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

DILINUER AJI[1]，HAILONG JING[2]，AKIHIKO KONDOH[3]

[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

Contents

1 Introduction

2 Objectives

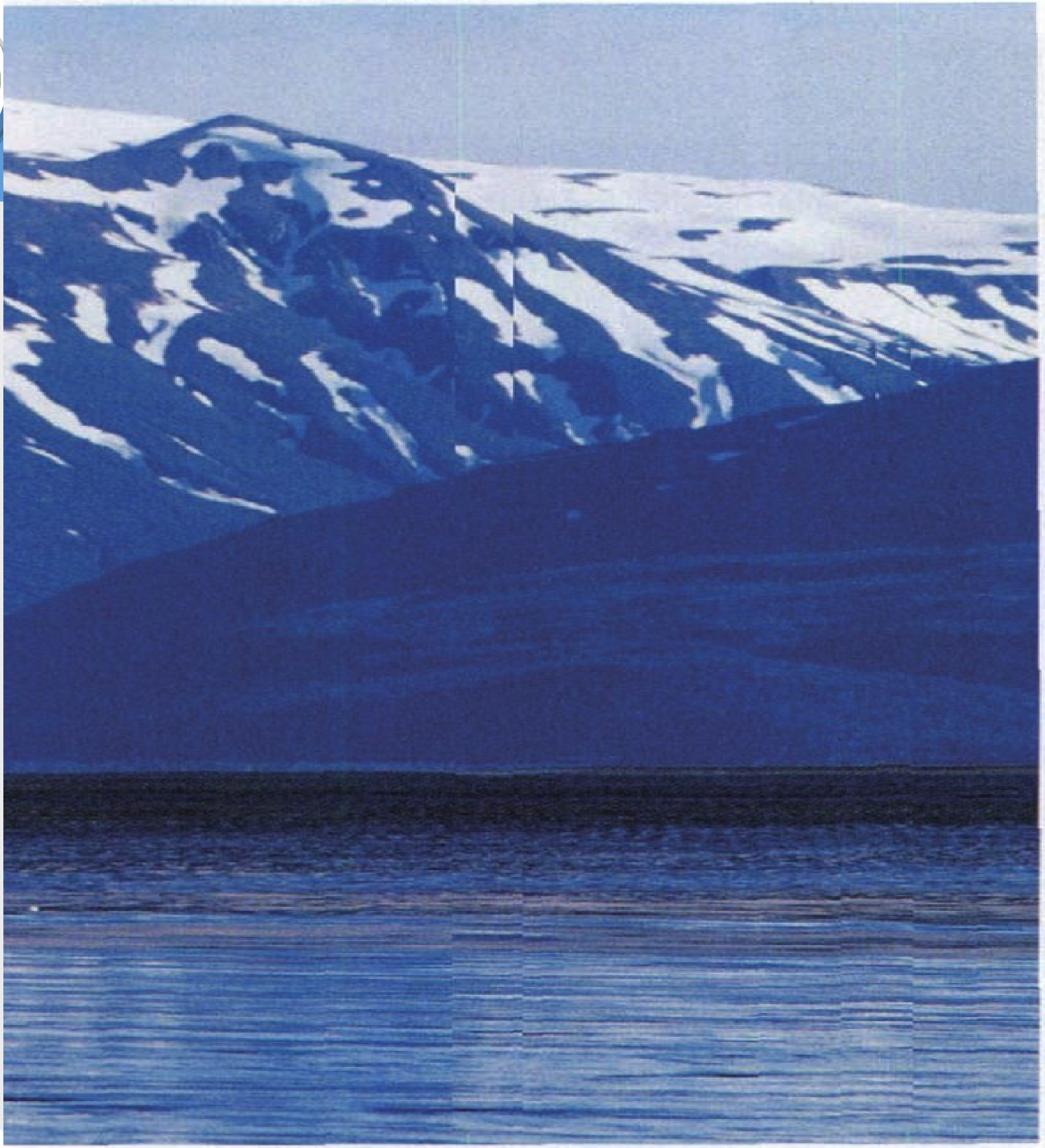
3 Used Data and Methodology

4 Results and Conclusions

Introduction

Seasonal snow cover is the major water source in many high mountain areas. There are over 1 billion people globally who depend on this snow melt as their water resource supply. It is used in homes, agriculture and industry, including power generation in some cases. Over 80% of water resources in Xinjiang are formed at the mid and high mountain areas around basins. Glaciers, snow cover and melt at high mountain areas are the major replenishment sources of rivers. With temperature rises caused by global change at cold areas of high mountains, the change of precipitation is sensitive here.

乌鲁木齐"河源1号"冰川正在加速消融/新楼网



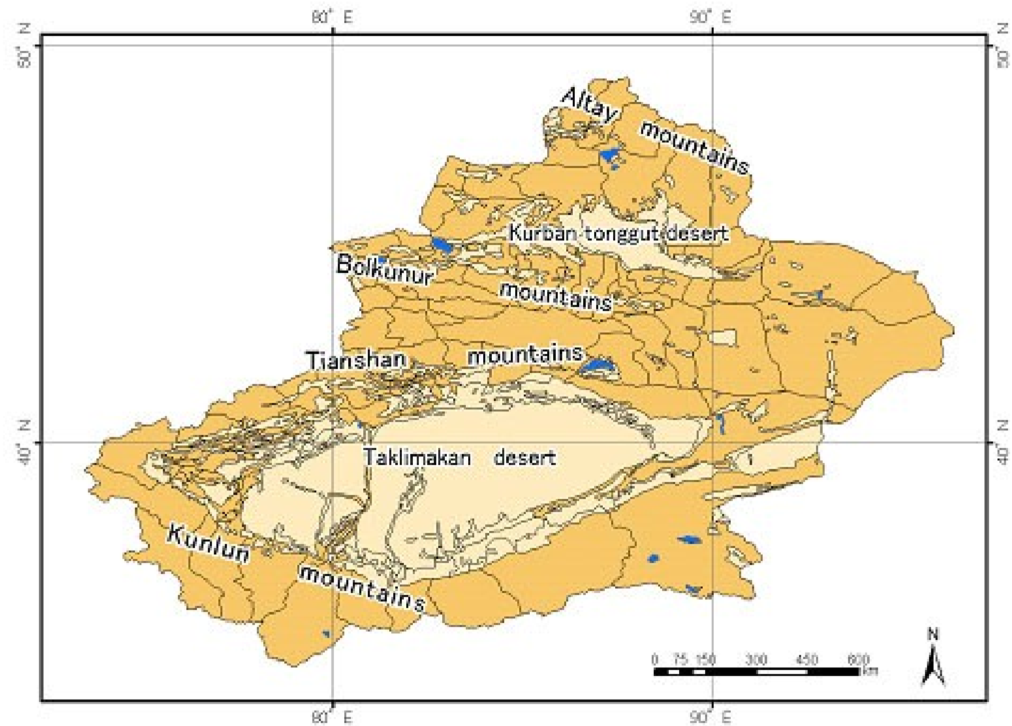
北极冰川融化，可能会使北极熊在60年内绝迹/本刊资料图片

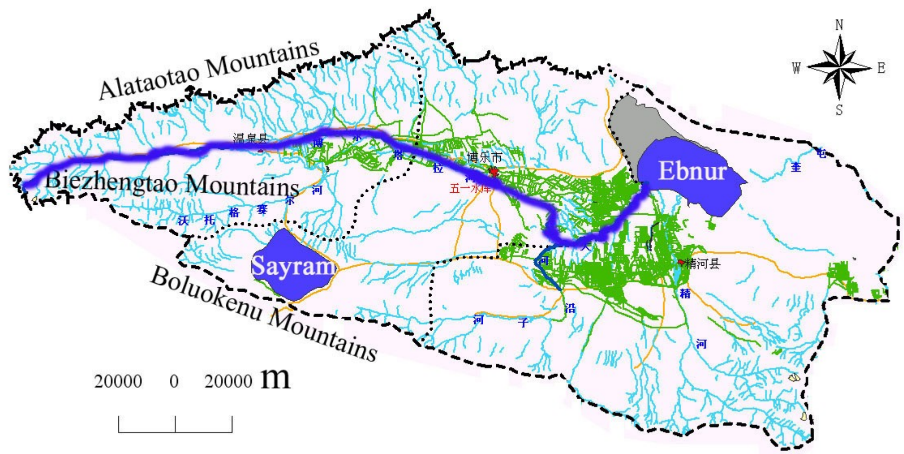
Introduction

喜马拉雅山脉的冰川在今后半个世纪内将面临消失的危险/NASA

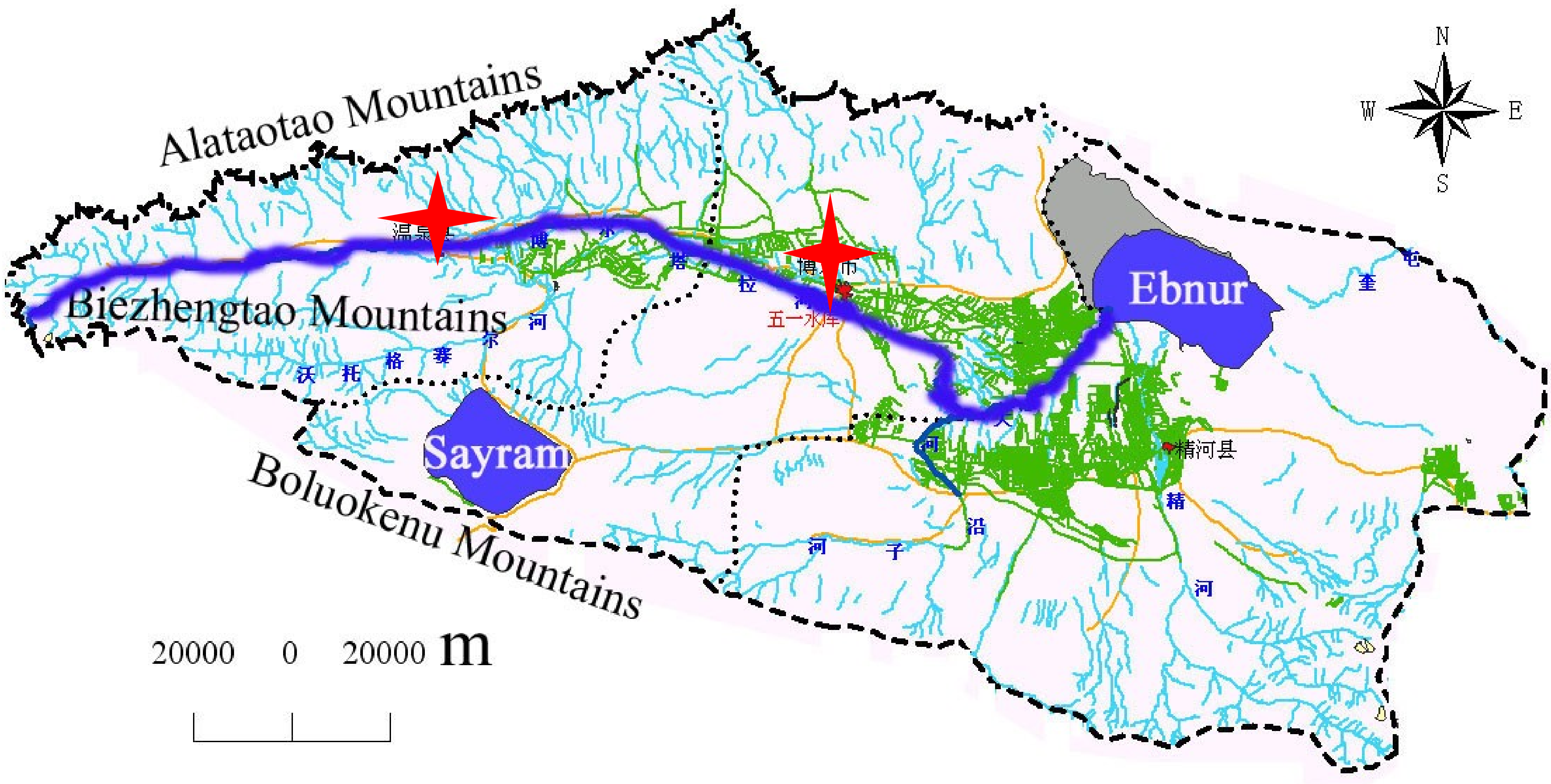
Introduction

Rivers coming from Altataw Mountains are all fed with ice-snow melt water. Glacier and melt from snow cover at mountain areas as well as precipitation runoff become the major water resources for the economic development in the middle and lower plains. However, the up and down change of water resources is greatly affected by climatic change. Ice-snow melt in mountainous areas plays an important role for the stability of river water.





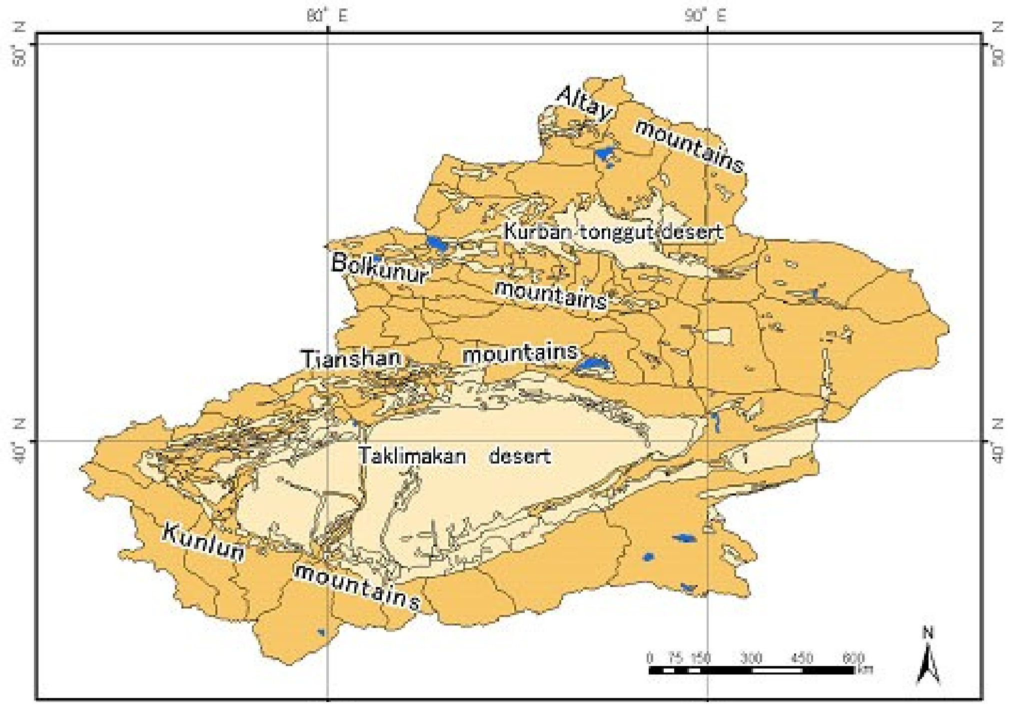
Study Area

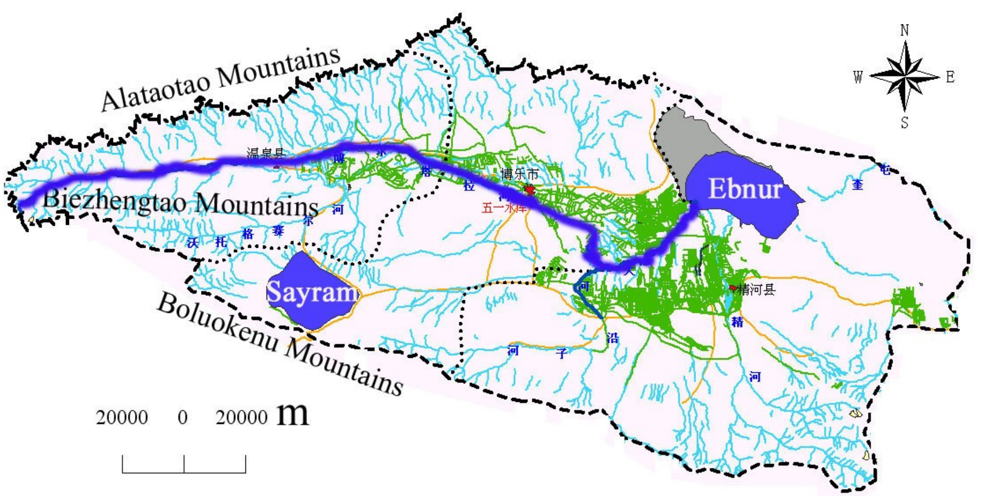


Alataotao Mountains
Biezhengtao Mountains
Boluokenu Mountains
Sayram
Ebnur
N
W
E
S
五一水库
精河县
20000 0 20000 m

Objectives

- To detect the climate change in Bortala River Basin
- To explore the Hydrologic Features in Bortala River Basin over the last 50 years
- To analyze the Hydrological Processes responding to Climate Change of Bortala river





Used data (Con.)

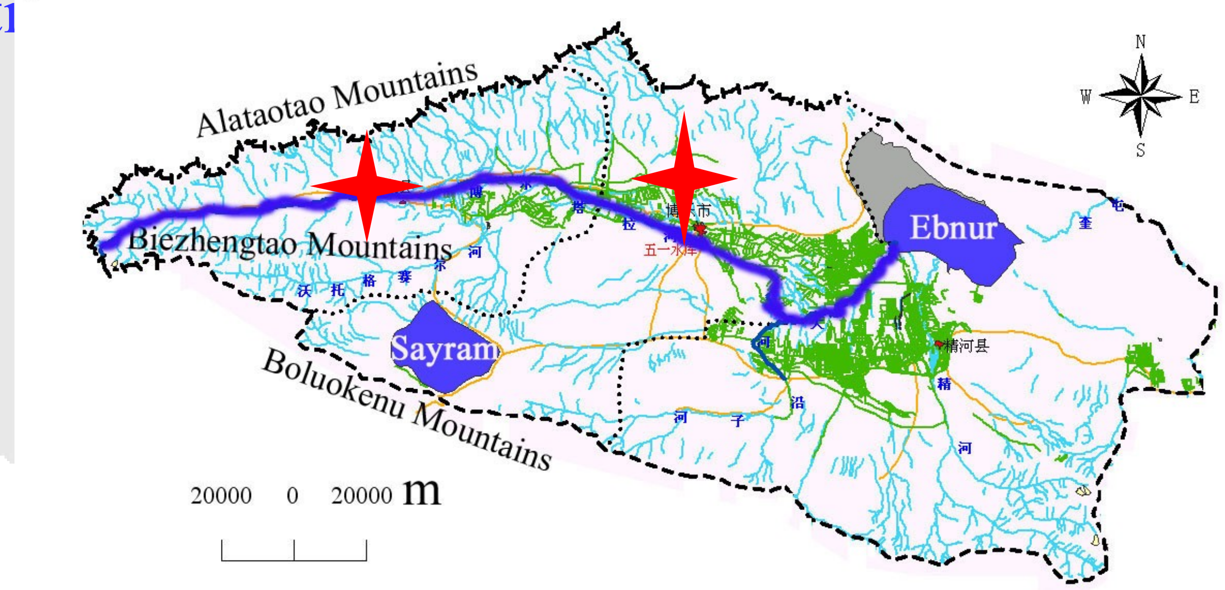
Image data

Satellite/Sensor	Observation date	Path/Row
Landsat 1/MSS	21 September 1972, 22 September 1977	157/29
Landsat 4/TM	5 October 1990	157/29
Landsat 7/ETM+	26 May 2003	146/29

Used data (Con.)

Meteorological data

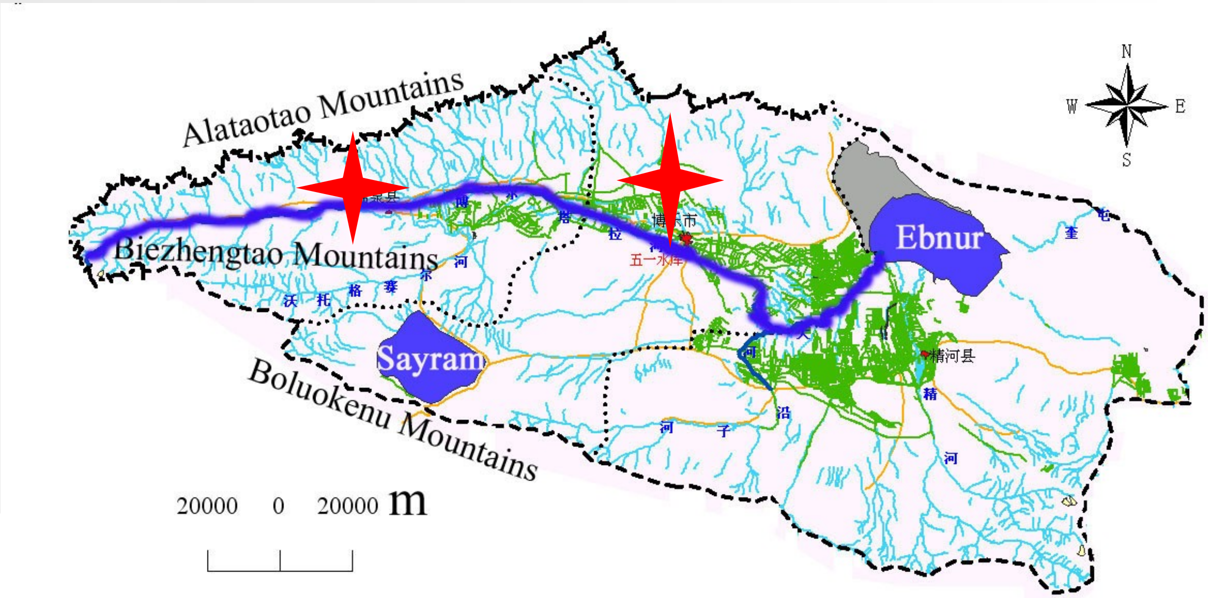
For analyzing the climate change for the study area， We extracted the precipitation and temperature data of Bortala River Basin during the period 1959~2008 from Wenquan and Bole Meteorology stati



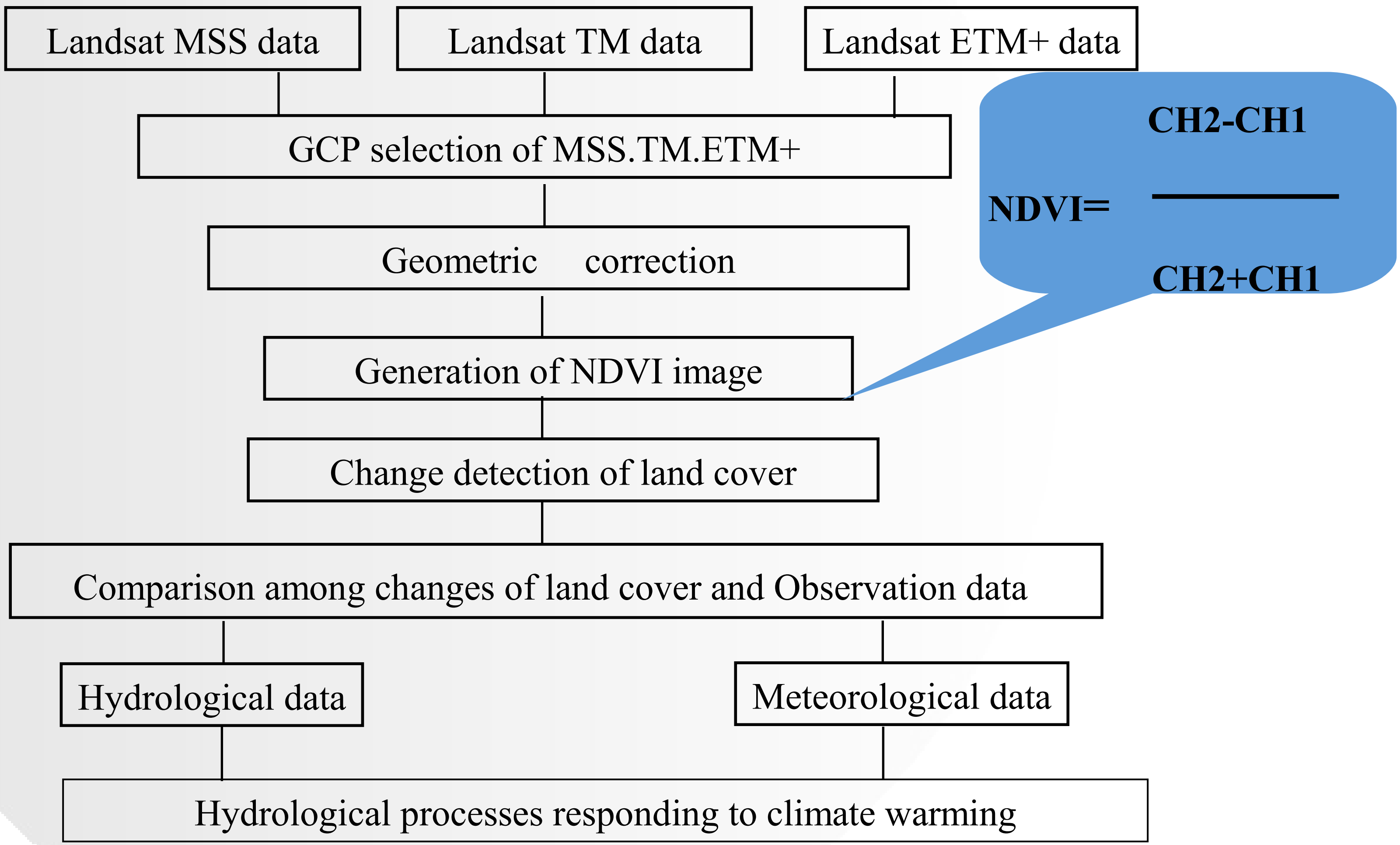
Used data

Hydrological data

To explore the Hydrologic Features in Bortala River Basin, We used the hydrogical data of Bortala River over the last 50 years



Methodology

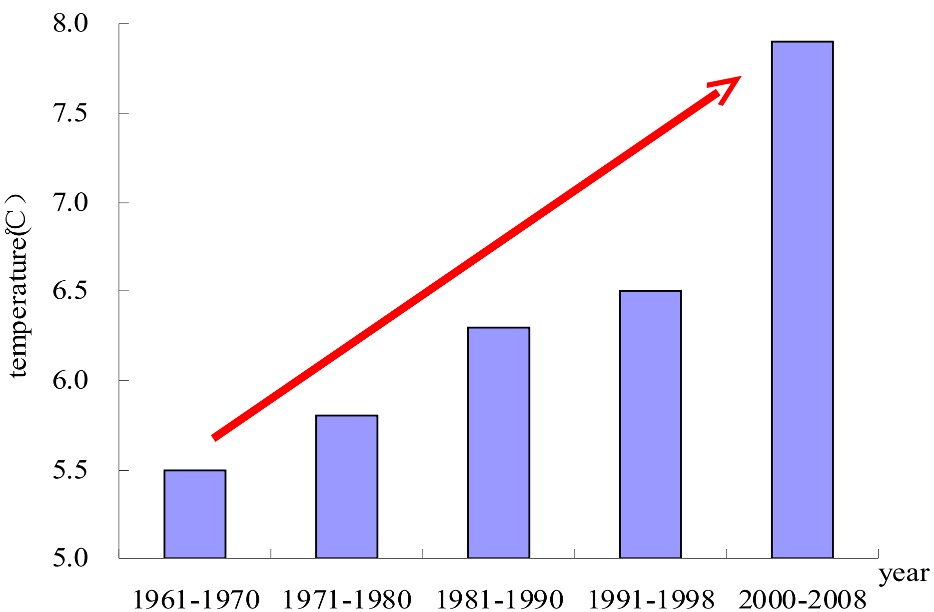


Result-Climate Change

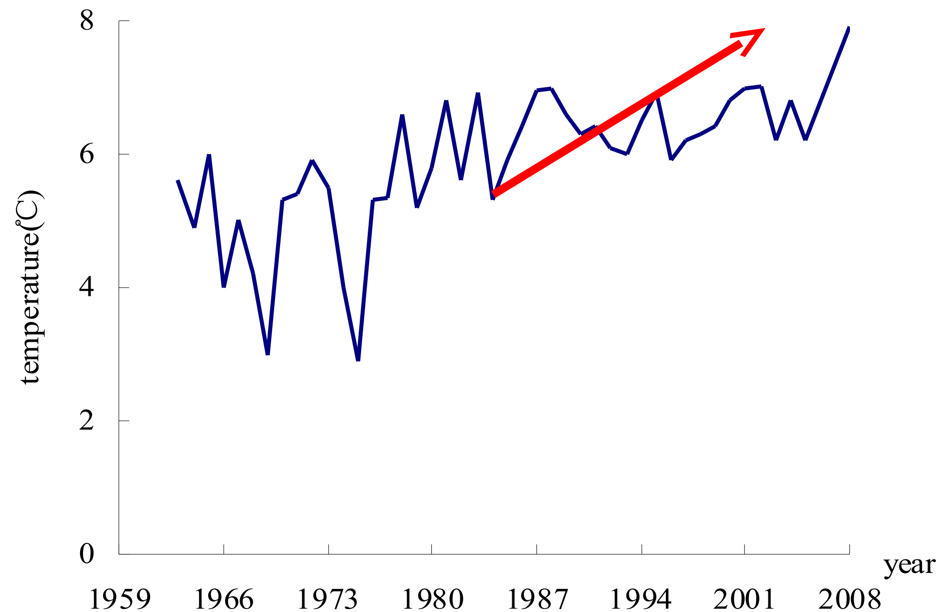
Temperature

Temperature rise due to climate warming

7.9-5.5=2.4(℃)

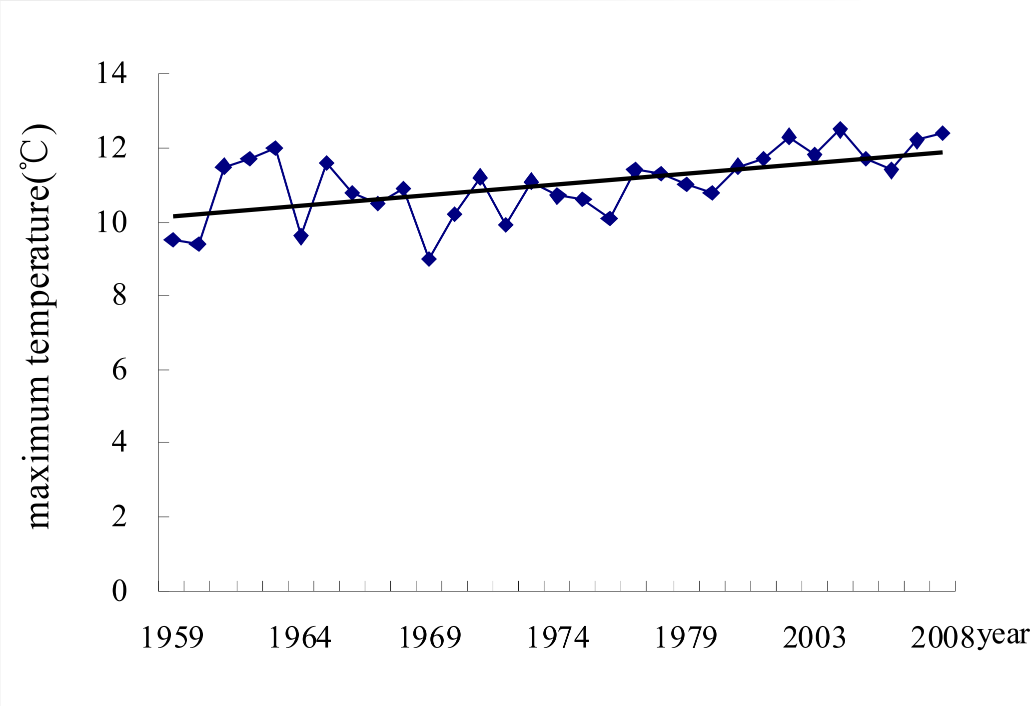


Average temperature distribution over 10years at Bortala Meterological Station in 1961~2008.



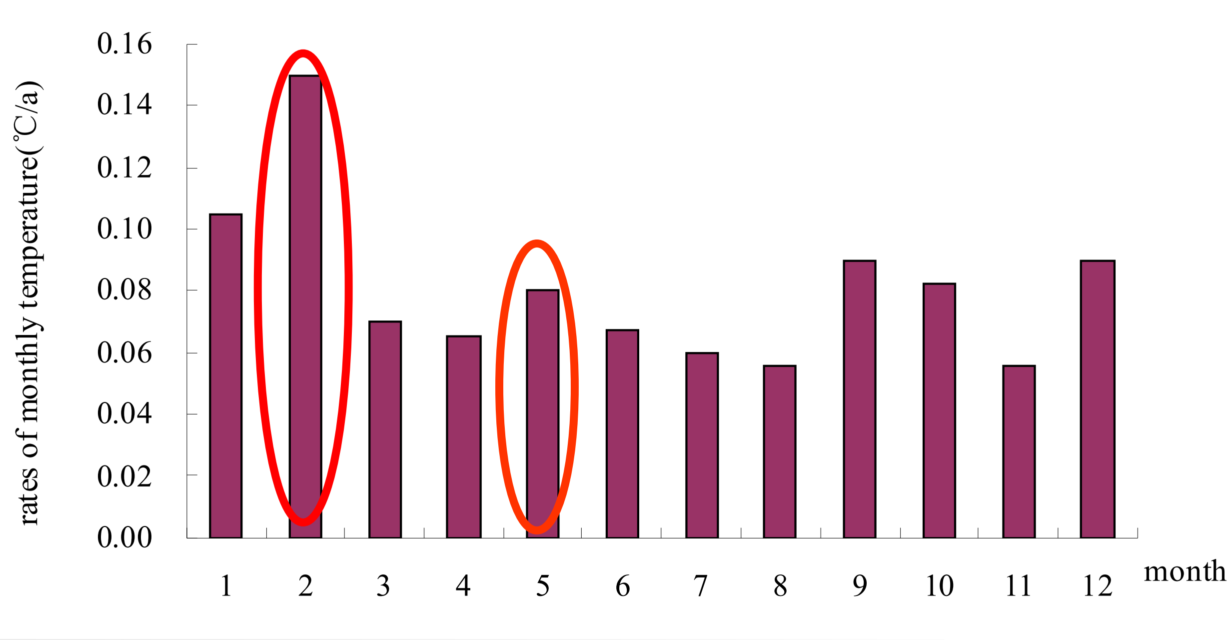
Yearly temperature at Bortala Meterological Station of Bortala River basin from 1959~2008.

Result-Climatic Change



Result-Climatic Change

The rise of temperature change reaches its peak in winter.



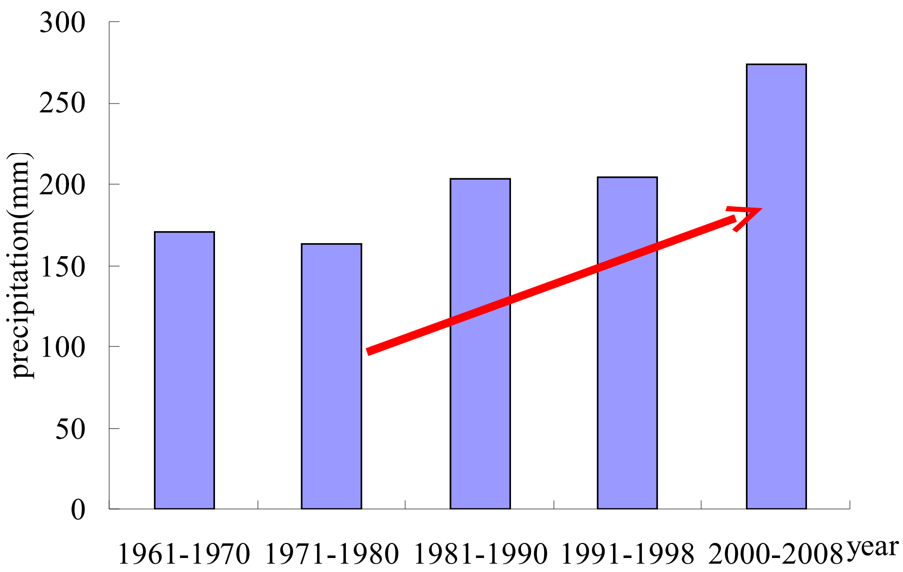
Increasing rates of monthly temperature change in Bortala River Basin during 1959~2008.

Result-Climatic Change

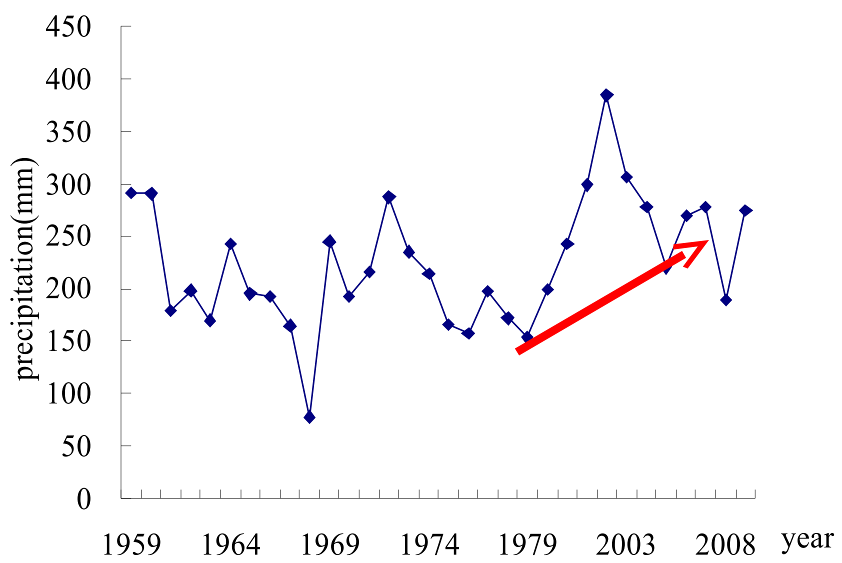
Precipitation

Annual average precipitation is on the rise.

274.1-170.9=103.2(mm）



Average prcipitation distribution over 10years at Bortala Meterological Station in 1961~2008.

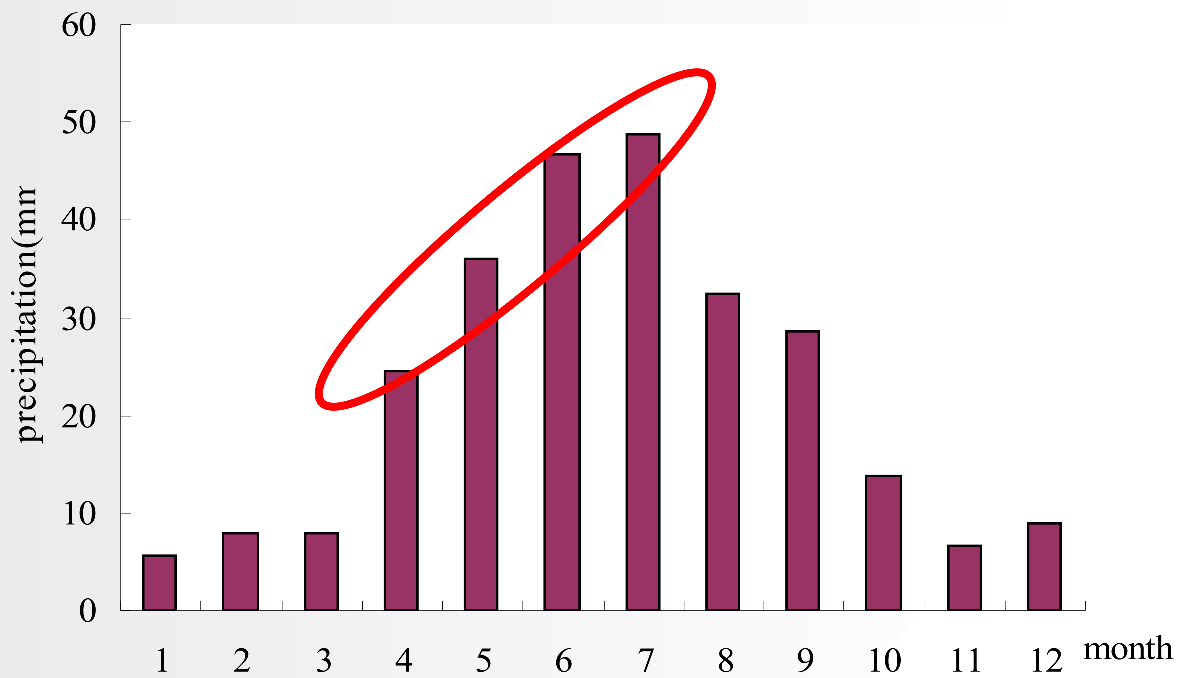


Yearly precipitation at Bortala Meterological Station of Bortala River Basin during 1961~2008.

Result-Climatic Change

Monthly Changes

precipitation on the rise from April to July, begin to decrease n August, and are lowest through the winter until the next March.



Changes in monthly average precipitation distribution at Bortala Meterological Station during 1958~2008.

Result-Climatic Change

Monthly Change of 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.

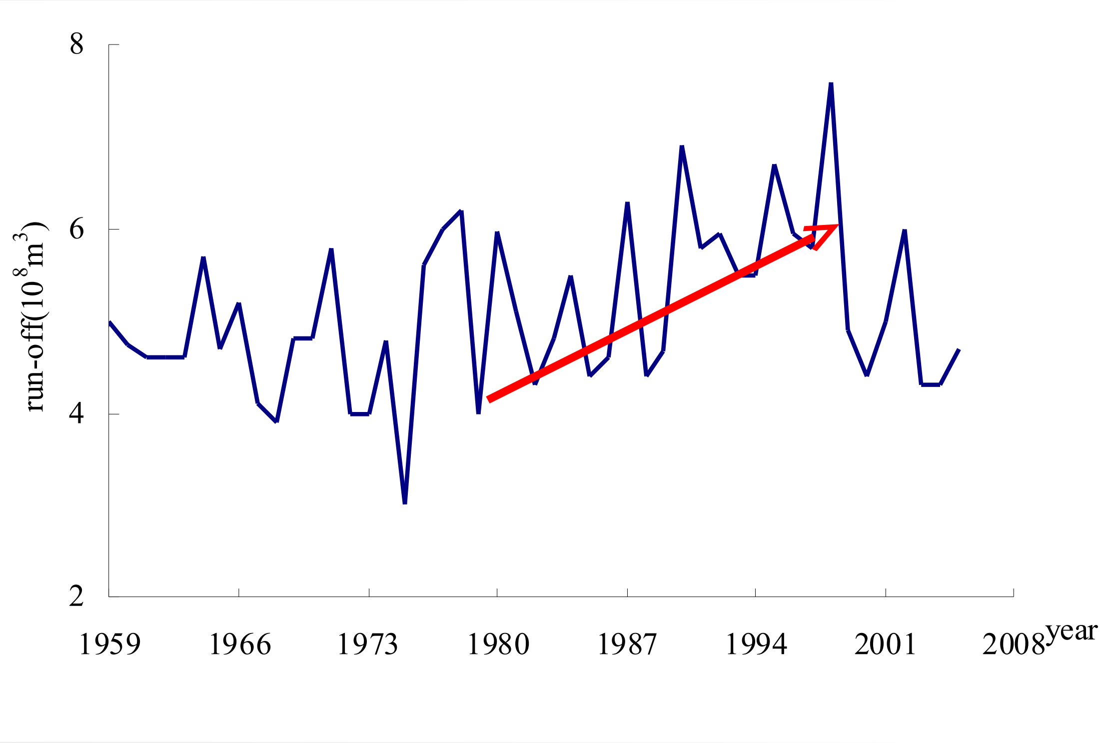
Winter

Spring

September

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

Result-Climatic Change



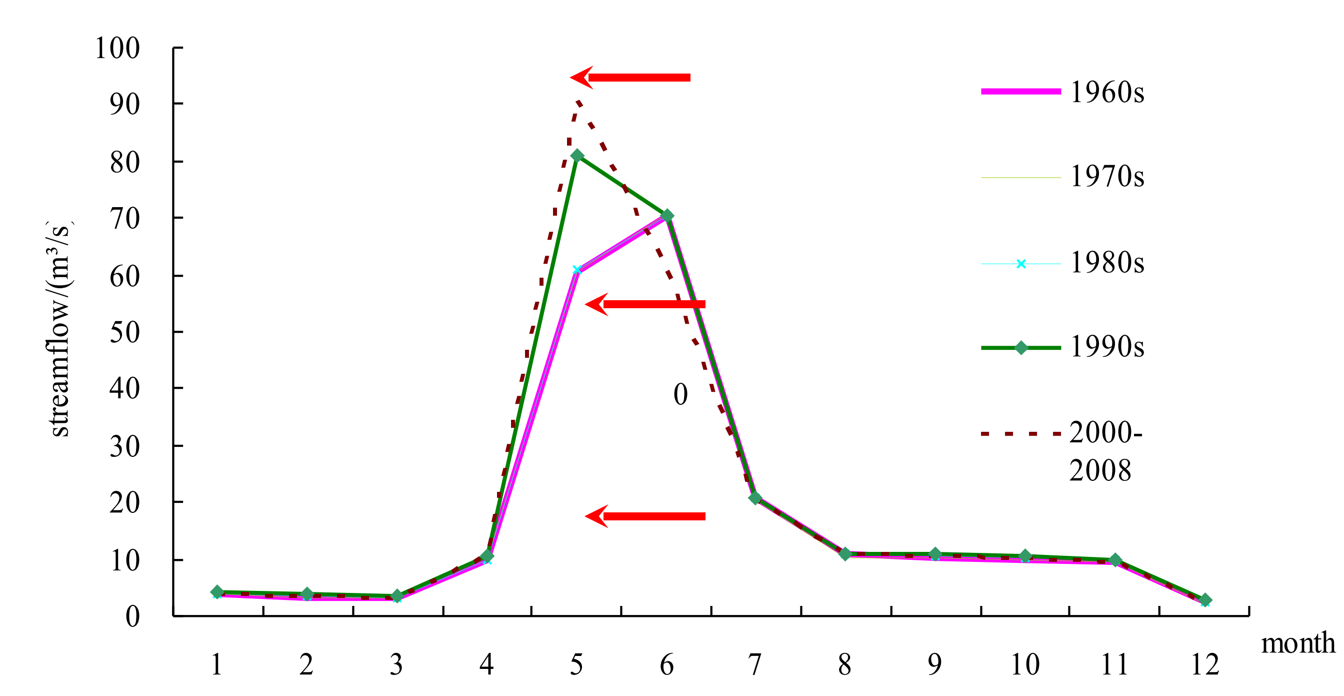
Hydrological processes responding to climate warming

distribution of runoff within the year is asynchronous with distribution of precipitation

June： rain

snow

July: rainfall



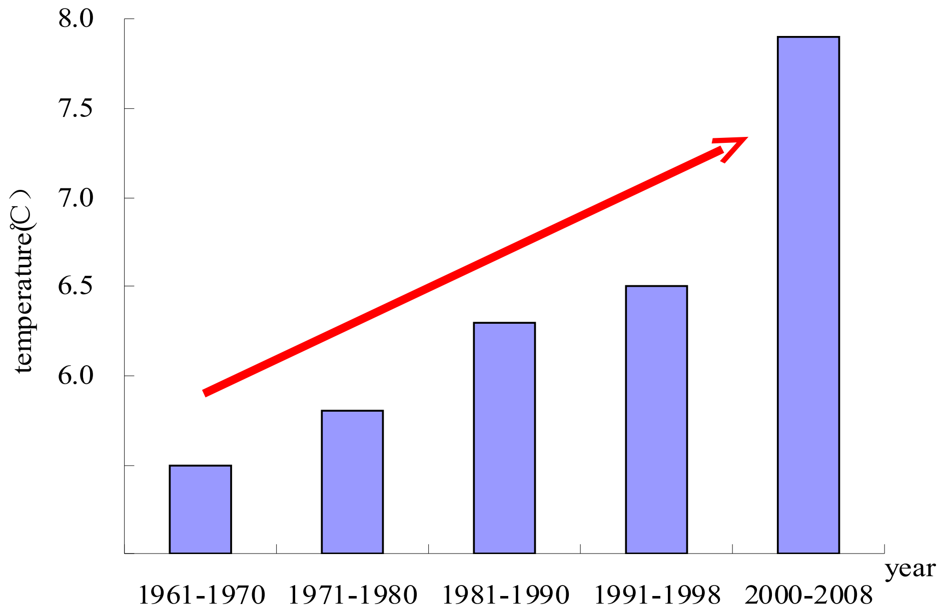
Ten year average monthly stream-flow changes at Bortala Hydrological Station in 1959~2008.

Hydrological processes responding to climate warming

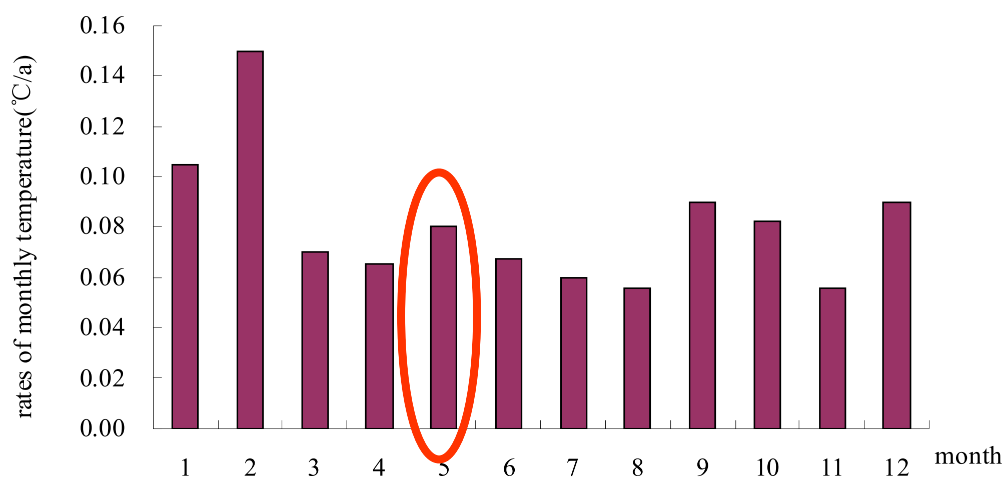
The annual change of precipitation in the Bortala River basin has started to go up since 1983. Its increase mainly occurs in winter and early spring, which greatly increases snowmelt runoff. The maximum flow occurred in June, and the second greatest flow occurred in May prior to the 1990s. However, beginning from the 1990s, the maximum flow occurs in May, and the runoff cycle within the year has moved forward; while continuous rainfall from May to July decreases, which causes obvious reduction of runoff from July to August.

Hydrological processes responding to climate warming

The rising of temperatures in May is obvious in spring and summer season, it causes the runoff cycle , which is most the important result of snow melt, to occur earlier in the year.



10years average temperature distribution at Bortala Methodological Station in 1961~2008.

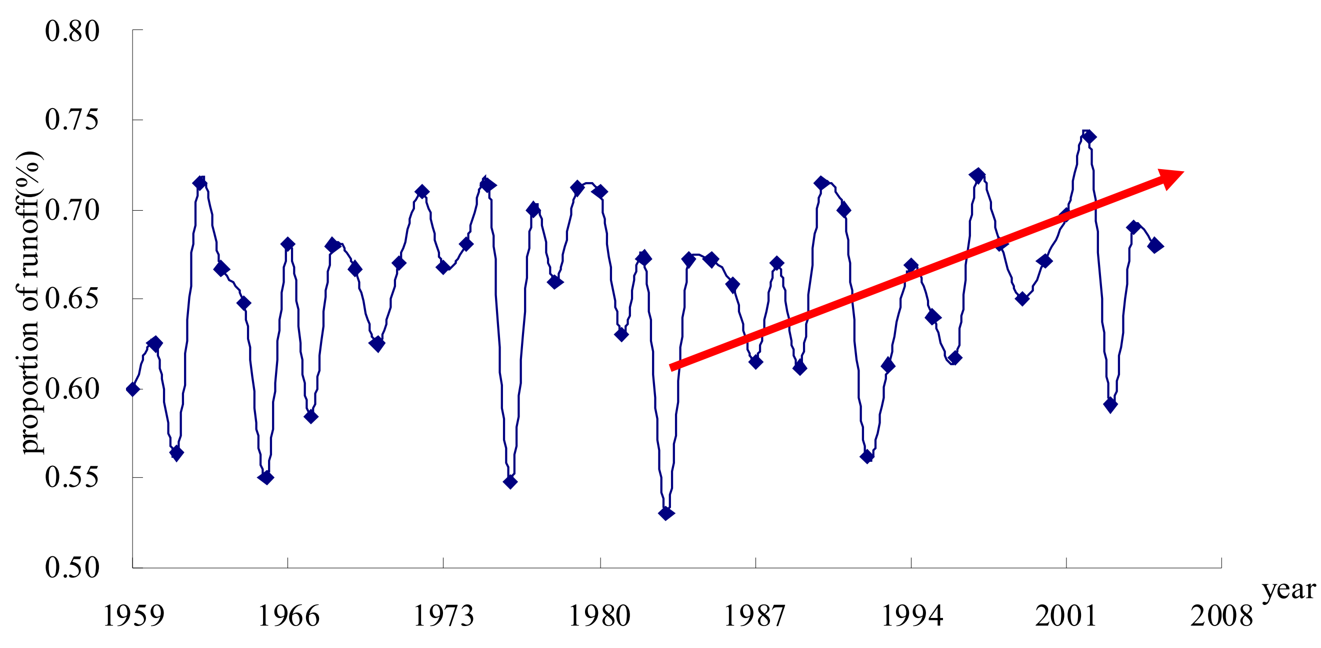


Increasing rates of monthly temperature in Bortala River Basin during 1959~2008.

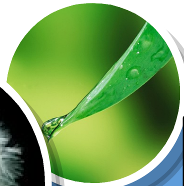
Hydrological processes responding to climate warming

Hydrological processes responding to climate warming

With the temperature rising in winter, the proportion of snowmelt runoff shows an increase.

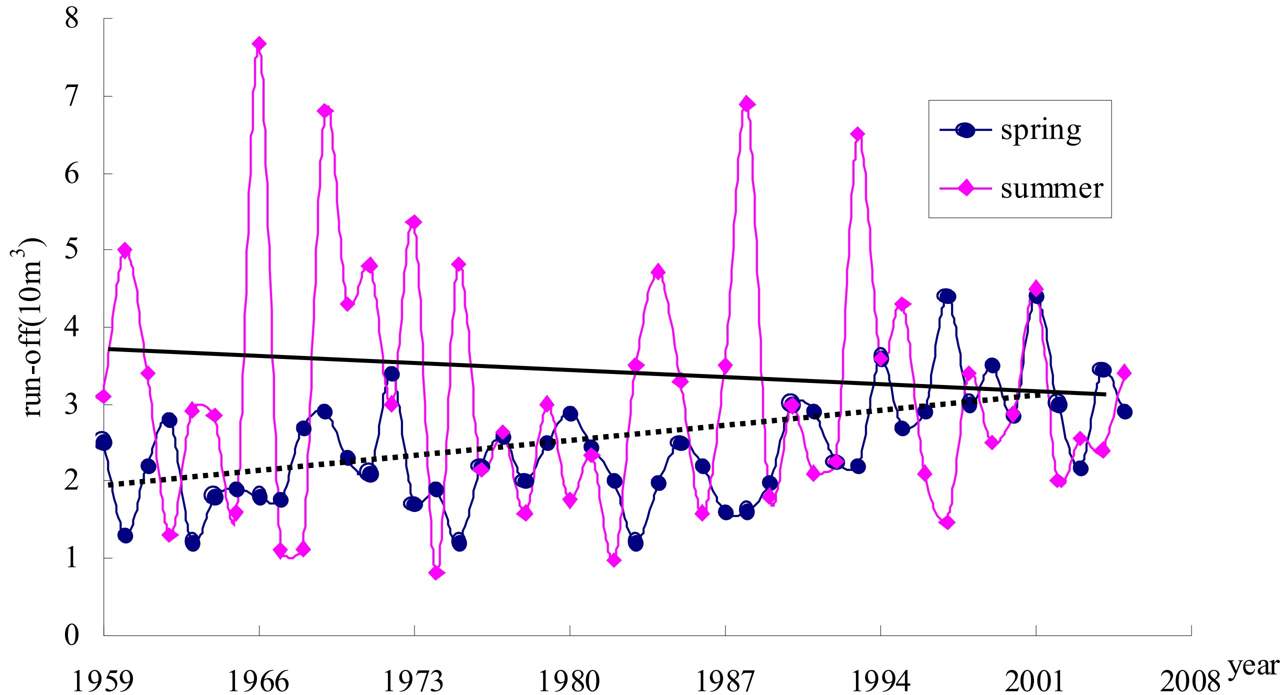


Change in Proportion of April to June runoff of snow melting season to annual runoff at Bortala River Hydrological Station of Bortala River



Hydrological processes responding to climate warming

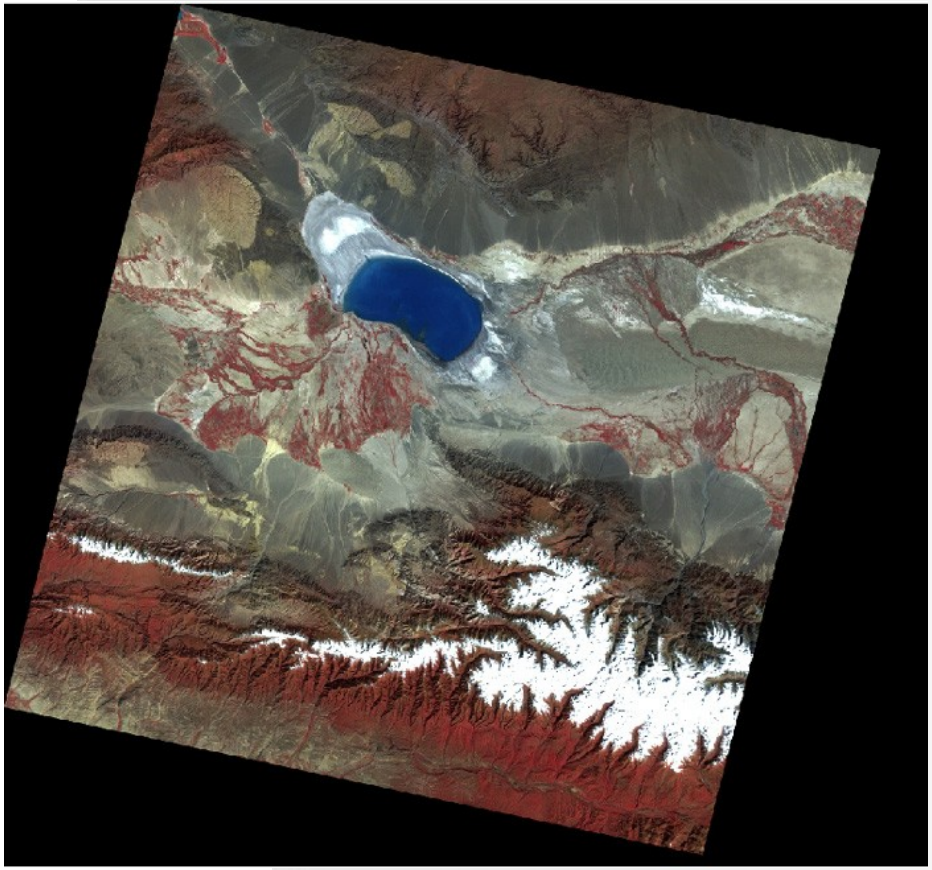
Runoff in spring is increasing.



Comparison of runoff changes between autumn and summer at Bortala River Hydrological Station of Bortala River in 1959~2008.

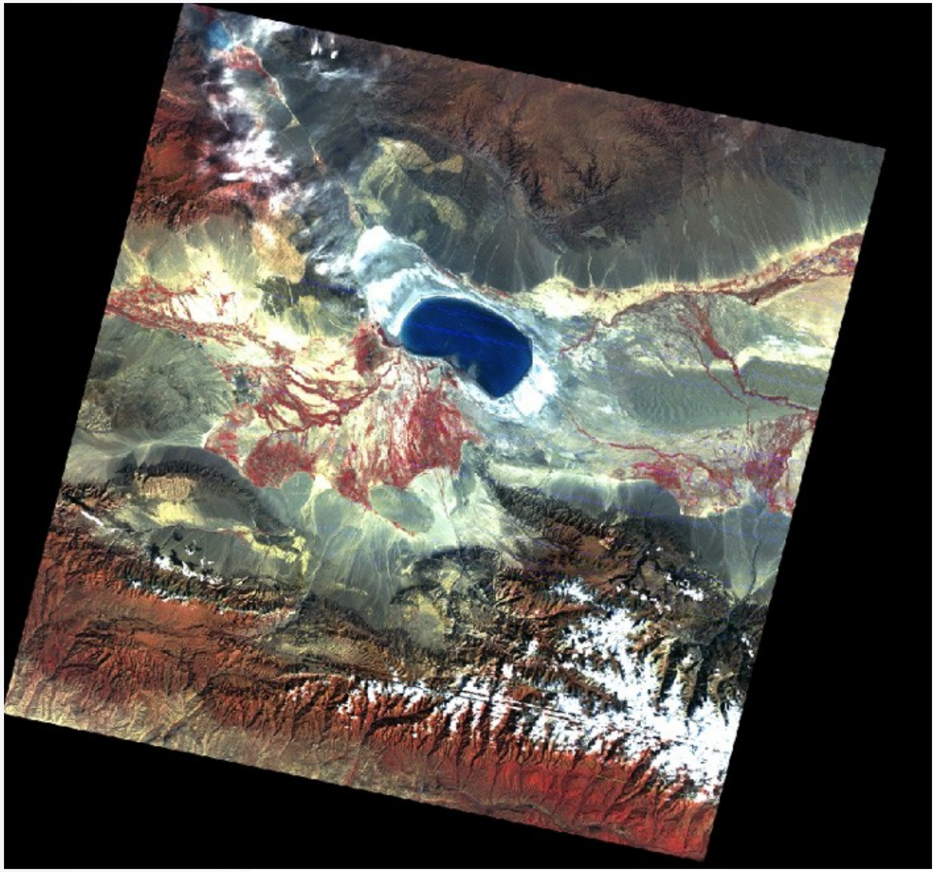
Hydrological processes responding to climatic warming

Land use/cover



Color composite image of Landsat MSS(1972) of Ebnur Lake region

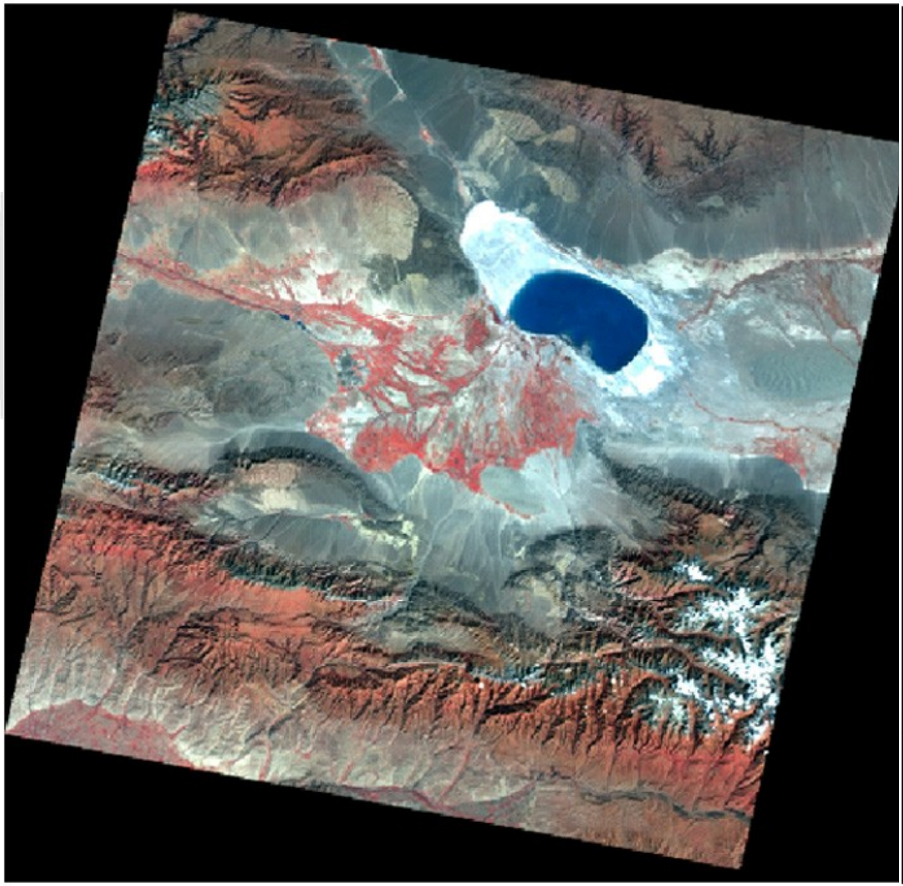
21 September 1972



Color composite image of Landsat TM(1977) of Ebnur Lake region

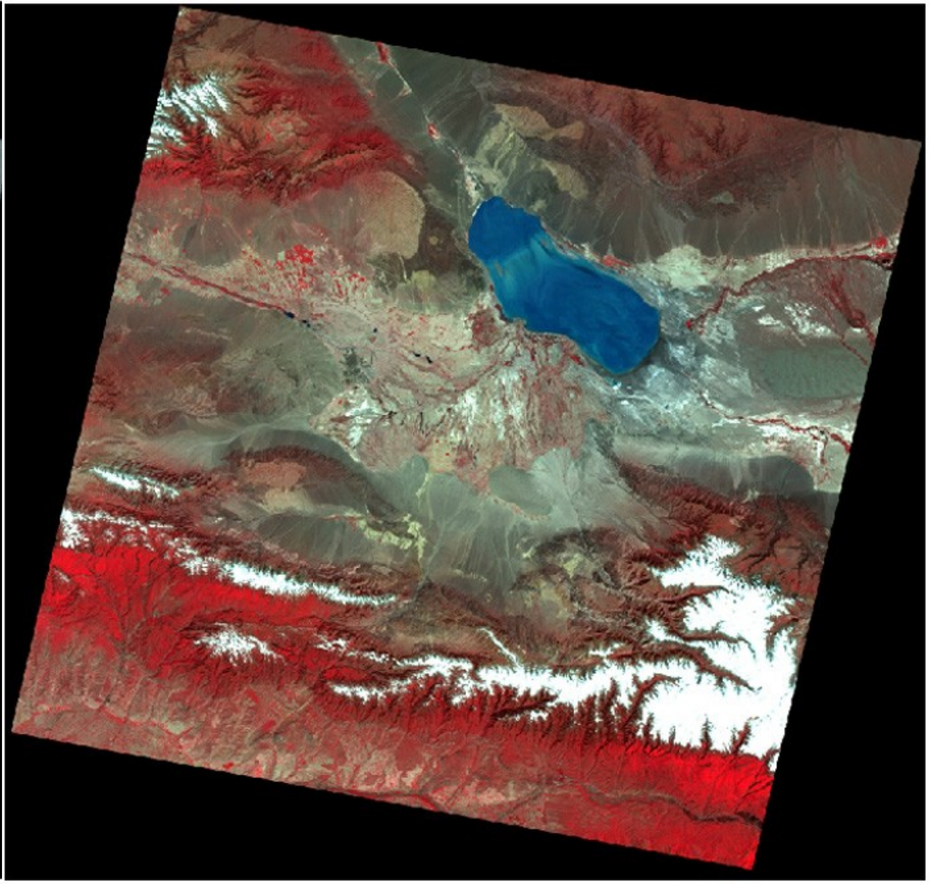
22 September 1977

Hydrological processes responding to climatic warming



Color composite image of Landsat TM(1990) of Ebnur Lake region

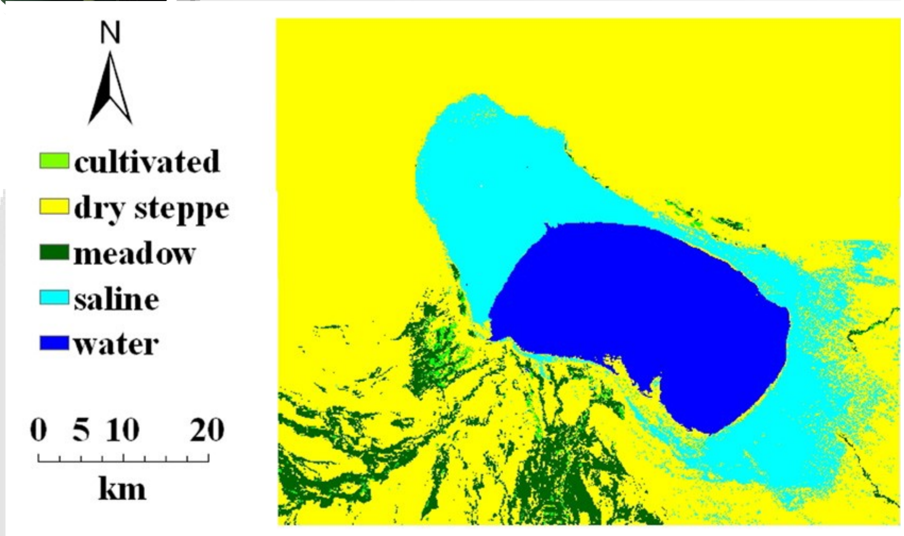
5 October 1990

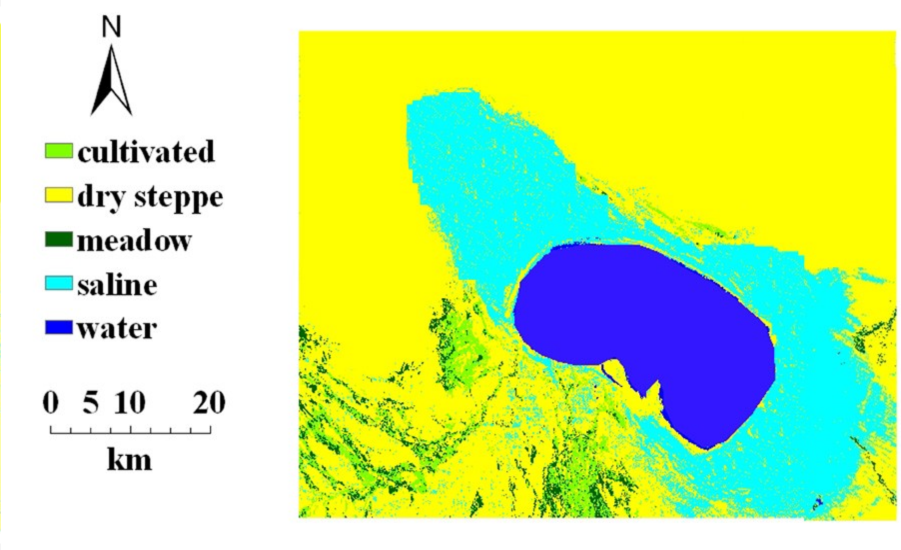


Color composite image of Landsat TM(2003) of Ebnur Lake region

26 May 2003

Hydrological processes responding to climatic warming



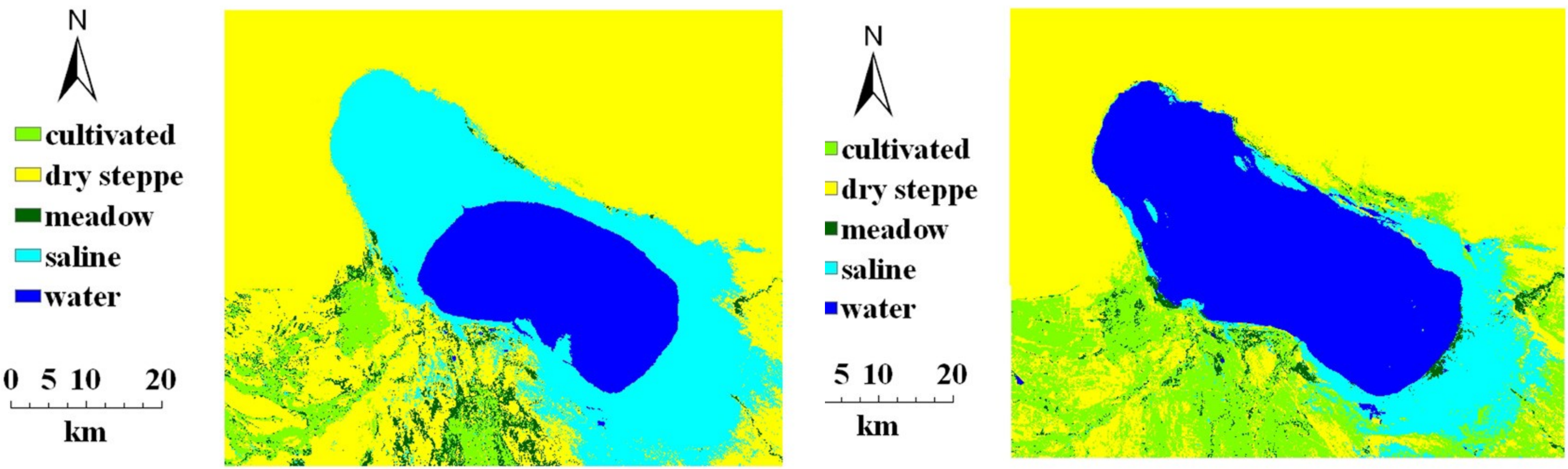


Land cover classification map around Ebnur Lake based on Landsat MSS1972 and LandsatMSS1977

(a) 21 September 1972

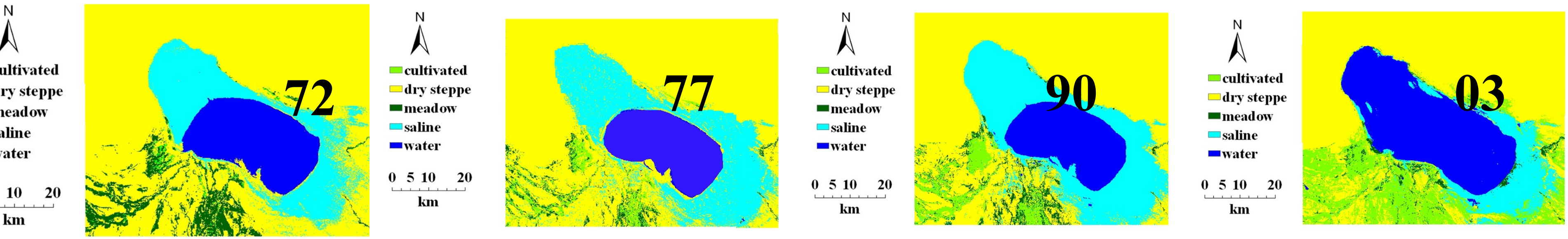
(b) 22 September 1977

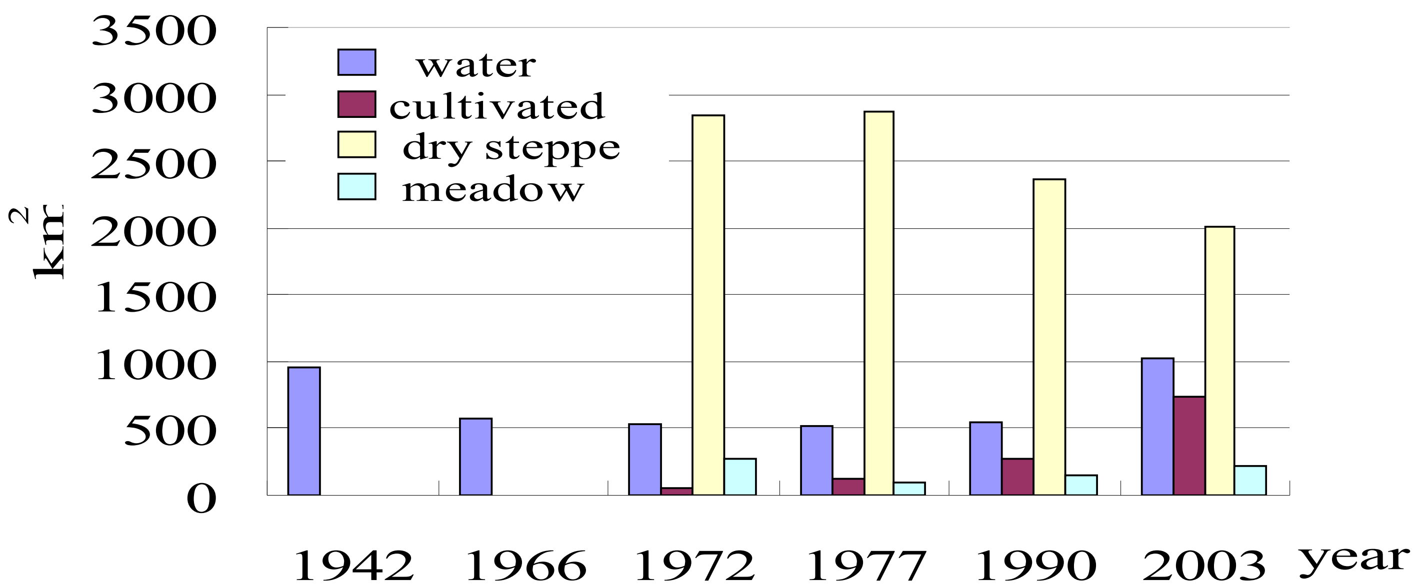
Hydrological processes responding to climatic warming



Land cover classification map around Ebnur Lake based on Landsat TM1990and Landsat ETM+1977

(c) 5 October 1990 (d) 26 May 2003

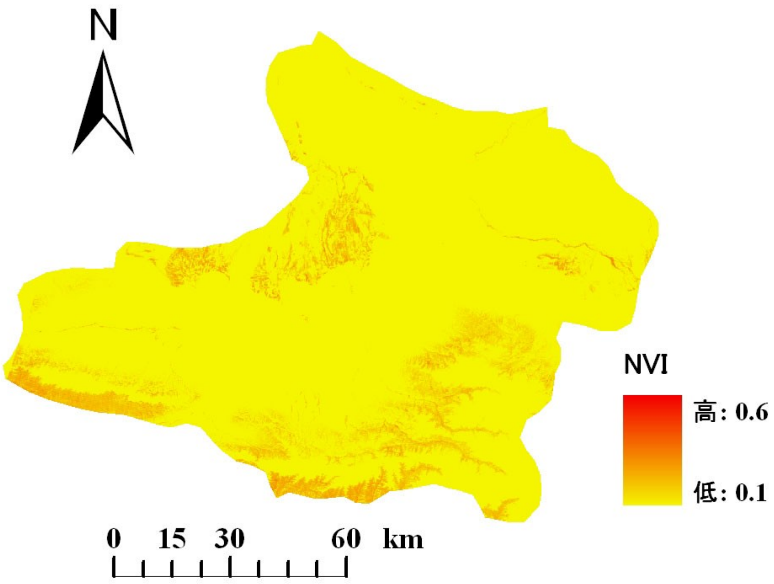




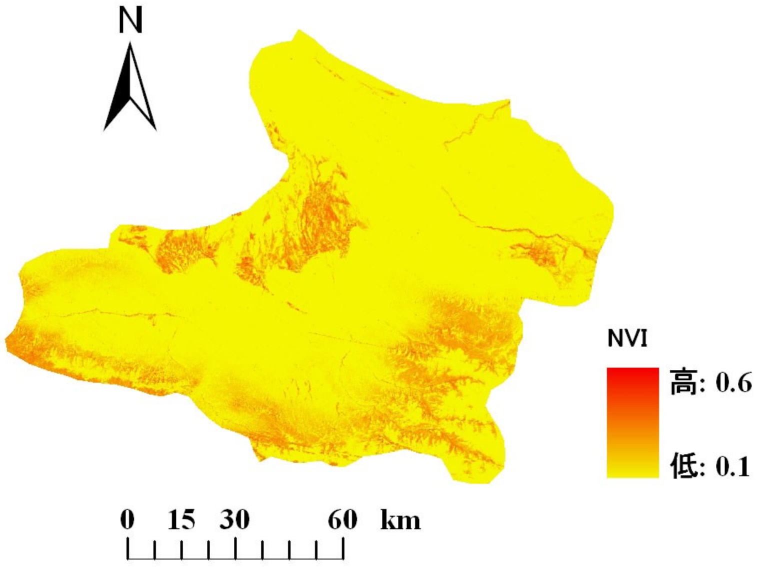
the water area changes of Lake Ebnur were governed by changes in cultivation from **1972** to **1990**. After **1990**, the water , water area has doubled without regard to even the growth of cultivated areas.

Related to climatic changes?

Generation of NDVI image

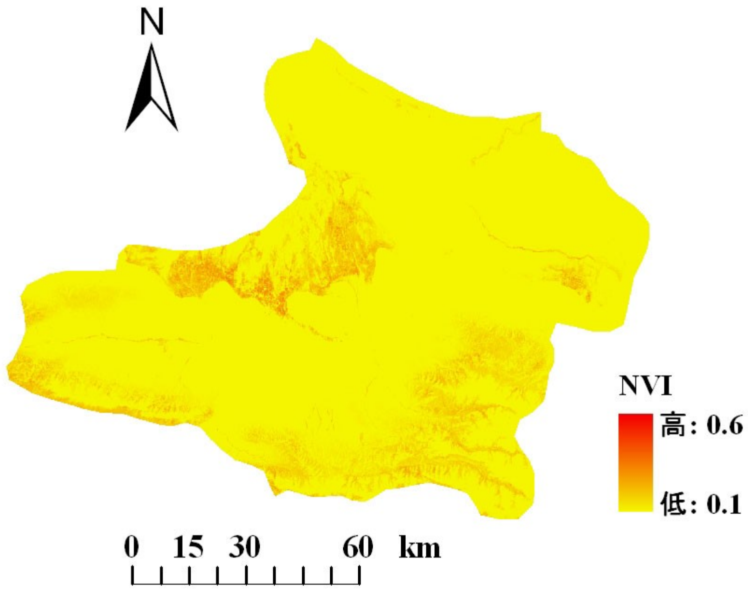


21 September 1972

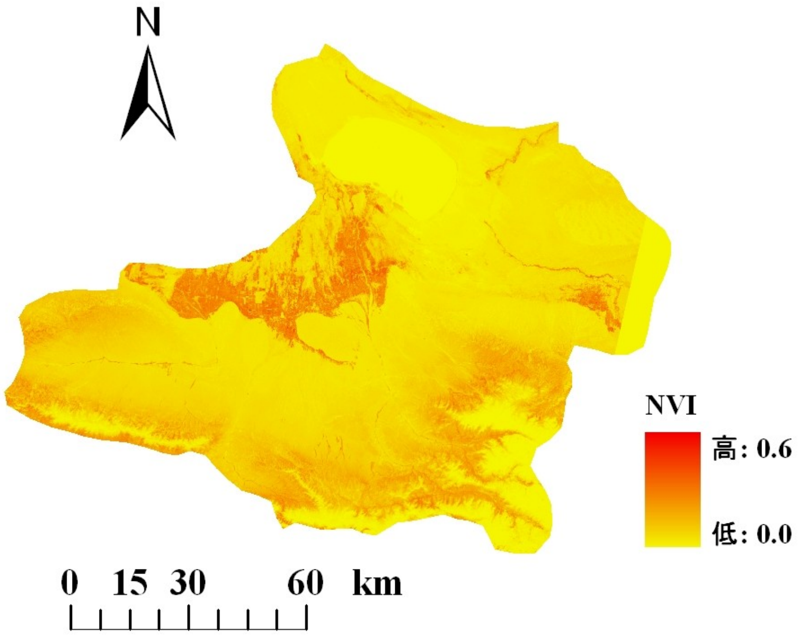


22 September 1977

Generation of NDVI image



5 October 1990



26 May 2003

Conclusions

- Temperature rise due to climate warming is obvious. The average rises to 7.9℃in th 2000s from 5.5℃in the 1960s. Among them, temperature rise in winter reaches its peak.

- Annual precipitation is on the rise. The increase of rainfall mainly occurs in winter an early spring; while precipitation is on the decline from June to August and from Octobe to November. The greatest reduction occurs from June to August in most cases.

- With climatic warming, the changes of hydrological processes of rivers within the yea is conspicuous. It is mainly reflected in the following: the maximum runoff is advance from June to May, and the runoff processes in the year moves forward.

- Water area changes of Lake Ebnur were governed by the runoff change of Bortala River.

- Generation of NDVI images shows that the NDVI also effected by the climate change.