Spatiotemporal Variation of Spring Drought in Qinghai Province in the Context of Climate Warming (Postprint)

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Date: 2020-04-26T00:00:00+00:00

Abstract

Based on observational data from 35 meteorological stations during 1961–2018, the spatiotemporal evolution characteristics of rainless days and drought frequency in the agricultural and pastoral areas of Qinghai Province were analyzed. The results indicate: From 1961 to 2018, the average spring temperature in Qinghai Province exhibited an increasing trend, while precipitation showed an increasing trend. Spatial differences in rainless days were significant, with the eastern agricultural region and pastoral region showing no obvious overall trend in rainless days. Over the past 57 years, the occurrence frequency of mild, moderate, and extreme droughts in the eastern agricultural region showed no significant trend, with only severe drought showing a slight increase. Since the beginning of the 21st century, the occurrence frequency of mild and severe droughts in the eastern agricultural region has shown an increasing trend. The spatial distribution of drought frequency of all grades in the agricultural region exhibited a pattern of more in the south and less in the north. Over the past 57 years, the total number of drought events and the frequency of different drought grades in the main pastoral areas of Qinghai Province showed a decreasing trend. Among them, mild drought showed the most significant decrease, while the spatial distribution of drought frequency of all grades in the pastoral region exhibited a pattern of more in the north and less in the south.

The number of drought events causing disaster losses in spring in Qinghai Province showed a decreasing trend, with a reduction rate of 2.4 次·(10a) -1 . The eastern agricultural region experienced the highest number of drought events causing disaster losses. Over the past 57 years, the frequency of drought events in the pastoral areas of Qinghai Province exhibited an obvious abrupt change around 1981, while no significant abrupt change was observed in the eastern agricultural region.

Full Text

Research on the Variation Characteristics of Spring Drought in Qinghai Province Under Climate Warming

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Abstract

Based on data from 35 meteorological stations and drought disaster events spanning 1961–2018, this study analyzed spring rainless and drought days in Qinghai Province. The results showed that: (1) Both temperature and precipitation exhibited significant increasing trends, though no obvious trend was observed for rainless days in either the eastern agricultural region or the pastoral region. (2) No clear trends were found for light, moderate, or severe drought frequency over the past 57 years, though a slight increase was noted for severe drought events. In particular, light and severe drought days showed an obviously increasing trend in the eastern agricultural region since the 2000s, with the spatial distribution of different drought scales decreasing from south to north. (3) A decreasing trend was observed for drought frequency and all scales in the pastoral region, particularly for light drought, with the spatial distribution decreasing from north to south. (4) Drought disasters exhibited a continuously decreasing trend of 2.4 occurrences per decade, with the highest decrease observed in the eastern agricultural region. (5) An abrupt change in drought frequency occurred in 1981 in the pastoral region, while no obvious change was detected in the eastern agricultural region.

Keywords: climate warming; drought; Meteorological Composite Index (MCI); spatial and temporal variation; Qinghai Province

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1. Introduction

Based on data from 35 meteorological stations and drought disaster records from 1961–2018, this study investigates the variation characteristics of spring rainless days and drought conditions in Qinghai Province. Previous studies [2, 3] have examined drought indices and their applicability in the region, while others [4-10] have analyzed meteorological drought characteristics. The Meteorological Composite Index (MCI) has been widely applied for drought monitoring [11], with particular attention to spring drought impacts on agriculture and pastoral activities.

2. Data and Methods

The analysis employed daily meteorological data from 35 stations across Qinghai Province spanning 1961–2018. The MCI was used to identify drought events, with spring defined as March–May. Statistical methods included linear trend analysis, t-tests for abrupt change detection (n = n = 15), and correlation analysis between meteorological elements and drought frequency.

3. Results

3.1 Temperature and Precipitation Trends From 1961–2018, spring temperature in Qinghai Province exhibited a significant increasing trend, with a warming rate of 0.3℃ per decade. An abrupt warming change occurred in 1998 [Figure 1: see original paper]. Spring precipitation also showed an increasing trend, with a rate of 2.8 mm per decade, and an abrupt increase occurred in 2002 [Figure 2: see original paper].

3.2 Rainless Days While no obvious trend was observed for spring rainless days across the entire province, significant regional differences emerged. The eastern agricultural region showed a decreasing trend, averaging 67 days annually. Specifically, the 1960s–1970s averaged 69 days, the 1980s–1990s averaged 59 days, and the period since 2000 has averaged 61 days [FIGURE:3–4].

In contrast, the pastoral region exhibited an increasing trend in rainless days, also averaging 67 days annually. The 1960s–1970s averaged 59 days, the 1980s–1990s averaged 67 days, and since 2000 the average has been 72–76 days [FIGURE:9–10].

3.3 Drought Frequency and Intensity Using the MCI, spring drought days showed a decreasing trend across the province at a rate of 2.4 occurrences per decade. However, regional patterns differed substantially. In the eastern agricultural region, light and severe drought days demonstrated an increasing trend, particularly since the 2000s, with the spatial distribution of different drought scales decreasing from south to north [Figure 11: see original paper].

Conversely, the pastoral region showed decreasing trends for all drought scales, with light drought days decreasing most obviously. The spatial distribution in this region decreased from north to south. An abrupt change in drought frequency was detected in 1981 in the pastoral region, while no obvious change was observed in the eastern agricultural region.

4. Discussion

The correlation analysis revealed significant negative relationships between temperature/precipitation and drought days . The decreasing trend of drought disasters at 2.4 occurrences per decade reflects improved moisture conditions overall, though the eastern agricultural region experienced increased drought

risk due to rising temperatures and variable precipitation. The 1981 abrupt change in the pastoral region aligns with documented climate regime shifts in the area.

5. Conclusion

Under climate warming, Qinghai Province has experienced significant increases in spring temperature and precipitation. While province-wide drought frequency has decreased, regional disparities are pronounced. The eastern agricultural region faces increasing light and severe drought risk, particularly since the 2000s, whereas the pastoral region shows decreasing drought frequency across all scales. These findings highlight the need for region-specific drought adaptation strategies.

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