

Spatiotemporal Distribution Characteristics of Drought in Central Asia Based on the SPEI Index: Postprint

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

Abstract

Based on monthly gridded data from the CRU (Climatic Research Unit) for the period 1961-2017, this study investigates the spatiotemporal distribution and variation characteristics of drought in Central Asia over the past half-century through calculation and analysis of the Standardized Precipitation Evapotranspiration Index (SPEI). The results indicate: Over the past half-century, rising temperatures have led to increased potential evapotranspiration across most of Central Asia, with the rate of increase centered in the Aral Sea basin and decreasing radially outward; From 1961 to 2017, the average SPEI value in Central Asia exhibited a continuous overall declining trend, albeit with substantial fluctuations. Intra-annual variations show that SPEI values in spring and winter displayed a slowly declining trend, whereas those in summer and autumn decreased significantly, indicating an intensifying drought trend during the summer and autumn seasons; Spatially, the drought trend in most regions of Central Asia was dominated by intensification during summer and autumn, while a trend of drought alleviation was prevalent in spring. The findings of this study can provide important information for drought risk assessment, water resources planning, and scientific management in Central Asia.

Full Text

Arid Zone Research (ChinaXiv Partner Journal)

Title: Spatiotemporal Distribution Characteristics of Drought in Central Asia Based on SPEI Index

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Abstract: As a core region of the Silk Road, the importance of Central Asia to China is self-evident. With climate change, high dependence on irrigated agriculture, and increasing human disturbance, drought and water resource availability have become key issues restricting development and regional stability in Central Asia. This paper focuses on five Central Asian countries (Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan, and Turkmenistan) to assess spatiotemporal distribution characteristics using the Standardized Precipitation Evapotranspiration Index (SPEI), calculated based on monthly Climatic Research Unit (CRU) data from 1961 to 2017. Specifically, CRU grid point data (including monthly precipitation, temperature, and potential evapotranspiration) were used for calculating SPEI to better reflect climate change in Central Asia in terms of data quality and sequence. While SPI and PDSI are widely used as drought indices, this study proposes using SPEI to analyze drought conditions in Central Asia as it can better reflect the effects of climate change on meteorological drought in arid and semi-arid regions. The Thornthwaite formula has generally been used in the initial calculation process of SPEI; however, this only considers temperature in the calculation of potential evapotranspiration, and the calculated values may have large errors in arid and semi-arid regions. Therefore, the Penman-Monteith formula was used in this paper to calculate potential evapotranspiration for the five Central Asian countries. In contrast to previous studies that mainly focused on a particular region of Central Asia, this paper calculated the SPEI value for each grid point across the five countries as a whole territory, thereby analyzing spatial and temporal drought variation trends in Central Asia in detail. The results showed the following: (1) With increasing temperature over the past half-century, precipitation in most parts of Central Asia showed a slow upward trend and potential evapotranspiration increased. The increase was centered in the Aral Sea basin and declined in a circular direction. (2) From 1961 to 2017, the average SPEI index in Central Asia has continuously declined; however, it fluctuated greatly. Annual changes showed a slow downward trend in SPEI values in spring and winter, and a significant downward trend in summer and autumn, indicating that drought conditions increased in summer and autumn in Central Asia. (3) Spatially, drought in most parts of Central Asia mainly increased in summers and autumns, and generally decreased in springs; in winters, drought at the border of Kazakhstan and Uzbekistan increased, while drought decreased in the eastern region. The results calculated using the SPEI drought index in this study were compared with actual drought events and satisfactory results were obtained, indicating that our analysis and calculation of SPEI can reflect real-time drought situations in Central Asia, both temporally and spatially. Therefore, SPEI can be used as an important reference index for drought in Central Asia and can provide a valuable reference for drought risk assessment and water resources planning in Central Asia.

Keywords: SPEI; drought analysis; temporal and spatial variation; Central

Asia

Note: Figure translations are in progress. See original paper for figures.

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