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SOIL EROSION AND SALINIZATION ON THE COAST OF THE BUGUN IRRIGATION RESERVOIR

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Annotation. *New trends in the development of negative ecological processes on the coast of the Bugun irrigation reservoir, primarily soil erosion and salinization, are considered. The role of monitoring these processes on the basis of remote sensing data by Landsat and Sentinel satellites, as well as quadrocopters, to prevent the dramatic consequences of the amplification of these processes, is noted.*

Key words: *reservoir, erosion, salinization, soil, monitoring*

Introduction.

The rapid development of the economy of the Turkestan region in South Kazakhstan requires a lot of water for water supply and the irrigated agriculture development. And the role of the Arys-Turkestan irrigation system with the Bugun reservoir is extremely important for this purpose. The requirements for this system, created back in the 60s of the last century, increased after the organization of a new region with a center in the city of Turkestan. However, the creation of the Bugun reservoir in complex geomorphological and lithological conditions led to the manifestation of a number of unfavorable processes that are still active today. This is primarily the erosion of the soils on the southern coast and the flooding and salinization of soils in the zone of seepage water wedging out in the lower pools of the Bugun and Karazhantak dams. We started studying these processes in the first years of the reservoir functioning [1-3, 5]. Later, monitoring of the processes continued based on remote sensing data from the Landsat and Sentinel satellites [4, 6]. But in recent years, new trends in the development of processes on the coast of the Bugun reservoir have also appeared.

Research methods.

Back in 1966-1970, detailed studies of soils, rocks, ground and surface waters of the reservoir coast were carried out to identify possible processes of flooding, salinization and erosion of soils of the coast. Taking into account the geomorphology of the territory (Fig. 1), two key areas were organized on the northern and southern coasts of the reservoir, where mapping of the soil cover on a scale of 1:5000, the morphology, water-physical properties of soils, and the content of water-soluble salts in the thickness up to 20 m were carried out. Observation wells are also equipped to monitor the dynamics of the level and salinity of groundwater. On these "keys" for 3 years regular studies of the water-salt regime of soils and the regime of groundwater have been carried out. The research results are reflected in our monographs and articles published in Russian and English [1-4]. In general, the content of salts in the aeration zone, their chemical composition, and the features of secondary soil salinization in the process of filling the reservoir and its functioning were assessed.

The development of erosion processes was also studied, especially on the southern coast, where they manifested themselves very intensively. In the future, studies in key areas were carried out sporadically, and since 1991 (after the collapse of the former Soviet Union) they continued based on remote sensing data [4, 6].

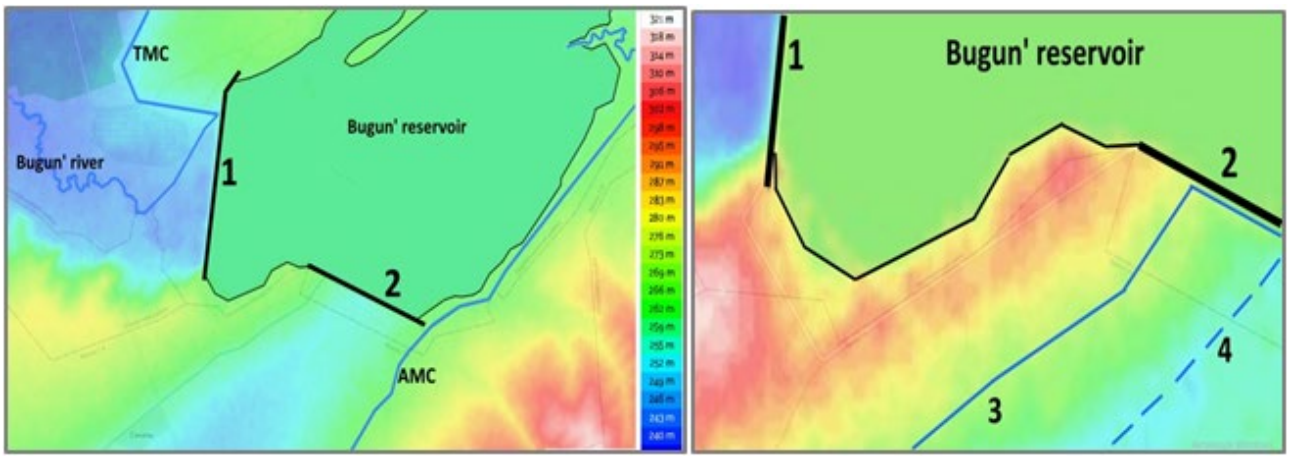

Fig.1. Digital model of the reservoir relief

(on the left - general view, on the right - the southern coast; 1 - Bugun dam, 2 - Karazhantak dam, 3 - A-9 channel, 4 - Sai Karazhantak)

Research results. The objective of this study was to verify the new trends in the development of negative processes identified in recent years [4, 6], in order to prevent their dramatic consequences. First of all, attention was paid to the increased soil erosion on the southern coast in the area adjacent to the Karazhantak dam. In our opinion, it is associated with climate change, which affected the runoff regime of the Bugun and Arys rivers, and caused a change in the timing of the reservoir filling, increased winds and a change in their direction. In the relief conditions of the foothill plain (Fig. 1), on which the Bugun reservoir was created, even at the design stage, the risk of erosion of soils and loess rocks of a low and narrow ridge, which served as the southern coast of the reservoir, was underestimated. This danger was noted by us back in the 60s [1, 2], and now it has manifested itself as a real threat of water breakthrough through the ridge and the possible destruction of the reservoir. If in the first decades the reservoir was filled in March-April, then in recent years it begins already in February, which is confirmed by the Sentinel-2 images in 2021 and 2022 (Fig. 2). At the same time, the time of influence of waves, currents and floating ice on the erosion of loess coasts is lengthened. An important factor in increasing soil erosion on the southern coast (Fig. 3, left) is an increase in the speed, frequency, and direction of winds. As a result, it is not the southwestern part of the shore of the reservoir that is eroded, as it was in the 60-80s, but the southern part. It was here that in 2021 there was an accelerated erosion of the coast and the creation of a dangerous situation threatening water overflow through the watershed and the reservoir destruction (Fig. 3, right). A quadcopter study confirmed this danger and measures were taken to prevent an emergency (Fig. 4).

Analysis of satellite images for the period 1966-2021 made it possible to draw a schematic representation (in plan) of the erosion dynamics on the southern coast (Fig. 5). And the erosion rate in key areas was shown by us earlier [3, 4].

Fig.2. Filling the reservoir in 2021 and 2022 *(1 - Bugun dam, 2 - Karazhantak dam)*

Fig Fig.3. Erosion of the south coast during strong winds (left) and the threat of outburst of the south bank of the reservoir in April 2021 (right)

Fig.4. Erosion-prone area (drone image, 2021-04-22)

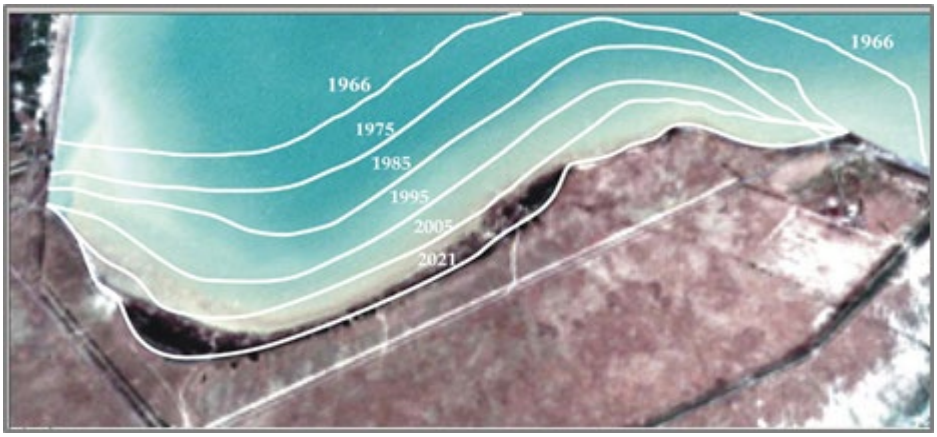

Fig. 5. Erosion of the southern coast during the observation period

Soil salinization due to flooding by seepage waters downstream of the Karazhantak dam is an important negative process that is increasing on the southern coast (Fig. 6). This process was shown by us earlier [2-4], but its manifestation is becoming larger. And drone observations made it possible to identify land salinization downstream of the Bugun dam, as well as on the outer slope of the dam.

Fig. 6. Strong salinization of bog (1), meadow-bog (2) and meadow-serozem soils downstream of the Karazhantak dam (above) and the slope of the Bugun dam (below)

Conclusion.

During the construction of the Bugun reservoir, the erosion resistance of the loess deposits of the southern coast (a low ridge between the valleys of the Bugun river and the Karazhantak sai) was overestimated. As a result, erosion manifested itself here quickly, and the coast needs prompt engineering protection. A negative consequence is the strong salinization of soils downstream of the Karazhantak dam, including the lands of perspective irrigation, as well as downstream of the Bugun dam. Of the new negative manifestations, we note an increase in erosion due to a change in the reservoir filling regime and a deterioration in the wind situation, as well as the impact on water quality in the reservoir of discharges into the Bugun River upstream (the village of Krasny Most).

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