Research on Key Technologies of Agricultural Drought Prevention and Drought Relief

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***Abstract* - Drought and water shortage has become a constraint to sustainable development bottleneck. Therefore, drought has become a major concern of the province's hot issues. While scientists have made some achievements in the study of drought, but people for basic research is not enough arid. Based on risk management philosophy, presented drought management planning, basic research, plan system, drought monitoring, drought information system, optimize the allocation of water resources, drought insurance and primary water service system in drought service organizations as the center of Liaoning northwest agriculture drought long-term defense responses; the second is based on the concept of crisis management, from engineering and non-engineering two levels, sub-regional organizations to prepare proposed emergency drought resistance, drought consultation, plans to start, water scheduling, call drought supplies, emergency water construction, emergency drought irrigation technology and other short-term emergency countermeasures.**

Keywords - Drought prevention, trend forecast; intelligent agricultural, spatial, incentive model

I. INTRODUCTION

Drought is the first meteorological disaster facing humanity, the global annual economic losses caused by drought up to 60 to 80 billion US dollars, far more than the other meteorological disasters [1]. Especially in the north and northwest, drought came in first in all kinds of meteorological disasters. This is not only because the wide distribution of drought, long duration, occur frequently, affecting wide, serious losses, but also because of its influence after ductility, although the drought is over, but it gives all aspects of socio-economic environment caused further It will continue for some time. Especially in recent years, under the impact of global warming, the drought was increasing the frequency, long duration, expand the scope of the loss worsening trend [2, 3].

Agricultural drought risk assessment usually contains a single index, double index and multi-index system evaluation [4]. Wherein, Wu and other two with SPI and CSDI drought index for the evaluation, analysis of drought risk of agricultural Nebraska soybean and corn growing season before, and divided by the index value of agricultural risk rating; Shahid and other binding SPI index and GIS technology to evaluate the risk of drought in West Bengal agriculture different time scales; often based on the principle of information diffusion. The drought affected area with plantings ratio index, agricultural drought risk of Gansu Province were assessment [5].

Agricultural drought risk that the combined effect of multiple indicators, it is hazards, hazard bearing body, the result of disaster environment interaction is the region to deal with the risk of drought, a comprehensive study of exposure, fragility and drought resistance. Thus, the present project from drought risk, exposure, vulnerability and drought resistance perspective, considering the regional meteorological and hydrological conditions, soil conditions, crop cultivation, irrigation capacity, regional drought mitigation capacity and other indicators, the establishment of agricultural drought risk evaluation system.

II. RELATED THEORY AND METHOD

A. Situation Index of Drought

Drought index is to determine whether the occurrence and severity of drought standard is the basis for research and analysis of the drought, all kinds of drought have their different advantages and disadvantages and applicability, from different angles, the resulting drought indices are not the same [6, 7]. To strengthen the study of drought indicators, analysis of drought situation, grasp drought events feature, many scholars have been studying the drought index is determined. However, due to differences in geography and climate characteristics, the definition is different in different parts of the arid, drought indicators are also diverse [8].

Meteorological drought index is generally a single factor index. Its main feature is a single feature (rainfall) as a measure of drought, the method is simple, but since the drought of this complex and comprehensive phenomenon attributable simply to the impact of a feature is not comprehensive enough, so the only large area occurred

severe droughts, rainfall has become the decisive factor in making the drought when the drought which gives results of the analysis possible with the actual match. Meteorological drought is mainly selected rainfall, temperature, evaporation and other factors to establish drought index, such as rainfall anomalies, standardized rainfall index, rainfall temperature homogenization index, dryness index, relative moisture index and so on [9, 10].

B. Surface Temperature Vegetation Index Slope Method

Exists between vegetation index (NDVI) and surface temperature (LST) significant negative correlation, LST/NDVI slope of the line is valid parameter reflects soil moisture condition, LST/NDVI characterize the slope the greater the smaller the soil moisture, LST/NDVI the smaller the greater the slope of the line characterization of soil moisture, which is the theoretical basis for the use of surface temperature monitoring soil moisture vegetation index slope method.The formula LST/NDVI slope of the line is as follows:

$$\sigma = LST / NDVI \qquad (1)$$

Where, - LST / NDVI slope of the line;
LST-- land surface temperature;
NDVI-- normalized difference vegetation index.

Northwestern Liaoning province is the most impoverished areas of water resources. Northwestern Liaoning average years total 6.95 billion cubic meters of water, accounting for 20% of the province's total water resources; annual average surface water resources 5.197 billion cubic meters, accounting for 17% of the province's surface water resources; groundwater resources 38.67 billion cubic meters, accounting for 31% of the province's groundwater resources which was shown in Table 1.

TABLE 1. NORTHWESTERN LIAONING WATER RESOURCES FACT SHEET

area	1	2	3
Northwest of Liaoning	69.50	51.97	38.67
All province	341.79	302.49	124.68
Ratio	20%	17%	31%

C. Drought Characteristics

C1. Seasonal

Liaoning Northwest drought has obvious seasonal occurrence, the highest frequency occurred in the spring drought, the lowest frequency of droughts in autumn, summer centered. Geographically speaking, the higher the frequency of drought in Chaoyang, Fuxin and Jinzhou area, prone agricultural drought, a relatively low frequency of droughts in other regions, in particular in Table 2.

TABLE 2. NORTHWEST OF LIAONING FROM 1949 TO 2009 SEASONAL DROUGHT FREQUENCY (%)

area	Spring	Summer	Autumn
Zhaoyang	52.5	37.7	21.3
Fuxin	41.0	29.5	13.1
Huludao	16.4	18.0	4.9
Jinzhou	36.1	31.1	11.5
Shenyang	24.6	26.2	4.9
Tieling	31.1	26.2	9.8
arverage	33.6	28.1	10.9

C2. Frequent sex

Between 1949-2009, the region in northwestern Liaoning increased frequency of drought in the following table northwestern areas of drought frequency despite a slight decrease in 1960 to 1969 and from 1970 to 1979 as shown in the two periods, but droughts overall frequency has increased, particularly in Table 3.

TABLE 3.DROUGHT FREQUENCY OF NORTHWESTERN LIAONING IN DIFFERENT YEARS (%)

Year	1960-1969	1970-1979	1980-1989	1990-1999	2000-2009
Zhaoyang	50.0	40.0	90.0	80.0	80.0
Fuxin	20.0	40.0	80.0	80.0	80.0
Huludao	30.0	30.0	20.0	40.0	60.0
Jinzhou	40.0	30.0	80.0	70.0	60.0
Shenyang	10.0	40.0	40.0	50.0	60.0
Tieling	30.0	30.0	50.0	40.0	50.0
arverage	30.0	35.0	60.0	60.0	65.0

C3. Continuity

Drought occurred in northwestern Liaoning cities have continuity, Chaoyang and Fuxin region is particularly evident for several years of continuous drought in the Chaoyang area more than 4-7 years, shorter number of years of continuous drought occurred in other regions.

D. Drought Risk Assessment Methods

Considering the above drought-related risk in the study area, the impact of the exposure, vulnerability, disaster mitigation and other evaluation factors, according to the correlation between the size of each layer and drought risk assessment factors, uniform layers of each factor reclassified and each factor must be given the right to classify respectively after heavy establish drought risk Liaoning northwest comprehensive Assessment Model.

Eventually come to evaluate the subsystems sorting unit value index. Comprehensive expert advice and refer to the literature on the basis of determining the relative importance of each factor of judgment matrix.

A=

1.0000	2.0000	5.0000	3.0000
0.5000	1.0000	3.0000	2.0000
0.2000	0.3333	1.0000	0.5000
0.3333	0.5000	2.0000	1.0000

B1=

1.0000	2.0000	3.0000	5.0000	4.0000	6.0000
0.5000	1.0000	2.0000	3.0000	2.0000	4.0000
0.3000	0.5000	1.0000	3.0000	2.0000	4.0000
0.2000	0.3000	0.3333	1.0000	0.5000	2.0000
0.2500	0.5000	0.5000	2.0000	1.0000	3.0000
0.1667	0.2500	0.2500	0.5000	0.3333	1.0000

B2=

1.0000	0.3333
3.0000	1.0000

B3=

1.0000	0.5000
2.0000	1.0000

B4=

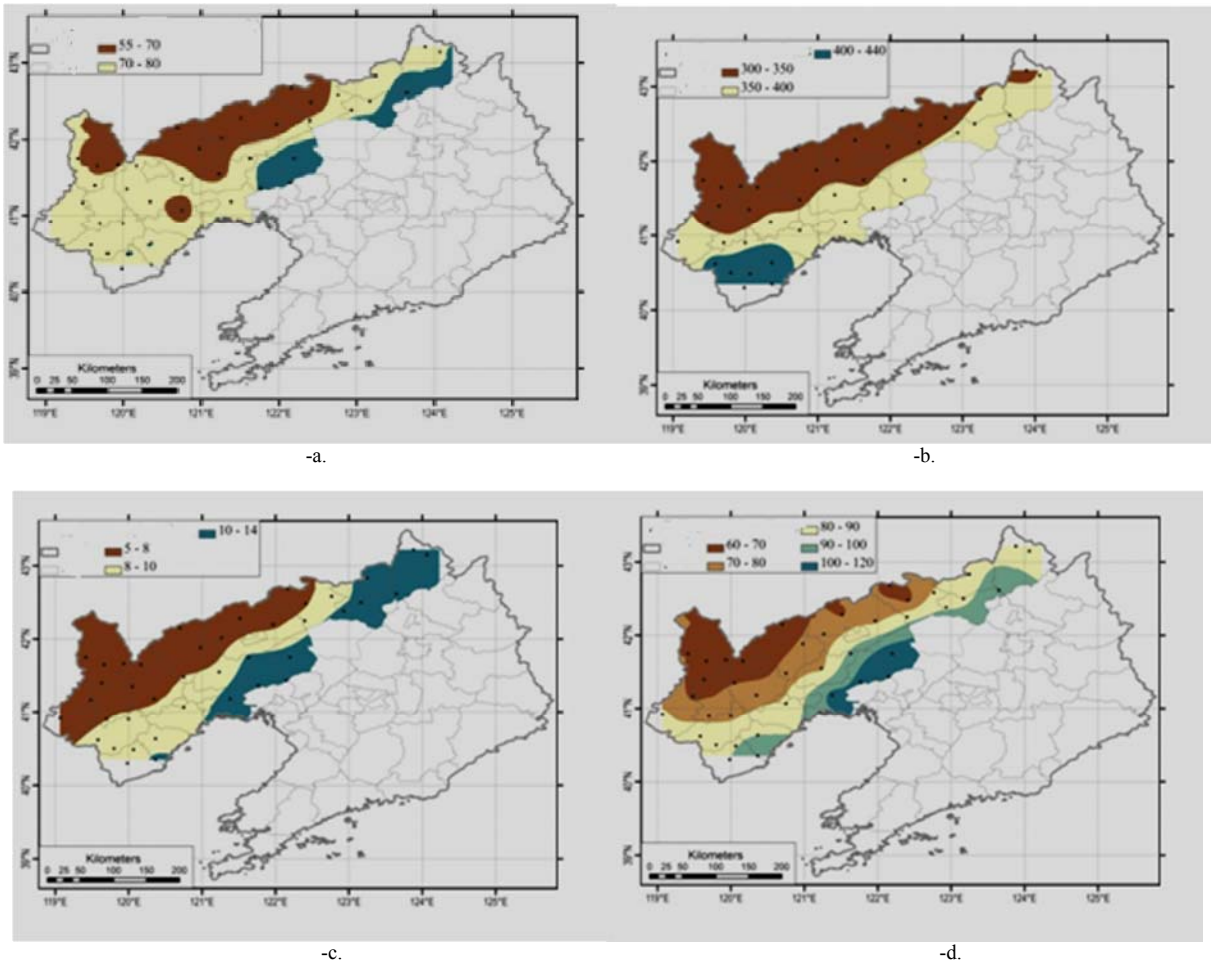
1.0000	0.5000	2.0000	3.0000
2.0000	1.0000	3.0000	5.0000
0.5000	0.3333	1.0000	2.0000
0.3333	0.2000	0.5000	1.0000

III. EXPERIMENTAL RESULTS

A. Distribution and Spatial Distribution of Rainfall During the Year

3, 4, 5 months in spring, 6, 7, in August for the summer, 9, 10, in November for the fall, December and next year in January and February for the winter. Changes in statistical analysis of rainfall characteristics of each season during the year, the results are shown in Table 41, the table shows that during the year seasonal distribution of precipitation in northwestern areas and the poor, average, maximum rainfall in summer, each station an average of 357.5 mm, accounting for the year 68.4% coefficient of variation is the smallest of the four seasons, is 0.323; spring and autumn rainfall equivalent, respectively, 74.1 mm and 82.9 mm, 14.2 and 15.8% of the year, the variation coefficient of 0.479 and 0.493; minimum winter precipitation , for many years an average of only 9.0 mm, 1.7% of the year, the largest coefficient of variation, 0.912. Obviously northwestern Liaoning wet and dry season, spring, autumn and winter rainfall rarely, and inter-annual differences, explained before the spring planting season and autumn crop harvest, prone to drought or autumn drought. But winter precipitation rarely, this will lead to lack of soil moisture, affecting the second crop sown in the spring, forming drought.

The spatial distribution of precipitation from the northwestern Liaoning seasons (Figure 1) can be seen, in general, all season precipitation have shown decreasing from southeast to northwest trend, which in Jinzhou, Xinmin City, Changtu County, Huludao southern city of high precipitation, and Chaoyang and Fuxin region region region as the center, low precipitation.



-a. -b.

-c. -d.

Figure 1. Seasons spatial distribution of precipitation in northwestern areas: (a) the spring; (b) summer; (c) autumn; (d) winter.

B. Spatial Distribution of Drought Duration Characteristics

Figure 2 different municipalities in northwestern areas of the growing season to reproduce the longest rainless days.It is seen from Figure 2, for each return period, Fuxin region and growing season in Huludao longest consecutive rainless days, followed by a minimum of Chaoyang and Jinzhou, Shenyang and Tieling. Continuous use and the growing season, no rain date analysis method similar analysis in spring, summer, autumn maximum continuous no statistical characteristics and spatial distribution of rain for several days.

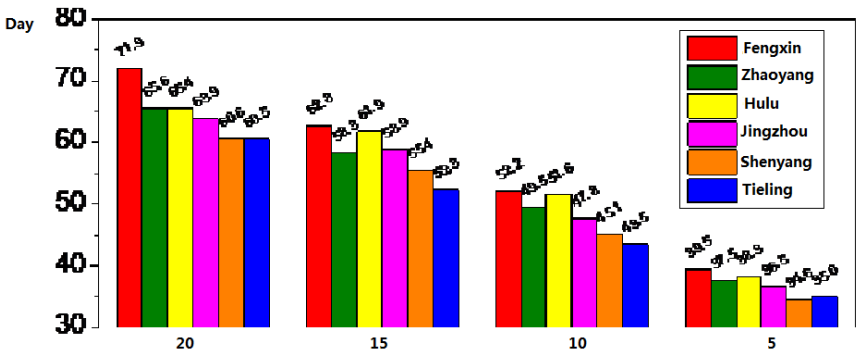


Figure 2. Northwestern Liaoning each different market average return period of the growing season (March to October) longest rainless days

C. Precipitation Cycle Analysis

Analysis of the average annual rainfall of 40 stations in northwestern areas, wet and dry season rainfall cycle this paper, wavelet analysis.

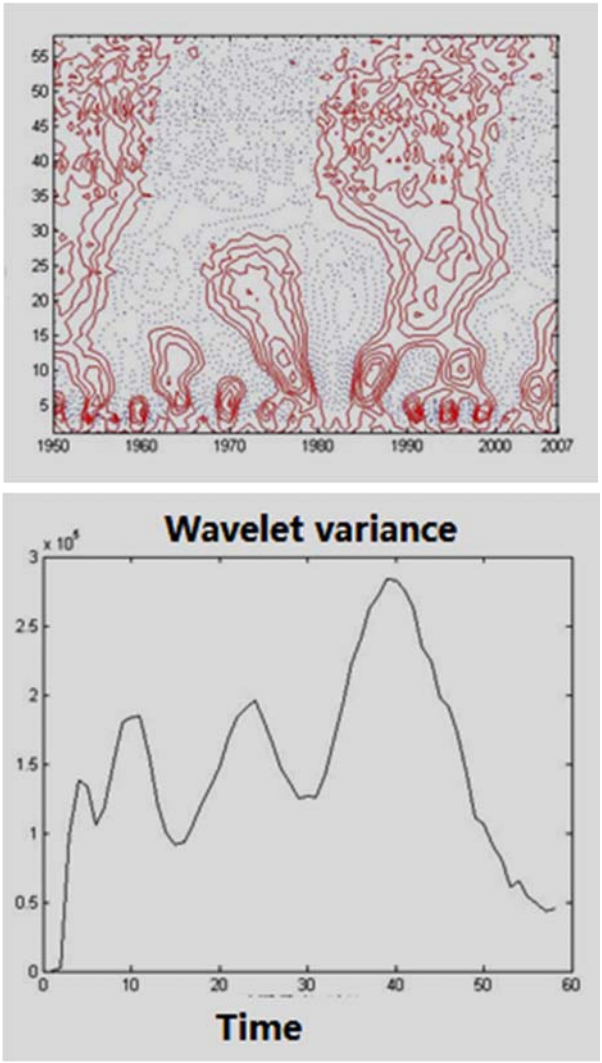


Figure 3. Wavelet analysis northwestern areas annual precipitation anomalies

And all of the above on the northwestern Liaoning season and accumulated precipitation anomaly curve is analyzed, it can be understood Year of wet and dry seasons occur and continuous length, but still to be analyzed on a periodic precipitation anomalies Figure there is a certain degree of difficulty, this section of northwestern areas using wavelet transform and various seasonal precipitation in cyclical analysis to more clearly show the dry periods and wet period precipitation.

Figure 3 is a wavelet analysis northwestern areas annual precipitation anomalies. Annual precipitation in northwestern areas exist five years, 9-11 years, 23 years and 40 years quasi-periodic variations. In the wavelet coefficients in the solid part of the layout, scale level 40 years from the time point of view, for the wet period throughout the 1950s, 60s and 70s for the dry season, the 1980s and 1990s as a wet period, after 2000 and into the dry season . With the decrease of time scales, 23 years, 9 to 11 years and five-year cycle is also evident, the shorter dimension of 9 to 11 years and 5-year period with better domain-wide.

D. Evaluation of Drought Risk and Drought

Agricultural drought are soil moisture and plant growth state characterized, in internal agricultural growing season long, no rain, the drought caused by the atmosphere, soil water, inhibited the growth of crops, leading to significant cuts, and even a kind of agricultural crops of meteorological disasters . On the basis of the collection of hydrological, meteorological, agricultural, social and economic history of a long series of drought-related data and field research, analysis of the history of western Liaoning and in recent years of drought-prone areas, the drought hit, and summarizes the occurrence and development of drought, refining the main impact of regional drought affecting factors. According arid Northwest Liaoning itself features a representative selection of indicators from the main influencing factors of drought, agricultural drought disaster construct risk evaluation system. According to the risk level analysis model established under the guidance of experts and prior knowledge, arid region of static risk assessment, risk map drawn arid northwestern areas and 17 major agricultural counties.

Drought risk assessment is an effective means to assist agricultural drought disaster risk management decision-making, the purpose of establishing drought risk evaluation system is a quantitative risk assessment of drought and standardized. Based on data collected in this project to analyze the characteristics of drought in northwestern Liaoning formation mechanism based on agricultural drought disaster risk, considering the risk of agricultural drought disaster in northwest Liaoning, exposure, vulnerability, and disaster mitigation four factors, from the drought the main factor in selecting a representative index, constructed northwestern Liaoning agricultural drought disaster risk evaluation system.

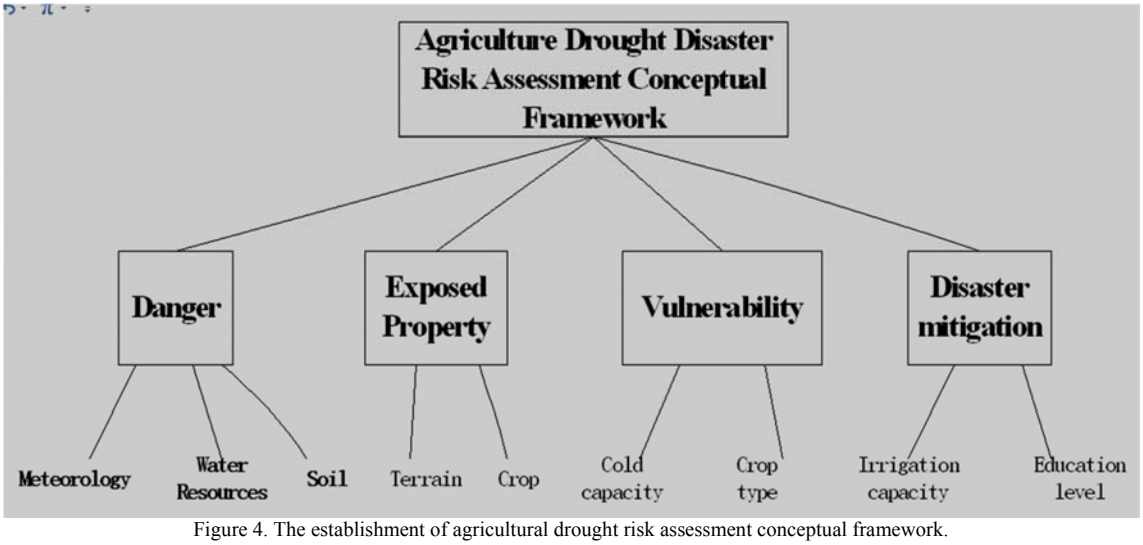


Figure 4. The establishment of agricultural drought risk assessment conceptual framework.

Taking full account of the dynamic nature of risk factors that affect maize drought and human factors, based on the establishment of agricultural drought risk assessment conceptual framework (Figure 4). The figure shows that agricultural drought risk into account the risk of agricultural drought disaster in northwest Liaoning, exposure, vulnerability, and disaster mitigation four main factors, each factor in turn constitute a particular sub-factor for each factor select the appropriate index based on climate and agriculture in northwestern Liaoning characteristics, building drought risk indicator framework.

IV. CONCLUSION

In this paper, northwestern Liaoning 1966-2010 years 47 stations in the information based on the use of rainfall anomaly percentage consecutive rainless days, soil moisture, river runoff from the Equality Index, analyzes the characteristics of temporal and spatial variation of rainfall in northwestern areas, different scales drought frequency, duration and other characteristics of drought; wavelet analysis method to analyze the characteristics of drought cycles and trends in northwestern areas, drought in northwestern areas proposed law of evolution; in rainfall as the main factor, the use of period superposition model, mean generating function model and time sequence analysis model, northwestern Liaoning (1966- 2010) 45 years of spring, summer, autumn and development trend of drought during the growing season was simulated.

REFERENCE

[1] Morid S, Smakhtin V, Moghaddasi M. Comparison of seven meteorological indices for drought monitoring in Iran[J]. International journal of climatology, 2006, 26(7): 971-985.

[2] Mozny M, Trnka M, Zalud Z, et al. Use of a soil moisture network for drought monitoring in the Czech Republic[J]. Theoretical and Applied Climatology, 2012, 107(1-2): 99-111.

[3] Du L, Tian Q, Yu T, et al. A comprehensive drought monitoring method integrating MODIS and TRMM data[J]. International Journal of Applied Earth Observation and Geoinformation, 2013, 23: 245-253.

[4] Chia-HungLien, Hsien-Chung Chen,Ying-Wen Bai, Ming-Bo Lin. Power Monitoring and Control for Electric Home Appliances Based on Power Line Communication[C]. Instrumentation and Measurement Technology Conference proccedings,2008,2-79

[5] Majid Khodier, Gamcel Saleh. Beamforming and Power control for interference reduction in wireless communications using particle swarm optimization[J]. International Journal of Electronics and Communications,2010,64(6):489-502

[6] Aleksandar Radonjie, Vladimir Vujicie. Integer SEC-DED codes for low power communications[J]. Information Processing Letters,2010,110(12-13):518-520

[7] Seungh wan Kim, Jinkyun Park, Sangyong Han, Hanjeom Kim. Development of extended speech act coding scheme to observe communication characteristics of human operators of nuclear Power Plants under abnormal conditions[J]. Journal of Loss Prevention in the ProcessIndustries,2010,23(4):539-548

[8] Son N T, Chen C F, Chen C R, et al. Monitoring agricultural drought in the Lower Mekong Basin using MODIS NDVI and land surface temperature data[J]. International Journal of Applied Earth Observation and Geoinformation, 2012, 18: 417-427.

[9] Hao Z, AghaKouchak A. A nonparametric multivariate multi-index drought monitoring framework[J]. Journal of Hydrometeorology, 2014, 15(1): 89-101.

[10] Pozzi W, Sheffield J, Stefanski R, et al. Toward global drought early warning capability: expanding international cooperation for the development of a framework for monitoring and forecasting[J]. Bulletin of the American Meteorological Society, 2013, 94(6): 776-785.