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ASSESSMENT OF THE ENVIRONMENTAL SITUATION AND WATER QUALITY IN THE LOWER DOWN OF THE DANUBE RIVER (ON THE EXAMPLE OF M. RENI)

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The Danube is the largest river in Western Europe (length 2960 km, basin area 817 thousand km^2). There are 19 countries fully or partially located within the river catchment [1], and its value for 80 million people is difficult to overestimate [2]. Scientists from many countries are researching the Danube. A small section of the Danube River (170 km) from Reni to its mouth runs through the territory of Ukraine. Above the Romanian city, the Tulcea River is divided into three branches (Kiliysky, Sulinsky, Georgievsky) and flows into the Black Sea. The most waterlogged of these is the Kiliysky sleeve (129 km^3 / year) passing through the border area of Romania and Ukraine [3].

The Danube Delta is included in the WWF (Global-200) list of the most valuable sites on Earth. In the northeastern part of it there are the Danube Biosphere Reserve, where 4300 species of fauna and flora are inhabited [2], dozens of which are on the verge of extinction.

On the other hand, the Danube is an important source of water for domestic and industrial needs of Ukraine's population, industry and agriculture. The total water abstraction from the river within Ukraine exceeds 2 billion m^3, and the number of water users - about 150 [2]. Delta ecosystems are a source of valuable natural resources. The Danube is also important for transport.

The waters of the Danube are used for drinking centralized water supply in the cities of Reni, Kiliya and Vilkove [4]. Therefore, it was important to perform "Assessment of the ecological situation and water quality in the lower reaches of the Danube River (on the example of Reni)". The calculations were made on the basis of data from the Danube Basin Water Resources Administration on the chemical composition of water in the Danube-Reni area for 2009-2018. The ecological situation is characterized by the degree of distress in accordance with table. 1 [5], the assessment of water quality was performed on the basis of the index of water pollution modified (WFD) [6] in comparison with the hydrochemical parameters of water with the maximum allowable values for drinking use [7].

Table 1.

Classification of environmental conditions [5]

Situation	Criteria for assessing the situation
Relatively satisfactory	$C_i \leq MPC_i$, for all substances
Tense	$C_i \approx 10\ MPC_i$
Critical	$C_i \approx (20-30)\ MPC_i$
Crisis (environmental emergency)	$C_i > 50\ MPC_i$, Persistent negative changes in nature.
Catastrophic (environmental disaster)	Deep irreversible changes in the natural environment. Imbalance, degradation of flora and fauna, loss of gene pool. Deterioration of human health.

A total of 25 substances were studied, the number of observations ranged from 98 to 104 for different indicators for the entire period. Substances such as dissolved oxygen, ammonium nitrogen, nitrate nitrogen, nitrite nitrogen, phosphates, iron, magnesium, sodium, calcium, silicon, chlorides, sulfates, chromium, copper, zinc, SPAR, petroleum products, oxidation permanganate, chromaticity the period of exceeding the MPC was not observed.

The biggest pollutants for drinking water supply in Reni are, suspended solids, biological oxygen consumption for 5 days (BOC_5), phenols, manganese and chemical oxygen demand (COD) (Table 2).

Table 2.

Relative frequency of cases of exceeding the MPC (%) for drinking water supply at the point of the Danube - Reni for 2009-2018

Substance	Empirical probability (relative frequency) of cases with exceeding the MPC, %			
	$C_i \leq MPC_i$	$C_i \approx 1-10 MPC_i$	$C_i \approx 10-50 MPC_i$	$C_i > 50 MPC_i$
Suspended substances	0	29	60	11
Chemical oxygen demand (COD)	44	56	-	-
Biological oxygen consumption for 5 days (BOC_5)	61	39	-	-
Manganese	71	29	-	-
Phenols	50	50	-	-

It was found that in the Danube - Reni for the period 2009-2018 the exceedance of the maximum permissible concentrations by 1.1 - 10 times for drinking water supply is for phenols (50%), manganese (29%), HSC (56%) and suspended solids. For suspended solids, the conditions C up to 10 MPC, C within 10-50 MPC and C> 50 MPC are met; exceedances up to 10 times amounted to 29%, 10-50 times - 60% and more than 50 times - 11%.

If we do not take into account the suspended solids, we can say that the ecological situation in the Danube - Reni for drinking water supply during the study period in the vast majority of cases is

"relatively satisfactory". The relative frequency of exceeding the maximum permissible concentration of drinking water supply in the range of 1-10 times more than 50% for HSC and phenols, so the environmental situation for these substances is "stressful". The empirical probability of exceeding the maximum permissible concentration of drinking water supply in the range of 10-50 times more than 50% is also set for suspended solids and is 60% (Table 2). This means that taking into account the suspended solids according to the classification of the environmental situation according to table. 1 and 2 in the Danube-Reni area there was a "critical" environmental situation and in 11% of cases - a "crisis".

The modified WFD index was calculated according to the following indicators: dissolved oxygen, BOC_5, which are mandatory, and the other four indicators - according to the largest ratio to the MPC from the list of test substances. WFD is calculated by the formula [5, 8]:

$$WFD = \frac{1}{6}\sum_{i=1}^{n}\frac{C_i}{MPC_i}, \quad (1)$$

where C_i is the average concentration of one of the six water quality indicators, and the MPC_i is the maximum permissible concentration of each of the six water quality indicators.

According to the magnitudes of the calculated water sources, the water quality is evaluated. Water quality classes [5, 8] are distinguished as follows: I - very pure (WFD ≤0,2); II - pure (WFD 0,2-1,0); III - moderately contaminated (WFD 1,0-2,0); IV - contaminated (WFD 2.0-4.0); V is dirty (WFD 4.0-6.0); VI - very dirty (WFD 6,0-10,0); VII is extremely dirty (WFD > 10).

The biggest pollutants for drinking water supply are suspended solids, phenols, manganese and chemical oxygen demand (COD). The following maximum concentration limits (mg / dm^3) were used to calculate the SAR modified for drinking water supply: suspended solids - 1.5; manganese - 0.05; COD - 15; phenols - 0.001 [7]. The average values of WFD by years, the range of fluctuations of WFD values in each of the studied years in the Danube - Reni for 2009-2018 are shown in Fig. 1.

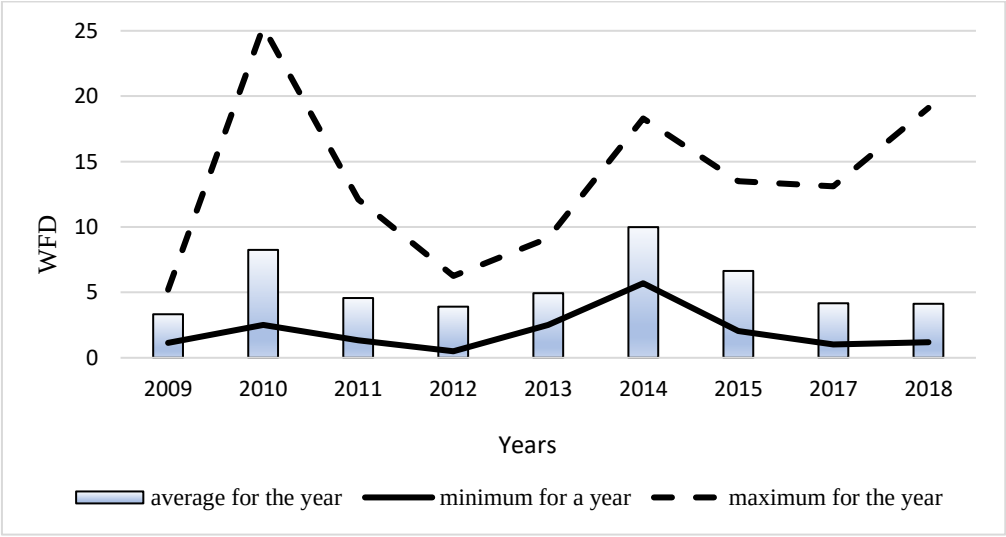

Figure. Changes of WFD in the creation of the Danube - Reni for 2009-2018

Water quality classes according to the average annual values of WFD are shown in table. 3. During the studied years, according to the standards for drinking water supply, water belongs to class IV - "contaminated" (22%), to class V - "dirty" (45%), to class VI - "very dirty" (33%).

Table 3.

Classes of water quality in the Danube - Reni for 2009-2018

Year	2009	2010	2011	2012	2013	2014	2015	2017	2018
Quality class	IV	VI	V	IV	V	VI	VI	V	V

Conclusions. In the Danube-Reni area, the ecological situation for drinking water supply for 2009-2018 is in the vast majority of cases "relatively satisfactory", for HSC and phenols - "tense". taking into account the suspended solids - "critical" and in 11% of cases - "crisis". Given that the greatest pollution is caused by suspended solids, great attention should be paid to settling and filtration during water treatment.

References:

1. Our Waters: Joining Hands Across Borders: First Assessment of Transboundary Rivers, Lakes and Croundwaters. New York and Geneva, 2007. http://www.unece.org/env/water

2. Videnie deltyi Dunaya, Ukraina [Vision of the Danube Delta, Ukraine]. https://danube.odessa.gov.ua/wpcontent/uploads/2019/02/danube_delta_vision_rus.pdf (in Russian).

3. Lozovitskyi P.S. Spetsyfichni rechovyny toksychnoi dii u vodi richky Dunai. [Specific toxic substances in the Danube River water] / Ekolohichni nauky, 2015, № 6, C. 21-34. (in Ukrainian).

4. Rehionalna prohrama «Pytna voda Odeskoi oblasti» na 2010-2013 roky i period do 2020 roku» [Regional program «Drinking water of Odessa region» for 2010-2013 and period till 2020»]. Rezhym dostupu (24.12.2019): http://oblrada.odessa.gov.ua/wp-content/uploads/1170-V.pdf (in Ukrainian).

5. Muzalevskiy A. A., Karlin L. N. Ekologicheskie riski: teoriya i praktika [Environmental risks: theory and practice]. – SPb.: RGGMU, VVM, 2011. – 448 s. (in Russian).

6. Snizhko S. I. Otsinka ta prohnozuvannia yakosti pryrodnykh vod [Assessment and forecasting of natural water quality]. Pidruchnyk- K.: Nika-Tsentr, 2001. – 264 s. (in Ukrainian).

7. DSTU 4808:2007 Dzherela tsentralizovanoho pytnoho vodopostachannia. Hihiienichni ta ekolohichni vymohy shchodo yakosti vody i pravyla vybyrannia. Rezhym dostupu (24.12.2019): http://document.ua/dzherela-centralizovanogo-pitnogo-vodopostachannja_-gigienic-std3067.html (in Ukrainian).

8. Osadchyi V.I., Nabyvanets B.I., Osadcha N.M., Nabyvanets Yu.B. Hidrokhimichnyi dovidnyk. Poverkhnevi vody Ukrainy. Hidrokhimichni rozrakhunky. Metody analizu [Hydrochemical reference book. Surface waters of Ukraine. Hydrochemical calculations. Methods of analysis]. – K.: Nika-Tsentr, 2008. – 655 s. (in Ukrainian).