The American Journal of Interdisciplinary Innovations Research (ISSN – 2642-7478)
VOLUME 05 ISSUE 12 Pages: 29-35
SJIF IMPACT FACTOR (2020: 5. 498) (2021: 5. 676) (2022: 6. 233) (2023: 7. 059)
OCLC – 1091588944
Publisher: The USA Journals

Journal Website: https://theamericanjournals.com/index.php/tajiir

Research Article

WATER RESOURCES MODELING UNDER CLIMATE CHANGE

Submission Date: December 20, 2023, Accepted Date: December 25, 2023,
Published Date: December 30, 2023
Crossref doi: https://doi.org/10.37547/tajiir/Volume05Issue12-07

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ABSTRACT

Modeling of changes in water resources in the Chirchik river basin in the past, present, and future has been carried out. Changes in river basin flow dynamics showed an increase in the proportion of precipitation frequency change by 2030 (2020–2039), 3050 (2040–2069) and 2070 under two IPCC scenarios (RCP4.5 and RCP8.5). Although there is a tendency to increase water flow in the Chirchik River basin under climate change scenarios, it was found that due to the uneven distribution of water resources in the future, the available water may not be sufficient based on the needs of water users in the basin.

KEYWORDS

Climate change, hydrometeorology, hydrology, Chirchik river, water resources, precipitation, urbanization, environment.

INTRODUCTION

Recent advances in remote sensing and information technology have improved the availability of hydrological data and computational resources. Although few remote sensing data can be directly applied to hydrology, many types of relevant hydrological data, especially spatial data, can only be obtained by remote sensing. This has greatly encouraged the development of distributed hydrological models that accurately take into account both spatial information and traditional hydrometeorological data [1,2,3]. However, most hydrological models are not satisfactory for simulating and predicting daily flow in high-altitude watersheds [1 ,3,5, 11,12]. The hydrological cycle is traditionally not related to water resources and is controlled to some extent by the values of factors such as precipitation, temperature, humidity, wind speed and salt radiation,

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any changes in these facts directly affect the spatial distribution of water resources in river basins.

The quality of water distribution may improve with high flow, but as the climate worsens, the precipitation trend may change to increase or decrease spatio-temporally, and this is also related to temperature. Climate models predict an increase in global mean annual temperature in the second half of the 21st century [4,5,6, 7,8]. The water resources of the Chirchiq river basin are used in agriculture, energy and urbanization, the river is the main river of the Tashkent region and Tashkent city of the Republic of Uzbekistan, therefore, the productivity of the Chirchik river basin has long-term consequences for the security of food, water and energy, which depends on the economy of the region. climate change [8,9,10, 11,12,13], therefore, any change in river flow in the Chirchik river basin will seriously affect the region's ecosystem, energy, food security, lifestyle and economy of the dependent population. Analysis and assessment are very necessary in the short and long term to avoid long-term problems in the Chirchik River basin. In recent years, climate change has been observed in the Chirchik river basin, and this change has affected the water flow dynamics.

Method and materials. Based on the past and present processes in the Chirchik river basin, there is a need for operational management of water resources in the Chirchik river basin, taking into account the needs of all water consumers of the river basin in the context of climate change. Demographic changes have a direct impact on climate characteristics, because all the resources necessary for human life indicate a parallel increase in population, and migration is required to be taken into account here. The characteristics of all climatic factors affect the flow of water, and water is the first resource for human life, it can be said that all factors related to human activity.

Climate change has had a great impact on the water resources of Central Asia, including Uzbekistan, as well as the world's water resources, which directly affects natural and extreme events such as temperature rise, movement of glaciers, precipitation, greenhouse gases, and floods. Currently, the Arol problem is the main environmental threat to Central Asia, especially Uzbekistan.

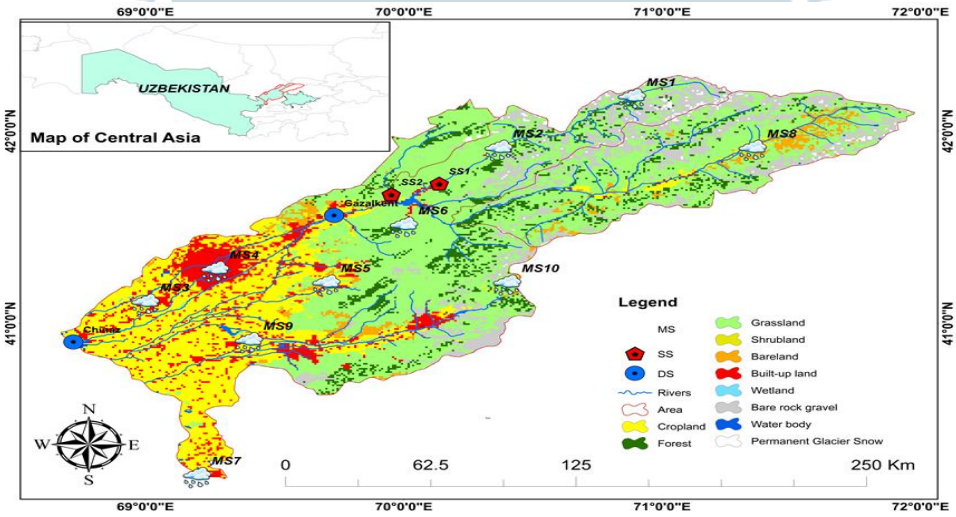

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Fig 1. - Land cover/use map of the study area.

The Chirchik River Basin, like many other rivers in the region, has experienced major changes in ecosystems due to misallocation of water resources, population growth, industry, urbanization, and migration. This has led to increased water consumption in agriculture and water supply. The result was widespread water scarcity and distribution of water resources among consumers. To solve these problems, many government programs have been developed, including the introduction of modern irrigation technologies and irrigation techniques to agriculture, the program for the preservation of reserves, the program for the promotion of environmental quality, and others. This complexity has increased the prospect of climate variability and long-term climate change creating new unknown conditions in the region.

Table 1

Different land use classes in the research object.

№	Type of LULC	Area (ha)	Territory %
1	Agricultural fields	4969.6	22.5
2	Forest	1396.4	6.3
3	Meadow	10092.9	45.6
4	Bushes	13.2	0.1
5	Bareland	781,0	3.5
6	Built up land	1696,9	7.7
7	Wetlands	62.3	0.3
8	Bare stone gravel	2823.4	12.8
9	Water basin	106.6	0,5
10	Permanent glageier snow	178.6	0,8

Any climate variability, socio-economic factor or transboundary issues in the water resources of the Chirchik River Basin will have a serious impact on the ecology and environment, food security, industrial use and electricity generation. In the future, the demand for water for irrigation and urban economy may increase due to the increase in the country's population.

Results. Studies show that changes in river basin flow dynamics increase the proportion of precipitation frequency change by 2030 (2020–2039), 3050 (2040–2069), and 2070 under two IPCC scenarios (RCP4.5 and RCP8.5). Although there is a tendency to increase water flow in the Chirchik River basin under climate change scenarios, the available water may not be sufficient based on the needs of water users in the basin due to the uneven distribution of water resources in the future. In the future, rapid reduction of water resources for use in the river basin will become more difficult due to environmental degradation, siltation and inefficient use of available resources.

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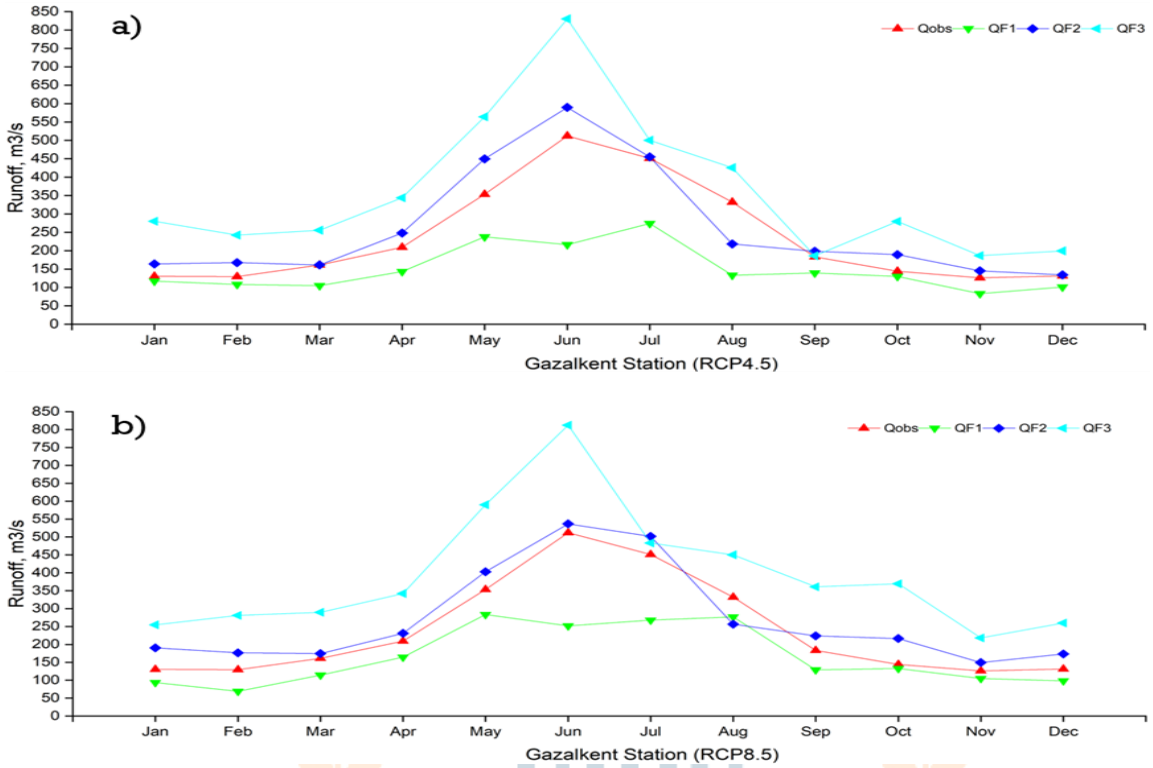

Fig 2. The precipitation level of the water system in the Chirchik river basin has increased, (data from 13 meteo stations and Gazalkent water measuring post collected from the hydrometeorological service.)

The analysis shows that water consumption at the Ghazalkent water measuring station has decreased over the next decade in Q1(2020–2039) (Figure 2), comparing the observed data and the future only RCP8.5 for August matched these observations.

Q2 (2040–2069) increases in RCP4.5 in July and September, and RCP8.5 from mid-July to mid-September.

The third Q3 (2060–2099) shows growth in two scenarios. Process runoff changes at the Chinoz hydrometric station (Figure 3) with precipitation ratios in Q1(2020–2039), Q2(2040–2069), and Q3(2060–2099), respectively (RCP4.5 and RCP8.5). The lowest flow is shown in August for the two scenarios, respectively, so the historical data also shows a decrease in the flow level in the same month, which may be related to the regulation of the reservoir.

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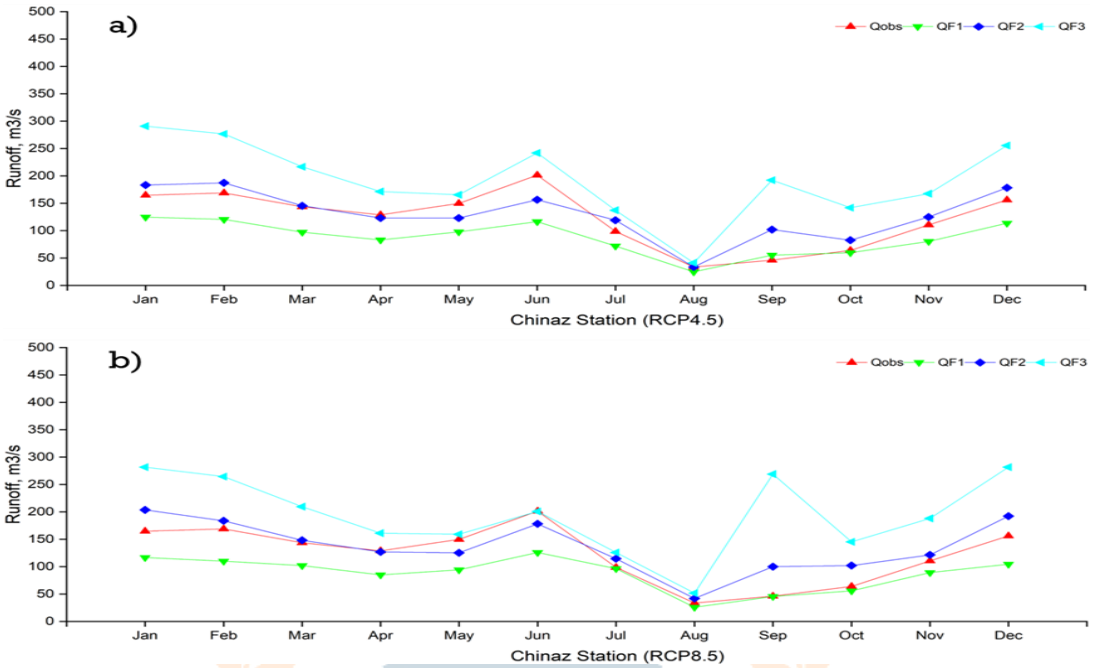

Fig 3. The ratio of the water level to the precipitation level at all stations in the Chirchik river basin, (Chinoz measuring station.)

Accordingly, water consumption decreases in both scenarios in 2030 and 2050, although the decrease occurs from May to mid-June, while water consumption values increase after May. Compared to 2050, 2070 shows an increase, in two scenarios this means an increase in water in the basin, but this does not determine the availability of water resources in the future, here we must take into account evaporation and temperature changes, two factors play a very important role in climate change, evapotranspiration changes parallel to temperature.

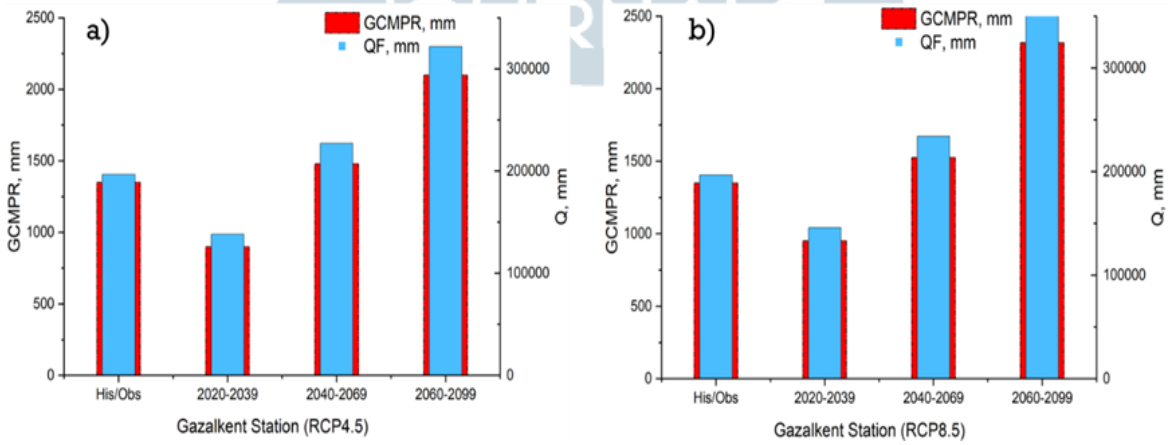

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Fig 4. The ratio of water flow to precipitation in 2030, 2050 and 2070 at all stations in the Chirchik river basin (Gazalkent measuring station.)

CONCLUSIONS

Based on the data of 2030, 2050 and 2070, the average annual change of the river flow was analyzed in terms of the relationship between the precipitation activity, which is represented in Figures 4 and 5 for examples of the relationship trend between the future annual changes of water. In general, the annual and monthly analysis of the Chirchik river flow changes show the same results, but unfortunately, the annual flow at the Chinoz gauging station shows a decrease, which gives an idea that water consumption is decreasing due to use (agricultural crops, industry, etc.). According to the graphs, average annual changes occur at both stations. At the Chinoz measuring station, the water level decreases when the water flow, precipitation coefficient increases at the Ghazalkent station, and this is related to the use of water resources between the two observation points. The main increase will occur in the 2070s. Here it is necessary to take into account all the factors of water use and the characteristics of the river. Based on these analyses, further research and analysis should be carried out, taking into account all the characteristics of the river and using other specific hydrological models such as SWAT.

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