

Water Security issue and Adaptive management to Climate Change

Jun XIA

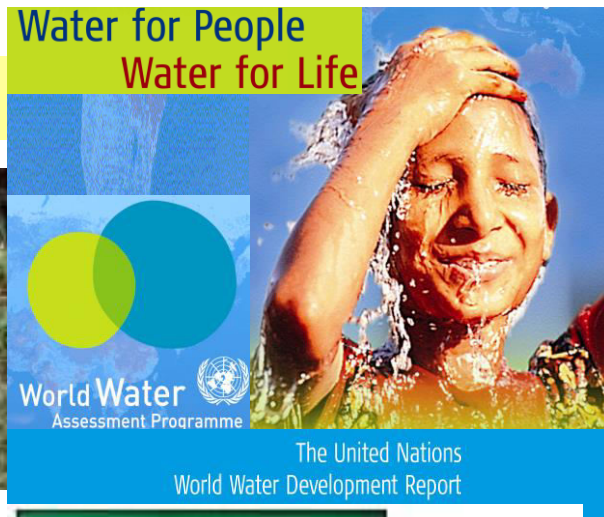
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1. Water Security has become the most important issue on Global Water Strategies

Water shortage



Water pollution



Water disaster



Ecosystem degradation



New vision on global water security

Gulbenkian Think Tank on Water
and the Future of Humanity



Water and the Future of Humanity

Revisiting Water Security



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Water and the Future of Humanity

Revisiting Water Security

The Gulbenkian Think Tank on Water and the Future of Humanity

Benedito Braga, Colin Chartres, William J. Cosgrove, Luis Veiga da Cunha, Peter H. Gleick, Pavel Kabat, Mohamed Ait Kadi, Daniel P. Loucks, Jan Lundqvist, Sunita Narain, Jun Xia (in alphabetic order)



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Gulbenkian Think Tank on Water and the Future of Humanity

Water and the Future of Humanity: Revisiting Water Security

This unique, engaging, and highly authoritative volume enlightens readers on changes needed in the way society accesses, provides, and uses water. It further shines a light on changes needed in the way we use food, energy, and other goods and services in relation to water, and offers projections and recommendations, up to 2050, that apply to water access challenges facing the poor and the common misuse of water in industry, agriculture, and municipalities. Written by an unparalleled slate of experts convened by the Calouste Gulbenkian Foundation, the book takes on one of the most critical issues on the planet today. In a frank yet optimistic assessment of major developmental challenges, but also opportunities, facing future generations, the author elucidates linkages between water and a range of other drivers from various disciplinary and stakeholder perspectives. Ultimately portraying the belief that Humanity can harness its visionary abilities, technologies, and economic resources for increased wellbeing and sound stewardship of resources, the book presents an optimistic statement stressing actions scientists, policy makers, and consumers can and must take to meet the water management challenges of a warming planet anticipating nine billion inhabitants by 2050.

The Book

- Provides interdisciplinary, multi-sector perspectives on fresh water issues for the widest audience
- Broadens understanding of the nexus among humans, water, energy, urban dynamics, agriculture, the environment, and other drivers
- Demonstrates results of a global water demand model up to the year 2050, accounting for socioeconomic trends and climate change
- Explores water use and conservation challenges in agricultural and other critical sectors
- Illustrates the possibilities for embarking on a path towards a desirable and just water future.

Gulbenkian Think Tank on Water and the Future of Humanity: Benedito Braga, Pres. World Water Council & Prof. of Civil Engineering, Univ. of São Paulo, Brazil; Colin Chartres, Director General of the International Water Management Institute, Sri Lanka; William J. Cosgrove, Pres. of Ecoconsult Inc. & Senior Adviser for the UN World Water Development Report, Canada; Luis Veiga da Cunha, Prof. Environmental Science and Engineering, Universidade Nova de Lisboa, Portugal; Peter Gleick, Pres. of the Pacific Institute, USA; Pavel Kabat, Director, International Institute for Applied Systems Analysis, Austria; and Prof. & Chair, Earth Systems Science, Wageningen University, The Netherlands; Mohamed Ait Kadi, President of the General Council of Agricultural Development, Morocco; Daniel P. Loucks, Prof. of Civil Engineering, Cornell Univ. USA; Jan Lundqvist, Senior Scientific Advisor, Stockholm International Water Institute, Sweden; Sunita Narain, Director, Center for Science & Environment, New Delhi, India; Jun Xia, Pres. International Water Resources Association, Chair Prof. & Dean, The Research Institute for Water Security (RIWS), Wuhan University, China.

Environment

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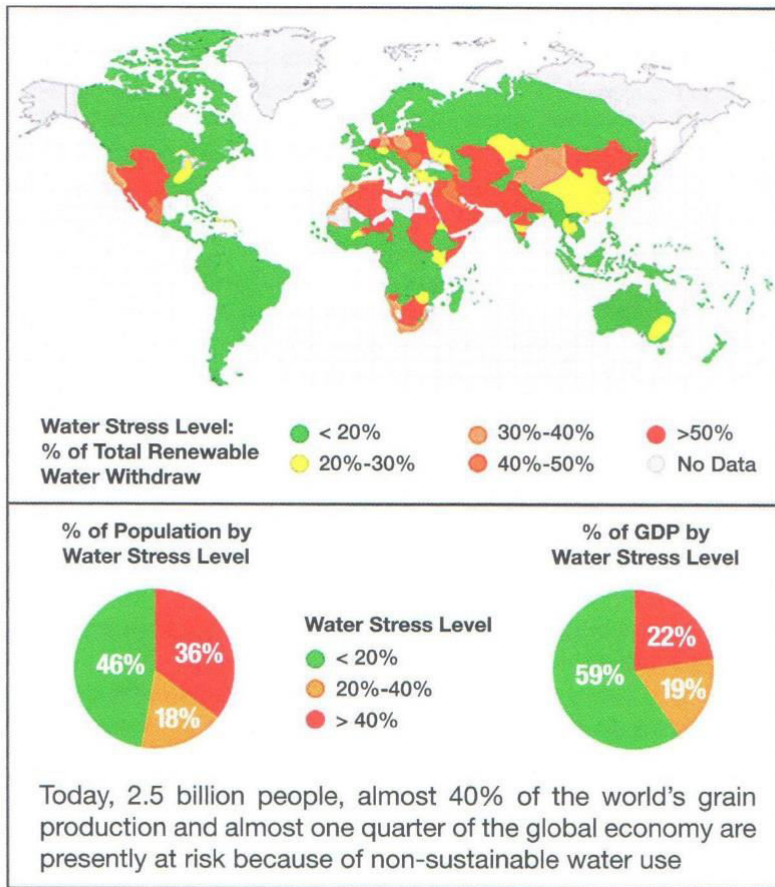


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Present situation



2050 in the future

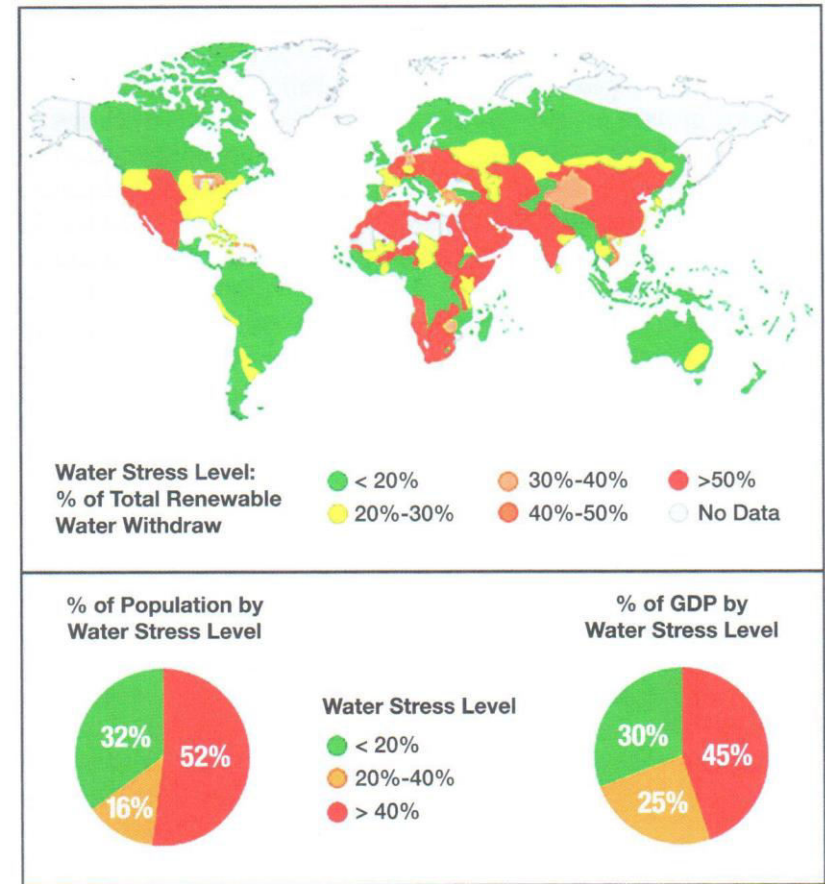


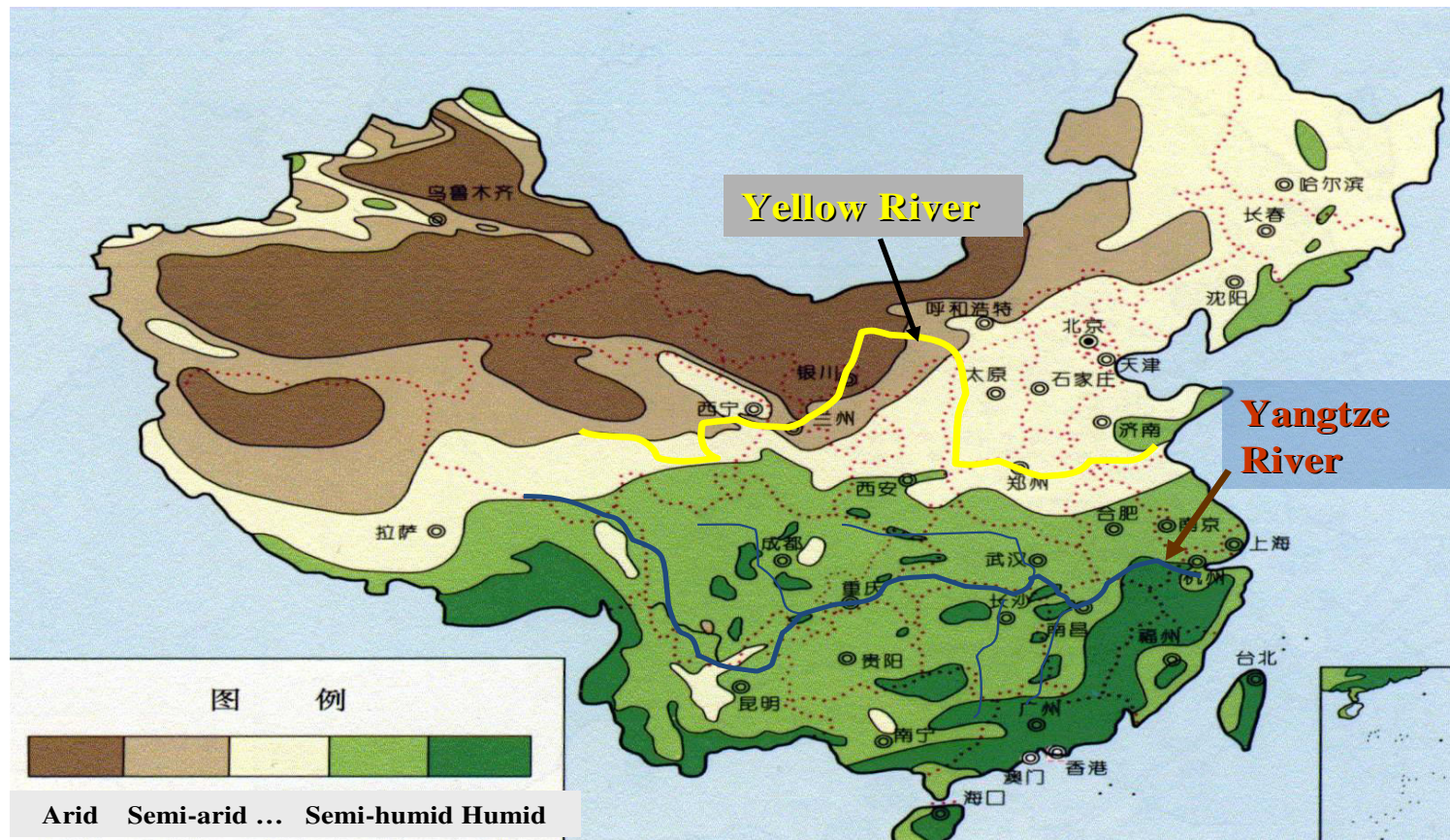
Fig. 1.1 Current water stress given present water supplies and management and use policies and practices. Source: Illustration courtesy of Growing Blue: www.growingblue.com

Fig. 1.2 Predicted water stress given current water management and use trends to 2050. Source: Illustration courtesy of Growing Blue: www.growingblue.com

Population: 7 Billion → 9 Billion in 2050
50% in Urban areas → 70 % in 2050

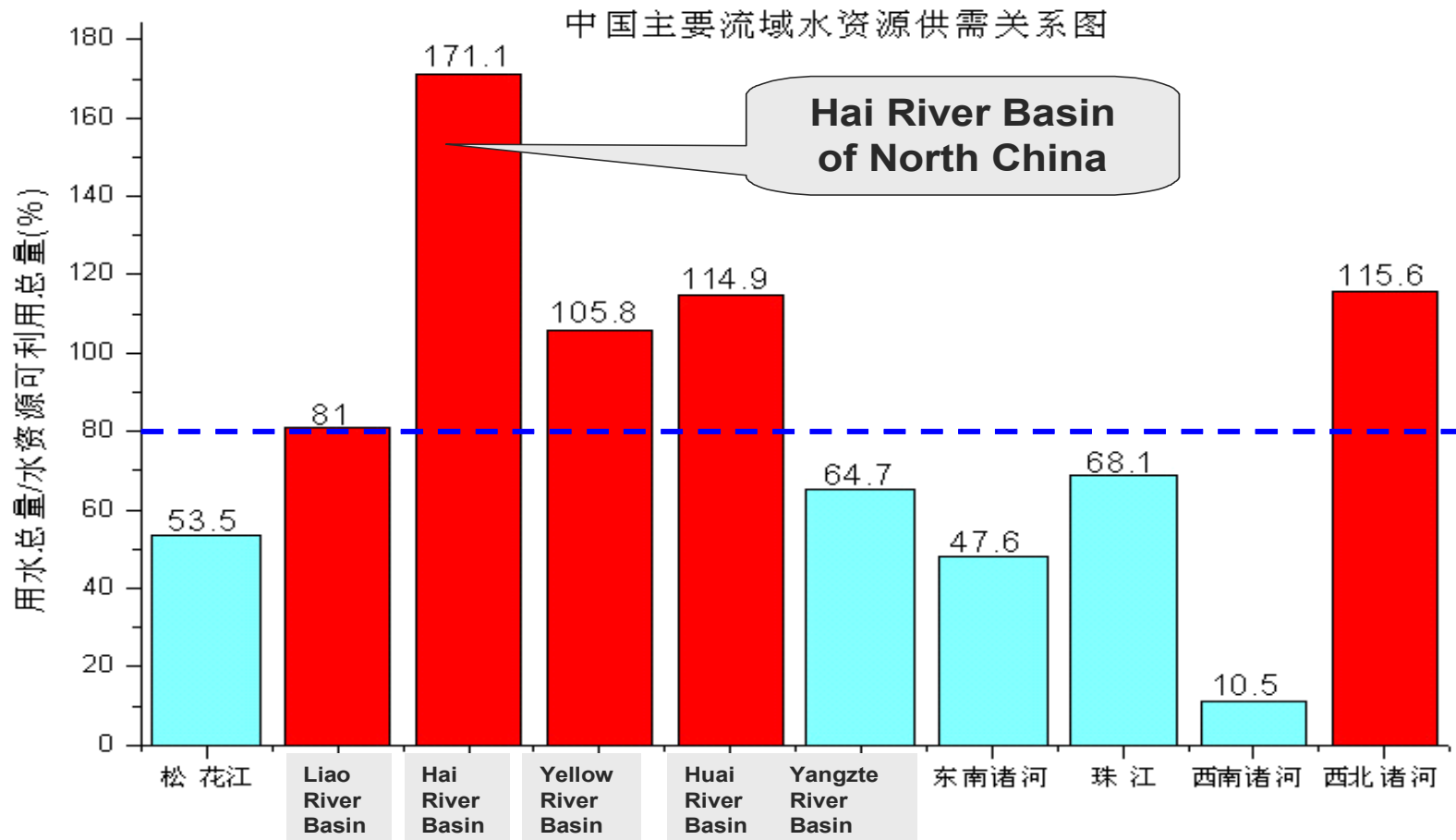
2. Water Security in China

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



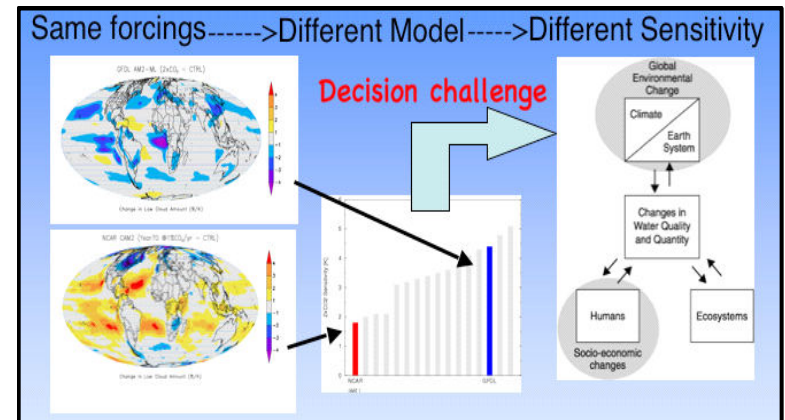
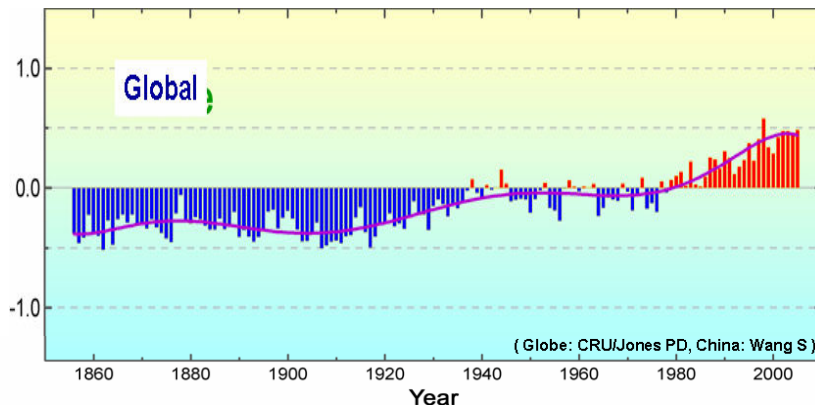
e.g., Water scarcity in China

Total water use / usable water resources in China



There are multiple impacts & challenges

(1). Climate change impact



It is quite possible to

- change water's time-space distribution

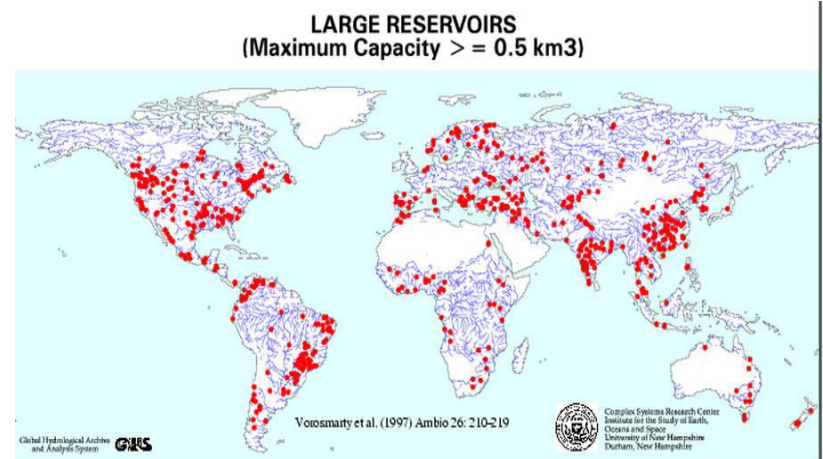
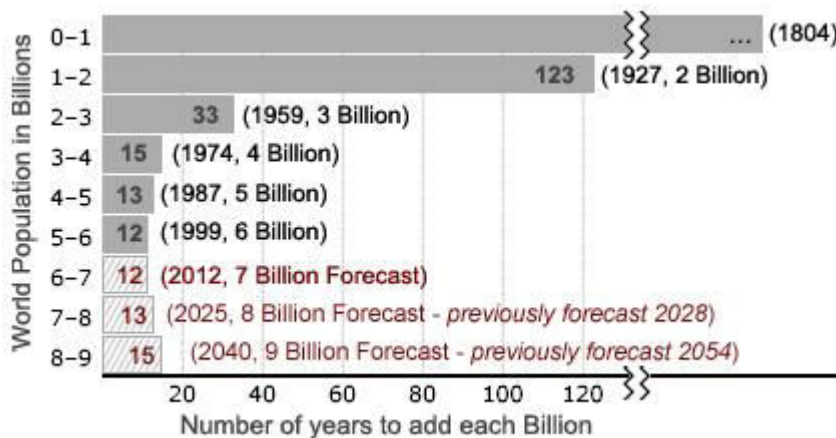
- increase risks on floods & droughts in water stress regions

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.**



An integrated indicator approach was developed to quantify vulnerability of water resources

(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 $R(t)$

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

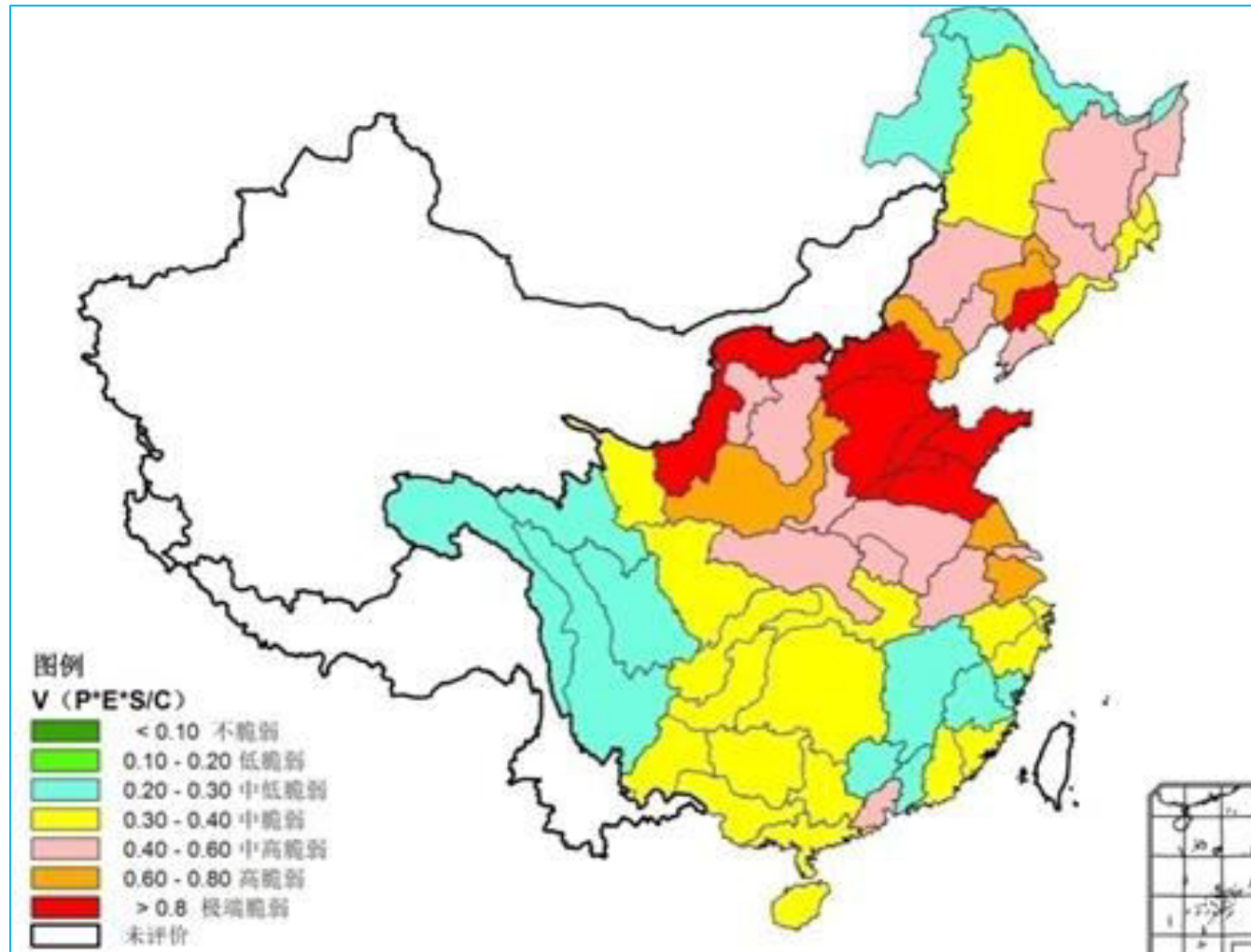
With three key indicators:

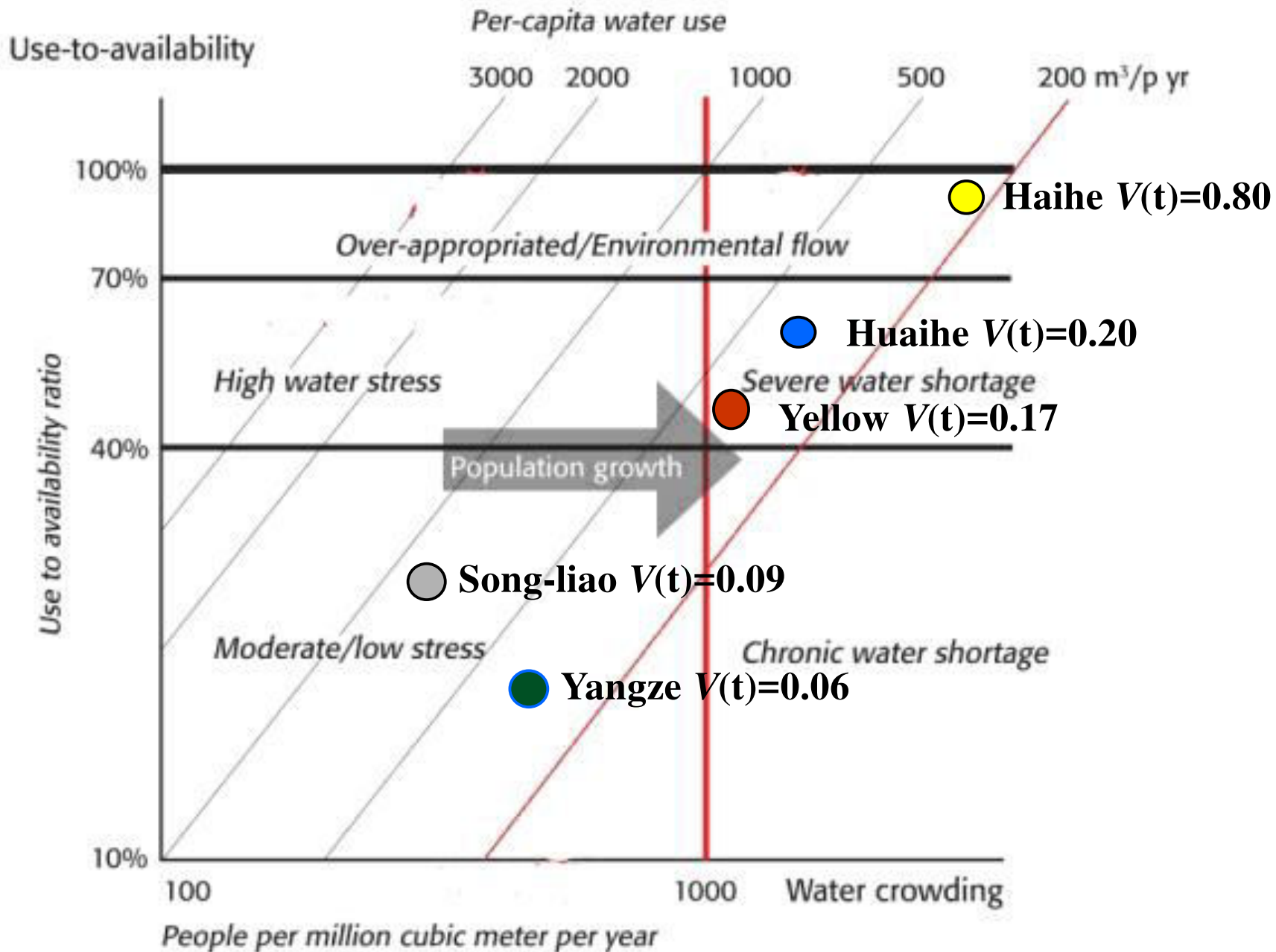
r - Use to availability ratio (%)

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, China (Xia J. & Li YY et al., 2014)

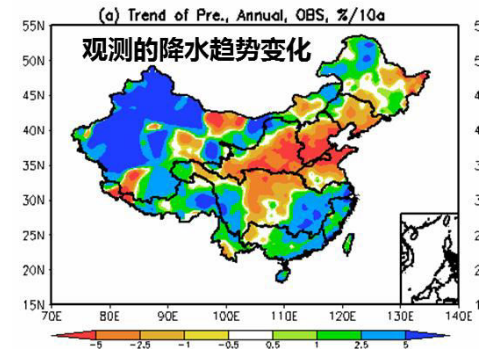




3. Impact of climate change & Adaptation

Our research shown (J.Xia, 2010-2015) that

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



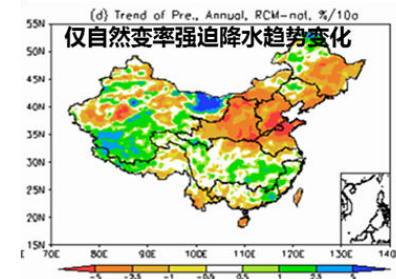
Averaged

Natural variation role reaches to 70-90%

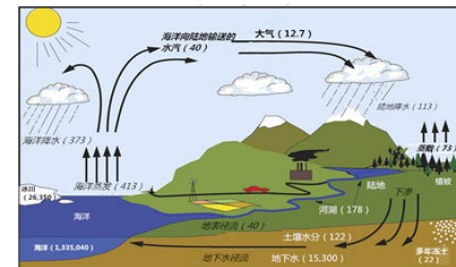
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CO₂ Contribution also reach to 30%-10%

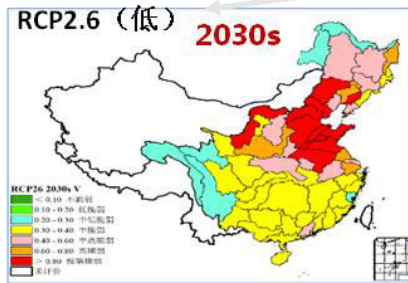
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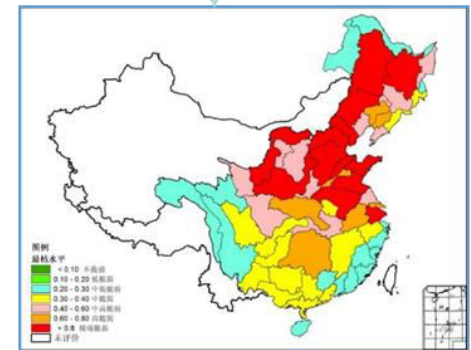
-For future, when CO₂ increase , impact of climate change will certainly increase. So, water management will face to more challenge from Climate change.



The change of water resources vulnerability in eight big rivers of China related to the future different scenarios (RCP2.6, RCP4.5, RCP8.5, IPCC-AR5).



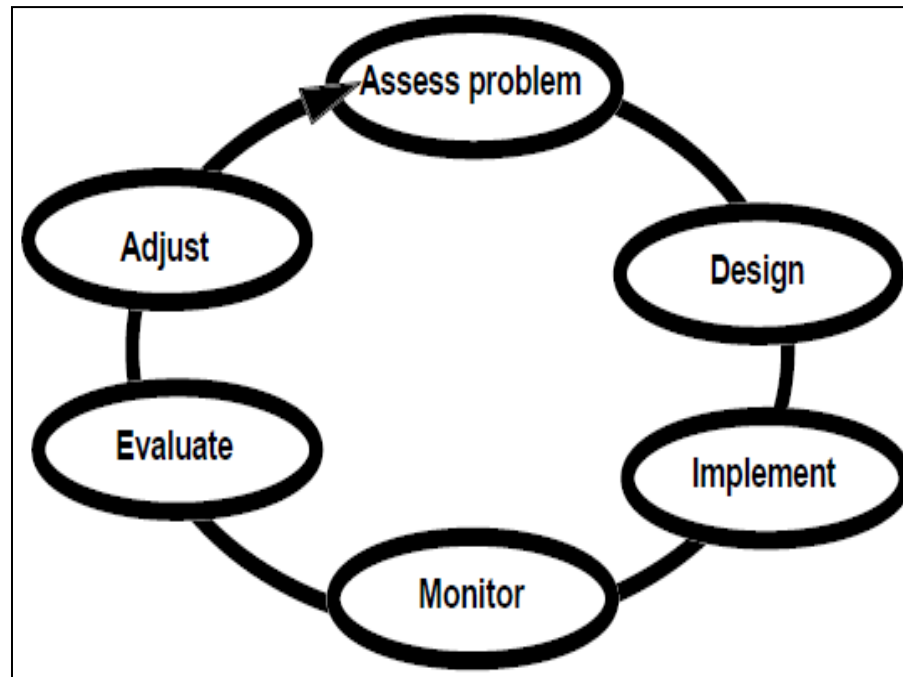
未来情景下我国东部季风区八大流域水资源脆弱性



未来最不利情景下东部季风区水资源脆弱性

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.

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

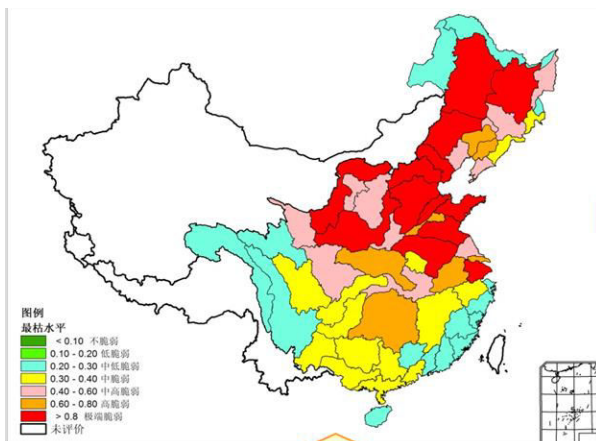
$$V = E \cdot R \cdot S / C$$

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

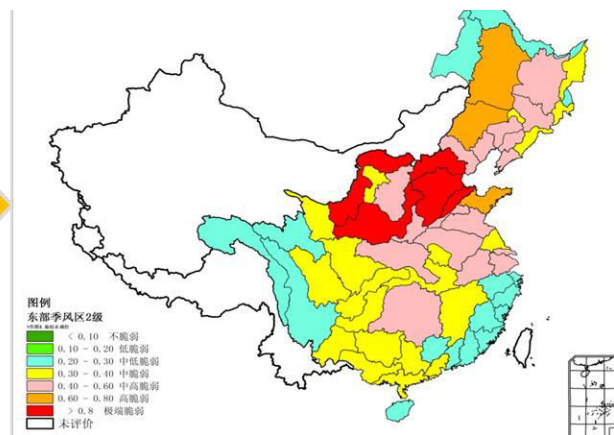
- WD_{max}**: Maximum useable Water Res.
- WD**: Total Water use
- WE**: Eco-water use
- WE_{min}**: Minimum eco-water demand
- WUE**: Water use efficiency
- RWF**: Ratio of water quality Target rate

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

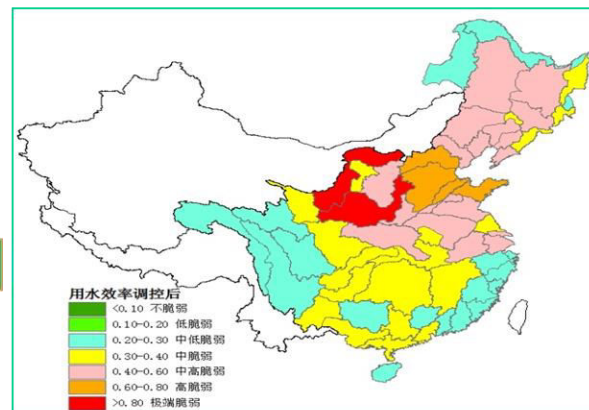
most unfavorable condition



• *Control of total water use*



对比效果明显



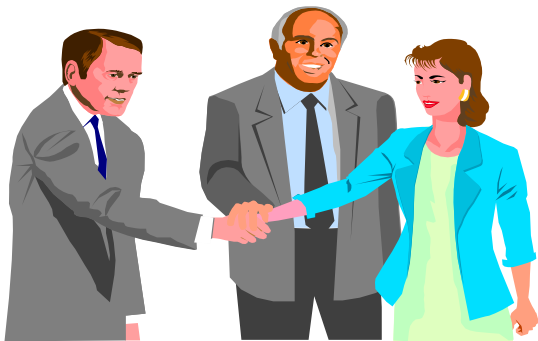
• *Control of total waste water load*

• *Control of lower water use efficiency*

Conclusions

- **Climate change** will be an important issue on water security. **Hydrologic Science** will play a key role on understanding & reduce risk under climate change.
- Water resources vulnerability & adaptive management will address a new challenges on **modifying current water project planning and water management to changing environment.**
- Thus, it is need to be further studies and practices on both methodologies and tools to ensure water security in China.

Cooperation are welcome !



Thank you !

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