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ASSESSMENT OF HEAVY METALS POLLUTION IN ABIOTIC COMPONENT OF ECOSYSTEM OF VYRLYTSA LAKE

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Abstract. *The main task was to investigate the pollution by heavy metals of abiotic component in the Vyrlytsa Lake. Was determined the amount of movable form of heavy metals in the water and bottom sediments by the method of atomic absorption spectroscopy. Anthropogenic pollution of the lake is connected with discharges of waste waters from enterprises that situated in the industrial zone.*

Keywords: abiotic component, heavy metals, migration, mobile form.

Introduction

Anthropogenic impact on the environment has increased in a period of intensive urbanization of society. Heavy metals are the most dangerous persistent pollutants. Their existance in natural ecosystems, especially in the water, leads to the formation of zones of increased toxicity, migration in trophic chains and biomagnifcation. The consequences are the destruction of aquatic organisms, reduction of biodiversity and toxic effects on humans through consumption of contaminated water and foods.

Vyrlytsa Lake located in a densely populated Darnitskiy district in Kyiv. There are several industrial facilities, highways, underground stations "Vyrlytsa" and "Kharkivska" on the banks of the Lake. It is recreational important zone (fig. 1).

It was investigated the contamination by acid soluble forms of heavy metals of water and sediments of Vyrlytsa Lake. Simultaneously it was determined the reaction of water solution (pH), which significantly affects on their forms of existence. Were determined sampling points on the banks of the lake.

Lake has a length of 1750 meters with a maximum width (east-west) 1,190 m. It is the largest close reservoir in Kiev. The water surface area is 100 hectares, characterized by a large number of bays especially in its northern part. The central part of the lake deep enough, here is dominated the depth of 10 meters; littoral - silty-sandy, marshy places in the bays, or consists of peaty.

Salinity of the Vyrlytsa Lake is 754,0 mg/dm^3. Chemical type of the lake water is hydrocarbonate calcium-sodium. Nowadays it is important to develop methods that will help to reduce anthropogenic impact on aquatic ecosystems. These methods should include: clearing system of household wastewater into storm drains, which is discharge in the ponds, and discharge of such waters to the city sewer utilities; suspension of discharge of sewage in storm drains companies and directly into the reservoir; fixing enterprises, whose territory adjacent to the reservoirs, to streamline the functions of relevant parts of watersheds, manage storage of chemicals and petroleum products, preventing their arrival in the waters of melting and storm waters.

Purpose

Heavy metals existence in water objects is a serious problem in urban areas. These elements are persistent pollutants and they can be accumulated in all components of the ecosystem and migrate to the trophic food chains, leading to deterioration of the water object state, and can also affect the human health and life. There is no essential information about the general state of abiotic component of Vyrlytsa Lake that bordered from one side with industrial objects and from other by recreational zone and residential array.

Materials and methods

For determination of mobile forms of heavy metals (Pb, Cu, Mn, Zn, Co, Cd) was used the method of atomic absorption spectroscopy.

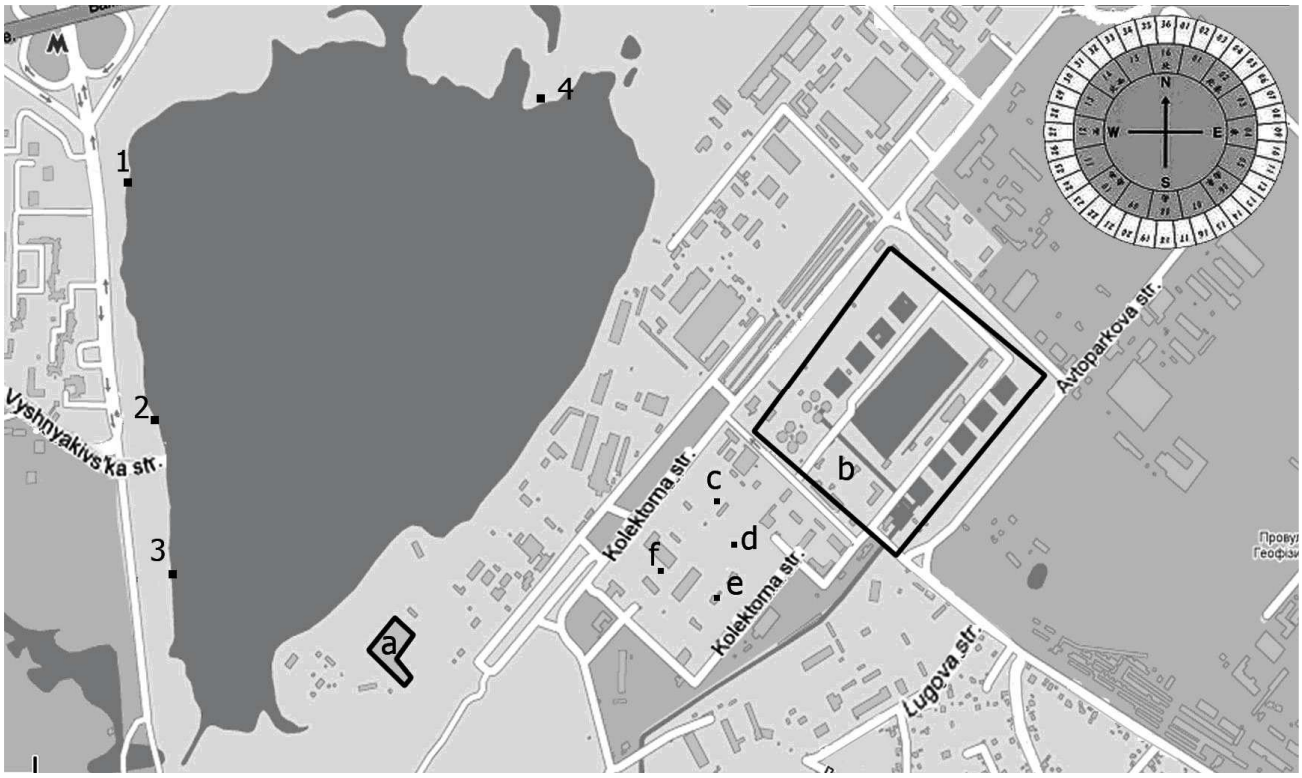

Fig. 1. Map of the Vyrlytsa Lake:
a – incineration plant “Energy”;
b – Bortnichi aeration station;
c – scientific production company “Sintez” (paints and allied products),;
d – “IPO Plasmas” (plumbing);
e – “FLOK”, (chemical preparations);
f – repair and construction service “Plus” (electrical work):
1 – point near “Kharkivska” underground station,
2 – 100 m from “Kharkivska” underground station,
3 – 200 m “Kharkivska” underground station,
4 – point near “Vyrlytsa” underground station

In analytical chemistry, atomic absorption spectroscopy is a technique used to determine the concentration of a specific metal element in a sample [1].

The water and the sediments were sampling on the banks of the lake in autumn 2010 on the depth of 5 sm.

Water samples preparation for analysis was provided in a few steps: it was taken in an amount of 6 liters from each points and 100 ml for determination of pH.

Water contain very low amount of heavy metals that is why it was concentrated. For concentration of heavy metals it need to evaporate water samples in ten times. We had 6 liters from each points and 600 ml in the end of concentration to each point.

Sediments samples preparation for analysis was provided in a few steps:

For analysis the sediments were dried to go in a constant weight, than sifted in a sieve, after that it was taken and measured 2 g of dry sifted sediment for each sample and burnt it in oven (automated sample preparation "Temos - Express" TE – 1) by 500 ºC during 3 h. After cooling of samples they were mixed with 0,1 N of HCl and shaked 100 times. The mixture was filtered through the special filter “White Ribbon”.

The pH value of the water was measured because the type of solution directly depend on the form of heavy metals existence and migration. In acid solution the migration is increasing [2].

Results and discussion

It is known that mobility of heavy metals is ecotoxicological criteria of its hazardous.

Potential mobility of metals in natural systems are represented in such sequence [3].

$Cu^{1}+>Pb^{2}+>Hg^{2}+>Cd^{2}+>Zn^{2}+>Cu^{2}+>Co^{2}+>$
$+>Ni^{2}+>Ni^{3}+>Co^{3}+>Pb4+$

Toxic effects dependent not on all the mass of heavy metals in soil and on their discharges, but only those that are in the soil solution. According to this, we can assume that the most dangerous portion of the heavy metals, which is in the mobile and potentially mobile forms, only this number determines the danger of heavy metals for biota, plants, and finally to humans.

Mobility of chemical elements in soil depending on the physical and chemical conditions of soils. With increasing acidity of soil solution fraction of mobile compounds of heavy metals increases.

According to results from investigation of water samples the most polluted points are 1 and 2 by Pb and points 2 and 3 by Cu in twenty times according MPC for water object of cultural use (fig. 2).

In our water samples didn't determine Co and Cd because of its very low concentration. The content of Zn doesn't exceed the MPC. Mn almost the same in each samples and exceeded the MPC level in 6 times.

According to maximum permissible concentration (MPC) of chemical elements in water objects of household-drinking and cultural water use the content of heavy metals are in such amounts Pb - 0,01, Mn - 0,1, Cd - 0,001, Cu – 1, Co – 0,1, Zn - 1 [4].

The results from investigation of bottom sediments samples shows us that the most polluted points are 1 and 3 by Pb. Points 2 and 3 by Mn were in ten times exceed the values, represented in the World experience of norming of bottom sediments on the content of specific substances (fig. 3, table).

Content of elements Co and Cd were too small in any samples and didn't exceed the regulatory indicators. In the same time, amount of Zn was in permissible limits. We determined the high content of manganese in all cases of analyzed samples.

This fact may be explained by the geochemical abnormality of the territory [3]. Bottom sediments were taken according ISO 5667-12.

ISO 5667-12 provides rules for sampling sediment in rivers, streams, lakes, estuaries and harbours. Requirements of the standard can be applied in the selection of sediment in the industrial effluents and sediments in the seas and oceans.

Sampling is carried out for the following tasks:

1. Study of sediments of the water system;
2. Monitoring changes in the composition of deposits.

According the results of measuring pH, water of investigated object is alkali in all sample points (fig 4). The mobility of heavy metals form depends on the water solution.

According to sanitary rules and norms of protection of surface water from pollution the permissible pH value is in the range from 6,5 to 8,5 [3].

World experience of norming of bottom sediments on the content of specific substances [5]

Toxicants, mkg/g	USA		Canada		Nerthenland	Consensus (MacDonald, 2000)	
	ERL	ERM	ISQG	PEL	PC	TEC	PEC
Cd	1,2	9,6	0,7	4,2	0,8	0,99	4,98
Cr	81	370	52,3	160	100	43,4	111
Cu	34	270	18,7	108	36	31,6	149
Pb	47	220	30,2	112	85	35,8	128
Zn	-	-	124	271	140	121	459

Abbreviations: ERL –Effect Range Low, ERM - Effect Range Medium, ISQG – Canadian Sediment Quality, PEL – Probable Effects Level, PC – permissible concentration,TEC – Threhold Effect Concentration, PEC – a probable effect Concentration.

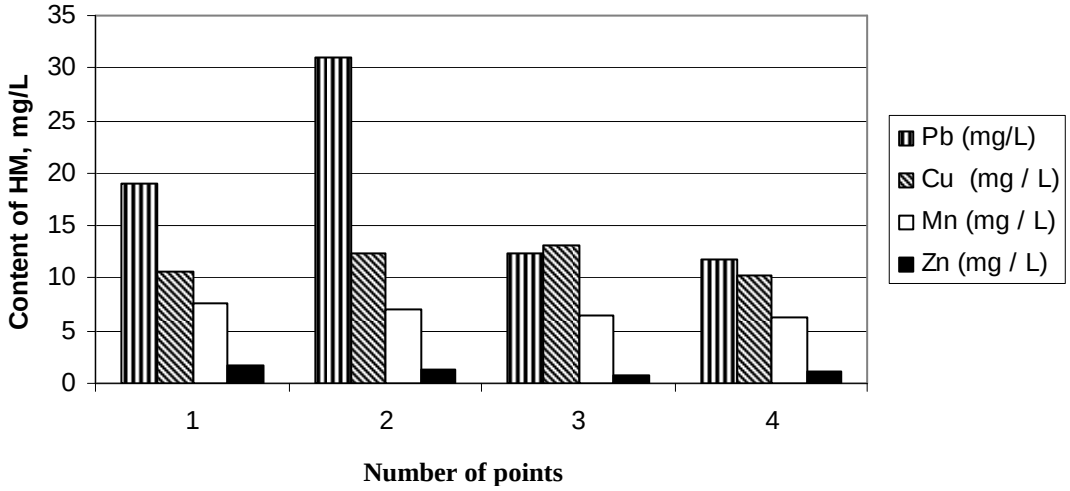

Fig. 2. Content of heavy metals (HM) in the water samples of Vyrlytsa Lake

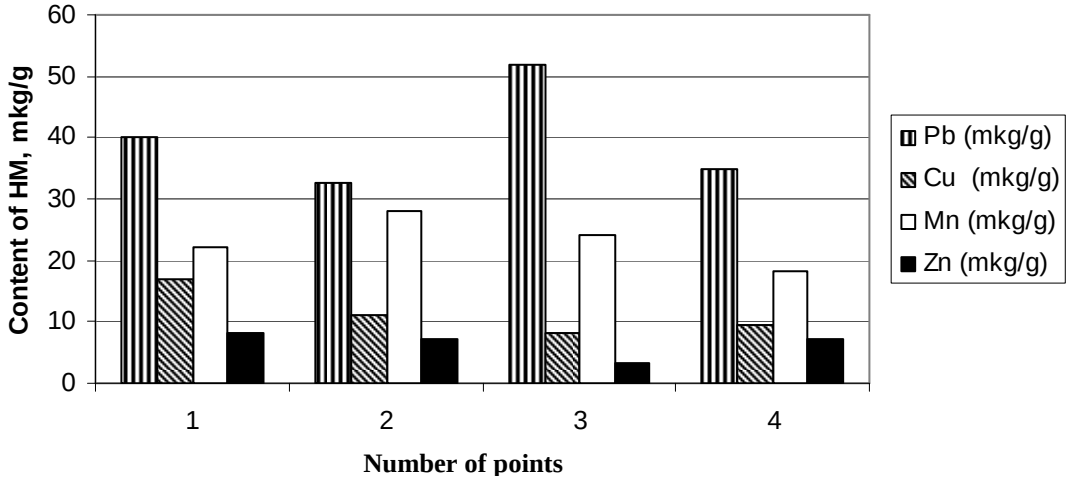

Fig. 3. Content of heavy metal (HM) in bottom sediments of Vyrlytsa Lake

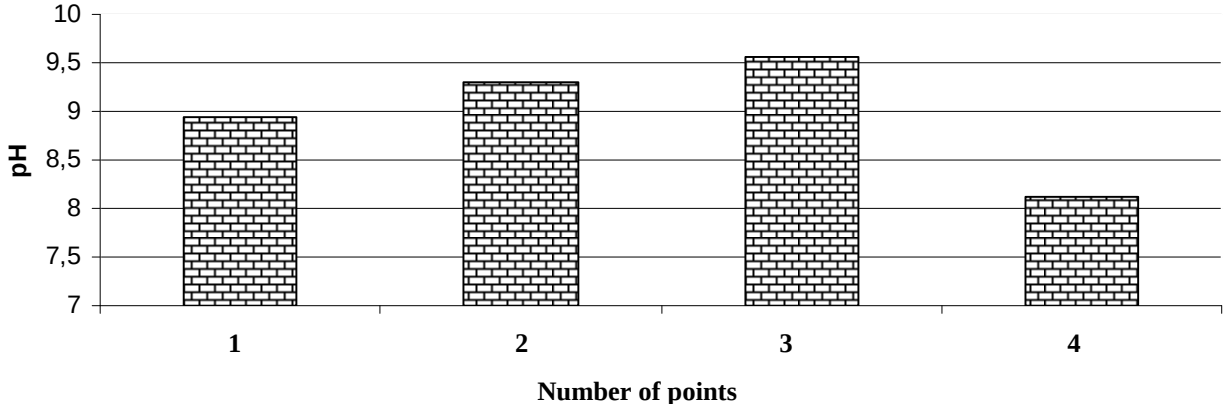

Fig. 4. pH of water from investigated points of Vyrlytsa Lake

The water solution is important in investigation of mobility of heavy metals. For instance the acid solution is a good state of water bodies where the chemical elements can migrate from abiotic component to biota of the lake.

It can easily go to the human digestion system and as a consequence health disturbance and even death.

The measuring of pH value was providing 5 times and after that it was taken the average values.

Conclusions

Our results show that significant water pollution in points 2 and 3 and pollution of bottom sediments in the same points. This fact may be explained by the proximity of industrial zone to these points especially of some harmful enterprises and a large highway.

Elements Pb and Cu are present both in water and bottom sediments of the lake and its content exceed maximum permissible concentration.

In our water and sediments samples didn't determine Co and Cd because of its very low concentration In the same time, amount of Zn was in permissible ranges. We determined the high content of manganese in all cases of analyzed samples. This fact may be explained by the geochemical abnormality of the territory [3]. Alkali solution in points 1, 2, 3 is a consequence of anthropogenic pollution and may be explained by the. The most dangerous elements are Cd>Pb>Zn.

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