Climatic Response of Runoff Variation in the Kaidu River Headwater Region (Postprint)

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Abstract

Spatiotemporal variation characteristics of mountainous runoff under climate change represent one of the hot topics in hydrology and water resources research in arid regions. This study selected the source area of the Kaidu River basin on the southern slope of the Tianshan Mountains as a typical study area. Based on runoff data from the Dashankou and Bayanbulak hydrological stations and meteorological observation data from Bayanbulak during 1958–2017, methods including the TFPW-MK trend test, wavelet analysis, and wavelet coherence were employed to analyze the trend, abrupt change, and periodic characteristics of runoff series and their response to climate change. The results indicate that over the past 60 years, runoff, precipitation, and air temperature in the source area of the Kaidu River have exhibited significant increasing trends, with accelerated increasing rates for runoff, precipitation, and maximum temperature, while the increasing rates for mean temperature and minimum temperature have slowed. The abrupt change years for runoff, precipitation, and mean temperature were concentrated in the 1990s, and all showed a 28-year periodicity. Increased summer runoff was mainly influenced by summer warming, while increased early spring runoff was primarily associated with increased winter precipitation and early spring warming. At the annual scale, precipitation was the main factor affecting runoff variation in the Kaidu River, while temperature mainly influenced runoff variation in the form of accumulated temperature. At the monthly scale, both accumulated temperature and precipitation showed significant positive correlations with runoff, and runoff in the upstream source area was more sensitive to temperature changes than runoff in the downstream area.

Full Text

Preamble

Climate Response of Runoff Variation in the Source Area of the Kaidu River

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Abstract: Temporal and spatial variability of runoff in inland rivers and mountainous regions under climate change represents a major focus in hydrological and water resources research in arid areas. This study selected the source area of the Kaidu River basin on the southern slopes of the Tianshan Mountains as the study region. Using data from the Dashankou hydrological station, Bayanbulak hydrological station, and Bayanbulak meteorological observation station covering 1958–2017, we analyzed trends, abrupt changes, wavelet characteristics, coherence, and climate responses of long-term runoff in the Kaidu River using the TFPW-MK trend test, wavelet analysis, and other methods. The results demonstrate that over the past nearly 60 years, runoff, precipitation, and temperature in the Kaidu River basin have all exhibited significant trends, with abrupt changes concentrated in the 1990s. The increasing rates of runoff, precipitation, and maximum temperature accelerated, while the increasing rates of average and minimum temperatures slowed. Annual average runoff, annual cumulative precipitation, and annual average temperature showed a periodicity of 28 years. Increasing summer runoff was primarily influenced by high summer temperatures, whereas increasing winter and early spring runoff was mainly associated with increased winter precipitation and rising early spring temperatures, respectively. At the annual scale, precipitation represents the primary factor affecting runoff change, while temperature influences runoff mainly through accumulated temperature effects. At the monthly scale, both temperature and precipitation showed significant positive correlations with runoff. Upstream runoff demonstrated greater sensitivity to temperature changes compared to downstream runoff.

Keywords: Kaidu River; climate change; runoff; precipitation; temperature; TFPW-MK; wavelet coherence

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