



PROBLEMS ASSOCIATED WITH THE SOKH RIVER ENTERING FROM NEIGHBORING COUNTRIES, ITS HYDROGRAPHIC CONDITIONS, AND THE STUDY OF HEAVY METAL CONTENT IN ITS WATERS BEYOND MERCURY

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Abstract

This article mainly examines the formation of the Sokh River, its relationship with groundwater, the influence of tributaries on the river's formation, and the major problems associated with the Sokh River. In addition, the hydrographic conditions of the Sokh River and information on heavy elements transported by the river, including heavy metals other than mercury, are presented. The study focuses on the composition of river flows and the environmental challenges related to transboundary water resources.

Keywords: Sokh River, groundwater, problems, hydrographic conditions, water abundance, flow composition, heavy elements.

Introduction

The Sokh River is considered one of the most water-abundant rivers in the Fergana Valley. It originates from glaciers located at an altitude of nearly 5,550 meters on the northern slopes of the Alay and Turkestan mountain ranges in Central Asia. The total length of the river is 124 km, while the total area of its drainage basin covers 3,510 km², with an average basin elevation of about 3,480 meters.



In this region, the Dalbek, Shudmon, and Khojaochkan streams merge near the village of Zardoli to form the Sokh River. In its upper reaches, the river flows through very deep and narrow gorges, with widths ranging from 4 to 10 meters. Upon entering the foothill zone, the river valley expands to approximately 500 meters. Further downstream, the river forms an alluvial fan composed of stone and gravel, with a width of about 70 km and a length of 50 km. In certain sections of the river, second and third terraces are also present.

After entering the Fergana Valley, the Sokh River splits into several branches. The river is mainly fed by glaciers and snow, as 71% of the annual precipitation in its basin falls as snow and 29% as rain. The Sokh River basin includes 364 glaciers covering a total area of 244 km², the largest of which is the Archaboshi glacier (12 km²). The average flow module is 17.0 L/s per km².

One of the key physical characteristics of the Sokh River is its moderate turbidity, with an average value of 0.99 kg/m³. This turbidity is largely attributed to the inflow of meltwater from snow and rainfall from higher elevations. Within the foothill zone, the Sariqorgon water management facility and the Okhchi Hydropower Plant are located along the river, while the Kokand hydraulic complex is constructed at its lower reaches.

The Sokh River plays a crucial role in supplying water to several districts of the Fergana Region, including Uzbekistan, Dangara, Uchkuprik, and Baghdad districts. The city of Kokand is located within the river valley [1].

Problems Associated with the Sokh River

The waters of the Sokh River are mainly used for irrigating agricultural crops and supplying water to the population. Due to the rapid population growth in the Sokh Valley, increasing pressure on the river's water resources has led to water scarcity, which in turn has caused specific problems related to water shortages.

According to calculations, the local population farming in the foothill areas of the Burgana massif uses nearly 23–30% of the river's flow within the territory of Kyrgyzstan, particularly for irrigating agricultural lands, including rice fields. The development and agricultural exploitation of foothill areas located upstream from the main territory of the Fergana Region have resulted in rising groundwater levels in the Rishton and Oltiariq districts of the Republic of Uzbekistan.



It is well known that the accumulation of groundwater and the formation of waterlogged soils lead to root decay in plants and a decrease in crop yields. As a result, due to the degradation of orchards and the decline in the productivity of other agricultural crops, a total of 6,313 hectares of agricultural land in the Rishton district have lost their fertility [2].

Hydrographic Conditions of the Sokh River

The alluvial fan of the Sokh River is located at the northern foothills of the Turkestan–Alay mountain system and covers the lower reaches of the Sokh River, which is a left tributary of the Syr Darya. The Sokh River originates on the northern slopes of the Turkestan Range and is mainly fed by glaciers and snowmelt.

The river discharge is measured near the village of Sariqorgon at a state hydrometeorological station operated by Uzhydromet, where the river emerges from the high mountainous zone. In the high-altitude areas, the main water collection area of the river basin covers approximately 2,480 km². At the outlet from the foothill zone near Sariqorgon village, a water distribution structure has been constructed, where the river water is diverted into the main canals of the Sokh irrigation system. As a result, the river serves as a major source for groundwater recharge in the region.

The highest average monthly water discharge occurs during July–August, while the lowest discharge is observed in March–April. Over the period from 1911 to 2014, the long-term average annual discharge of the Sokh River was 42.0 m³/s. The highest average annual discharges were recorded in 1914 (50.8 m³/s), 1942 (50.6 m³/s), and 1973 (50.7 m³/s).

The chemical composition of the river water varies depending on the hydrological regime. During low-water years (1982–2005), when the average annual discharge ranged from 0.75 to 12.5 m³/s, the mineralization of the water reached 1.3–2.2 g/L. In the summer period, when the average monthly discharge increased to 25.3–28.5 m³/s, the mineralization decreased and ranged from 0.55 to 0.74 g/L. On an annual basis, the volume of water with a mineralization of 0.45 g/L reaching the alluvial fan of the Sokh River is 1.5–2 times greater than the volume



of water with higher mineralization levels of 1.3–2.2 g/L. The long-term average annual mineralization of water reaching the alluvial fan is 0.79 g/L.

During low-water (baseflow) periods, the chemical composition of the river water is classified as sulfate–chloride calcium–magnesium type, whereas during high-water periods it shifts to a sulfate–bicarbonate calcium–magnesium type [3].

In addition to sulfate (SO_4^{2-}), chloride (Cl^-), calcium (Ca^{2+}), and magnesium (Mg^{2+}) ions, the Sokh River may also contain other heavy metals. This can be further illustrated and analyzed based on the data presented in the following tables.

Table 1. Concentration of Heavy Metals in the Flow Composition Entering via the Sokh River from Neighboring Countries

№	Sampled area	Incoming streams	Consumption Q M ³ /s	Annual flow volume Q ₀ million m ³	Amount of elements (C ₀) in mg/liter						
					Mn	Zn	Sb	Sr	Cu	Al	Mo
1	Sokh River	Sub-surface flow	1,498	46,594	0,00008	0,0020	0,00046	0,42	0,0019	-	-
		Sub-surface flow along the Sokh River valley	2,1	65,318	0,0003	0,0003	0,0010	0,31	0,0008	-	-
		River flow rate	46	1430,73	0,0003	0,0005	0,0011	0,34	0,0008	-	-

Table 2.

№	Sampled area	Incoming streams	Consumption Q M ³ /s	Annual flow volume Q ₀ million m ³	C = C ₀ x Q amount of elements entering the area, in kg/year						
					Mn	Zn	Sb	Sr	Cu	Al	Mo
1	Sokh River	Subsurface flow	1,498	46,594	0,01	0,25	0,05	53,61	0,24	-	-
		Subsurface flow along the Sokh River valley	2,1	65,318	0,05	0,05	0,17	55,47	0,14	-	-
		River flow rate	46	1430,73	1,17	1,95	4,31	1332,7	3,13	-	-

Table 3.

№	Sampled area	Incoming streams	Consumption Q M ³ /s	Annual flow volume Q ₀ million m ³	Stream width, km.	The amount of elements entering 1 linear meter of the stream section, kg/year; Maximum permissible intake concentration						
						Mn	Zn	Sb	Sr	Cu	Al	Mo
1	Sokh River	Subsurface flow	1,498	46,594	13,5	7*10-6 10-3	18*10-4 53*10-2	-	-	-	-	-
		Subsurface flow along the Sokh River valley	2,1	65,318	1,0	5*10-4 10-3	5*10-4 5*10-2	-	-	-	-	-
		River flow rate	46	1430,73								



The concentrations of heavy metals in the streams entering from neighboring countries are presented above. Based on the analysis of the tabulated data, the presence of minerals such as manganese (Mn), zinc (Zn), antimony (Sb), strontium (Sr), copper (Cu), aluminum (Al), and molybdenum (Mo) was investigated.

The results of scientific studies indicate that the concentration of strontium in the groundwater-fed stream is relatively high, reaching 0.42 mg/L. In addition, measurable concentrations of copper (Cu – 0.0019 mg/L), zinc (Zn – 0.0020 mg/L), antimony (Sb – 0.00046 mg/L), and manganese (Mn – 0.00008 mg/L) were also detected.

In conclusion, the elevated concentration of strontium (Sr) in groundwater suggests the necessity for further detailed scientific investigations into the origin, migration, and accumulation processes of this element. Such studies are of significant importance for identifying potential new subsurface mineral deposits within the groundwater systems of the Fergana region [4,5].

Conclusions

The Sokh River represents one of the most important transboundary water resources of the Fergana Valley and plays a critical role in irrigation, domestic water supply, and groundwater recharge. The study demonstrated that the hydrographic conditions of the Sokh River are largely controlled by glacier and snowmelt processes, seasonal discharge variability, and interactions with irrigation systems and groundwater.

The analysis of water samples revealed the presence of several heavy metals, including manganese (Mn), zinc (Zn), antimony (Sb), strontium (Sr), copper (Cu), aluminum (Al), and molybdenum (Mo). Among these elements, strontium exhibited a comparatively elevated concentration in groundwater-fed flows, reaching 0.42 mg/L, indicating a geochemical peculiarity of the study area.

Seasonal and hydrological variations significantly influence both the mineralization and chemical composition of the river water, with higher mineralization observed during low-flow periods. The dominance of sulfate–chloride and sulfate–bicarbonate calcium–magnesium water types further reflects the geological and hydrogeochemical characteristics of the basin.



The elevated strontium content suggests the need for further comprehensive investigations into its sources, transport mechanisms, and accumulation processes. Such studies are essential not only for assessing potential environmental and health risks but also for identifying prospective subsurface mineral resources in the groundwater systems of the Fergana Region. The findings of this study provide a scientific basis for sustainable water management and transboundary water resource monitoring in the Sokh River basin.

References

1. Sokh River. (2004). Geography of Kyrgyzstan. Bishkek, Kyrgyzstan, p. 204.
2. Northern Sokh: Uzbekistan and Kyrgyzstan Share Oil and Gas Fields. (2017). Central Asia Information Portal (Centrasia.org). Archived from the original on September 23, 2017. Accessed on March 27, 2019.
3. Centrasia.org. (2017). Northern Sokh: Uzbekistan and Kyrgyzstan. (In Russian; archived source).
4. Jorayev, T., & Qurbanov, J. (2010). Assessment of groundwater pollution levels in transboundary areas of the eastern part of the Republic of Uzbekistan and development of environmental protection measures. Research Report No. 322 (2007–2010), Volume I, 115 p. State Enterprise “HYDROINGEO Institute”, Tashkent, Uzbekistan.
5. Bazarov, A. (2023). Some remarks on the level of study of the geological and hydrogeological structure of the Fergana area. European Journal of Emerging Technology and Discoveries, 1(3), June 2023. ISSN (E): 2938-3617.