

Comparing analysis of hydroclimatic changes in glacier-fed rivers between the Tibet- and Bhutan-Himalayas

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Both glacier and climate changes have increased the amount of water supplying the Himalayan rivers. Kurichu River in the Bhutan-Himalayas(BH) and Karuxung River in the Tibetan Himalayas(TH) were selected as representative glacier-fed watersheds with high glacier coverage of 20.8% and 14.6% and long term data of 20 years (1986–2006) respectively. The Mann-Kendall trend test and correlation analysis were employed to analyze hydrometeorological data at the gauge stations (1600 m and 4550 m) and a related meteorological stations (2600 m and 4450 m). The results indicate that there are close correlations between monthly air temperature and discharge in the studied watersheds. However the annual runoff have significant increasing trends with increasing air temperature and precipitation in TH, but decrease in BH with increasing air temperature and decreasing precipitation. Monthly runoff was the parameter most sensitive to climatic warming, especially during the autumn and winter. It was concluded that far more trends were observed than were expected to be occur by chance. In the past 20 years, the mean annual air temperature has risen dramatically by 0.38°C in TH and 0.68°C in BH each decade, the latter is 0.26°C warmer than that in TH. The increasing trend in runoff rate of TH varied during different times of the year, increased by 44% from October to February in the winter flow, by 24% in the spring flow and by 27% in the summer flow, but the streamflow decreased in BH. The change in runoff is affected mostly by climatic warming from April to June in TH, whereas when the Indian Monsoon prevails in BH, the runoff is affected by both air temperature and precipitation, and the summer rainfall has unpredictable influences on the runoff. During the non-monsoon period, the change in runoff is significantly influenced by air temperature and subsurface water, and the runoff loss in BH is supplied by the increase in TH.