Water Security issue and Adaptive management to Climate Change

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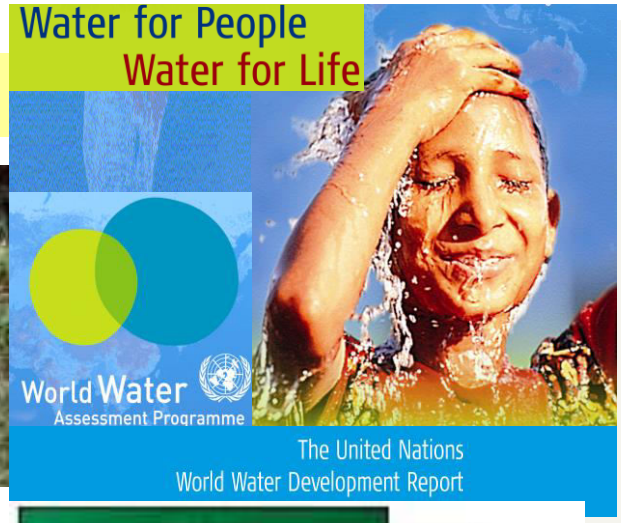
1. Water Security has become the most important issue on Global Water Strategies

Water shortage

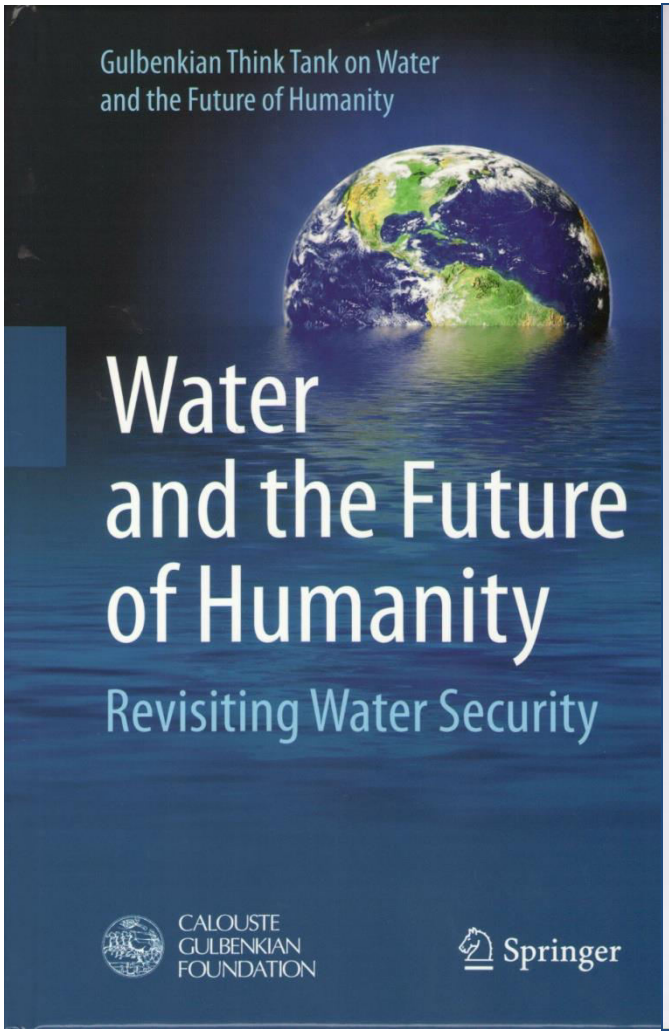


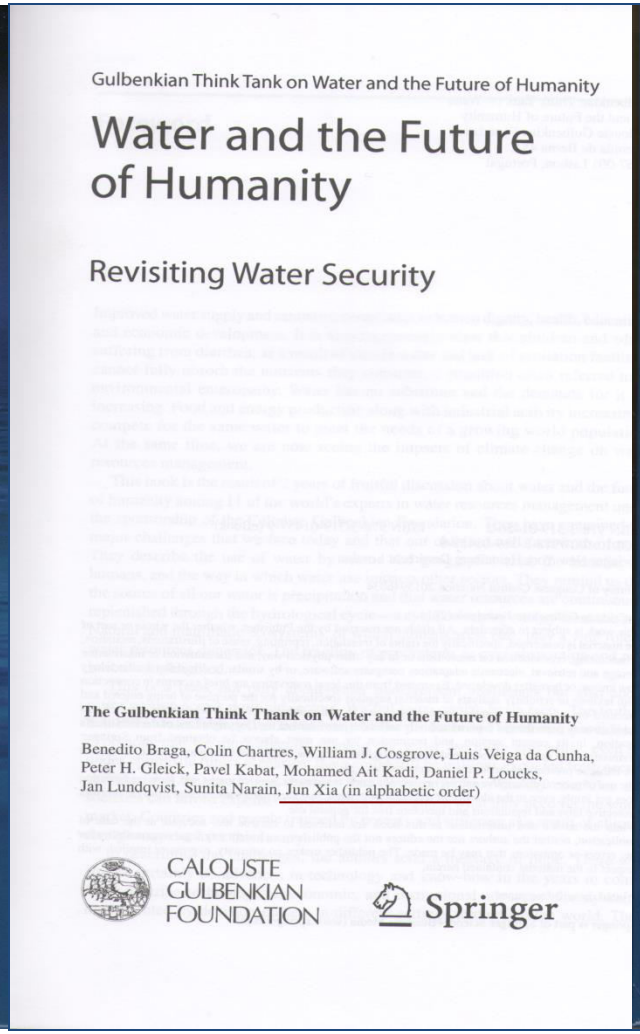
Water pollution

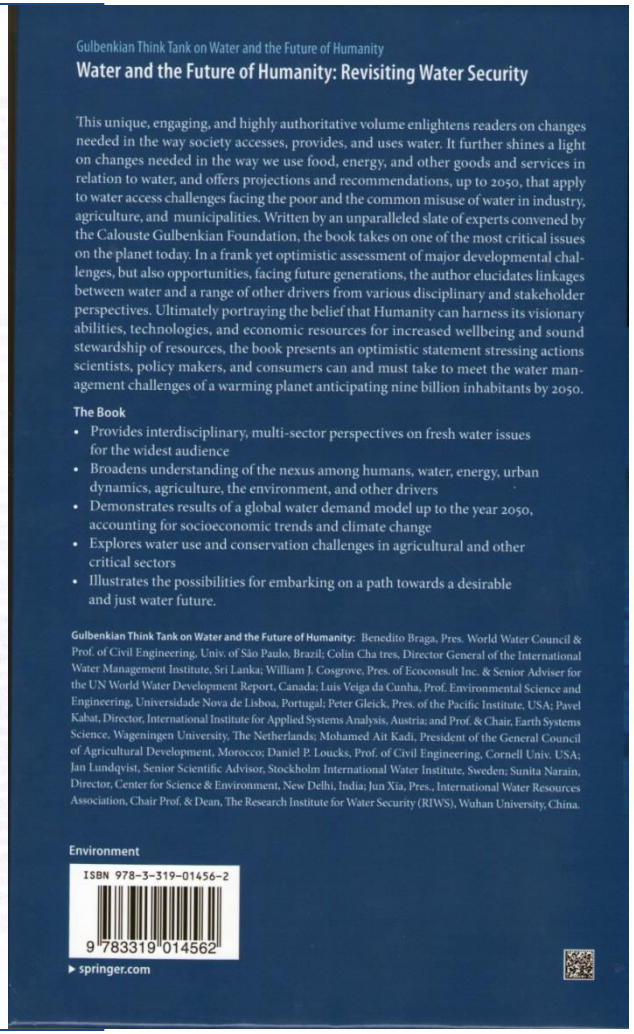
Water disaster

Ecosystem degradation

New vision on global water security







Present situation

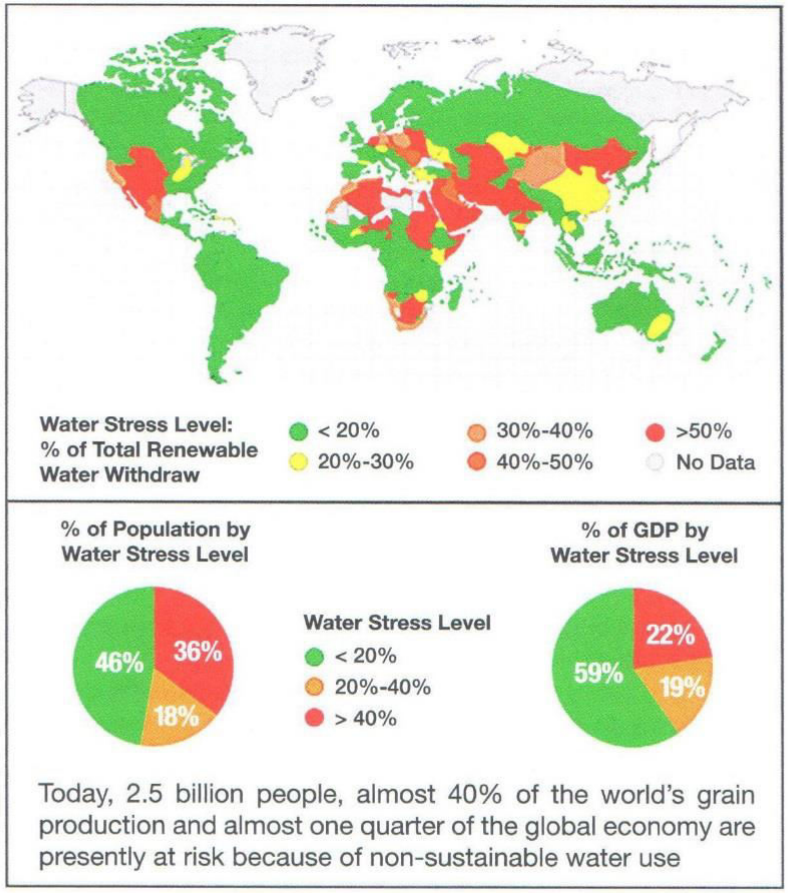


Fig. 1.1 Current water stress given present water supplies and management and use policies and practices. *Source*: Illustration courtesy of Growing Blue: www.growingblue.com

2050 in the future

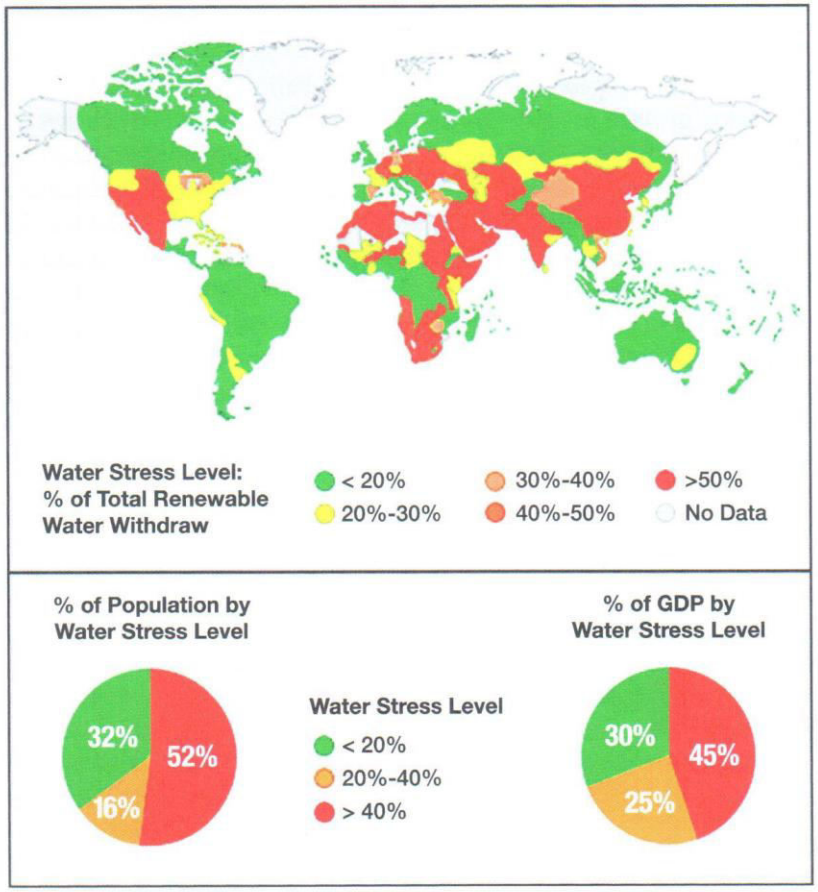


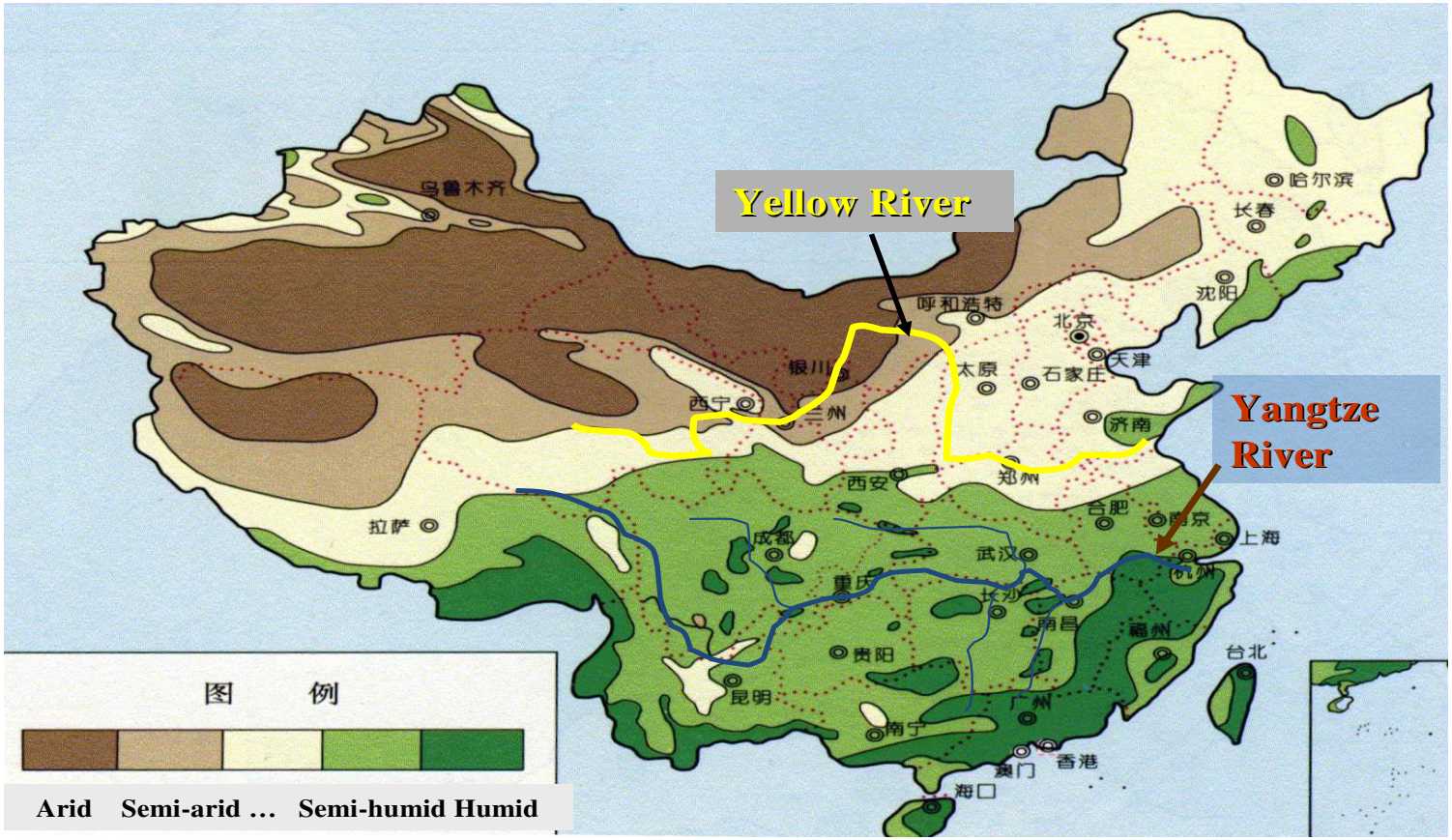
Fig. 1.2 Predicted water stress given current water management and use trends to 2050. *Source*: Illustration courtesy of Growing Blue: www.growingblue.com

Population: 7 Billion → 9 Billion in 2050

50% in Urban areas → 70 % in 2050

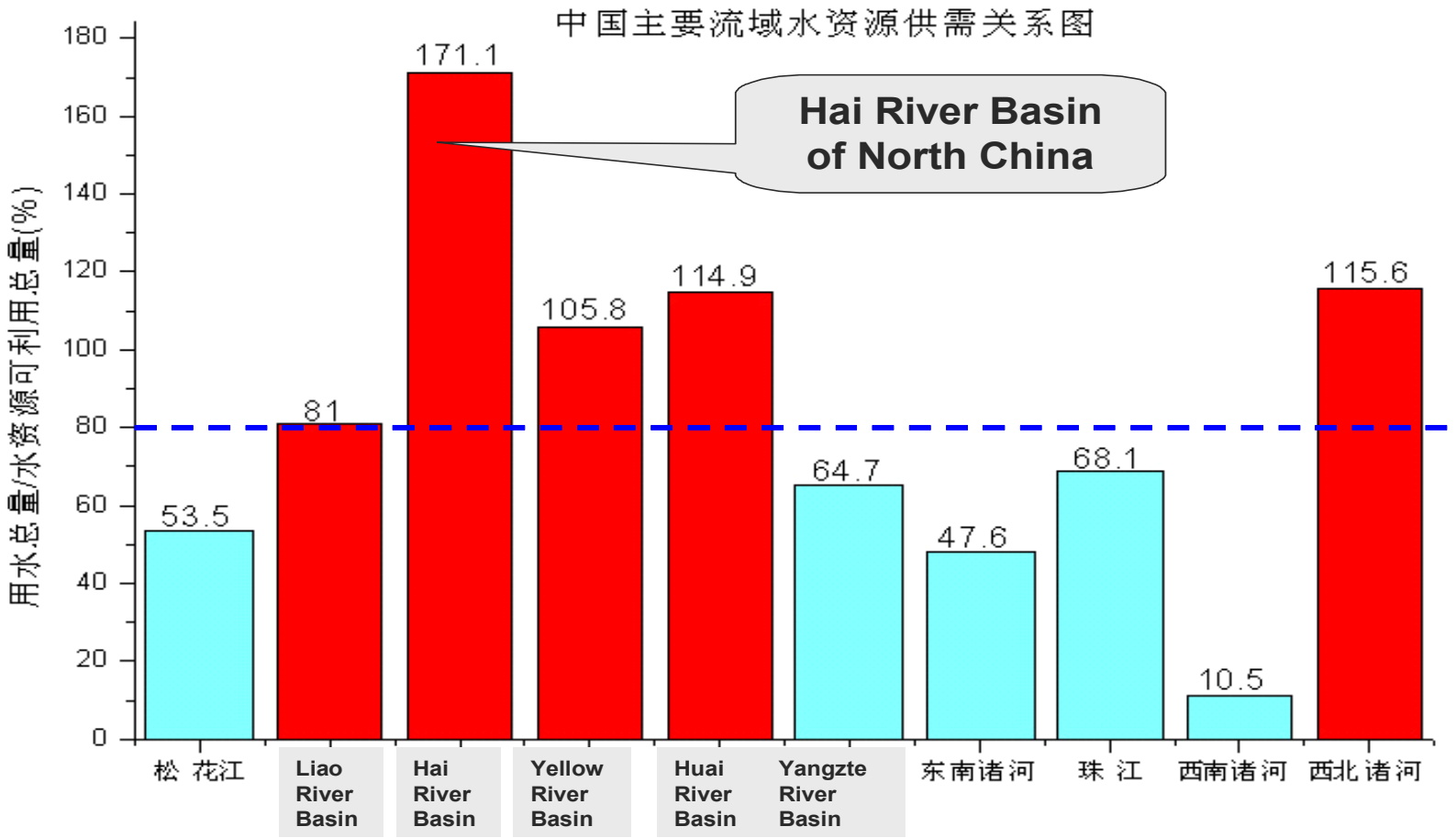
2. Water Security in China

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



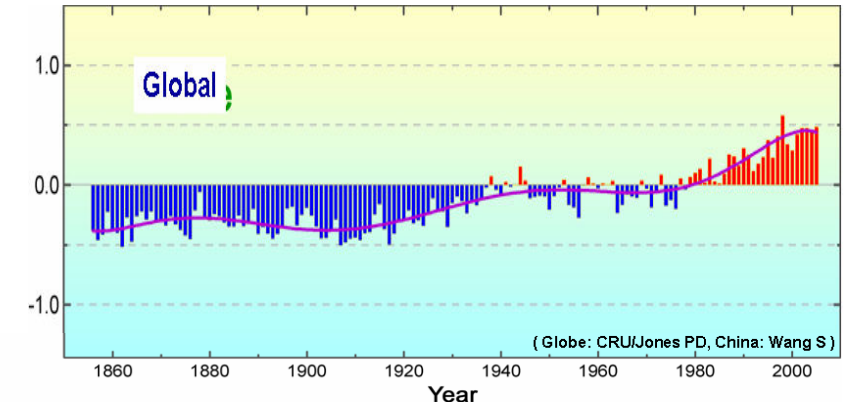
e.g., Water scarcity in China

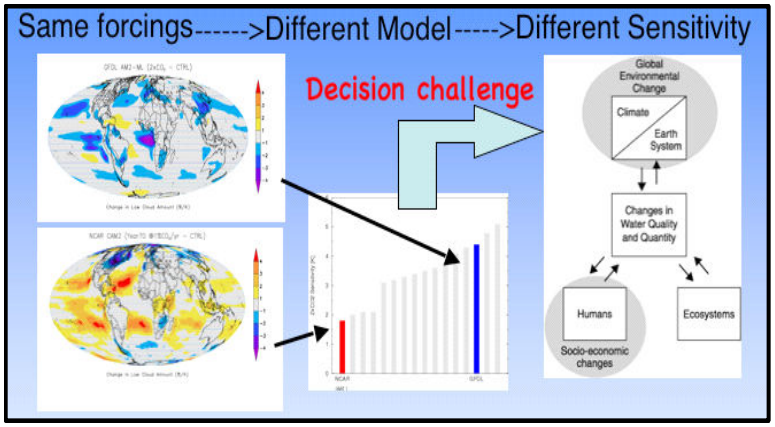
Total water use / usable water resources in China



There are multiple impacts & challenges

(1).Climate change impact





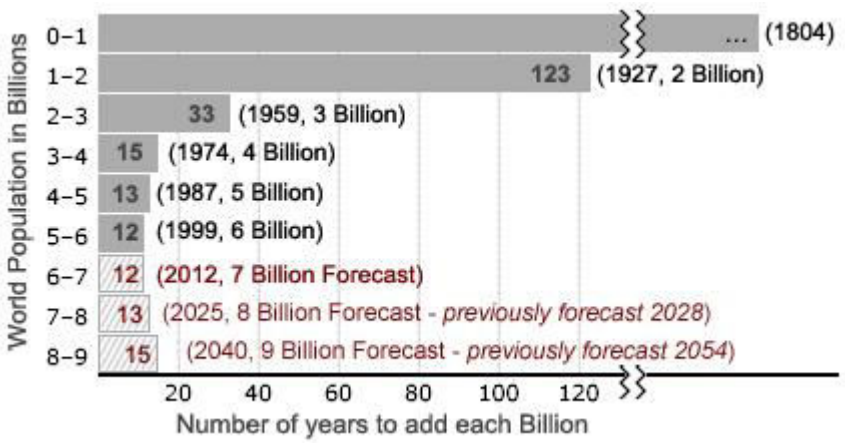
It is quite possible to

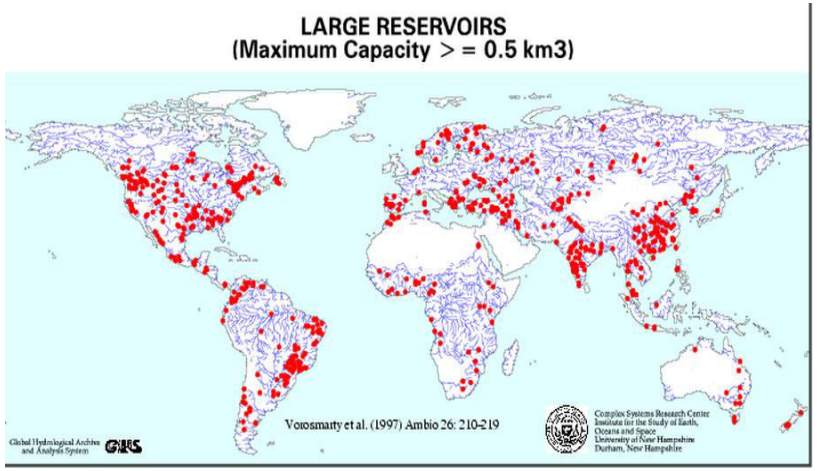
- **change water's time-space distribution**
- **increase risks on floods & droughts in water stress regions**

IPCC AR4 (2009)

(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)

$$\mathbf{V(t)} = E(t).R(t).\mathbf{S(t)/C(t)}$$

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

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

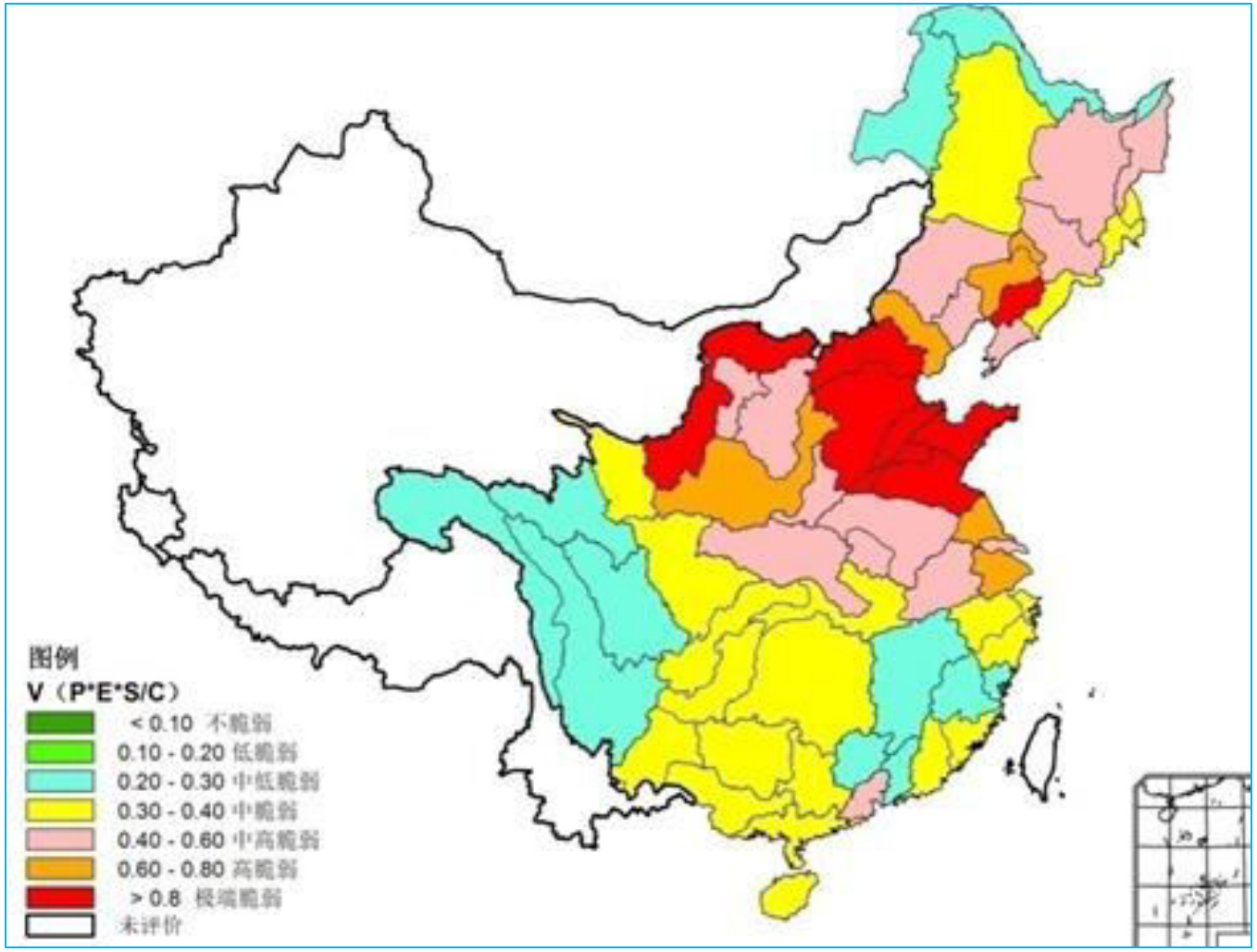
With three key indicators:

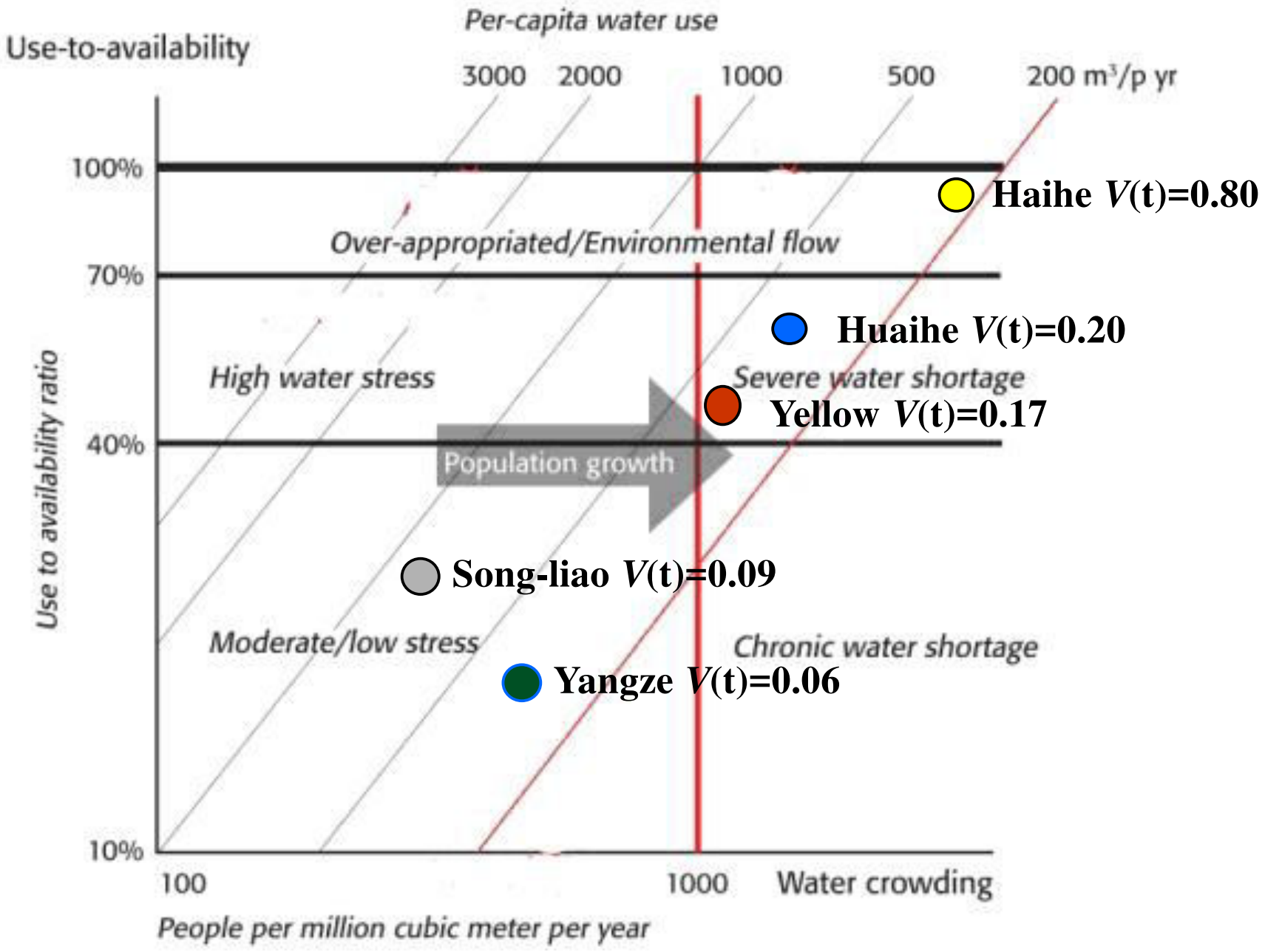
r – Use to availability ratio (%)

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

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

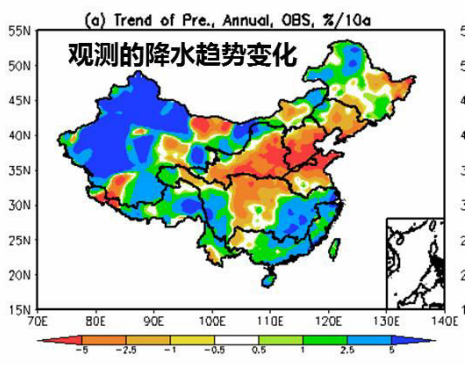
Mapping of Water Res. Vulnerability in eight big river basins, China (Xia J. & Li YY et al., 2014)




Use-to-availability
Per-capita water use
3000
2000
1000
500
200 m³/p yr
100%
70%
40%
10%
Over-appropriated/Environmental flow
High water stress
Severe water shortage
Population growth
Moderate/low stress
Chronic water shortage
Use to availability ratio
100
1000
Water crowding
People per million cubic meter per year
Haihe V(t)=0.80
Huaihe V(t)=0.20
Yellow V(t)=0.17
Song-liao V(t)=0.09
Yangze V(t)=0.06

3. Impact of climate change & Adaptation

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

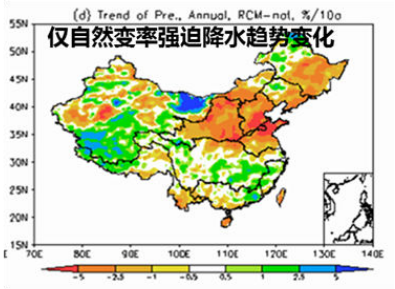


- **Hydrological change in China is due to both natural variation, and also arising from greenhouse gas emission.**

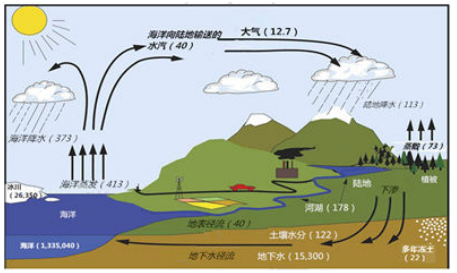
Averaged

Natural variation role reaches to 70-90% — **2/3**

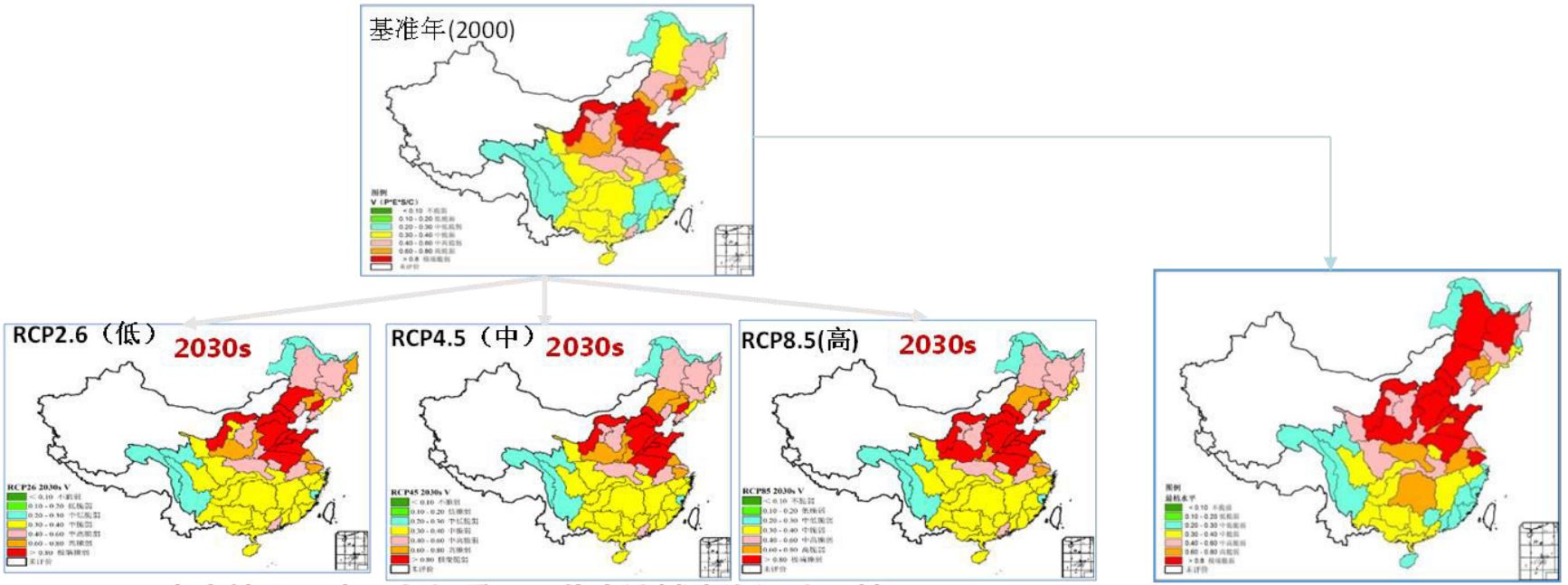
CO^2 Contribution also reach to 30%-10% — **1/3**



-For future, when CO_2 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).

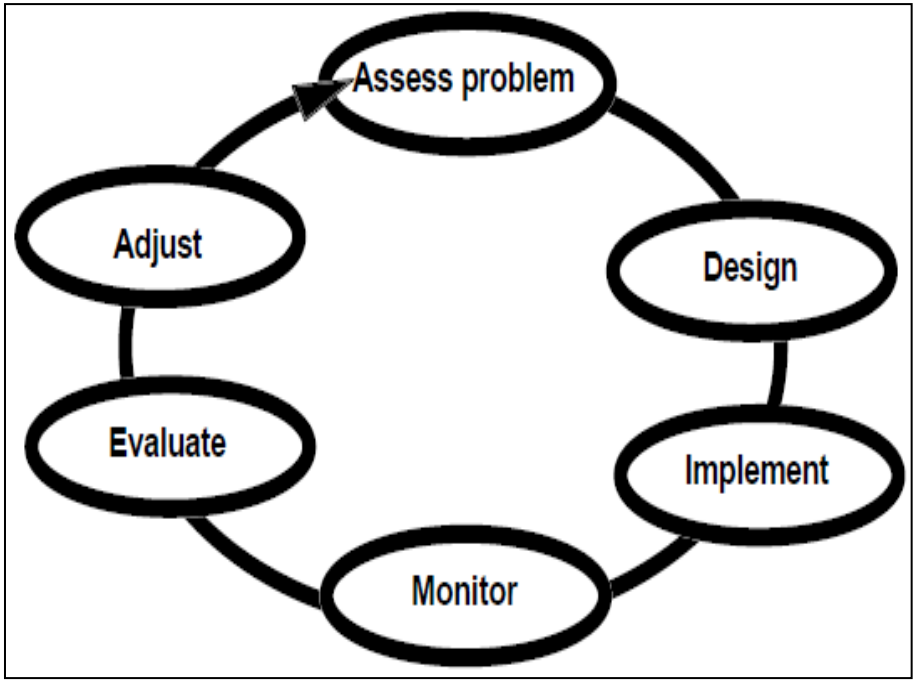


未来情景下我国东部季风区八大流域水资源脆弱性

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

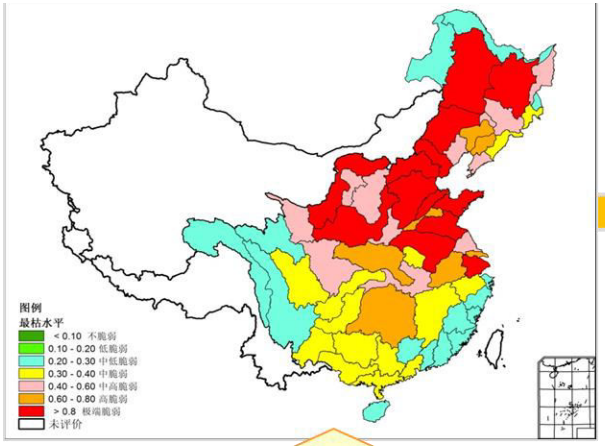
$V = E.R./S/C$

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

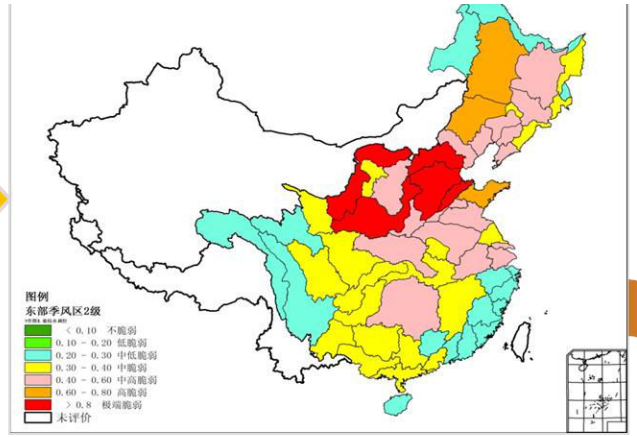
- **WD_{max}:** Maximum useable Water Res.
- **WD:** Total Water use
- **WE:** Eco-water use
- **WE_{min}:** Minimum eco-water demand
- **WUE:** Water use efficiency
- **RWF:** Ratio of water quality Target rate

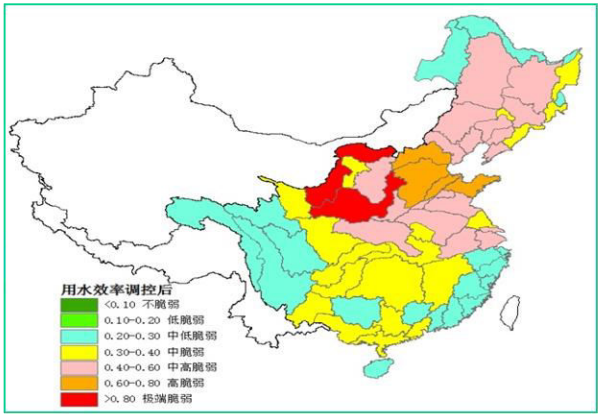
Vulnerability change of water resources when taking “Three Red Line Controls ” policy

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***

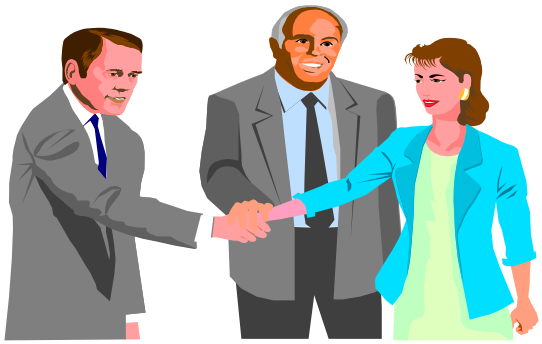
Conclusions

- 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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