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THE HYDROLOGICAL REGIME OF THE SHO‘RKO‘L RESERVOIR AND ITS IMPACT ON THE ENVIRONMENT

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Abstract. This article studies the hydrological regime of the Sho‘rko‘l reservoir, a saline terminal water body of the lower Zarafshan (Karakul oasis, Bukhara region), and its impact on the surrounding environment. The water balance, level regime, thermal and salinity dynamics of the reservoir are analysed, and it is shown that the regime is mainly formed by collector–drainage inflow and intensive evaporation under arid conditions. The results are presented through tables, diagrams and schemes. On this basis, the positive and negative environmental effects of the reservoir are assessed and recommendations for sustainable management are proposed.

Key words: Sho‘rko‘l reservoir, hydrological regime, water balance, mineralization, evaporation, collector–drainage water, salinization, environment, Bukhara region.

Аннотация. В статье изучается гидрологический режим водохранилища Шоркуль — бессточного солёного водоёма низовьев Зарафшана — и его влияние на окружающую среду. Анализируются водный баланс, режим уровня и динамика минерализации. На этой основе оцениваются экологические последствия и предлагаются рекомендации по устойчивому управлению.

Ключевые слова: водохранилище Шоркуль, гидрологический режим, водный баланс, минерализация, испарение, засоление, окружающая среда.

Introduction: Water bodies of arid regions play an important role in regulating the local water balance, maintaining biodiversity and shaping the ecological state of the surrounding territory. In the lower reaches of the Zarafshan river, within the Karakul oasis of the Bukhara region, a number of small, shallow and saline lakes and reservoirs have formed, the regime of which is closely linked to irrigation activity. The Sho‘rko‘l reservoir (whose name literally means “salt lake”) is one of such water bodies, and the study of its hydrological regime is of considerable scientific and practical importance.

A characteristic feature of these water bodies is that they are fed mainly by collector–drainage (return) water discharged from irrigated lands, rather than by a permanent river. Under the sharply continental and arid climate of the region, where annual evaporation considerably exceeds

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precipitation, such reservoirs accumulate salts and gradually become more mineralized. This determines both their value as wetland ecosystems and the environmental risks associated with them.

The aim of this article is to analyse the hydrological regime of the Sho‘rko‘l reservoir — its water balance, level and mineralization dynamics — and to assess its impact on the environment. The study is based on the methods of hydrological analysis, the water-balance approach, and the generalization of regional scientific data; the quantitative values presented are characteristic (representative) of this type of collector-fed saline water body and require refinement through field monitoring.

General characteristics of the reservoir

In its origin and regime, the Sho‘rko‘l reservoir belongs to the type of terminal (endorheic) saline water bodies, that is, it has no permanent surface outflow. Its main morphometric and hydrological characteristics are summarized in Table 1. Such water bodies are typically shallow, with a large surface-area-to-volume ratio, which makes evaporation the leading factor of their regime.

Table 1

Main characteristics of the Sho‘rko‘l reservoir (representative)

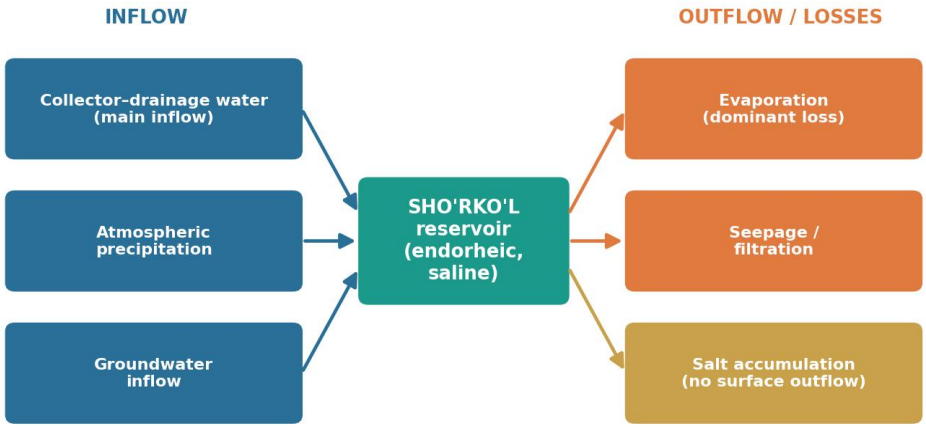
Indicator	Characteristic value
Location	Lower Zarafshan, Karakul oasis, Bukhara region
Type	Terminal (endorheic), saline lake-reservoir
Main water source	Collector–drainage (return) water of irrigated lands
Climate	Sharply continental, arid (evaporation ≫ precipitation)
Dominant water loss	Evaporation; partly seepage / filtration
Mineralization	High and variable (about 10–19 g/L, seasonally)
Salinization type	Sulfate–chloride (typical of the region)
Level regime	Spring rise, summer–autumn drawdown

Source: compiled by the author based on regional hydrological data.

Water balance and feeding sources

The hydrological regime of any reservoir is determined first of all by its water balance — the ratio between the incoming and outgoing components of water. For the Sho‘rko‘l reservoir, the income side is formed by collector–drainage water (the dominant component), atmospheric precipitation and groundwater inflow, while the expenditure side is dominated by evaporation, with a smaller share of seepage. Since the reservoir has no surface outflow, dissolved salts brought in with the water are not removed but accumulate (Scheme 1).

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Scheme 1. The water-balance structure of the Sho‘rko‘l reservoir.

The quantitative structure of the balance is shown in Diagram 1. Collector–drainage water provides the overwhelming majority of the inflow, which makes the regime of the reservoir directly dependent on the volume and schedule of irrigation in the surrounding fields. On the expenditure side, evaporation accounts for the largest share of losses, which is typical of shallow water bodies in arid zones.

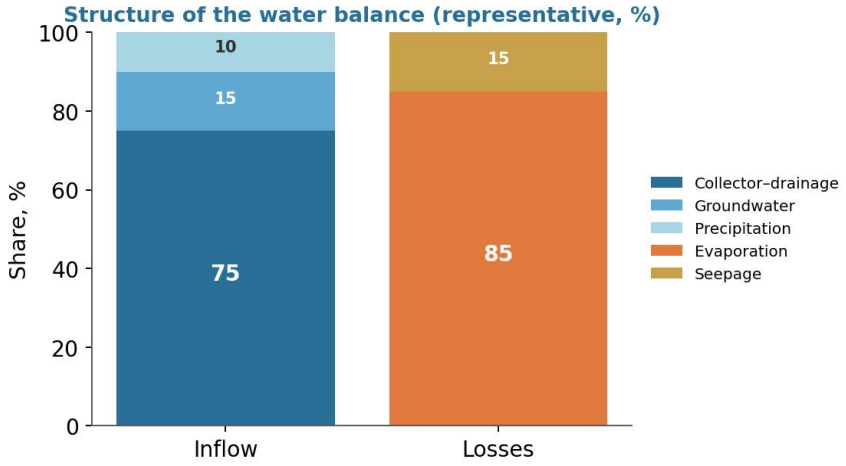


Diagram 1. Representative structure of the water balance, %.

Level, thermal and salinity regime

The intra-annual dynamics of the reservoir are governed by the seasonal pattern of inflow and evaporation (Diagram 2). The water level rises in spring (March–May), when the discharge of collector water increases and evaporation is still moderate. From summer onwards, intensive evaporation exceeds inflow, and the level gradually falls, reaching its minimum in early autumn. In winter the level partly recovers as evaporation decreases.

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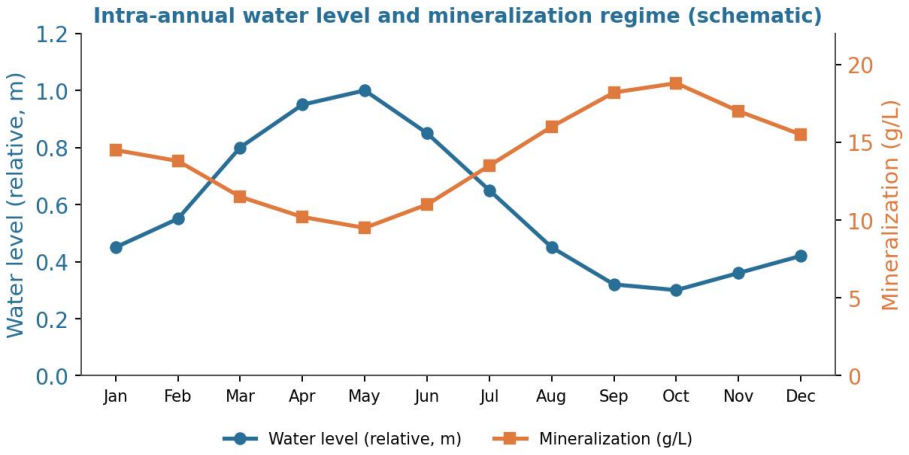
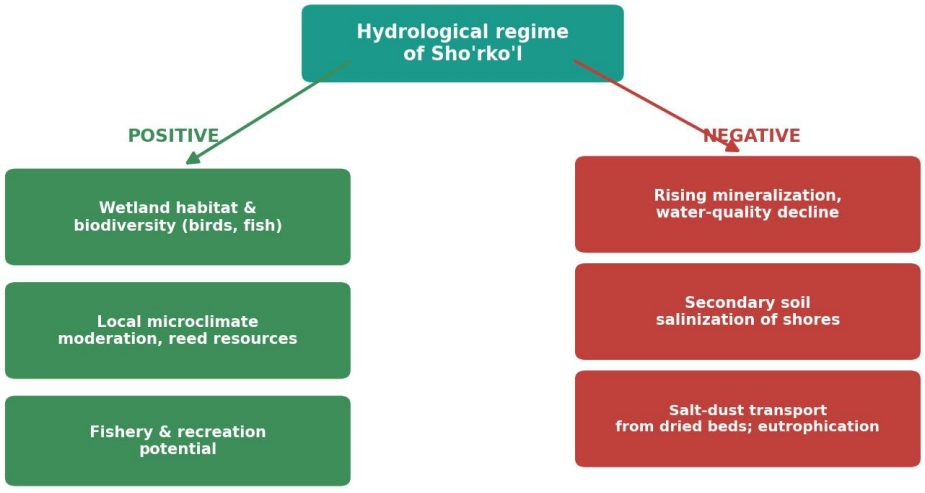


Diagram 2. Intra-annual dynamics of water level and mineralization (schematic).

The mineralization (salinity) of the water changes in the opposite direction to the level. In spring, the inflow of relatively fresher drainage water dilutes the reservoir and mineralization decreases; in summer and autumn, evaporative concentration sharply increases the salt content. As a result, the highest mineralization coincides with the lowest water level. The thermal regime is also pronounced: being shallow, the water warms strongly in summer and cools quickly in winter, and a thin ice cover may form in the coldest period. These features intensify biological processes and, together with high salinity, determine the specific ecological conditions of the water body.

Impact on the environment

The Sho‘rko‘l reservoir exerts a dual — both positive and negative — influence on the surrounding environment (Scheme 2). On the one hand, as a wetland it supports biodiversity, provides habitats for waterfowl and fish, moderates the local microclimate and yields reed and fishery resources. On the other hand, its regime is associated with serious ecological risks.



Scheme 2. Positive and negative environmental effects of the reservoir.

The negative effects are linked primarily to salt accumulation. The continuous rise of mineralization degrades water quality and limits its use. The high level of mineralized water raises the groundwater table along the shores and causes secondary salinization of the adjacent soils. During the drawdown period, the exposed and dried saline beds become a source of salt-dust transport by wind, which damages surrounding farmland and affects air quality. In addition, nutrients and pollutants

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carried in with drainage water may cause eutrophication and the deterioration of the hydrochemical state of the reservoir. These impacts are systematized in Table 2.

Table 2

Environmental effects of the Sho‘rko‘l reservoir

Positive effects	Negative effects
Wetland habitat for waterfowl and fish; support of regional biodiversity	Rising mineralization and decline of water quality
Moderation of the local microclimate and humidity	Secondary salinization of adjacent soils and rising water table
Reed, fishery and recreation resources	Salt-dust transport from dried beds, damaging farmland
Use of return water (re-use of drainage flow)	Eutrophication and pollution from drainage nutrients

Source: compiled by the author based on the analysis.

To reduce the negative effects, a number of measures are advisable: systematic hydrological and hydrochemical monitoring of the reservoir; regulation of the volume and quality of incoming collector water; improvement of the drainage and collector network to limit salt input; stabilization of the water level to prevent the exposure of saline beds; and phytomelioration (planting of salt-tolerant vegetation) along the shores to fix the soil and reduce dust transport.

Conclusion

The analysis shows that the hydrological regime of the Sho‘rko‘l reservoir is formed mainly by collector–drainage inflow and intensive evaporation under arid conditions, which gives it the character of a terminal, progressively mineralizing water body. The level and salinity of the reservoir vary inversely over the year, with the highest mineralization coinciding with the lowest level in autumn.

The reservoir has a contradictory environmental role: as a wetland it is valuable for biodiversity and the local microclimate, but its rising salinity, the secondary salinization of shores and salt-dust transport pose real ecological threats. Therefore, the sustainable functioning of the Sho‘rko‘l reservoir requires regular monitoring, the regulation of inflow quality and quantity, and shore-protection measures, which together will help to preserve its positive functions while minimizing the negative impact on the environment.

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