

Previous Impact Models in China

CISNAR Team, CAS, China
March, 2000

Climate Change Impact Studies

- Ƨ Climate Change Impact on Agricultural Production in China
- Ƨ Climate Change Impact on Surface Runoff
- Ƨ Climate Change Impact on Water Demands in China
- Ƨ Sensitivity of Different Ep Methods to Temperature
- Ƨ Impact on Distribution of Climate Zones in China

Other Researches

by Dr. Liu Yunfen

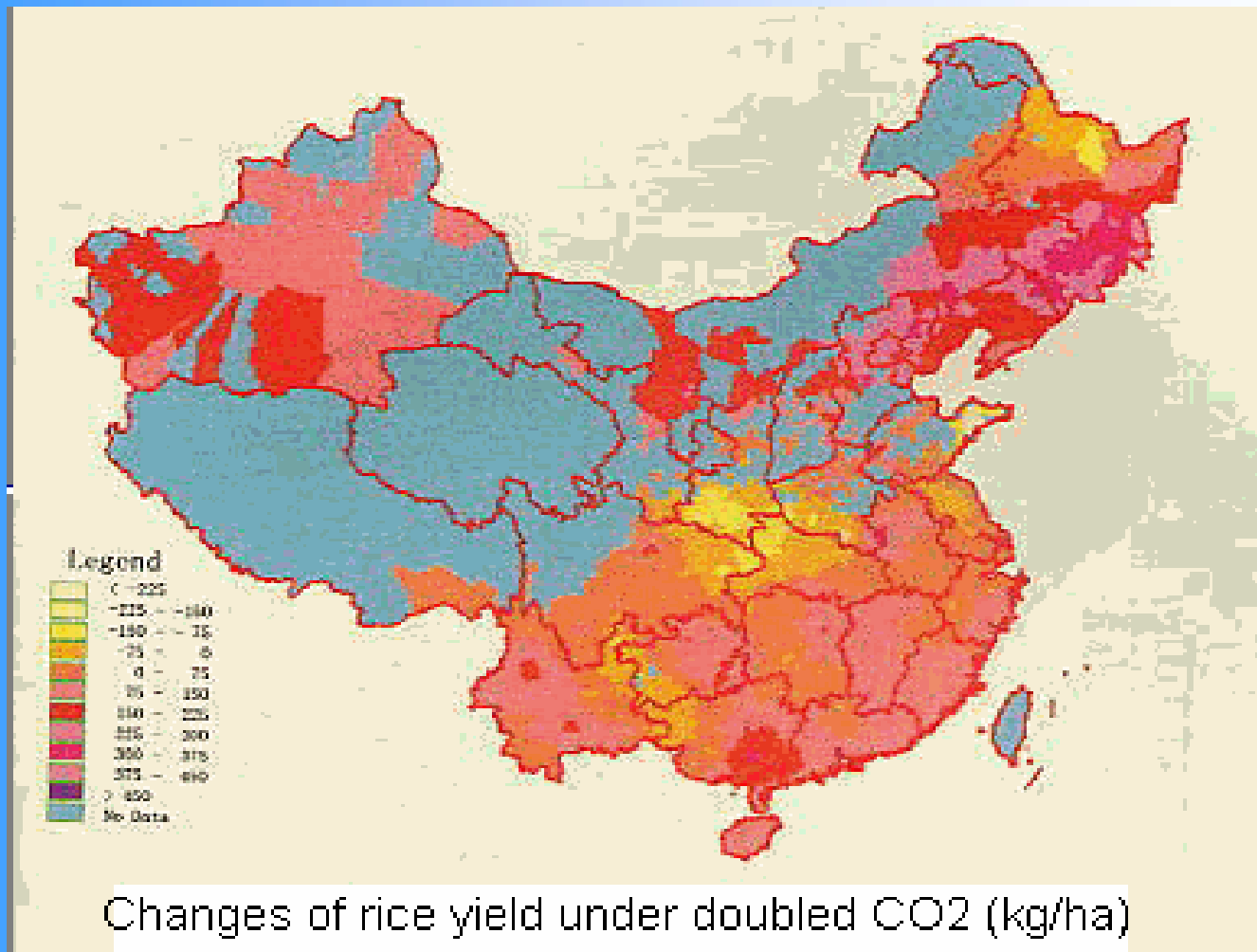
- IJ Climate Change Impact on Fishery Production at Coastal Area in China
- IJ Study on CO₂ Emission flux from Ecosystem in the Eastern Part of Qingzang Plateau
- IJ Stud on CO₂ Emission from Farmland Soil in Tibetan Plateau
- IJ Study on Carbon Cycle in the Agroecosystem of China

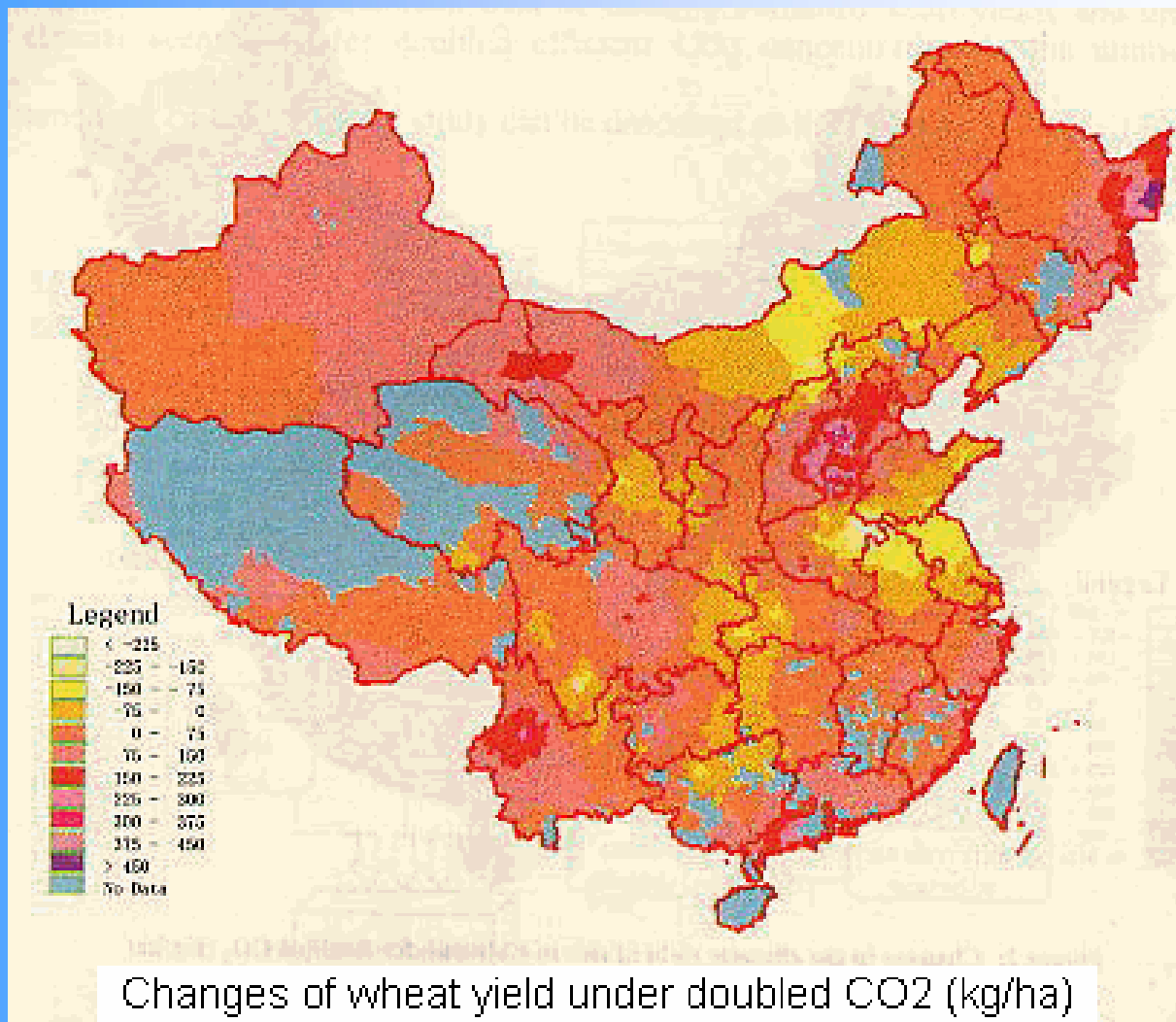
Climate Change Impact on Agricultural Production in China

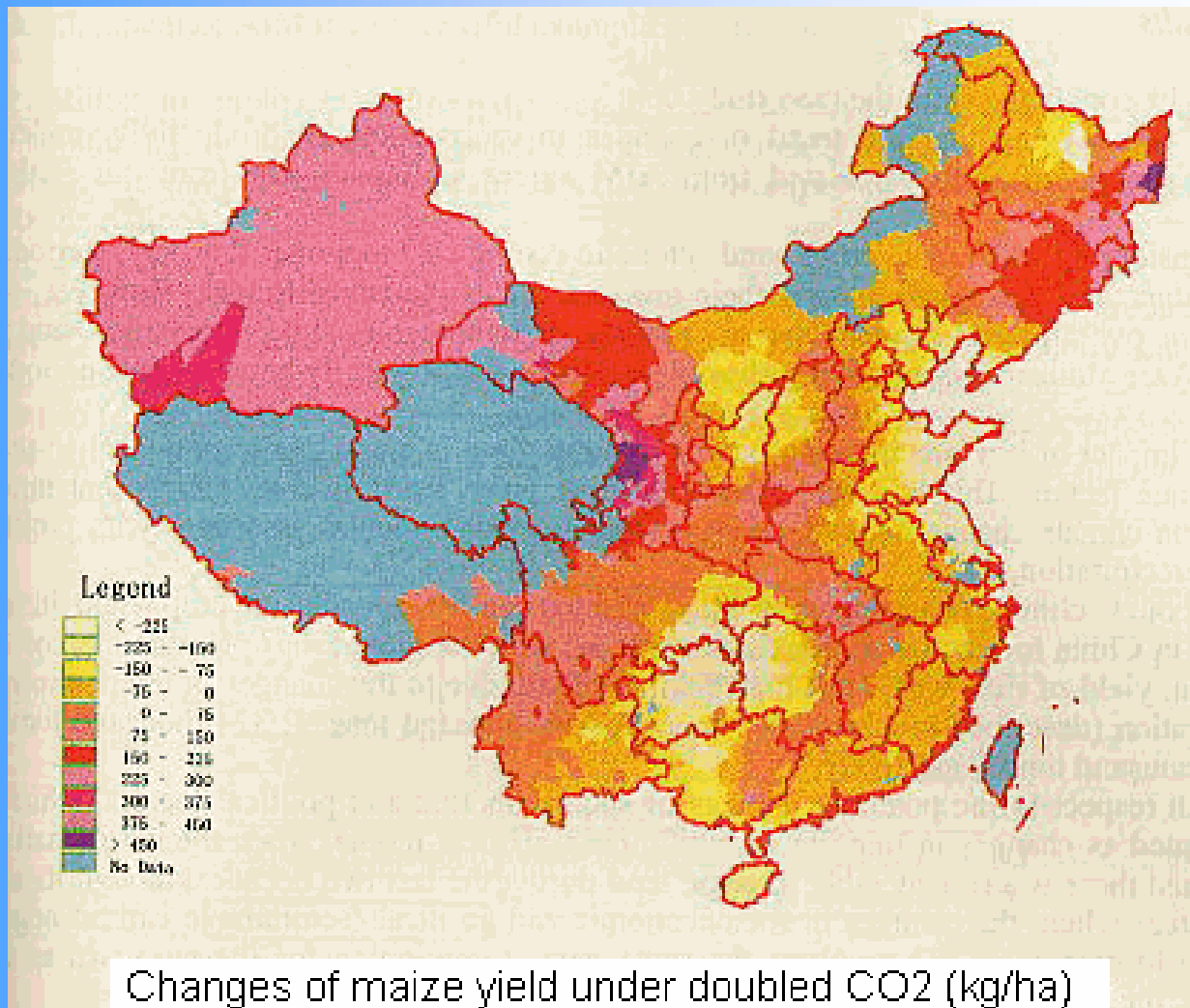
Rice

Wheat

Maize







Conclusion

Negative and positive impacts were found in different areas to three staple crops. Totally, the output will increase by about 4.827 Mtons, assuming that the planting area keep as that in 1993.

Climate Change Impact on Surface Runoff

River Discharge Change (future/present in percentage)

	Annual	Spring	Summer	Autumn	Winter
Songhuajiang River	128	168	64	197	-
Yellow River	40	68	38	38	32
Yangtze River	38	43	34	34	43
Yaluzangbu River	40	60	35	34	45

DISCUSSION

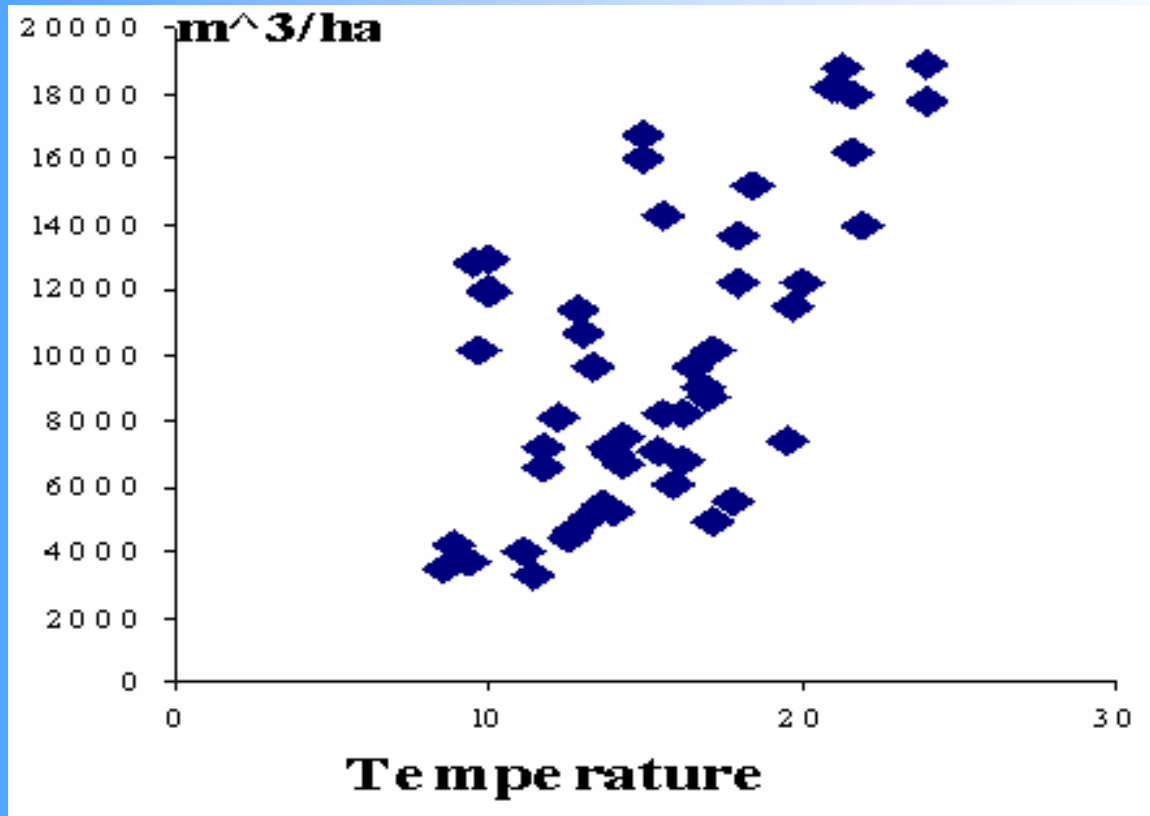
- Water withdrawal in the upper reaches of the water basins is not taken into account
- Only one climate change scenario was used in the study

Climate Change Impact on Water Demands in China

- Irrigation Water Demand Projection
- Residential Water Demand Projection

Crop water requirements and Climate

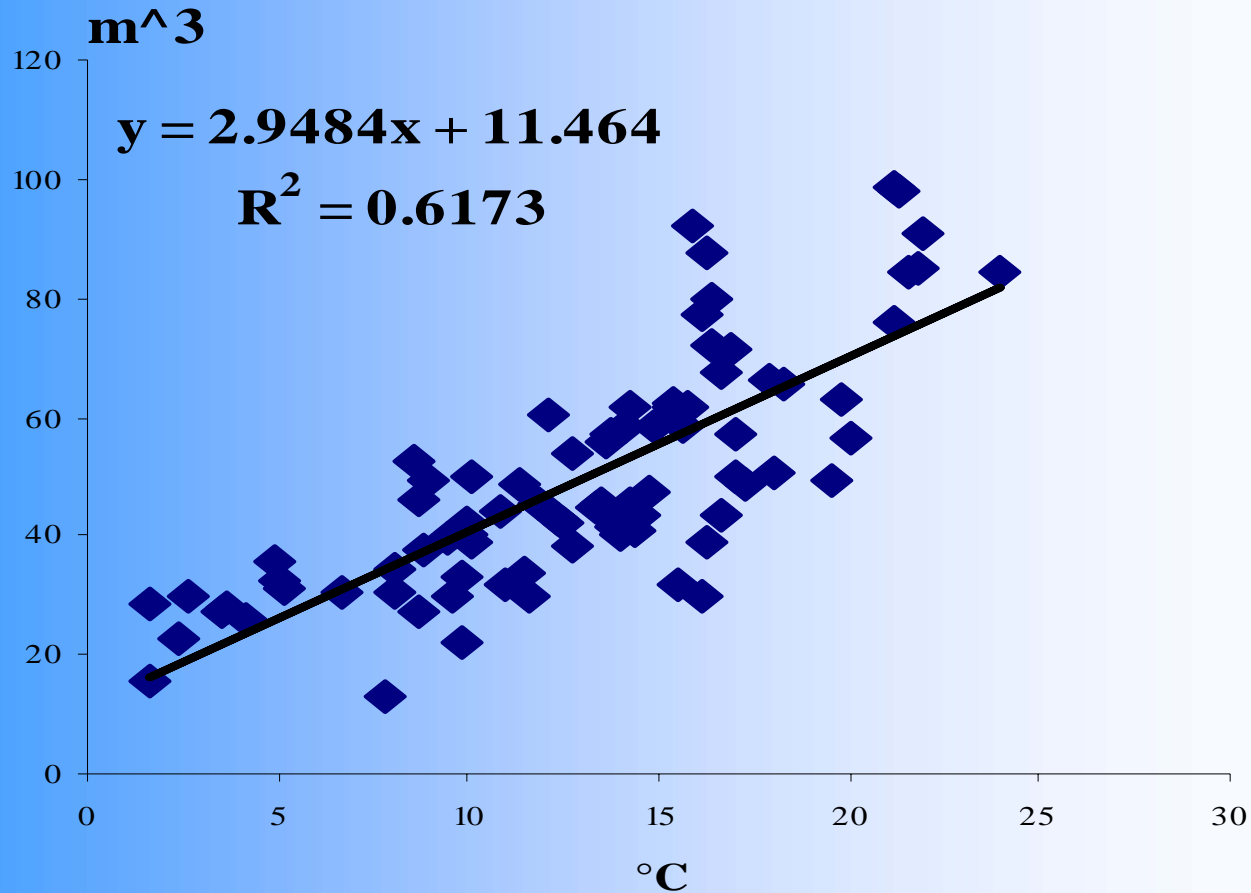
Irrigation index and annual average temperature



Urban Residential Water Demand and

Climate

Residential water use and annual average temperature



Irrigation Water Demand

$$IWD = A.B$$

Where:

IWD is annual irrigation water demand;

A is effective irrigated;

B is irrigation index.

B can be calculated as following:

$$B = (PET - P)/f$$

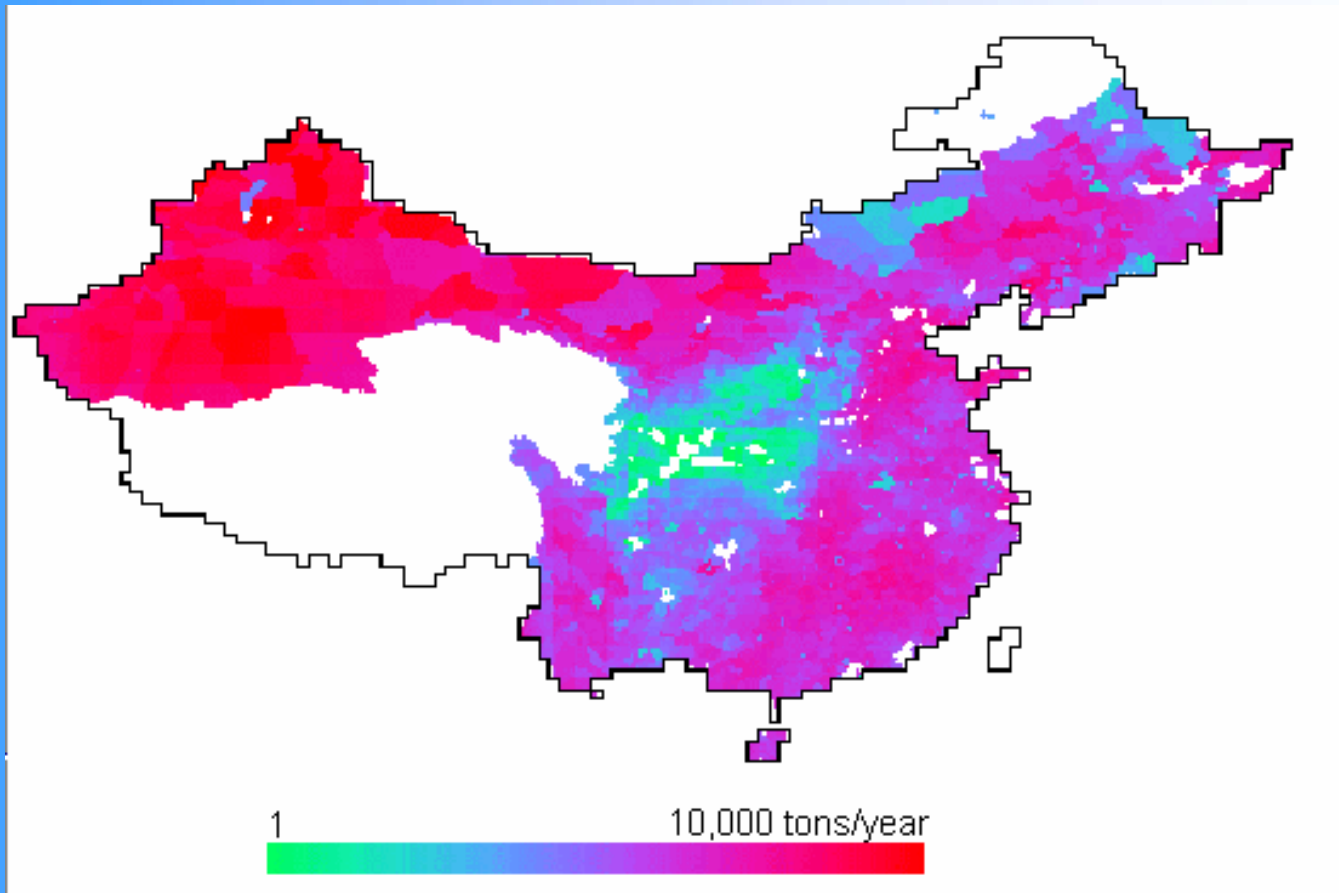
Where:

PET is the total crop potential evapotranspiration during growing season;

P is the total precipitation during growing season;

f is irrigation efficiency.

Irrigation Water Demand under Doubled CO₂



Residential Water Demand Projection

$$RWD = I.P.R$$

Where:

RWD is annual residential water demand;

I is residential water use per capita;

P is total population;

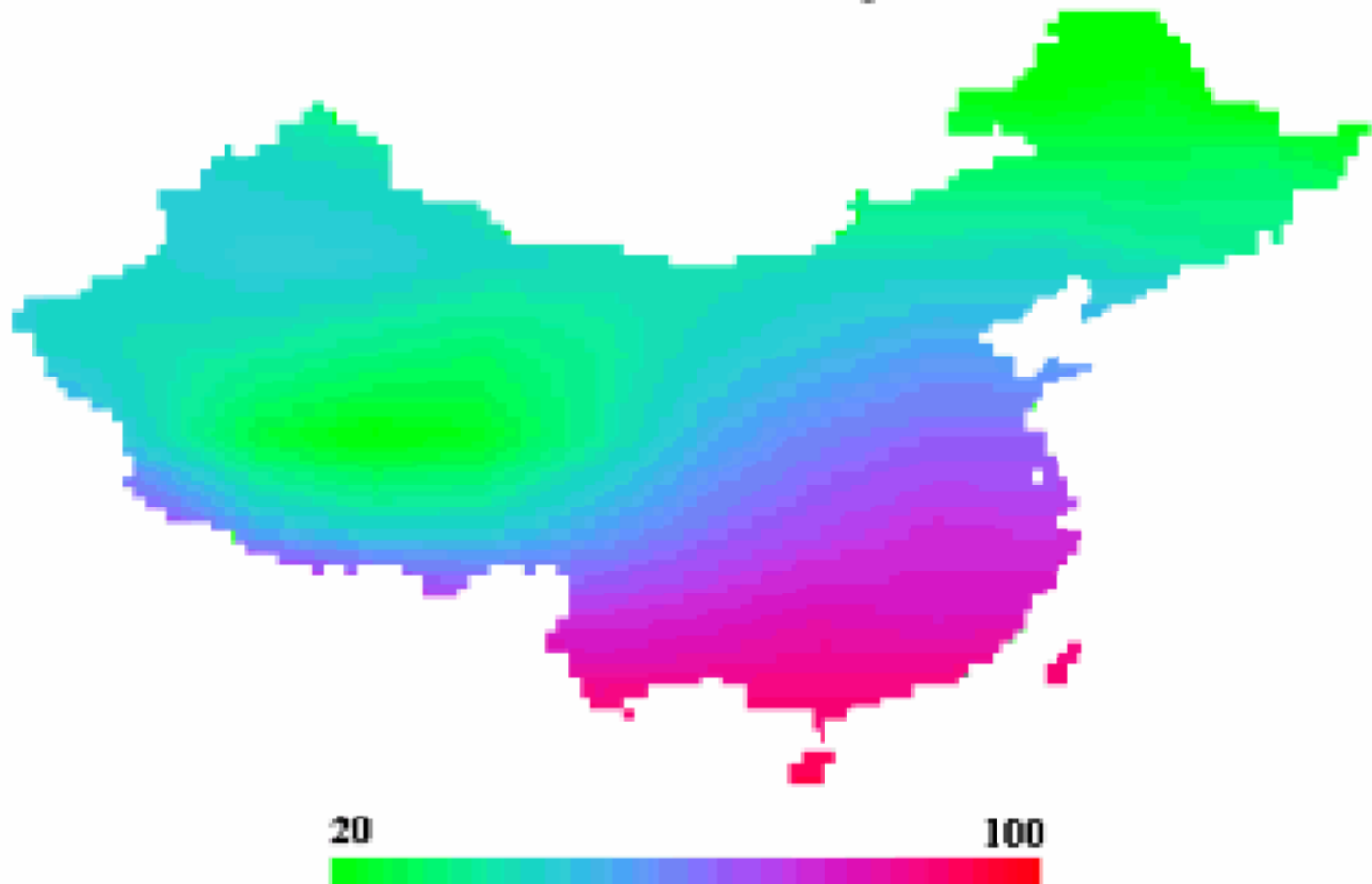
R is the adjusting factor to consider the ratio of agricultural population.

$$I = 2.9484T + 11.64$$

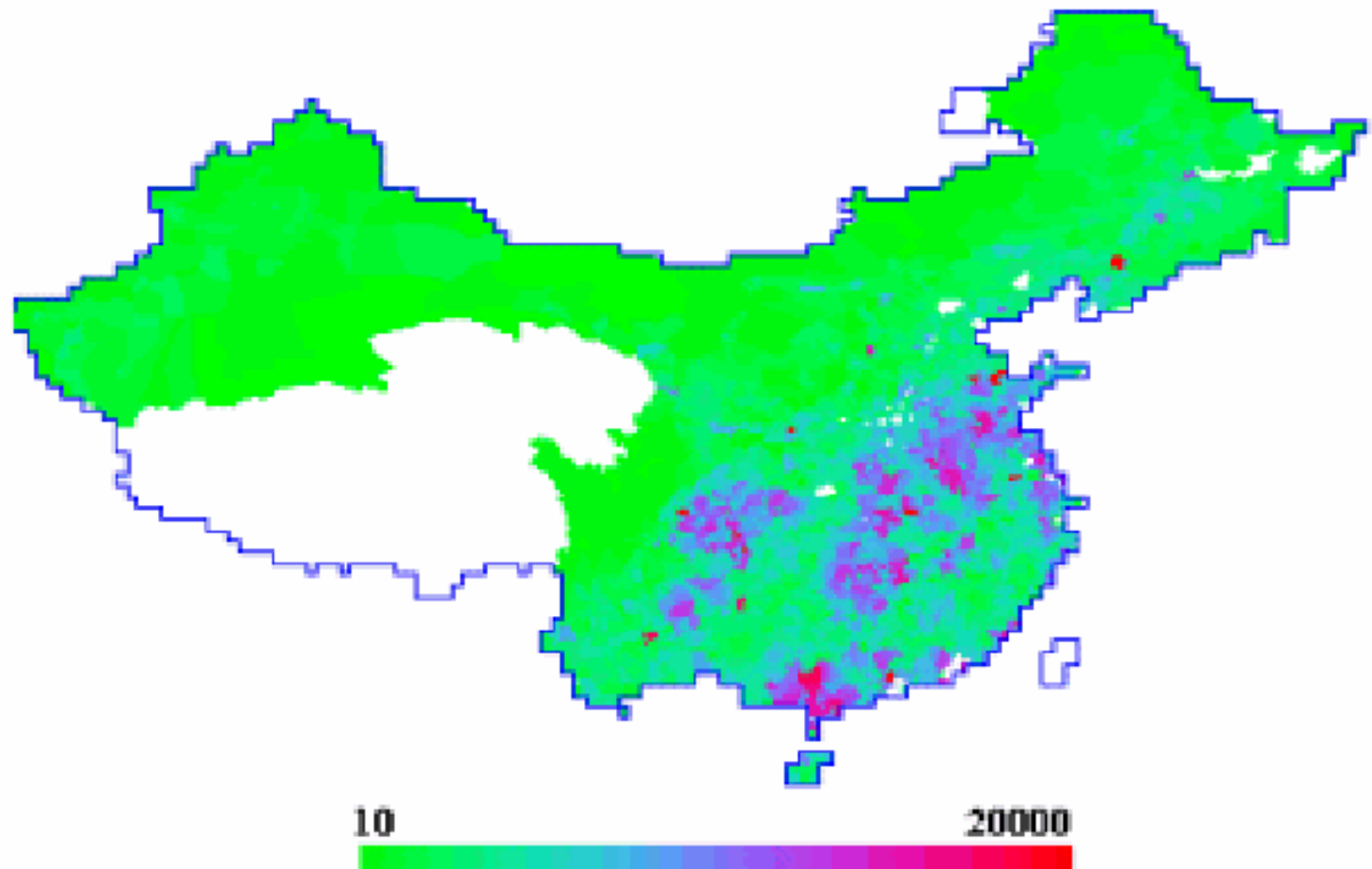
Where:

T is annual temperature.

Residential Water Demand Per Capita under Doubled CO2



Residential Water Demand under Doubled CO2



Sensitivity of Different Ep Methods to Temperature

- **Modified Penman**
- **Priestly-Taylor**
- **Thornthwaite**
- **Local**

Characteristics of Selected River Basins

River Basin	Observing Station	Catchment Area (Km²)	Climate Zone
Yangtze River	Hankou	1488036	Subtropic, Humid
Yellow River	Lanzhou	222551	Temperate, Semi-arid
Yujiang River	Nanning	75520	Subtropic, Humid
Lasha River	Lasha	27482	Plateau Temp. , Semi-arid

Sensitivity of Different Ep Methods to Temperature

a. Lasha River

	1°C	2°C	3°C	4°C	5°C
Modified Penman	3.6	7.2	10.8	14.5	19.0
Priestly-Taylor	3.5	7.0	10.5	14.0	17.5
Thornthwaite	10.2	20.2	32.2	43.6	51.0
Local	6.4	12.8	19.3	27.4	34.5

b. Yellow River

	1°C	2°C	3°C	4°C	5°C
Modified Penman	3.2	6.4	9.6	12.8	16.5
Priestly-Taylor	3.2	6.4	9.6	12.8	16.0
Thornthwaite	15.1	31.8	47.4	68.7	97.5
Local	10.1	20.2	31.4	42.3	53.2

c. Yangtze River

		2°C	3°C	4°C	5°C
Modified Penman	2.8	5.7	8.5	11.5	14.2
Priestly-Taylor	2.5	5.0	7.5	10.4	13.0
Thornthwaite	12.5	25.5	38.9	50.0	66.8
Local	3.2	6.5	9.8	13.4	16.2

d. Yujiang River

	1°C	2°C	3°C	4°C	5°C
Modified Penman	3.6	7.8	10.8	14.5	19.0
Priestly-Taylor	3.2	6.4	9.6	12.8	16.9
Thornthwaite	12.0	24.0	38.0	50.0	65.0
Local	4.0	8.0	12.0	16.0	19.0

Relative Changes in Annual Potential Evapotranspiration (E_p),
Evapotranspiration (E_v) and Runoff (R) in Different Basins under Different
Climate Scenarios
Lasha River

	Modified Penman Method		Priestly-Taylor Method		Thornthwaite Method		Local Method	
%	E_p		E_{rc}		E_p		E_p	
T°3	10.8		10.5		32.2		19.3	
T°5	19.0		17.5		51.0		34.5	
%	R	E_v	R	E_v	R	E_v	R	E_v
T°3 P%0	-13.82	4.80	-9.87	4.90	-15.46	19.30	-16.79	13.2
T°3 P%15	44.56	30.78	32.41	30.97	-6.93	40.20	14.88	27.89
T°3 P%-5	-58.69	-21.13	-43.38	-20.42	-51.47	-14.57	-47.34	-7.74
T°5 P%0	-15.96	7.40	-17.15	8.40	-21.42	28.69	-22.43	18.47
T°5 P%15	22.74	34.47	24.83	35.77	-11.37	59.44	4.67	31.45
T°5 P%-5	-47.63	-24.53	-58.26	-28.46	-74.65	3.38	-49.87	-6.68

Relative Changes in Annual Potential Evapotranspiration (Ep),
Evapotranspiration (Ev) and Runoff (R) in Different Basins under Different
Climate Scenarios

Yellow River

	Modified Penman Method		Priestly-Taylor Method		Thornthwaite Method		Local Method	
%	E _p		E _{rc}		E _p		E _p	
T°3	9.6		9.6		47.4		31.4	
T°5	16.5		16.0		97.5		53.2	
%	R	E _v	R	E _v	R	E _v	R	E _v
T°3P%0	-12.67	4.23	-13.06	4.63	-5.86	2.46	-27.32	-3.86
T°3 P%15	40.13	25.18	41.46	25.77	-1.04	5.87	20.46	18.71
T°3 P%-5	-58.97	-20.07	-57.24	-23.46	-10.79	-1.68	-38.92	-4.83
T°5 P%0	-20.46	5.61	-20.80	6.84	-7.80	4.74	-34.58	4.96
T°5 P%15	28.84	22.84	29.76	34.21	-4.32	9.95	18.28	11.03
T°5 P%-5	-59.63	-18.51	-69.07	-20.34	-21.25	-1.03	-59.17	-4.54

Relative Changes in Annual Potential Evapotranspiration (Ep),
Evapotranspiration (Ev) and Runoff (R) in Different Basins under Different
Climate Scenarios
Yangtze River

%	Modified Penman Method		Priestly-Taylor Method		Thornthwaite Method		Local Method	
	E_p	E_{rc}	E_p	E_{rc}	E_p	E_{rc}	E_p	E_{rc}
T ⁰ 3	8.5	7.5	38.9	9.8				
T ⁰ 5	14.2	13.0	66.8	16.2				
%	R	E_v	R	E_v	R	E_v	R	E_v
T ⁰ 3P%0	-5.53	6.67	-4.35	4.18	4.67	-3.47	-0.88	0.42
T ⁰ 3 P%15	34.83	21.18	26.25	15.21	5.50	16.33	20.21	7.48
T ⁰ 3 P%-5	-38.26	-11.69	-36.63	-9.24	-13.38	-15.24	-11.06	-4.11
T ⁰ 5 P%0	-5.96	8.83	-6.37	6.26	12.02	-3.81	1.13	1.25
T ⁰ 5 P%15	21.72	20.25	24.72	20.42	36.67	16.54	25.72	18.42
T ⁰ 5 P%-5	-28.41	-7.98	-31.56	-5.91	-10.44	-20.26	-7.62	-6.07

Relative Changes in Annual Potential Evapotranspiration (Ep),
Evapotranspiration (Ev) and Runoff (R) in Different Basins under Different
Climate Scenarios
Yujiang River

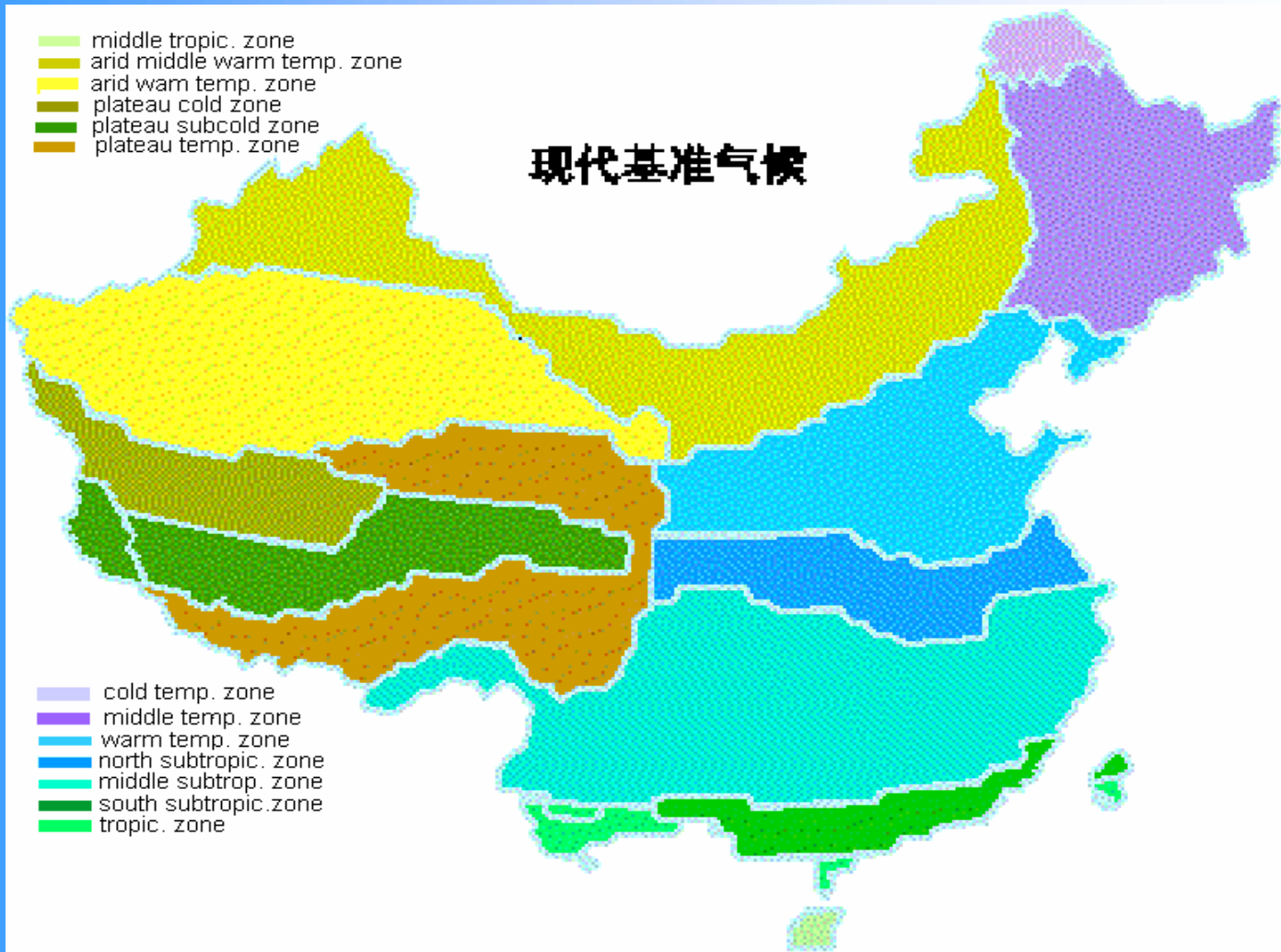
%	Modified Penman Method		Priestly-Taylor Method		Thornthwaite Method		Local Method	
	E _p		E _{rc}		E _p		E _p	
T°3	10.8		9.6		38.0		12.0	
T°5	19.0		16.9		65.0		19.0	
%	R	E _v	R	E _v	R	E _v	R	E _v
T°3P%0	-5.08	6.15	-5.18	5.04	-23.56	19.18	-2.76	1.94
T°3 P%15	30.48	20.27	32.29	20.79	24.81	27.73	19.45	9.87
T°3 P%-5	-36.62	-10.83	-36.88	-10.45	-62.75	3.17	-9.74	-6.22
T°5 P%0	-7.79	8.77	-4.69	4.22	-34.45	26.64	-2.66	3.15
T°5 P%15	29.81	21.28	16.63	13.78	5.68	33.71	23.45	20.74
T°5 P%-5	-39.93	-7.90	-21.75	-3.99	-67.71	12.58	-8.17	-5.41

Conclusions

- Different Ep methods bring about considerable differences in modeled runoff values, the choice of the Ep method in assessing the impact of climate change on river basin discharge is important
- Empirical methods, mainly temperature based, give significantly different marginal changes to temperature fluctuations

Impact on Distribution of Climate Zones in China

Climate Zones under Current Climate

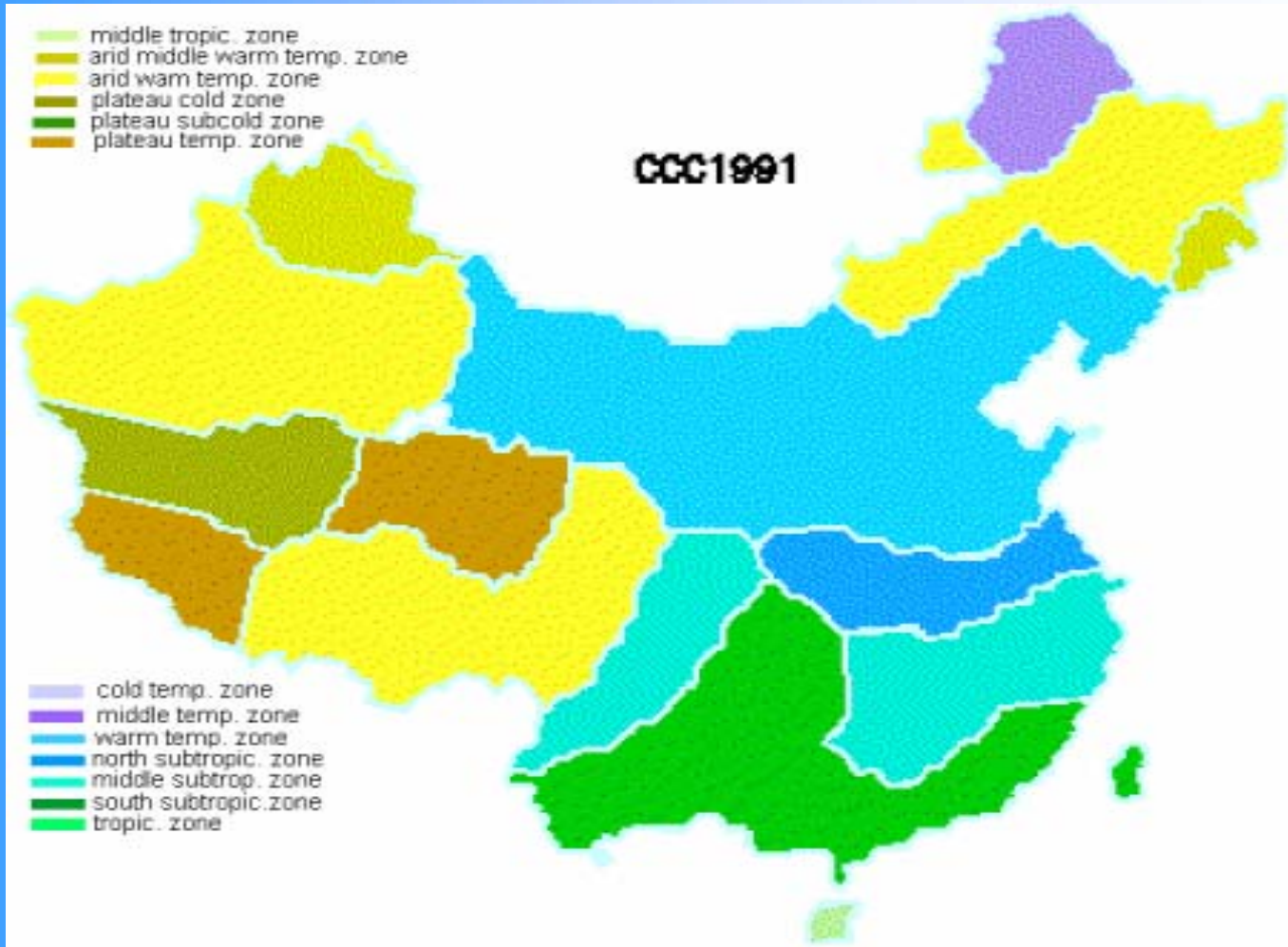


Climate Zones under Mean Climate Scenario of 11 GCMs

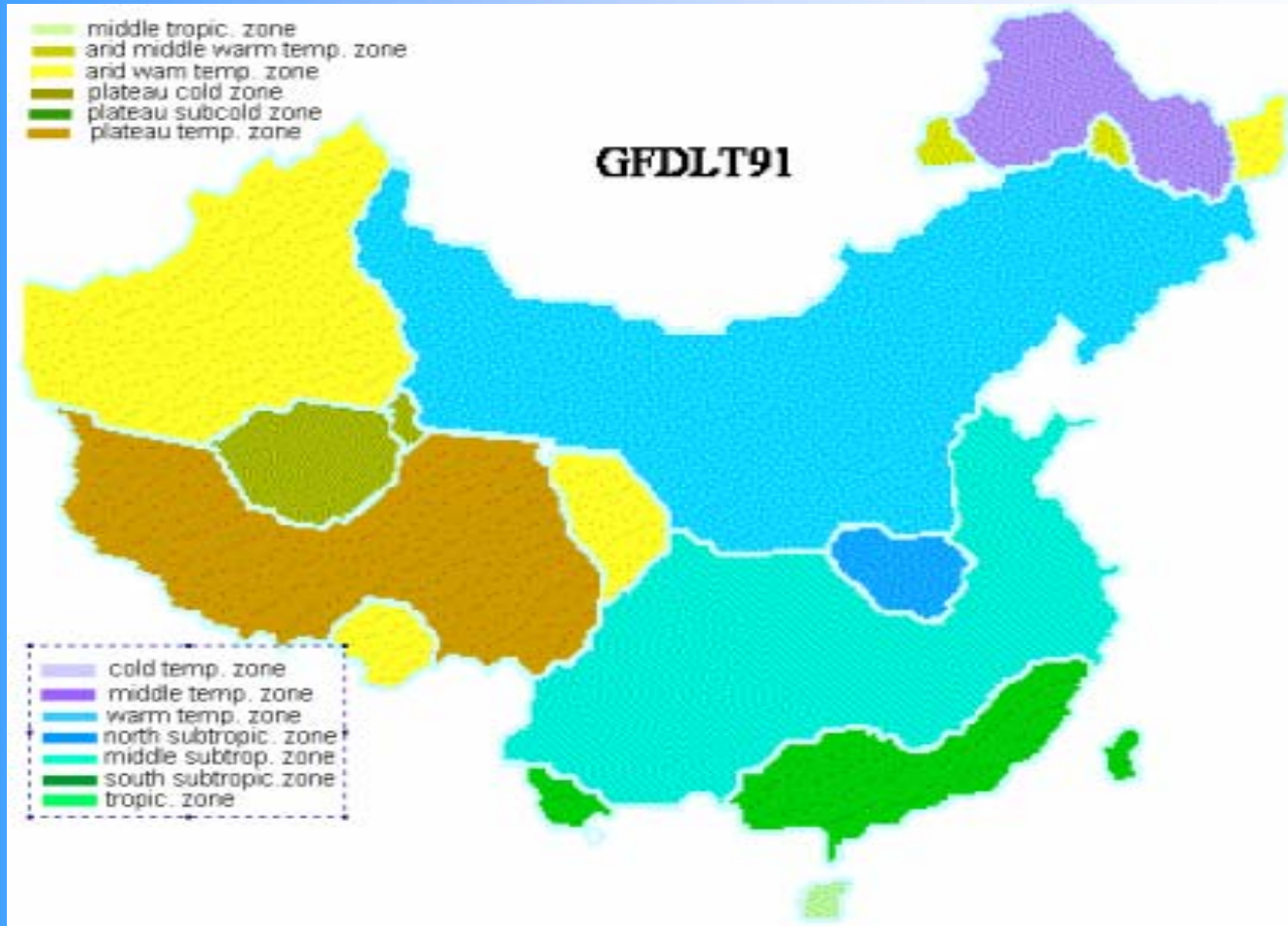


The End

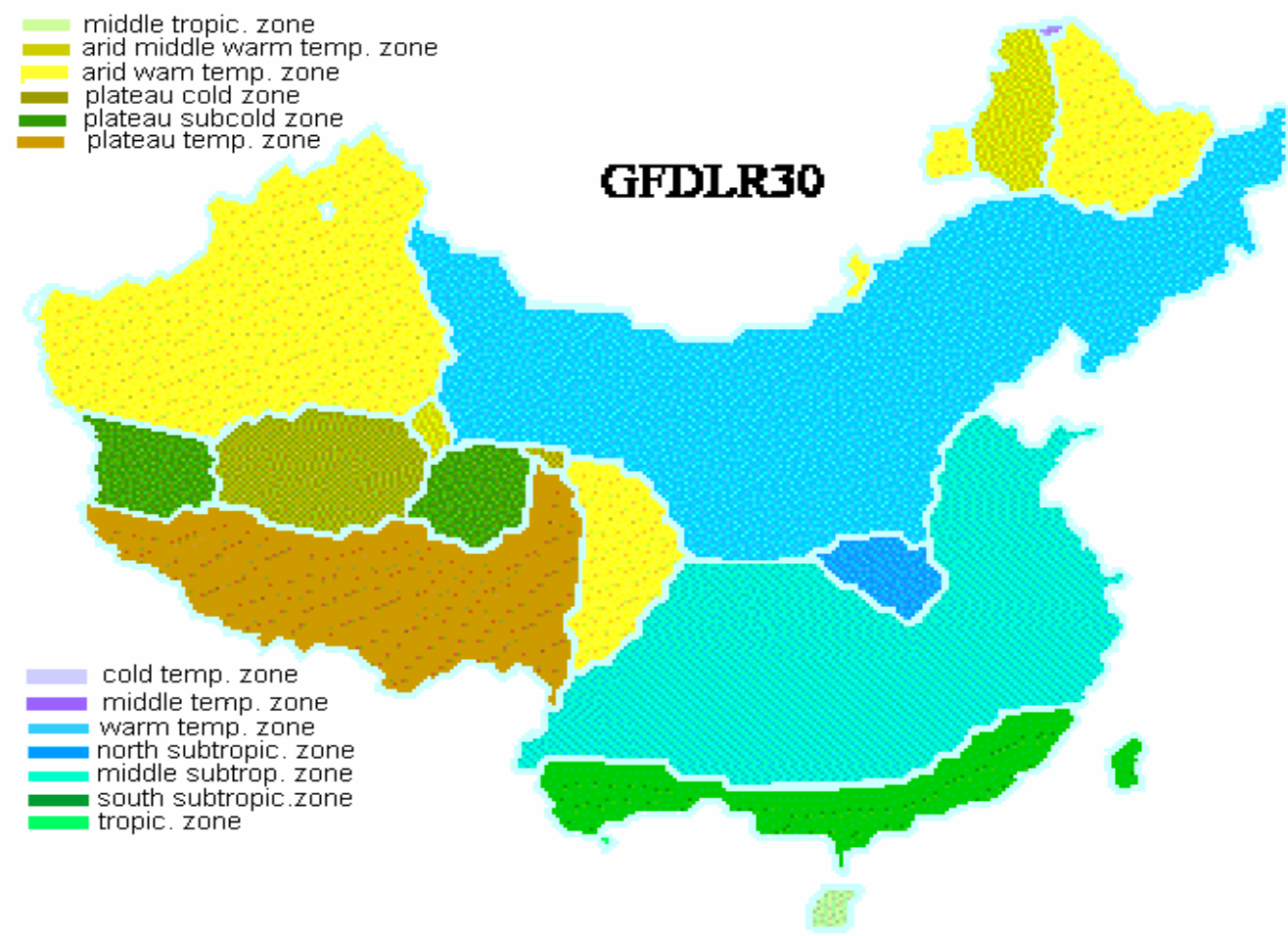
Climate Zones under Climate Scenario of CCC1991



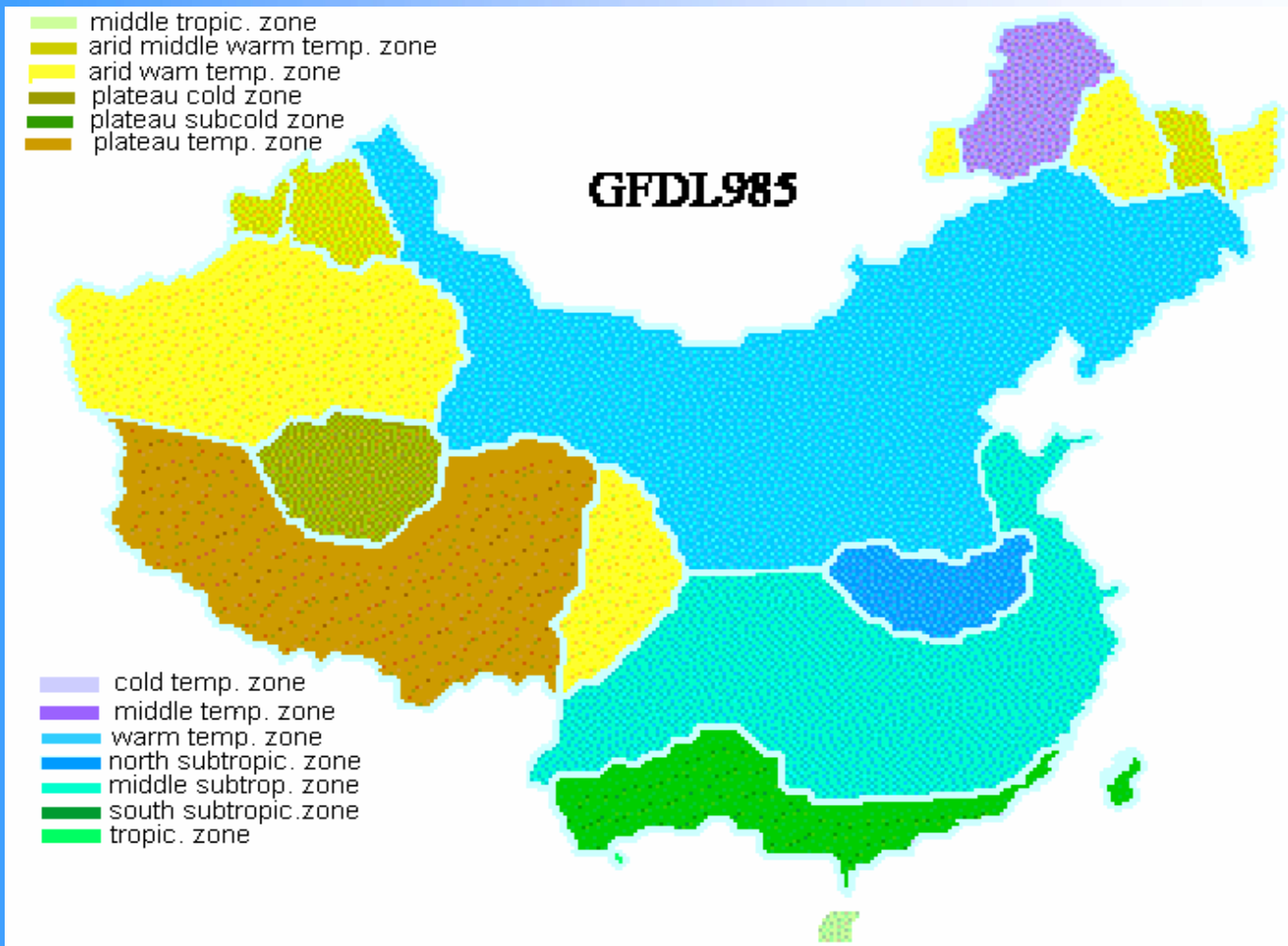
Climate Zones under Climate Scenario of GFDLT91



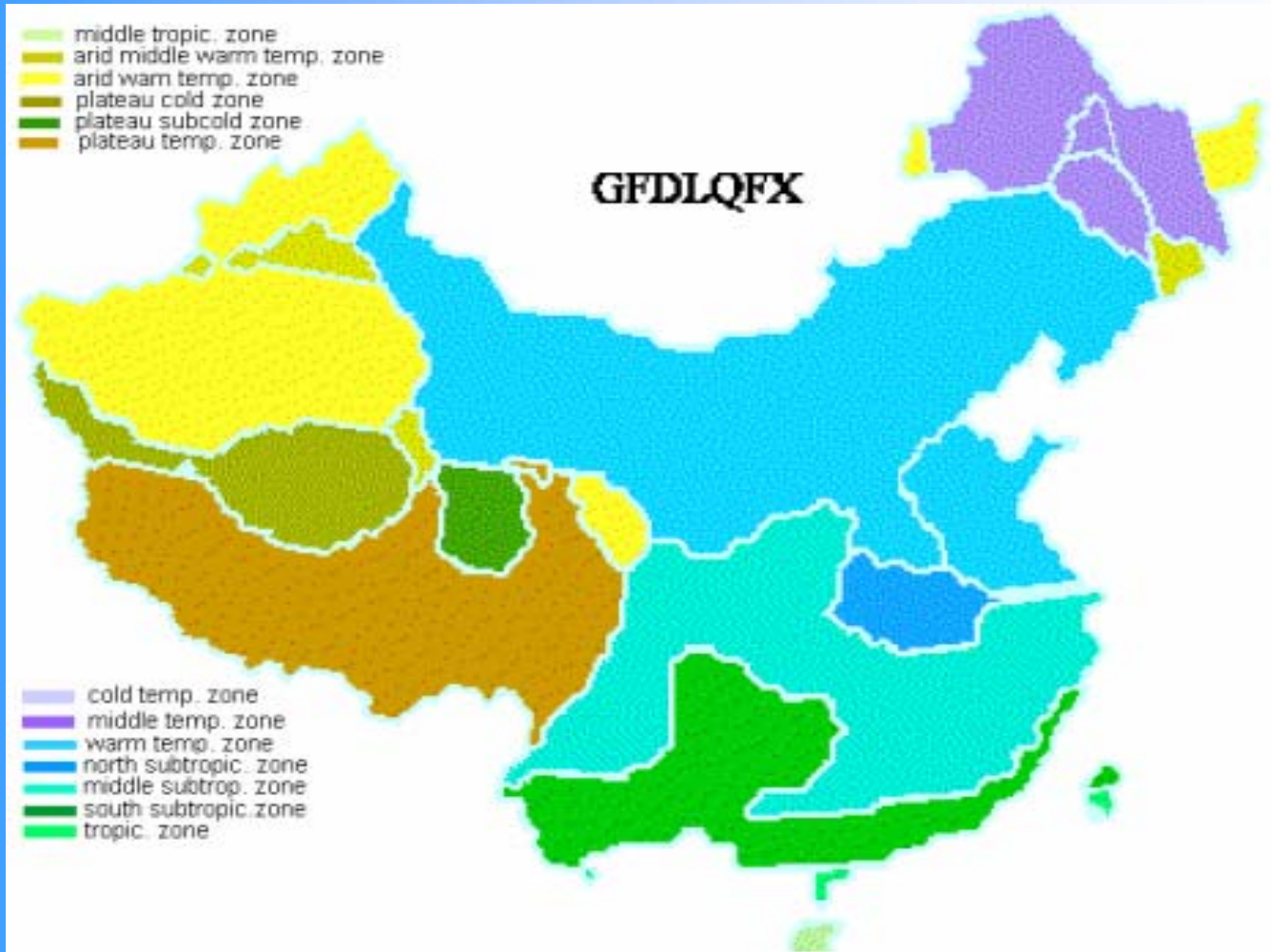
Climate Zones under Climate Scenario of GFDLR30



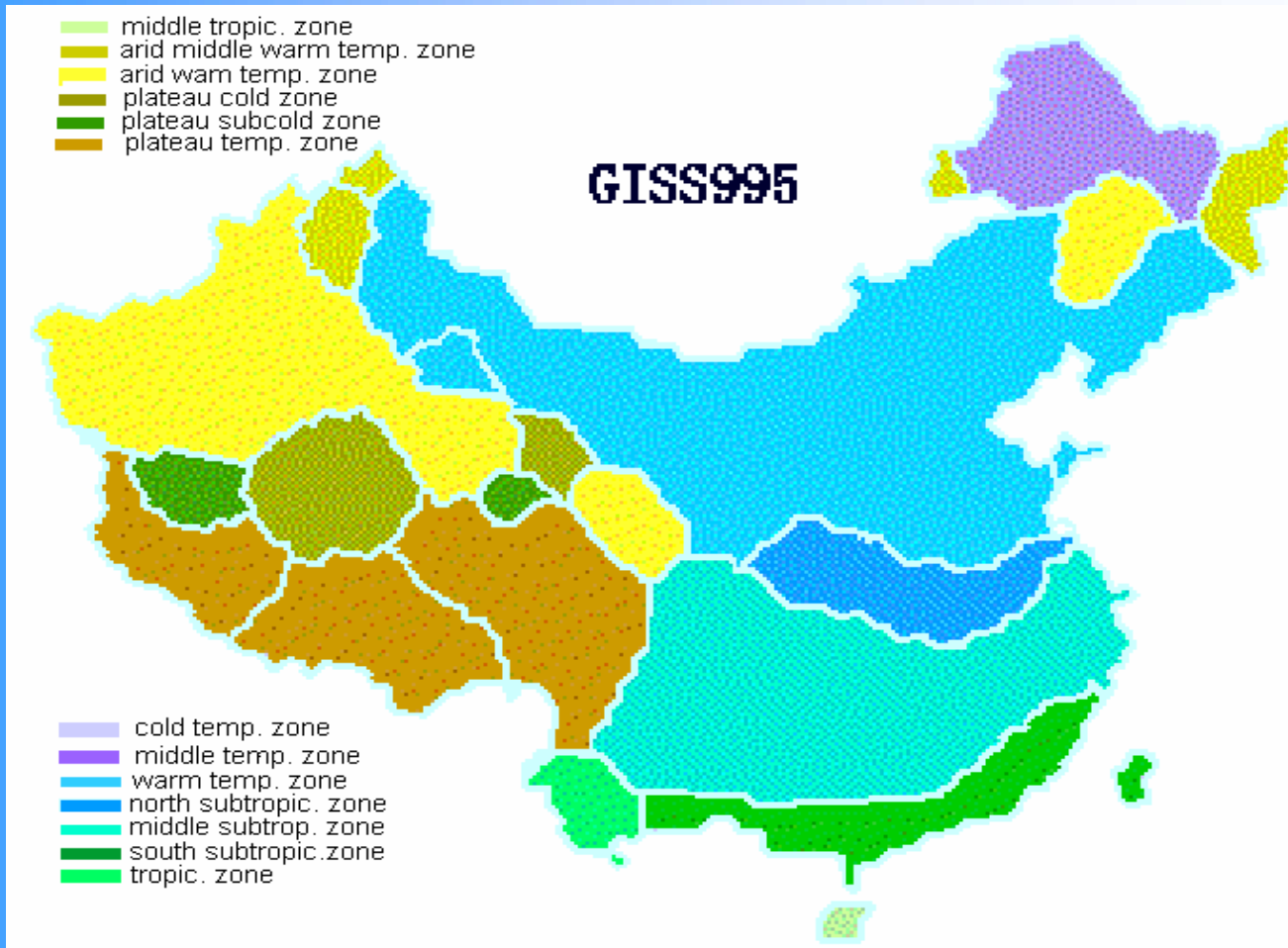
Climate Zones under Climate Scenario of GFDL985



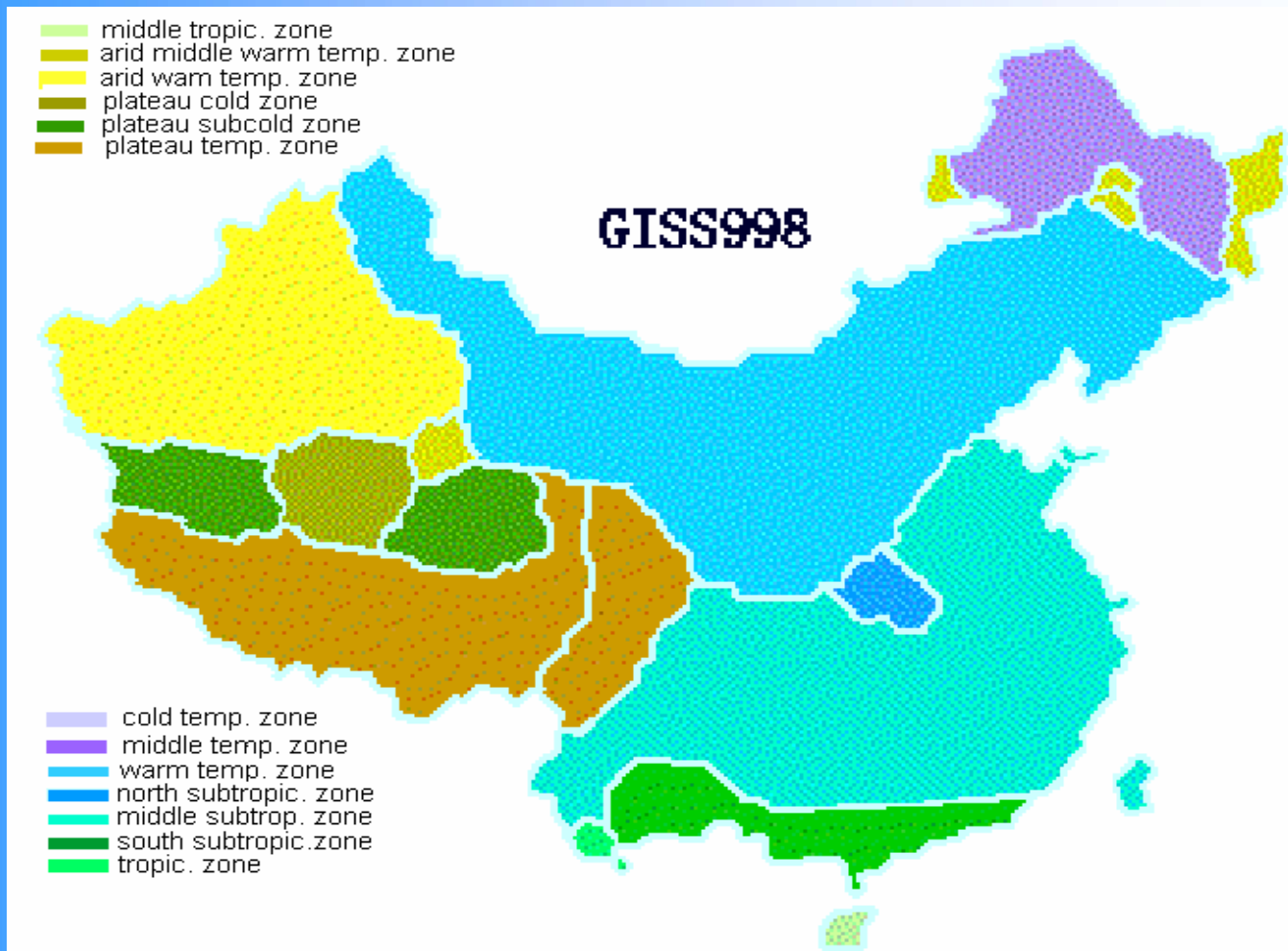
Climate Zones under Climate Scenario of GFDQFX



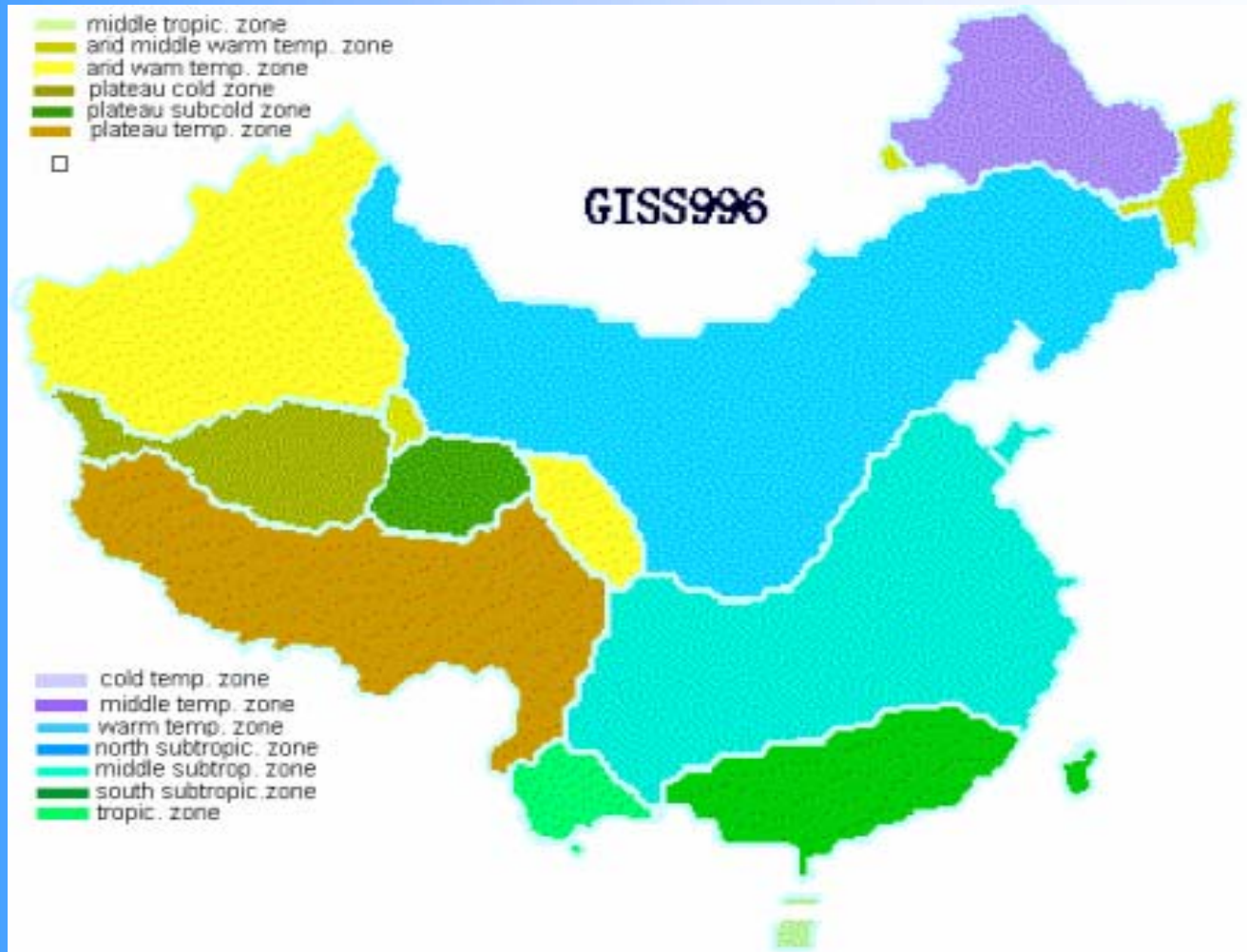
Climate Zones under Climate Scenario of GISS995



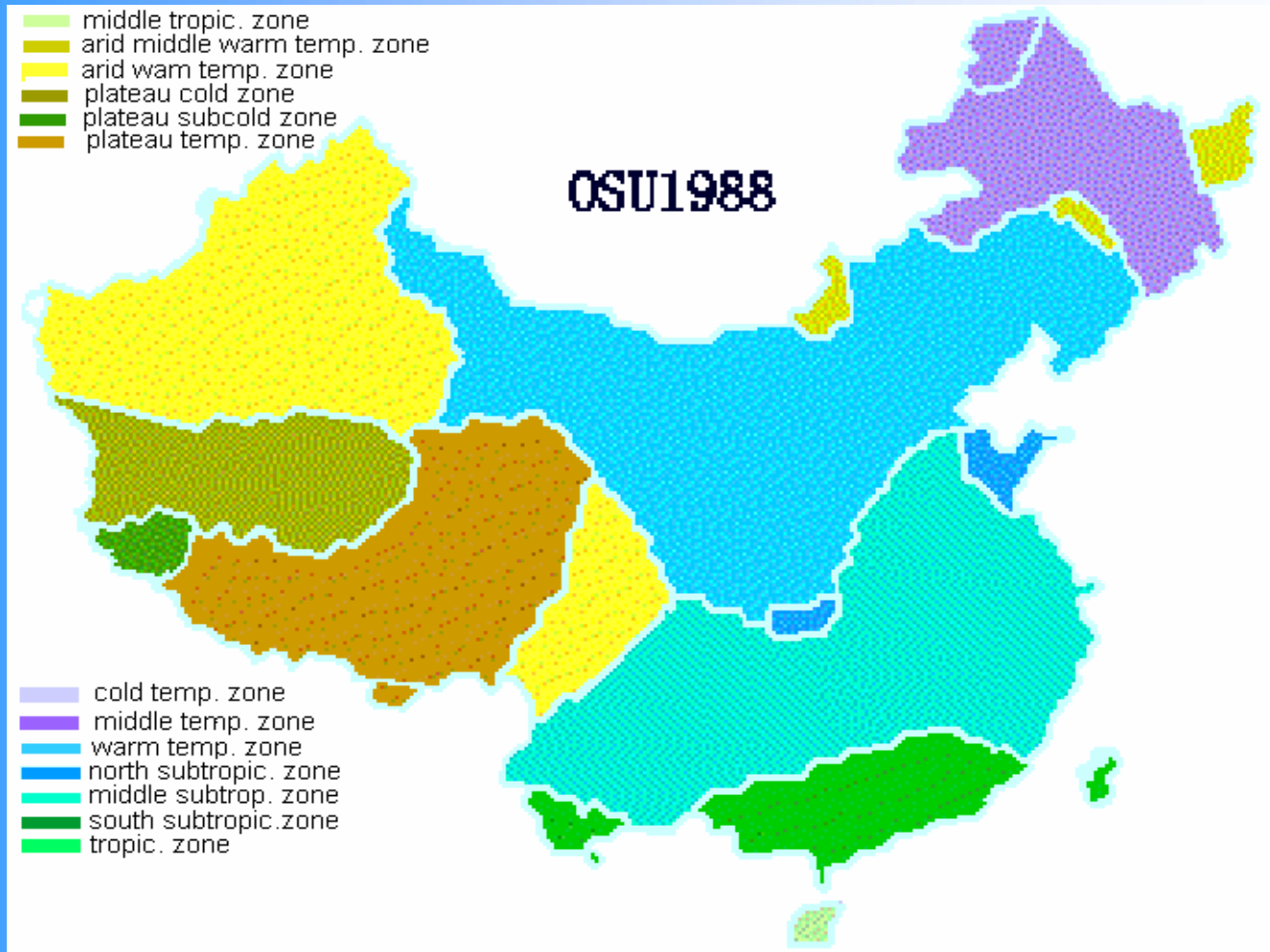
Climate Zones under Climate Scenario of GISS998



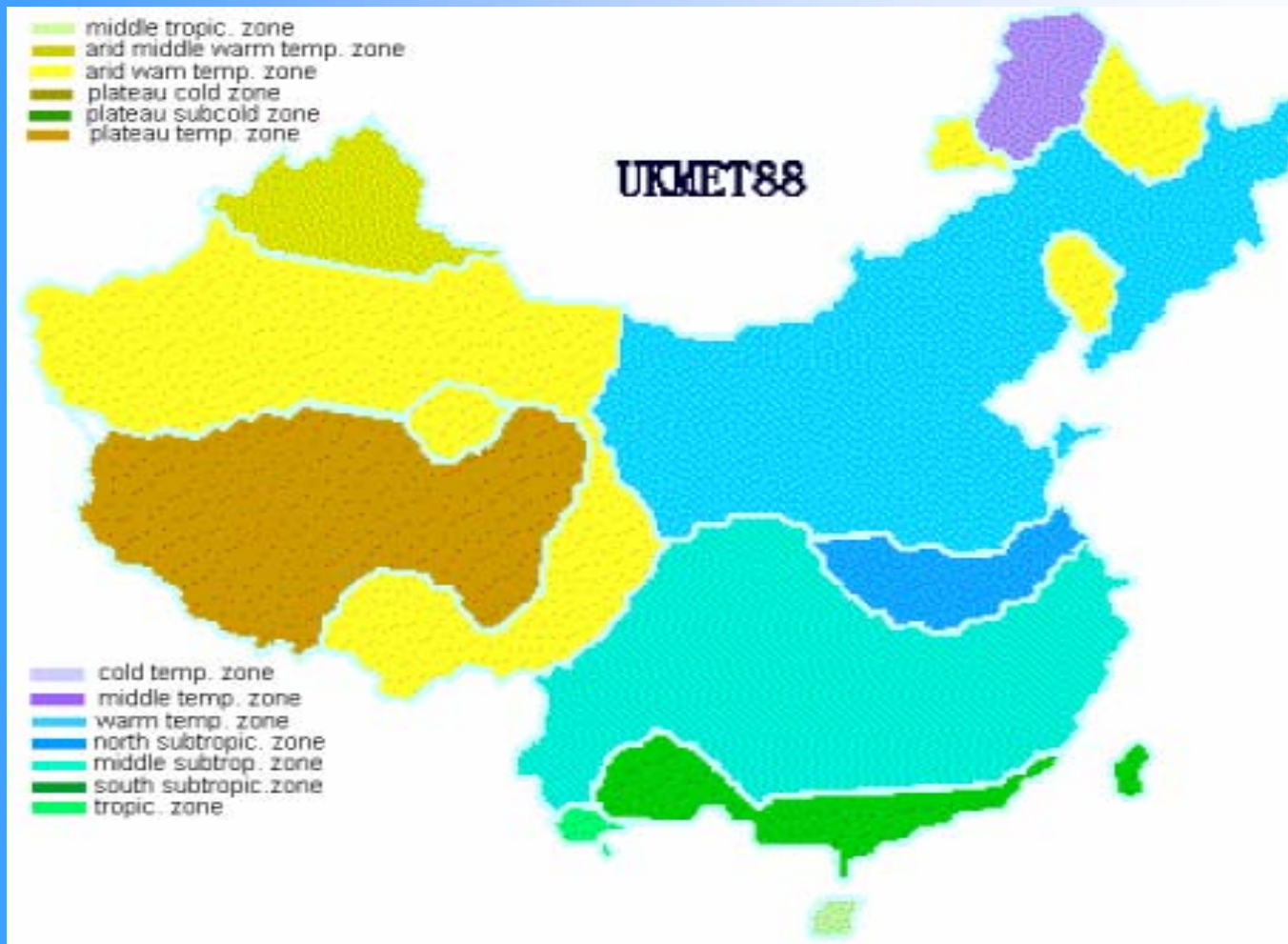
Climate Zones under Climate Scenario of GISS996



Climate Zones under Climate Scenario of OSU1988



Climate Zones under Climate Scenario of UKMET88



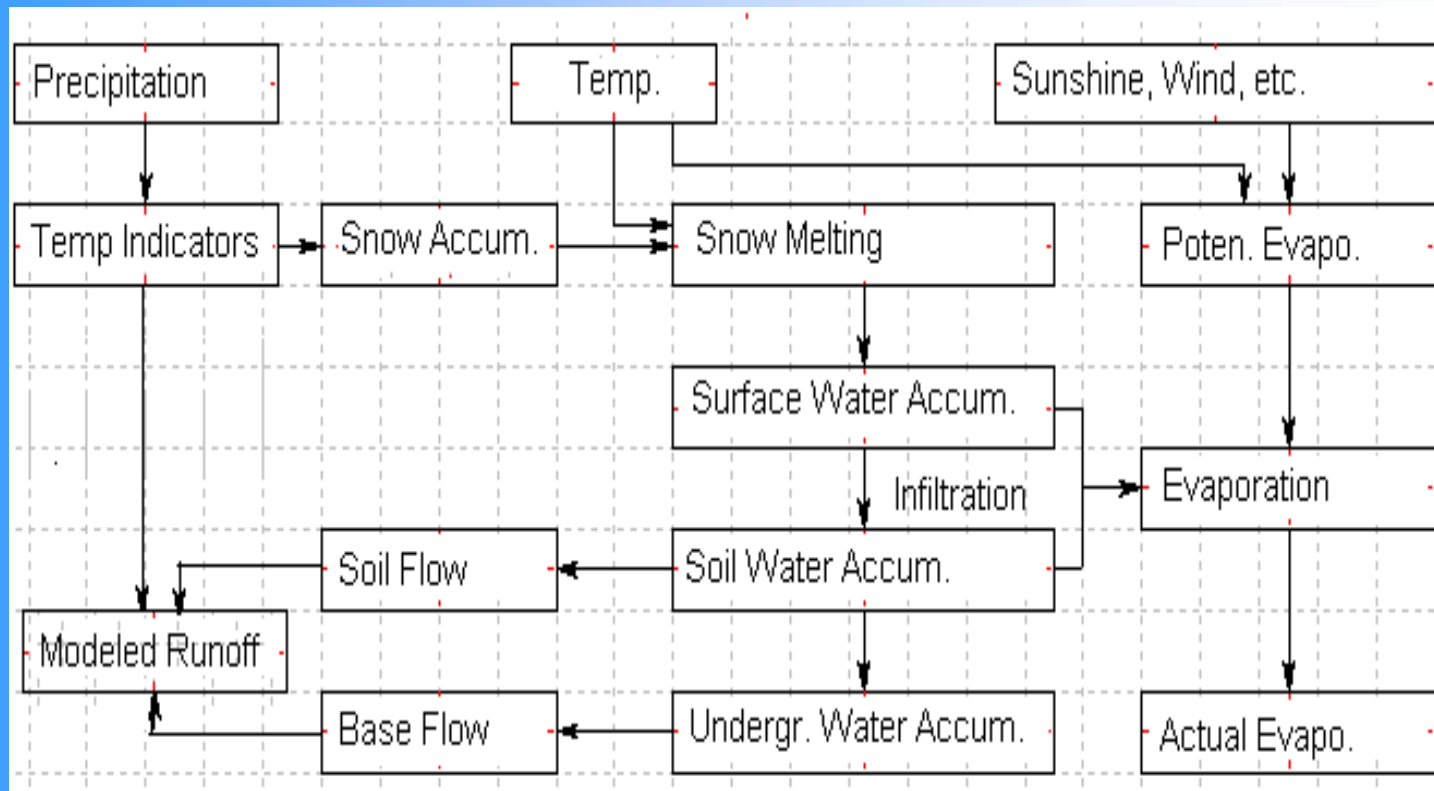
Some Facts

- Climate change imposes impacts on both Water supply and Water demand (directly/indirectly)
- 1.5 ° C increase in temperature led to 20 ~ 30% of increase in irrigation water demands, while 4.5 ° C increase can make the irrigation demand double

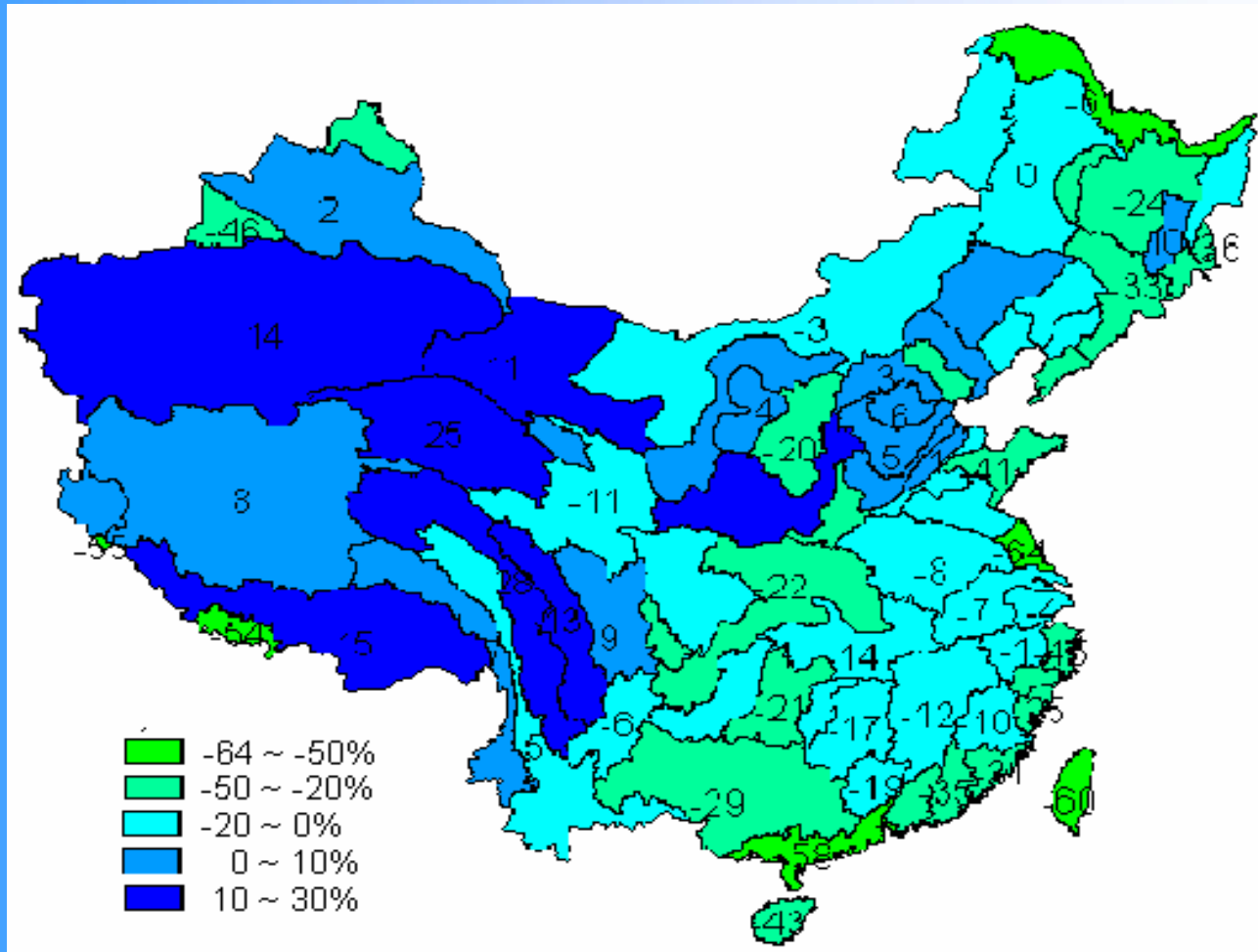
Information Inventory

- Social economic data (provincial level)
- Climate data
- Data on water use in cities
- Data about Irrigation (provincial level)
- River discharge data
- Background data on water basins
- Sectoral water use for water basins
- Water supply capacity and actual water supply of water conservancy facilities by water basins
- China water basin boundaries map
- China river system map
- China vegetation map
- China geographical map
- China soil map

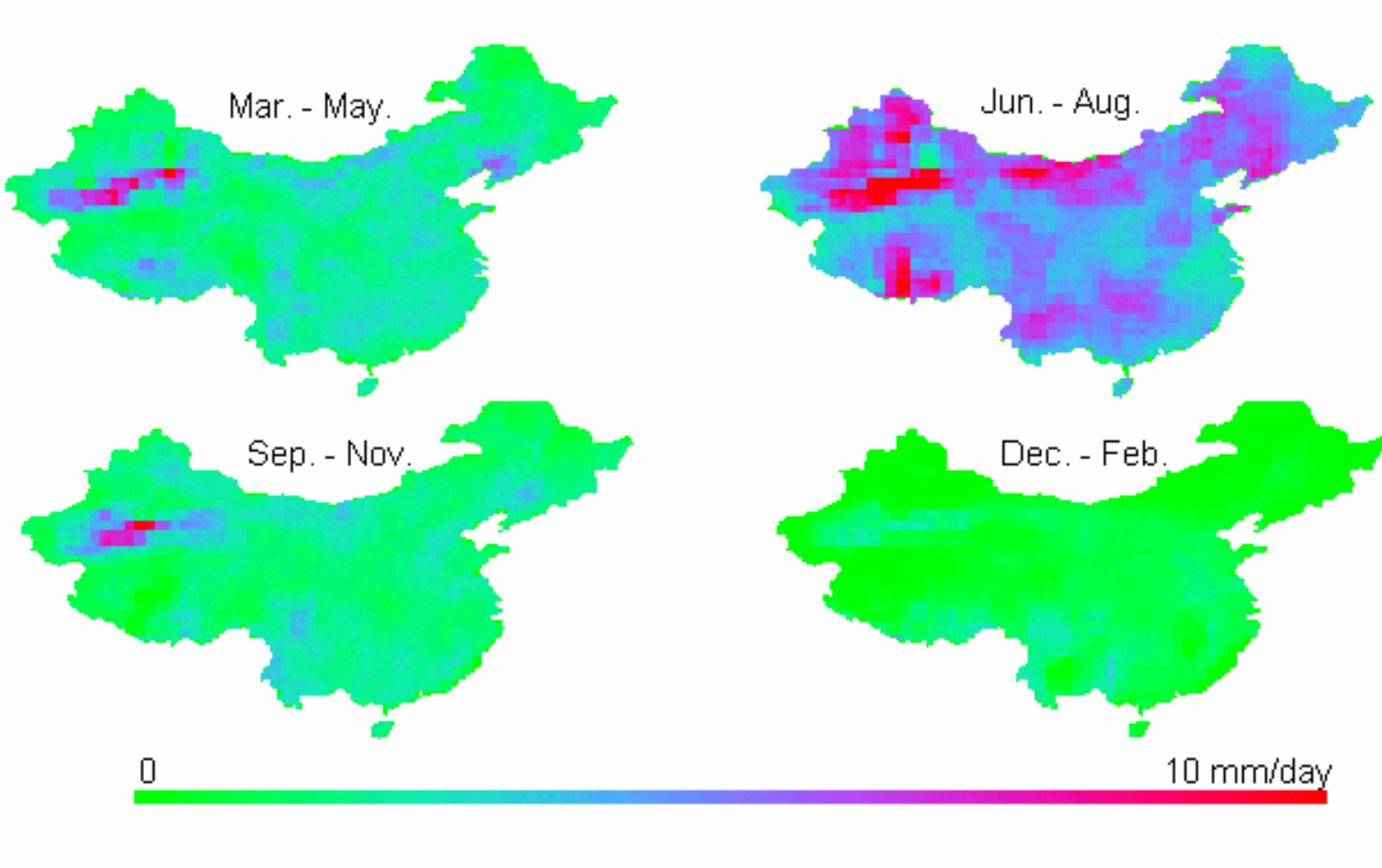
Research Approach



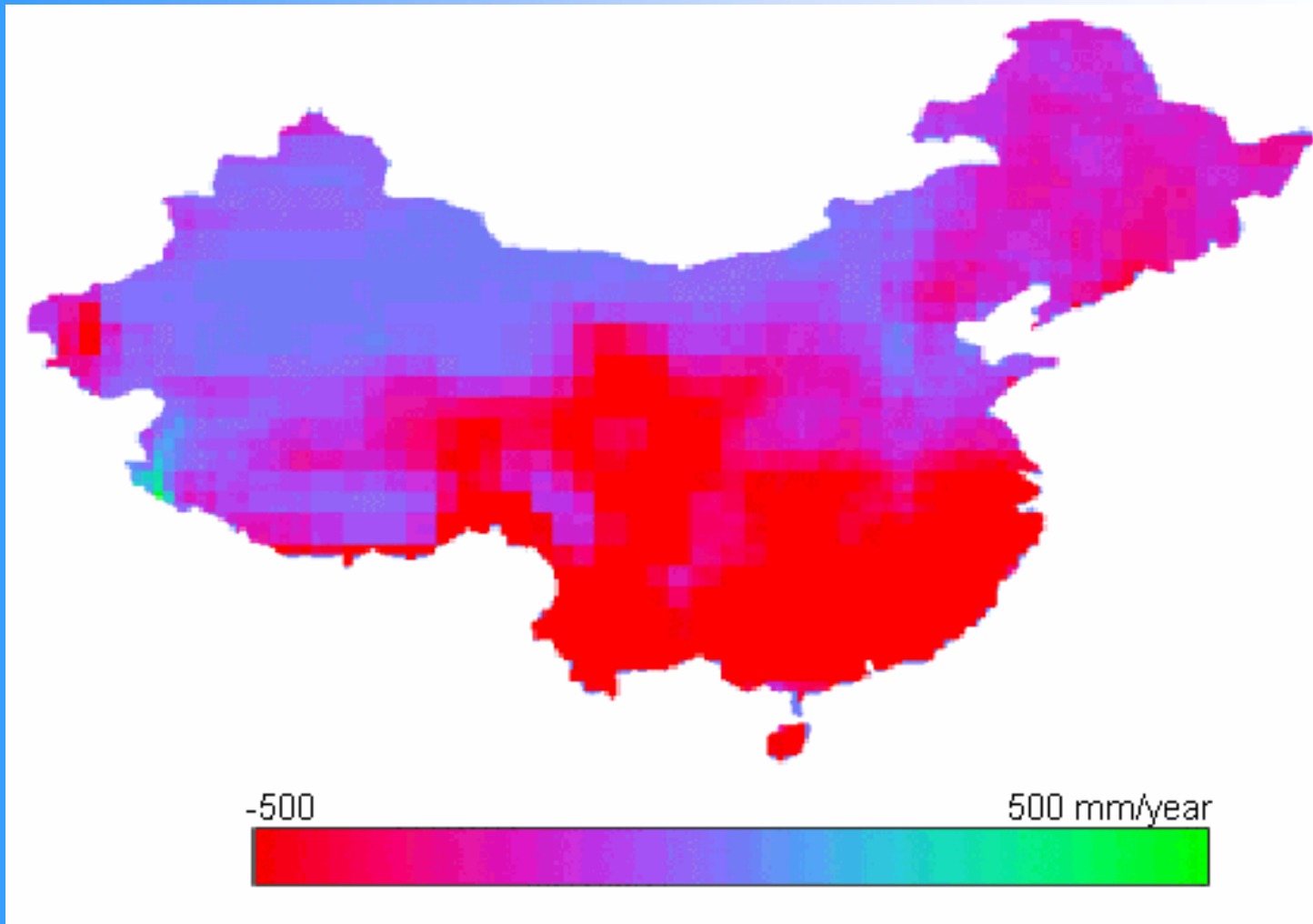
Percentage of Changes in Annual Runoff



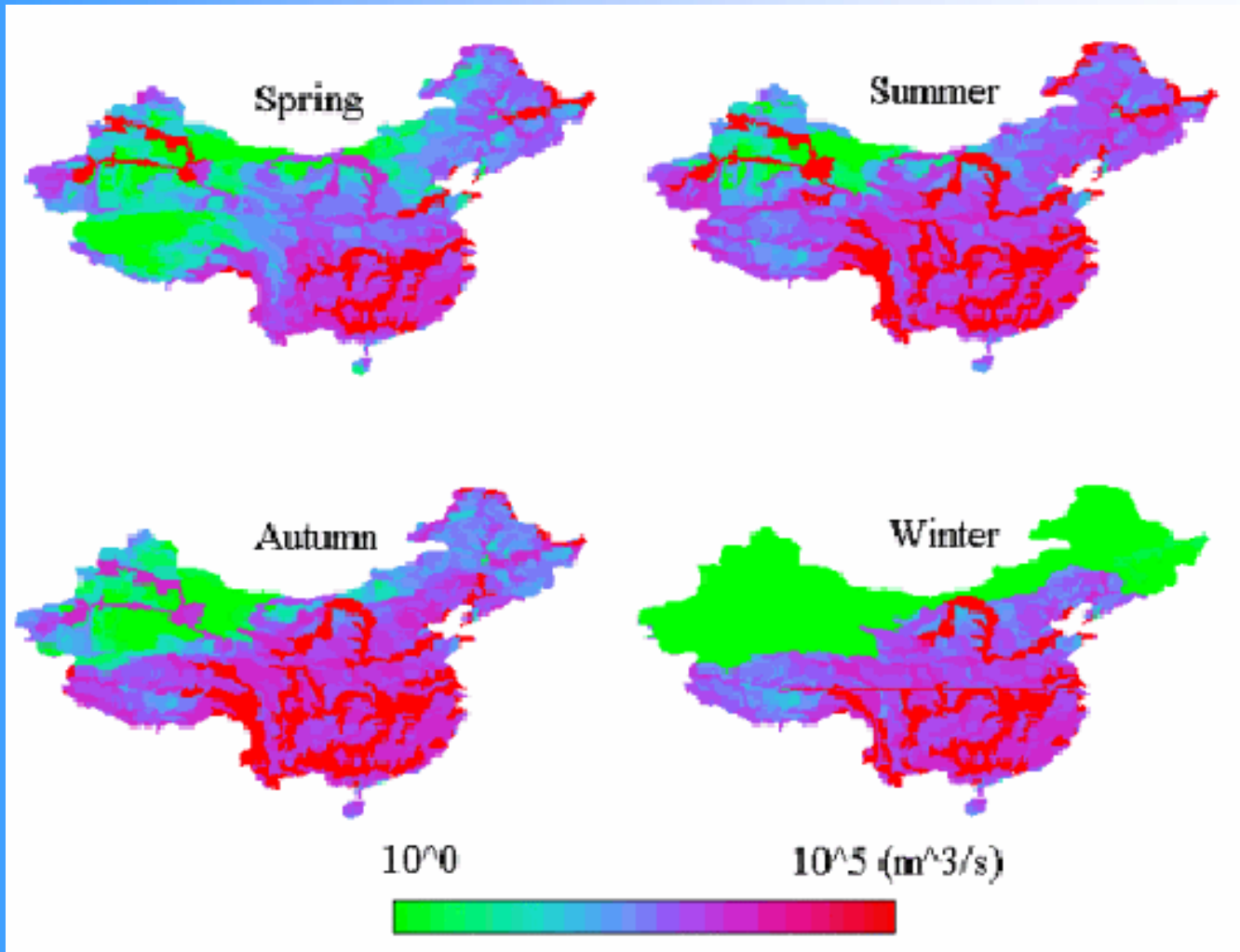
Difference of Potential Evapotranspiration between Present and Future Climate



Differences of Surface Runoff between Present and Future Climate



Seasonal River Discharge under Present Climate



Seasonal River Discharge under Future Climate

