Journal of Ecology of Health & Environment
An International Journal

http://dx.doi.org/10.18576/jehe/060201

Monitoring of the Hydrochemistry of the Iskanderkul Lake of the Republic of Tajikistan and the Flowing Rivers

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Received: 15 Jan. 2017, Revised: 12 Apr. 2018, Accepted: 21 Apr. 2018
Published online: 1 May 2018

Abstract: The results of monitoring the meteorological conditions of the Iskanderkul Lake coastal areas of the Zeravshan river basin are presented. It is observed that for the period 1960-2017 years the temperature trend is increasing at almost constant rainfall. Comparison of the trend of temperature changes and precipitation in three meteorological stations located at different altitudes of the Zeravshan river basin shows a significant contribution of the mountainous terrain orography on the formation of microclimate of the area. The results of chemical analyses of water Iskanderkul Lake and its feeder rivers indicate that the lake water conforms to the requirements of the state standard for drinking water.

Keywords: Zeravshan River, Iskanderkul Lake, hydrochemistry, trend, temperature, precipitation

1 Introduction

The basin of the Zeravshan River is one of the most complicated geoecological areas of the region not only of Tajikistan, but also throughout the Central Asia. Mountainous terrain, high-altitude zonality of the climate, a considerable heterogeneity of the meteorological conditions are causes of great geoecological contrasts.

At present, the study of regional climatic changes due to global warming have great scientific and practical importance and is relevant in relation to the influence of meteorological conditions on water resources, geoecological systems that differ in the variability in time and space.

Comparison of long-term observations of the meteorological parameters of the basin of the river Zeravshan in Tajikistan allows identifying the general patterns and individual specific features and thus contributes to the development of effective mechanisms for the adaptation of geo-ecological systems to climate change and their resilience to natural emergencies [1,2,5,8].

It is known that the location of natural areas is very sensitive to fluctuations in temperature and precipitation, and long-term unidirectional changes of these components can lead to a shift of landscape boundaries.

The study of the peculiarities of the Zeravshan valley geoecological variation and meteorological condition has a great importance not only for the development of regional scenarios for prognosis of climate change. But also to solve a number of practical problems such as rational use of hydropower resources by the effective placement of hydraulic structures, planning of agriculture development and comprehensive and effective use of the recreational potential of the valley [9].

The water quality monitoring of recreational facilities, identification of environmental hazards and their elimination are of great importance for prevention of the factors contributing to the violation of the natural dynamics of the development of geoecological systems [3,4,6,7,10].

At present, it is no reliable data on the hydrochemistry of one of the Zeravshan river basin pearls waters - Lake Iskanderkul.

2 Material and Methods

Data set obtained during monitoring of the climatic conditions of the geoecological system of the lake Iskanderkul includes:

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- monitoring, collection, systematization and processing of data on temperature;
- monitoring, collection, systematization and processing of data on atmospheric precipitation.

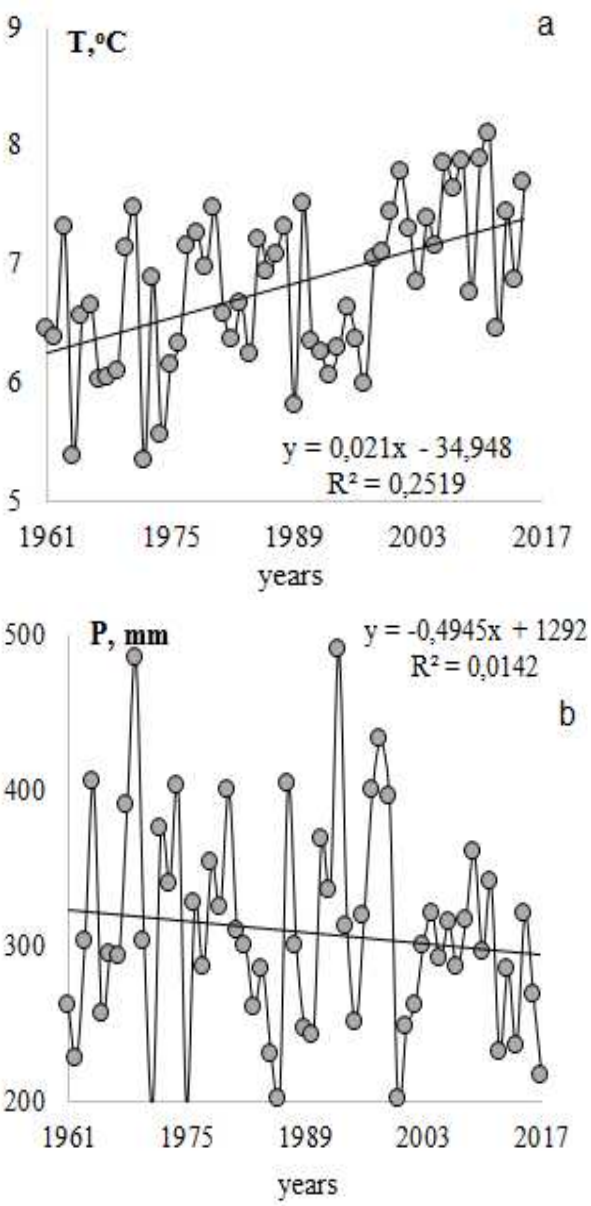

Fig. 1: The annual average temperature (a) and precipitation (b) on the Iskanderkul (2204 m) meteorological station

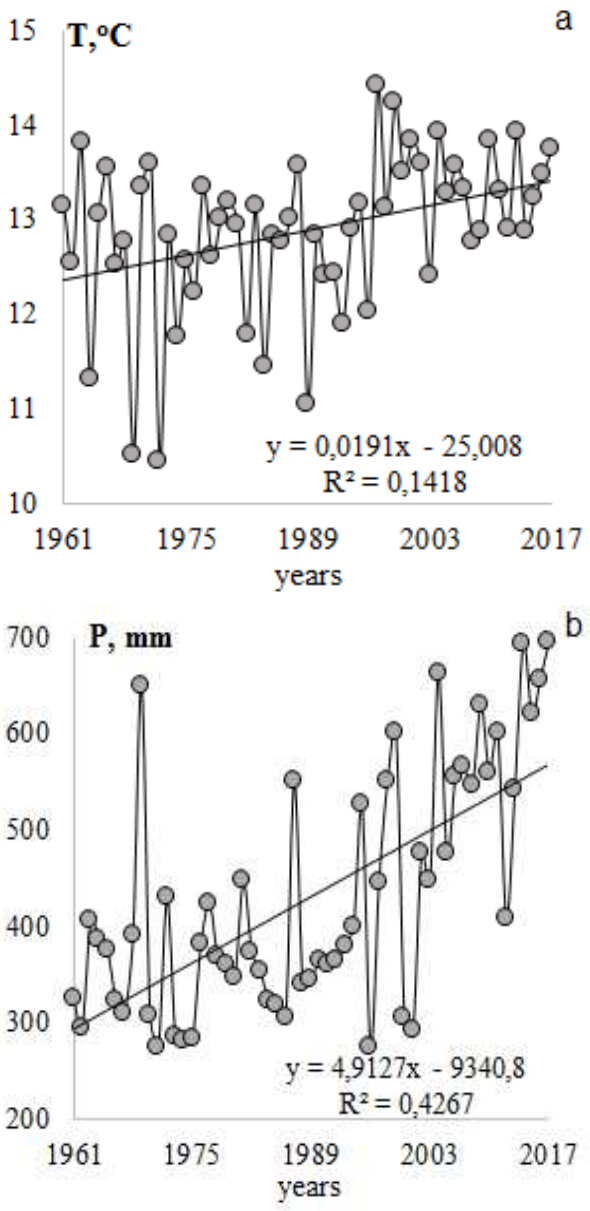

Fig. 2: The annual average temperature (a) and precipitation (b) at the meteorological station Penjikent (1015 m)

For study the chemical composition of Iskanderkul Lake and the tributaries inflow to and outflow from the lake water samples were collected year-round at intervals of four times per month and were transported to a stationary laboratory for analysis. Standard methods was used for elemental analysis of water composition. The quality of the studied waters was estimated at comparing the results of the analyses with the state standard (GOST 2674-82 Drinking Water).

The annual averages of temperature and precipitation at the meteorological station Iskanderkul (2204 m) are shown on the Fig.1.

For the period 1960-2017, as it can be seen from Fig.1, a continuous increase of temperature at an almost constant value of precipitation on around Iskanderkul Lake is observed. The character of the temperature and precipitation changes on the Fig.1. It is a reflection of this

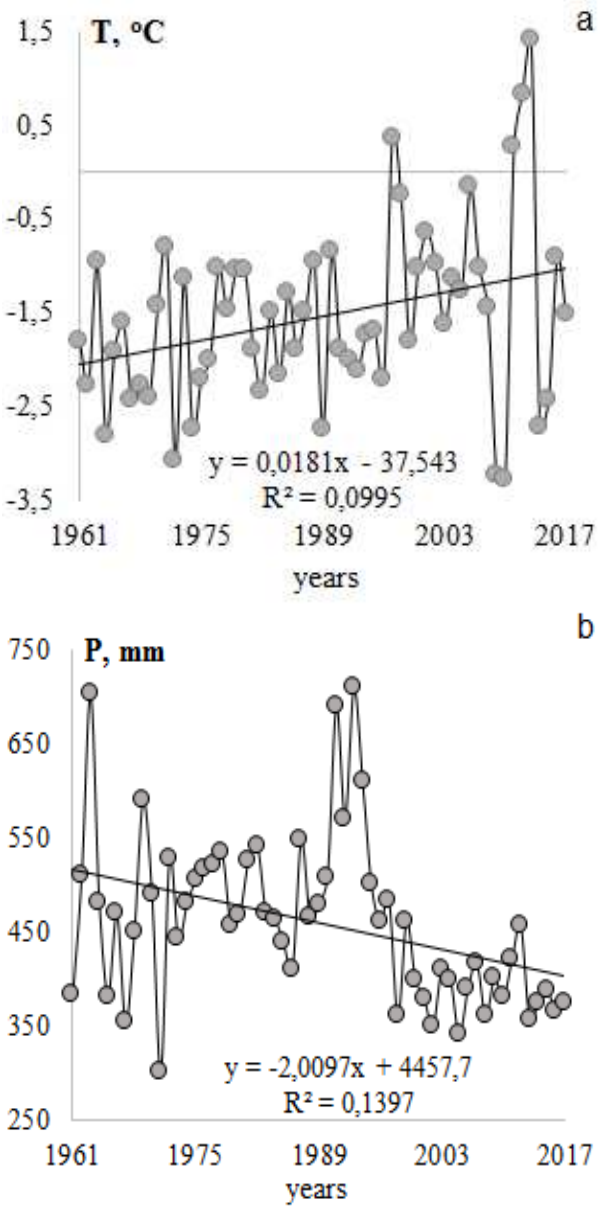

Fig. 3: The annual average temperature (a) and precipitation (b) at the meteorological station Anzob (3379 m)

parameters characteristic trend only for the area of the lake Iskanderkul and it is not total for throughout of the Zeravshan river basin. The trend of changes of temperature and precipitation at the meteorological stations Penjikent (1015 m) and Anzob (3379 m) can be seen on the Fig.2 and Fig.3.

A comparison of temperature and precipitation trends in different latitudes of the Zeravshan river basin and at different heights above sea level can be assumed about the existence of the influence of the orography of the mountainous terrain on the formation of the local meteorological conditions.

Atmospheric precipitation is mainly determined by orographic conditions and atmospheric circulation. The height and orientation of the mountains has a significant impact on the strengthening of cyclonic precipitation. The basic amount of atmospheric precipitation on the territory of Zeravshan, are brought in by air masses from the Atlantic Ocean, Mediterranean Sea and Indian Ocean. The great variability from year to year with the occurrence of very dry or wet periods are characterized for them. In the Western part of the Zeravshan river basin falls 100-150 mm/year, and in some dry years no more than 600 to 700 mm/year. In the East the rainfall increases up to 600-700 mm/year, and on the slopes of mountain ranges up to 900 mm/year.

The Iskanderkul Lake is called the pearl of the Zeravshan valley, due to its unique nature, flora and fauna and clean water. It is considered one of the main recreational geoecological systems of Tajikistan.

Now one of the urgent tasks to conserve the lake in its natural form is the prevention of lake contamination by chemical elements and compounds. Today it is no reliable data on the hydrochemistry of the waters of the lake Iskanderkul.

For the period 2010-2017 397 samples of the lake water and 140 wastewater samples from coastal areas of the lake Iskanderkul have been sampled to determine the chemical composition of the water Iskanderkul Lake and rivers flowing to lake by 25 points of geoecological systems. Data set obtained during monitoring of the climatic conditions of the geoecological system of the lake Iskanderkul includes:

- monitoring, collection, systematization and processing the temperature data;
- monitoring, collection, systematization and processing the atmospheric precipitation data;
- the results of the chemical analyses and other laboratory tests of the natural environment samples.

Lake Iskanderkul is located at an altitude of 2195 meters above sea level, the total area of water surface of the lake is 3.4 square kilometers, and the lake reaches a depth of 72 meters.

The Saratog, Hazormesh Rivers and small mountain streams flow into the lake. The Iskanderdarya River flows from the lake that through 30 km flows into the Fondarya River - one of the main tributaries of the Transboundary Zeravshan River.

The length of the Iskanderdarya River is 20 km and the basin area is $950 km^2$. The River powers by snow and ice. The mean annual flow at the outlet of the lake Iskanderkul is 19 m^3/s and the turbidity of the water is $16 g/m^3$. The width of the river upstream of 2.7 m, downstream - 5 m; depth upstream and 1.8 m downstream and 1.0 m, rocky bottom.

Saratog River. The Saratog River have a length of 35 km and flows to the lake Iskanderkul from the South-

Table 1: The content of anions in waters of the Iskanderkul lake, inflowing and outflowing rivers

	Ph	Cl-	NO2-	NO3-	PO4-3	HCO3-	SO4-2	SiO2
	mg/l							
Iskanderkul Lake	6.2	4.85	-	1.31	0.018	105.68	9.25	0.25
Rivers								
Saratog	6.5	2.98	0.008	1.28	0.011	89.6	0.008	0.12
Saridevor	6.5	1.25	0.021	2.12	0.010	225	0.002	0.24
Hazormesh	6.7	1.34	0.011	0.64	0.009	119.5	4.56	0.36
Sarima	6.4	1.34	0.014	0.86	0.006	25.5	9.65	1.68
Iskanderdarya	6.5	4.21	0.012	1.08	0.005	148.4	0.098	0.48

Table 2: The content of cations in waters of the Iskanderkul lake, inflowing and outflowing rivers

	Zn	Cu	Ca	Mg	Fe	Pb	Mn	Sn	Sb	As
	mg/l									
Iskanderkul Lake	0.0186	0.017	58.96	26.78	0.023	0.048	0.007	0.0056	0.0038	0.0012
Rivers										
Saratog	0.0042	0.014	26.46	8.97	0.056	0.014	0.004	0.016	0.0065	0.0010
Saridevor	0.0096	0.005	25.76	19.02	0.021	0.076	0.005	0.007	0.0062	0.0012
Hazormesh	0.0081	0.013	41.24	22.56	0.016	0.079	0.003	0.0076	0.0066	0.0016
Sarima	0.0074	0.021	27.32	16.78	0.011	0.005	0.001	0.0018	0.0064	0.0023
Iskanderdarya	0.0125	0.035	31.18	4.24	0.014	0.102	0.005	0.0082	0.0010	0.0010

West direction and is characterized by average annual water discharge of about 13.5 m^3/s and a basin area of 562 km^2. The high water and low water of the river is respectively June-August and February. Each year the Saratog River brings more than 3760 tons of sediment to the lake Iskanderkul.

Hazormesh River has a length of 15 km and a catchment area of about 125 km^2. It flows to the Iskanderkul Lake from the southern part. Annual water consumption is of 4.64 m^3/s and each year the river brings 1375 tons of sediment into the lake Iskanderkul.

Saridevor River is one of the biggest tributaries of the Hazormesh River with a length of 10 km and a basin area of more than 52.3 km^2. The average water flow is 1.77 m^3/s.

The water sampling in such rivers as Saratog, Saridevor, Hazormesh, Sarima, Darya and the North -Eastern shore of the lake during the years 2010-2016 with a frequency of three times per month was carried out to monitor the hydrochemistry of the lake Iskanderkul and his torturing of the rivers.

The data on the Tables 1 and 2 show that the water quality of the lake Iskanderkul and tributaries flowing into the lake meets the requirements of state standard (GOST 2674-82 ”Drinking Water”). However, the water of Lake Iskanderkul in terms of dissolved oxygen, copper, zinc, lead and iron does not meet the requirements of water for fish farming.

3 Conclusion

Thus, as a result of monitoring the meteorological conditions of the lake Iskanderkul it was found that it is not possible to talk about the weather conditions of the entire basin from one weather station in mountainous areas according to the testimony of climatic parameters. There is the influence of mountainous area orography on the establishment of particular conditions.

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