KAPITEL 9 / *CHAPTER 9* [11]
EUTROPHICATION OF SMALL RESERVOIRS IN SOUTHERN UKRAINE AND POSSIBLE METHODS OF ITS CONTROL

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Introduction.

There are a large number of natural and artificial water bodies within Ukraine. Throughout the territory of Ukraine, the objects of the water fund are located extremely unevenly. Territorial disparities in the placement of water bodies at one time became the main reason for the creation of artificial water fund objects. However, in the conditions of constant economic use and a high level of urbanization of the territory of Ukraine, degradation and negative ecological processes are becoming noticeable on water bodies of Ukraine of both natural and artificial origin [1-2].

It should be noted that modern adverse natural processes that occasionally occur within artificial water bodies in different regions of Ukraine have adverse not only ecological, but also economic and social consequences. Given such a diverse adverse impact on various aspects of the population's life, this topic is quite relevant for conducting scientific research.

At the current stage of socio-economic development, in the conditions of rapid development of scientific and technical progress and prolonged military actions on the territory of Ukraine, the problem of rational nature management is gaining relevance. In this context, the problem of deterioration of the ecological state of water bodies of Ukraine is of particular importance. Constant pollution of water ecosystems leads to deterioration of their ecological condition and degradation, which gradually makes them unsuitable for fishing, domestic and recreational use [6].

Discussion, current state of the problem

Previous scientific developments allow us to judge that there are close connections between the anthropogenic impact on aquatic ecosystems and the number of plankton formations in them [8, 12]. Certain regularities of how anthropogenic human activity affects the change in the ecological state of natural water bodies due to

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the reproduction of plankton formations, which can have both positive and negative effects on water bodies, have been revealed. In view of this, the development of plankton formations in natural reservoirs makes it possible to judge the change in their ecological state [16]. At the same time, to this day, there are practically no thorough experimental studies on the effects of anthropogenic activity on the ecogrouping of artificial water bodies, in particular on reservoirs of Ukraine.

In general, the process of eutrophication of small reservoirs is influenced by two groups of factors: biotic and abiotic [15]. The biotic group of factors includes the following: anthropogenic, phytogenic and zoogenic. The abiotic group of factors includes: temperature indicators, amount of light, acidity, transparency, water regime and amount of biogenic elements [4 - 5]. However, a lot of scientific work and conducted research indicate that the modern processes of flowering of small reservoirs are connected to a greater extent precisely with anthropogenic activity and the irrational use of these artificial reservoirs.

The main results of the study

According to statistical data, as of 2022, the total number of reservoirs of various sizes within Ukraine amounted to 1,072 reservoirs [table 1]. Such an extremely high level of development of artificial objects of this type is connected with the fact that the territory of Ukraine belongs to the water-scarce states. At the same time, such a rather extensive system of reservoirs with various purposes has caused a number of environmental problems that, to one degree or another, significantly change the primary natural regime of rivers [10].

From a geospatial point of view, reservoirs are extremely unevenly distributed across the territory of Ukraine. The largest number of reservoirs of various sizes is located in the south of Ukraine. In our opinion, the concentration of a significant number of this type of reservoirs in the south is mainly related to the arid climate and the intensive development of the agricultural complex.

In terms of socio-economic regions, the total number of reservoirs looks like this [10]:

- Central region – 230 reservoirs (21.5% of the number throughout the country);

- Western region – 133 reservoirs (12.4% of the number throughout the country);

- North-Eastern region 169 reservoirs (15.8% of the number throughout the country);

- Eastern region – 203 reservoirs (18.9% of the number throughout the country);

- Central-Eastern - 213 reservoirs (19.9% of the number throughout the country).

As for the small reservoirs of the Southern socio-economic region of Ukraine, there are fewer of them, but the area they occupy is much larger than in other regions of Ukraine. Thus, as of 2022, there are 124 reservoirs on the territory of Mykolaiv, Kherson, and Odesa regions, which is about 11.6% of the total number of water bodies of this type on the territory of Ukraine. Small reservoirs in the south of Ukraine cover an area of 80,032 hectares.

In the section of the southern socio-economic district, the territorial distribution of small reservoirs is as follows:

1. There are 45 small reservoirs operating on the territory of the Mykolaiv region, the total volume of which is 374.7 million m3, of which 7 reservoirs have a total volume of more than 10 million m^3.

2. There are 64 small reservoirs within the Odesa region, the total volume of which is 2106.7 million m^3, of which 9 reservoirs have a volume of more than 10 million m^3;

3. There are 15 small reservoirs in the Kherson region with a total volume of 138.3 million m^3, of which 2 reservoirs have a volume of more than 10 million m^3.

Reservoirs in the south of Ukraine perform a number of functions, the main ones include: irrigation of agricultural lands; fish breeding; water supply.

However, most of the small reservoirs in the south of Ukraine suffer from eutrophication processes. "Water bloom" means an adverse natural phenomenon in reservoirs, which is accompanied by a rapid or long-term change in the color of the reservoir of natural or artificial origin, the cause of which is the significant reproduction of planktonic formations, filamentous algae, and phytomicrobenthos.

It was found that under the conditions of rational economic use of small reservoirs, the reproduction of phytoplankton has a positive effect on reservoirs of this type. Phytoplankton formations form the basis of the positive influence from the point

of view of feed resources - it is possible to conduct fishing activities in small reservoirs at the expense of the natural feed base without significant financial costs, which is quite profitable and promising from an economic point of view.

Table 1 - The number of reservoirs by administrative and territorial regions within the socio-economic regions of Ukraine [10]

The name of the socio-economic district	Administrative-territorial unit	The number of reservoirs in the administrative-territorial unit	Number of reservoirs in the region	Area of reservoirs in the region, ha
Central	Kyiv region	62	230	35771
	Zhytomyr region	54		
	Chernihiv region	24		
	Cherkasy region	38		
	Vinnytsia region	52		
Western	Lviv region	20	133	27757
	Ivano-Frankivsk region	3		
	Zakarpattia region	9		
	Chernivtsi region	3		
	Ternopil region	26		
	Khmelnitsky region	51		
	Rivne region	12		
	Volyn region	9		
North-Eastern	Kharkiv region	57	169	44177
	Sumy region	43		
	Poltava region	69		
Eastern	Donetsk region	130	203	25589
	Luhansk region	73		
Central-Eastern	Dnipropetrovsk region	101	213	32075
	Zaporizhzhia region	28		
	Kirovohrad region	84		
Southern	Odesa region	64	124	80032
	Mykolaiv region	45		
	Kherson region	15		

However, at this stage of socio-economic development and in the conditions of intensive military actions in the south of Ukraine, small reservoirs are not used to their

full extent from the point of view of fishery exploitation, and some of them are not used at all.

Those small reservoirs, in which fish farming is still carried out, do not provide for the rational use of their natural bioproduction potential [12 - 13].

The ichthyofauna of small reservoirs in the south of Ukraine is mostly represented by a poor species composition, represented mainly by low-value fish species from the catchment areas of the Ingulets, Dnipro, Danube, Southern Bug and Dniester river basins. In connection with such features of the formation of ichthyofauna, the species composition of small reservoirs of southern Ukraine is mainly represented by the following main directions [7]:

– about 20-23 species of fish of small reservoirs of the south represent fish of freshwater complexes of the Danube, Dnipro, Ingulets and Southern Bug;

– 3 – 5 species of fish enter the small reservoirs of the south due to bays and estuaries of the Black Sea-Azov basin, which are represented by brackish-water species of fish;

– in small reservoirs, where their fishery development took place, sometimes valuable species of fish are artificially introduced, which usually consists of 5 – 8 species.

Thus, we can see that the ichthyofauna of small reservoirs of the southern socio-economic region of Ukraine includes about 29 – 35 species of low-value fish species.

In view of such a rather poor species composition of the ichthyofauna, we can judge that the use of the bioproductive potential of small reservoirs does not take place to its full extent, which leads to a significant development of plankton formations and organics of autochthonous origin, which are one of the main reasons for the eutrophication of the water ecosystems of this type of artificial water bodies. In addition to eutrophication, a large amount of autochthonous organic matter and a significant number of plankton formations are the cause of the degradation of water ecosystems of small reservoirs and their gradual pollution.

The course of natural processes in small reservoirs does not always correspond to the interests of man and the economic complex, since these reservoirs were

purposefully artificially created, and their "environmental" characteristics differ significantly from other natural reservoirs.

The southern region of Ukraine is located in the steppe zone, where, compared to other regions of our country, the growing season is much longer and the climate is warmer. Thus, the duration of the growing season in the south of Ukraine ranges from 211 to 220 days, and the number of days when the temperature is above 15^0C is 136 – 150 days [table 2].

From Table 2, we can see that it is in the steppe zone that the highest level of natural fish productivity of small reservoirs is found. Thus, 240 kg/ha of carp and 70 kg/ha of herbivorous fish can be grown in these artificial reservoirs due to natural fodder resources in the steppe zone. Indicators of natural fish productivity in the Steppe zone are the highest in comparison with the Forest steppe and Polissia.

It should be noted that during the last ten years there has been a noticeable change in the climate towards positive temperatures not only in the south, but also in the entire territory of Ukraine and within the limits of the entire planet. This climate change causes a gradual increase in the growing season. In view of this, we can judge that the climatic indicators of the south of Ukraine are the most favorable in comparison with other regions of the country for the development of plankton formations.

Table 2 - Climatic (long-term average) and fishery (normative) indicators of the main zones of Ukraine [14]

Zone	Duration of the growing season, days	Duration of days with a temperature above 15^0C, days	Number of degree days	Atmospheric precipitation, mm	Natural fish productivity, kg/ha, at the expense of	
					carp	herbivorous fish
Polissia	190 – 200	100 – 120	2360-2520	700 – 800	190	500
Forest steppe	201 – 210	121 – 135	2470-2990	500 – 700	230	600
Steppe	211 - 220	136 – 150	2820-3600	300 - 500	240	700

It should be noted that the high level of eutrophication of reservoirs in southern

Ukraine is not only related to their high production potential. Among the reasons that lead to the intensification of the "blooming" of water in artificial water bodies in the south of Ukraine can be attributed also the following: high level of agricultural development in the southern regions; rapid processes of development of the coastal zone, which are increasing every year; discharge of polluted waters into artificial water bodies.

Note that anthropogenic activity increases the processes of water bloom in small reservoirs in the south of Ukraine. In connection with economic activity, small reservoirs are constantly receiving biogenic elements that accumulate over a long period of time and contribute to increasing the natural bioproductivity of reservoirs. And the consequence of the unused potential of the natural level of bioproductivity is the activation of eutrophication processes of artificial water bodies of this type [3].

Due to the fact that reservoirs in the south of Ukraine are promising objects for fish farming and suffer from eutrophication for a long period of time, it is urgent to develop measures that would curb negative processes in reservoirs of this type. Such measures should be based not only on the ecological component, but also on the economic one, which would provide for obtaining a high level of fish production due to the rational use of these reservoirs.

As part of the integration of Ukraine into the EU, when developing measures to reduce the eutrophication of small reservoirs in the south of Ukraine, we should pay attention to the European Green Course, and based on this, the experience of European countries in the fight against water bloom.

Nowadays, Austria is a vivid example of an effective fight against the eutrophication of water bodies. It is in Austria at the legislative and regulatory level that a whole series of measures and more than 30 recommendations have been developed for the ecological control of bloom processes and the fight against them in natural and artificial water bodies. Thus, a vivid example for Ukraine can be the method of artificial destratification, which is very actively used by the Austrian government and involves the reduction of flowering due to the so-called "precipitation" of phosphorus. A method of biomanipulation is in the process of active development. It

is based on the removal of fish species that feed on zooplankton from water bodies by introducing predatory fish. This method will allow to increase the amount of zooplankton in reservoirs, which in turn will consume blue-green algae, due to which manifestations of eutrophication will decrease [9].

Reducing the flow of phosphates into natural and artificial water bodies will allow not only to reduce blooming processes, but also to improve the general ecological condition of water bodies. At the moment, the state policy of banning detergents containing phosphate has already been introduced in Italy, the Netherlands, Germany and Austria. In addition, all other EU countries are taking active state measures to ban all household products that contain phosphate.

In connection with the climatic features of southern Ukraine, we have proposed the following methods of reducing the eutrophication of small reservoirs:

1) method of ichthyomelioration, which is the most effective and economically beneficial for this type of artificial water bodies. Due to the fact that the ichthyofauna of small reservoirs is based on a spontaneous process of formation, its species composition is rather poor. Due to the introduction of plant-eating fish into reservoirs, it is possible to reduce the process of water bloom due to the consumption of phytoplankton by fish. Cultivation of fish products at the expense of the existing natural fodder base will simultaneously improve the ecological condition of artificial reservoirs, and at the expense of the natural fodder base, obtain a positive economic effect from the obtained fish products in the future;

2) implementation of regulatory documents at the state level and development of measures that would regulate economic activity within small reservoirs at all territorial levels: national, regional and local. Such regulation should be based on the existing experience of combating eutrophication of the EU countries and on the principles of rational nature management;

3) control over the use of fertilizers and reduce their concentration on agricultural lands located near water bodies. Particular attention should be paid to the reduction of nitrogen and phosphorus fertilizers in agriculture, which are the main factors of water "blooming";

4) implementation of innovative methods of wastewater treatment of various origins. Due to the fact that most pollutants enter small reservoirs with insufficiently treated wastewater, the installation of high-quality treatment systems is of particular importance to prevent water eutrophication;

5) compliance with the principles of rational nature management. Balanced land use is of particular importance in the context of preserving the ecological state of water bodies. Given the fact that a significant amount of organic matter enters reservoirs from the soil, the use of "correct" methods of soil cultivation aimed at its preservation will have a positive effect on the ecological state of the waters of small reservoirs.

Conclusions

From a geospatial point of view, the largest concentration of small reservoirs is in the south of Ukraine (Kherson, Mykolaiv, and Odesa regions). Quantitatively, the south has 124 reservoirs of various purposes, which is approximately 11.6% of the total number of reservoirs in Ukraine. The total area of small reservoirs in the south of Ukraine is 80,032 hectares.

Numerous scientific studies and research indicate that small reservoirs in the south of Ukraine suffer from eutrophication. The main reasons for the eutrophication of the waters of small reservoirs in the south of Ukraine are anthropogenic activity and irrational fishing use of these artificial reservoirs. As a result of economic activity, a considerable amount of biogenic elements are constantly entering small reservoirs, which gradually accumulate, and as a result - contribute to the growth of biological production indicators of artificial reservoirs. In turn, in the south of Ukraine, small reservoirs are poorly studied from the point of view of fishery exploitation and their natural production potential. As a result, natural feed resources in small reservoirs are not used to their full extent, which leads to a massive process of water eutrophication.

The problem of eutrophication of reservoirs in the south of Ukraine needs an immediate solution. In this context, the introduction of legal regulation of economic activity on artificial water bodies of this type at all territorial levels is relevant. It is also quite important to develop methods to reduce and prevent eutrophication

processes. In our opinion, the following methods can be effective in combating eutrophication of water bodies: ichthyomelioration; compliance with the principles of rational nature management; implementation of innovative methods of wastewater treatment of various origins; implementation of regulatory documents at the state level and development of measures that would regulate economic activity within small reservoirs at all territorial levels; control over the use of fertilizers and reduce their concentration on agricultural lands located near water bodies.

In this context, further experimental scientific studies of the bioproduction potential of small reservoirs in the south of Ukraine under conditions of changes in climatic indicators will be promising. Further scientific research should be aimed at the study of hydrobiological changes in small reservoirs of southern Ukraine and the development of rational measures to prevent eutrophication of this type of reservoirs, which would be ecologically effective and economically beneficial.