Yale 耶鲁大学-南京信息工程大学大气环境中心

Yale-NUIST Center on Atmospheric Environment

Temporal and Spatial Characteristics of Drought in Summer Maize Season of Hebei Province and Its Effect on Yield

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Outline

- Introduction
- Materials and Methods
- Results
- Discussion and Conclusions

Introduction

ise in the future, the
des will fall, and droughts

account for about 85% of
and drought causes about
50% of the damage.

Hebei province, located in th
drought disaster frequently
summer maize growing area

Materials and Methods

- Observed data
- Drought indexes
- Mann–Kendall test
- Drought frequency (Pi)
- Drought station ratio (Pj)

Materials and Methods

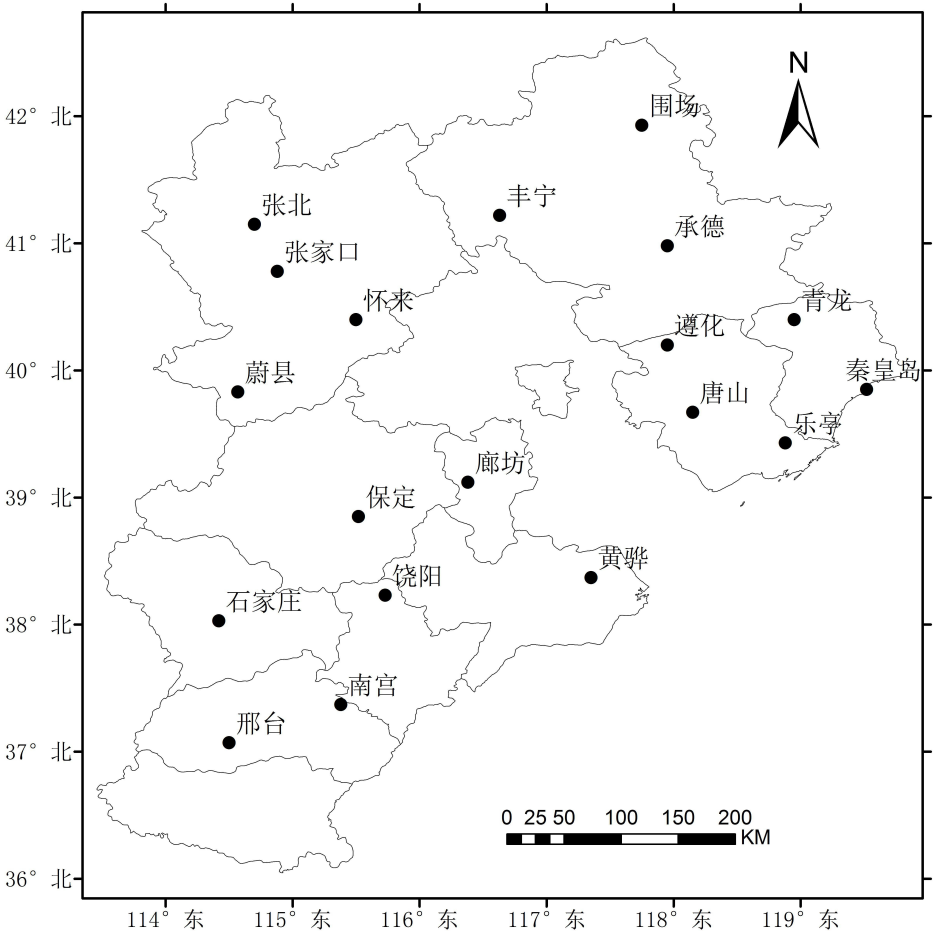
- **Observed data**

This study uses 19 weather stations meteorological data, from the China Meteorological Data Service Center(CMDC).

The dataset covers the period 1961–2014 .

The summer maize yield data from the Agricultural Meteorological Test Station

This study uses drought disaster data from Statistical Yearbook of Hebei Province



Materials and Methods

- **Drought indexes**

SPI (Standardized Precipitation Index)

SPI is a simple, and more commonly used, drought index.

$$g(x) = \frac{1}{\beta^{\alpha}\Gamma(\alpha)} x^{\alpha-1} e^{-x/\beta} \qquad (x > 0)$$

$$\Gamma(\alpha) = \int_0^{\infty} x^{\alpha-1} e^{-x} dx \qquad \alpha = \frac{1+\sqrt{1+4A/3}}{4A} \qquad \beta = \frac{\bar{x}}{\alpha}$$

$$A = \ln(\bar{x}) - \frac{\sum \ln(x)}{n}$$

$$H(x) = q + (1-q)G(x)$$

Materials and Methods

- SPI

当0<H(x)≤0.5时

$$SPI = -(t - \frac{c_0 + c_1 t + c_2 t^2}{1 + d_1 t + d_2 t^2 + d_3 t^3}) \qquad t = \sqrt{\ln\left[\frac{1}{H(x)^2}\right]}$$

当0.5<H(x)<1时

$$SPI = (t - \frac{c_0 + c_1 t + c_2 t^2}{1 + d_1 t + d_2 t^2 + d_3 t^3}) \qquad t = \sqrt{\ln\left\{\frac{1}{\left[1.0 - H(x)^2\right]}\right\}}$$

c0=2.515517；c1=0.802853；c2=0.010328；
d1=1.432788；d2=0.189269；d3=0.001308。

Materials and Methods

- Drought classification according to SPI Values

SPI range	Drought classes
2 or more	Extremely Wet
1.5-1.99	Very Wet
1-1.49	Moderately Wet
0.99-0.0	Normal
0.0 to -0.99	Near Normal
-1 to -1.49	Moderately Dry
-1.5 to -1.99	Severely Dry
-2 and less	Extremely Dry

Materials and Methods

- **Mann–Kendall test**

H0：The data {Xi} are a sample of n independent and identically distributed random variables.

H1：Each value {Xi|i = 1, 2,. . ., N-1} is compared with all subsequent values of {Xj|j = i+1, i+2, ..., N} and sum of the times of Xj > Xi.

$$p = \sum_i n_i$$

$$S = \left(\frac{4p}{(N(N-1))}\right) - 1$$

$$E(S) = 0$$

$$Var(S) = 2(2N+5)/(9N(N-1))$$

$$Z = S/(Var(s))^{\frac{1}{2}}$$

Materials and Methods

- Drought frequency (Pi)

Representation site has a frequent occurrence of drought in the year of data

$$Pi = (\ \mathrm{n}\ /\ N\ ) \times 100\ \ \%$$

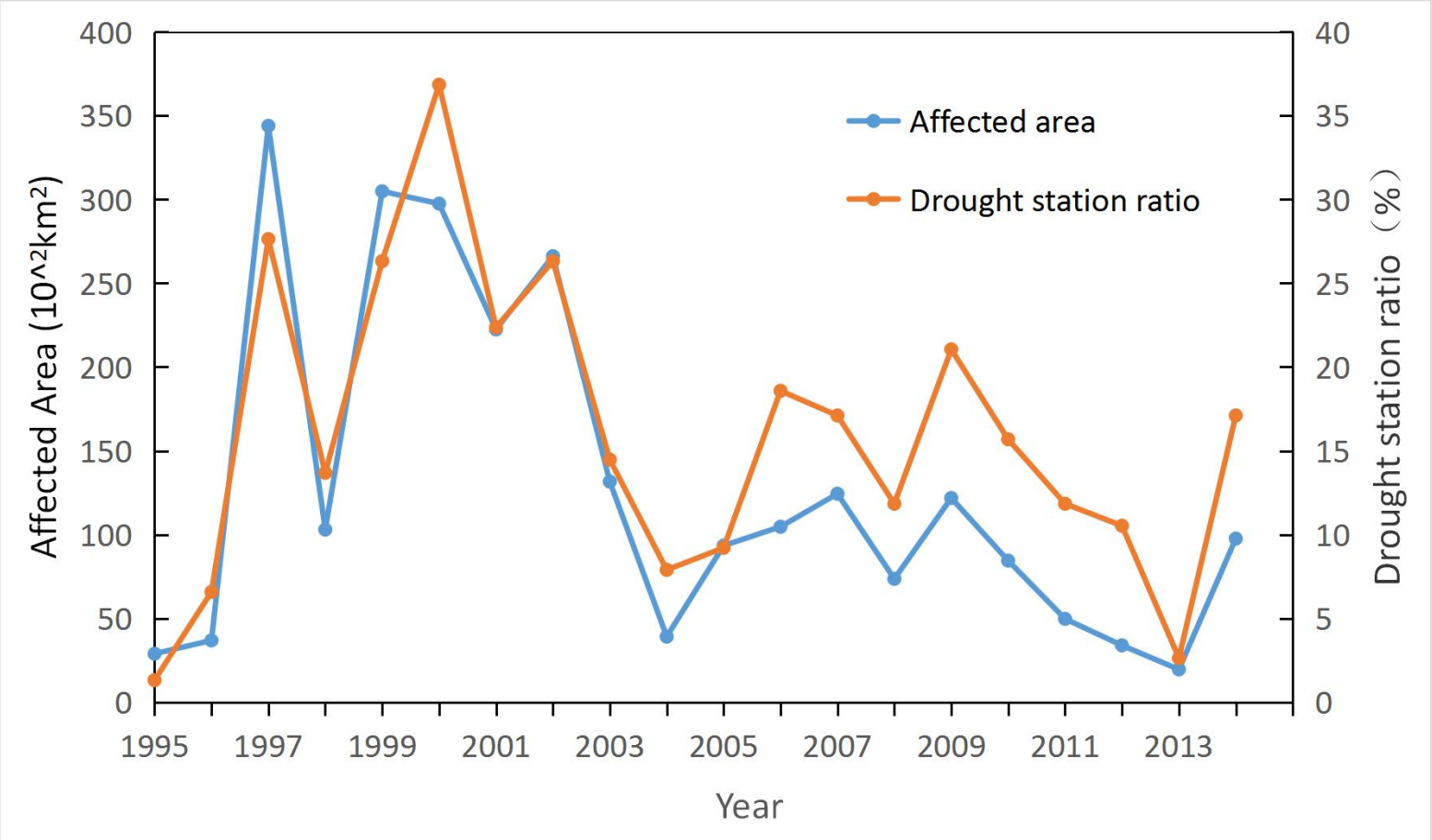
- Drought station ratio (Pj)

Pj is the size of the drought affected by the proportion of the number of stations in the area to the total number of stations

$$P\,\mathrm{j} = (\,m\ /\ M\ ) \times 100\ \ \%$$

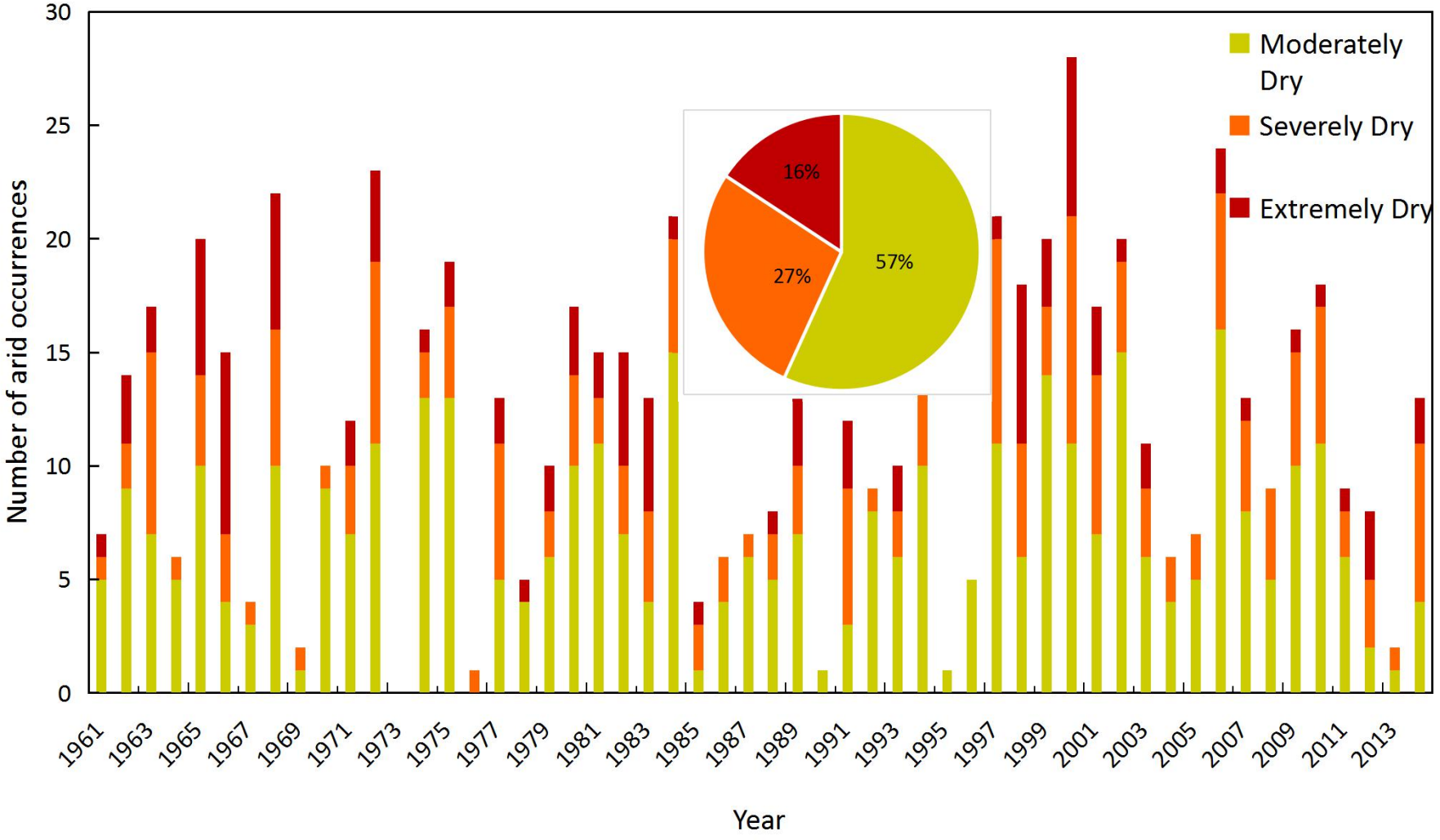
Results

- Comparison of Drought Disaster Area and Drought Station Ratio in Hebei Province over Time



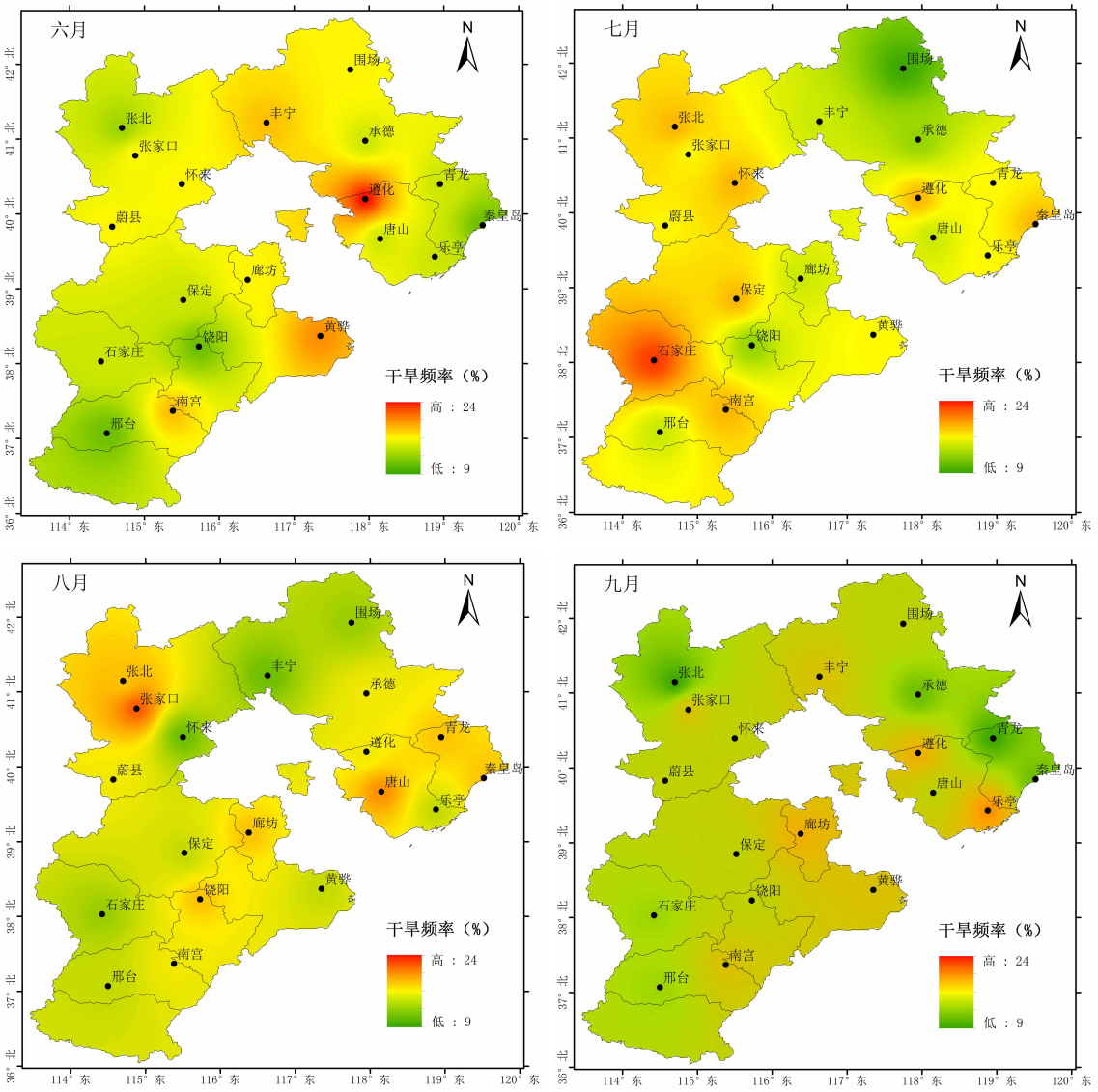
Results

- Time Variation of Occurrence of Drought in Different Degree in Hebei Province



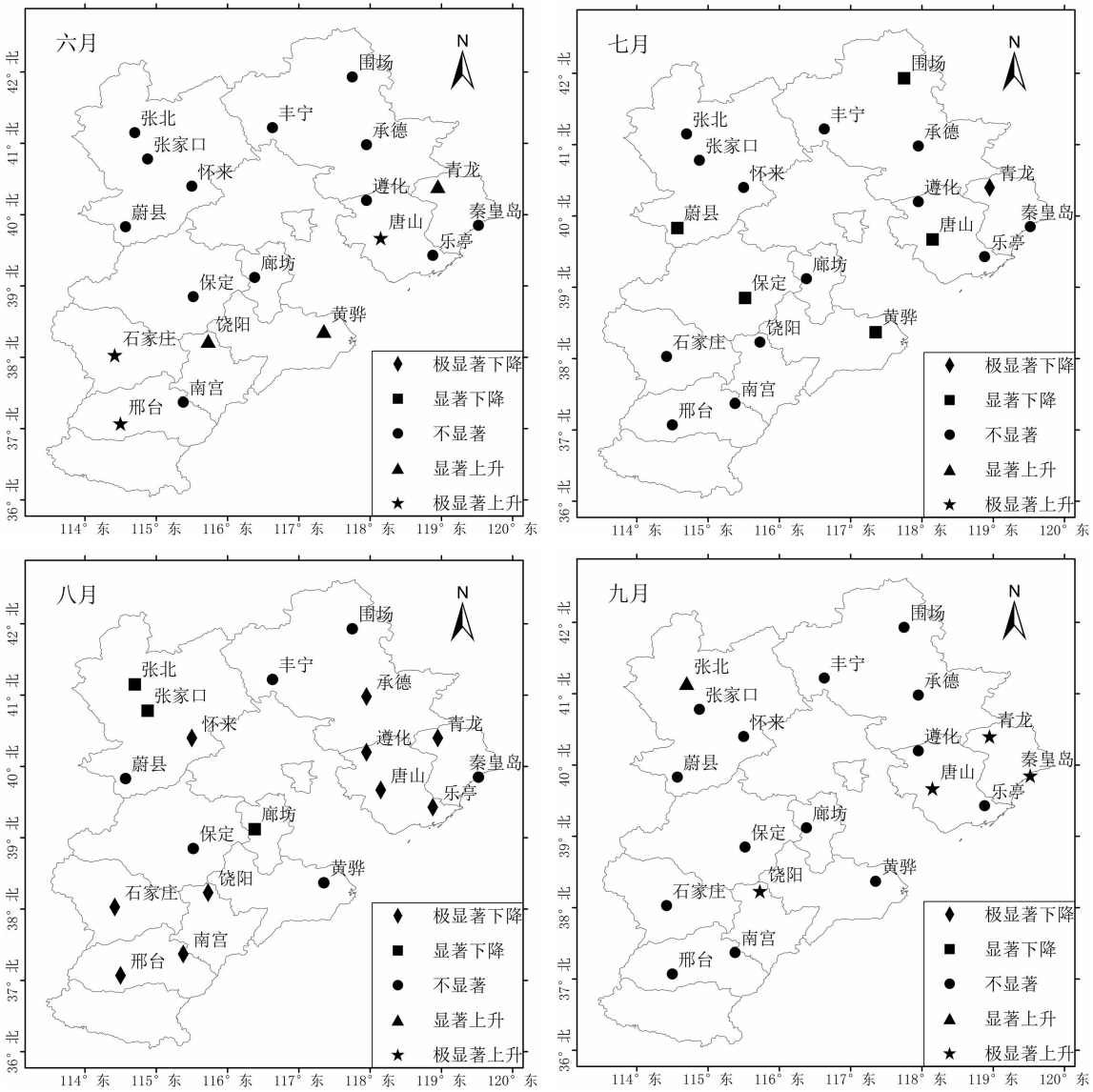
Results

- **Spatial Characteristics of drought**



Results

- **Drought trend analysis**



Results

- The correlation between SPI and summer maize yield

月份 / 站点	六月	七月	八月	九月
张北	-0.212	0.382*	0.02	-0.111
蔚县	0.093	0.479**	0.359*	0.053
石家庄	-0.286	0.058	-0.126	0.049
邢台	-0.12	0.191	0.052	0.425*
丰宁	0.237	0.437*	0.307	-0.126
围场	0.096	0.144	0	-0.189
张家口	0.243	0.199	-0.001	0.085
怀来	0.407*	0.594**	0.473**	-0.206
承德	0.183	0.558**	0.217	0.024
遵化	0.216	0.478**	0.098	0.321
青龙	0.025	0.278	-0.089	0.068
秦皇岛	0.307	0.426*	-0.096	0.249
廊坊	0.476**	0.144	-0.12	0.245
唐山	0.233	0.248	-0.446*	0.234
乐亭	-0.035	-0.164	-0.053	0.006
保定	0.09	-0.098	-0.115	-0.149
饶阳	-0.003	-0.137	-0.203	0.055
黄骅	0.281	0.359*	0.355*	0.148
南宫	0.055	0.047	0.034	0.221

Discussion and Conclusions

Analysis of temporal characteristics of drought in Hebei Province for the period 1961–2014

(1) The more severe the drought level, the less the number of occurrences.

(2) After 80 years the situation of drought in Hebei Province more and more severe.

(3) 60, 80 years of extreme drought occurred more. Since 2000, it is in the drought and drought occurred more.

Discussion and Conclusions

Analysis of temporal characteristics of drought in Hebei Province for the period 1961–2014

Times Age	Moderately Dry	Severely Dry	Extremely Dry	Average drought times
60 years	6	3	2.9	11.9
70 years	6.8	2.7	1.4	10.9
80 years	7	2.8	2.1	11.9
90 years	6.5	3	1.7	13.9
Since 2000	7.4	4.4	1.6	13.4

Discussion and Conclusions

Analysis of spatial characteristics of drought in Hebei Province for the period 1961–2014

(1) The frequency of drought were between 9% -24%, the drought situation is still more serious, especially Zunhua, Zhangjiakou,Nangong.

(2) The maximum precipitation was in September, and the frequency of drought was only 14.7%. Most sites in June have a low frequency of drought, except for individual sites. Drought occurred more frequently in July and August.

Discussion and Conclusions

Analysis of trends in SPI for the period 1961–2014

(1) June and September SPI trends are on the rise.

July and August SPI changes are showing a downward trend.

(2) Most of the site changes trend is not significant, showing the complexity of space

Discussion and Conclusions

Correlative Analysis of SPI and Summer Maize Yield

(1) July, August correlation is better, June, September correlation is poor.

(2) Strengthen monitoring of drought in July and August.

Period	Growth Period
6/10-6/20	Sowing
6/17-6/27	Emergence
6/23-7/5	Three leaf stage
7/1-7/15	Jointing
7/28-8/11	Tassel
8/25-9/15	Grouting
9/15-9/30	Maturity

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