

## OIL CONTAMINATION OF THE BOTTOM SEDIMENTS OF THE DNIEPER RIVER

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### НАФТОВЕ ЗАБРУДНЕННЯ ДОННИХ ВІДКЛАДІВ РІЧКИ ДНІПРО

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*The present state of the ecosystem of the Kaniv reservoir is determined by the powerful economic complex of Kyiv, adjacent to the city's infrastructure and recreational zone. In addition to the natural processes associated with the transformation and destruction of the shores, unsystematic and environmentally unsustainable dredging works, mining of building materials, but especially the centres of man-made pollution and water management in the basin play an essential role.*

**Keywords:** *oil products, technogenic surface water pollution, bottom sediments, fluorometric method.*

*У статті представлено результати оцінки небезпеки існування гідробіоценозів, розглянуто стан забруднення водних об'єктів нафтопродуктами у межах м. Київ. В основу методу дослідження покладено аналіз формування нафтопродуктового забруднення вод і донних відкладів водного об'єкта. Дані дослідження були отримані флюорометричним методом аналізу проб донних відкладів та води з 11-ти точок відбору. При дослідженні відібраних проб було виявлено, що на таких ділянках, як Русанівський канал, Видубичі та гирло р. Либідь, присутнє перевищення гранично допустимих концентрацій нафтопродуктів, що в довгостроковій перспективі може негативно впливати на стан гідробіоценозу водойм. Але в цілому концентрації нафтопродуктів у багатьох точках відбору знаходиться у межах норми, що не призводить до надмірного впливу на водне середовище та нівелюється здатністю водойм до самоочищення.*

**Ключові слова:** *нафтопродукти, техногенне забруднення поверхневих вод, донні відкладення, флюорометричний метод.*

Within the Kiev metropolis are concentrated large electric and industrial facilities (TPP-5, Darnytsia CHP-6, etc.), a dense network of communal services, the largest enterprise of which is "Kyivvodokanal". The household sewage collector crosses the Dnipro River in the area of the railway bridge and supplies contaminated water to the treatment facilities of the Bortnickaya Aeration Station (BAS) on the southeastern outskirts of Kyiv. The technological facilities of the plant have long worked their operational life and are not able to effectively clean water. They are currently undergoing preparations for reconstruction, which will be sponsored by the Government of Japan. Taking into account the observance of all international procedures, the comprehensive reconstruction of the BAS will begin in mid-2018 and will end in the second quarter of 2023 [1].

The environmental status of the Kaniv reservoir is largely determined by the processes of receiving, migrating and transforming toxic substances of different chemical nature. It is common knowledge that oil and petroleum products, along with pesticides and heavy metals, are the most dangerous toxicants of aquatic ecosystems [2, 3].

It should be noted that the environmental and toxicological studies of the Kaniv reservoir were conducted long ago. The last such complex of works was carried out by specialists of the Institute of Hydrobiology of the National Academy of Sciences in 1992-96 [4]. During this time, certain changes occurred in the composition, structural organization and functional activity of the biota, the list of toxicants, which were not determined and not taken into account in the previous environmental assessments, significantly changed, the structure of the main sources of pollution of

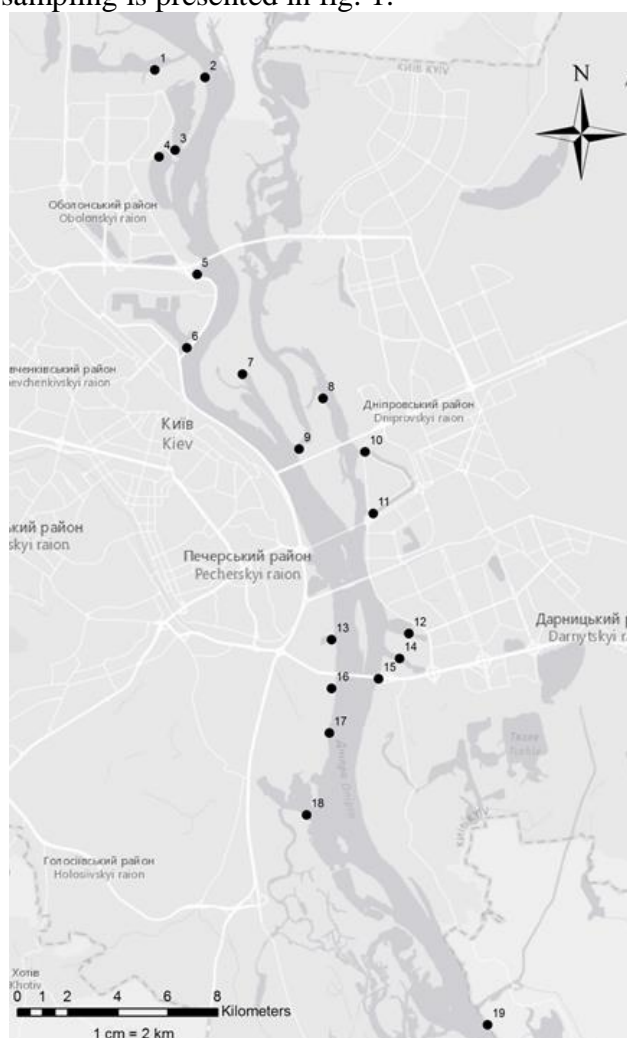
the reservoir also suffered, the man-made press on the reservoir has considerably intensified from the side of the megacity – Kyiv.

In this regard, the study of the current state and characteristics of oil pollution of the water ecosystem of the Kaniv reservoir remains relevant for assessing the danger of the existence of hydrobiocenoses and preserving the ability of the reservoir to self-purify.

A sampling of water and bottom sediments was carried out in accordance with the methods generally accepted in the practice of hydroecological research [5, 6]. Samples were taken from the surface (0.5 m) of the water layer and the upper layer (0.1 m) of the sediment, where the concentration of pollutants is maximum, in the littoral from the water reservoir. The mass of each water sample for analysis was 100 g, and the bottom sediments 200 - 300 g.

The mass concentration of petroleum products was determined by the fluorimetric method on the fluorine analyzer "Fluorat-02-3M" according to the manufacturer's method (Lumex, Russia, St. Petersburg). The method is based on the extraction of petroleum products from water or bottom sediments by hexane, followed by measuring the fluorescence intensity of the obtained hexane extract [7, 8]. The results of the measurements were processed statistically.

Investigation of oil pollution of water and bottom sediments of the Kyivan part of the Kaniv reservoir was carried out in July-August 2017. The map of the reservoir within the city of Kyiv specifying the points of sampling is presented in fig. 1.

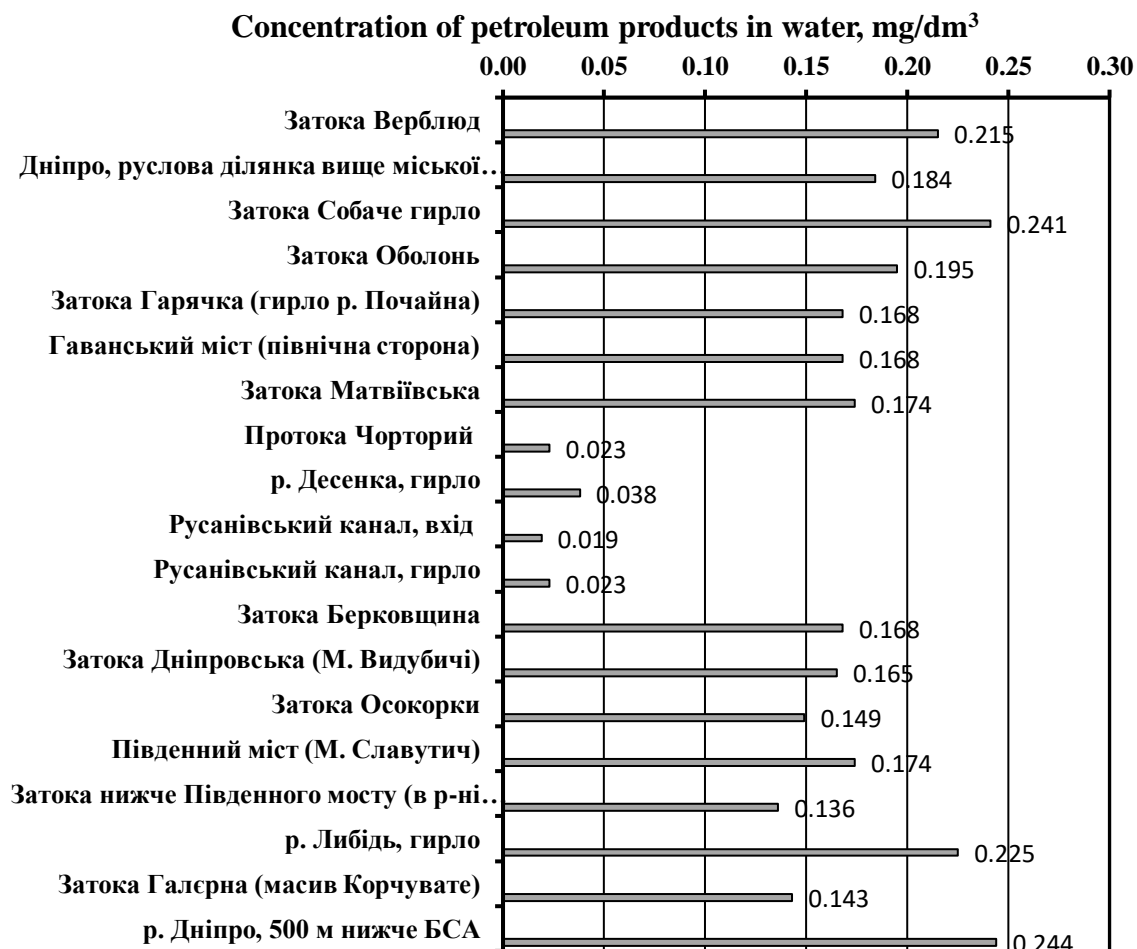


**Fig. 1.** Map of the sampling of water and sediments from Kaniv Reservoir within the city.

Kyiv in July and August 2017: 1 - Gulf camel; 2 - the river Dnepr, river channel above urban development; 3 - Gulf Dog's mouth; 4 - Obolon Bay; 5 - Goryachka Bay (mouth of the Pochayna River); 6 - Havana Bridge; 7 - Matveevskaya Bay; 8 - Strait of Chortory; 9 - River Desenka, mouth; 10 - Rusanivsky channel, entrance; 11 - Rusanivsky Canal, mouth; 12 - Berkivshchyna Bay; 13 -

Bay of Dniprovsk (Vydubychi); 14 - Osokorki Bay; 15 - Southern bridge ( Slavutych); 16 - the bay below the Southern Bridge (in the district of HPC-5); 17 - Lybid, mouth; 18 - Gahrena Bay (Korchute massif); 19 - Dnipro River, 500 m below BAS.

The analysis of the results for determining the concentration of petroleum products in the surface layer of water in the Kaniv reservoir within the limits of Kyiv (fig. 2) showed that the level of water pollution varied in a very wide range depending on the place of sampling.



**Fig. 2. The concentration of petroleum products in the water of the Kaniv reservoir within the limits of Kyiv in July-August 2017**

Immediately, the fact that even in water from the channel section of the Dnieper above the main urban development was found a high concentration of petroleum products (0.18 mg/dm<sup>3</sup>), which is more than three times greater than the MPC fishery (0.05 mg/dm<sup>3</sup>). Water samples taken at the upper part of the Kiev reservoir in the Gulf of Obolon (Gulf of Camel, Gulf of Dog's mouth, Gulf of Obolon) differed even higher content of petroleum products (0.20 - 0.24 mg/dm<sup>3</sup>), which was almost four times higher MAC fishery. High levels of pollution in this part of the reservoir can be facilitated by active navigation, numerous parking and storage facilities and maintenance of boats.

The not much better situation was observed below the current, in the middle part of the Kiev area of the reservoir. In the water selected in the Goryachka Bay, in the area of the Havana Bridge, as well as in the left-bank part of the Matviyiv Bay, the oil content was also three times higher than the MPC fishery and was about 0.17 mg/dm<sup>3</sup>.

Against this background, relatively pure oil products are allocated to the reservoir, namely,

in the area of the Dolobeky Island, the Trukhanov Island and the Rusanivka residential estate. This is evidenced by the results of the analysis of water samples from the Strait of Chortory, the mouth of the River Desenka, the Rusanivsky Canal at the entrance and in the mouth. The content of petroleum products at all above-mentioned points did not exceed the MPC fishery (0.05 mg/dm<sup>3</sup>).

The expected high level of water pollution by oil products was observed in the industrial zone (right bank) in the Dniprovsky Bay (Vydubychi) and below the Southern Bridge in the district of TPP-5, where the content of petroleum products was about 0.17 mg/dm<sup>3</sup>. To the significantly polluted is also the Gulf of Galier, which is on the residential enclosure Korchutva, in which the concentration of oil products was 0.14 mg/dm<sup>3</sup>.

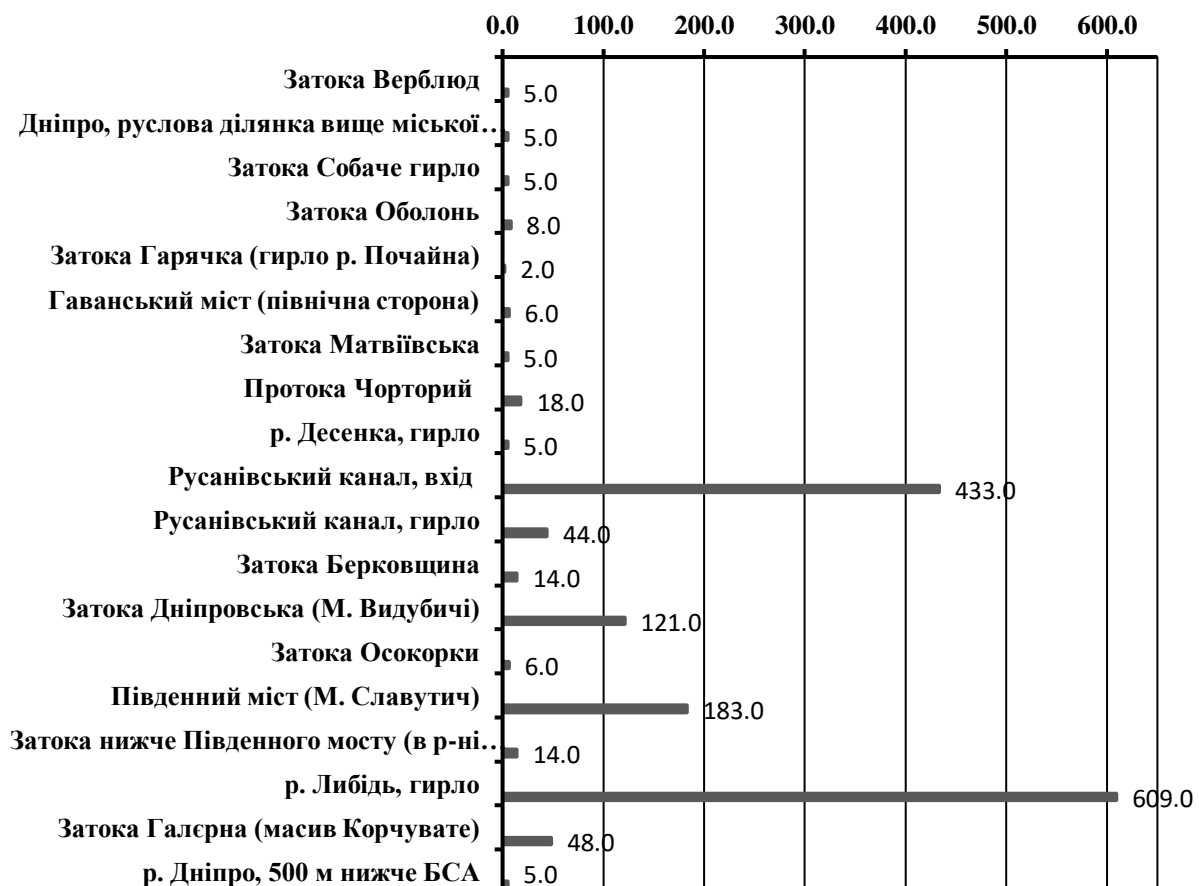
The opposite left-bank part of the reservoir, namely the Gulf of Berkovitschina, Osokorki Gulf and the Southern Bridge (Slavutich), were also heavily contaminated with petroleum products whose concentration ranged from 0.15 to 0.17 mg/dm<sup>3</sup>, which is three times higher than the MPC.

As expected, a high concentration of petroleum products (0.23 mg/dm<sup>3</sup>) was detected in water in the mouth section of the Lybid River. In general, the catchment of Lybid is marked by a very significant economic development - it covers almost the entire central part of the city. Within the catchment area, there are more than a million residents of Kiev. Lybid's feature is also its intersection of a large number of bridges and pipelines; some of them stretch along the shores.

The high concentration of petroleum products (0,24 mg/dm<sup>3</sup>) in samples of Dnieper water, selected on the southeastern outskirts of Kiev below Bortnitskaya aeration station, also attracts attention. At present, the BAS structures are a permanent source of pollution at the site due to the discharge into the Kaniv reservoir of insufficiently treated return water.

Investigation of the content of petroleum products in the Kaniv reservoir bottom sediments within the limits of Kyiv showed (fig. 3) that it varied in a very wide range depending on the place of sampling.

Content of petroleum products in bottom sediments, mg/kg of dry soil



**Fig. 3. The content of petroleum products in the bottom sediments of the Kaniv reservoir within the city of Kyiv in July-August 2017**

The content of petroleum products in the bottom sediments (mainly sandy) was very small in the upper part of the Kyiv reservoir site above the city's development, in the bays of the Obolon housing estate, as well as in the middle of the reservoir to the mouth of the Desen River, and was in the range of 5-18 mg/kg dry soil.

Bottom sediments deposits in the mouth of the Rusanivsky Canal and the Galiernyi Gorge (Korchute massif) turned out to be more contaminated with petroleum products, the content of which was 44 and 48 mg/kg of dry soil, respectively. Significantly higher level of contamination of bottom soils (121 and 183 mg/kg of dry soil) was observed in the Gulf of Dniprovsk (Vydubychi), and in the Southern Bridge (Slavutich), which is obviously due to the influence of nearby industrial Objects. The highest amount of petroleum products was detected in the bottom sediments at the entrance to the Rusanivsky Canal (433 mg/kg of dry soil), and in the mouth of the Lybid River (609 mg/kg of dry soil). Possibly, the high degree of contamination of the Rusanivsky canal is caused by the close proximity of boat parking. As for the Lybid River, a large amount of petroleum products is concentrated within its catchment area, a significant proportion of which precipitates and accumulates in the bottom sediments. Many of them get into Lybid with a surface runoff of rain and thawed waters, as well as from numerous car washes along the river bed. Potential pollutants whose return water comes to the Lybid River are PJSC "Ukrtelecom" and heat networks. There is also a railway station, a bus station, a confectionery factory, a margarine plant, a TPP-5, etc., at the catchment of Lybid. It should be noted that bottom sediments below the discharges of BAS (outside of urban development), unlike water, were practically not contaminated with petroleum products.

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