Changes in the Reliability of Seasonal Control Reservoirs for Resource Management

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Abstract

This study investigates the reliability and management of seasonally managed water reservoirs in Uzbekistan, focusing on technical, hydrological, and ecological factors. Uzbekistan aims to reduce reliance on external water policies by enhancing irrigation stability through interventions like managing and evaluating remedial water reservoirs. The study's methodology involved using wind, wind direction, elevation, discharge volume, wave duration, and frequency data, with wind data sourced from the Uzhydromet agency and other data measured during a field visit to the Kurgontepa water reservoir. The findings suggest that to prevent water overflowing from the reservoir dam, maintaining the water level below 562.4 m and raising it to 565.55 m after floodwater release is recommended. Restricting any increase beyond these thresholds until the dam is repaired is imperative. Comparative analysis under different conditions highlighted differences in wind availability, recorded speeds, reservoir depths, and wave characteristics, crucial for reservoir operation and dam safety strategies.

Keywords: water reservoir, reliability, wind, Kurgontepa reservoir

Nomenclature

Please use standard notations. Should you choose to skip this section, all symbols must be clearly defined everywhere relevant in the text. Leave only one blank line between the title of this section and the first parameter description. Please do not forget to delete this paragraph or the entire section accordingly.

D	Diameter of the jet , m
T	Temperature of the jet, K

Greek Symbols

μ	Dynamic viscosity, Pa.s
ρ	Mass density, kg/m^3

Subscripts

0	Reference value

Exponents

K	Iteration number

Notations

D/Dt	Total derivative

Non-dimensional Numbers

1. Introduction

To reduce Uzbekistan's reliance on external water policies and enhance the stability of its irrigation supply, the government has embarked on strategic interventions, including the management and systematic evaluation of remedial water reservoirs [1-2]. Currently, over 55 reservoirs across the nation are engaged in the seasonal modulation of water flows. However, these reservoirs, constructed 40 to 60 years ago, are not able to meet the full irrigation demands due to decreased storage capacity primarily caused by sediment deposition [3-5]. Moreover, the reliability of these water supply systems is compromised by significant technical degradation and the oversight of environmental considerations during operational processes. Consequently, this deterioration has led to an increased probability of disruptions in water supply to agricultural areas [6-8].

The outlined scenarios underscore the imperative to enhance the dependability of seasonally managed water reservoirs under Uzbekistan's specific conditions, with consideration for technical, hydrological, and ecological factors. This underscores the criticality of research in this area for the nation's economic health [6, 8-11]. Initial findings from this research indicate viable strategies to significantly improve water distribution to irrigated regions through the advancement of seasonally managed reservoir systems. Accordingly, it is essential to fortify the reliability of these reservoirs by restructuring their operational processes, focusing on the technical robustness of infrastructure, the annual variability of water levels, and the environmental quality of water inputs and outputs. Such enhancements will ensure consistent water delivery [1-5].

The enhancement of guaranteed water supply through improved management of seasonally operated water reservoirs is a critical concern not only for Uzbekistan but also for the broader Central Asian region and other arid areas globally [7-10]. The application of research findings in this area presents significant opportunities to not only augment water supply to agricultural lands but also to support other natural ecosystems. Consequently, this facilitates the sustainable utilization of water resources, which are regarded as a vital natural asset, and promotes social activities such as recreation around these water bodies [9-11].

Furthermore, the transfer of water from reservoirs under extreme conditions poses substantial risks and can lead to structural failures, particularly in the lower sections of the infrastructure. For instance, the corrosion of concrete or metal surfaces, malfunction of mechanical components, and erosion of the reservoir bed are potential hazards [7-13]. Additionally, during periods of heavy rainfall, when reservoirs reach full capacity, rapid measures are often taken to prevent overflow by releasing water. However, this can paradoxically prevent reservoirs from achieving maximum water storage capacity, as preemptive discharges made in anticipation of flooding can lead to suboptimal water levels. This highlights the need for more refined management strategies that balance flood risk with optimal water storage practices [1-4, 7-9]. Overflow from the upper portion of a dam, known as the crest, can occur under several conditions:

- Alterations in the structural integrity of the dam's crest;
- Resonance of wave patterns within the reservoir induced by wind;
- Resonance of wave patterns due to seismic activity;
- The hydrological characteristics of the Arabtepasoy basin and the capacity of the water transfer infrastructure to handle floodwaters.

Alterations in the condition of the dam's upper portion are contingent upon the subsidence experienced within its base and structure. Comprehensive measurement and monitoring efforts were executed by the State Inspection "Davsuvhojaliknzorat" to assess the status of the Kurgontepa reservoir dam located in the Arabtepasoi. The hydrological regime of the Arabtepasoy basin, alongside the capacity of the water transfer structures to convey floodwaters, plays a pivotal role. The Kurgontepa reservoir functions as part of an integrated system of reservoirs dedicated to the provision of water for irrigation purposes [1-5]. It also serves a critical flood mitigation role by intercepting floodwaters via the Burbuloksoy spillway, thereby safeguarding the agricultural interests of the Altiariq district from potential flood damage. The Oltiariqsoy stream, a bifurcation of the Shakhimardan river commencing from the village of Vadi Tog, has been regulated post-1993 through the Vuodil hydroelectric dam. The catchment area of Oltiariksoy is noted for its hydrological stability, with no substantial variations in streamflow recorded from 2004 to 2020. Oltiariksoy boasts a maximum conveyance capacity of 50 m³/s and incorporates several tributaries from the Mindon flood system [1-4]. The anthropogenic alterations in the area have induced changes in the streamflow distribution, with Oltiariksoy currently utilized as an irrigation channel. The hydrologic calendar typically commences in April, with the advent of floodwaters predominantly in June. The Kurgontepa reservoir is designed to accommodate 0.1% and 0.01% floodwaters, corresponding to volumes of 4.0 million m³ and 5.2 million m³ respectively.

The evaluation and management of the hydro-ecological conditions of water reservoirs are critical issues that require definitive solutions. It is observed that many reservoir structures in our region, including concrete dams, metal water levelers, and earthen dams, are subject to erosion due to the saline and aggressive nature of the basin's water. This erosion can compromise the structural integrity of both concrete and metal components [1-4, 7-9]. Notably, the Sultansanjar and Koshbulok reservoirs within the Tuyamoyin hydroelectric system, along with the Todakol, Shorkol, and Shegekol reservoirs, exhibit water salinity levels typically ranging from 1 to 2 grams per liter.

Furthermore, the reduction in water exchange rates within these reservoirs leads to a deterioration in water quality, specifically an increase in mineral content. Such conditions, especially under intense evaporation, result in heightened mineralization and aggression of the water, which in turn accelerates the erosion of dam structures. The pronounced mineralization and aggressive water chemistry in these basins have been identified as significant factors contributing to dam deterioration. This research investigates potential adverse scenarios stemming from diminished operational reliability of seasonally managed water reservoirs. We have identified key elements of reliability influenced by technical, hydrological, and ecological factors across different types of seasonally managed reservoirs. The research proposes strategies to enhance the operational reliability of these reservoirs by considering these same factors. Additionally, it provides forecasts on the potential improvements in operational reliability following the implementation of these strategies, offering scientifically grounded recommendations for increasing the resilience of these structures. Specifically, this research focuses on modifying operational conditions to prevent overflow, ensure safe water transfer during flood events, and maximize water storage capacity. The Kurgontepa reservoir in the Arabtepasoy basin serves as a case study for examining these interventions.

2 Materials and methods

2.1. Study area

The Kurgontepa Water Reservoir, situated in the Altiariq District of the Fergana Region, is a significant hydrotechnical structure located approximately 10 kilometers from the town of Altiariq (Figure 1). Constructed in phases, the first phase occurred between 1975 and 1977, and the second between 1980 and 1981. This facility comprises two adjacent reservoirs formed by impounding the natural flows of the Shahimardan river and Fayziobodsoy stream. The first reservoir, established in the Arabtepasoy area, has a total storage capacity of 24.0 million cubic meters. The embankment dam associated with this reservoir reaches a height of 45 meters with a length of 620 meters across. The surface area of the water spans approximately 2.4 square kilometers, and it has a maximum discharge capacity of 5 cubic meters per second.

Adjacent to it, the second reservoir located in Kemkolsoy holds up to 8.7 million cubic meters of water. Its dam measures 35 meters in height and stretches 450 meters in length. The water surface of this reservoir covers an area of 1.3 square kilometers, with a water transfer capacity of 10 cubic meters per second. Together, these reservoirs are instrumental in providing water to the Southern Fergana canal and the Sokh-Shahimardon canal. They are crucial for the irrigation of approximately 11,000 hectares of agricultural land in the region. The supply of 0.1% and 0.01% of flood waters in the Kurgontepa reservoir is 4.0 million m3 and 5.2 million m^3.

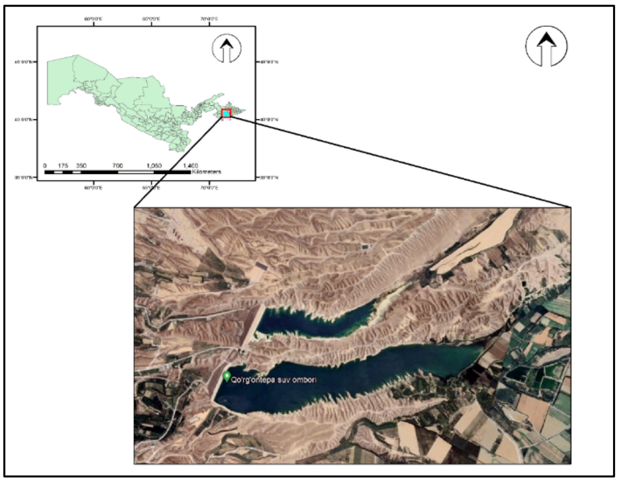

Fig. 1. Kurgontepa water reservoir

2.2. Material

In this research, wind, wind direction, elevation, discharge volume, wave duration and frequency were used and analyzed towards predicting changes in in reliability of seasonal reservoirs in Uzbekistan. The wind data was obtained from Uzhydromet agency, whereas the rest of the data was measured and taken during field visit to study site, Kurgontepa water reservoir. The available data from 2021 encompasses detailed measurement and monitoring results of the dam's upper section, documenting elevations that range from 567.08 to 567.70 meters. These findings indicate deviations from the planned elevations in the original project design by 10 to 72 centimeters. The data includes specific readings from geodetic markers across various locations on the dam, as well as subsidence rates which were recorded over the course of the year. Additionally, historical wind data from the Fergana and Kokand weather stations for the period between 1990 and 2020 is included, providing insights into potential environmental impacts on the dam structure.

2.3. Methods

The reservoir operates in a mode fully influenced by wind, with a design focusing on high-strength slopes and elevation directly above the Normal maximum level (NML), in accordance with standards reinstated to building codes and regulations protection. Presently, the methodology for determining dam heights is specified in the sections of KMK 2.06.05-98 "Dam with soil material" and KMK 2.06.04-97 "Impact and safety measures on hydraulic technical structures". This approach differs from traditional reservoir design methods. The following describes the methods for managing dam crest heights in the upstream water zone in two scenarios:

- At the Normal maximum level (NML).
- At the Forced level (FL).

The calculations for the dam's upper height, hs, are derived through two formulas:

$$hs = hset + hrun\ i\% + a \quad (3.1)$$

where:

hset - is the height increase due to wind-driven water at the upper boundary;

hrun i%- is the required height for maintaining full wind capacity;

a - is the additional height reserved for the upper part of the dam.

Data from the Fergana and Korikhona weather stations, established near the Kurgantepa reservoir, support the maintenance of the full wind regime.

Wave mode of the reservoir under the influence of an earthquake: The Korgontepa reservoir is located in a seismic zone, the overflow of water from the upper part of the dam (graben) under the influence of an earthquake is determined by taking into account gravity waves.

Hydrotechnical structures are built taking into account two types of earthquakes: operational base (OB) and maximum damage (MD). While the first case does not affect the working condition of hydrotechnical structures, in the second case, subsidence deformation of the upper part of the dam can be observed.

According to the Institute of Seismology of the Academy of Sciences, there are the following coefficients:

- OB да kc=0,37g=K1;
- MD да km=0,84g=K2; ;

The displacement of the top of the dam in the maximum damage earthquake is determined according to the following formula and the strength of the earthquake:

Lgu=2,3-3,3(kc/km)
(3.2)

here:

she is - displacement of the upper part, cm;

kc – seismic acceleration coefficient, kc=1;

km – seismic acceleration calculated in MD km =0.84;

0.0< kc / km<0,8

kc / km=0.296/0,84=0.35

lg u=2,3-3,3(0,296/0,84)=1,137, u=13,7 см

Earthquake under the influence of dam top part of deformation the following formula through is determined:

H=3*10-4(M-4,5)3*kmH (3.3)

this where :

H - deformation of the upper part of the dam m;

M - earthquake magnitude, M=6.8;

N is the height of the dam, N=45.0 m.

H=3*10-4(6.8-4.5)3*0.84*45.0=0,14 м.

The reservoir project specifies a Normal maximum level (NML) of 564.0. The technical design did not account for the timing of incoming floodwaters. As a result, during operation, the reservoir is maintained at, but not exceeding, the (NML). To prevent overflow at the dam's upper part, the water level in the reservoir should not surpass 565.55 meters, aligning with the Forced level (FL) limit. Additionally, the drainage channel's capacity is constrained to 5.0 cubic meters per second, which also limits the drainage facility's capacity. Since there is no curve linking water levels to water volumes that accounts for silt-sediment accumulation in the reservoir, the original design curve is used instead.

3 Results and discussion

Data collected from measurement and monitoring activities in 2021 indicated that the elevation of the upper section of the dam ranged between 567.08 and 567.70 meters. This range reflects a deviation of 10 to 72 centimeters below the elevation specified in the original design specifications of the project (Figure 2). Notably, at picket 200, the reservoir water level was recorded at 0.1 meters below the projected level. Beyond this point, from picket 250 onwards, a gradual decrease in water level was noted, reaching a minimum of 567.05 meters at picket 495 (Figure 2). Conversely, an increase in reservoir water levels commenced from picket 500, with a measured elevation of 567.07 meters. This ascending trend continued to picket 600, where the water level reached 567.7 meters.

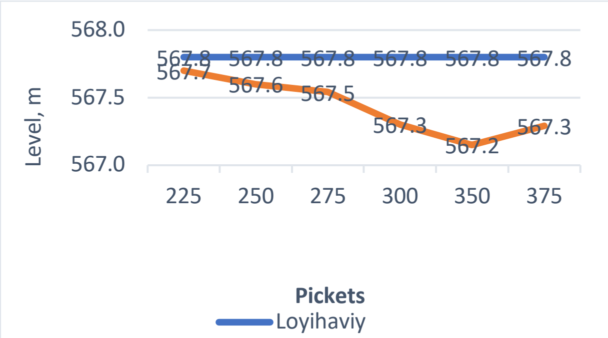

Fig. 2. Change in the Elevation of the Dam's Upper Section

Table 1 presents the minimum elevation values derived from the measurement and monitoring of geodetic markers installed on the upper section of the dam. It is important to note that these markers are positioned 2-3 cm above the dam's crest. The data indicate that the lowest recorded elevation was at marker M52, with a value of 567.0360 meters. In contrast, the highest elevation recorded was at marker M61, reaching 567.7002 meters, as detailed in Table 1. This differential provides critical insights into the vertical stability and structural integrity of the dam over the observed period.

Table 1. The lowest level marks on the top of the dam

# Mark	Picket	level	# Mark	Picket	level
M61	2+10	567.7002	M53	4+83	567.0772
M60	2+33	567.6053	M52	5+33	567.0360
M59	2+50	567.5312	M51	5+33	567.4879
M58	2+90	567.3029	M50	5+40	567.4223
M57	3+33	567.1589	M49	5+47	567.4335
M56	3+50	567.2833	M48	6+00	567.3371
M55	3+90	567.2981	M47	6+33	567.3831
M54	4+33	567.1003	M46	6+40	567.5420

The monitoring data indicate ongoing subsidence in both the base and the body of the dam. According to the results, the maximum observed subsidence reached 12 mm at picket 5+33, while the minimum subsidence recorded was 1.2 mm at picket 2+50, as presented in Table 2. Additionally, the data reveal that the annual average rate of subsidence varied between 0.6 mm and 6 mm. Notably, the highest annual average subsidence rate was 6 mm, also recorded at picket 5+33 (Table 2). These measurements are critical for assessing the structural health and long-term stability of the dam, highlighting areas of potential risk and necessary maintenance.

Table 2. Dam top part sinking

Picket	2+10	2+33	2+50	2+90	3+50	3+90	4+83	5+33	5+40	5+47	6+00	6+40
Sinking, mm	1.7	2.4	1.2	4.5	7.8	8.5	11.7	12.0	11.6	11.8	5.5	5.0
Average yearly sinking, mm	0.85	1.2	0.6	2.25	3.9	4.25	5.85	6.0	5.8	5.9	2.75	2.5
Difference between Mark	0.35	0.60	1.65	1.65	0.35	1.60	0.15	0.20	0.10	3.15	0.25	

3.2. Effect of wind on Kurgontepa water reservoir

Wind action creates waves on the surface of a reservoir. The intensity and size of these waves depend on wind speed, wind duration, and the fetch (the distance over water that the wind blows in a single direction). Furthermore, Wind-induced waves and surface currents can lead to mixing of the water column. This mixing can affect temperature stratification within the reservoir, leading to more uniform water properties across different depths, which is important for aquatic life and water quality management. Wind enhances the evaporation from the water surface. Increased wind speed accelerates evaporation by removing the humidity-laden air from above the water surface more quickly, thus affecting water levels and reservoir storage capacities. Therefore, it is vitally important to analyze the speed of wind on weather station in the research site. In this research, two weather stations, Fergana and Kokand, were considered, where wind speed was investigated.

The data analysis, considering periods of calm wind, indicates diverse wind directions at the Fergana weather station, with calmness being the most common at 25 times. Predominant winds originate from the east and south, with the east seeing 17 instances and the south 10 (Table 3). Conversely, at the Kokand weather station, calm conditions are predominant, recorded 23 times, with significant wind coming from the south-west (20 times) and east (12 times), suggesting these as primary wind directions in the area (Table 3).

When calm periods are not considered, the data from the Fergana station shows a noticeable increase in winds from the east to 23 occurrences, with the south-western winds noted 15 times, indicating a robust influence from these directions during active wind conditions during 1990-2020 (Table 3). At the Kokand station, ignoring calm conditions reveals the south-west direction as most frequent at 26 occurrences, followed by the east at 15, underscoring a dominant wind pattern from the south-west and east when wind levels are higher (Table 3). This analysis highlights the variability in wind patterns between calm and active conditions, critical for understanding local climatic behaviors.

Table 3. Fergana and Kokand weather stations according to the wind direction (%) year during repetition (1990-2020)

Weather station	North	North East	East	Southern-East	South	southern west	West	Northern west	The wind silence
Taking into account the calmness of the wind									
Fergana	9	6	10	17	7	5	12	10	25
Kokand	4	10	12	9	9	20	10	2	23
Disregard the periods of low or no wind									
Fergana	12	7	13	23	9	7	15	13	-
Kokand	6	14	15	11	12	26	13	3	-

During the research, wind speed at the different rates was calculated and analyzed. Accordingly, the highest results were observed in the rate of 1 and 2%, both accounted for 34%, meanwhile the lowest was 20 at the rate of 20% (Table 4).

Table 4. Calculation of wind speed at different rates

#	**Variabilities**					
1	Availability, %	1	2	5	10	20
2	The wind speed, m/sec	34	34	28	24	20

The table 5 provides a comparative analysis of wind and wave parameters at a certain location, categorized under 'main' and 'separately' conditions. In terms of wind availability, the 'separately' condition reports a significantly higher wind occurrence at 20%, as opposed to a mere 2% under the 'main' condition. This suggests that wind is a more influential factor in the 'separately' scenario. Both conditions experience prevailing winds from the south and south-east directions. For the 'main' condition, the wind speed recorded by the wind vane is 34 m/s, which is substantially higher than the 20 m/s observed in the 'separately' scenario. However, the accounted wind speed, which perhaps factors in certain adjustments or averages, is recorded at 27.5 m/s for the 'main' and 18.0 m/s for the 'separately' condition. The slope's location is consistent across both scenarios at 2.5 meters high. The average depth of the reservoir varies, with the 'main' condition showing a shallower depth of 11.3 meters compared to the 'separately' condition's 13.6 meters (Table 5). This could influence wave characteristics and sediment dynamics within the reservoir.

Regarding wave parameters, the origin distance is slightly greater in the 'separately' condition (3550 m) compared to the 'main' condition (3500 m). Wave average height is greater in the 'main' condition at 0.69 meters than in the 'separately' condition at 0.59 meters (Table 5). This difference could affect shoreline erosion and the design of protective structures. Wave duration is slightly longer in the 'separately' scenario at 2.94 seconds, compared to 2.85 seconds in the 'main'. Wave length also follows this trend, with the 'separately' condition having longer waves at 13.46 meters compared to 12.72 meters in the 'main'.

The height of the wave hitting the shore is higher in the 'separately' condition at 1.74 meters, indicating potentially greater impact on the shoreline than the 2.42 meters in the 'main' condition. Both conditions maintain an altitude reserve of 0.5 meters. The height of the dam is stated as 2.98 meters, and the calculated symbol of the dam is given as 566.98 for the 'main' and 568.55 for the 'separately' condition. Lastly, the water level in the dam is noted between 567.08-567.70 meters for the 'main' and between 567.80-567.70 meters for the 'separately' condition (Table 5). Overall, this data is crucial for understanding the impact of wind and waves on reservoir operations and dam safety, informing the design and management of such hydraulic structures.

When the reservoir reaches a level of 563.2 meters (holding 18.61 million cubic meters) and an additional 0.1% floodwater inflow occurs (as per Class II Hydraulic structure standards), the total storage in the reservoir expands to 4.0 million cubic meters, setting the water level at 565.55 meters, which aligns with the Forced level mark. At this level, and accounting for a wind probability of 20%, the generated waves do not exceed the dam's crest. It is advised not to exceed an Upper Bound Scenario (UBS) level of 562.4 meters (17.39 million cubic meters) when managing guaranteed 0.01% floodwater flows (Table 5). Therefore, to manage the transfer of 0.1% and 0.01% assured floodwaters in the hydroelectric network's hydrotechnical structures effectively, the upper reservoir levels should be maintained at 563.2 meters and 562.4 meters respectively on June 1. Additionally, it is crucial to restore and maintain the dam's upper elevation at the originally planned mark of 567.8 meters.

Table 5. Parameter calculation metrics

#	Parameter's name	Impact and severity	
		main	separately
1	The wind of speed availability, %	2	20
2	The wind direction	South, South-East	
3	Wind speed according to the wind vane (V_1), m/s	34	20
4	Accounting the wind speed (V_w), m/s	27.5	18.0
5	High the slope location (m)	2.5	2.5
6	The average depth of the reservoir (d), m	11.3	13.6
7	Wave origin distance, m	3500	3550
8	Wave average height, m	0.69	0.59
9	Wave average duration, s	2.85	2.94
10	Wave average length, m	12.72	13.46
11	The height of the wave hitting the shore, m	2.42	1.74
12	Altitude reserve, m	0.5	0.5
13	The height of the dam, m	2.98	1.75
14	Calculation symbol of the dam, m	566.98	568.55
15	Dam water level, m	567.08-567.70	

Table 6. Reservoir volume change due to flood waters

Headwater level	Volume, million m^3		comment
	In the basin	Accumulation and flood	
566.3	**24.03**		Maximum storage according to the project plan
566.2	23.84		
566.1	23.65		
566.0	23.46		
565.9	23,27		
565.8	23.08		
565.7	22.89		
565.6	22.71		
565.55	**22.61**	**0**	Limit of Maximum storage
565.5	22.52	0.09	
565.4	22.34	0.28	
565.3	22.16	0.46	
565.2	21.97	0.64	
565.1	21.79	0.82	
565.0	21.62	1.00	
564.9	21.44	1.17	
564.8	21,26	1.35	
564.7	21.09	1.52	
564.6	20.92	1.70	
564.5	20.74	1.87	
564.4	20.57	2.04	
564.3	20.40	2.21	
564.2	20,23	2.38	
564.1	20.07	2.55	
564.0	**19.90**	**2.71**	Maximum storage according to the project plan
563.9	19.73	2.88	
563.8	19.57	3.04	
563.7	19.41	3.20	
563.6	19.25	3.37	
563.5	19.09	3.53	
563.4	18.93	3.69	
563.3	18.77	3.84	
563.2	**18.61**	**4.00**	Headwater level 0.1% security for
563.1	18.46	4.16	
563.0	18.30	4.31	
562.9	18.15	4.47	
562.8	17.99	4.62	
562.7	17.84	4.77	
562.6	17.69	4.92	
562.5	17.54	5.07	
562.4	**17.39**	**5.22**	Headwater level 0.1% security for
562.3	17.25	5.37	
562.2	17.10	5.51	

4 Conclusions

Monitoring activities in 2021 identified elevation deviations in the upper section of the dam, ranging from 10 to 72 centimeters below the project's original design elevation. It was reported that geodetic markers showed the lowest and highest elevations at 567.0360 m (M52) and 567.7002 m (M61), respectively, offering insight into the dam's vertical stability. Subsidence in the dam's base and body is ongoing, with a maximum of 12 mm at picket 5+33 and a minimum of 1.2 mm at picket 2+50, highlighting potential areas for maintenance.

The findings indicate that the dam experienced vertical displacement ranging from 0.06 to 0.6 cm. This displacement, while not leading to water overflow, plays a crucial role in managing the suffocation process within the dam structure.

Wind impact on Kurgontepa water reservoir influences wave creation, water mixing, and evaporation rates, with wind speed variability critical for reservoir management. Analysis of wind patterns at Fergana and Kokand weather stations shows distinct wind directions and frequencies, emphasizing the importance of considering calm and active wind periods for local climate understanding. Wind speed calculations indicate that higher rates of 34% were observed at 1 and 2%, while the lower rate of 20% was observed at 20%.

It was found that to avoid water overflowing from the upper part of the reservoir dam, it is recommended to maintain the reservoir water level below 562.4 m and raise it to 565.55 m after floodwater release. It is imperative to restrict any increase in the reservoir level beyond these thresholds until the dam is repaired.

Comparative analysis under 'main' and 'separately' conditions reveal differences in wind availability, recorded speeds, reservoir depths, and wave characteristics, essential for reservoir operation and dam safety strategies.

References

[1]. Gapparov F., Khaydarov A., Kogutenko L., Gafforova M. (2023) Change of hydrochemical and hydrobiological regimes of water reservoir //E3S Web of Conferences, (CONMECHYDRO - 2023), 401, 03074, https://doi.org/10.1051/e3sconf/202340101006

[2]. Khaydarov, A., Apakxujayeva, T., & Atakulov, D. (2023). Influence of geographical location on reservoir vegetation formation. In E3S Web of Conferences (Vol. 401, p. 01013). EDP Sciences

[3]. Gapparov, F. A., Gafforova, M. F., & Eshquvatov, Q. S. H. (2022). Operating regime of water reservoirs for safe transportation of floods. AIP Conference Proceedings, 2432, 030017. https://doi.org/10.1063/5.0090192

[4]. Gapparov, F., Khaidarov, A., Yakhshiev, S., Gafforova, M., & Atakulov, D. (2023). Reservoir

overgrowth and its relationship with morphometry: Research problem and prospects for Uzbekistan. Journal of Advanced Zoology, 44(S-3), 955–967. Retrieved from http://jazindia.com/index.php/jaz/article/view/828/

[5]. Rakhmonov, S., Khaidarov, A., Samarkhanov, K., Seidakmatova, M., Komilov, U., & Maderbek kyzy, A. (2023). Classification of seasonal dynamics of soil moisture according to satellite data Sentinel-2, Jizzakh region, Uzbekistan. E3S Web of Conferences, 386, 01005. https://doi.org/10.1051/e3sconf/202338601005

[6]. Gapparov, F., Khaidarov, A., Yakhshiev, S., Gafforova, M., & Atakulov, D. (2023). Reservoir Overgrowth and its Relationship with Morphometry: Research Problem and Prospects for Uzbekistan. Journal of Advanced Zoology, 44, 955-967.

[7]. Mercado-Bettín, D., Clayer, F., Shikhani, M., Moore, T. N., Frías, M. D., Jackson-Blake, L., ... & Marcé, R. (2021). Forecasting water temperature in lakes and reservoirs using seasonal climate prediction. Water Research, 201, 117286.

[8]. Li, L., Xu, H., Chen, X., & Simonovic, S. P. (2010). Streamflow forecast and reservoir operation performance assessment under climate change. Water resources management, 24, 83-104.

[9]. Wurbs, R. A. (2005). Modeling river/reservoir system management, water allocation, and supply reliability. Journal of Hydrology, 300(1-4), 100-113.

[10]. Steinschneider, S., & Brown, C. (2012). Dynamic reservoir management with real-option risk hedging as a robust adaptation to nonstationary climate. Water Resources Research, 48(5).

[11]. Gerlitz, L., Vorogushyn, S., & Gafurov, A. (2020). Climate informed seasonal forecast of water availability in Central Asia: State-of-the-art and decision making context. Water Security, 10, 100061.

[12]. Rakhmatullaev, S. (2010). Improvement of operational methods for the assessment of the water reservoir useful storage capacity using geoinformation systems. Case study of the Akdarya Reservoir, Samarqand Province, Uzbekistan (Doctoral dissertation, Université Sciences et Technologies-Bordeaux I).

[13]. Chen, X., Liu, T., Duulatov, E., Gafurov, A., Omorova, E., & Gafurov, A. (2022). Hydrological Forecasting under Climate Variability Using Modeling and Earth Observations in the Naryn River Basin, Kyrgyzstan. Water, 14(17), 2733.