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Assessment of Climate Warming of Qinghai Province in 53 years (1961 - 2013)

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Abstract **– China drought is particularly prominent, involving a very wide range, mainly in the northwest, north and northeast regions, Qinghai Province is located in the dry arid areas of northwest China. The main objectives of the present study to investigate the climate and drought in Qinghai Province using characteristics of SPEI drought index as a meteorological drought index over a 53 years period of 1961 - 2013, for measuring the degree of climate change. This study to investigate distinguishes the effects of climate change on grassland over the Qinghai Province. Results showed a Qinghai Province, the high frequency of annual-SPEI drought in Banma, Tongde, Xining, Chaka and Ge'ermu. SPEI 12-month shows a high frequency of drought in 1972, 1992-1993, 1995-1996, and 1998-2004.Seven stations are selecting from all direction of Qinghai Province, which are: Mangya for Northwest, Tuolei for north, Nuomuhong for middle, Minhe for east, Tuotuohe for the west, Jiuzhi for southeast and Nangqian for the south. Mangya, Nuomuhong, Tuotuohe and Jiuzhi showed significant positive relationship between SPEI drought index with precipitation at the 0.01 while there is a significant negative relationship between SPEI and temperature at the 0.01. Minhe showed a significant negative relationship between SPEI and temperature at the 0.01. Nangqian and Tuolei showed there is no a significant relationship between SPEI drought index with precipitation and temperature. Annual-SPEI UF curve shows lines intersect in 1993 which that is the beginning of mutation detection of the droughts in Qinghai Province, the location of the areas which is changing from humid to drought is: Mangya, Lenghu, Xiaozaohuo, Dachaidan, Ge'ermu, Nuomuhong, Chaka, Yushu, Jiuzhi and Qiaboqia. UF curve beyond the 0.05 level significant lines.**

Keywords **– Qinghai Province, Meteorological Drought, SPEI Drought Index, Climate Warming.**

I. INTRODUCTION

Due to the monsoon climate interacted with the complicated geographical landscapes, severe drought of high frequency is one of the most devastating natural disasters in China. According to statistics, the drought affected area and drought damaged area have greatly increased in the past 50 years [1]. In the 2000s, extreme droughts occurred frequently in China, for example, the winter-spring drought in southwest China during 2009-2010 [2-3] and the spring-summer drought over the middle and lower reaches of Yangtze River in 2011 [4]. Commonly, regional ecosystem changes are the consequence of both climate change and local anthropogenic activities, but it is almost impossible to directly differentiate between these two factors [5]. Drought is a major meteorological and environmental problems facing humanity, according to information released by UNESCO, about one/third of the world's countries located in arid and semi-arid areas [6]. Drought index is the basis for research arid climate, but also to measure the extent of the drought key [7].

[8] has proposed a new drought index, precipitation minus evapotranspiration index, which provides important ideas for later research by other scholars' drought. Drought indices are continuous functions of rainfall and/or temperature, river discharge or other measurable hydro-meteorological variables, commonly used to quantify the definition of drought.

[9] proposed a new drought index, considering a number of elements precipitation, temperature, soil moisture, evapotranspiration and so on. Palmer after being recognized as a milestone in the index made the history of drought index, the index in the United States and around the world has been widely used, despite decades since the emergence of new drought index, but none proved to be superior to the Palmer Index.

Both global climate change and anthropogenic activities are the main driving forces of terrestrial ecosystems [10]. Meteorological drought occurs more frequently and commonly than other three kinds of droughts; meanwhile, it normally triggers other types of drought, including agricultural, hydrological, and socioeconomic drought [11]. Drought has especially affected the agricultural areas over northern China [12]. Northwest China is located in the transitioning area of the three natural zones, namely the eastern monsoon region, northwestern arid area, and the Qinghai-Tibetan Plateau. It contains four major types of climate: tropical monsoon climate, temperate monsoon climate, temperate continental (arid) climate, and plateau alpine climate from south to north. The regional geological, geomorphologic and ecological systems are complex and diverse. These natural factors and climate change are intertwined, making regional economic and social developments extremely challenging. The regional economic community has demonstrated a high degree of sensitivity to these changes. The research shows that there has been a significant warming trend in Northwest China since 1951, as reported by [13-14]. Thus, droughts are difficult to pinpoint in time and space since it is very complex to identify the moment when a drought starts and

ends, and also to quantify its duration, magnitude and spatial extent [15-16].

II. MATERIALS AND METHODS

A. Study Area

Fig. 1 shows the Qinghai Province in China has a large variety of ecosystem types, from sub-tropical rain forest in southeast to alpine desert in the northwest. Among all types of land cover vegetation, alpine grassland is the dominant ecosystem, combined cover an area of 715823.8 km^2, extending from latitude of 31° 40' - 39° 30' N and longitude of 89° 25 ' - 103° 04' E and altitude 1721 - 8500 m. Table 1 shows the longitude and latitude, altitude and annual precipitation of meteorological stations in Qinghai Province. The irrigated area in Qinghai Province as reports in [17] as: total irrigated area, effective irrigated area, woodland, orchard, pasture land and actual effective irrigated, respectively: 259.3, 182.4, 31.2, 6.8, 38.9 and 155 (10^3 ha). The major economic indices as: number of enterprises, employment in the year (person), business income (10^3 RMB) and Tax payment (10^3 RMB), respectively: 20, 2966, 1273 and 1035.

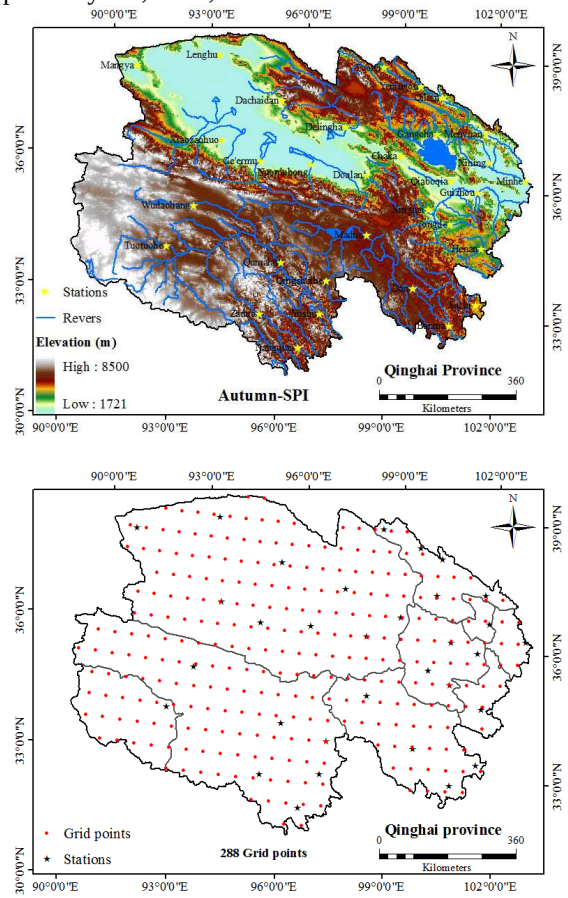


Fig. 1. The distribution of meteorological stations and grid points of climate data in two study areas

*Source of DEM data: (http://srtm.csi.cgiar.org/), resolution = 90 m × 90m

Table 1 The Longitude and latitude, altitude and annual precipitation of meteorological stations in Qinghai Province

	Stations	Longitude	Latitude	Altitude (m)	Precipitation (mm)
1	Mangya	38°15´	90°51´	2945	49.2
2	Lenghu	38°45´	93°20´	2770	17.0
3	Tuolei	38°48´	98°25´	3367	297.1
4	Yeniugou	38°25´	99°35´	8320	416.3
5	Qilian	38°11´	100°15´	2787	406.5
6	Xiaozaohuo	36°48´	93°41´	2767	28.9
7	Dachaidan	37°51´	95°22´	3173	89.1
8	Delingha	37°22´	97°22´	2981	180.7
9	Gangcha	37°20´	100°08´	8301	382.2
10	Menyuan	37°23´	101°37´	7850	519.1
11	Ge'ermu	36°25´	94°54´	2808	43.0
12	Nuomuhong	36°26´	96°25´	2790	46.5
13	Doulan	36°18´	98°06´	3191	202.9
14	Chaka	36°47´	99°05´	3088	211.3
15	Qiaboqia	36°16´	100°37´	2835	318.3
16	Xining	36°43´	101°45´	2295	387.3
17	Guizhou	36°02´	101°26´	2237	255.5
18	Minhe	36°19´	102°51´	1814	345.2
19	Wudaoliang	35°13´	93°05´	4612	289.6
20	Xinghai	35°35´	99°59´	3323	365.3
21	Tongde	35°16	100°39´	3289	428.6
22	Tuotuohe	34°13´	92°26´	4533	291.6
23	Zaduo	32°54´	95°18´	4066	535.0
24	Qumalai	34°08´	95°47´	4175	420.9
25	Yushu	33°01´	97°01´	3681	486.2
26	Maduo	34°55´	98°13´	4272	321.5
27	Qingshuihe	33°48´	97°08´	4415	517.0
28	Dari	33°45´	99°39´	3968	554.2
29	Henan	34°44´	101°36´	8500	585.7
30	Jiuzhi	33°26´	101°29´	3629	744.0
31	Nangqian	32°12´	96°29´	3644	538.3
32	Banma	32°56´	100°45´	8530	659.0

B. Standard Precipitation Evapotranspiration Index (SPEI)

Monthly temperature and precipitation records of all available 32 stations during 1961 to 2013 were obtained from China meteorological data service over the Qinghai Province (http://data.cma.gov.cn), which is shown in Fig. 2. SPEI is a relatively new drought index, proposed by [18], which includes both precipitation and potential evapotranspiration (PET) influence. The SPEI is based on precipitation and potential evapotranspiration (PET), and it combines the sensitivity of PDSI to changes in evaporative demand with the multi scalar nature of the SPI. Details of the method used to calculate the SPEI can be found in [18-19] and [18] applied the Thornthwaite procedure [8] to estimate the PET, which has the advantage of requiring limited data on monthly mean temperature. However, as indicated earlier, in the present research, the Hargreaves-Samani equation [20] was applied to calculate PET. Drought identification and characterization is a pre-requisite to spatial and temporal variation analysis and drought frequency analysis. In general, drought is often characterized by its duration, severity, intensity and spatial extent. The value obtained by the normal standardized SPEI, drought grade in Table 2.

Table 2 Classification criteria of SPEI drought index in Qinghai Province

	Drought category	SPEI
1	No drought	< -0.5
2	Mild drought	-0.5 — -1.0
3	Moderate drought	-1.0 — -1.5
4	Severe drought	-1.5 — -2.0
5	Extreme drought	> -2

Note: Refer to [21-22]

III. Results And Discussion

Qinghai Province has a complex and diverse climate types, variability precipitation and temperature, dry climate, uneven distribution of water resources and serious water shortages in the northern west part, harsh natural conditions, and high frequency of drought. A drought is one of the most important natural disasters in Qinghai Province. Drought disasters in Qinghai Province agricultural production especially for relatively large impact not only affect the stability and security of food production, one of the main factors in Qinghai Province, is also one of the main factors restricting the development of the economy in Qinghai Province.

A. Variation of the Annual Precipitation and Temperature

Fig. 2a shows changing in precipitation anomaly map of Qinghai Province, nearly 53 year. Alternating positive and negative anomalies fluctuate more obvious. The annual precipitation distribution is negative anomalies periods of 1962, 1991, 1992, and 200-2002. The annual precipitation negative anomaly corresponding year mainly dry years and drought disaster in Qinghai Province. Annual precipitation is positive anomalies mainly distributed in the 21st century in 2003 - 2013. Fig. 2b shows Changing in temperature anomaly map of Qinghai Province, nearly 53 year Qinghai Province annual temperature anomalies overall an upward trend, increasing rate of 0.375/10a. [23] reports that global climate warming and increasing anthropogenic activities, the Qinghai-Tibet Plateau experienced approximately a three times increase of the global warming rate over the last 50 year. The increasing in temperature one of the reasons of climate will become changing to drought, and has negative effect in vegetation cover by increase in evapotranspiration.

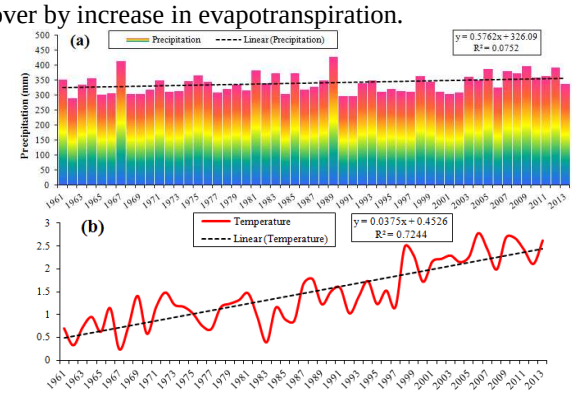


Fig. 2 (a-b) The mean annual precipitation and temperature trend in Qinghai Province during 1961 - 2013

B. SPEI Drought Index Analysis

Fig. 3 shows the SPEI, respectively corresponding to the Qinghai Province (32 meteorological stations), SPEI is calculated at time scales of 1-, 3-, 12-, 24-, 36- and 48-month of the stations from 1961 to 2013. The SPEI series has oscillations of a greater temporal frequency because the time scales are shorter, whereas at longer time scales the SPEI exhibits a lower frequency, enabling the detection of persistent dry and humid periods. SPEI 12-month shows a high frequency of drought in 1972, 1992-1993, 1995-1996, and 1998-2004. 24-month shows a high frequency of drought in 1992, 1995-2005 and 2008-2009. 36-month shows a high frequency of drought in 1996-2005. 48-month shows a high frequency of drought in 1997-2005.

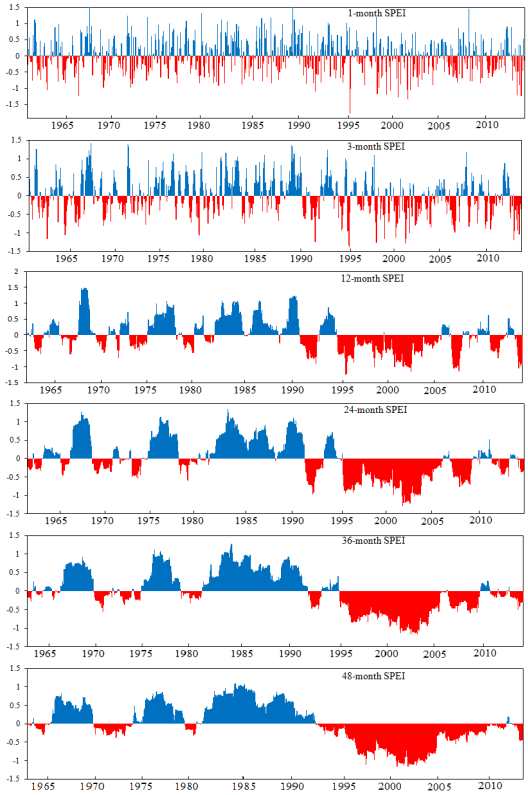


Fig. 3 SPEI values on 1, 3, 12, 24, 36 and 48-month time scale in Qinghai Province during1961- 2013

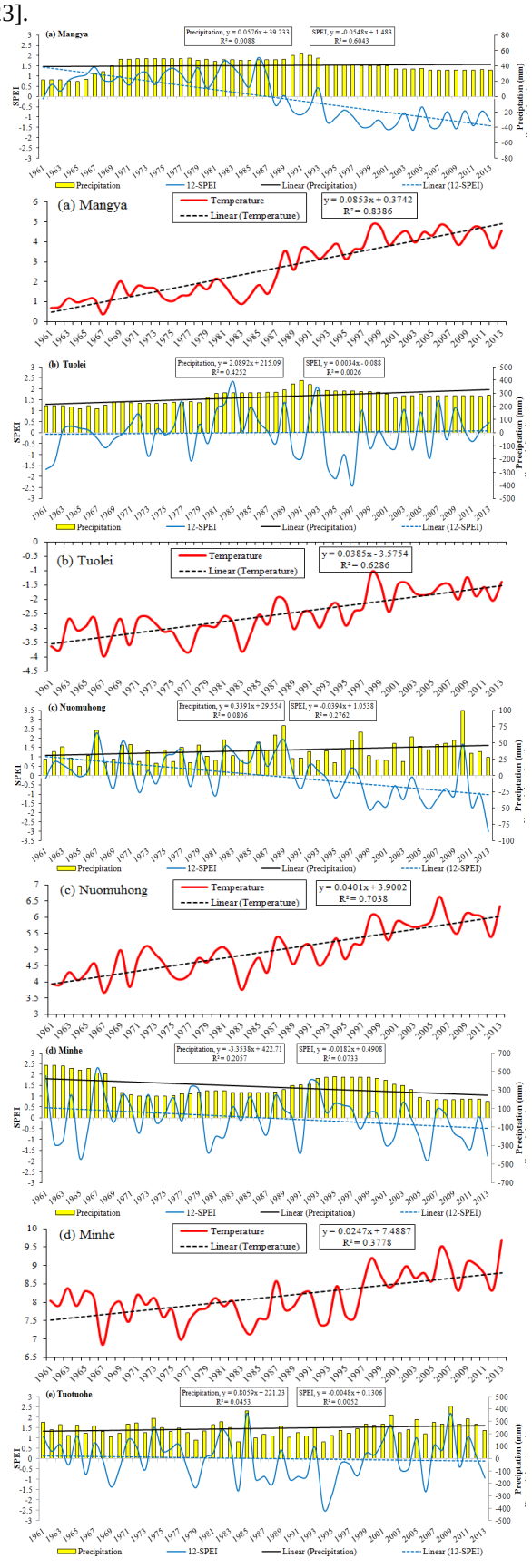
The drought category is consisting of four classes which are: mild, moderate, severe and extreme drought. Table 3 shows total annual-SPEI drought is: 50.30 % as 32.29, 10.55, 05.34 and 02.12 % for mild, moderate, severe and extreme drought, respectively. The total seasonal-SPEI drought is 49.58, 49.76, 49.71 and 51.21 % for winter, spring, summer and autumn, respectively. Mild drought is a biggest amount of drought categories.

Table 3 The percentage of seasonal and annual-SPEI drought index frequency in Qinghai Province during1961 - 2013

	Drought category	SPEI %				
		winter	spring	summer	autumn	**annual**
1	No drought	50.42	50.24	50.29	48.79	**49.94**
2	Mild drought	32.81	31.66	30.96	33.71	**32.29**
3	Moderate drought	12.08	10.02	10.14	09.96	**10.55**
4	Severe drought	03.85	06.13	06.43	04.95	**05.34**
5	Extreme drought	00.84	01.95	02.18	02.59	**02.12**
	Total drought	49.58	49.76	49.71	51.21	**50.30**

C. Correlation of the SPEI Drought index with Climate Factors

Seven stations are selected from all direction of Qinghai Province, which are: Mangya for Northern west, Tuolei for northern, Nuomuhong for middle, Minhe for eastern, Tuotuohe for the west, Jiuzhi for southeast and Nangqian for south. The 12-SPEI is analyzed in each station, to correlate with annual precipitation and temperature. Fig. 4 (a-g) shows SPEI drought index and annual precipitation and temperature in Qinghai Province during 53 year obvious, Fig. 4a which that is Mangya shows the SPEI is downward trend, the rate of decline is: -0.548/10a. Temperature is an upward rate of 0.853/10a. Table 5 shows there is a significant negative relationship between SPEI and temperature at the 0.01, correlation coefficients -0.905** with P value 0.00, there is a significant positive relationship between SPEI with precipitation at the 0.01, correlation coefficients .353** with P value 0.00. Fig. 4b, which that is Tuolei SPEI, precipitation and Temperature shows an upward trend, the rate of increase is: 0.03/10a, 0.0255/10a, and 2.758/10a, respectively. Temperature is an upward rate of 0.083. Fig. 4c, which that is Nuomuhong SPEI, is a downward rate of -0.394/10a. Table 5 shows there is a significant positive relationship between SPEI with precipitation at the 0.01, correlation coefficients 0.457**, with P value 0.00, respectively. There is a significant negative relationship between SPEI with temperature at the 0.01, correlation coefficients -.700** with P value 0.00. Fig. 4d, which that is Minhe SPEI and precipitation shows a downward trend of decline: -0.182/10a, -0.065/10a, respectively. Temperature is an upward rate of 0.247/10a. Table 5 shows there is a significant positive relationship between. There is a significant negative relationship between SPEI with temperature at the 0.01, correlation coefficients -0.591**, with p value 0.00. Fig. 4e, which that is Tuotuohe SPEI, is downward rate of -0.048/10a. Table 5 shows there is a high significant positive relationship between SPEI with precipitation at the 0.01, correlation coefficients 0.904**, with P value 0.00, respectively. Fig. 4f, which that is Jiuzhi SPEI and precipitation show a downward trend of decline is: -0.245/10a and -0.072/10a, respectively. Temperature is an upward rate of 0.383/10a. Table 5 shows there is a significant positive relationship between SPEI with precipitation at the 0.01, correlation coefficients 0.925*, with p value 0.00, respectively. Fig. 4g, which that is the Nangqian, precipitation and temperature show an upward trend of increase is: 0.128/10a, 0.951/10a, respectively. SPEI is a downward trend, the rate of decline is: -0.026/10a. With both global climate warming and increasing anthropogenic activities, the Qinghai Tibet Plateau has experienced approximately a three times increase of the global warming rate over the last 50 years [23].



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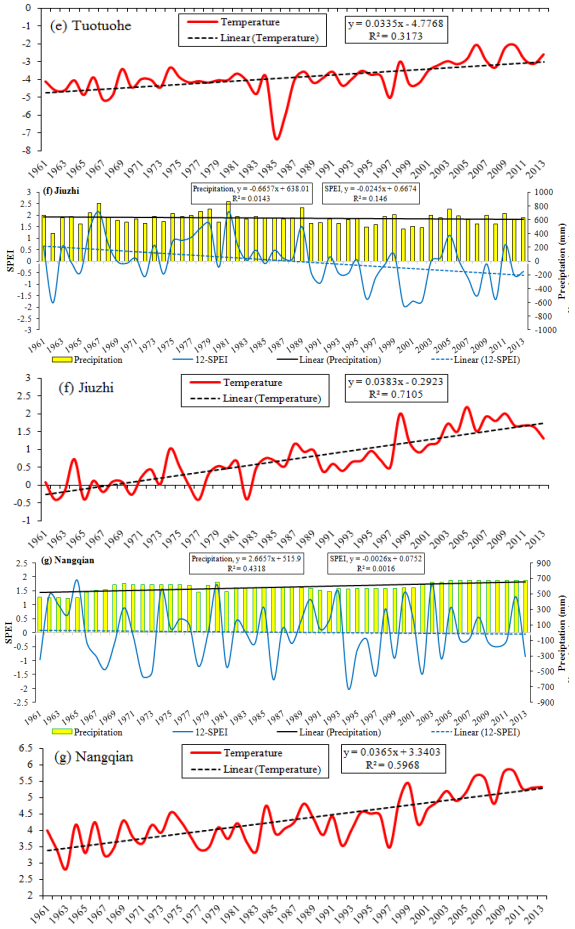


Fig. 4 (a-g) The SPEI drought index trends of seven stations and relationship by precipitation and temperature in Qinghai Province during 1961-2013

Table 5 Correlation coefficients of SPEI drought index with climate data using SPSS software of seven stations in Qinghai Province during 1961 - 2013

	SPEI with Precipitation		SPEI with Temperature	
	Pearson correlation	P value, Sig.	Pearson correlation	P value, Sig.
Mangya	.353**	0.009	-.905**	0.000
Tuolei	0.046	0.742	0.002	0.988
Nuomuhong	.457**	0.001	-.700**	0.000
Minhe	0.178	0.202	-.591**	0.000
Tuotuohe	.904**	0.000	-0.172	0.219
Jiuzhi	.925**	0.000	-0.265	0.056
Nangqian	-0.047	0.739	-0.109	0.436

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

D. *Drought and Flood of SPEI Drought Index Identify the Typical Drought Events*

Fig. 5 shows 1-month SPEI index and monitoring a drought of Mangya in: 2001/7, 2004/3, 2007/8, 2007/5, 1998/4, 2010/8, 2002/8. 1-month SPEI index is monitoring a drought of Tuolei in: 1998/4, 1995/5, 2009/4, 2010/8, 2008/5, 1999/9 and 2004/4. 1-month SPEI index is monitoring a drought of Nuomuhong in: 2001/7, 2013/6, 1998/4, 2006/8, 2013/8, 2009/6, 2009/4, 2007/5, 1999/9, 1995/5, 2001/6 and 2000/7. 1-month SPEI index is monitoring a drought of Minhe in: 2013/3, 1994/11, 1966/6, 2013/10, 1962/6, 1980/10 and 2000/7. 1-month SPEI index is monitoring a drought of Tuotuohe in: 1994/7, 1987/6, 1995/5 and 1986/7. 1-month SPEI index is monitoring a drought of Jiuzhi in 2000/5, 1964/8, 1985/8, 2008/3, 2002/6, 1997/4 and 2001/4. 1-month SPEI index is monitoring a drought of Nangqian in: 1974/11, 1999/4, 2006/7, 2004/3, 2010/3, 1981/10, 2003/4, 1995/5 and 1971/7.

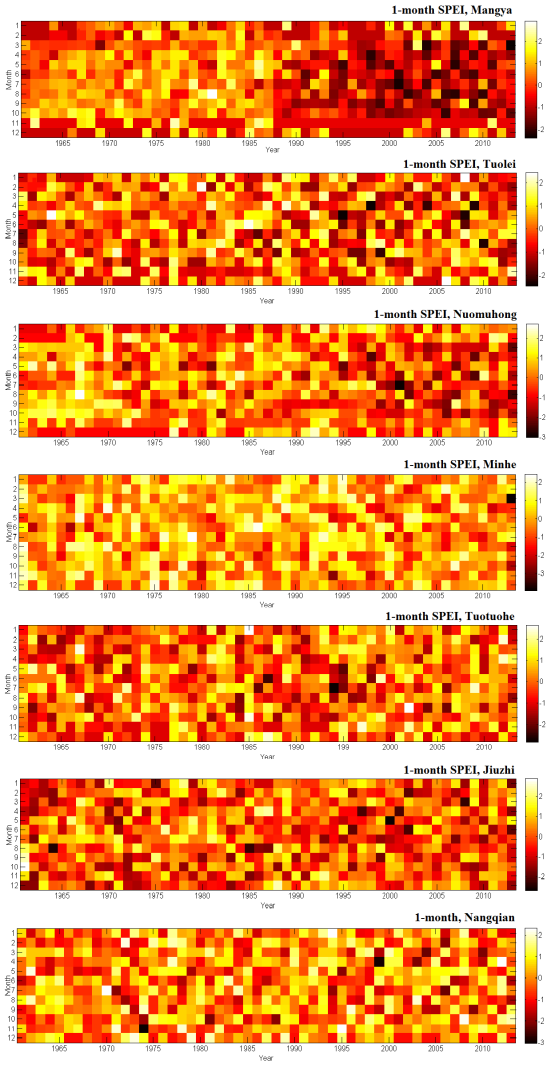
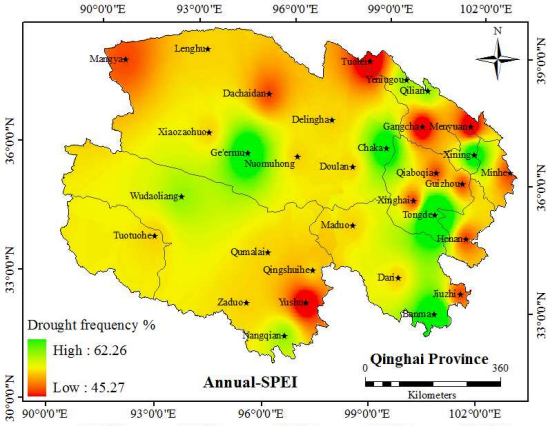


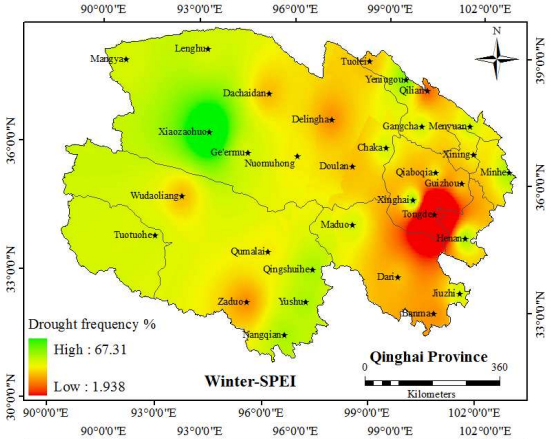
Fig. 5 Drought and flood of seven stations 1-month of SPEI in Qinghai Province 1961 – 2013

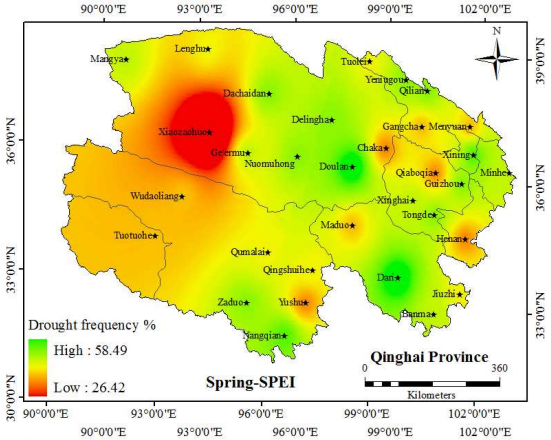
E. *Drought Frequency Spatial Variation*

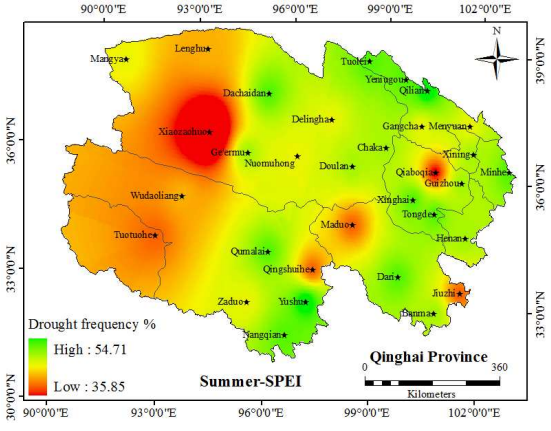
Fig. 6 shows that the frequency distribution of an annual-SPEI of a total drought category in Qinghai Province during 1961 - 2013. The high frequency of an annual-SPEI drought in: Banma, Tongde, Xining, Chaka and Ge'ermu. The high frequency of a winter-SPEI of a total drought category in Qinghai Province during 1961 - 2013. The high frequency of a winter-SPEI drought in: Xiaozaohuo, Mangya, Lenghu, Tongde, Yeniugou, Qingshuihe, Yushu and Nangqian. The high frequency of a spring-SPEI of a total drought category in Qinghai Province during 1961 - 2013. The high frequency of spring-SPEI drought in: Mangya, Doulan, Zaduo, Nangqian, Dari and Xining. The high frequency of a

summer-SPEI drought in: Dachaidan, Ge'ermu, Qumalai, Yushu, Nangqian, Dari, Maduo, Qilian, Xining, Tongde and Minhe. The high frequency of an autumn-SPEI drought in: Lenghu, Xiaozaohuo, Chaka, Tuolei, Tongde Dari and Banma









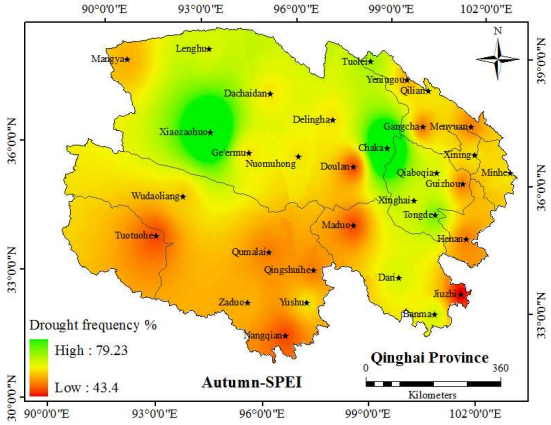


Fig. 6 The frequency distribution of an annual and seasonal-SPEI of a total drought category in Qinghai Province during 1961 - 2013

F. Drought Trends and Mutation Detection

Fig. 7 shows that the annual trends of SPEI drought index in Qinghai Province, the annual-SPEI UF curve shows that the nearly Qinghai Province 53 years to the overall trend shows a drought, which in the 1960s to the 1990s drought trend is not significant, alternating wet and dry cycles; after the 1990s, drought aggravated northwest of Qinghai Province. Fig. 8 shows that the location of the areas which are changed from humid to drought: Mangya, Lenghu, Xiaozaohuo, Dachaidan, Ge'ermu, Nuomuhong, Chaka, Yushu, Jiuzhi and Qiaboqia. The UF curve is 0.05 level significant lines, in 2001 shows that the drought trend is very significant level at 0.05 in the line, UF and UB lines intersect in 1993 which that is the beginning of mutation detection of the droughts.

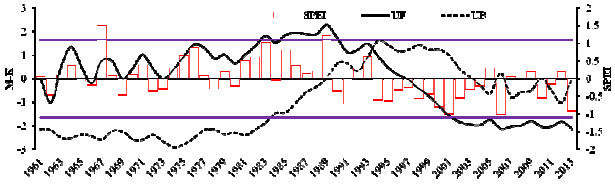
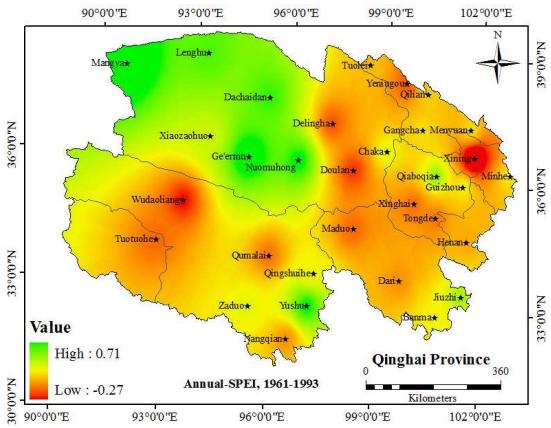


Fig. 7 Interannual variation and Mann-Kendall test of SPEI drought index in Qinghai Province during 1961 - 2013



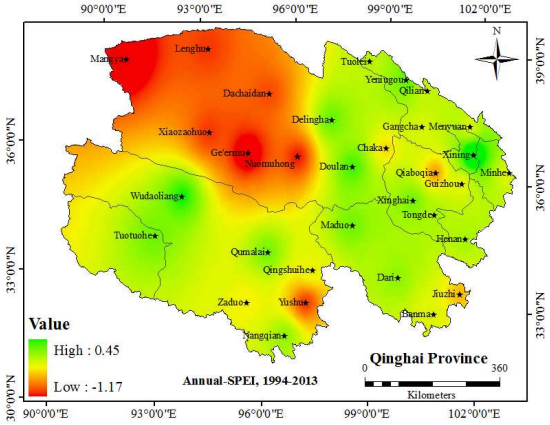
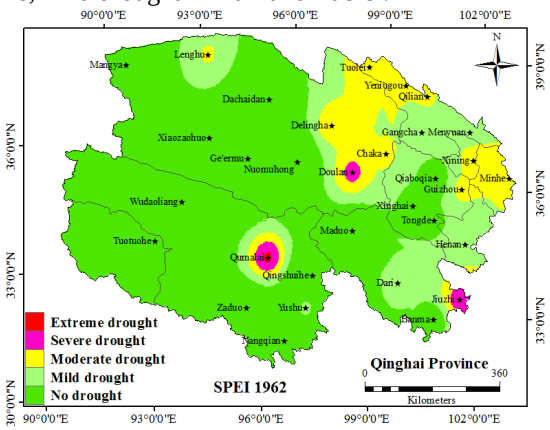


Fig. 8 Drought change point by UF curve, annual-SPEI during 1961 - 1993 and annual-SPEI during 1994 - 2003 in Qinghai Province

G. Actual Comparison of SPEI Drought Index in a High Drought Periods

Fig. 9 shows that the monitoring of SPEI drought index of 1962, 1991 and 2001. The actual comparison of SPEI drought index in high drought periods to monitor the degree of drought in Qinghai Province using SPEI drought index, three years of the high drought frequency are been selected (1962, 1991 and 2001). 1962-SPEI drought index shows that the extreme drought in: Qumalai; severe drought in Doulan and Jiuzhi; moderate drought in Lenghu, Tuolei, Yeniugou, Qilian, Chaka, Xining, Minhe and Guizhou; mild drought in Yushu, Dari, Henan and Menyuan; there is no drought in the most of middle, southern west and south part. 1991-SPEI drought index shows that the extreme drought in Yeniugou and Xining; severe drought in Gangcha, Menyuan, Minhe and Xinghai; moderate drought in Lenghu, Henan, Qiaboqia, Guizhou and Qilian; mild drought in: Jiuzhi, Banma, Tongde, Maduo, Qingshuihe, Nuomuhong, Tuotuohe and Mangya. 2001-SPEI drought index drought index shows that the extreme drought in Xiaozaohuo and Doulan; severe drought in Mangya, Dachaidan, Banma, Jiuzhi, Yushu, Gangcha, Menyuan, Ge'ermu and Nuomuhong; moderate drought in Lenghu, Qumalai, Delingha, Guizhou and Minhe; mild drought in Dari and Tuolei.



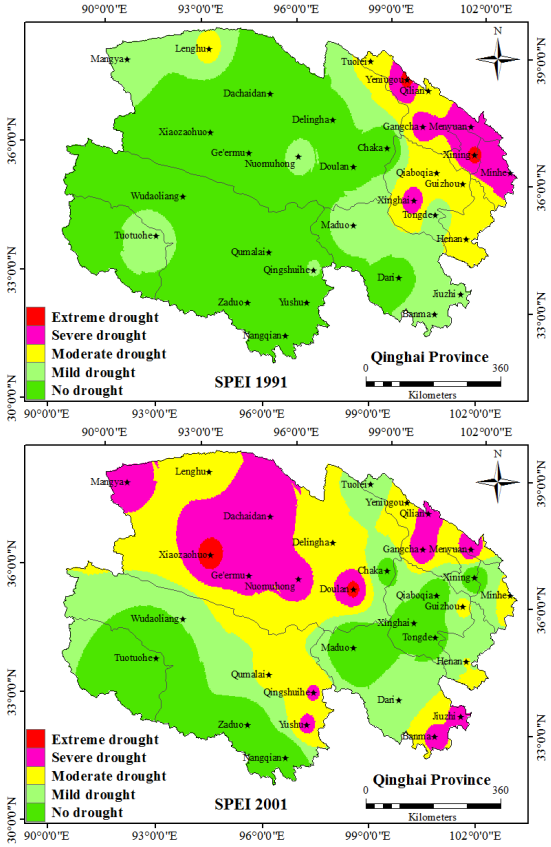


Fig. 9 Monitoring results of SPEI drought index in Qinghai Province of 1962, 1991 and 2001

IV. CONCLUSIONS

The discussion and conclusions of this study show that when drought occur due to decreased of precipitation, can reduce the natural vegetation cover and crops, livestock production consistent with actual losses. In recent years Qinghai Province there is affected climate warming intensifies and decrease of precipitation, arid zone showed frequent trend in recent years, affecting the region more widely, the economic losses caused by drought is also growing, the need to take comprehensive measures, the whole society a common response, the principle of the whole society to participate fully in the role of the government and drought relief headquarters, coordination and management functions. The interaction of multiple stresses-endemic poverty, ecosystem degradation, complex disasters and conflicts, and limited access to capital, markets, infrastructure and technology have all weakened people's ability to adapt to changes in climate.

Most drought studies focus on quantifying drought at the regional or global scale, but this generalization can obscure localized effects. This study is focusing on a Qinghai Province by using inputs and outputs of SPEI drought index, to characterize drought type, severity, and duration, which that can assist in identifying appropriate adaptation strategies to minimize the impacts of drought to the agriculture and water sector. Losses in agricultural production occurred during drought years, with the largest losses in Qinghai Province 1962, 1991, 2001.

This study recommends adapting and mitigating the

drought periods: improving livelihoods, agro-ecosystem resilience, agricultural productivity and the provision of environmental services. Also essential to note that a range of fundamental natural resources, including land, water, air, biological diversity including forests, grassland, etc., provide the indispensable base for agricultural production system and sustenance of agricultural ecosystems. These linkages between natural resource use and the social and physical environment across space and time are important issues for scaling out and the dissemination of agricultural knowledge, with significant implications for sustainable development and the mitigation of adverse impacts of climate change.

This study recommends with more additional investigations on crops suitable to the Qinghai Province during drought should be carried out for more accurate information, which can be used for crop modeling of appropriate agricultural and water management during drought. Further studies on drought prediction using future climate scenarios in Qinghai Province using methods presented in this study will be part of the future direction of this study.

Notes:

- The seasonal-SPEI drought in Qinghai Province is autumn > spring > summer > winter.
- The SPEI drought periods in Qinghai Province, respectively: 1990s > 2000s > 1960s > 1970s > 1980s.
- In Qinghai Province the northern west part is a significant changing to drought since 1990s, while some of eastern, southern and east southern significant change to humid.
- The climate factors have a high result in drought, In Qinghai Province is temperature > precipitation.
- This Study provides a clear picture of the increase of temperature and decrease of precipitation trends across most areas of Qinghai Province.
- This study assesses Qinghai vulnerability to climate change, by overlaying maps of precipitation distribution and variability and year's drought frequency and incidence of environmental hazards.
- The influences of drought in Qinghai Province as: The shortage of food security led to humanitarian disaster as the risk of death, injury and diseases during the famines, many of individual's perished in rural areas; a succession of dry years resulted in severe social and economic impacts, including many human and livestock. Reduced moisture content of soil led to direct affect in agricultural production, resulting poor plant growth, or even wither and significantly reduced crop yield; Grassland is decline and decreasing the palatable forbs led to appear the invader grasses which is an unpalatable to livestock and affecting by derogates from livestock by the death, emergency slaughter, direct economic losses and affected in livestock herders.
- It also outlines some of the actions being taken to help the country to adapt to climate change, and makes recommendations for how such actions could become more effective.
- For example: Adaptation activities need to be implemented in an integrated way and take a long-term view, rather than involving short-term, stand-alone projects. Institutions working on environmental issues should be better coordinate.

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