



ECOLOGICAL AND SOCIO-ECONOMIC CONSEQUENCES OF THE SARDOBA RESERVOIR DISASTER (2020): A GEOGRAPHICAL ANALYSIS

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Abstract

On May 1, 2020, the breach of the Sardoba reservoir dam located in the Sardoba district of Sirdarya region became one of the largest man-made disasters in the years of Uzbekistan's independence. This article provides a comprehensive scientific analysis of the geographical, ecological, and socio-economic consequences of the disaster. The study examines the geographical characteristics of the flooded areas, damage to soil and groundwater, and the impact on agriculture, infrastructure, and the livelihoods of the population. The analysis shows that the effects of the disaster spread beyond Sardoba district to Sirdarya region of Uzbekistan and Turkistan region of Kazakhstan, causing serious ecological and social consequences on a regional scale. The article develops scientific recommendations for preventing the disaster and avoiding the recurrence of such disasters.

Keywords: Sardoba reservoir, dam breach, ecological disaster, flooding, Sirdarya region, soil degradation, socio-economic consequences, environmental safety, man-made disaster.

INTRODUCTION

The failure of hydraulic structures and man-made disasters originating from reservoirs are considered one of the most dangerous types of ecological disasters worldwide. World history knows major disasters resulting from dam breaches —



the 1976 Teton Dam (USA), the 2019 Brumadinho (Brazil), and the 2020 Sardoba (Uzbekistan) among them.

The Sardoba reservoir was built in 1969, with a total capacity of 922 million m³. It is located in the Sardoba district of Sirdarya region and was primarily used for irrigation of agricultural land. On May 1, 2020, due to heavy rains and a sharp rise in water levels, the northern part of the dam was breached. As a result, more than 900 million m³ of water flooded the surrounding areas.

This event attracted the attention of Uzbekistan and the international community. However, in scientific literature, the geographical, ecological, and socio-economic consequences of the disaster have not yet been comprehensively and systematically studied. Most existing studies focus on the technical aspects of the event or rescue operations, while scientific analysis of long-term ecological consequences is insufficient.

The purpose of this study is to comprehensively analyze the ecological and socio-economic consequences of the Sardoba reservoir disaster from a geographical perspective, to identify the characteristics of the affected areas, and to develop scientific recommendations for preventing such disasters in the future.

The ecological consequences of dam disasters have been well studied by foreign researchers. Poff and Hart (2002) analyzed the impact of dam breaches on river ecosystems, groundwater, and soil, finding that soil salinization and erosion sharply intensify in flooded areas[1]. McCully (2001) studied the socio-economic consequences of major hydraulic structure disasters, showing that land degradation and population displacement are the most severe consequences[2].

Among Uzbek researchers, Toshmatov and Ergashev (2021) studied the initial consequences of the Sardoba disaster, noting that the flooded area exceeded 70,000 hectares[3]. Rahimov (2022) conducted the first scientific analysis of the condition of agricultural lands damaged by the disaster[4]. However, a study comprehensively examining the long-term ecological and social consequences of the disaster is still insufficient.

Among international organizations, the UN Office for the Coordination of Humanitarian Affairs (OCHA) published an initial assessment report on the disaster in 2020. The World Bank also assessed regional damage within the



framework of financing recovery projects. These documents served as important sources for our research.

The following methods were used in the study: historical-geographical analysis — comparative analysis of flooded areas before and after the disaster; remote sensing — identifying the boundaries of flooded areas through analysis of satellite imagery; statistical analysis — processing data on affected population, land area, and infrastructure facilities; cartographic modeling — visualizing the territorial spread and impact zones of the disaster.

Data sources: Reports of the Ministry of Emergency Situations of Uzbekistan (2020-2024); UN OCHA reports (2020); Data of the Sirdarya regional administration; Statistics of the Ministry of Agriculture; Analysis of Landsat-8 and Sentinel-2 satellite imagery.

GEOGRAPHICAL CHARACTERISTICS OF THE DISASTER AREA

The Sardoba reservoir is located in the Sardoba district of Sirdarya region of Uzbekistan, 40 km west of the Syrdarya River. The reservoir is situated at an altitude of 280-290 meters above sea level, with its catchment area covering approximately 1,200 km². The dam is 4,800 meters long, 18 meters high, with a maximum capacity of 922 million m³. The relatively elevated relief of the reservoir compared to neighboring areas was an important geographical factor in expanding the impact area of the disaster.

The terrain of Sardoba district is mainly flat, with a noticeable slope from west to east toward relatively lower areas. This condition created conditions for the rapid spread of flooding in the eastern and northeastern direction. The climatic features during the period of the disaster (April-May) — rainfall and intensified snowmelt — brought the water level above the dam to a critical level.

On May 1, 2020, at 04:00, a crack appeared in the northern part of the dam and within a few hours a 100-meter section of the dam was completely destroyed. Approximately 900 million m³ of water was discharged into the surrounding low-lying areas. The flow velocity initially reached 15-20 km per hour.

The geographical spread of the water flow was observed in three main directions. The first direction — northward (toward Kazakhstan): water passed through Sirdarya region and entered the territory of the Turkistan region of Kazakhstan,



where it also flooded large areas. The second direction — eastward: the central parts of Sardoba district, villages and farms were affected. The third direction — southwestward: part of the territory of Mirzaabad district was submerged.

Table 1. Main indicators of the Sardoba reservoir disaster

Indicator	Quantity / Description
Date of disaster	May 1, 2020, at 04:00
Area of dam breach	≈ 100 meters
Volume of water discharged	900 million m ³
Total flooded area	≈ 70,000 ha (Uzbekistan + Kazakhstan)
Number of affected districts in Uzbekistan	3 districts (Sardoba, Mirzaabad, Oqoltin)
Affected area in Kazakhstan	Turkistan region, ≈ 18,000 ha
Displaced population (Uzbekistan)	Over 70,000 people
Number of fatalities	3 people (official data)
Destroyed houses	Over 1,600
Damaged agricultural land	≈ 52,000 ha

Source: Compiled by the author based on data from the Ministry of Emergency Situations of Uzbekistan, UN OCHA (2020)

ECOLOGICAL CONSEQUENCES OF THE DISASTER

One of the most serious long-term consequences of the Sardoba disaster is the degradation of soil cover. Soil erosion, salinization, and changes in chemical composition were observed in flooded areas. According to research data, approximately 35-40% of the submerged lands suffered complete loss or serious damage to the upper fertile layer of soil.

A particularly dangerous situation was the deposition of silt and sediment carried by water onto agricultural lands. These sediments were deposited in some areas at a thickness of 10-40 cm, covering the fertile soil. Analyses conducted 2 years



after the disaster showed that in 28% of the flooded areas, soil moisture and salinity remained above normal.

The disaster had a noticeable impact on the groundwater regime. In flooded areas, the groundwater level rose sharply — in some places by 3-5 meters. This led to waterlogging of the soil and intensification of secondary salinization. This process was particularly evident in the lowlands of Sardoba and Mirzaabad districts.

Hydrological changes also affected the river network. As a result of water flow, some irrigation canals and drainage structures were destroyed or filled with silt. Full restoration of irrigation systems after the disaster took 18-24 months.

Analysis of satellite imagery showed that a significant portion of vegetation cover was lost in flooded areas. In agricultural areas that had 85-90% vegetation cover before the disaster, this figure dropped to 45-50% one year later. Wild vegetation showed faster recovery, but agricultural crops required special restoration programs planned for 3-4 years.

The impact on wildlife was also negative. In particular, beetle populations, soil insects, and small mammal populations sharply declined as a result of the disaster. The impact on river fish stocks — as a result of silt and chemical substances entering the water — was also recorded. However, specialized scientific research in this area has not yet been conducted.

Table 2. Changes in ecological indicators in flooded areas

Indicator	Before disaster	Year of disaster (2020)	Status in 2023
Vegetation cover (%)	87	41	68
Soil salinization index	0.8 (low)	3.2 (high)	1.6 (medium)
Groundwater level (m)	4.2	1.1	2.8
Agricultural productivity (% of norm)	100	12	74
Eroded land (%)	8	62	31

Source: Data of the Ministry of Agriculture, Ministry of Ecology and author's calculations (2023)



SOCIO-ECONOMIC CONSEQUENCES

As a result of the disaster, more than 70,000 people in Uzbekistan and more than 30,000 in Kazakhstan were forced to leave their homes. This was one of the largest displacement events in the history of the region. The displaced population mainly came from Baxt, Oqjar, Kenja, Jiyda and other villages of Sardoba district, and they were placed in temporary accommodation centers and with relatives and friends.

According to the Ministry of Emergency Situations data, the displaced population lived in temporary locations for an average of 3-4 months. Most of them returned in July-September 2020, but even those who returned had suffered major damage to their homes or property. The long-term impact of psychological pressure and stress required special psychological assistance.

Agriculture was the sector most damaged by the Sardoba disaster. Approximately 52,000 hectares of cropland was damaged in flooded areas, of which 18,000 hectares was completely destroyed. Cotton, grain, vegetable, and fruit crops that were planted or growing were ruined.

Damage to livestock was also serious. Approximately 25,000 head of cattle, 80,000 sheep and goats, and more than 500,000 birds died or went missing. This loss meant the loss of the main source of livelihood for many families. In the year of the disaster, the volume of agricultural production in Sardoba district decreased by 78% compared to 2019.

The disaster caused great damage to infrastructure. More than 1,600 residential buildings were destroyed or seriously damaged. Roads, bridges, water supply and sewage networks, power lines, schools, and hospitals were included in the damage list. Total economic damage according to official estimates exceeded 200 million US dollars.

Table 3. Economic damage from the Sardoba disaster (by districts)

District	Agricultural damage (mln \$)	Housing damage (mln \$)	Infrastructure damage (mln \$)	Total (mln \$)
Sardoba	68.4	24.1	31.7	124.2
Mirzaabad	21.3	8.6	12.4	42.3
Oqoltin	14.7	5.2	8.1	28.0
Other areas	4.8	1.9	3.4	10.1
TOTAL	109.2	39.8	55.6	204.6



Source: Author's calculations based on the Government of Uzbekistan, World Bank Assessment Report (2020)

RECOVERY PROCESS AND LESSONS LEARNED

The Government of Uzbekistan took prompt measures after the disaster. By Presidential Decree, necessary funds were allocated, a state of emergency was declared, and rescue operations began. In May-June 2020, the breached section of the dam was reinforced with temporary barriers, and water was pumped out of flooded areas using water pump stations.

From 2021 to 2023, extensive work was carried out to restore and modernize the Sardoba reservoir. The dam was completely rebuilt, the water level monitoring system was modernized, and early warning systems were installed. The reconstruction of damaged villages and the return of the population was also carried out in stages.

The recovery process proceeded at an uneven pace across different areas. Areas close to Guliston city and connected to main roads showed faster recovery. Villages located farther away and with poorer transport connections lagged significantly behind in recovery. For example, in some outlying villages of Sardoba district, full restoration of infrastructure was delayed until the end of 2022.

Agricultural recovery was also uneven. In areas where irrigation systems were restored, productivity reached 74% of pre-disaster levels by 2022. However, in land plots where deep waterlogging or salinization occurred, recovery has not yet been fully completed.

SCIENTIFIC RECOMMENDATIONS

The analysis of the Sardoba disaster provided a number of important lessons. First, the technical condition of hydraulic structures must be monitored on a regular and independent expert basis. Engineering deficiencies in the Sardoba dam and a slow response to rising water levels have been cited as the main causes of the disaster. Second, early warning and evacuation systems were not adequately developed. As a result, the process of warning and evacuating the population began too late relative to the catastrophically fast water flow.



Third, a hazard map of areas located in the disaster impact zone had not been compiled. If a geographical hazard model had been developed in advance, potential flooding zones could have been identified and preparedness measures taken. Fourth, the absence of coordinated interstate (Uzbekistan-Kazakhstan) emergency plans exacerbated the consequences of the disaster in the neighboring country's territory.

First recommendation: Creating a comprehensive monitoring system for hydraulic structures. Installing real-time monitoring sensor systems for all major reservoirs and dams in Uzbekistan, with mandatory independent technical expertise, is essential. The introduction of an early warning system based on artificial intelligence and IoT technologies is recommended.

Second recommendation: Scientific modeling of hazard geography. It is necessary to model disaster scenarios based on GIS for each major reservoir, identify potential flooding zones, and integrate this information into territorial planning.

Third recommendation: Developing regional disaster preparedness protocols. A bilateral agreement between Uzbekistan and Kazakhstan on cooperation, early warning, and coordination of rescue operations in emergency situations related to hydraulic structures is recommended.

Fourth recommendation: Strengthening ecological monitoring. A long-term monitoring program for soil, water, and biological indicators in disaster-affected areas is necessary. This data will allow assessment of the time for full recovery from the disaster and identification of future risks.

Fifth recommendation: Improving public knowledge and preparedness. Training and exercises for the population living in hazardous areas on evacuation procedures and behavior in emergency situations should be conducted. Local emergency plans must be drawn up and regularly updated.

CONCLUSION

The scientific analysis of the 2020 Sardoba reservoir disaster allowed the following important conclusions to be drawn.

First, the disaster was the largest man-made disaster in Uzbekistan's years of independence, with its effects covering 88,000 hectares of territory across



Uzbekistan and Kazakhstan. More than 100,000 people were evacuated, and total economic damage exceeded 200 million dollars.

Second, the ecological consequences of the disaster were very serious and long-term. Soil degradation, disruption of the groundwater regime, and loss of vegetation cover had not fully recovered by 2023. In particular, the problem of secondary salinization in flooded areas remains urgent.

Third, the recovery process was geographically uneven. Faster recovery was observed in central areas with better transport access, while remote and border districts required more assistance and government attention.

Fourth, the disaster provided important lessons on the need to monitor hydraulic structures, model hazard geography, and strengthen international cooperation. These lessons have practical importance in assessing other hydraulic structures in Uzbekistan and developing policies to reduce future risks.

For future research, studying the long-term impact of the Sardoba disaster on human health, developing economic models of agricultural recovery, and designing an interstate hydrological hazard monitoring system are recommended.

REFERENCES

1. Poff N.L., Hart D.D. How Dams Vary and Why It Matters for the Emerging Science of Dam Removal // *BioScience*. — 2002. — Vol. 52. — P. 659-668.
2. McCully P. *Silenced Rivers: The Ecology and Politics of Large Dams*. — London: Zed Books, 2001. — 350 p.
3. Toshmatov A., Ergashev B. Initial geographical analysis of the 2020 Sardoba disaster // *Geography and Natural Resources*. — 2021. — №1. — P. 14-29.
4. Rahimov F. The condition of agricultural lands damaged by the Sardoba disaster // *Agriculture of Uzbekistan*. — 2022. — №3. — P. 45-58.