INSAFS, Hyderabad, India

Climate Change and Its Effects on Reference Evapotranspiration and Crop Water Requirments in Hebei Province, China during 1965-1999

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Introduction

- **Climate Change**

  global warming : annual temperature increased
  rainfall changes: increase & decrease

- **Impact on Agriculture**

  Temperature: growing season, freeze, heat wave

  rainfall: water resources & balance

  hazards: drought, storm

- **Agricultural & water**

  water resources affect the food production

Problems

- Evaporation and evapotranspiration variation

  decreased in most of world, including the U.S., the FSU, China, India, Australia;

  but increased in Isreal & Central Asia

  related irrigation and water management

- Pan evaporation paradox

  contrast between expectation & observation *why ???*

Methods

- ET0: Peman-Monteith Method recommended by FAO in 1998

$$E = \frac{0.408\Delta(Rn - G) + \gamma \frac{900}{T + 273} U_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34U_2)}$$

used widely in the world

good results in China

Methods

- **Crop water requirement (ETm)**

  calculated by reference evapotranspiration (ET_0) times crop coefficients (Kc)

  $$ETm = Kc * Eto$$

  Kc used here from FAO irrigation guide (Allen et al, 1998).

Methods

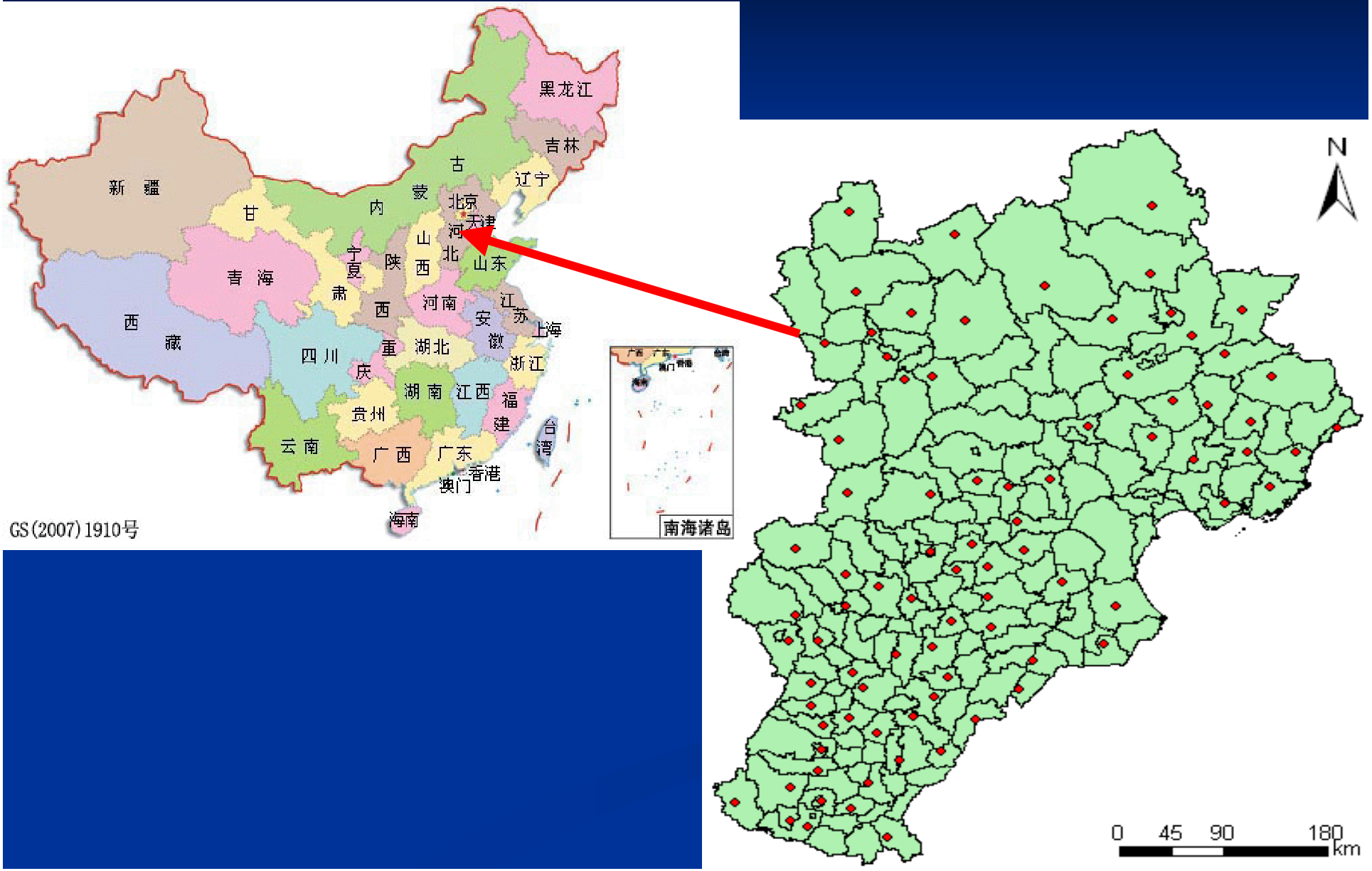
- GIS Technology

  points to surface

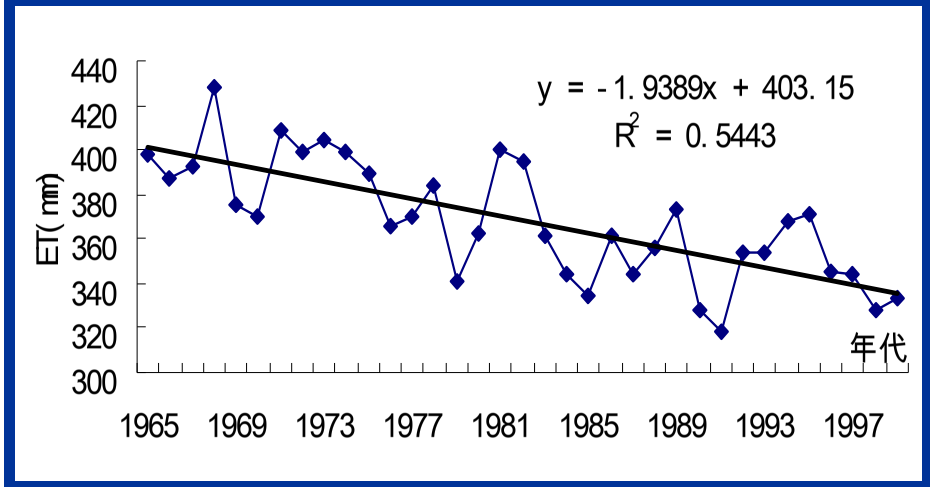
    IDW

 Spatial distribution & variations

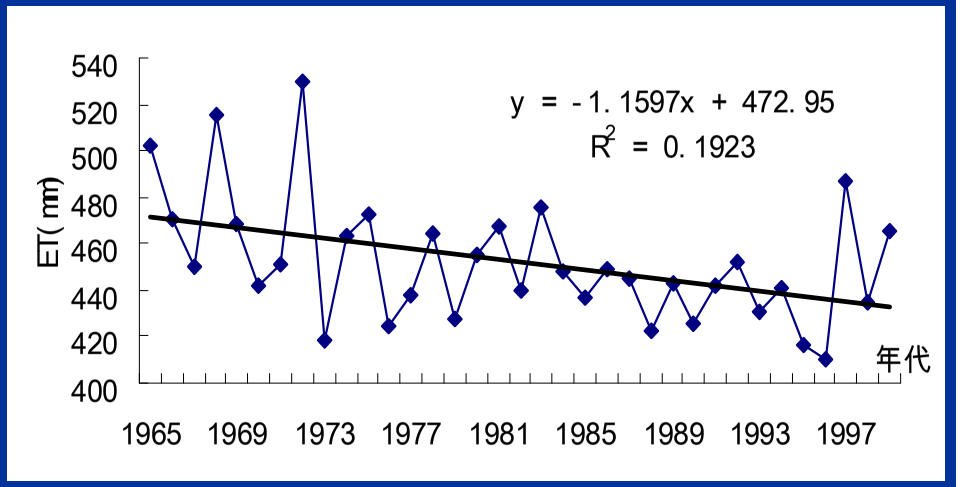
Hebei Province, China



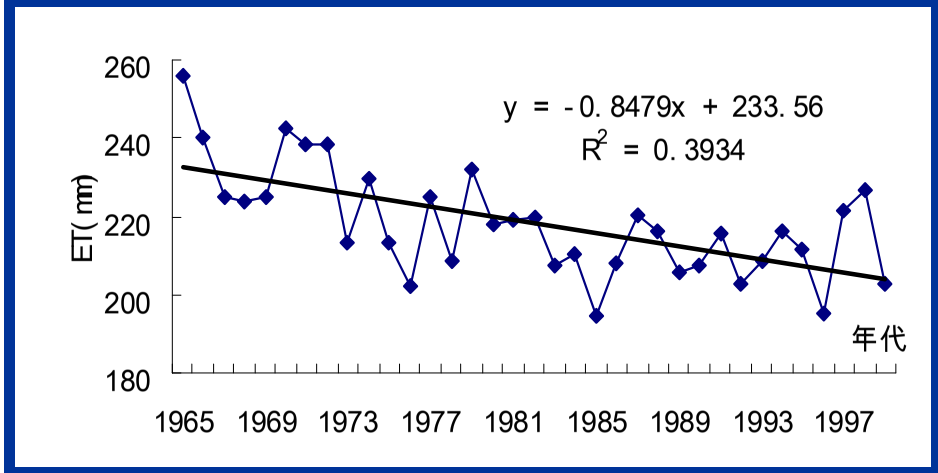
ET_0 Change Trends (season)



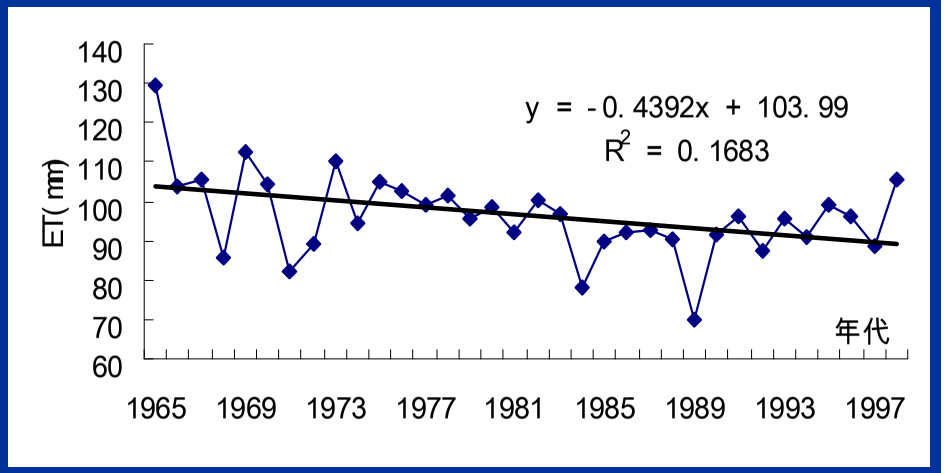
Spring



Summer

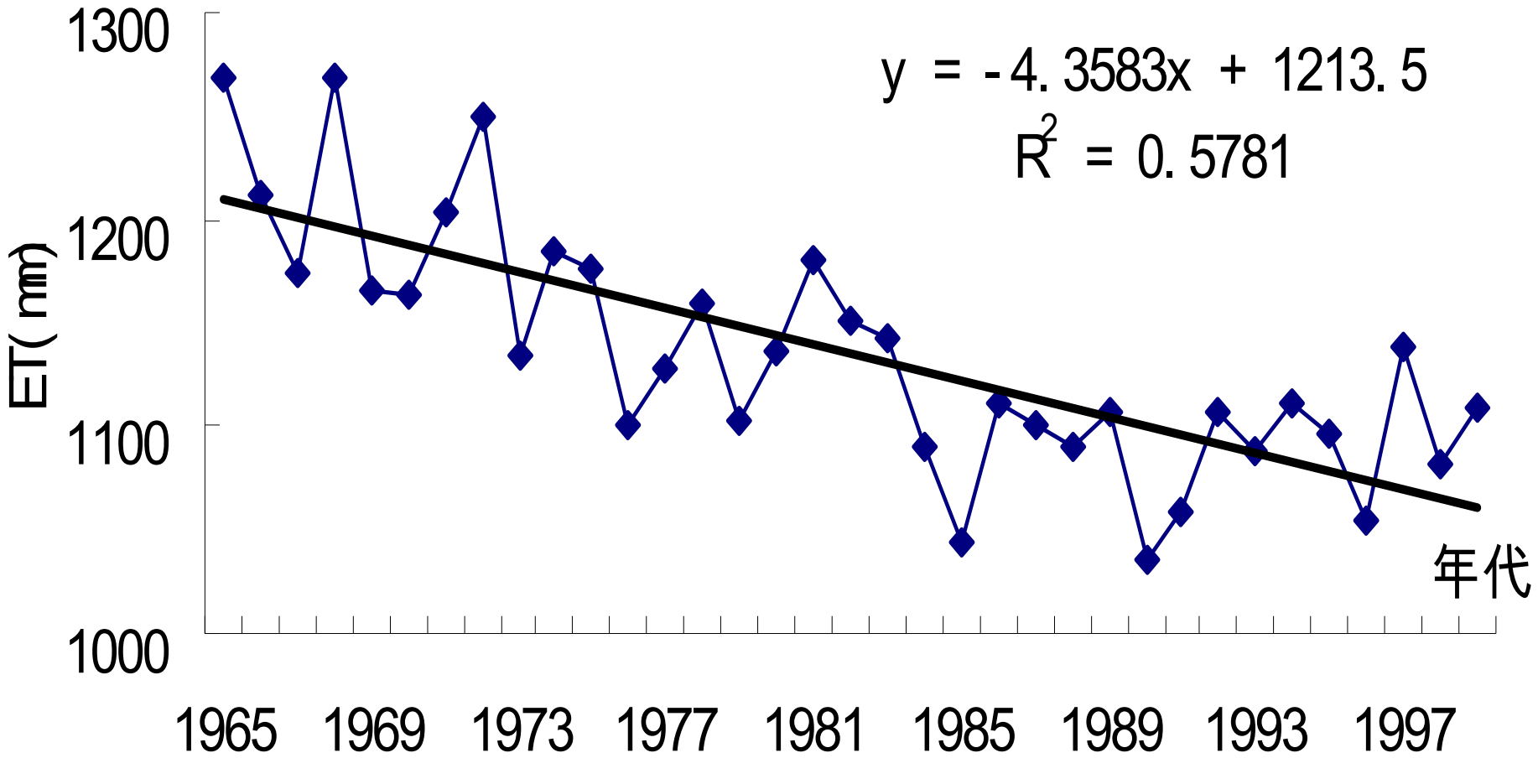


Autumn



Winter

ET_0 Change Trends (year)



Results & Analysis

- ET_0 changes in four seasons

  the same tendency for decreasing during 1965-1999 , but the value is not the same

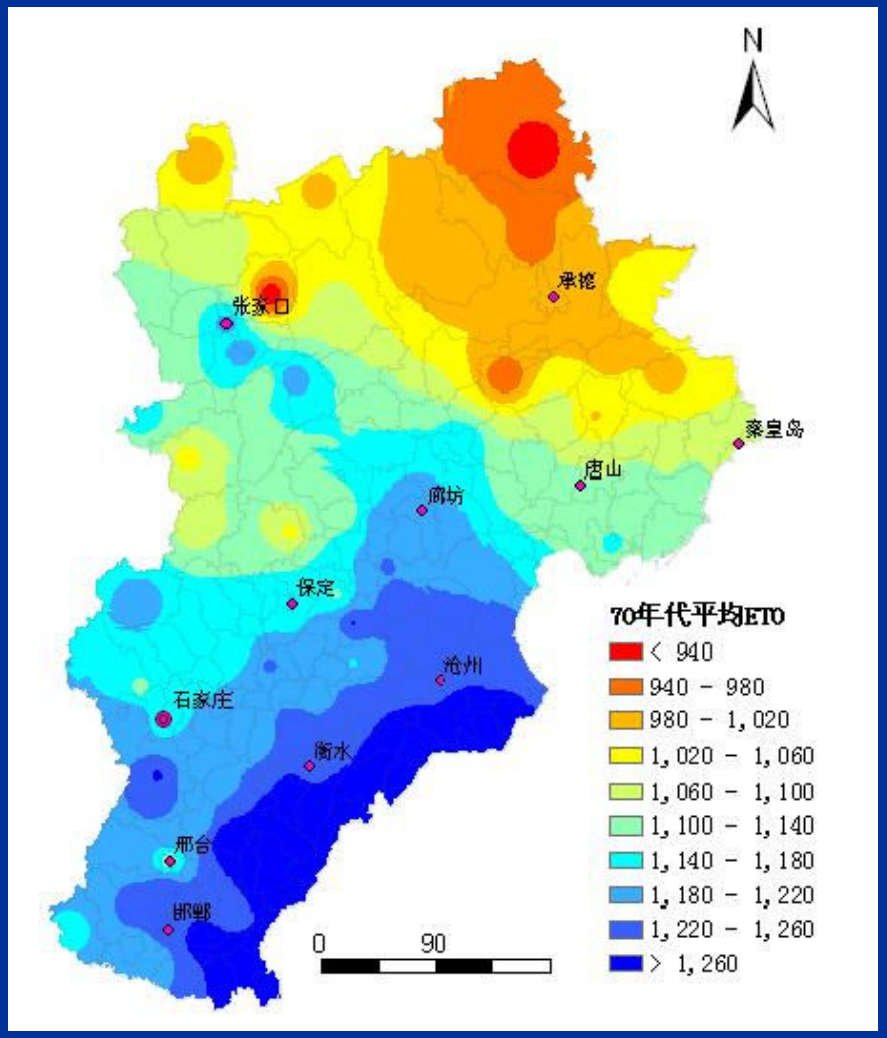
  spring - 19.9mm/10a

  summer - 11.6mm/10a

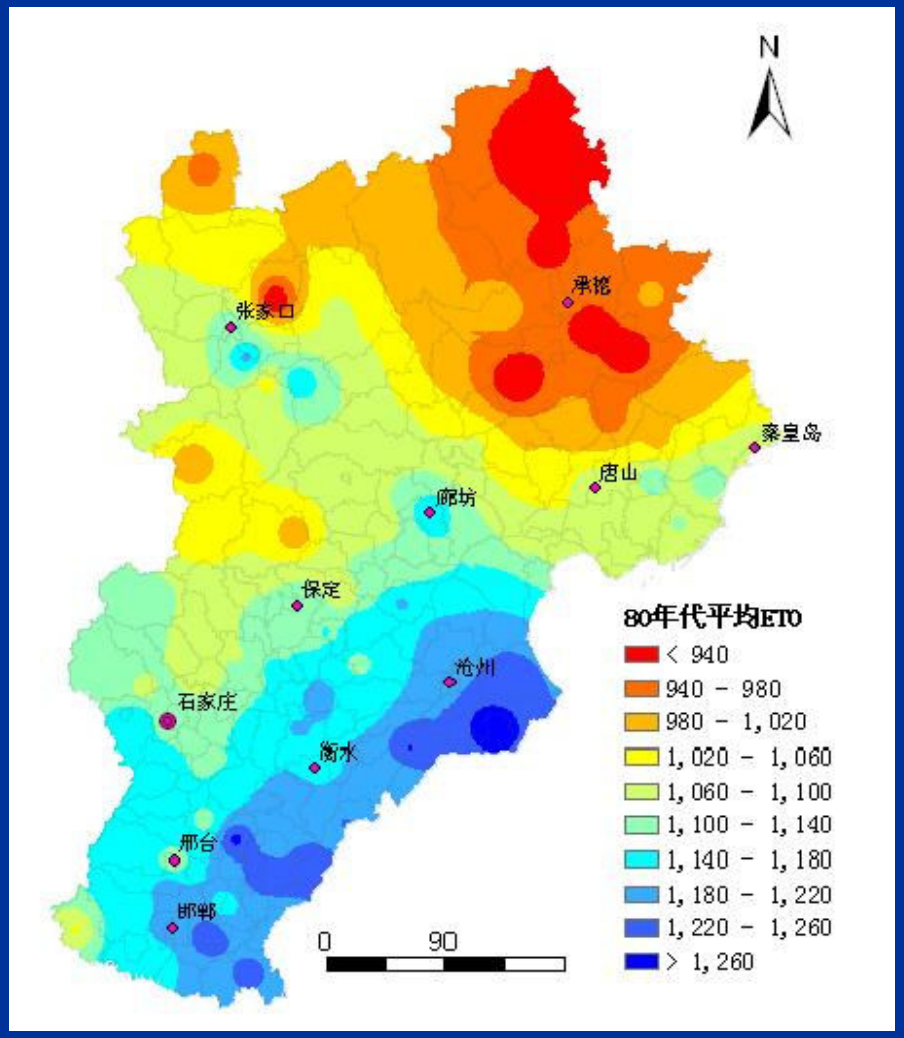
  autumn - 8.5mm/10a

  winter - 4.4mm/10a

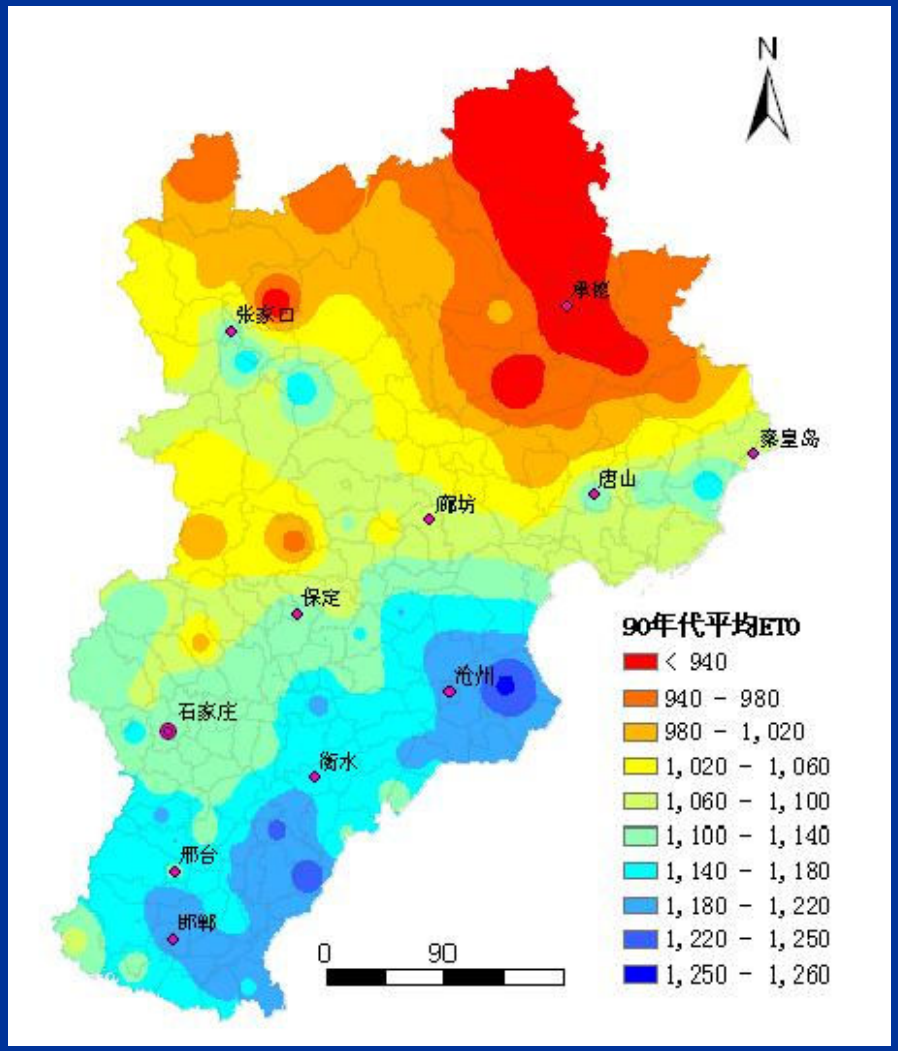
- year - 43.6mm/10a



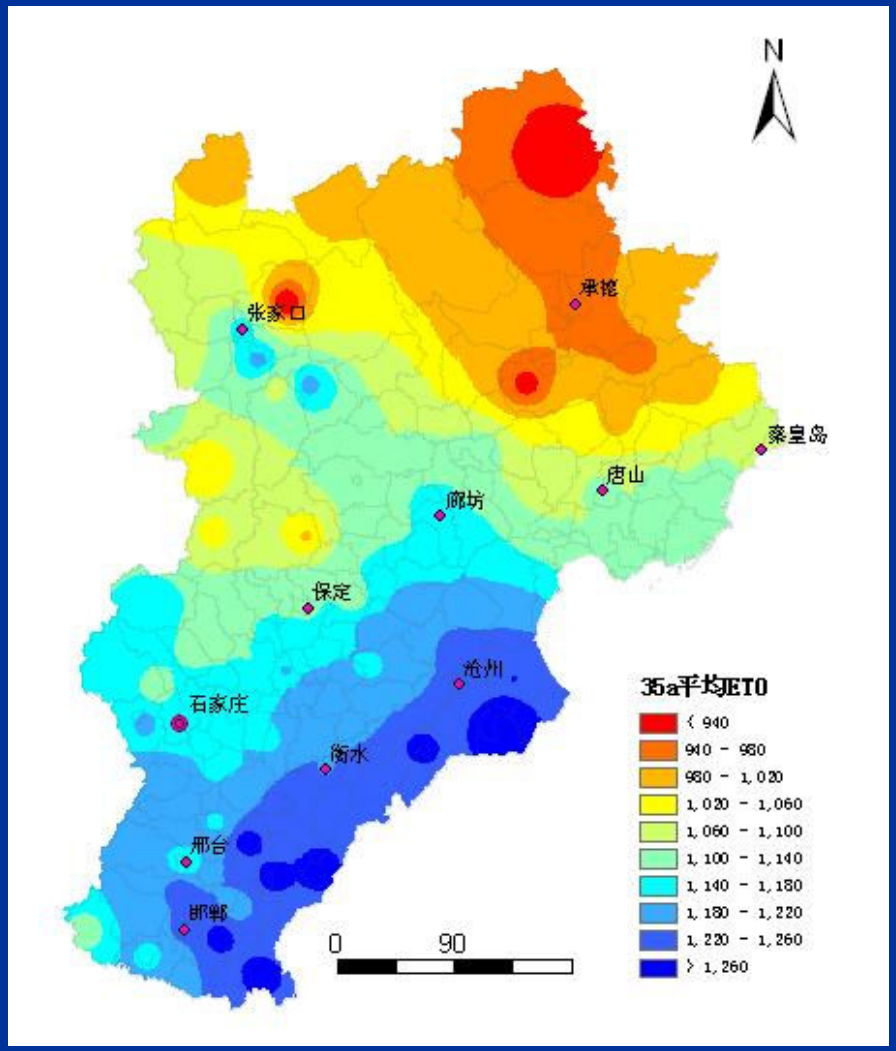
1971-1980



1981-1990



1991-1999



1965-1999

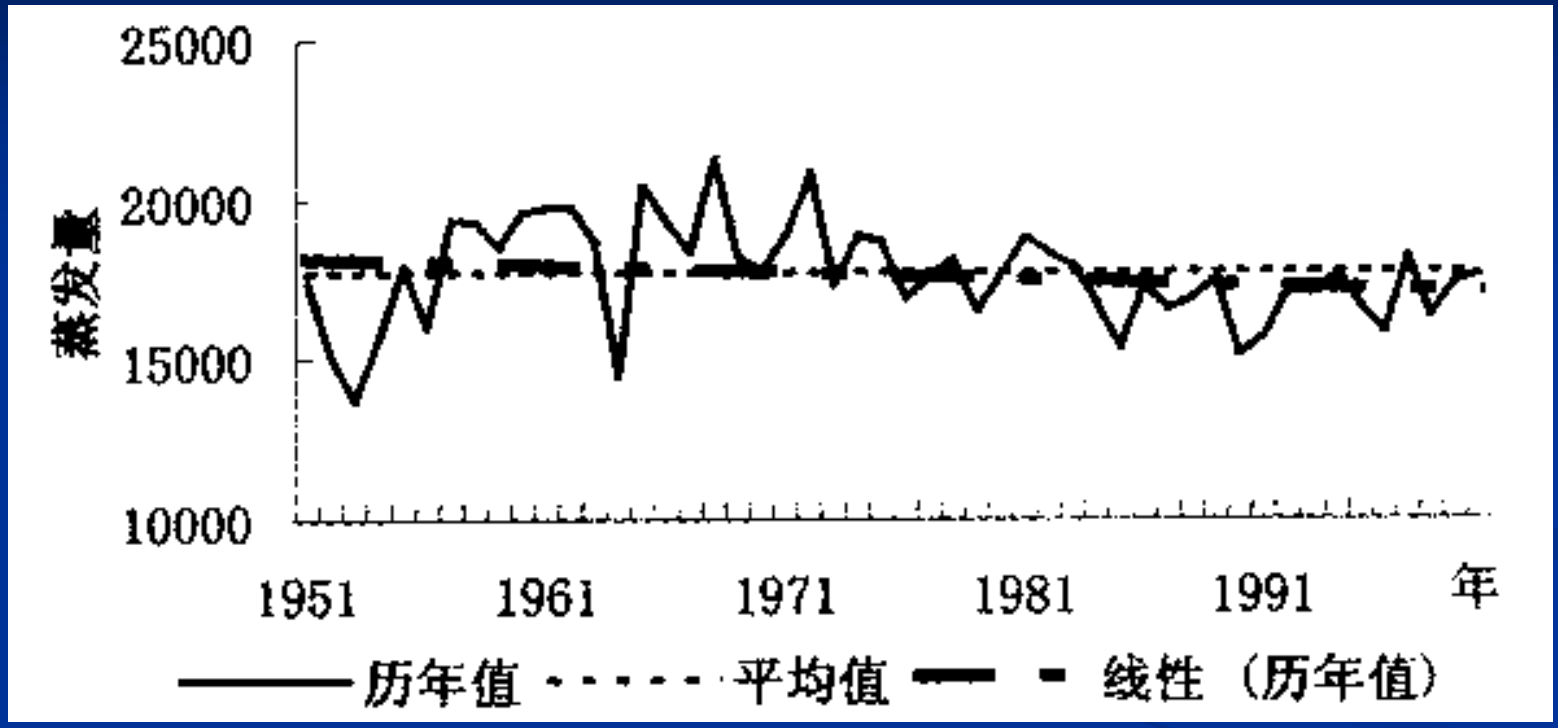
ETo Change & Climate

- the correlation between ETo and meteorological elements

S N	Wind Sp.	SunS. H.	Temperature	Relative Humidity
Kangbao	0.7209**	0.6018**	-0.1400	-0.2745
Zhangjiakou	0.7729**	0.5769**	-0.3120	-0.1414
Chengde	0.8413**	0.7309**	-0.0077	-0.7117**
qinhuangdao	0.6136**	0.6281**	0.2652	-0.5108**
Tangshan	0.3772*	0.7019**	0.3486*	-0.7260.**
Baoding	0.6439**	0.3206	0.1819	-0.4592**
Hengshui	0.8676**	0.7336**	-0.1914	-0.5928**
Shijiazhuang	0.4987**	0.5093**	0.0047	-0.394*
Xingtai	0.7817**	0.7091**	-0.0745	-0.2024
Handan	0.6485**	0.5347**	0.0829	-0.5650**
shenzhou	0.8207**	0.7206**	0.0535	-0.4700**

** 0.01 , *0.05 , No * no significant

Observed evaporation change



Decreased yearly and seasonly

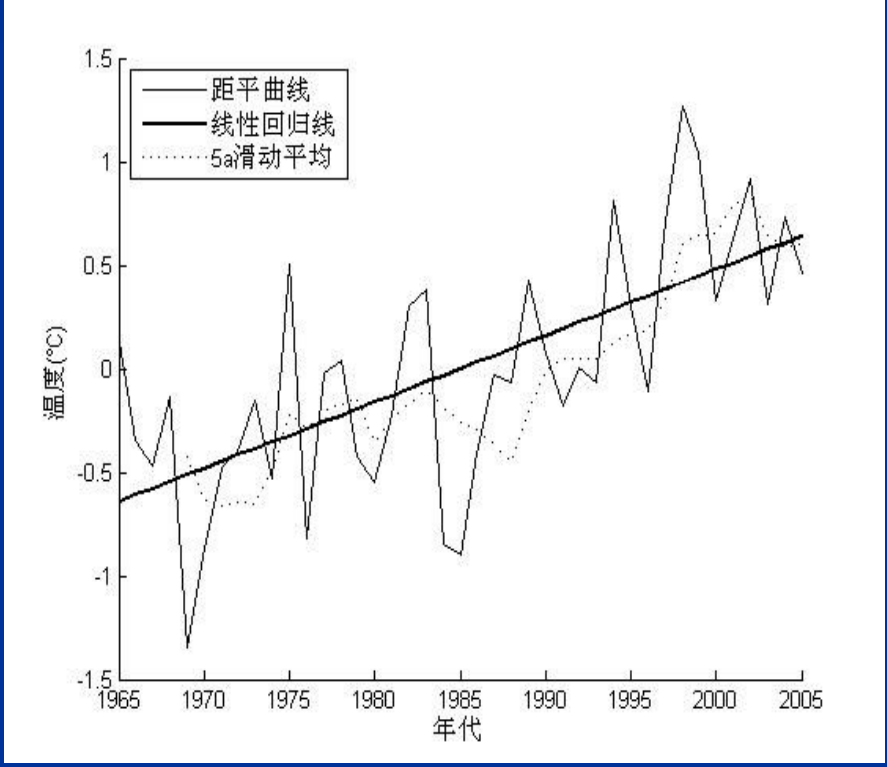
Spring, summer, autumn , winter

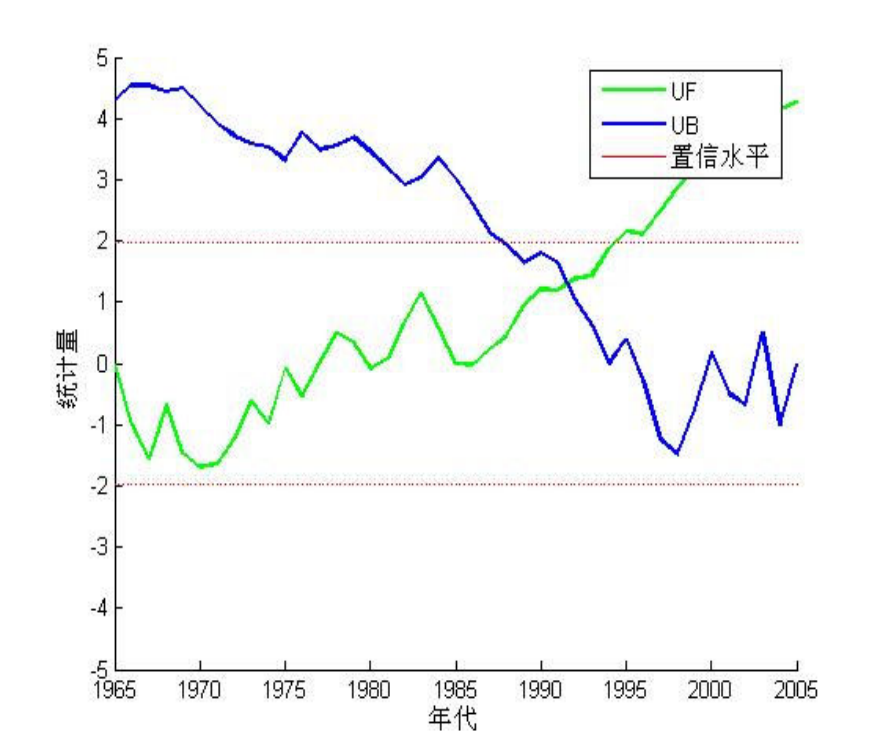
9.97, 6.28, 2.92, 0.82

(After Yuegai An,

Climate Change of Hebei

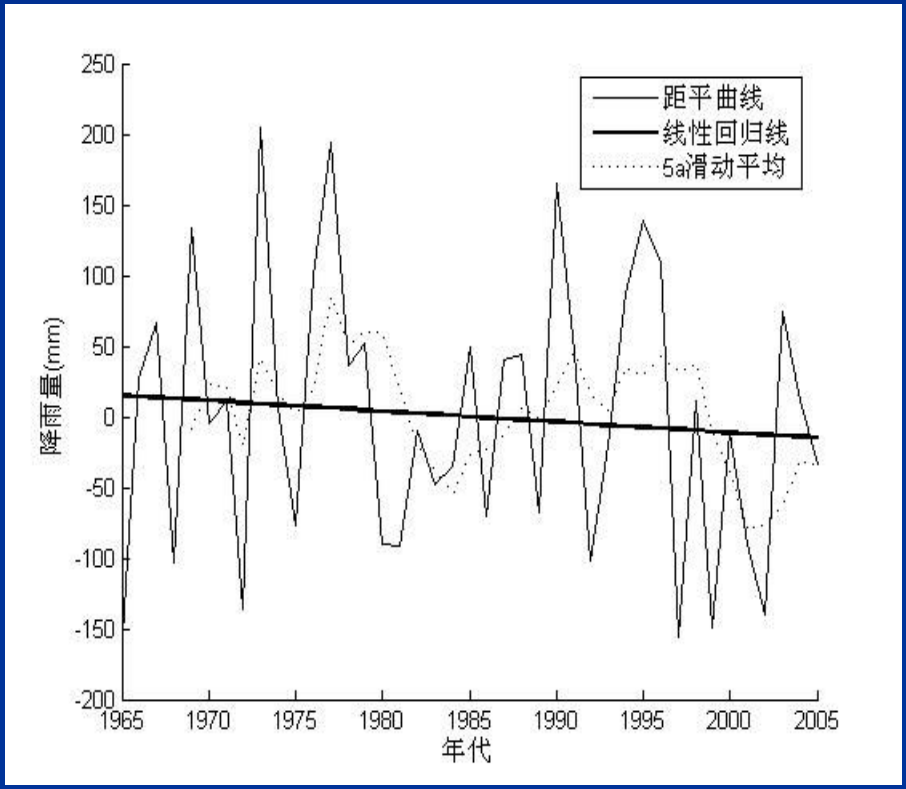
- Annual temperature

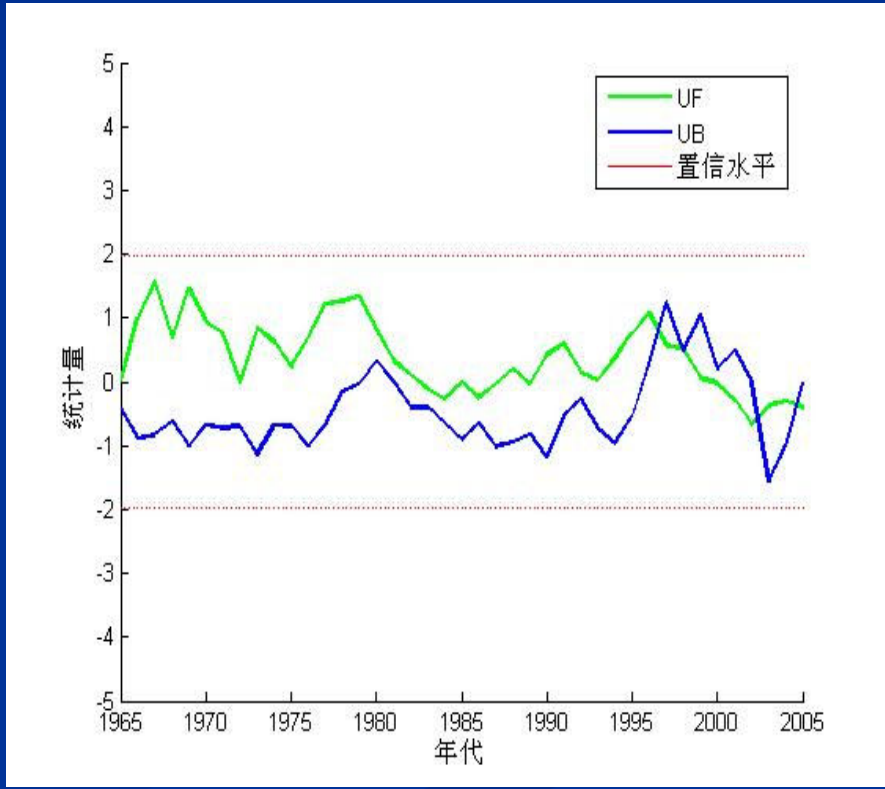




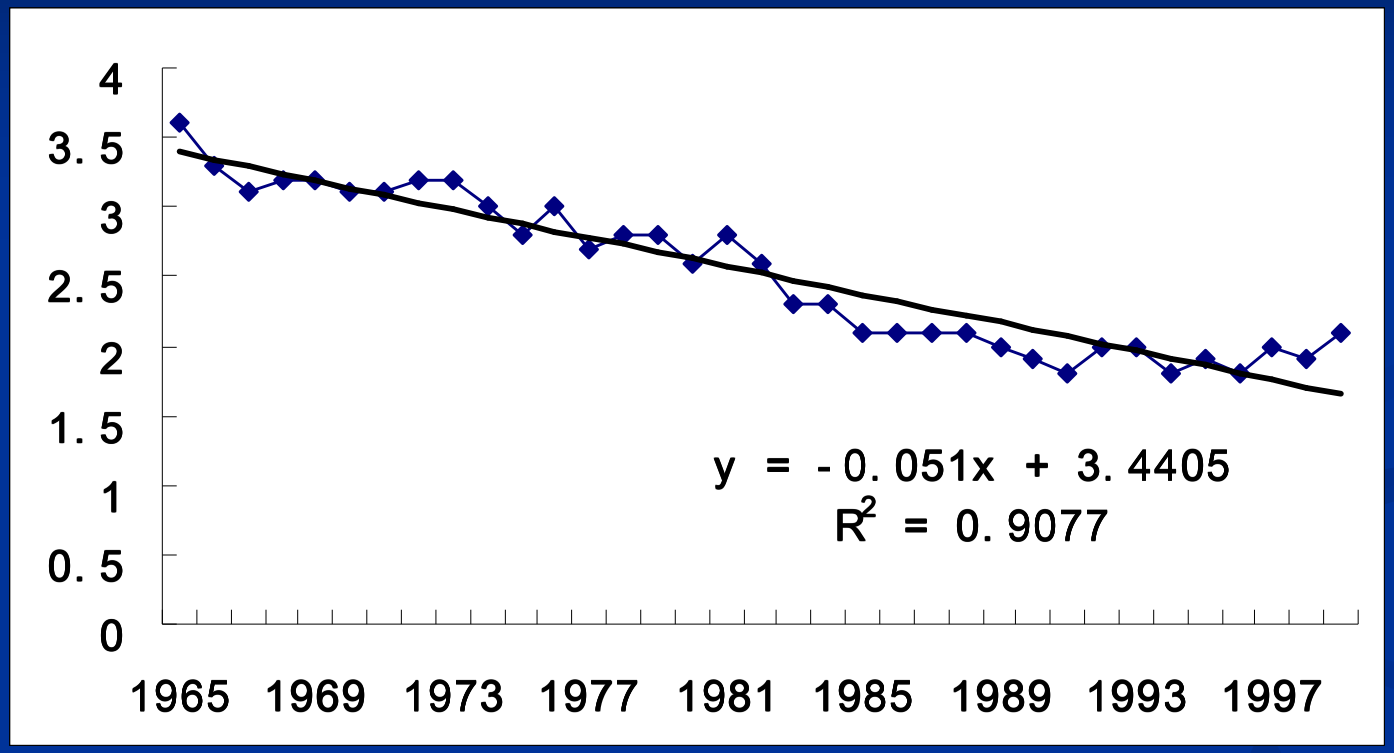
Climate Change of Hebei

- Precipitation



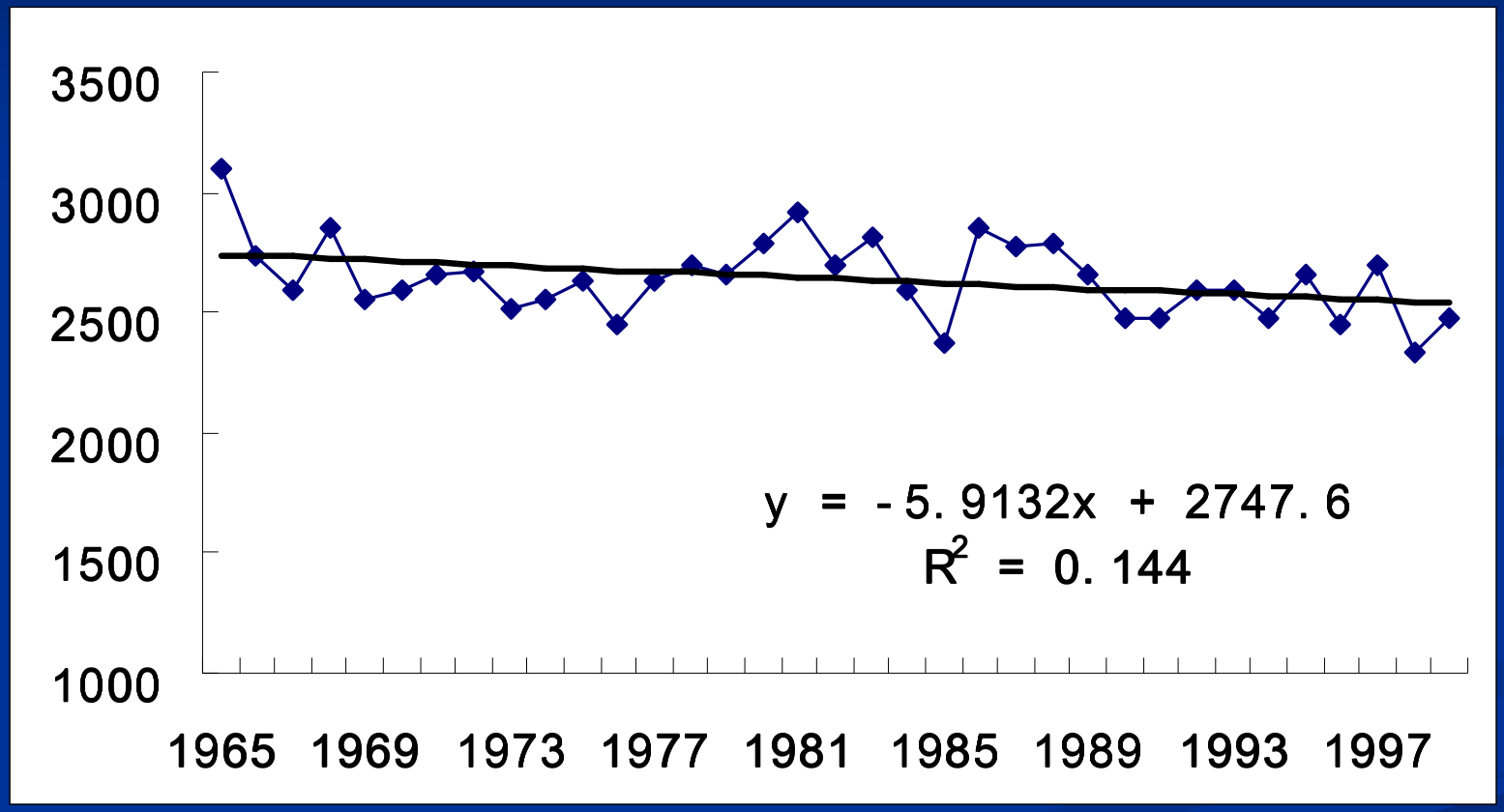


Wind speed change



Shenzhou Weather station

Sunshine hours change



Shenzhou Weather station

ET_m Changes Trends

- **Winter wheat**

decreased from 1960S to 1990S,

and the mean value was 26mm/10a

$y = -2.5843 x + 540.13$ $R^2=0.5554^{**}$

decreased by 15mm/10a in east

$y = -1.4994 x + 496.49$ $R^2= 0.3037^{**}$

decreased 28mm/10a in middle and south

$y = -2.8396 x + 550.39$ $R^2= 0.5812^{**}$

**** p=0.01**

ET_m Changes Trends

- Summer Corn

  decreased tendency by 9.7mm/10a

  y = -0.9729 x + 433.85 R^2= 0.1573*

  decreased by 10.1mm/10a in middle areas

  y = -1.0159 x + 428.96 R^2= 0.169 *

  decreased by 9.4mm/10a in south areas

  y = -0.9414 x + 437.43 R^2= 0.1393*

  * p=0.05

Conclusion & Discussion

- The reference evapotranspiration of annual and seasons were decreased with time in Hebei, and its declined tendency was statistically significant ($p > 0.95$).
- The main reason for ET decrease was the reduction of sunshine hours and wind speeds.

Conclusion & Discussion

- The crop water requirements (winter wheat and summer corn) have a decreased tendency during 1965-1999 in Hebei Province, China.

Conclusion & Discussion

- It declined 26mm/10a and 9.9mm/10a for wheat and corn respectively
- The rate of CWR was sensitive to the variations of sunshine hours, wind speed and humidity

Discussion

- **Climate change & water lose**

  the result is not as we think in general

  other elements are change, too

- **Climate change's effect on food security**

  extreme weather and climate events

  water resources: available water

Thanks
for your attention