Study on The Bortala River Watershed Hydrological Process Effects on The Climate Warming

DILINUER AJI[1,2], HAILONG JING [1,2], AKHIKO KONDOH [3], AIKEBAER[4]

[1]School of Geographic Science and Tourism, Xinjiang Normal University, China

[2]Xinjiang Laboratory of Lake Environment and Resources in Arid Zone, China

[3]Center for Environmental Remote Sensing, Chiba University, Japan

[4]Bohe Basin Management Department of Bozhou, China

Email: dilnura@xjnu.edu.cn

Abstract

Bortala River, originated from the Alatao Mountain in Xinjiang China, is supplied mainly by the melting snow. The annual melting snow is about 45% of the total annual run-off. The annual monthly maximum run-off usually occurs in June, run-off in April to June consists 60% of the total in snow-melt seasons. Temperature of the river basin has started to heat up since late 80s in last century, and the annual mean temperature raised from 5.5 that is in 60s to 7.9 in 2000s, annual precipitation has been in the tendency of rising too, especially got its peak in springs. Along with the climatic warming, there has been an enormous change in the hydrological process of the river, it mainly includes that the monthly maximum run-off in June has shifted to May, the total monthly run-off has increased about 15%, and the percentage of monthly melting snow in April to June in total run-off has raised from 60% to 70%. In the change tendency of long standing, raising of the temperature mainly occurs in winter, increasing of the precipitation in winter is also distinct, the hydrological process is mainly obvious decreasing of the run-off in summer and obvious increasing of the run-off in spring. Analysis by the image data of the same time shows that the hydrological process caused by climatic warming has already effected the land use/cover changes around the lake Ebnur that situated in the lower reaches of the river.

Key words: Bortala River, Hydrological process, melting snow, run-off, climate warming

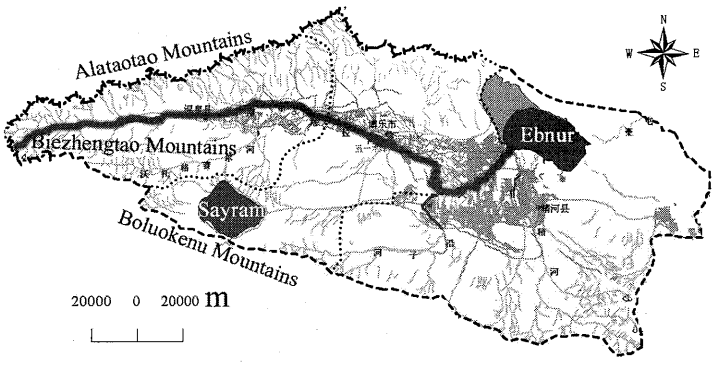


Fig.1 Location map of the study area

1. Introduction

Seasonal snow cover is the major water source at many high mountain areas. There are over 1 billion populations globally who depend on these snow water as their water resource supply. It is used in family, agriculture and industry, including power generation in some cases. Over 80% water resources in Xinjiang are formed at the mid and high mountain areas

around basins. Glaciers, snow cover and melt water at high mountain areas are the major recharge sources of rivers. With temperature rise caused by global change at cold areas of high mountains, the change of precipitation is sensitive here.

In this research, recent changes of hydrological processes in Bortala River were specially discussed. Multi-temporal satellite dates and meteorological observations of Bortala River basin were used for evaluating the climatic changes of Bortala River basin. Finally, the relationship between the change of hydrological processes in Bortala River and the climatic change in the area were discussed by using the Mann-Kendall way.

2. Object area

Bortala River is located at Hongbielindaban, the junction of Alatao Mountain and Biezhentao Mountain. The area of drainage basin is 11367km^2, and the total length of the river is 252km. It passes through Wenquan County from west to east, and flows into Ebnur Lake via Bole(Fig1). The source of the ditch passes up to Kazakhstan. We take the river basin above Wenquan County as the upstream of Bortala River basin, that is, the drainage basin above Wenquan Meteorological Station. With the length of about 100km, Wenquan Meteorological Station at the upstream of Bortala River is located at 44°59′N and 81°04′E within Wenquan County. With the altitude of 1133m, Wenquan Hydrologic Station enjoys the annual average precipitation 199.7mm from 1971 to 1980. Among them, 39% in spring, 36.3% in summer, 17.9% in autumn, 6.8% in winter. Bortala River is fed with snowmelt, rainfall and underground water.

3.Used data and Methodology

In this study, multi-spectral image data, multi-temporal meteorological and hydrological observations of Bortala River basin for about past 50 years, are used as an input data for evaluating the change of hydrological processes in Bortala River and the climatic change of Bortala River basin. For analyzing the climatic change for study area We extracted the precipitation and temperature data of the study area during the period 1959~2008 from the meteorological and hydrological station which located in Bortala River basin.

A subset of each of the Landsat MSS digital images(1972, 1977), Landsat TM digital image(1990), and Landsat ETM+ digital image(2003), were used for evaluating water area change detection of Ebnur lake region. Only the TM and ETM+ images were used for another three lake regions. The digital images were geometrically calibrated to each other to facilitate their comparison for Ebnur lake region. The 1990 Landsat TM image, which was supplied by Earth Satellite Corporation, had already been rectified and georeferenced to UTM map projection (Zone 44), and WGS1984 ellipsoid. Then, this image was therefore employed as a reference scene to which the 1972 Landsat MSS scene, the 1977 Landsat MSS scene, and the 2003 Landsat ETM+ scene of Ebnur lake region were registered. Using image to image registration, the other 3 images (MSS of 1972, MSS of 1977, and ETM+ of 2003) were matched to the TM image with the total root mean square error (RMSE) of less than half-pixels. The nearest neighbor resampling method was used to avoid altering the original pixel values of the image data. Finally, the relationship between the change of hydrological processes in Bortala river and the

climatic change in the area were discussed.

4. Results and Discussions

4.1 Climate change

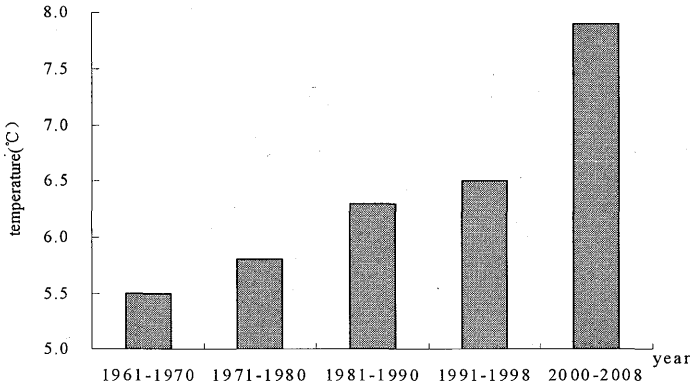


Fig.2 Average temperature distribution over 10years at Bortala Methodological Station in 1961~2008.

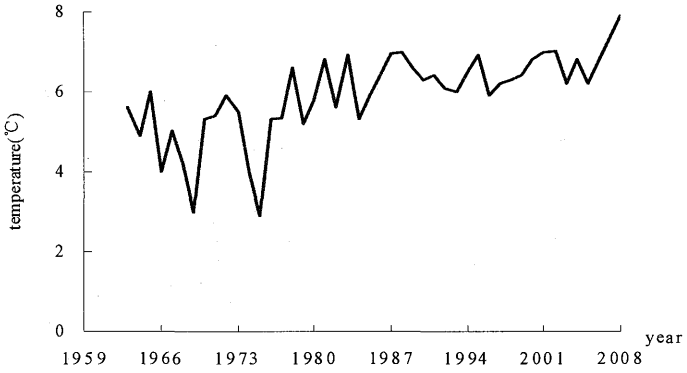


Fig.3 Yearly temperature at Bortala Methodological Stationof Bortala River basin from 1959~2008.

4.1.1 Temperature rise due to climatic warming is obvious. The average temperature rises to 7.9□in the 2000s from the 1960s(Fig2,Fig3), Among them, temperature rise in winter reaches its peak(Fig4).

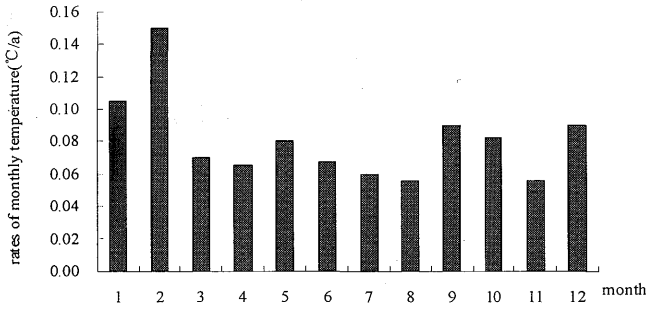


Fig.4 Increasing rates of monthly temperature change in Bortala River Basin during 1959~2008.

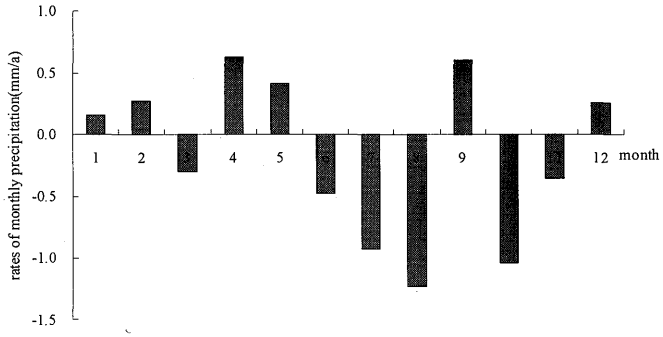


Fig.5 Increasing rates of monthly precipitation in Bortala River basin during 1959~2008.

4.1.2 Annual precipitation is on the rise. The increase of rainfall mainly occurs in winter and early spring; while precipitation is on the decline from June to August and from October to November. The greatest reduction occurs from June to August in most cases(Fig.5).

4.2 land use/cover change around Lake Ebnur

There are four scenes of MSS (1972,1977), TM (1990) and ETM+ (2003) images that include the Lake Ebnur region, and they were used for the post-classification change detection as shown in Fig6.Cultivated, and water, were the major land use/cover classes of interest in this study. Based on Fig6, cultivated area has a continuing increase, which increased from 54.2km² in 1972 to 127.3km² in 1977, to 267.2km²in 1990, and then to 734.4km² in 2003 for the studied area of Lake Ebnur region. The water class has also showed a significant change in this area. In 1972, there were 528.2km²of water area (or 12%), which declined to 524.8 km² (or 11.9%) by1977. On the contrary, the water area has increased in 1990 from 547.6 km² (or 12. 4%) to 1029.2 km² (or 23.4%) in 2003, which means, the water area changes of Lake Ebnur were governed by cultivated changes from 1972 to 1990. After 1990, water area has doubled without regard to even the growth of cultivated area.

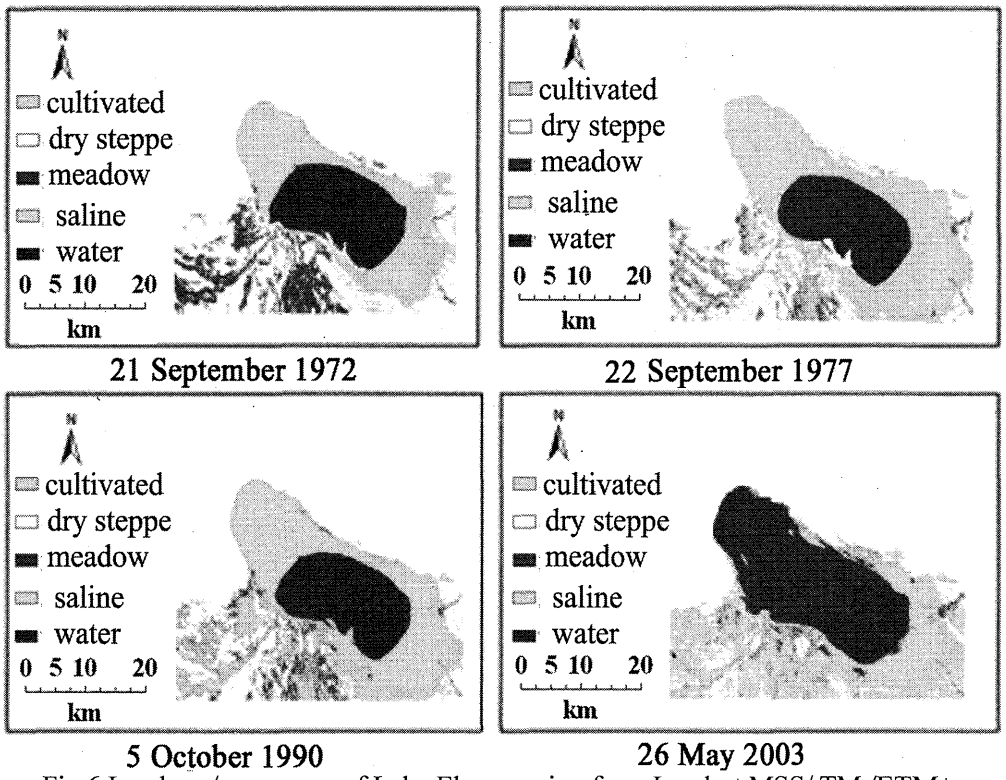
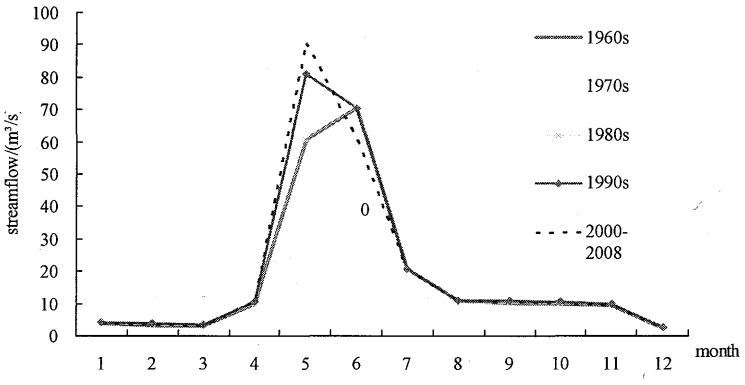


Fig.6 Land use/cover map of Lake Ebnur region from Landsat MSS/ TM /ETM+

4.3 Hydrological processes

With climatic warming, the change of hydrologic processes of rivers within the year is conspicuous. It is mainly reflected in the following: the maximum runoff is advanced from June to May, and the runoff within the year moves forward.



Reference

Dyurgerov M. Mountain and subpolar glaciers show an increase in sensitivity to climate warming and intensification of the water cycle [J]. Journal of Hydrology, 2003,282:164-1761.