Journal of Advanced Zoology

ISSN: 0253-7214

*Volume **44** Issue **S-3 Year 2023** Page **955:967***

Reservoir Overgrowth and its Relationship with Morphometry: Research Problem and Prospects for Uzbekistan

Furkat Gapparov[1], Aziz Khaidarov[1], Shohzod Yakhshiev[1], Mushtariybonu Gafforova[1], Dinislam Atakulov[1]

[1]Tashkent Institute of Irrigation and Agricultural Mechanisation Engineers" National Research University

Article History

Received: 06 June 2023
Revised: 05 Sept 2023
Accepted: 12 Oct 2023

Abstract

The article deals with the relationship between morphometry and hydrobiological regime. The Shurtan reservoir located in the southern part of the Republic of Uzbekistan is chosen as the Object of the study. Studying the problem of reservoir overgrowth and its connection with morphometry, especially in reservoirs with depth up to 2 metres, and the influence of sunlight penetration, requires application of various research methods. The water level mark in the reservoir during the period of field studies was ∇ 420.325 m, the reservoir water volume was 7.5 million m3 and the water surface area was 7.10 km2. On the basis of application of modern technologies of geoinformation system for assessment of hydrological and hydrobiological processes on the reservoir, an electronic map of the Shurtan reservoir basin was made. The results of the study using GIS technologies showed that the coastal zones of the reservoir bowl are covered with algae (reeds), their area is growing every year. If its area in 2007 was-0.386km2, in 2014 it reached an area of 0.677km2. In 2018, work was done to clear the coastal zones of vegetation, but by 2023 everything is covered with plants again.

Keywords: *Reservoirs, Morphometry, GIS Technologies, Overgrowth, Uzbekistan*

1. Introduction

Reservoirs play an important role in many countries, providing water supply, energy production and flood control. However, they are also subject to various environmental threats, including overgrowth, which can have serious impacts on the ecosystem and the viability of the reservoir (Gapparov & Abdullaev, 2008). In this paper, we consider the problem of reservoir overgrowth and its relationship to morphometry using the example of Uzbekistan, where it is becoming particularly relevant.

Reservoirs in Uzbekistan, such as the Chardara, Talimarjan, Shurtan and other reservoirs, play an important role in maintaining rural and urban water supply, water supply to factories, and in agriculture. However, in recent decades, reservoirs in this country have faced the problem of siltation and overgrowth, which threatens their functionality and long-term sustainability (Ruziev et al., 2023).

One of the key causes of reservoir overgrowth in Uzbekistan is sediment carried by rivers, especially during floods. Increased river clogging leads to an increase in the amount of sediment deposited at the bottom of the reservoir. This sediment contains densely growing plants such as bulrush, which can spread rapidly in wet conditions. As a consequence, reservoirs become clogged, their volume decreases and water quality deteriorates. The area covered by plants can vary depending on the morphometry of the terrain.

The relationship between the overgrowth of reservoirs and their morphometry, i.e. geometric and hydrological characteristics such as area, shape, depth and volume, is becoming evident. Morphometry affects the hydrodynamics of the reservoir and the conditions for vegetation growth

[Arifjanov et al., 2023]. Reservoirs with shallow and flat morphometry, such as those with a large surface area and shallow depth, are more susceptible to overgrowth because they provide optimal conditions for plant growth. Reservoirs that are too deep may have less of a problem with overgrowth, but are less efficient in terms of water storage and management.

The depth of the reservoir also plays a major role. Reservoirs with shallow depths, especially those less than 2 metres deep, are more prone to overgrowth. Shallow reservoirs provide optimal conditions for vegetation growth as they often have a large surface area and high water temperature. This favours the reproduction of plants, including bulrush. Reservoirs with large areas and unusual shapes can also suffer from overgrowth. An unbalanced reservoir shape may favour sediment accumulation in some areas, especially in narrow bays or inlets, resulting in localised overgrowth.

To cope with the problem of reservoir overgrowth and its relationship with morphometry, various measures and strategies are being introduced in Uzbekistan. One such measure is regular cleaning and removal of vegetation from the bottom of the reservoirs to maintain its depth and volume at optimum levels. In addition, studies are being carried out to optimise the morphometry of the reservoirs to minimise overgrowth and maximise their efficiency.

In recent years (2004-2016), comprehensive studies have been conducted in the Karadag area, which were aimed at studying the ecological state of the coastal zone. Previously, this zone was considered "clean" and least affected by human activities (Kovrigina N.P. et al., 2017). Kovrigina notes that chemical and hydrodynamic conditions of water influence the species composition, abundance and biomass of phyto- and meroplankton (Kovrigina et al., 2007). Kostenko in his research notes the presence of different ecological groups of microalgae in the study area. It was observed that at the beginning of the 21st century there was a more intensive development of planktonic algae compared to the 20th century, as well as a change in the dominant species (Kostenko, 2015; Senicheva, Pospelova, 2015).

According to Kostenko and co-authors, a study of the population structure of the dominant species of Cystoseira algae in the coastal zone of the Black Sea in 1981-1982 and 1984-1985 showed that populations of Cystoseira crinita were characterised by a fluctuating type of biomass dynamics and size composition. The population of Cystoseira barbata is evenly distributed among the individuals of C. crinita, and interspecific competition between these two species has been observed (Kostenko, 1990c, 1995).

Studies of flora and developing vegetation cover in the Gorki and Kuibyshev reservoirs were carried out by hydro-botanists of the I.D. Papanin Institute of Inland Waters Biology. These studies, carried out in the initial years of the reservoirs' creation, provide the most detailed data. Among the scientists engaged in this topic were Exertsev, Exertseva, Lisitsina, Golubeva, Papchenkov and others. The results of the research were published in various scientific works, such as those by Exertsev (Exertsev, 1973), Lisitsina (1972a, 1990), Exertsev and Lisitsina (1974), and Golubeva (1976, 1978).

Researchers have studied the flora and vegetation, as well as the nature of overgrowth and its factors in the shallow waters of various reservoirs, including the Uglich, Kamsk, Ivankovsk, Volgograd, Rybinsk and Uvodsk reservoirs (Ovesnov and Aristova, 1962; Ekzertsev and Sokolova, 1963; Lyashchenko, 1997; Papchenkov and Markevich, 2002, 2003).

On small and large reservoirs of the Middle Volga region, such as the Cheboksarskoye, Kuibyshev and Nizhnekamskoye reservoirs, V. G. Papchenkov carried out a set of works (1999, 2001a) aimed at revealing floristic and syntaxonomic diversity, as well as patterns of reservoir overgrowth. In 2000, O. G. Baranova and A. N. Puzyrev conducted an additional study of the Izhevsk Reservoir, which resulted in the discovery of new and rare plant species of the reservoir (Baranova and Puzyrev, 2001). They also presented a species list of 157 native vascular plant species present in the reservoir.

O. A. Kapitonova and D. G. Melnikov conducted hydrobotanical studies on the Votkinskoye Reservoir. Their work was devoted to the study of the flora of the Berezovsky Bay of the Votkinsk Reservoir, and they compiled a list of the higher plants of this bay. The list contains 136 species of aquatic and coastal-water plants (Kapitonova and Melnikov, 2003). In the process of floristic studies at various reservoirs in different years, several new species were discovered that had not previously been found in the flora of Udmurtia (Dyukina, 2005).

From the literature analysis it became known that overgrowth of reservoirs in Uzbekistan is mainly connected with sediment accumulation and growth of aquatic plants such as reeds. These processes complicate the hydrotechnical use of reservoirs and worsen water quality. The main cause of siltation is the accumulation of sediment carried by rivers and streams into reservoirs during floods and inundations. With increasing pollution of rivers and changes in their operation regime, this problem is observed to intensify.

Object of study

The Shurtan reservoir (Fig.1), located in the southern part of the Republic of Uzbekistan, was chosen as the object of the study. The Shurtan reservoir was constructed in 1998-2000

The reservoir is an in-fill reservoir and has a full volume of 11.5 million m^3, usable - 11 million m^3 with water intake from the Karshi main canal, located in the territory of Guzar district of Kashkadarya province in the mouth part of Davrazakam sai 3 km north-east of the production zone of Shurtan gas-chemical complex [Rules of operation of the Shurtan reservoir, 2008].

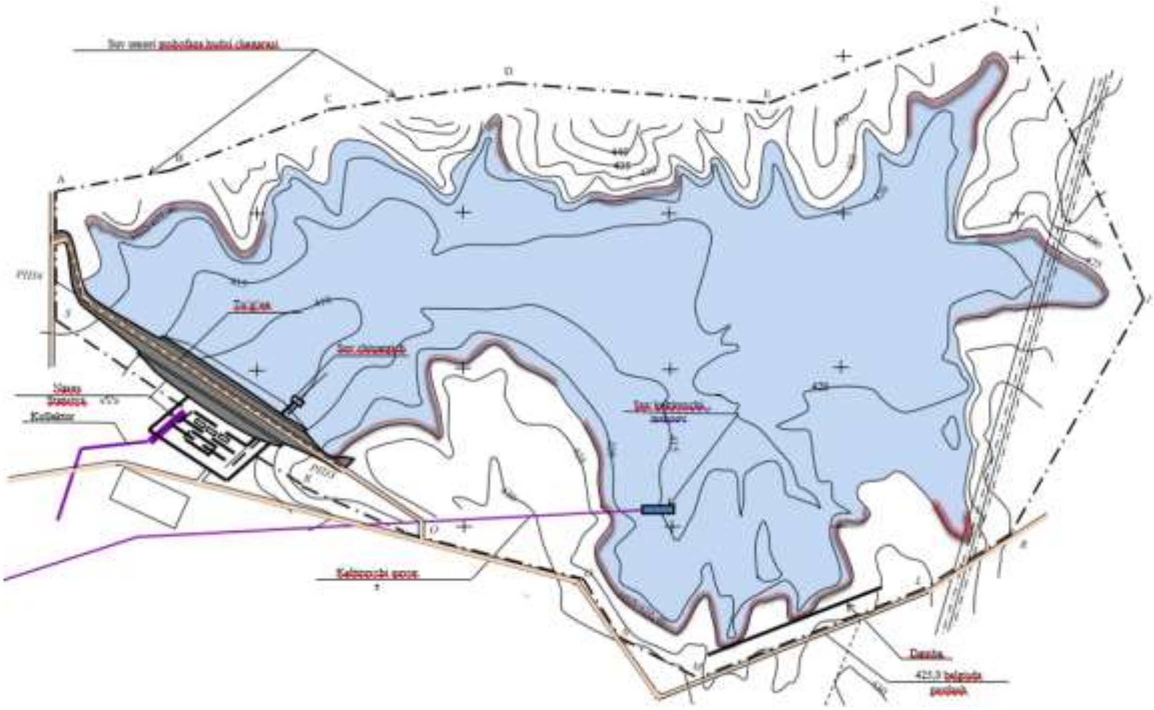

Figure 1: Schematic plan of the Shurtan reservoir.

2. Methods

The study of reservoir overgrowth and its relationship to morphometry, especially in reservoirs with depths of up to 2 metres and the influence of sunlight penetration, requires the application of a variety of research methods. Field studies play a key role in this process, allowing data collection and analyses of aquatic ecosystem parameters [Garragov et al., 2023].

To determine the relationship between morphometry and overgrowth, detailed measurements of the size and shape of the reservoir are required [Khaydarov et al., 2023]. This includes measuring depth, reservoir surface area, shoreline length, basin volume and shape. These data can be collected using bathymetric measurements, GPS technology and geodetic instruments (Fig.2.).

Figure 2: Data collection process using bathymetric measurements, GPS technology and geodetic instruments

The following field investigations were carried out to determine the change in the usable volume of the reservoir (Fig.3.). Initially, the elevation of the normal reservoir backwater level (located at elevation ∇ 422.4 m) was recorded by referents on the dam, and iBase GNSS equipment receiving the data was placed on the reservoir dam at a point at elevation ∇ 422.4 m above the normal backwater level. The reservoir shoreline value at an absolute elevation of ∇ 422.4 m was determined every 30 m along the shore.

Figure 3: Determination of normal reservoir backwater level marks

Determination of water surface area and water volume changes within the range from the normal background level ∇ 422.4 m to the minimum level mark ∇ 399 m was carried out by determining absolute height points on each metre of the reservoir and through 2 rover devices transmitting information to the 73 GNSS database, which receives data by determining absolute height points on each metre of the reservoir using iBase GNSS hardware and transmitting via satellite.

The water level mark in the reservoir during the period of field studies was ∇ 420.325 m, the reservoir water volume was 7.5 million m3 and the water surface area was 7.10 km2. Field studies using modern measuring instruments have determined the change in the usable volume of the Shurtan reservoir under the influence of sediment, and the morphometric indicators of the reservoir have been clarified.

Today there are more than 300 satellites in space, and each satellite has its own mission. That is, the area of use of different satellites is different. In this research work data of Sentinel 2 satellite were used. Initially the data for the last 3 years was downloaded from https://scihub.copernicus.eu/dhus/#/home. The downloaded data were analysed using ArcMap application of ArcGis software (Figure 4).

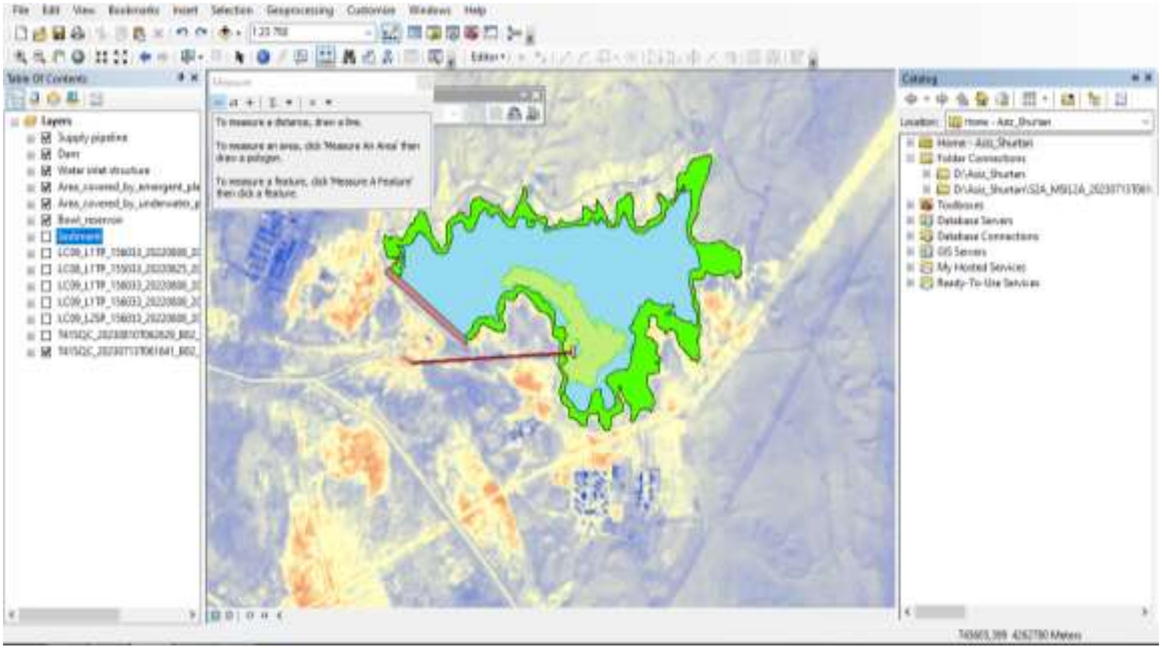

Figure 4: ArcMap programme working window

The NDWI (Normalised Difference Water Index) model of ArcMap software was used. With the help of this model the water area is separated from the reservoir shore using the following formula:

NDWI = (B03 - B08) / (B03 + B08)

here:

-B03 - B03 (green). Use: It gives excellent contrast between clear and turbid (muddy) water, and penetrates clear water fairly well. It helps in highlighting oil on water surfaces, and vegetation. It reflects green light stronger than any other visible color. Man-made features are still visible.

-B08 (NIR). Use: The near infrared band is good for mapping shorelines and biomass content, as well as at detecting and analyzing vegetation. (https://custom-scripts.sentinel-hub.com/custom-scripts/sentinel-2/bands/)

Sentinel-2 is an Earth observation mission from the Copernicus Programme that systematically acquires optical imagery at high spatial resolution (10 m to 60 m) over land and coastal waters. The mission is currently a constellation with two satellites, Sentinel-2A and Sentinel-2B.

The mission supports a broad range of services and applications such as agricultural monitoring, emergencies management, land cover classification or water quality.

Sentinel-2 has been developed and is being operated by the European Space Agency, and the satellites were manufactured by a consortium led by Airbus Defence and Space in Friedrichshafen. (https://en.wikipedia.org/wiki/Sentinel-2)

On the basis of application of modern technologies of geoinformation system for assessment of hydrological and hydrobiological processes on the reservoir, an electronic map of the Shurtan reservoir basin was made (Fig.5).

3. Results and Discussion

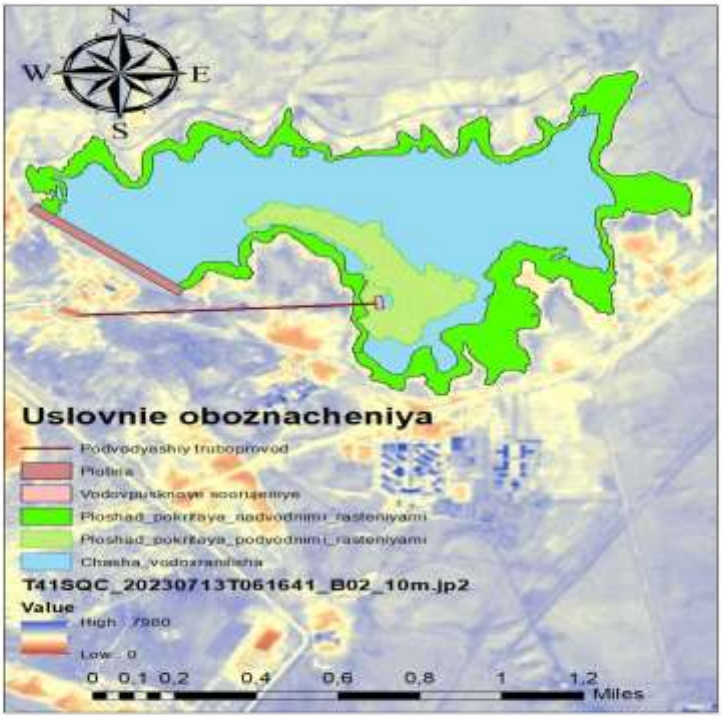

Figure 5: Electronic map of the Shurtan reservoir basin

Reservoir parameters were determined to determine the area covered by vegetation

To assess overgrowth and its impact on the ecosystem, phytoplankton and aquatic plant surveys are conducted. Collection of water and vegetation samples allows to determine the species diversity, density and distribution of plants in the reservoir [Xoshimov et al., 2023]

The shores and bottom of the reservoir are overgrown with reeds, bulrush and underwater vegetation. The width of the overgrown and emergent vegetation zone ranges from 10-15 to 100 m at elevations 418.5-422.4 metres. The zone of underwater vegetation (algae) runs parallel to the overgrowth of the previous zone from marks 418.5 and below. The greatest overgrowth of the reservoir is observed in the southern and south-eastern parts of the reservoir, where a large number of shallow waters are concentrated. The northern part of the reservoir is less overgrown (Fig.6.)

Figure 6: Overgrowing of the reservoir banks

The northern part of the reservoir is drained by 3 intermittent sai-streams. During the field inspection of the reservoir on 14.06.2023, after the past rains, there was a trace of discharge into the reservoir of a large amount of pollutants in the form of manure, plants, leaves and other debris.

A prerequisite for the analysis of hydrochemical and hydrobiological regimes of the current state and their further forecasting is the calculation of basic hydrological and morphometric characteristics of the reservoir, which are presented in Table 1.

Main parameters of the reservoir

Table 1: Morphometric parameters**.**

Volume, million m^3			Length, km (NRL)	Width (NRL), max / average, km	Depth, max / average, m, (NRL)	Reservoir area, km		Water surface with depth up to 2 m in the NRL,km2	Bank length (DVL), km	Отметки уровня воды, м.	
Full	Useful	Dead				In NRL	in the DVL			Normal retaining level, (NRL)	Dead volume level, (DVL)
11,5	11,0	0,5	2,0	1,310 / 0,764	14,4 / 5,3	2,17	0,18	0,42	11	422,4	413,0

To determine the area covered by plants in a part of the reservoir, the dependence of water surface area and water volume on water level (depth) should be determined (Fig.7).

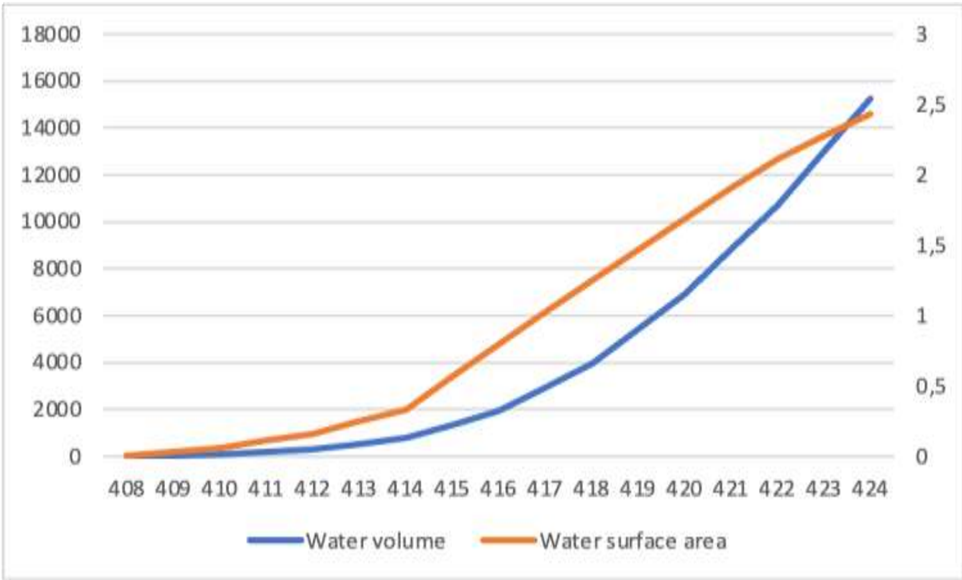

Figure 7: Graph of the dependence of water surface area and water volume on water level (depth).

As a result of the analysis of the collected data of the conducted field studies on the basis of the methods of mathematical statistics, the following expression expressing the dependence of the area of the NRL of the water surface depending on the depth in the reservoir from the depth of the NRL to the depth change was obtained (Fig.8.).

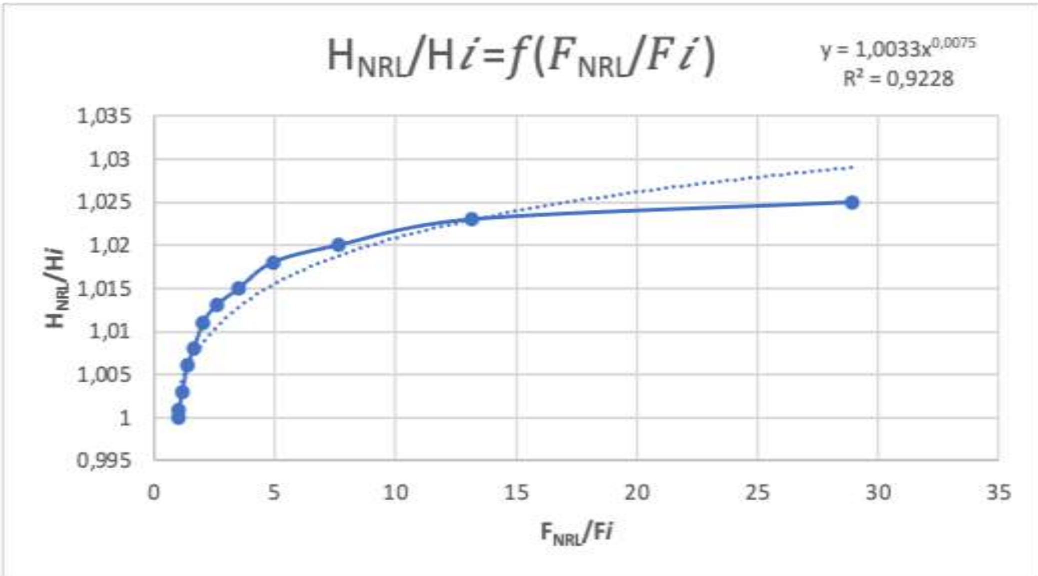

Figure 8: Graph of the dependence of the area of the water surface NRL as a function of depth in the reservoir from the depth of the NRL to the depth change.

The graph shows that the veracity coefficient was 0.9229, which shows the validity of the research conducted. Combining these research methods allows for a more complete and accurate understanding of reservoir overgrowth problems and their relationship to morphometry, which in turn can contribute to the development of effective management and conservation strategies for these important water resources.

As a result of the study it was revealed that at the present time siltation of the reservoir bowl is observed, which affects the increase of vegetation area and decrease of water exchange coefficient. The volume of siltation calculated by turbidity of the flow filling the bowl is 7.5 thousand m3/year or for the whole period of operation (23 years)-172.5 thousand m3.

The results of the study using GIS technologies showed that the coastal zones of the reservoir bowl are covered with algae (reeds), their area is growing every year. If its area in 2007 was-0.386km2, in 2014 it reached an area of 0.677km2. In 2018, work was done to clear the coastal zones of vegetation, but by 2023 everything is covered with plants again (Fig.9.).

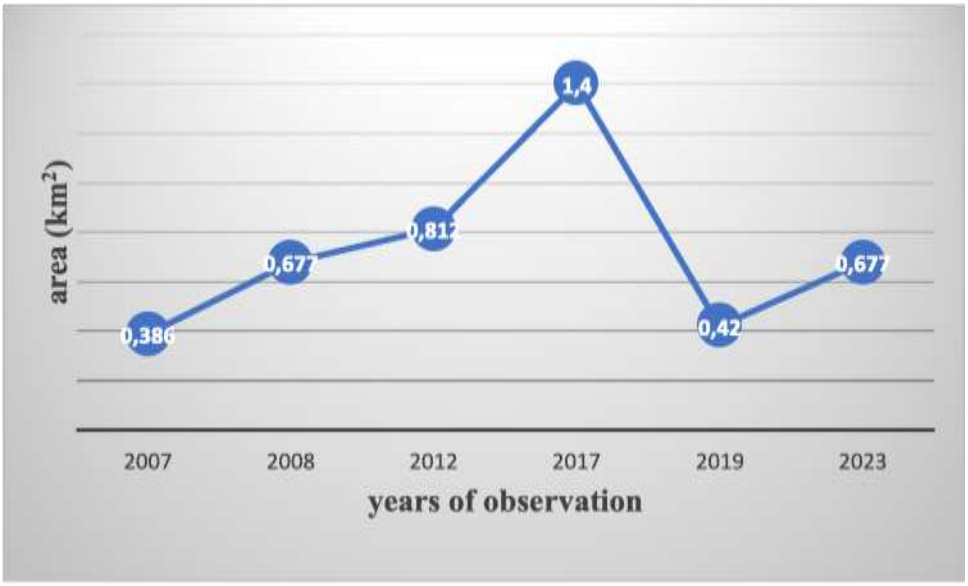

Figure 9: Graph of changes in the area covered by vegetation by years of observation

The analyses show that the area covered by vegetation is increasing every year. In addition, results were obtained for the following indicators:

Water Transparency

Taking into account relative depth of the Shurtan reservoir (hotn.) and relatively large share of shallow waters, water transparency in it is much lower than in the Talimarjan reservoir. In the deep part of the reservoir, transparency reaches 3-4 m, and in the shallow part - 0.5 -1.0 m, sharply decreasing during periods of summer wind mixing, especially in the zone of feed water inflow, which depresses phytoplankton development and restrains water blooming processes. In case of emergency reservoir drawdown, turbidity and nutrient load will not increase in the upstream part of the reservoir, as the influence of the littoral southern zone with increased turbidity decreases in proportion to the water level drop.

Water temperature

Taking into account the shape of the Shurtan reservoir, the temporary formation of a more or less pronounced thermobar during the summer period under easterly wind directions and especially during windless periods summer period under easterly wind directions and, especially, during windless periods of more or less pronounced thermobar, water exchange between the deep northern and shallow southern zones is restrained, which reduces water blooming in the near-dam part as a result of biogens flowing into the deep part. Table 2 summarises the Main Climate Elements. In calculations the layer of atmospheric precipitation is taken as the average of the values,established by long-term observations of meteorological stations in Karshi and Kerki.

Table 2: Main climate elements. In calculations the layer of atmospheric precipitation is taken as average of the values, established by long-term observations of meteorological stations of Karshi and Kerki.

Station	I	И	III	IV	V	VI	VII	VII	IX	X	XI	XII	Год
							1. Air temperature ^{0}C						
Karshi	1,1	5,5	9,8	16,1	22,7	27,5	30,1	28,0	21,8	14,6	3,2	3,8	15,8
Guzar	2,	. 5,1	9,	16,	22,	27,	29,	28,	23,	15	9,	5,	16,

	3		8'	1	5	4	9	3	0	,9	4.	0	2
Mubarak	-0,1	3,0	9,0	16,2	23,5	28,6	31,6	29,5	22,7	14,5	7,2	2,1	"15,6
Laykak	3,5	5,8	8.8	17,7	24,7	28,8	32,5	29,5	23,5	15,7	7,2	3,8	16,8
Kerki	2,7	5,8	11,0	18,7	24,1	28,2	30,0	28,2	21,9	15,5	9,5	4,9	16,5
2. Absolute air humidity, mb													
Karshi	5,7	6,3	7,8	10,8	12,1	11,1	11,9	11,3	9,0	7,2	6,0	5,9	8,8
Guzar	5,2	5.8	7,4	10,3	11,5	9,6	9,8	8,9	6,9	6,3	5,8	5,6	• 7,8
Mubarak	• 5,3	5,7	7,2	9,8	10,6	9,2	9,7	8,7	7,2	6,3	5,5	5,6	7,6
Laykak	5,8	6,5"	7,4	10,7	п,о	9,4	9,8	8,4	6,6	6.5	6,1	6,1	7,9
Kerki	5Д	6,3	8,0	10,7	12,8	13,6	14,6	13,5	10,6	8,4	6,4	5.8 -	9,7
3. Average wind speed													
Karshi	23,	3,2	3,2	3,1	3,5 .	3.5	4,4	3,6	2,7	2,5	2,6	2,6	3,1
Guzar	2,7	3,4	3,0	2,7	2,7	2,8	2,8	2,4	2,3	2,1	2,1	2,2	2,6
Mubarak	5,3	5,7	7,2..	9,8	10,6	9,2	9,7	8,7	7,2	6,3	5,5	5,6	7,6
Laykak	3,9	4,2	4,2	3,4	3,8	4,4	4.8	4,1	3,4	3,5	3,4	3,1	3,8
Kerki	3,5	3,9	3,6	3,2	2,8	2,6	2,9	2,4	1,9	1,9	2,2	2,7	2,8
Layers of precipitation, in mm													
	38	34	48	36	14	1	0	0	0	6	20	28	225

Dissolved oxygen

Taking into account the significant importance of the wind factor in the area of the Shurtan reservoir location and its water exchange, in the first years of its operation no oxygen-free zones were formed in the reservoir, which contributed to the preservation of a favourable hydrochemical regime. In the first years of its operation, oxygen-free zones were not formed in the reservoir, which contributed to the preservation of a favourable hydrochemical regime.

Mineralisation, content of major ions.

In accordance with classification of reservoirs according to changes in hydrochemical regime, water mineralisation and content of main ions in comparison with the same indicators in the river, which is carried out according to two features - water exchange by flow and elongation indicator, the Shurtan reservoir belongs to the reservoirs of II class (elongation less than 20, water exchange to flow 0.93 years). Under these conditions, especially when the width of the upper part of the reservoir increases sharply compared to the river (canal), in addition to the runoff current, counterclockwise currents caused by the Earth rotation may occur, which promotes mixing of river (canal) and reservoir waters. The highest salinity is observed before the intake of water from the river (canal). Since the water intake from the reservoir is long-term, due to wind mixing of water in the reservoir along its depth, length and width, its water is basically homogeneous in terms of mineralisation and content of major ions. Stratification of water by its mineralisation was observed in the first months after filling of the reservoir, and then, if it remained, then in a weakly expressed form, with a slight difference in the values of the surface and bottom horizons, but it does not exceed the sanitary norms for water of drinking water reservoirs.

Biogenic elements and nutrient load on the reservoir.

The content of biogenic elements in reservoirs determines the potential of activity of biological processes and the character of hydrobiological regime. The most important of them are nitrogen and phosphorus, of which the latter is the limiting factor. Water in reservoirs is eutrophied by phosphorus content. During eutrophication, physico-chemical properties of water deteriorate due to intensive development of planktonic algae, fouling algae (periphyton) and higher aquatic vegetation (macrophytes), which, when dying off, cause secondary pollution, formation of toxins, and the organisms themselves create biocontamination of water supply. The results of the study indicate that surface flood and rainwater runoff may be the main supplier of nutrients, especially if the catchment area is occupied by agricultural land or farmland or industrial and urbanised landscapes. Given the small specific spillway of the Shurtan reservoir (Cd.Cd.-5.99) and its undeveloped nature, as well as the low rainfall (225 mm), the importance of surface runoff and atmospheric inputs of nutrients in the overall reservoir balance is not very significant (<50). One of the simplest ways to assess whether a reservoir has reached eutrophic status is to check whether the actual concentrations of nutrients exceed the maximum permissible values. Special calculations to determine the concentration of total phosphorus determined its annual average concentration, which was 0.0012 mg/l, which was an order of magnitude below the range accepted as a condition guaranteeing the ecological reliability of the reservoir.

Toxic heavy metals

When assessing the water quality of reservoirs, a complicating factor is the in-water processes that can lead to either removal of heavy metals from the water column or their input from bottom sediments. Heavy metals in the Shurtan Reservoir come with runoff from the catchment area, groundwater, dry and wet atmospheric precipitation (influence of industrial enterprises in the region). precipitation (influence of industrial enterprises in the region). Heavy toxic metals practically do not come with the water feeding the reservoir. Among autochthonous sources of heavy metals, it should be noted that some metals are released during decomposition of hydrobionts, mainly phytoplankton. Accumulation of metals in bottom sediments due to sorption capacity is also characteristic of reservoirs, but the reverse direction of the processes is not excluded.

Based on the available factual data, it can be concluded that, in general, the hydrochemical and hydrobiological parameters of water quality over the past years of its operation, in general, do not exceed the MPCs required for open water bodies intended for drinking water supply; At the same time, irreversible increasing eutrophication of the water body by unregulated factors of its development will inevitably lead to the growth of biogenic load, i.e. to the change of water quality of the water body with exceeding the project limits in the nearest period; Under these conditions, the hydrochemical and hydrobiological situation of the water body should be regulated by managing the eutrophication processes, appropriate operation regime and increasing its flow rate.

4. Conclusion

Overgrowing of reservoirs is a serious problem for Uzbekistan and other regions with similar climatic conditions. This problem is directly related to reservoir morphometry and requires comprehensive measures and scientific research. Maintaining optimal reservoir parameters and regulating water resources can help prevent overgrowth and preserve important ecosystems. This is an important effort to ensure the sustainability of agriculture, water supply and biodiversity conservation in the region. Based on the results of the study, it was determined that the shoreline areas of the reservoir are occupied by algae (bulrush) and the area is increasing every year. For example, while in 2007 this area was 0.386 square kilometres, by 2014 it had increased to 0.677 square kilometres. In 2018, work was carried out to clear the coastal areas of vegetation, but by 2023 they were covered with plants again. The results of the study using GIS technology showed that submerged plants cover an area of 0.24 square kilometres and overwater plants cover an area of 0.63 square kilometres. Reservoirs, as important elements of hydrological infrastructure, play an integral role in water resources, water supply and agriculture. However, in recent decades they have faced a serious environmental problem due to their overgrowth. This problem is becoming increasingly important, especially in reservoirs with limited depths of less than 2 metres, where sunlight penetration plays a key role in the ecosystem. In this paper, we review the problems of reservoir overgrowth and their relationship with morphometry, focusing on the importance of depth and the impact of sunlight on these important aquatic resources. Based on all actual and calculated characteristics, it can be concluded for the Shurtan reservoir that the negative impact of eutrophication processes on water quality in the first years of its operation was minimal. However, the general tendency of trophic increase in reservoirs is related to unregulated factors of geographical environment and therefore natural eutrophication of the reservoir is irreversible due to its accumulating effect.

References

Act of operation of Shurtan reservoir, (2007), Shurt

Arifjanov, A., Jurayev, S., Qosimov, T., Xoshimov, S., Abdulkhaev, Z. (2023) Investigation of the interaction of hydraulic parameters of the channel in the filtration process. E3S Web of Conferences, (CONMECHYDRO - 2023), 401, 03074 https://doi.org/10.1051/e3sconf/202340103074

Baranova O.G., Puzyrev A.N. New and rare plants of the Izhevsk pond // Proc. of 5th Russian Un. Acad. scientific-practical conf. 2001. p.109-110 [in Russian].

Data of base. Date of reference: 10.09.2023. https://en.wikipedia.org/wiki/Sentinel-2

Dyukina G.R. (2005). To the study of distribution of Typha x Smirnovii E. Mavrodijev and T. glauca Godrom in the Udmurt Republic // Actual Problems of Biology and Ecology: Proc. of XII Youth Scientific Conference of the Institute of Biology, Komi Scientific Centre, Ural RAS. Syktyvkar. p. 77-78. [in Russian].

Eksertsev V. A., Sokolova M. A. (1963) Communities of riverine horsetail on the Ivankovskoye Reservoir // Proc. of the Institute of Biological Water Resources. Institute of Biol. vodohr.. Vol. 5(8). p. 21-36[in Russian].

Ekzertsev V. A., Lisitsina L. I. (1974). Conspectus of the flora of the Gorki Reservoir // Proc. of the Institute of Internal Waters. USSR ACADEMY OF SCIENCES. № 28 (31). p. 100-116 [in Russian].

Ekzertsev V.A. (1973) About the vegetation of the Kuibyshev reservoir // Biol. of inland waters. Inform. bulletin. № 19. p.18-21[in Russian].

Gapparov F.A., Abdullaev J. (2008). The role of youth in the development of scientific research in water management and land reclamation". Gapparov F.A., Abdullaev J. Organization of safe use of Todakol reservoir.//, Proceedings of the republican scientific and practical conference dedicated to the year of youth. - Tashkent. 2008 .-76-78 p. *GISCA 2022 and GI 2022* https://doi.org/10.1051/e3sconf/202338601005

Golubeva I. D. (1976) Some regularities of vegetation formation in shallow waters of the Kuibyshev Reservoir // Biol. of Inner Waters. Inform. bulletin. L.: Nauka. №32. p.15-17 [in Russian].

Golubeva I.D. (1978) Results of the study of higher aquatic vegetation in shallow waters of the Kuibyshev Reservoir // Stages and rates of formation of coastal biogeocenoses. M.: Nauka. p.17-29 [in Russian].

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

Gapparov F., Mansurov S. (2023). Investigations on determination of changes in inactive volume of water reservoirs (case study of South Surkhan water reservoir) //E3S Web of Conferences. – EDP Sciences. – T. 401. – C. 01011.

Kapitonova O. A., Melnokov D.G. (2003). Flora of the Berezovsky bay of the Votkinskiy pond (Udmurt Republic) // Vest. of Udm. Udm. Udm. Ser. Biol. p.21 – 33 [in Russian].

Khaydarov A., Apakxujayeva T., and Atakulov D., (2023). Influence of geographical location on reservoir vegetation formation //E3S Web of Conferences, (CONMECHYDRO - 2023), 401, 03074 https://doi.org/10.1051/e3sconf/202340101013

Kostenko N.S. (1995). Ecological state of the water area of the Karadag reserve //Zapovidna prava in Ukraine. - VOL. 1. - P. 72 - 79[in Russian].

Kostenko N.S. (2015). Hydrobiological studies on Karadag (review) // 100 years of Karadag scientific station named after T.I.Vyazemsky. T.I.Vyazemsky: collection of scientific papers. - Simferopol: N. Orianda. - p. 401-456 [in Russian].

Kostenko N.S. (1990). Seasonal and long-term dynamics of phytobenthos of the eastern part of the Crimean coast of the Black Sea. Abstract of dissertation... Candidate of Biological Sciences. in Sevastopol. - 24 p. [in Russian].

Lisitsina L. I. (1990). Flora of the Volga reservoirs // Proc. of the Institute of Water Resources of the USSR Academy of Sciences. IBVV OF THE USSR ACADEMY OF SCIENCES. L.: Nauka. Vyp. 59 (62). p. 3-49[in Russian].

Lisitsina L.I. About the flora of the Gorki Reservoir // Biol. of inland waters. Inform. bulletin. 1972a. № 14. p. 25-28 [in Russian].

Lyashchenko G. F. (1997). Vegetation of the Rybinsk Reservoir // Bot. zhurn. T. 82, № 11. p.57-65 [in Russian].

Ovesnov A. M., Aristova G. A. Vegetation of shallow waters of the Sylvensky Bay of the Kamskoye reservoir in the third and fourth year of filling // Bulletin of the Institute of Biological Water Resources. Inst. of Biol. vodohr. 1962. №12. C. 15-17 [in Russian].

Papchenkov V. G. (1999) Regularities of overgrowing of watercourses and reservoirs of the Middle Volga region // Autoref. dis....dok. biol. nauk. St. Petersburg. 48 p. [in Russian].

Papchenkov V. G., Markevich G. I. (2002). Ecology of the Uvodskoye Reservoir. Higher aquatic vegetation and its distribution // Ecology, biodiversity and systematics of aquatic invertebrates. Ч. 3. Borok,. p. 98-108 [in Russian].

Papchenkov V. G., Markevich G. I. (2003). Flora and vegetation of the Uvodskoye Reservoir // Biol. of Inner Waters. №4. p. 18-25[in Russian].

Papchenkov V.G. (2001a).Vegetation cover of water bodies and watercourses of the Middle Volga region. Yaroslavl: CMP MUBiNT,. 200 p. [in Russian].

Rakhmonov S., Khaidarov *A.*, Samarkhanov *K.*, Seidakmatova *M.*, Komilov *U.* and 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 (2023)

Rules of operation of the Shurtan reservoir. Uzgip Ltd. Tashkent, 2007

Ruziev, I., Samiev, L., Mustafoyeva, D., Nortaev, S., & Yakhshiev, S. (2023). Geographic Information System for changing the level of soil salinity in Jizzakh province, Uzbekistan. In E3S Web of Conferences (Vol. 371). EDP Sciences. https://doi.org/10.1051/e3sconf/202337101013

Senicheva M.I., Pospelova N.V. (2015). Seasonal and long-term changes in phytoplankton in the coastal waters of the Karadag Nature Reserve // 100 years of the Karadag Research Station named after T.I. Vyazemsky. T.I. Vyazemsky: collection of scientific papers. - Simferopol: N. Orianda. - p. 467-477[in Russian].

Sentinelhub. Date of reference: 10.09.2023. https://custom-scripts.sentinel-hub.com/custom-scripts/sentinel-2/bands/

Xoshimov, S., Atakulov, D., Yalgashev, O., Komilov, S., & Boykulov, J. (2023). Evaluation of sedimentation of water reservoirs with modern technologies. Paper presented at the E3S Web of Conferences, , 365 doi:10.1051/e3sconf/202336503033