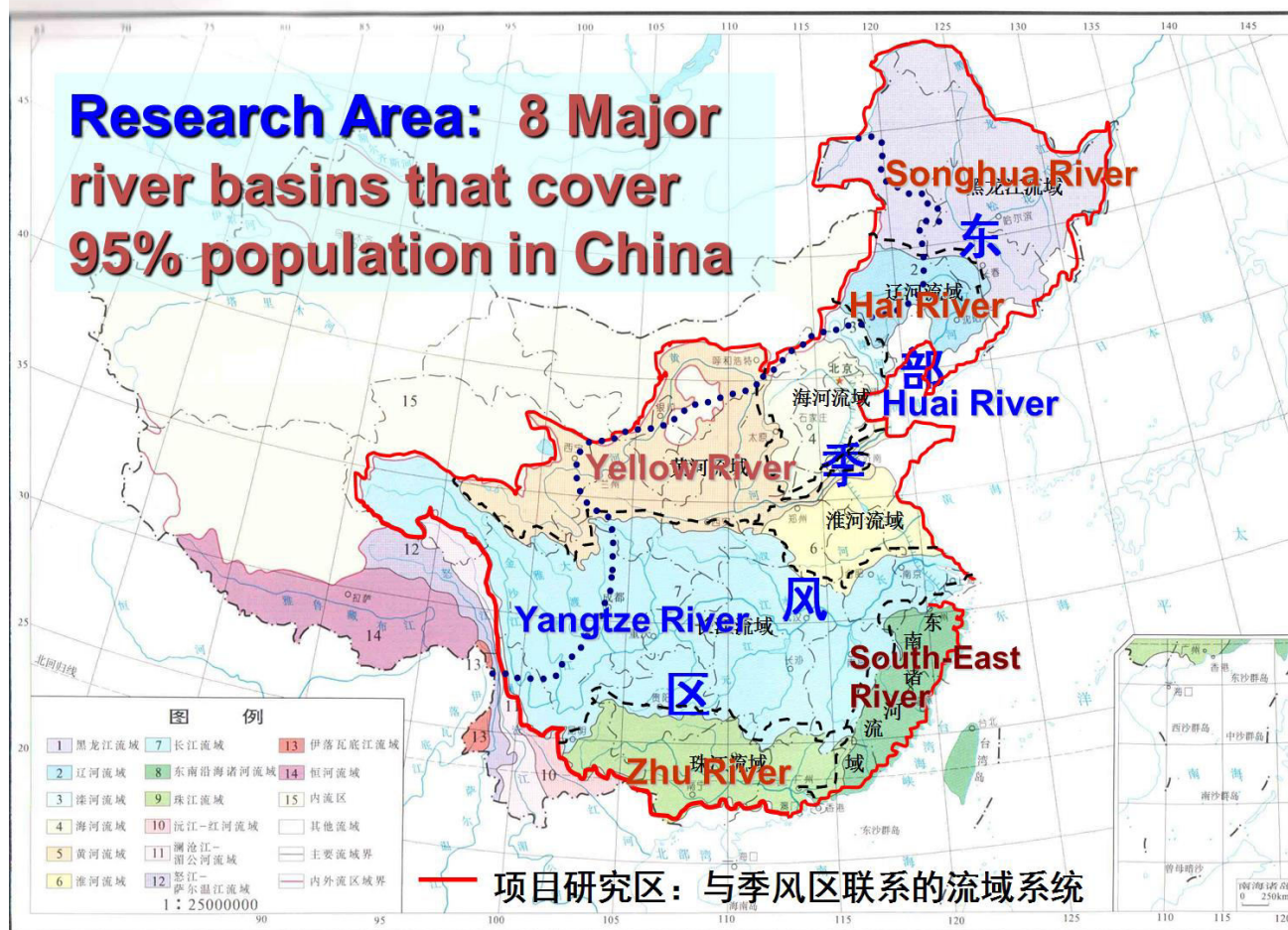
Climate change may increase risk for available water res.!

Questions related climate change to water sector

- **How to detect & understand climate changes impact to water sector ?**
- **How to take adaptation & wisely managing water for existing water projects and developing new water policy in China?**



2. Through fund from MOST, China, a National Basic Research Project (i.e., the 973 project), on **Climate Change Impact to Water Cycle & Water Security in China**, was completed on 2010-2014, lead by Jun XIA



Research Team for the Project

- **Chinese Academy of Sciences (CAS)**
 - *Institute of Geographic Sciences and Natural Resources Research (CAS/IGSNRR)*
 - *Institute of Atmospheric Physics (CAS/IAP)*
 - *Center for Agricultural Resources Research (CAS/CARR)*
- **Chinese Meteorological Administration (CMA)**
 - *National Climate Centre (CMA/NCC)*
- **Ministry of Water Resources (MWR)**
 - *Bureau of Hydrology*
 - *Water Resources and Hydropower Planning & Design Institute (WRHPDI)*
- **Ministry of Education**
 - *Beijing Normal University – College of Global Change and Earth System Science (BNU-GCESS)*
 - *Wuhan University-State Key Lab. of Water Res. & Hydropower Eng. Science (WU-SKLWRHES)*

MAJOR RESEARCH THEMES

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

National Climate Centre

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

Beijing Normal University

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

CAS-IAP & IGSNRR

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

CAS-IGSNRR

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

MWR-BH

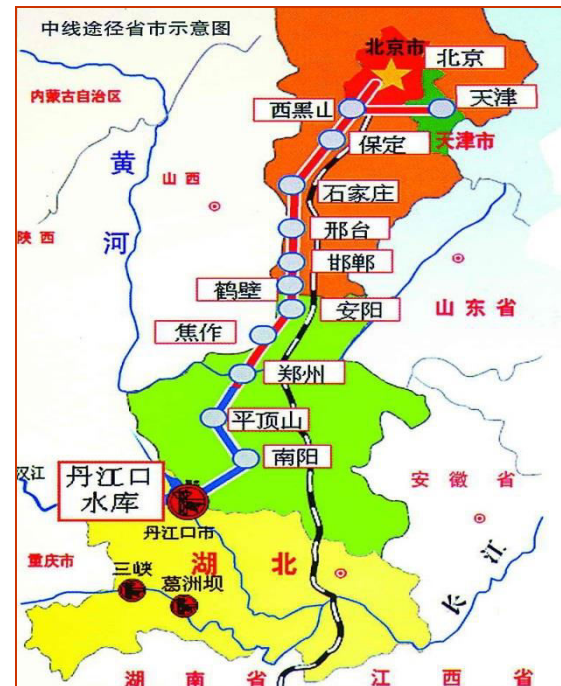
➤ **Water resources vulnerability & adaptation management**

*CAS-IGSNRR
MWR- WRHPDI*

Our research & preliminary conclusion:

- 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)* .**

e.g., It is quite possible to **increase probability** of the most dis-bennifit for both low water in N & S for the WDPSN could be **2.6-8.2%**



Preliminary detection shown that

- Hydrological change in China is due to both natural variation, and also arising from greenhouse gas emission.

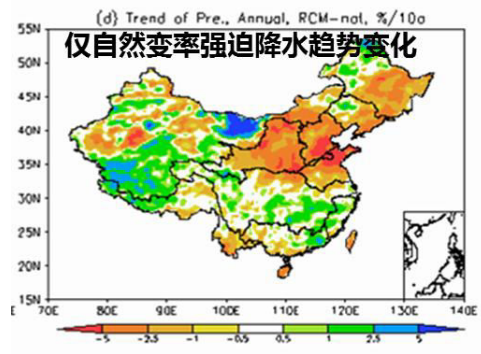
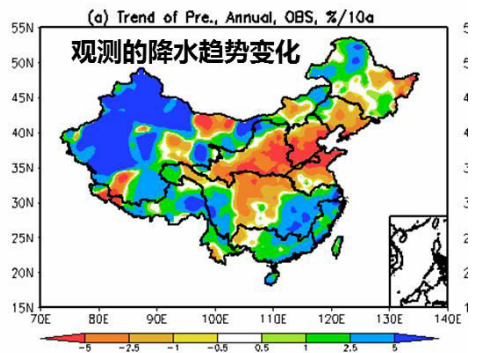
Natural variation role reaches to 70-90%

CO² Contribution also reach to 30%-10%

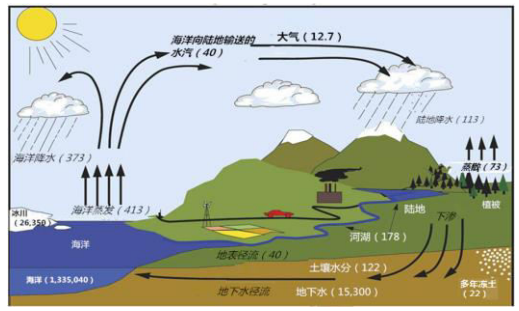
Averaged

2/3

1/3



-For future, when CO₂ increase, impact of climate change will certainly increase. So, water management will face to more challenge from Climate change.



2. Vulnerability & Adaptation will be priority issues for adaptive water management.

New study on Water vulnerability & adaptation (2014, J.Xia)

$$V(t) = E(t) \cdot R(t) \cdot S(t) / C(t)$$

- resilience $C(t)$
- Sensibility $S(t)$
- Exposure $E(t)$
- risk $R(t)$

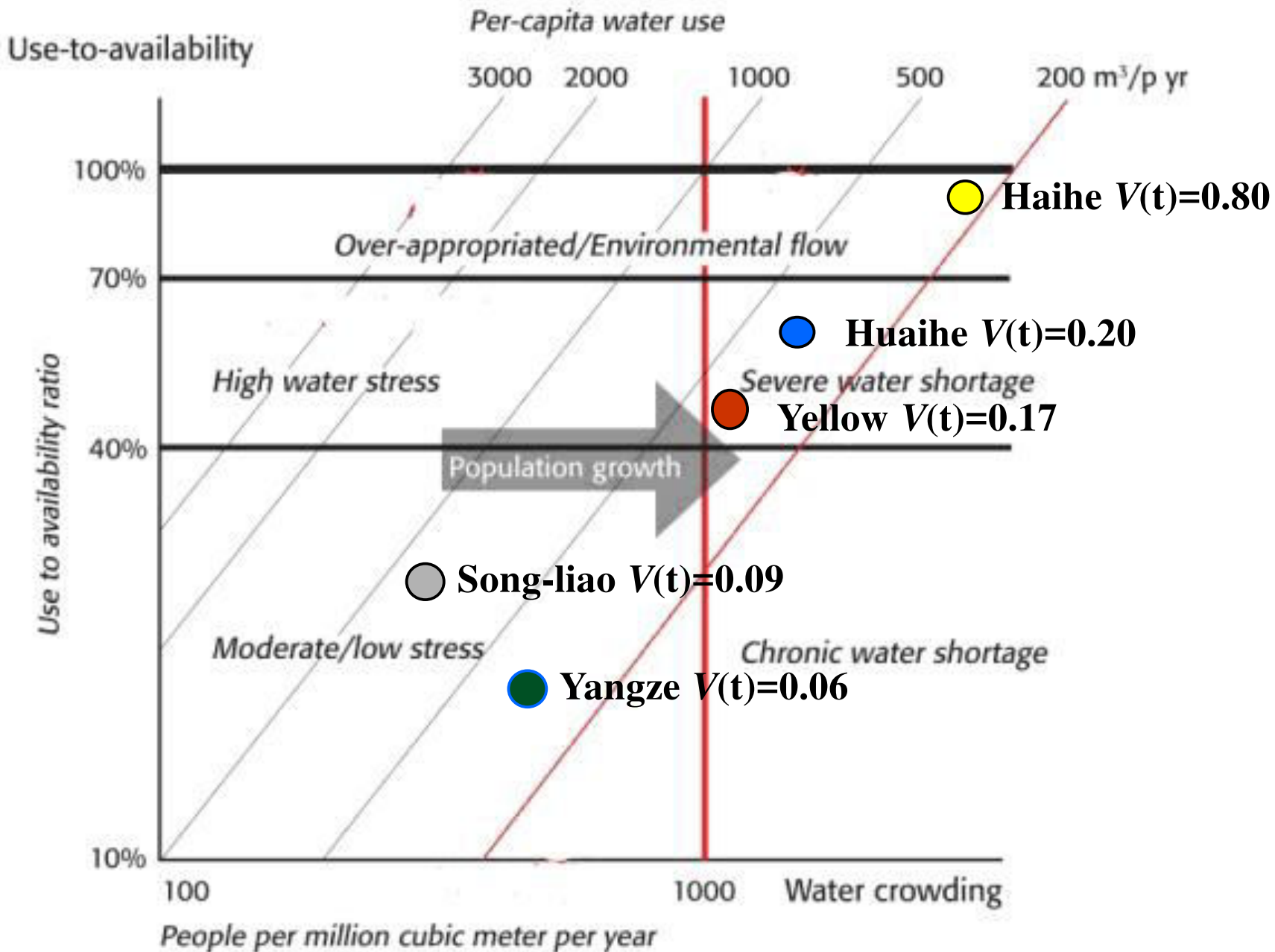
$$C(t) = f_1(r) \cdot f_2\left(1/\left(\frac{P}{Q} \cdot \frac{W_D}{P}\right)\right)$$

With three key indicators:

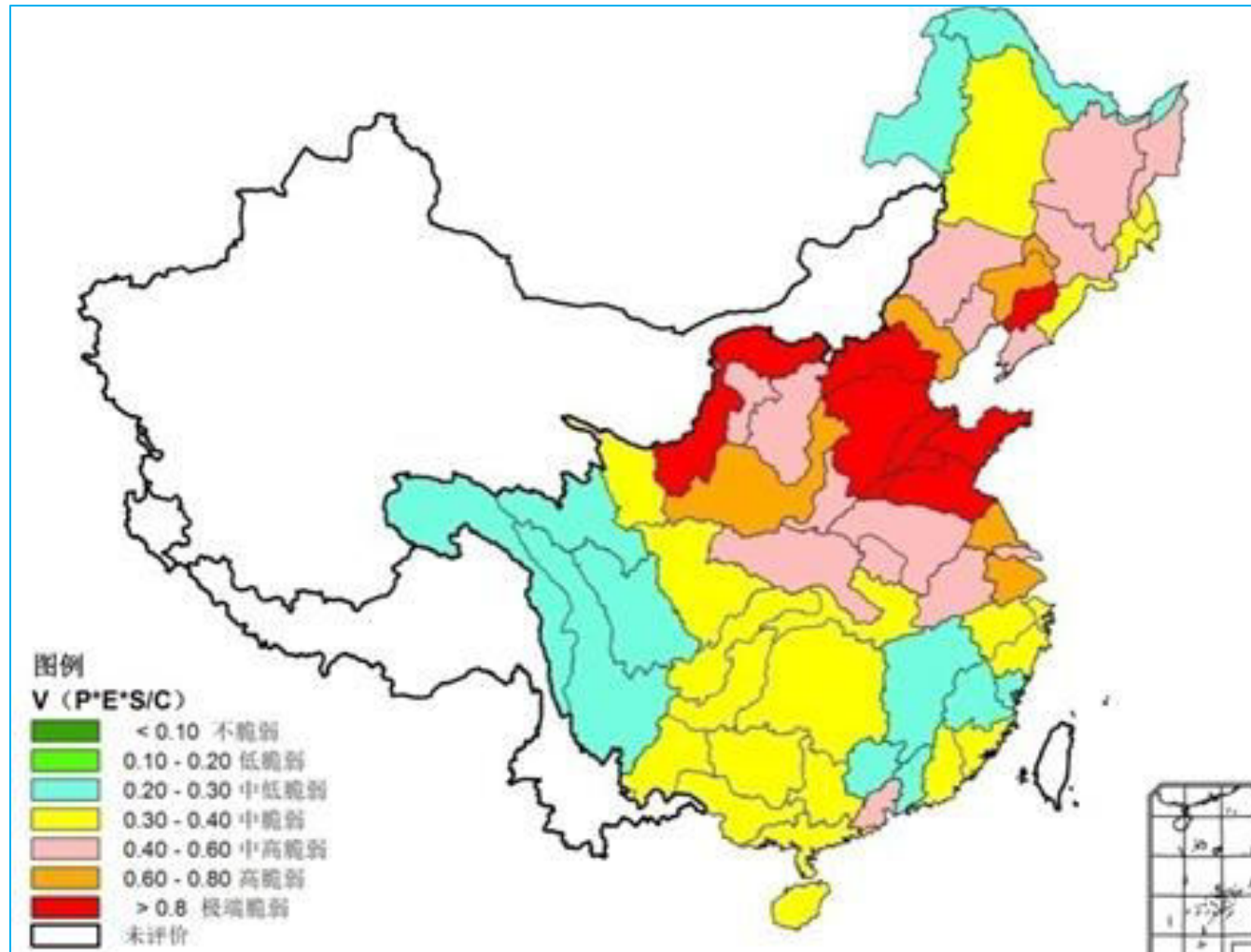
r - Use to availability ratio (%)

P/Q - Water crowding (p / Million m^3 / yr)

W_D/P - Per capita available water use (m^3/p yr)

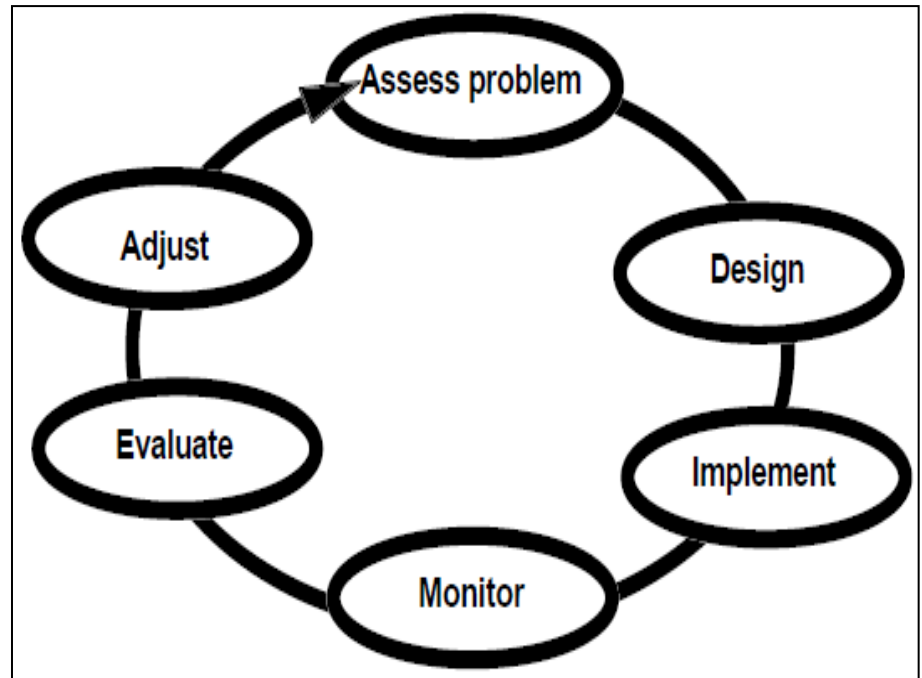


Mapping of Water Res. Vulnerability in eight big river basins of China (Xia J., 2014)



3. Adaptive water management

- **Adaptive management** is a systematic process for improving management policies and practices by **learning & updating process** under changing conditions with uncertainty.



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

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

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

Our research shown that vulnerability is also a function of adaptive policy

**water resource
vulnerability**

Key Indicators

Adaptive management
by regulation & control for
three red line target

$$V = E \cdot R \cdot S / C$$

r : Use to availability ratio (%)

P/Q : water crowding (p/Million m³/ yr)

W_D/P per capita water use (m³/p yr)

WD_{max}: Maximum useable Water Res.

WD: Total Water use

WE: Eco-water use

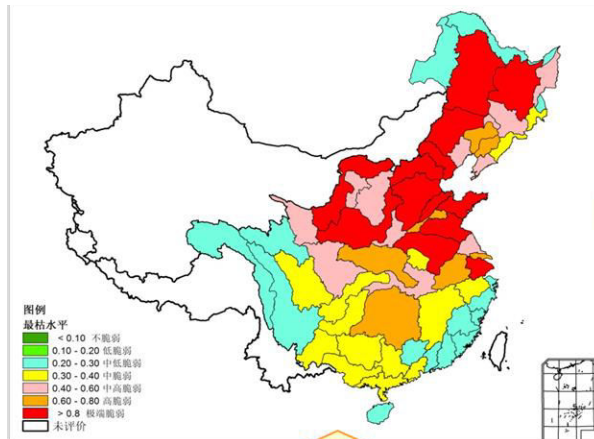
WE_{min}: Minimum eco-water demand

WUE: Water use efficiency

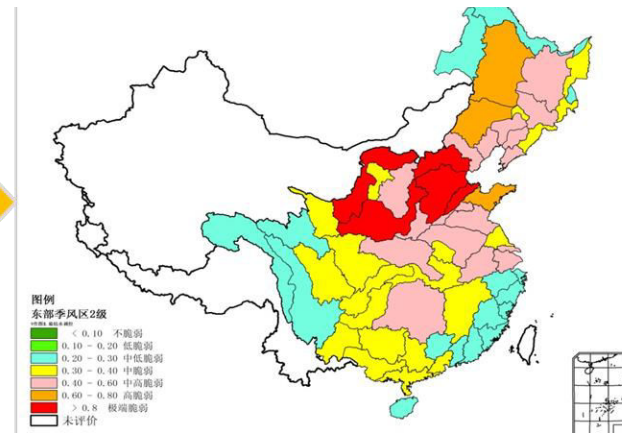
RWF: Ratio of water quality
Target rate

Vulnerability change of water resources when taking "Three Red Line Controls" policy

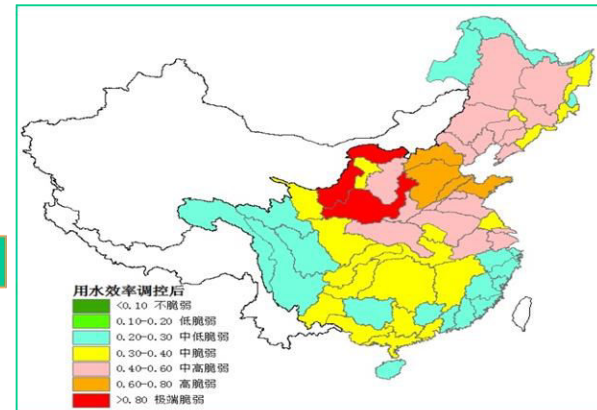
most unfavorable condition



• *Control of total water use*



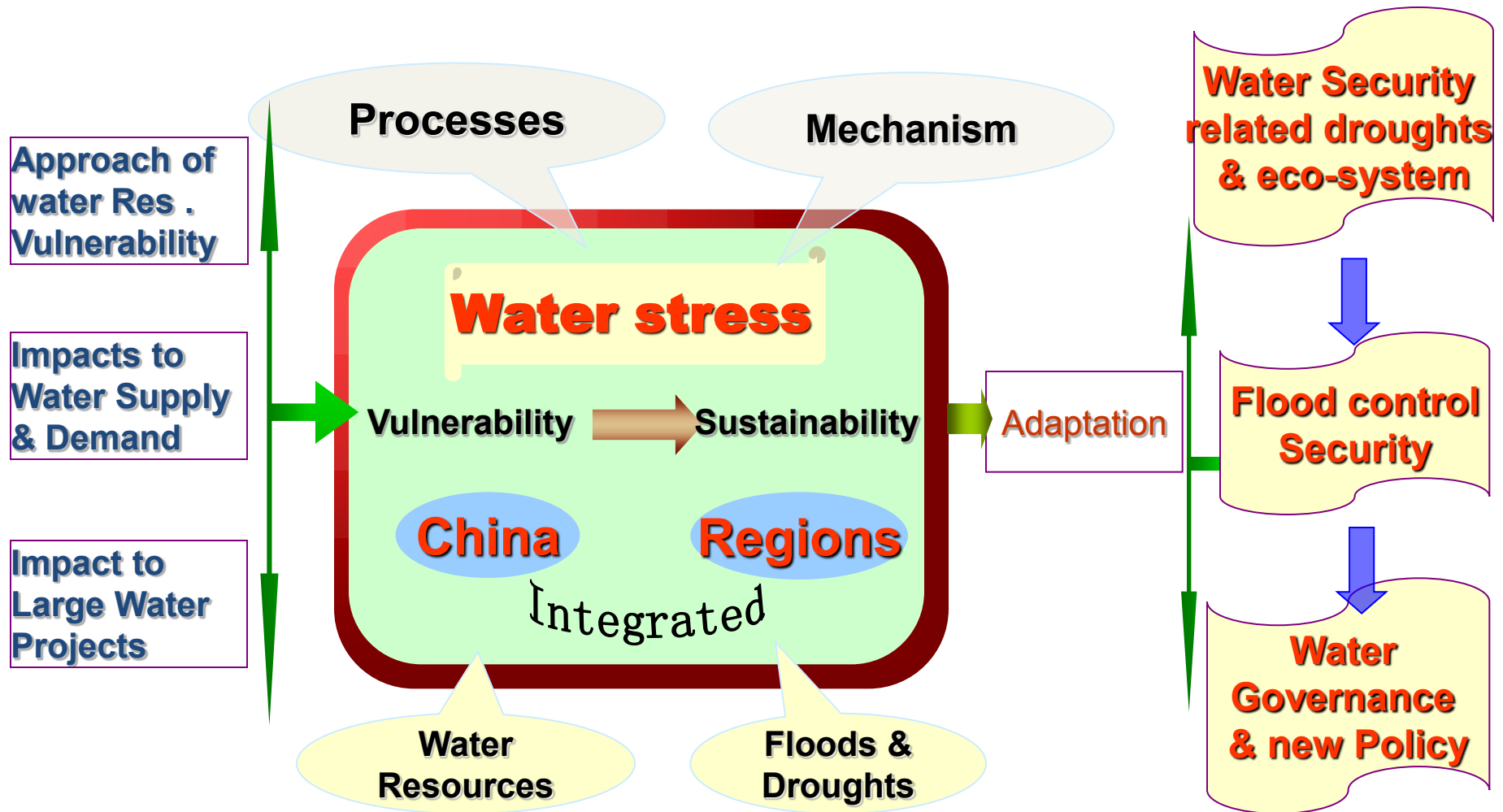
对比效果明显



• *Control of total waste water load*

• *Control of lower water use efficiency*

Adaptation water management under multiple risks need to be further studied



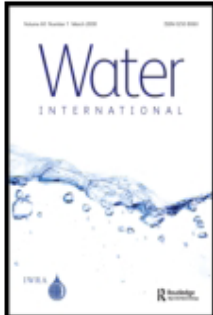
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Drawing down our resources: estimating the total appropriation of water in China

Jianting Cao^a, Yuanyuan Li^a, Fuxin Shen^a, Yiwei Chen^a & Jun Xia^b

^a General Institute of Water Resources and Hydropower Planning and Design, Ministry of Water Resources, PRC, Beijing, China

^b Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing, China

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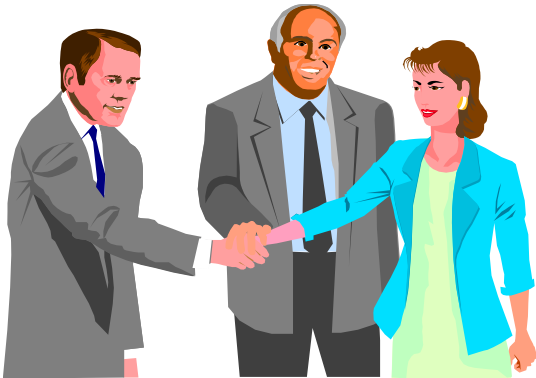
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***International & cooperation
are welcome !***



Thank you !

Prof. Xia Jun,
E-mail: xiajun666@whu.edu.cn