MANAGEMENT AND SPATIAL PLANNING IN THE COASTAL ZONE OF THE CHEBOKSARY RESERVOIR

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Cheboksary reservoir impact to the coast is manifested in the geophysical impact associated with abrasion activities. Geomorphological area of influence at the moment reaches a width of about 40 m, where are the coasts reformation (erosion, collapse, slumping, sliding, transfer or accumulation of sediments, waterlogged processes). Hydrogeological impact is effect on the level of groundwater.

We have proposed the conceptual foundations of functional zoning of the reservoir banks that will help to optimize its operation. Selection zones came in accordance with the principles of landscape planning:

1. The zone of strict water protection: the main purpose – preservation of needing special protection areas.

2. The zone of moderate restrictions: preservation extensively used landscapes.

3. The zone of partial restrictions: improving the pre-emptive particularly vulnerable areas and changing intensity or type of use.

4. The zone of conservation of natural components in agricultural landscapes: ensuring health of the natural environment in the habitats used in agricultural economy.

5. The zone of preservation of vacant space and the natural environment in the settlements: to maintain the required quantity and quality of available green space in the large towns.

6. The zone of improving heavily used areas: elimination of harmful stress and environmental sanitation in the countryside where economic activities and the lack of measures to reduce their risks lead to degradation natural system.

Key words: reservoir, coastal zone, nature factors, technogenic impact, geomorphological and exogeodynamic factor, hydrological zones, principles of landscape planning.

I. INTRODUCTION

Lowland hydroelectric reservoir created as a complex, multi-functional building. Along with a positive result, they had a number of negative consequences. Many forecasts on the functioning of aquatic and coastal geosystems of reservoirs were not justified (for example, forecasts for the damping abrasion on the banks of the Volga reservoirs over time proved to be wrong). Therefore, a further, deep, detailed, comprehensive monitoring of reservoirs as GTS is need. For today there are developed methods of exploded monitoring for reservoirs, but still the most important task is developing the methodological principles of complete integrated monitoring such geosystems.

Many researchers address to the problem of reservoirs, especially in the second half of the twentieth century. Writings on this subject can be found in the scientific literature of Russia, USA, China and some European countries (Poland, Ukraine, and others). A great contribution to the study of this field of science has Russian scientists: Avakian, Matarzin, Ikonnikov, Shirokov, Edelstein, Ershova, Berkowitzch, Rulyova, Nazarov, et al. In this scientific field has significant methodological, methodical, conceptual experience.

Cheboksary reservoir was formed by the hydroelectric dam of the same name on the river Volga. Within Chuvashia Volga has a length of 127 km. Like the whole valley, this plot suffered a complete overhaul with the establishment in 1981 of the last stage of the Volga Hydroelectric Power Plant Cascade - Cheboksary hydroelectric plant. Growth of urbanization, development of services sphere nominates the ever-increasing demands on environmental parameters of aquatic and coastal geosystems for Cheboksary Reservoir and its watershed basin.

Since 1981 Cheboksary reservoir is exploited on unplanned water-level mark - 63 m instead of 68 m on the project. As a result, the ships is not provided with the necessary depth for river transport, hydro-systems of power station do not operate at full capacity, there is formed an extensive area of shallow water that does not correspond to sanitary norms, also anxiety affects to the base of bank protection structures and destroys them. At the same time, the rise of the water level of the reservoir would flood vast areas of the Nizhny Novgorod region, Mari and Chuvash republics. Proposed various options to further the reservoir: rise of the mark-level to 65 m or a mark 68 m, descent Cheboksary reservoir, construction of the low pressure dam at Nizhny Novgorod and others. Each of versions requires a thorough examination, as the reservoir further use on the modern mark does not satisfy the essential requirements for sustainable development of natural and technogenic landscapes. In any case, will the restructuring of aquatic and coastal geosystems of reservoir, due to which needs careful monitoring for them.It is necessary to find the optimal path of sustainable development for the Cheboksary reservoir. Solution of this problem is "stagnant". There are some results of surveys and studies from various institutions about the design and impact assessment Cheboksary reservoir on the environment at the finite water-level 68 m or intermediate 65 m. However, for over 30 years reservoir exploited by unplanned mark (63 m), and Cheboksary hydro-power plant (HPP) is an unfinished construction project.

II. Materials and methods of research

Department of Physical Geography and Geomorphology of the Chuvash State University studied it since 1992. There are obtained results of monitoring banks, geoecological study of water masses and coastal geosystems, defined zones, types and extent of its recreational use [1].

Cheboksary reservoir is complex, and performs a number of functions: energy, transport, water supply and recreation. In connection with the operation at 63 m instead of 68 m on the project, the implementation of these functions is not comprehensive enough. In the case of project-level rise is expected to increase the efficiency of the first three functions, but on the other hand, many valuable recreational, foresters and other coastal areas will be flooded and the implementation of this function would be problematic. Therefore, a comprehensive analysis and assessment of the

natural resource potential of the reservoir at different levels of retaining exploitation, analysis of the current status and forecast it on different levels is necessary.

III. Results of the research

Impact Cheboksary reservoir to the adjacent territory is manifested in the geophysical impact associated with abrasion activities. Geomorphological area of influence at the moment reaches a width of about 40 m, where are the reformation coasts (erosion, collapse, slumping, transfer or accumulation of sediments). Hydrogeological impact is effect on the level of groundwater. As a result of the filling of the reservoir occurred rising groundwater and formed waterlogged coasts. Changing the groundwater contribute to the process of sliding. Changed the hydrological regime and formed the new boundaries of hydrological zones (shallow water, the average depth and deep zones). Sediment also had undergone changes, increased eutrophication in the shallow waters [1].

There is defined maximum coastal retreat over the years of operation - 39 m on the right bank and 36 m on the left. Almost 40% of the length the coastline exposed to abrasion on the Cheboksary Reservoir. Within Chuvashia has been allocated 7 coast types, differing in their modern formation. (There are abrasion-crumbling, abrasion-landslide, abrasion-accumulative, accumulative, erosion, underflooding, protected types). Abrasion-crumbling coast presented on the left sand bank of Cheboksary reservoir, folded Quaternary alluvial sediments of the Volga. Maximum underwashing of sandy ledge registered near the village Octabrskoye - 36 m.

Abrasion-landslide banks have spread on the right bank, folded by sediments of Upper Permian. The greatest danger is abrasion-landslide coast, threatening various economic objects [4, 5, and 6].

Abrasive-accumulative coast confined to the numerous islands on the left bank of the shallow waters of the reservoir. Typical accumulative processes occur mainly on the left bank of the shallow water, blocked numerous sand island, in flooded estuaries of small rivers, ravines and gullies.

Erosion type is presented in the lower befe and high right bank of the reservoir, where numerous ravines out by estuarine part to coast line of the Volga.

By flooding of the reservoir there is a rise of ground water level and formed underflooding coasts and as a consequence of waterlogging territory. This type of underflooding is presented on the left bank of the Cheboksary reservoir. Area of the zone of underflooding in Chuvashia was 12 km^2. In subzone of strong underflooding began waterlogging and formed strong gley soil there. Raising groundwater leads to waterlogging and rapid destruction of woody vegetation. At the moment the length of the zone forest dieback reaches 3 km or more. Width of the zone underflooding from the water's edge along the left bank up to 4 km, and the valley of the river Parat underflooding observed at a distance of 10 km.

The last type of the bank – is protected. When filling the reservoir it was necessary to engineer protection of individual sections of the coast, especially in the city of Cheboksary and others.

Influence of natural and anthropogenic factors on the hydrochemical and hydrodynamic processes in Cheboksary Reservoir directly affect its ecological status. Characteristic features of the

hydrological regime affecting the hydrochemical features are: a large length of the area of wedging out backwater reservoir level from Nizhny Novgorod to village Proseky and large areas of shallow water. At the same time, this reservoir has the highest rate of water exchange - 20, as compared to other reservoirs of the Volga-Kama cascade. It is characterized by the predominance of lateral inflow (64%) in the water balance compared with the inflow through the Gorky HPP. There is tending to have higher flow velocity in the surface water layer of channel part (0.3 m / s at low water, and 0.6 m / s during high).

Cheboksary reservoir is the main source of drinking water for the Cheboksary agglomeration. Therefore is particular relevance of the study of factors that influence on the quality of water in the reservoir. We have carried out geoecological analysis the zone affecting the quality of water of the river Volga within Cheboksary agglomeration. Natural factors determining the geo-ecological condition of the coastal land and water areas are precipitation, coastal erosion, heavily wooded areas. And anthropogenic factors are residential, agricultural and recreational load. We have considered the amount and mode of precipitation, which are the main source of supply of the Cheboksary reservoir and its catchment area within Cheboksary agglomeration, as is precipitation carry with them pollutants from the atmosphere and surface runoff. We analyzed the course the average annual precipitation in 30 years according gidrometostations in Cheboksary and Canash cities. Then we studied the main watershed, in which are concentrated substances of organic and inorganic origin, and there is an influence on the quality of water in the area adjacent to reservoir. Thus, we have a network of catchments adjacent to the water protection area and have a direct impact on the waters of the Cheboksary reservoir (catchment areas are highlighted on the general geographic map of the Chuvash Republic of scale 1: 200 000).

Within the zone of influence of the reservoir anthropogenic sources of pollution are represented by the following main types. Resorts, boarding houses, motels, camps are the main sources of pollution of recreational type. There are the following recreational areas. The first is located in the west of the Cheboksary agglomeration and represented by the institutions of organized recreation. All of them are confined to the right bank of the waters and the Cheboksary reservoir. The second area is the northern part of the agglomeration which is located on the left bank of the river Volga. Institutions of organized recreation and non-organized places as well tend to be the Volga and the water area. There is total amount of about 20 recreation centers, 10 children camps and 1 resort of regional significance in coastal area.

The second type of pollution is agricultural sources. These are farms and poultry factories. There are located 69 farms and 5 poultry factories in the catchment area of the selected zone. Their provisions of storages for manure and droppings is low, these agricultural objects fairly close situate for the water protection zone. Manure are siphoned as fertilizer on fields, these wastes are hazardous, especially during the spring flood and rainfall runoff. Most concentrated and, therefore, more dangerous is when people used improperly bird droppings. Pollution wastewater reaching rivers, make a real threat to water quality in the reservoir, and the health of the local population.

The following - is residential sources of pollution. There are large industrial cities, such as Cheboksary, Novocheboksarsk on the Cheboksary agglomeration territory and which are located on the right Cheboksary reservoir bank. There are concentrated the company of energy, engineering, chemical, building, textile and food industries. But due to the lack of publicly available

information, indicators of industrial pollution were assessed only qualitatively, but not quantitatively. Also a list of those settlements was included in the analysis, which are located in close proximity to the water's edge (that is, within the water protection zone). In smallholdings not complied with the rules of storage and waste disposal. Storage of household waste is carried out in the gullies and ravines. These factors have a negative impact on the ecological condition of the reservoir and adjacent areas. Next was calculated complex human pressure on Volga section within Cheboksary agglomeration for each of the catchment areas of the following indicators: number of recreational facilities, rural settlements, cattle-farms (solid and liquid waste, t/year). Also we calculated the degree of forested catchments, which indicates the presence of an environment territory balancing anthropogenic load. The analysis showed that there is dominated catchment as the average and above average anthropogenic load, which allows us to conclude about tense geo-ecological conditions in the area, affecting the water quality of the river Volga within Cheboksary agglomeration.

Analysis of the dynamics of hydrochemical characteristics of the Chuvash site at Cheboksary reservoir for 1998-2016 years [3, 7] shows that the concentrations of the main chemical elements does not exceed the maximum permissible concentration (MPC) for ponds household and drinking purposes. In some years there were a few cases a slight excess of copper, vanadium, and others. Basically excess of MPC are observed in the chemical oxygen demand (COD) and iron. Moreover, these exceedances are observed in all sampling points and are 1-2 MPC. The main contribution to water pollution makes transboundary transport and lateral inflow (Government reports on the state of the environment in the Chuvash Republic, 1998-2015). But not yet analyzed the dependence of the dynamics of hydrochemical characteristics of the hydrodynamic zones of the reservoir.

By S.L.Vendrov in reservoirs stand hydrodynamic zones within the main bed and the area adjacent to it. Within the main reservoir beds allocated deep zone, medium depth and shallow water. Deepwater area in Cheboksary Reservoir is dedicated to the flooded river bed of the Volga and close to the right bank. Maximum depth is 21 m (within Chuvashia). Excitement is growing freely, does not interact with the bottom, except for the coastal strip. In this zone is the transit of water masses and significant exchange of water. Its width varies from 350 m to 1.2 km. Often, its boundary is the steep slope of the Volga. Hydrochemical pollution is minimal.

The second is zone of average depths. At normal water level here freely evolving excitement, while reducing the level - wave actively cooperates with the bottom. This area is adjacent to the deep water from both coasts, but the largest area is the part of the left bank. Its width may be different. On the left bank of the reservoir, it can reach 1.75 km. On the right - 1.95 km. Underwater topography is complicated by its shallows. When going to the dam of their number decreases. Ability of hydrochemical pollution both primary and secondary is increases.

Shallow water zone is presented mainly on the left bank of the pond. There are dozens of islands, with the abrasion abundant amounts debris receives in the water masses. In addition, small depth is lead to rapid heating and abundant reproduction of blue-green algae. In turn they require large amounts of oxygen, which leads to fish killing. These processes increase the silting of the bottom. In some areas, capacity of silt reached 1 m. Among sediments large place occupied tanotsenozyes. This area is fraught with shoals and flooded trees and shrubs areas. Hydrochemical pollution is maximal, especially as a result of secondary processes of resuspension.

At Cheboksary reservoir formed following types of shallow water [1]:

- wedging out backwater zone of the reservoir, like the form of densely branched network of submerged ducts and intermane depressions, they are developed in flooded plain terraces;
- shallow coastal waters - areas with continuous development of shallow water and relatively rare islands of land or aquatories of deep water, this type is the most common, is distributed almost throughout the reservoir;
- separated by shallow water - between the shallow area and the coast of the reservoir, there are areas with deep water;
- islands shallows presented limited shallow areas on large deepwater fields.

The first type occurs just above the dam on the left bank. The second and third types are observed in the flooded part of the first terrace in the lake-like part of the reservoir and at the dam. The fourth type - shallow water is occurring in the fairway the Volga. When designing Cheboksary reservoir the section from the dam to the western borders of Chuvashia was named as grassroots area and characterized as a water area, devoid of shallow water. Today, as we can see, this site was completely in the other conditions.

With the current water level in the reservoir area of shallow waters with depths of up to 4 m reaches 38% and with a depth of up to 2 m - 33%, although the sanitary norms allowed 20%. In the shallows is a favorable situation for eutrophication. If at first eutrophication looks like a positive process because rapidly increased the productivity of aquatic organisms (fish, at the expense of low-value species), then comes the final stages of degradation of the reservoir, as the oxidation of dead organic matter spent all dissolved oxygen.

There is no the useful (regulating) capacity on the Cheboksary Reservoir. Due to unplanned exploitation level lack of capacity does not move from weekly to daily regulation, and even more so - for the seasonal. For Hydropower and water-transport factories it is the most important argument towards lifting water-level. It is impossible pre-flooding reservoir drawdown in the spring. If raising the level to 68 m, the area of shallow water will be reduced to 19%.

No less important problems have arisen in the area of medium depth and deep zone. Although coastal protection and geotechnical activities were fully implemented, but coast processing continues. The main process of reshaping the right coasts of Cheboksary reservoir is wave abrasion. At other sites mainly processes reshaping coasts are eroded shallows and cliffs by surf stream, slope processes (landslides), erosion occurring on the slopes, shedding, longshore currents. Preparation of the reservoir bed (clearing of trees and shrubs) before flooding was not implemented in full, resulting it in adverse events waterlogging and rotting flooded forests and shrubs in areas of medium depths and shallows.

Economic use of hydrodynamic zones of Cheboksary reservoir is seen in the following plan. Deep-zone - there is the route of the fairway. The main purpose is transportation, as well as the use of hydro-mass for Energy and Water Supply. In the zone of average depths basic use is fishery (the fishing water area) and recreational. Shallow water used for fish productivity economy (spawning grounds), bunds, drainage and subsequent recommendation for agricultural use.

We have proposed the conceptual foundations of functional zoning of the reservoir as a geotechnical system that will help to optimize its operation. Include zones:

1. The belt strict water protection zones: the main purpose of the zone – the preservation of needing special protection areas.

2. The belt moderate restrictions: purpose - preservation extensively used landscapes.

3. The belt partial restrictions: goal - to improve the pre-emptive particularly vulnerable areas and changing intensity or type of use.

4. The belt conservation of natural components in agricultural landscapes: goal - ensuring health of the natural environment in the habitats used in agricultural economy.

5. The belt preservation of vacant space and the natural environment in the settlements: the goal - to maintain the required quantity and quality of available green space in the large towns.

6. The belt improving heavily used areas: purpose - the elimination of harmful stress and environmental sanitation in the countryside where economic activities and the lack of measures to reduce their risks lead to degradation natural system.

Selection zones came in accordance with the principles of landscape planning and help us to design water protective zone [2].

IV. Conclusion

The obtained test results allow to assess the suitability of the coastal territory for varied purposes, allow correct economic activities in different natural-territorial and natural aquatic complexes, which will help to correct functional zoning spent on landscaping basis and make appropriate recommendations for the environmental measures.

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