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Forms of Lake Basins in Ukrainian Polissya

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Abstract: Statistical analysis of the complex investigation results of reservoirs in Ukrainian Polissya testify that the most wide spread lakes are the basins of parabolic and half-elliptical forms. In the process of evolution the changes of forms are directed to increasing the capacity factor. Correlating dependence between the form of the lake basin and degree of filling it with bottom sediments is determined. The form of the basin and the peculiarities of its underwater composition define the formation of the limnosystem in the whole, temperature and gas regimes, and accumulation of bottom sediments, etc. In most cases the configuration of basins is one of the most significant factors, determined by the limnoprocesses in reservoirs.

Key words: lake, basin, the form of basin, morphological-morphometrical peculiarities, limnological peculiarities, Ukrainian Polissya.

Introduction

A thorough scientifically based study of lake reservoirs and dynamic processes in them, has great theoretical and practical significance for creating a developed theory of the geosystem of a lake. The essence of this is in the investigation of forms and the kinds of links between the structural parts of a lake geosystem and the processes of exchanges between them. Exact analysis and monitoring of a lake as a geographical object, planning of resource preservation strategy and tactics of natural use, and elaboration of natural protective measures are possible only with a complex and detailed study of the forms of lake basins and their links with limnological peculiarities.

Complicated links between the lake basin and its water mass belong to the most important peculiarities of every reservoir, which determine the development of its natural complex. The structure of the underwater part of the basin is determined by the origin, the degree of sedimentation and together with its size, are the main morphological indices of the lake which determines the direction and intensity of biolimnological processes (temporal and gas stratification, hydrodynamic mixing, speed and processes of new formation of substance). The form of the basin determines intensification of the conglomeration and the character of sediment division, according to the area of the bottom. Thus, morphological-morphometric peculiarities of reservoirs are the necessary typological index.

Materials for investigation

The result of a complex investigation of lakes in Ukrainian Polissya (Ilyin et al., 1998, 2000) and theoretical-methodological gains of certain explorers (Guryanova, 1988, Kurzo et al., 1989, Jakushko, 1981, Vlasov et al., 1992) were used, as the materials for the investigation.

Implementation of the systematic approaches in the investigation of complicated natural objects, (lakes in this case), is based on consecutive use of analysis and synthesis. The constructive method of investigation used, which proved its profit in these stages, is the method of mathematical modeling. The essence of this method is in the results of the investigation, adequate to

a real object of a mathematical model and finally transferred to its ecosystem.

The indices of the depth of the lake (maximal and average), the area of water surface, the volume of water and sediments, and also, derived from them, the indices of capacity, depth, exposed surfaces, length, were used in the calculating. The indices of range correlation between the form of lake basins and the degree of their sedimentation were also calculated. Proceeding from the methodology, cited above, and based on the certain usage of morphometric indices in systematization of lakes, the links with limnological peculiarities and between themselves are determined.

Results and discussion

Depending upon its size, the area of lake (F_o) determines the amount of received solar radiation, and the temperature of water, which, in its turn, is determined by the development of the organic life in a lake. In equal conditions, reservoirs with large area receive larger amounts of solar radiation, increasing warmth reserve in this manner. Besides, the index of area influences the quantity of evaporation (the larger is F_o, the stronger is evaporation). The lakes such as Lubyaz (4.4 km^2), Pulemets (16.4 km^2), Turske (13.4 km^2) are referred to as large ones, in which correlation of the area to the depth is much larger than in other reservoirs.

The volume of water (V) allows for determination of the heat reserve of a lake. As a result, the index of the volume has a great influence on the seasonal and daily rhythm of the development of the limnological processes. An especially large volume, and, correspondingly, high index of heat capacity delay the cooling of water and the onset of freezing. In its turn, this is reflected the development of the life in lakes. Svityaz (190 mln. m^3), Pulemetske (71 mln. m^3), Bile (32 mln. m^3) are referred to the lakes with the largest volume.

The function of the depth of a lake (average, maximal) is very different. First and foremost, the depth influences the temporal stratification on the surface and in different deep layers, in accordance with the seasons of the year. Having an analogy with a volume of water, the average depth is defined by calculating the total heat reserve of a lake. Besides, the index of the depth refers to the number of inner components, which control gas regime and the life of limnobionts. The deepest lakes are Svityaz – 58.4 m, Somynske – 30 m, Perevirske – 21 m, Zabolotske – 18 m.

Quite different links of morphometric indices are derived from the basic characteristics of the lake with the limnic peculiarities, which take place in them. The index of the relative depth refers to those indices. It characterizes the level of the protection of lake water mass, capacity of the layer, oxygen content, hydrochemical indices of the top and natural layers, etc.

The reservoirs with small sizes and significant maximal depth, refer to the lakes with the largest index of depth ($H_{aver.}/F_o$). They are – Somyne (1.24 km^2 and 53.2 m), Radomich (0.94 km^2 and 19 m), Dolske (0.18 km^2 and 17 m). The smallest indices of depth have the lakes which are large in area but with small average depth. They are Lubyaz (4.41 km^2 and 2.1 m), Bile (7.16 km^2 and 2.3 m), Orihove (5.14 km^2 and 1.11 m).

The index of exposed area opposite to the index of depth ($F_o/H_{aver.}$) characterizes the originality of big plain basins accessible to the windy influence on the water mass. Lakes with large openings, exposed area as a rule, don't have a large definite distinction in temperature and content of oxygen. Hydrochemical indices differ very little in these cases. Among investigated reservoirs, the biggest index of exposed area is typical for the lake Turske 12.3. Smaller ones are for lakes Seletske (6.15), Orikhove (4.63).

The form of the underwater part of a lake basin is characterized by the capacity factor which shows the relationship between the average depth and the maximal depth ($H_{aver.}$ / $H_{max.}$). The underwater part of a lake can be observed as a correct geometric figure: conic (K<0.33), parabolic (0.33–0.50), half-elliptical (0.50–0.66), cylindrical (>0.66). According to these indices, the division of the investigated lakes in Ukrainian Polyssya is represented in Tab. 1.

Table 1. The division of lakes in Ukrainian Polissya, according to the form of underwater part of basin

№	Form of underwater part of lake basin	Capacity factor	Lakes	
			amount	%
1.	Cylindrical	>0.66	32	16.4
2.	Half-elliptical	0.50–0.66	72	36.9
3.	Parabolic	0.33–0.50	65	33.3
4.	Conic	<0.33	26	13.3
	Total		195	100.0

A cylindrical form of a basin is typical to karst and suffusion lakes which are not widely spread, their portion is not larger than 16.4% (from the total number of those investigated lakes). Average to maximal depth is not larger than 4 m in these lakes, e.g. Orikhove, Ozertse etc. Karst lakes have half-elliptic form of basins. They are mostly spread (36.9%) shallow (2–5 m) reservoirs (Turske, Blysna etc.). But deep lakes have half-elliptical form too. A parabolic form of a basin is ob-

served mainly among the lakes of complicated karst origin, that part is 33%. The depths in these lakes range between 10–20 m. A conical form of basin is observed very rarely in 13.3% cases. These are karst lakes with the depth from 5 to 20 m (Pulemetske, Dolske etc.) the Svityaz has a conical form of basin. Thus the basins of parabolic and half-elliptic forms are the most widespread on the territory of Ukrainian Polissya.

The investigation of basin forms testifies that in the process of evolution and sedimentation they are changed in the direction of an increase of the capacity factor. Basins of parabolic forms are characterized by the smallest degree of sedimentation – approximately 52.8% when maximal is 99.7i% and minimal is 3%. The lakes with a cylindrical of basin are filled the most approximately 66.1%. When maximal filling is 97.2% minimal one is 33%. Conical and half- elliptical basins are filled to 62.2% and 56.1%. The maximal degree of filling of these basins 98.2 and 94% and minimal is 22.1% and 14.7%. Comparatively high sedimentation of conical basins is determined by shallow reservoirs with the average depth to 1 m and maximal depth 3–4 m. Shallow reservoirs have a larger volume of bottom sediments, when compared with the volume of water.

This isn't typical for deep lakes. Analyzing the range of factors of correlation between the form of lake basins and the degree of filling with sediments shows that the most tight link between those numbers is typical for lakes with half-elliptical and cylindrical forms of basin (Tab. 2). The correlation factors for these groups is 0.37 and 0.38 respectively. The low correlation factors for conical and parabolic forms of a basin (0.25–0.26) testify that in addition to morphological-morphometric indices, other factor influence the process of sedimentation in the lakes.

Table 2. Counting range correlation factor between the form of lake basins and the degree of filling with the sediments

№	Form of underwater part of lake basin	Capacity factor	Correlation factor	Average degree of filling of basins with sediments (%)	Lake. amounts
1.	Conic	< 0.33	– 0.25	62.2	18
2.	Parabolic	0.33–0.50	+ 0.26	52.8	58
3.	Half-elliptical	0.50–0.66	+ 0.37	61.1	71
4.	Cylindrical	> 0.66	+ 0.38	66.1	25
	Total		+ 0.69	59.3	172

Although, in spite of the low numbers for different types of basins, the correlation factor, counted for the lake in whole (near 0.69) proves the statement that the form of a basin is one of the important factors, which determine limnic peculiarities of reservoirs.

Conclusions

This statistic analysis testifies that the form of a basin, and the peculiarities of its underwater composition plays an important role in the formation of the ecosystem in the lake as a whole, as to temperate and gas regimes, and bottom sedimentation.

In most cases, the configuration of the basin is one of the most important components of limnic processes. The morphological-morphometric parameters of the basin determine (in the same climate zone) the differences of one reservoir from the other, according to geomorphologic, hydrological, hydro-chemical and biological links.

The cited links of certain parameters of the basin forms, with limnic processes in the lakes, are not drawn. This indicates that there are wide opportunities for future investigations in this direction.

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Streszczenie

Analiza statystyczna wyników kompleksowych badań zbiorników wodnych Polesia Ukraińskiego pokazuje, że najczęściej występującymi formami mis jeziornych są misy paraboliczne i półeliptyczne. W procesie ewolucji przekształcania form jeziornych zmiany były nakierowane na powiększenie współczynnika pojemności. Określona została korelacyjna zależność między formą misy jeziornej i stopniem jej zapełnienia osadami dennymi. Forma misy jeziornej, a zwłaszcza jej części podwodnej określa formowanie systemu jeziornego w ogólności, rezimów termicznego i gazowego, nagromadzenia osadów dennych itp. W większości przypadków konfiguracja mis jeziornych jest jednym z najbardziej znaczącym czynnikiem, określającymi procesy limniczne, przebiegające w zbiorniku wodnym.