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INTEGRAL EVALUATION OF THE TROPHIC STATUS OF THE DANUBE – BLACK SEA WATER BODIES

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The northwest coast of the Black Sea is characterized by a large number of the liman-estuary water bodies. The Danube Delta, the Lower Danubean Lakes, the River Dniester, and the Dnieper-Bug estuary-liman, as well as twelve other open, semi-closed and closed limans of the northern Black Sea Coast form a system of wetlands, which to a great extend influences the water quality, biodiversity and bioproductivity of the Ukrainian Black Sea shelf.

During the last decades the water bodies of the northern Black Sea coast have undergone significant anthropogenic changes due to active water-management activities in this area. As a result of the Danube-Dnieper Irrigation System construction, the lower Danubean Lakes have been transformed into regulatory water-reservoirs. The marine liman Sasyk has been separated from the sea and transformed into fresh-water reservoir and was used for irrigation of the adjoining areas. Large-scale activities have caused a number of ecological problems in this area that could not, but influence both the water bodies and adjoining land eco-systems, as well as marine coast.

To elaborate water management strategy that would allow to improve the ecological situation of the Danube-Black Sea area, it is necessary to renew the research activities, aimed at carrying out the up-to-date evaluation of the water bodies in the area in question.

Among many criteria that are taken into account while conducting ecological evaluation of the water eco-systems, the trophic status of the water body is the most integral and practical index, since it shows the level of the bioproductional process as well as quality of the aquatic envionmenrt. Moreover, it allows to make practical decisions in water management.

To define the present level of the eutrophication of some Danubean Lakes and to compare the results obtained with those characteristics of sea

limans, an integrated approach has been used. This approach allows to evaluate simultaneously the whole primary production link, including communities of pelagic (phytoplankton) and bottom (submerged macrophytes) vegetation. The morpho-functional approach, that has been also applied, allowed to evaluate the quality of the aquatic environment and trophic status of the water body taking into consideration the photosynthesis surface index.

The evaluation of the main parameters of the aquatic environment quality of the regulated fresh water lakes Sasyk and Yalpug, as well as the sea liman Alibei, have been carried out during the hottest period of the year, which is characterized by the maximal indexes of the production processes (table 1). The concentration of the chlorophyll "a" and phytoplankton biomass, as well as area of the vegetation surface which is being formed in m^3 of water and per m^2 of the bottom proves the fact that the production processes in the saline liman with the natural hydrology can exceed greatly those in fresh water bodies with the artificial water exchange. The results obtained while defining water quality and trophic indexes of the water bodies in question speak for integral evaluation, which considers not only highly dynamic physical and chemical indexes but also integral biological parameters. During evaluation the regulatory document was used, meant for defining water quality of the surface waters in Ukraine (Pomanenko, Zhukinskiy and all 1998) (table 2). Despite the fact that there is the difference observed between the categories of water quality, which has been defined with the help of different indexes (dissolved oxygen and plankton biomass), the relative gradation of the water bodies in question still can be traced. The most favorable situation as for eurotrophication is in Yalpug Lake, the Sasyk Liman comes after it. Alibei Liman can be referred to endangered ecological zones as for level of eurotrophication there.

The concept of the adjoining surfaces (Lebedev, 1986), allowed to reveal the pattern between morphological parameters of the water-body ("activeness of the environment" – S/V, which is the ratio between water body surface and water body volume) and their trophic level. This pattern is common for all Danube – Black Sea freshwater lakes and saline limans. The lower ratio S/V is the better quality of the aquatic environment is, as well as the lower the trophic level turns out to be. The trophic level in this case is defined according to the classification based on macrophytes surface index (Minicheva, 1998 b) (table 3). The better quality of the aquatic environment in Grigoryevsky Liman is explained by the fact that it is an open liman and the water exchange is quite intensive, due to wind tidal effect.

Table 1. Characteristics of the principal indexes of the aquatic environment quality in August 2000 in the Danubean Lakes Yalpug and Sasyk and in Liman Alibei

Aspects		Indexes	Water body		
			Yalpug	Sasyk	Alibei
Physical and chemical		Salinity, ‰	1,79 * / 2,38 **	1,63 / 2,80	32,4 / 35,5
		Temperature, C^0	25,2 / 28,2	28,2 / 30,5	28,7 / 30,0
		Dissolved oxygen, $m^2O_2 . l^{-1}$	8,3 / 12,7	7,5 / 10,9	5,5 / 8,0
Biological	Phytoplankton	Chlorophyll concentration «a», mg. m^{-3}	6,5 / 27,3	9,6 / 63,2	16,5 / 30,2
		Pheophytin content, %	25,5 / 74	34,8 / 96	56 / 83
		Biomass, mg . l^{-1}	4,4 / 14,1	9,6 / 34,1	28,3 / 68,4
		Phytocoenosis surface index (algaesurface in m^3 of water)	4780 / 14198	15465 / 33075	18242 / 27354
	Macrophytes	The average index of the phytocoenosis surface (vegetation surface per bottom m^2)	95	118	203
		Minimal specific surface, $m^2 . kg^{-1}$	4,7	10,8	22,8
		Average specific surface, $m^2 . kg^{-1}$	72,5	76,0	310

* average, ** maximum

The pattern defined allows to make conclusions for practical water management aimed at restoration of the quality of aquatic environment in the water bodies of Danube – Black Sea region:

- The quality of the aquatic environment and trophic level does not depend on saline composition of the water body;
- Coefficient of the "active environment" of the water body (S/V) can be used for defining the expected trophic status
- It is possible to improve the quality of the aquatic environment of the water bodies with a certain S/V coefficient by increasing water exchange.

Table 2. Evaluation of the aquatic environment quality in the lakes Yalpug, Sasyk and liman Alibei in compliance with the regulatory document "Technique for Ecological Evaluation of the Surface Water Quality According to Relevant categories" (Pomanenko, Zhukinskiy and all 1998)

Type	Water quality category	Trophic status	Water bodies					
			Yalpug		Sasyk		Alibei	
			Dissolved oxygen	Phytoplankton biomass	Dissolved oxygen	Phytoplankton biomass	Dissolved oxygen	Phytoplankton biomass
1	Very pure	Oligo– oligo–mezo– trophic						
2	Pure	Mezotrophic						
3	Pure enough	Mezo – eutrophic						
4	Low-polluted	[redacted]						
5	Medium-polluted	[redacted]						
6	Polluted	[redacted]						
7	Heavily polluted	Hypertrophic						

Table 3. Interrelation between morphemic indexes of the water body and quality of the aquatic environment based on indexes of macrophyte's surface

Water body	Depth, m		Coefficient S/V	Index of the macrophytes phytocoenosis surface, unit	Aquatic environment category	
	Average	Maximum			Trophic saprobness	Quality
Alibei Liman	1,2	2,5	0,776	203	Hypertrophic (α-polysaprobic)	Highly polluted
Lake Sasyk	1,9	3,3	0,529	118	Polytrophic (β-polysaprobic)	Polluted
Grigoryevsky Liman	2,0	6,0	0,439	68	Eutrophic (α-mezosaprobic)	Medium polluted
Lake Yalpug	2,6	6,0	0.346	95	Polytrophic (α''-mezosaprobic)	Extremely polluted
Tiligulsky Liman	3,0	21,0	0,290	38	Mezotrophic (β'-mezosaprobic)	Pure enough

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