THE YALPUG AND KUGURLUI LAKES IN THE LOWER DANUBE: HYDROLOGICAL REGIME AND WATER MANAGEMENT.

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Abstract: Hydrology of the Lower Danube Lakes was influenced significantly by water management measures taken in their basin. Disturbance of natural water exchange between the Danube and the lakes caused changes in level regime of the lakes, speeded up siltation and increased their water mineralisation.

1. Introduction.

At the early stages of the Danube estuarine area there was a marine bay on the place of the present lakes Yalpug and Kugurlui. As it was filled with solids brought by the Danube, the delta progressed towards the sea and the lakes were cut from the Danube by a waterlogged floodplain. At present the lakes are about 100 km far from the Black Sea and they are the biggest natural fresh water lakes in Ukraine (Fig. 1).

2. Lakes Yalpug and Kugurlui under Natural Conditions.

Before early 70th of the XX century lakes Yalpug and Kugurlui in fact were the single waterbody with total area of about 300 km². The lakes were separated by sand spit across their water area from the east to the west. At that, the direct hydraulic connection between the lakes was preserved and their hydrology was practically the same.

The level regime of the lakes was determined mainly by the level changes in the Danube. There was a natural water exchange between the Danube and the lakes through the channels that were connecting Lake Kugurlui with the river and at high water levels due to free overflow over the edges of the beds.

Maximum level marks of the lakes changed from year to year in accordance with the highest water levels in the Danube (Fig. 2). In the years with high water (1962, 1970) water level in the lakes increased up to 3.8 – 4.4 m, and in the years of low floods on the Danube (1959, 1968) they did not reach mark 2.2 m, Baltic System (BS). Minimum water levels in the lakes were 0.6 – 0.7 m BS (1953, 1954).

Under natural conditions maximum annual amplitude of water level fluctuation in the lakes reached three meters (Table 1), and coefficients of water exchange calculated using the formula $K = \frac{W_{\max} - W_{\min}}{W_{\max}}$ (1)

where W_{max} and W_{min} – maximum and minimum volumes of the lakes during a year was 0.6 – 0.7 (Fig. 3.)

Substantial part of suspended solids brought by the Danube water settled during floods on the inundated floodplain area, which was slowing down the process of the lakes siltation.

Lakes Yalpug and Kugurlui had high biological productivity: catches of fish made 500-600 t par year and catches of crayfish reached 140 t per year.

Under the natural conditions mineralisation of water in Yalpug and Kugurlui did not exceed 0.5 – 0.6 g/l (Fig. 3) and was close to that in the Danube (0.3 – 0.4 g/l), especially during the period of lakes' filling [1].

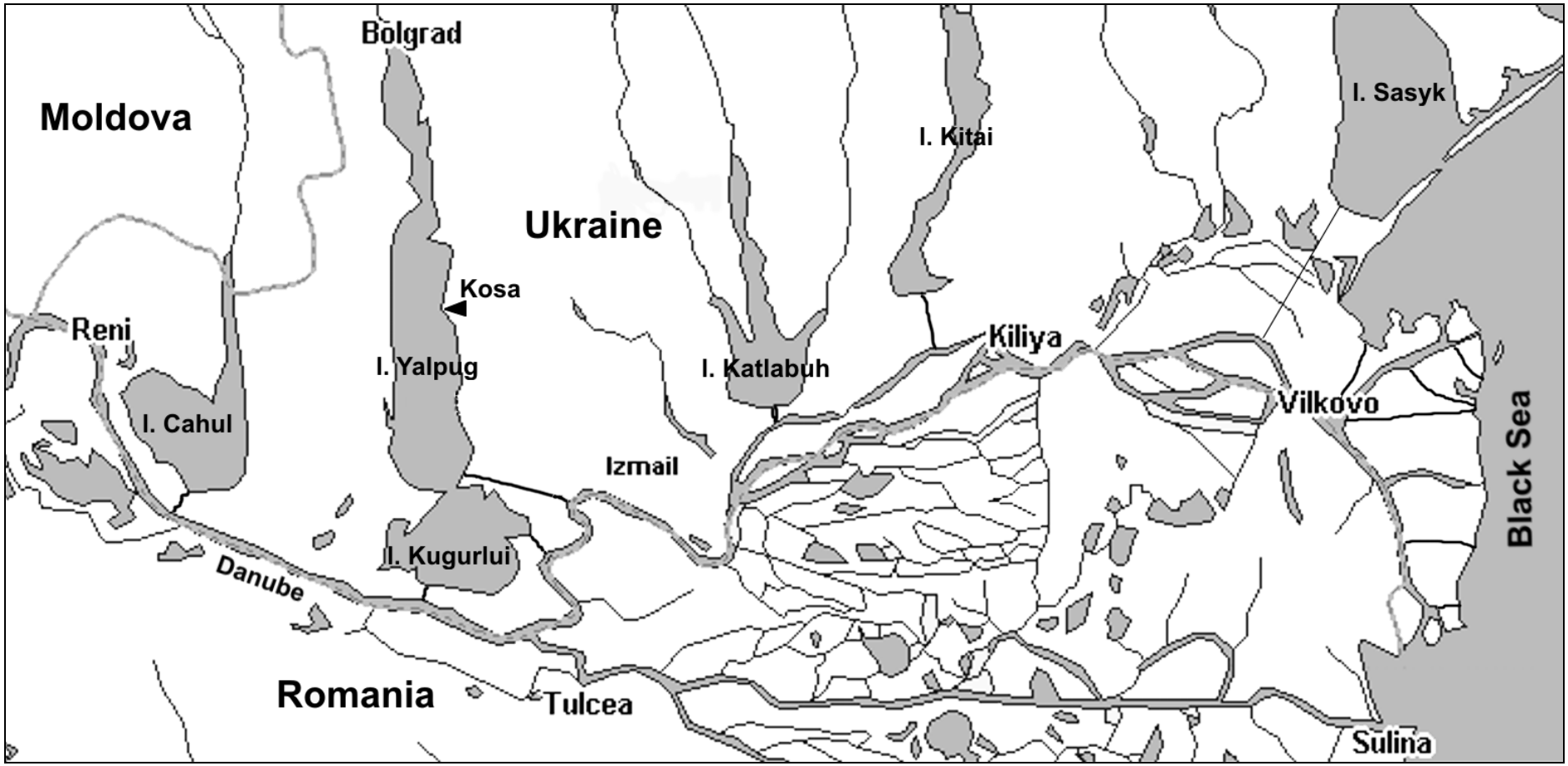

Fig. 1 Scheme of the Danube estuarine area

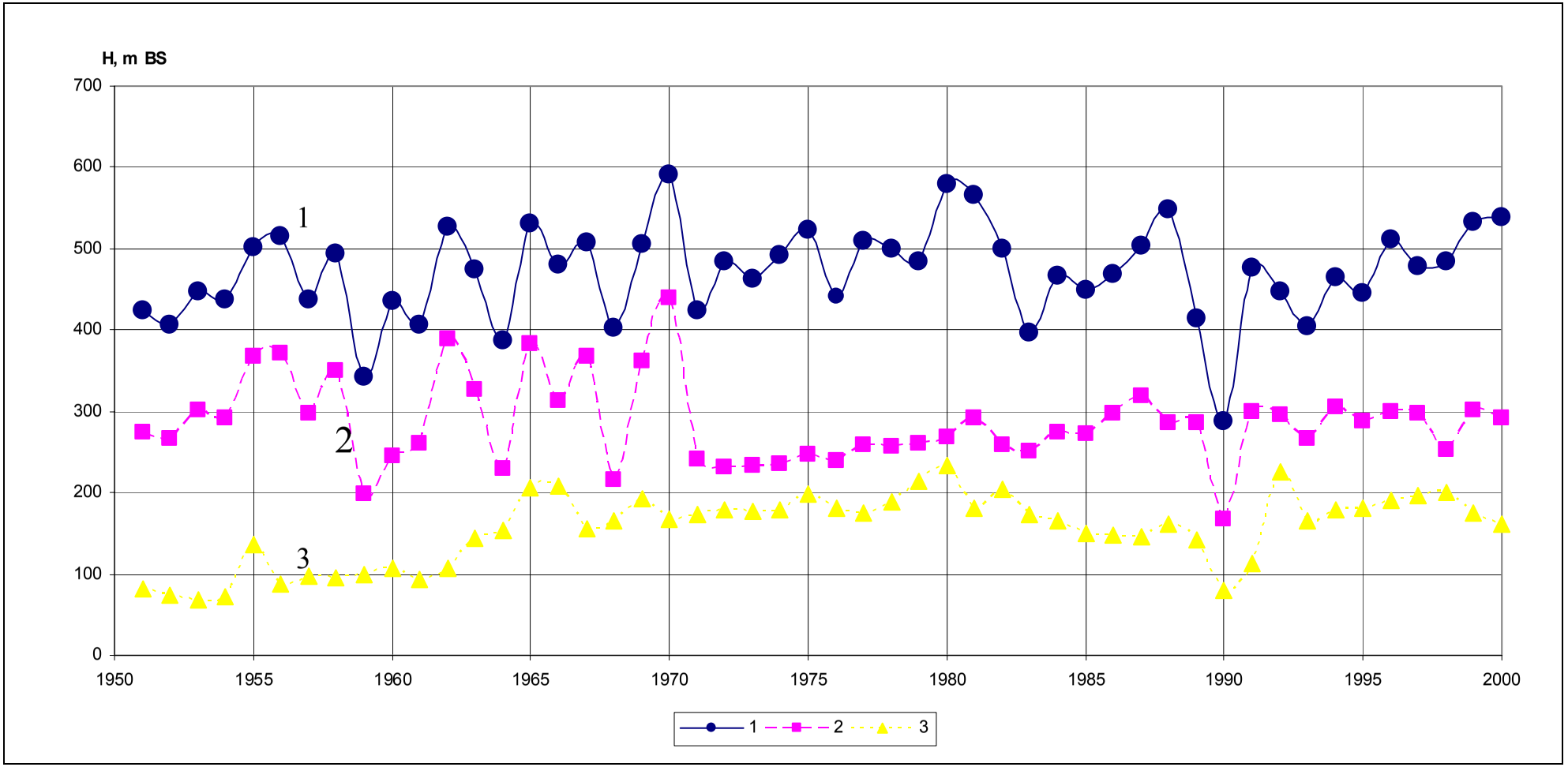

Fig. 2. Extremes of water levels of the Danube river and Yalpug lake:
1 – maximum Danube river (station Reni)
2 – maximum Yalpug lake (station Kosa)
3 – minimum Yalpug lake (station Kosa)

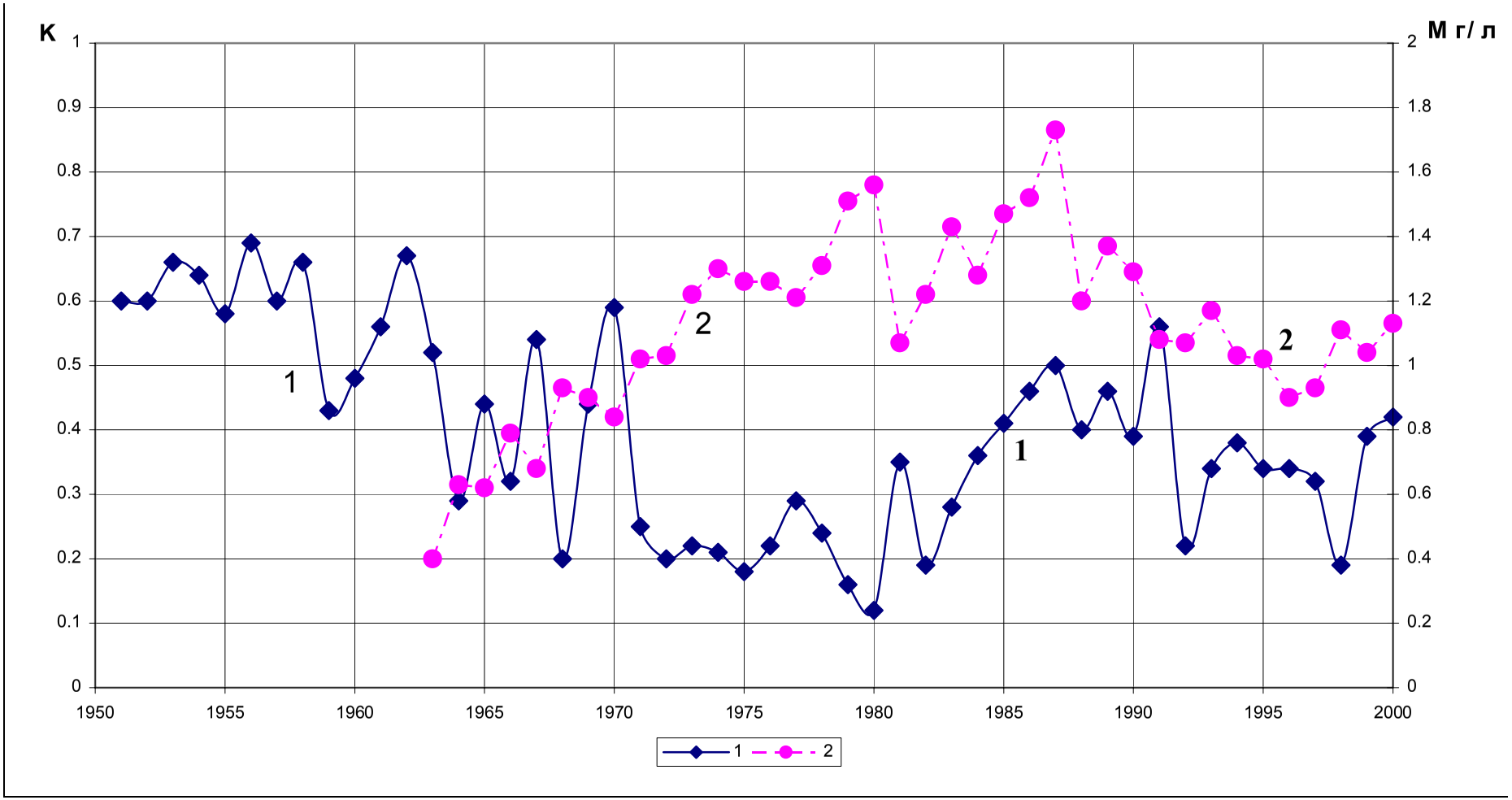

Fig. 3. Annual coefficients of water exchange (1) and annual average mineralisation of water (2) in Yalpug lake.

Table 1. Annual Amplitude of Water Level Fluctuation (m) in the Danube River and the Lake Yalpug in 1951 - 2000.

Period	River Danube – Town Reni			Lake Yalpug – Village Kosa		
	Average	Max.	Min.	Average	Max.	Min.
1951-1960	3,6	4,5	2,4	2,2	3,0	1,2
1961-1970	4,0	4,8	3,0	1,9	3,0	0,8
1951-1970	**3,8**	**4,8**	**2,4**	**2,1**	**3,0**	**0,8**
1971-1980	4,0	4,4	3,6	0,6	0,8	0,4
1981-1990	3,9	4,7	2,6	1,1	1,7	0,5
1991-2000	3,8	4,2	3,4	1,1	1,9	0,5
1971-2000	**3,9**	**4,7**	**2,6**	**0,9**	**1,9**	**0,4**

3. Information about Water Management Activities.

Availability of rich water resources of the Danube and the Lower Danube Lakes in the arid steppe region of the south-western Ukraine was the pre-condition for the development of irrigation agriculture and fishery. Besides, at the same time there was a need to resolve the problem of riverside areas protection from inundation during floods of the Danube. In connection with that by early 70th a number of big water management projects was completed in the Ukrainian Danube Delta.

Left bank of the Danube from Reni to Vilcovo was embanked. The dikes were intended to protect the area from the maximum annual levels of 1-3% probability. The similar dikes were built along the southern bank of Lake Kugurlui and on the perimeters of some isles in the Danube Delta.

Canals with sluices were built on the places of former channels that used to connect the lakes to the Danube. Part of waterlogged floodplain area was drained and used for agriculture, the other is currently converted into fishponds.

Dike with road on top was built in the place of sand spit that used to separate Yalpug from Kugurlui, which restricted significantly the possibility for water exchange between the lakes.

4. Changes in Hydrology of Lakes Yalpug and Kugurlui.

The water management measures taken caused significant changes in hydrology of Yalpug and Kugurlui.

After the sluices were built the level regime of lakes Yalpug and Kugurlui became partially regulated. By mid-60th that caused of minimum water level rising in the lakes 0.6 – 0.8 m compared to the natural conditions (Fig. 2). At that time the regulation could be done only at low water level in the Danube, as during floods there was free water exchange between the river and the lakes.

In early 70th, when the construction of protection dikes was finished, the level regime of the lakes became completely regulated. That caused the decrease of maximum water levels in the lakes by more than 1 m as the rule the levels do not exceed mark 3.0 m BS (Fig. 2). Annual amplitude of water level fluctuation in average for 1971 – 2000 was 0.9 m at maximum value 1.9 m (Table 1).

The most visible changes took place in the lakes' hydrology in the first decade after complete regulation started, during 1971 – 1980. During that period exchange between lakes Yalpug-Kugurlui and the Danube decreased sharply and relatively stable level was

maintained in the lakes. Annual amplitude of level fluctuation did not exceed 0.8 m (Table. 1), and coefficient of water exchange decreased 3-4 times if compared to the natural conditions.

The decrease of exchange between the lakes and the Danube, as well as between the lakes themselves with simultaneous increase of water abstraction for irrigation and potable water supply caused the noticeable increase of water mineralization. Average annual mineralization in Yalpug acquired a vivid trend towards increasing and reached its maximum values (over 1.7 g/l) in the 80th (Fig. 3). At that time mineralisation values sometimes exceeded 2.0 g/l in autumn-winter periods.

Later on, as the exchange increased and the quantities of mineral fertilisers applied in the catchment decreased, a trend towards mineralisation decrease began to show. In 1991 – 2000 average annual mineralization of water in Lake Yalpug did not exceed 1.2 g/l.

Although less water from the Danube was entering the lakes siltation processes speeded up. That was due to the fact that now suspended sediments from the Danube are being brought from the connecting canals directly to the bowl of lake and do not settle in the shallow floodplain as it used to be under the natural conditions. Only during the last 20 years over 1 million tons of suspended sediments accumulated in the Lake Kugurlui. Wave destruction of the banks and organic bottom sediments contribute significantly to siltation processes.

Significant anthropogenic load on the Lower Danube Lakes and the adjacent area had caused sizeable changes in the environmental conditions in the region. As the result of embankment and draining of the floodplain areas the biodiversity that existed before in the floodplain wetlands was lost to a considerable degree. In the last 15 mass fish kills were more than once observed in springtime in Yalpug and Kugurlui (mainly silver carp). The reasons of the fish kills are not found till now. Catches of fish decreased in late 90th to 200 – 250 tons a year and commercial catching of crayfish became inexpedient. Degradation of ecological situation in the region caused sharp aggravation of the problem of drinking water supply and reduced significantly the possibility to use Yalpug and Kugurlui for tourism and recreation.

Conclusions.

Analysis of hydrology of the Lower Danube Lakes Yalpug and Kugurlui for the last 50 years enables us to state that the main reason for the changes is the disturbance of the natural conditions for water exchange in the system river-lake.

Changes of the lakes filling adjacent areas watering regime caused degradation of a number of components in the natural complex of Lakes Yalpug and Kugurlui, as well as degradation of environmental situation in the region in general.

Restoration, sustainable use and conservation of the Lower Danube Lakes' natural resources are impossible without taking into consideration the history of their development, detailed complex studies of current hydrological and ecological situation of the lakes and the development of a sound scientific forecast.

5. References

Henderson-Sellers and Markland, H. R. (1987): Decaying Lakes. John Wiley and Sons.

Hydrology of the Danube mouth area (1963): Moscow - Bucharest. (In Russian and Romanian)

Mikhailov, V. N. (1997): River Mouth of Russia and Adjacent Countries: Past, Present and Future. GEOS, Moscow.