清華大學
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Asian Water Cycle Initiative

Climate Change Assessment & Adaptation on Water Use and Agriculture

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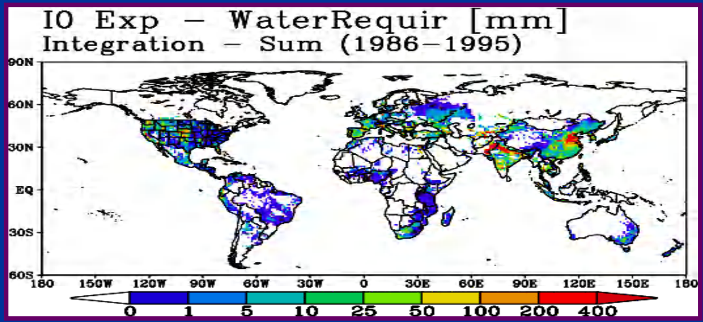
Outline

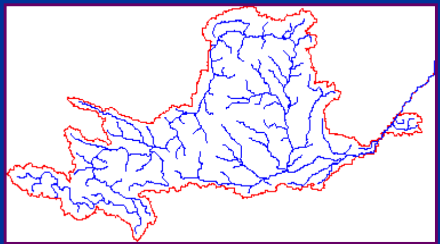
- Background
- Climate change & its impact on water use and agriculture
- Suggestion to the Implementation Plan
- Summary

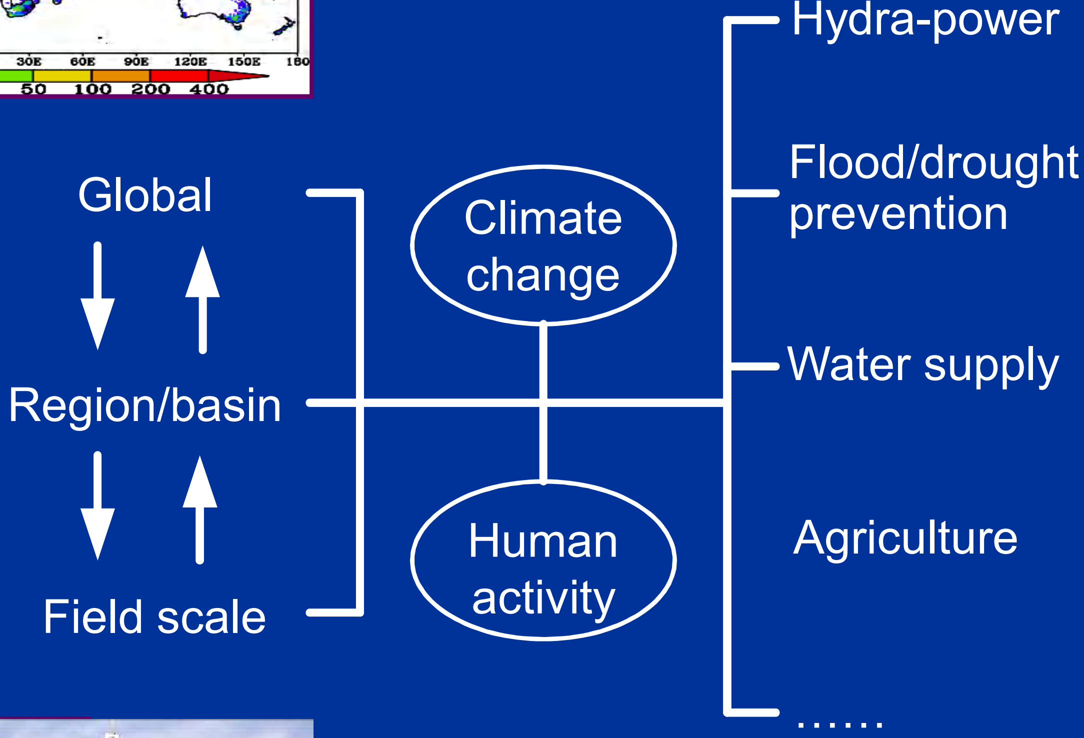
Background

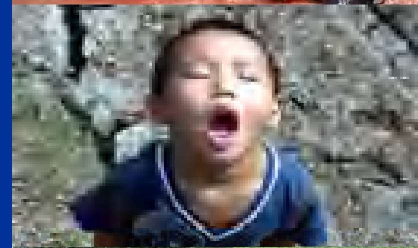
——Scientific issue and social need

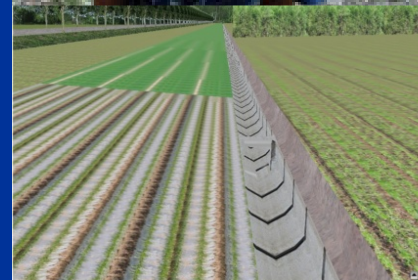
➢ Water resources issue under impacts of human activity and climate change is multi scale issue.

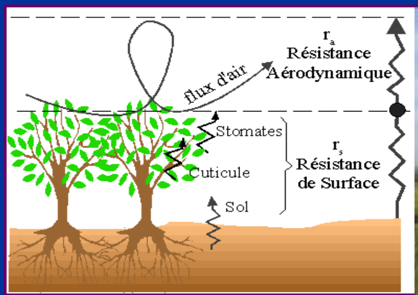






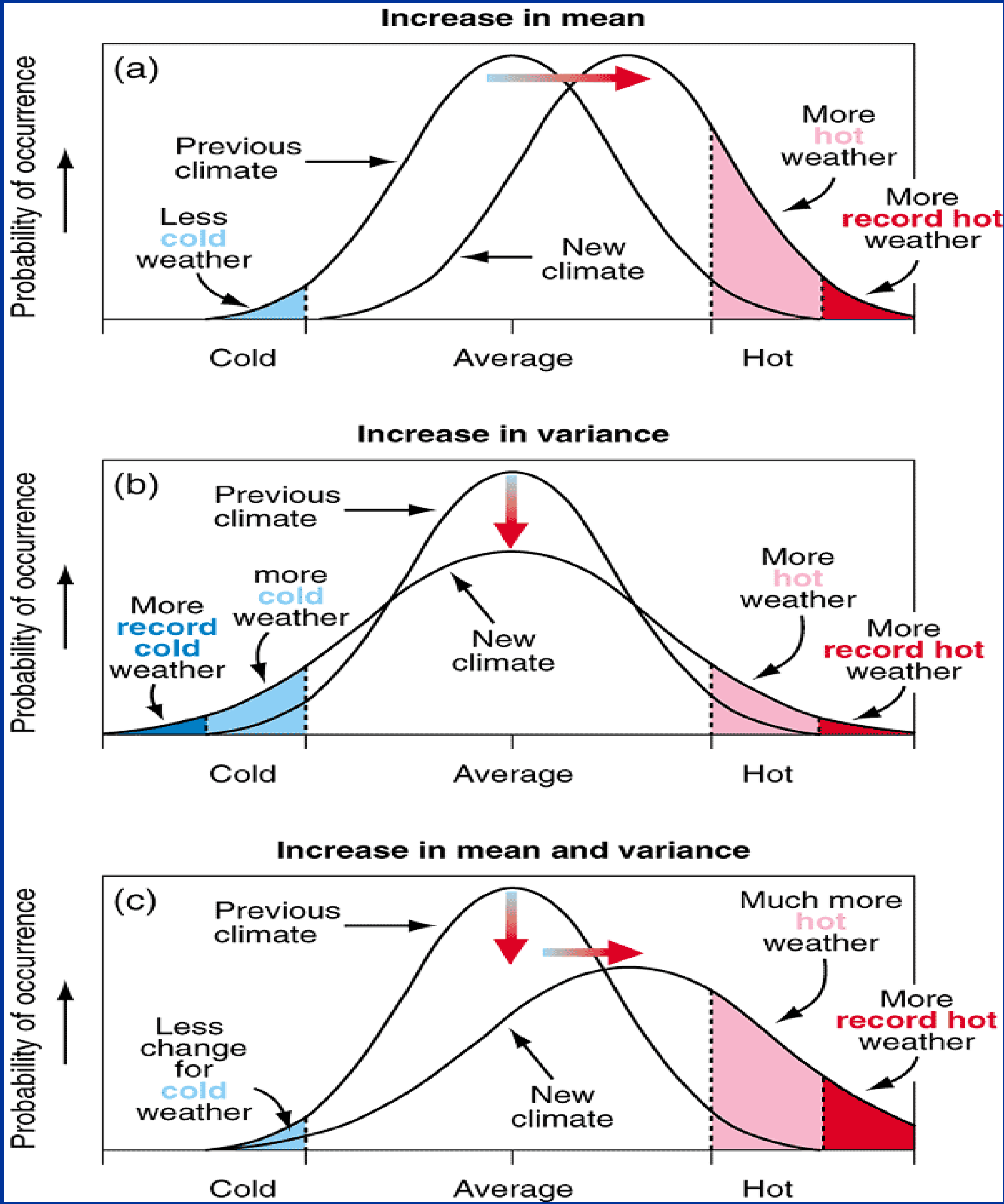






Hydrological stationarity is dead.

➢ Climate change includes trend and variability

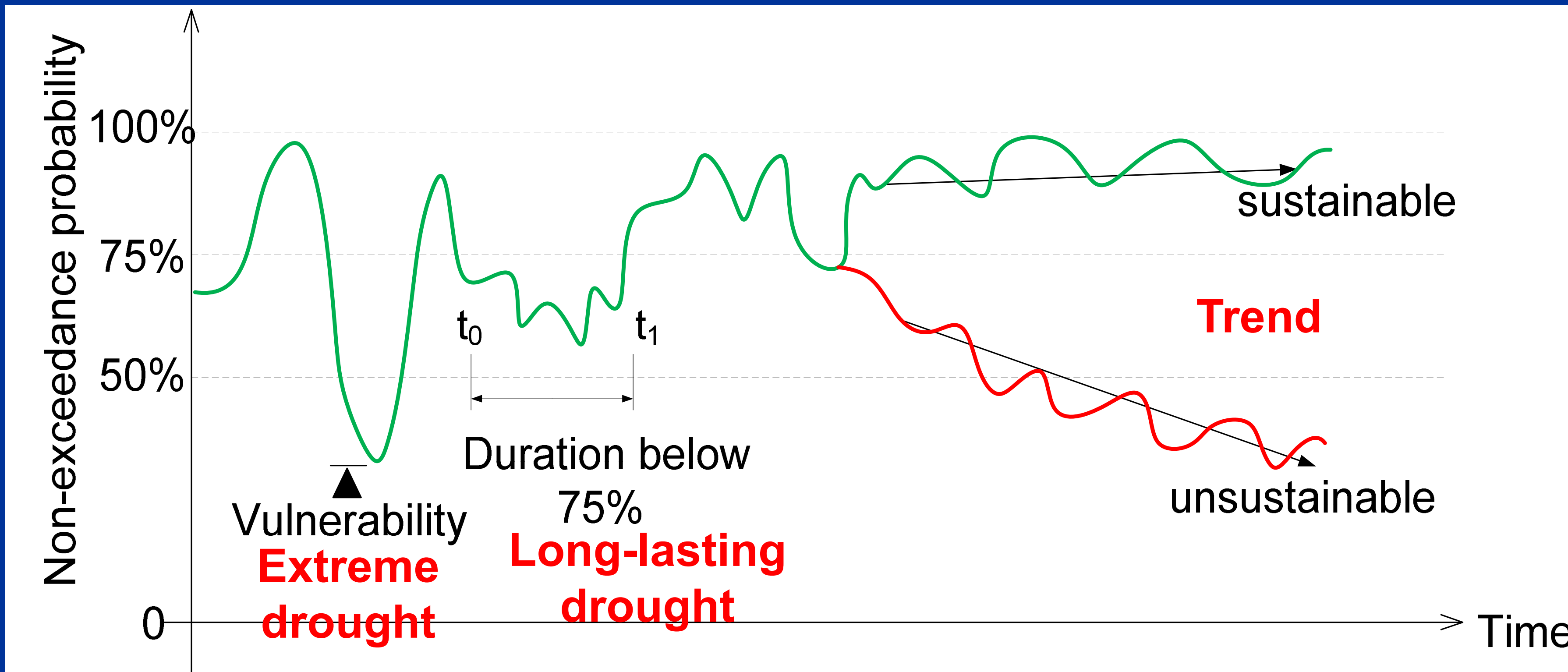


Adaptations to the trend and variability of climate change should be different.

(IPCC TAR, 2001)

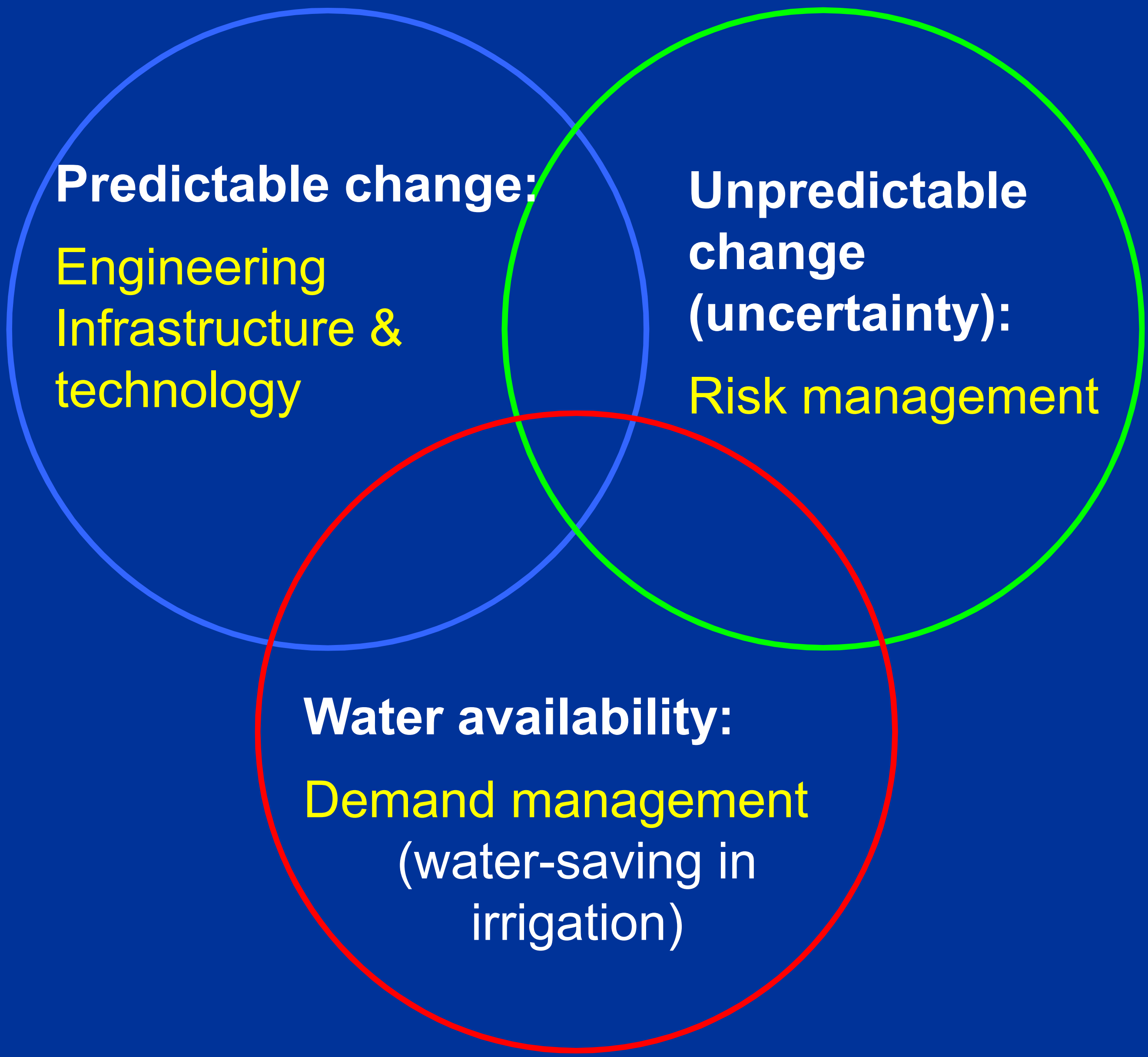
➢ Water security under climate change

- ❖ Characteristics of climate change：trend and variability
- ❖ Impact on water security: water shortage and disaster (flood and drought)



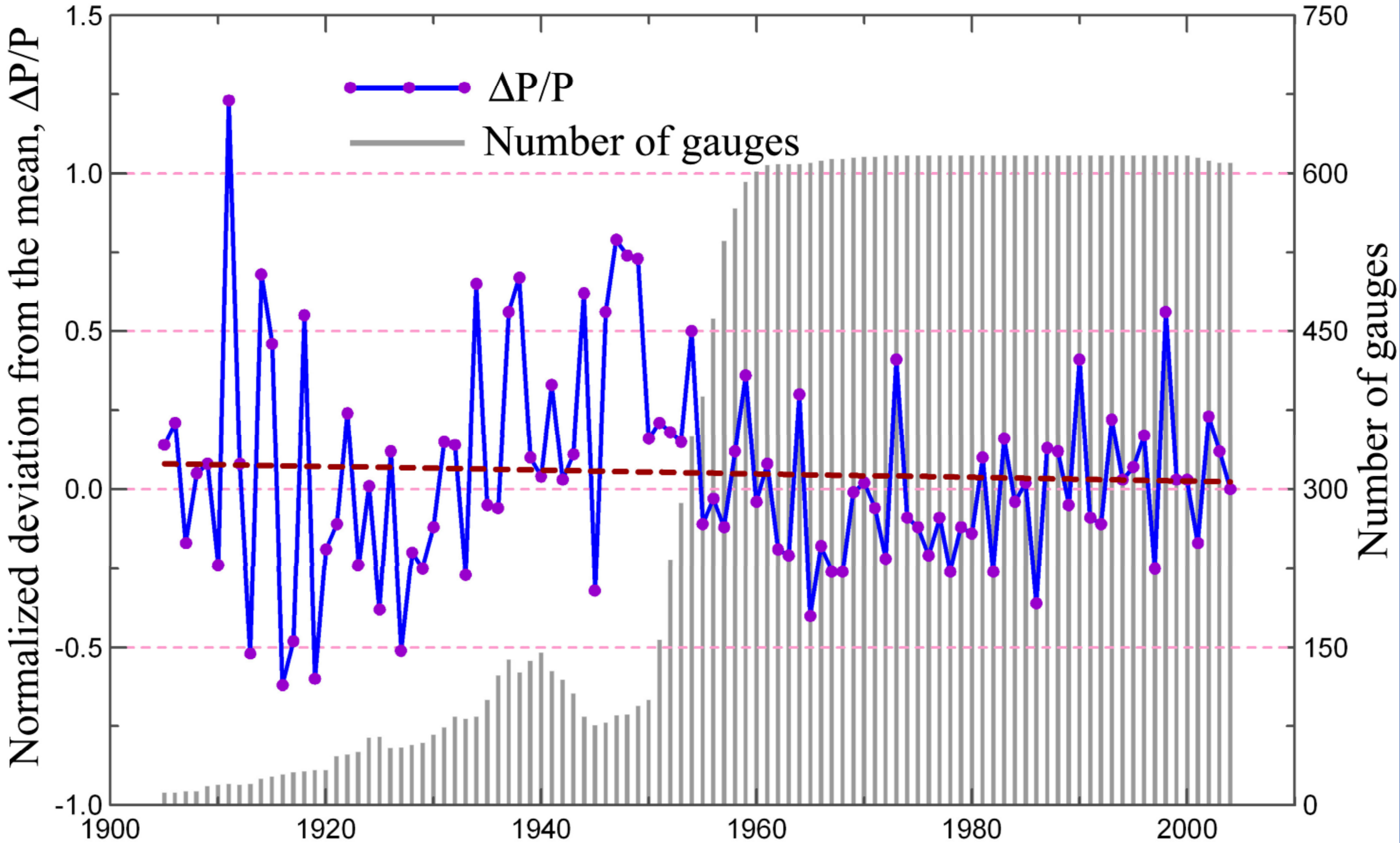
Water resources sustainability as an exceedance probability, P (supply ≥ demand)

➢ A conceptual framework for sustainability of water use under the climate change



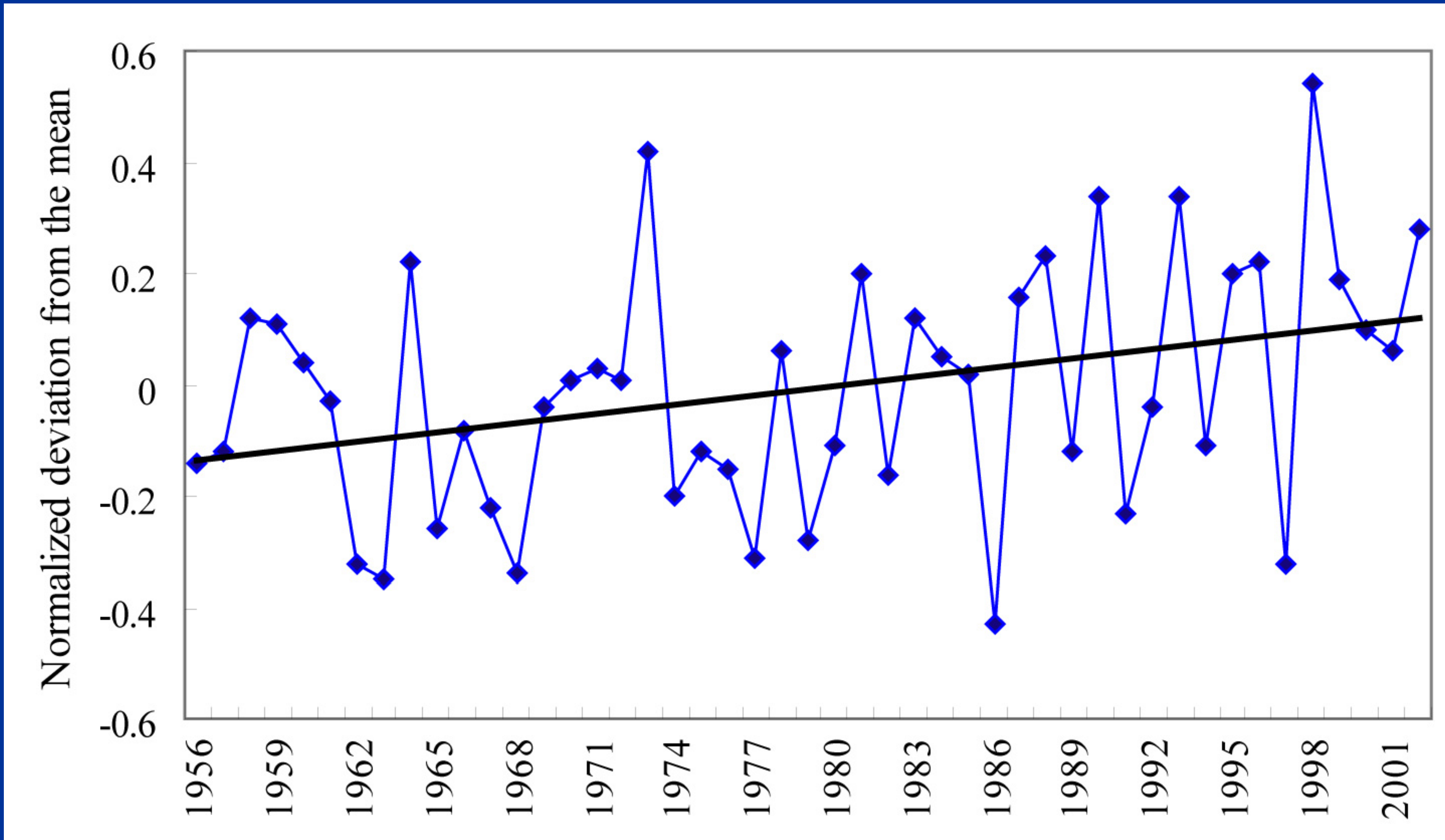
Climate change & its impact on water use and agriculture

➢ Variability of the annual precipitation in China over the past 100 years（1905-2004）

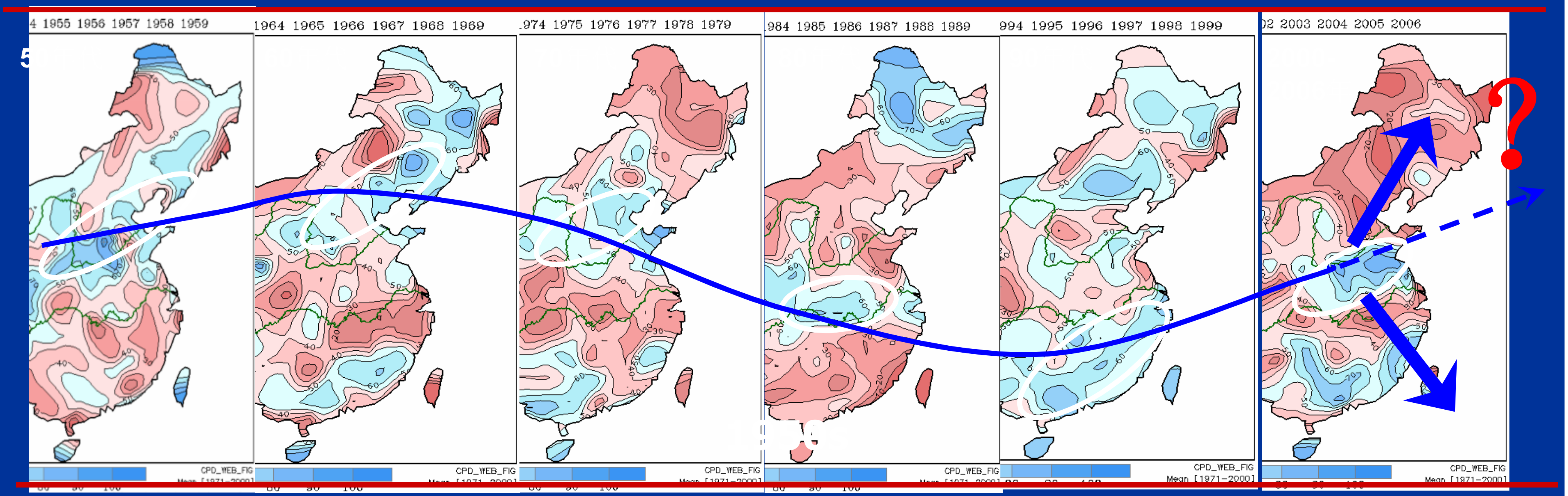


(National Climate Center of China)

➢ Variability of the annual precipitation in China over the past 50 years（1905-2004）

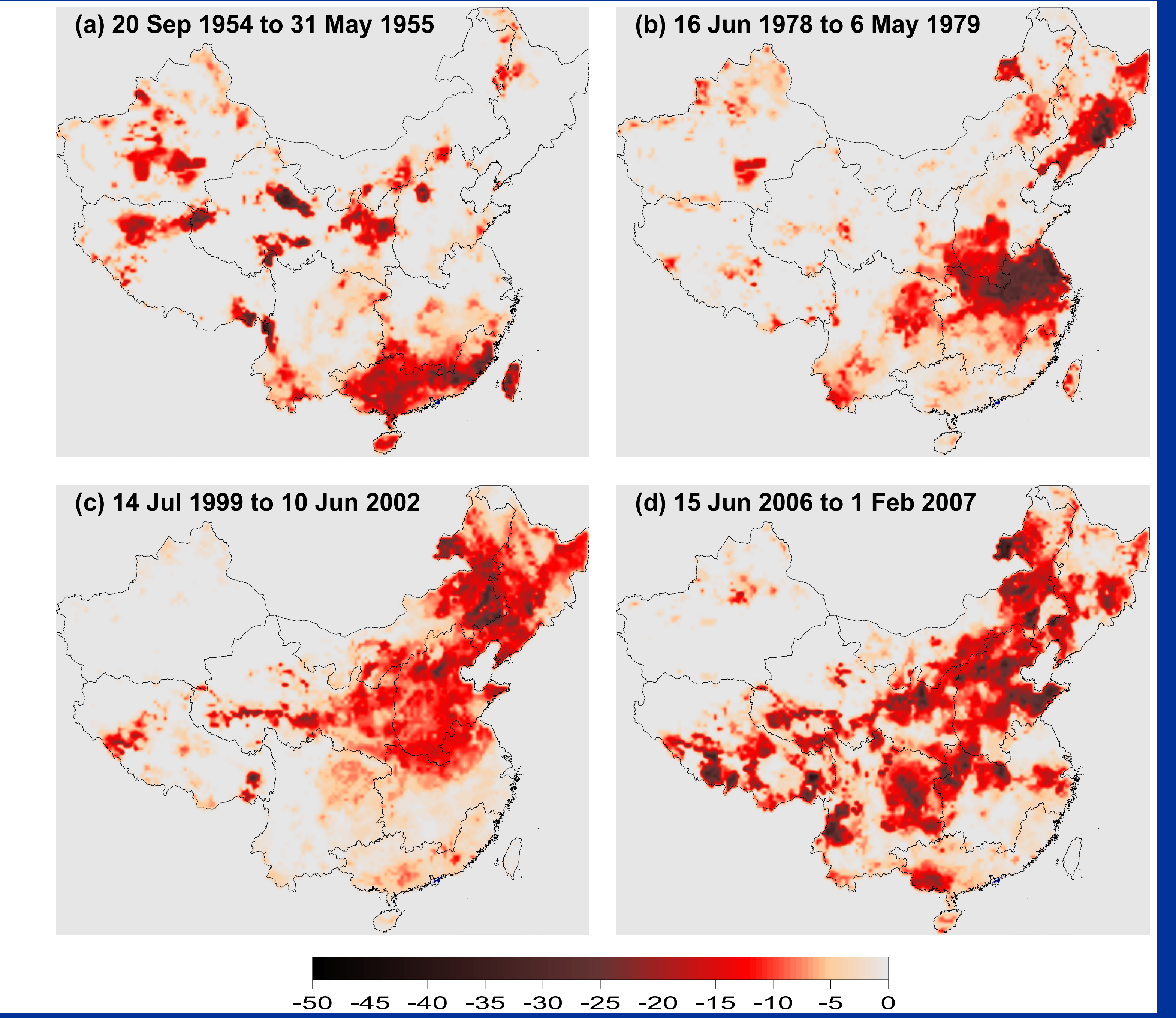


➢ Shift of summer rain belt over eastern China from 1950s to 2000s

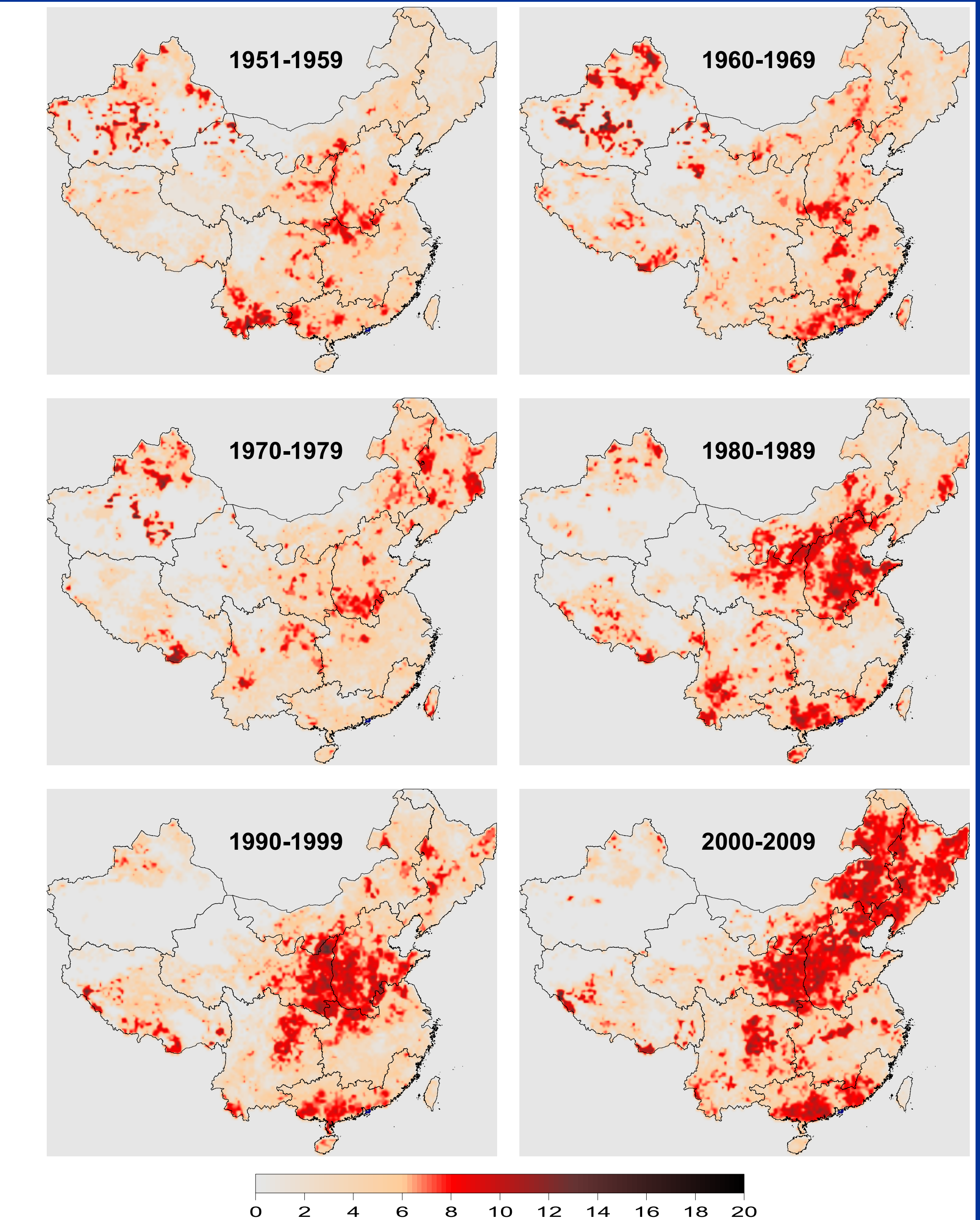


(National Climate Center of China, 2007)

➢ Drought-affected areas for the top most 4 severe drought events during the period of 1951-2009



➢ Frequency of drought occurred in China during the recent 6-decades



- **Impact of climate change: A preliminary, first-order assessment by Cai, et. al., 2008**

The assessment is based on an ensemble prediction of 17 GCMs with the consideration of intra-season variability

Change of monthly average temperature (K) between 2050 and 2000

Basins		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Huai River	Upper	1.95	1.88	1.91	1.68	1.65	1.69	1.73	1.82	2.00	1.89	1.76	1.79
	Lower	1.94	1.91	1.88	1.68	1.68	1.71	1.66	1.77	1.94	1.81	1.70	1.85
Hai River		2.28	2.14	1.96	1.86	1.84	1.85	1.79	1.88	2.04	1.90	1.87	2.16
Yellow River	Upper	2.41	2.28	2.09	2.04	1.93	1.92	1.89	1.96	2.03	1.99	2.11	2.34
	Middle	2.30	2.15	1.96	1.90	1.97	1.95	1.97	2.07	2.07	1.95	1.89	2.10
	Lower	2.12	1.98	1.94	1.76	1.77	1.77	1.82	1.89	2.01	1.89	1.82	1.95
Yangtze River	Upper	2.01	1.93	1.86	1.78	1.61	1.51	1.48	1.47	1.57	1.57	1.64	1.92
	Middle	1.91	1.97	1.89	1.79	1.72	1.72	1.80	1.83	1.90	1.78	1.72	1.80
	Lower	1.85	1.84	1.71	1.64	1.59	1.66	1.73	1.78	1.93	1.75	1.64	1.81
Songhua River		2.64	2.48	2.24	1.89	1.84	1.90	1.87	2.00	2.11	2.02	2.40	2.61
Yili River		2.46	2.39	2.19	2.02	2.02	2.19	2.50	2.52	2.41	2.24	2.18	2.42
Zhujiang River	Upper	-1.69	-1.76	-1.70	-1.69	-1.55	-0.56	0.94	1.15	0.66	-0.44	-1.23	-1.53
	Lower	0.76	0.24	0.08	0.18	0.75	1.62	2.53	2.75	2.59	2.15	1.70	1.48
Langcang River		2.19	2.12	1.92	1.79	1.69	1.51	1.53	1.43	1.45	1.58	1.82	1.99

Change of daily precipitation (mm) between 2050 and 2000

Basins		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Huai River	Upper	0.08	0.34	0.18	0.63	0.39	0.18	0.33	0.36	0.01	-0.34	-0.01	0.18
	Lower	0.10	0.32	0.20	0.46	0.20	0.10	0.49	0.31	0.16	-0.11	0.01	0.19
Hai River		0.07	0.12	0.20	0.12	0.30	0.13	-0.01	-0.05	0.13	0.15	-0.01	0.12
Yellow River	Upper	0.08	0.11	0.11	0.25	0.30	0.21	0.36	0.08	0.25	0.11	0.03	0.08
	Middle	0.04	0.07	0.09	0.22	0.12	0.21	0.15	0.15	0.15	0.15	0.02	0.06
	Lower	0.03	0.19	0.23	0.32	0.23	0.15	0.07	0.11	0.04	0.13	-0.02	0.11
Yangtze River	Upper	0.02	0.09	0.20	0.25	0.39	0.21	0.46	0.55	0.30	0.10	-0.01	0.00
	Middle	0.01	0.09	0.11	0.24	0.31	0.18	0.03	-0.01	-0.04	-0.11	-0.01	0.08
	Lower	0.06	0.15	0.05	0.24	0.35	0.24	-0.02	0.02	0.03	-0.14	-0.02	0.12
Songhua River		0.07	0.07	0.06	0.08	0.21	0.22	0.25	0.12	0.09	0.09	0.10	0.06
Yili River		0.06	0.07	0.08	0.09	0.07	0.06	0.01	0.01	0.01	0.05	0.05	0.06
Zhujiang River	Upper	0.16	0.40	0.39	0.51	0.96	-0.08	-2.31	-2.17	-1.13	-0.23	0.20	0.19
	Lower	0.51	0.29	0.01	0.01	-0.14	-0.61	-1.17	-0.50	-0.76	-0.30	0.27	0.79
Langcang River		0.01	-0.02	0.01	0.06	0.21	0.28	0.22	0.24	0.20	0.16	0.05	-0.02

Change of rainfed crop yield between 2050 and current, in percentage

Basins		Rice	Wheat	Maize	Other Grains	Potato	Sweet Potato	Soybean
Huai River	Upper	-0.2	15.0	10.7	3.5	5.0	5.0	3.6
	Lower	1.5	15.2	7.2	2.6	3.5	3.5	2.7
Hai River		4.9	27.3	2.8	2.7	2.2	2.2	1.9
Yellow River	Upper	9.9	20.2	10.3	6.9	5.3	5.3	4.2
	Middle	14.3	17.7	11.1	6.6	5.3	5.3	3.9
	Lower	2.9	22.8	5.2	3.4	1.2	1.2	0.8
Yangtze River	Upper	5.0	26.9	10.2	5.0	5.9	5.9	4.9
	Middle	-1.7	1.2	1.3	-0.7	0.0	0.0	-0.3
	Lower	-2.2	-0.2	0.6	-0.5	-0.2	-0.2	-0.3
Songhua River		6.1	4.1	4.3	3.2	3.8	3.8	1.8
Yili River		0.0	14.3	18.9	9.4	13.4	13.4	6.4
ZhuJiang River	Upper	-14.7	22.3	7.7	-13.0	-10.1	-10.1	2.5
	Lower	-10.2	5.2	-5.6	-10.6	-10.3	-10.3	-5.6
Langcang River		-1.0	-16.5	-0.2	0.2	0.1	0.1	-0.4

Change of net seasonal irrigation water requirement, in percentage, between 2050 and current

Basins		Rice	Wheat	Maize	Other Grains	Potato	Sweet Potato	Soybean
Huai River	Upper	4.6	-8.1	-4.1	-2.9	-4.5	-4.5	-4.1
	Lower	1.9	-6.4	-0.8	-1.4	-2.0	-2.0	-1.8
Hai River		2.7	0.2	1.3	1.5	2.0	2.0	1.6
Yellow River	Upper	2.2	2.2	-0.9	0.1	0.6	0.6	0.0
	Middle	3.1	3.6	1.8	2.0	2.4	2.4	2.2
	Lower	3.5	-1.0	1.2	1.5	3.3	3.3	3.5
Yangtze River	Upper	-10.2	5.4	-3.0	-7.3	-6.5	-6.5	-7.6
	Middle	14.7	5.8	0.4	7.2	4.3	4.3	6.1
	Lower	13.4	8.2	-0.4	6.5	5.4	5.4	6.4
Songhua River		1.8	0.3	-0.9	0.5	-0.5	-0.5	0.7
Yili River		5.8	5.3	5.4	5.7	5.4	5.4	5.8
ZhuJiang River	Upper	89.8	-25.4	-30.5	123.7	103.5	103.5	-16.9
	Lower	82.5	-20.7	188.1	118.2	148.4	148.4	270.6
Langcang River		10.3	22.9	8.5	8.0	8.2	8.2	8.7

➢ Drought and flood occurred in China (which might be related to the climate change)

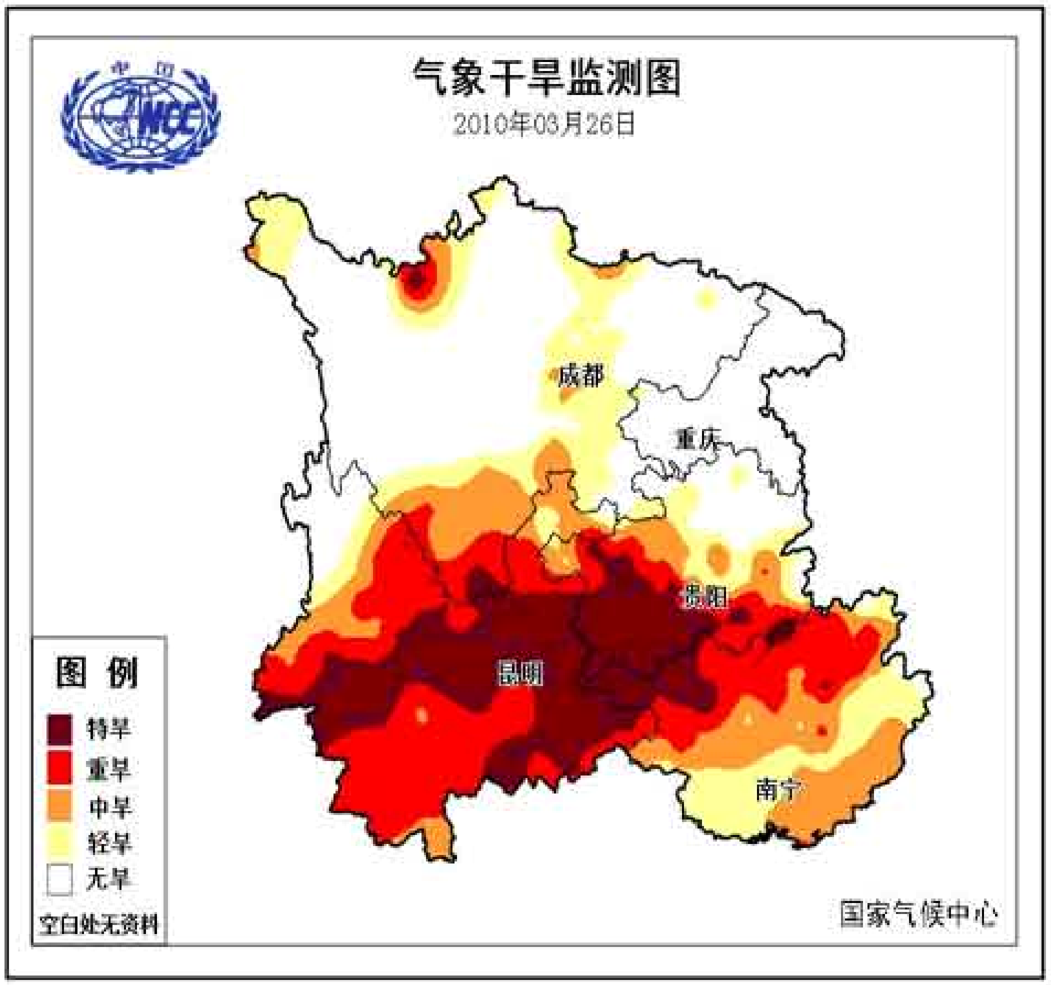


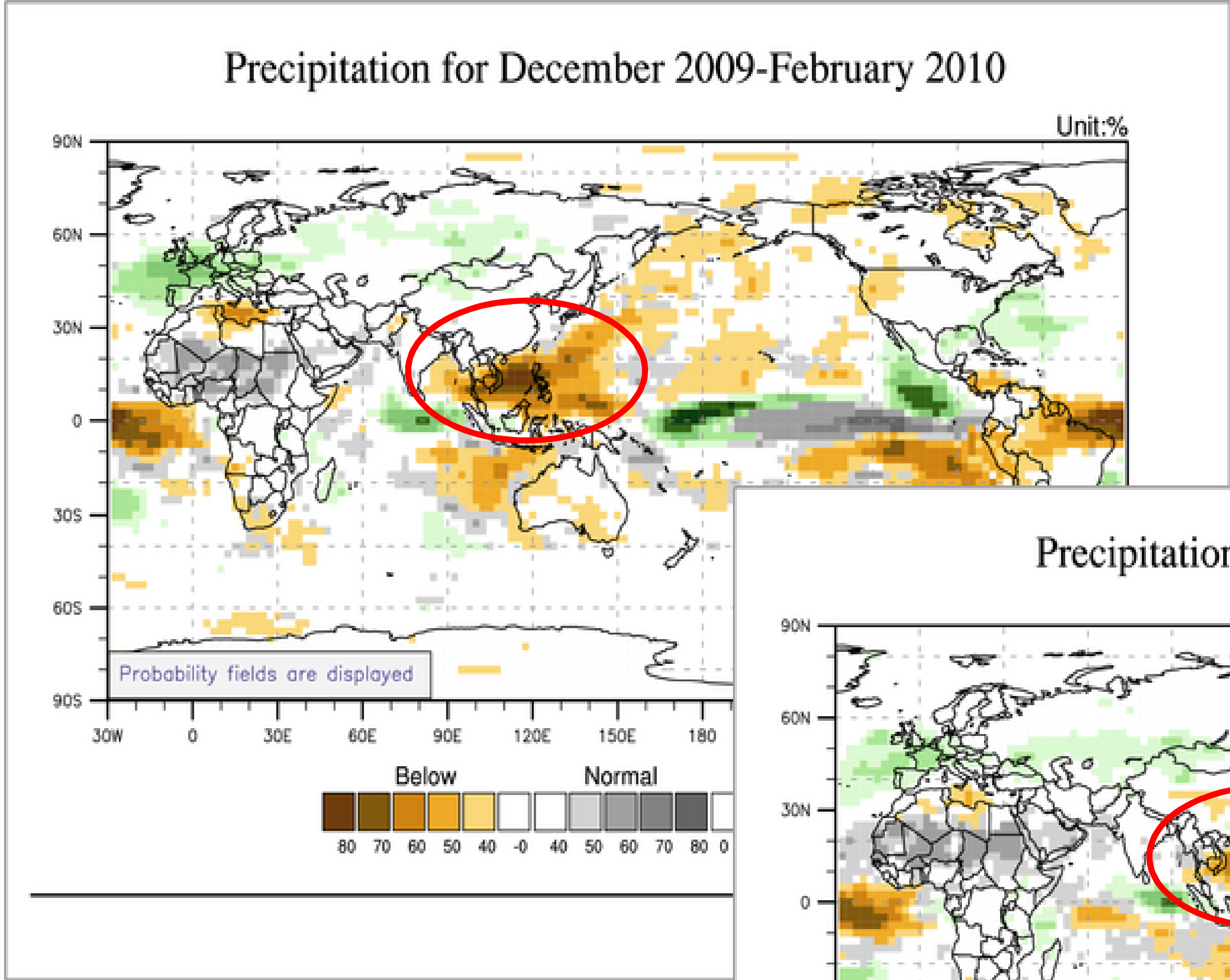

Photo in March near Kunming

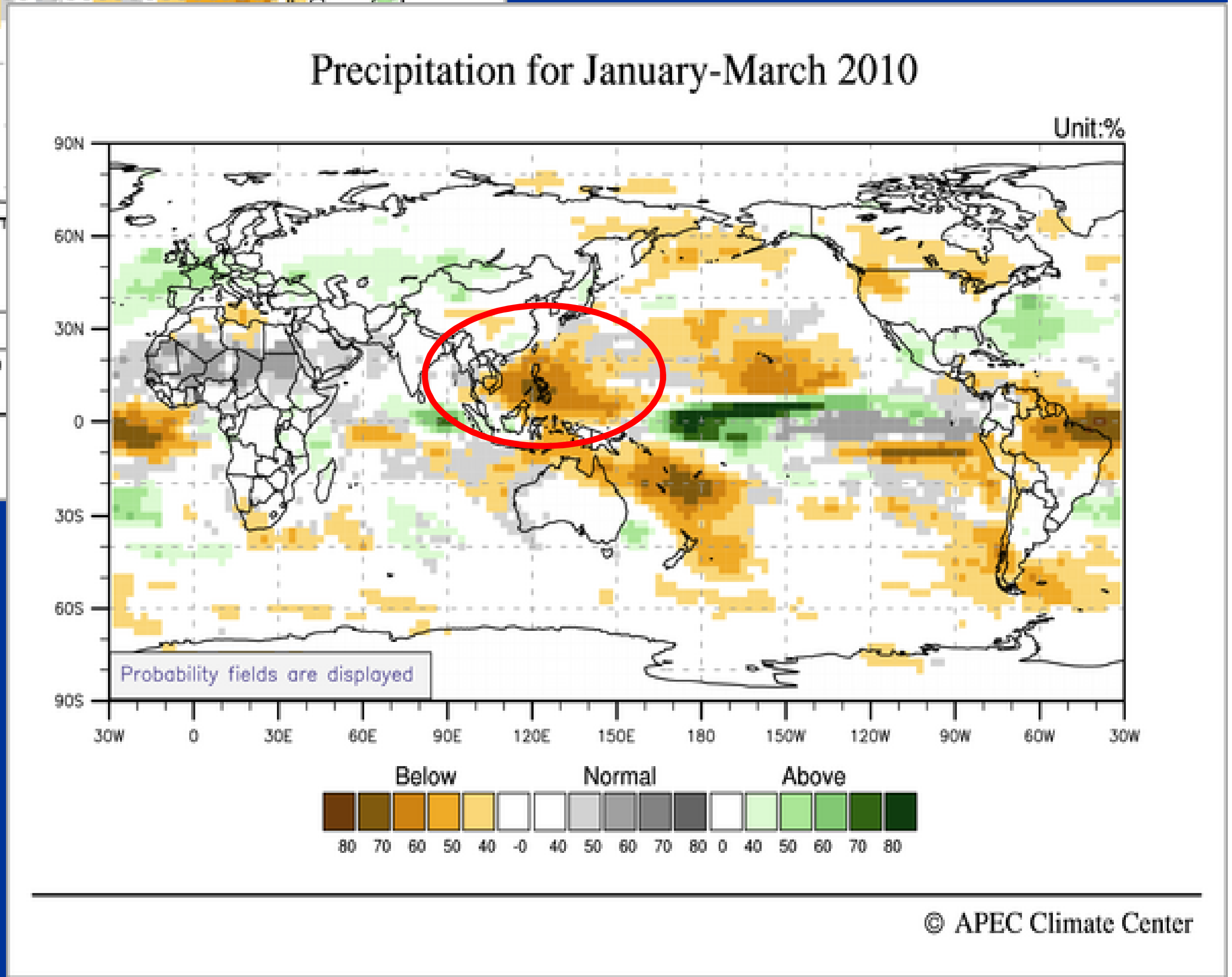


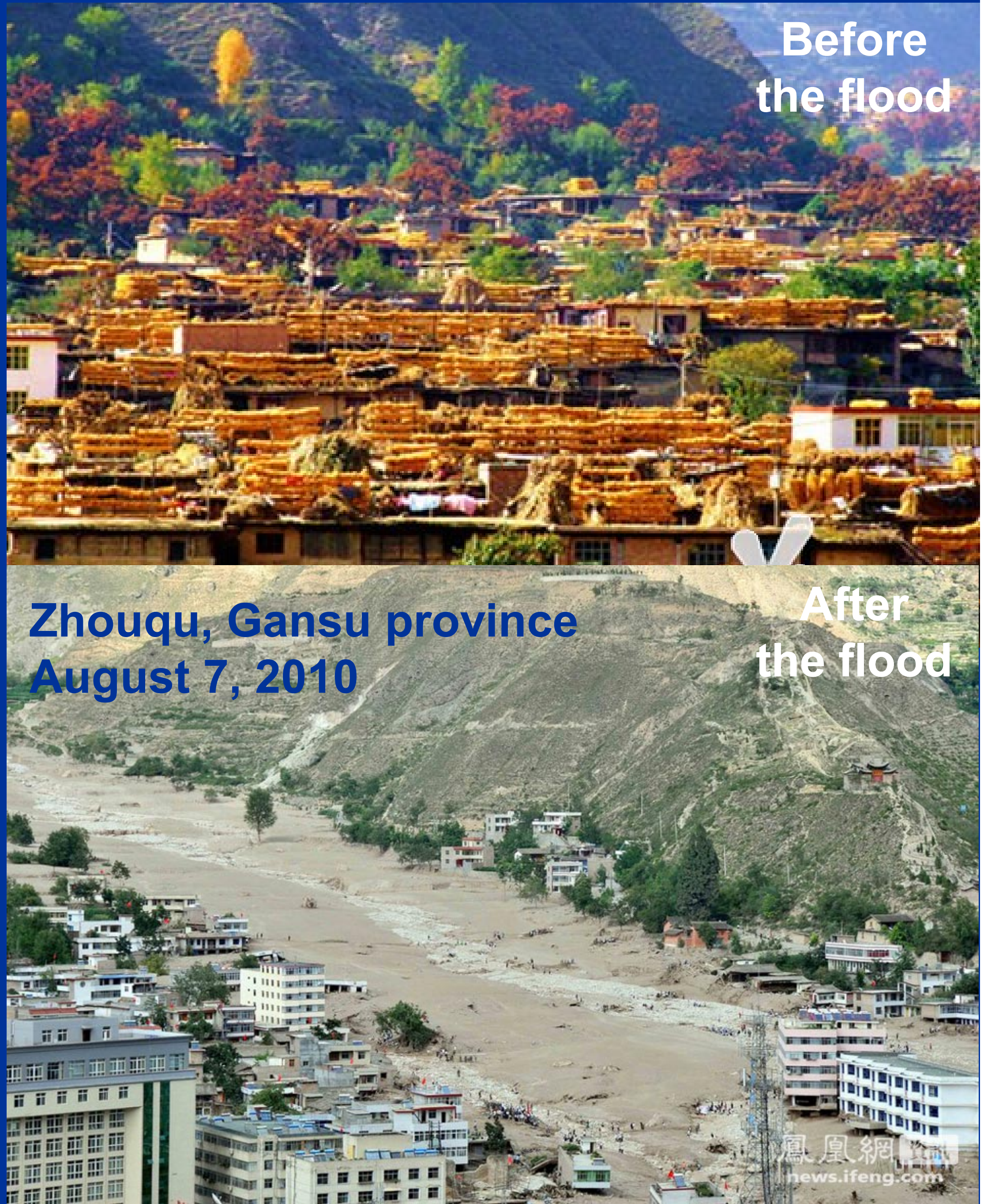
Photo in March in Guangxi

This drought started from December of 2009 and ended in the June. This might be related abnormity of the India Ocean Monsoon.

Has anyone predicted this drought?







Flood occurred in the lower Yangtze River, about 100,000 persons were suffered.

Flood occurred in Northwest China, about 1,300 persons were killed.

Suggestion to the Implementation Plan

Emphases on several important aspects for Climate Change Assessment and Adaptation

➢ Development of assessment model/tool for water management policy-making

Most of the present assessments are based on the GCM prediction and downscaling.

The major task of hydrological model/tool is:

- ❖ to predict the changes of water resources including mean and extreme, trend and variability
- ❖ to quantify uncertainty and risk

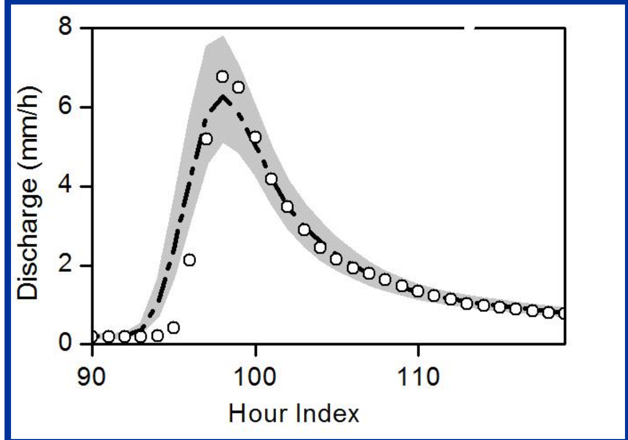
➢ Long-term forecast of flood and drought for natural disaster prevention

Current forecasts of flood and drought have very limited leading-time for disaster prevention. An urgent need of hydrology is the long-term forecast of flood and drought (e.g. monthly or seasonal forecast).

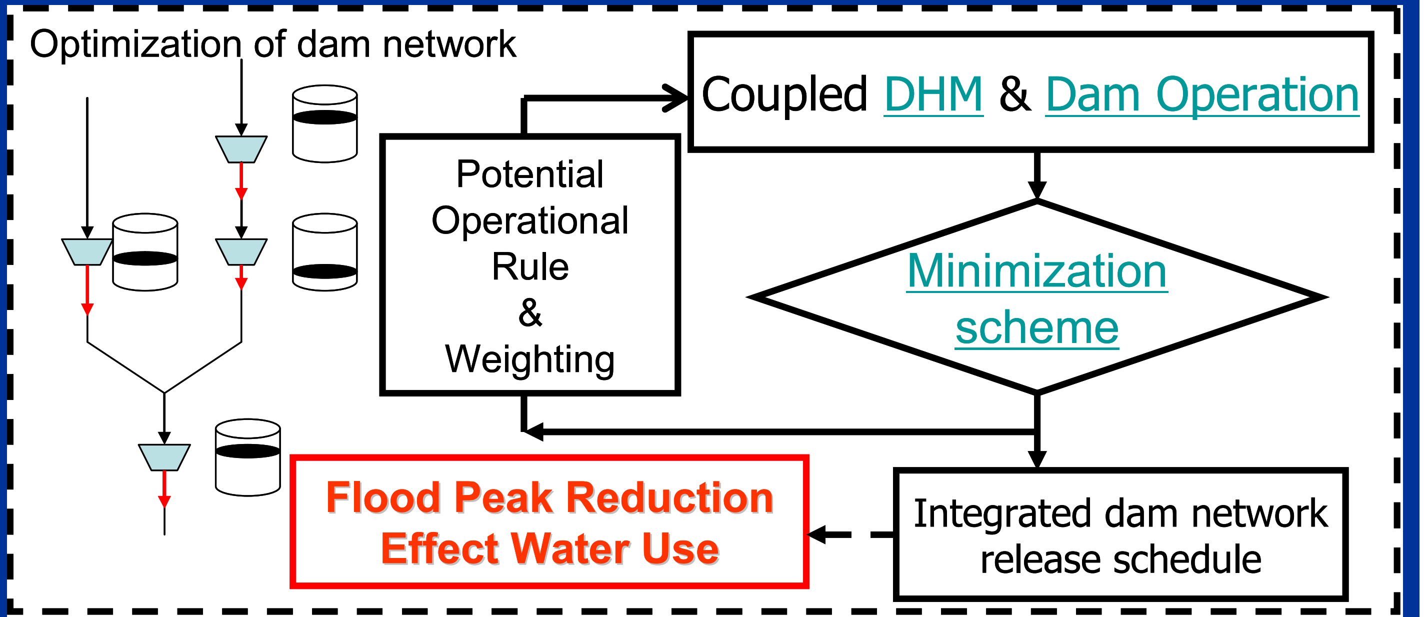
There are two basic issues facing by the scientific community:

- ❖ Prediction of the GCM/RCM is reliable?
- ❖ What is the new method/model?

➢ Infrastructure (e.g. reservoir) operation considering prediction uncertainty



Predicted inflow with uncertainty



Existing optimization model should also be changed for considering the input uncertainty.

➢ Prediction of the agricultural water use

Climate change	•temperature •precipitation •CO_2 •sunshine

Evapotranspiration (water use) is related closely to photosynthesis, which is not be predicted simply from the potential evaporation.

Simulation of Water-CO_2- Nitrogen-Cycle is required.


Rice


wheat


maize

Summary

- There is a big gap between society need and scientific capacity.

  precise prediction ←→ large uncertainty

- Filling/narrowing this gap is the major task for scientist and engineer.

  → **New model/tool should be developed.**

Thank You for your attention!