Response of Runoff Variation to Climate Change and Human Activities in the Xilin River Basin (Postprint)

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Abstract

The Xilin River catchment was selected as the study area. Based on hydrological and meteorological data series from 1968 to 2015, the Mann-Kendall trend test was applied for trend analysis, while the Mann-Kendall change point test and double mass curve method were used for change point analysis. Subsequently, the double mass curve method, cumulative slope change rate comparison method, and elasticity analysis method were employed to quantitatively investigate the contribution rates of climate change and human activities to runoff variation. The results indicate that annual runoff in the Xilin River basin showed a significant decreasing trend from 1968 to 2015, with change points occurring in 1984 and 2000. Accordingly, the period 1968–1984 was designated as the baseline period, while 1985–2000 and 2001–2015 were designated as change periods. The double mass curve method yielded a contribution rate of human activities to runoff impact ranging from 86% to 88%, which differs substantially from results obtained by other methods. The cumulative change rate comparison method, however, simultaneously considers the effects of precipitation and evaporation on runoff, and its results are basically consistent with those derived from the elasticity coefficient method, with contribution rates ranging from 52.44% to 69.02% (1985–2000) and 42.39% to 43.64% (2001–2015), respectively. In summary, different quantitative methods have different foundations and structures; the elasticity coefficient method, which integrates multiple methods, is more reliable than empirical statistical methods and is more suitable for quantitative response studies of runoff in the Xilin River basin.

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Full Text

Response of Runoff Volume Change to Climate Change and Human Activities in the Xilin River Basin

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Abstract

Study on the quantitative response of runoff volume to climate change and human activities can not only provide a theoretical basis for the redistribution of water resources in a drainage basin, but also a policy reference for the management of water resources. This study was based on the hydrological and meteorological data series in the Xilin River Basin, a typical grassland basin, during the period from 1968 to 2015, and the Mann-Kendall trend test was used to analyze the change trend of runoff volume. The Mann-Kendall mutation test and the double-accumulation curve method were also used. The contribution rates of climate change and human activities to the change of runoff volume were quantified using the double-accumulation curve method, cumulative slope comparison method and elasticity coefficient method.

The results showed that the annual runoff volume in the Xilin River Basin was in a significant decrease trend during the period from 1968 to 2015, and its mutations occurred in 1984 and 2000 respectively. The period of 1968-1984 was regarded as the reference period, and the periods of 1985-2000 and 2001-2015 were the mutation periods. The results from the double-accumulation curve method revealed that the contribution rate of human activities to runoff volume varied in a range of 86%-88%, which was quite different from the results obtained by other methods. The effects of both rainfall and evaporation on runoff volume were simultaneously considered in the cumulative slope comparison, so the results estimated by this method and by the elasticity coefficient method were similar, and the contribution rates varied in ranges of 52.44%-69.02% (1985-2000) and 42.39%-43.64% (2001-2015) respectively. Holistically, the foundations and structures of different quantitative methods were different, the multiple methods were integrated in the elasticity coefficient method, and this method was more reliable in quantifying the response of runoff volume in the Xilin River Basin.

Keywords: runoff volume; human activity; climate change; quantitative response; Xilin River Basin

[Figure 1: see original paper]

[Figure 3: see original paper]

[Figure 6: see original paper]

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