Impact of Climate Change on Runoff Dynamics of the Rivers of Issyk-Kul Basin.

Kalashnikova O. Yu., o.kalashnikova@caiag.kg

Central Asian Institute of Applied Geosciences (CAIAG), Bishkek, the Kyrgyz Republic

The purpose of the work was to study the change in annual rivers runoff over the 80-year observation period, the establishment of cycles and periods of change; study of the impact of climate change on the water regime of the Issyk-Kul Lake basin on the example of Chon-Jargylchak and Juuku glacier feeding rivers.

In this work, a study of the average annual change of rivers runoff and establishment of synchronism and cyclicity of changes was conducted on the 21st watercourse, on inflows to Issyk-Kul Lake, with a natural runoff for the period from 1930 (1940) to 2012 by the data from the network of gauging stations of Kyrgyzhydromet. Gauging stations are located at altitude of 1,700 to 2,100m.above sea level, at the exit from the canons above water intake facilities (canals, etc.).

The rivers of the Issyk-Kul basin can be divided into 3 groups, which have similar, synchronous changes in the average annual runoff and periods of hydrological cycles. The rivers of greatest interest are those where a steady increase of water content has been observed since 1970s and 1990s, which leads to a gradual increase of the water level in the Issyk-Kul Lake. These rivers constitute the majority and the increase of water content depends on the area of the basin and geographic location.

On the rivers of eastern, the most wet part of the of the Issyk-Kul Lake coast, where the average annual runoff is 4.0-7.5 m^3 /s, the increase of runoff over the period from 1994 to 2012 in comparison with the period from 1930 (1940) to 1993 is 107-125%. The exceptions are Chon-Jargylchak and Oi-Tal rivers - 157 and 171%, which is associated with small areas of basins (128 and 38 km^2) and the average annual water discharge rates (3.5 and 1.0 m^3 / s)) The water content of the Karakol, Kichine-Kyzyl-Suu, Barskoon and Chon-Oryuktu rivers, as a percentage ratio over the observation periods, has not changed.

On the rivers of the western arid part of the Issyk-Kul coast, with a small average annual water discharge of 0.6-4.0 m^3 / s, the greatest percentage increase in runoff is observed - 130-165% over the period 1994-2012 in comparison with the period 1930 (1940) -1993. On some rivers of the western part of the Issyk-Kul Lake - Toru-Aygyr, Tosor and Ak-Terek - there is a drop in water content - 73-83% over the same periods.

In order to study the impact of climate change on the runoff of the rivers of the Issyk-Kul basin, the glacial feeding rivers Chon-Jargylchak and Juuku have been selected with neighbor basins on the southeastern shore of the Issyk-Kul Lake with the sources on the northeastern slopes of the Terskey-Alatoo range. The hydrological parameters of the rivers were studied for the period 1933 (1940- 2016 by the data from gauging stations on these rivers; and a study of the change in the meteorological parameters (air temperature and precipitation) was conducted based on the data from the Chon-Ashuu avalanche weather station and the Chon-Kyzyl-Suu gauging station.

In the interim of 1994 – 2016, the average annual runoff of the Chon-Jargylchak River was 3.32 m^3 / s, or 153% of 1940-1993 period. (2.16 m3 / s). The average annual runoff of the Juuku

River for the period of 1994-2016 was 8.22 m^3 / s or 129% of the period 1933-1993. (6.37 m^3 / s). Intraannual change of runoff over the period from 1994 to 2016 comparing to the period from 1933 (1940) to 1993 shows its increase in all months; but in the percentage ratio on the river Chon-Jargylchak, the largest change in runoff was recorded in the months of seasonal snowmelt and in the low water period - 149-206%; the lowerest level was recorded in July and August - 131-133%. On the Juuku River, the changes are more flattened, in the months of seasonal snowmelt and in the autumn period - 122-155%, and in the winter months and in August - 112-123%

To calculate the change of the rivers' feeding sources, the method of partitioning hydrographs over characteristic years was applied. Calculations of glacial and thawed snow flow were carried out by the method of Dikikh AN. [2]; calculations of rain and ground nutrition - by the method of Shcheglova O.N. [1]. The results of calculations for feeding sources on the rivers were as follows: on the rivers Chon-Jargylchak and Juuku for the period 1994-2016 in comparison with 1940-1993, there registered an increase in ground feeding by 10 and 4%, and a decrease in glacier runoff - by 11 and 13% respectively. Thawed snow feeding on the river Chon-Jargylchak has not changed, and on the Juuku river has increased by 8%. The beginning of the seasonal snow melting is observed 10 days earlier and its duration is 25 days longer. Melting of glaciers begins 13 days later and its duration is 15-20 days less.

According to Konovalov V. G, the average glacial runoff for the period from 1940 to 1980, on the Chon-Jargylchak River was 31%, and on the Juuku River - 29% [3]. According to the author of the article, in 1992 the glacial runoff on the Chon-Jargylchak River was 29%, similar to Konovalov V. G. calculations, and on the Juuku River - 40% of the annual runoff, which is higher than calculated by Konovalov V.G.

Changes in the interannual distribution of runoff depend on climatic factors. According to the Chon-Ashuu weather station and the Chon-Kyzyl-Suu gauging station, there is a tendency to precipitation increase by 30-40 mm over the period 1994-2016 comparing to the period 1940-1993gg. From 1994 to 2016, there is a tendency for an earlier, for 10 days, passage through 0 ° C towards positive temperatures, and later, for 15 days, a transition through 0 ° C towards negative temperatures.

These studies allow us to conclude that the increase in runoff during the months of seasonal snowmelt is affected by the increase in mountainous areas of snow reserves for the cold period, as well as the increase in duration of the warm period. Accordingly, the role of glacial melting in the annual runoff decreases, while the role the melted snow increases. River basins with a larger area and greater glaciation (Juuku) have greater inertia and react less to changes in climatic factors; the ones with smaller areas and glaciation of basins (Chon-Jargylchak) react much faster.

References:

1. Sheglova O. P. *Feeding of Central Asian Rivers*. Works of Tashkent State University – Tashkent: Samarkand State University, Edition №167, Geographical Sciences №17. 1960. – 245 p.
2. Dikikh A. N., Mihailova V. I. *Regime of Glaciers and Water Balance of Northern Slope of Terskey-Ala Tau Ridge*. – Moscow: Science. 1976. - 131 p.
3. Konovalov V. G. *Melting and runoff from glaciers in the basins of rivers of Central Asia.* Leningrad: Hydrometeoisdat CARRHMI, 1985. p.217.