Analysis of Build-Up of Pollutants in Bottom Deposits and Their Environmental Impact

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Abstract. Problem immediacy. Modern environmental situation in Rostov region is characterized by great pollution supply in the open air, industrial and household waste production, and presence of waste and surface watercourses. The main sources of pollution are motor transport, industrial and public utility companies in the region. Bottom deposits are generators of pollutants that are entering to water bodies. Whereas it determines the immediacy of research of their specific aspects, structures, chemical constitution and material composition and their impact on ecosystems as well.

Purpose. Researching of build-up of pollutants in bottom deposits and analysis of their environmental impact.

Object of research: Bottom deposits in water bodies of Rostov region.

Subject of research: Analysis of heavy metal accumulation in bottom deposits in water bodies.

Methods. Toxico-chemical agents’ extraction in bottom deposits in water bodies of Rostov regions was performed in accordance with GOST 17.1.5.01-80, RD 52.18.191-89 based on atomic-and-absorption analysis.

Results. Problem of pollution of bottom deposits is a result of human impact on the environment. Bottom deposits owing to their high set sorption properties could be thought of as an integrated indicator of man-caused impact to water supplies. Survey findings shows that there are toxic heavy metals such as copper, lead, zinc, nickel, cadmium in bottom deposits composition in water bodies of Rostov region. Index of impact of pollutants in bottom deposits on natural ecosystems is excess of their concentration over MAC (maximum allowable concentration).

Findings: Survey findings shows the serious overrun of MAC of heavy metals in bottom deposits composition in water bodies of Rostov region. This points to necessity of survey of economy heavy metals recovery techniques and bottom deposits detoxification methods. This problem’s solution is the most pressing thing not only for Rostov region but the whole Russia.

1. Introduction

Modern environmental situation in Rostov region is characterized by great pollution supply in the open air, industrial and household waste production and presence of waste and surface watercourses. All of these things makes a great contribution to spoilage of prevailing ecosystems of the region. [1, 2].
The main sources of pollution are motor transport, industrial and public utility companies in the region. In the last 20 years, the anthropogenous factor became the number one in the environmental contamination. [3].

The question of adverse impact of upbuilding process of pollutants in bottom deposits on environment is understudied up to the present moment. There is no enough data about pollutants quantity and their impact intensity on nature ecosystems. As can be seen from the above the purpose of our work is researching of build-up of pollutants in bottom deposits and analysis of their environmental impact. The objects of the research are the bottom deposits in water bodies of Rostov region. In addition, the subject is analysis of heavy metal accumulation in bottom deposits in water bodies.

2. Problem urgency
Heavy metals pollution of the soil and water supplies is one of the recent problems.[4]. At the present time the issue of soil and water supplies pollution with heavy metals remains one of the most pressing. The main sources of heavy metals (HM) pollutions are sewage disposal of various plants and factories, for instance chemical, petrochemical and machinery production [3, 5]. Urban transport makes a great contribution to the heavy metals pollution of the open air as well. Repugnant substances enter the soil due to accumulation of industrial wastes. Many researches deal with ecological problems of Rostov region (V.V. Privalenko, V.E. Zakrutkin, O.S. Bezuglova, O.V. Nazarenko, etc.) [2-5].

Water supplies of Rostov region are the accumulators of polluting substances entering the environment of our region. It is outline the urgency of research of their features, structure, chemical and material composition and their impact on ecosystems as well. When the release of pollutants with sewage disposal is decreased significantly, there is no improvement of water sources quality. It is directly because of broad range of causes: accumulated pollutants in soil and ground, pollution supply with land runoff or by the air, loss of functioning of cleansing structures in the result of depreciation and aging of equipment and polluted storm water runoffs. These are the main sources of water bodies’ pollution and bottom deposits as well.

Bottom deposits are the accumulators of anthropogenic contamination. Moreover, hazardous chemical content is an index of peculiarities of water bodies’ ecological state and current impact on regional water environment. [6].

Heavy metals and its mixtures pollutions exert downward pressure on phytoplankton condition, aquatic vegetation, shellfish, and fish. This question was already studied well (Favero et al., 1995; Lochovske, Puncocchar, 1995; Viola, Albergoni, 1995) [7-9].

It must be noted that water bodies’ pollution by seven heavy metals - Cd, Cu, Cr, Hg, Pb, Zn, and Ni is the great toxicological hazard for water grass and phytoplankton (Mueller, Furrr, 1998). Number of researches noticed the adaptability of fish and shellfish to bad habitat conditions, but upon that there is a magnification of heavy metals with hazard concentration on man in their bodies [3, 4-6].

With that, the following factors mean a lot in heavy metals accretion studies: their high-pollution in lower concentration for living organisms and their bio accumulative and biomagnificative potential [10, 11].

The numerous research has shown that [4-6, 9] modern problems of bottom deposits pollution in water bodies are the result of human economic activities and human impact on natural environment.

Immediacy of the problem of hazardous pollutant accretion in bottom deposits process consists of intensity of their effect to natural ecosystems.

3. Discussion
Bottoms deposits are accumulations of various sediment at the bottom of the water bodies; inorganic substance which accumulates at the bottom of the rivers, lakes and seas as a result of various physical, chemical and biological processes. All the bottom deposits vary in water bodies’ type: lake, river, marine deposits, etc. Bottom deposits content includes [12]:
- biological part of water grass, protozoan and micro-organisms;
- organic substances naturally and human occurred;
- nonorganic substances: phosphates, hydroxides, precipitated carbonates and clay particles.

Bottom deposits are the accumulators of pollutants entering the water bodies. Whereas it determines the immediacy of studies of their characteristics, structure, chemical and physical composition and their impact on ecosystems. Because of the fact that bottom deposits have high sorption properties they can be considered as integrating indicator of human impact on water resources.

Now there are known about 40 types of chemical substances classified as heavy metals. One part of heavy metals is biologically important for the living organism, but the other and large part exerts downward or even toxic pressure on natural environment components[10, 11].

According to GOST 17.4.1.02-83 in our country toxic chemical elements are divided into the following classes of hazards: 1 class - As, Be, Hg, Se, Cd, Pb, Zn, F; 2 class - Cr, Co, B, Mo, Ni, Cu, Sb; 3 class - Ba, V, W, Mn, Sr. Toxic level of heavy metals based on both their wide spread occurrence and high migration mobility near ground surface and their ability to accumulate in human body and causes various physical impairments [12, 13]. Great majority of metals take active part in biological processes and occur in many enzymes.

Such heavy metals as lead, cadmium, zinc, cobalt, nickel, cuprum, stannic, vanadium, manganese, chrome, arsenic are of important interest [14, 15]. They are popular in manufacturing industry and agriculture, but also they pose serious danger when accumulate in environment because of their biological activity and toxicant properties.

There are many microelements that are biologically important for living organism among heavy metals. However, their hyper level in various bioenvironmental objects that includes grounds exerts downward or even toxic pressure on biota. It is paid closer attention to bottom deposits as they suffer from technogenic geochemical press.

Heavy metals pass to bottom deposits from suspended substances in water objects that sorb heavy metals. In fact, water body is an accumulator of heavy metals coming from the atmosphere through land, ground and delayed runoff from the water shade area. The dominant suppliers of heave metals to water bodies are soil loss because of erosion, irrigation systems water and wastewaters from manufacturing, domestic and agricultural enterprises [2, 4, 16].

All the substances passed to are both anthropogenic and natural because of heavy metals coming from the atmosphere through land, ground and delayed runoff [16].

Let us consider ecological and health-related aspects of bottom deposits formation and build-up pollutants:

- the process of bottom deposits formation is permanent and continual;
- bottom deposits serious by volume accumulated in water objects;
- all the bottom deposits have different level of pollution;
- bottom deposits extraction process is followed by gas release, bacterial decay, and migration of polluting substances. All of these processes pose epidemical damage;
- waste disposal on the open-air waste dumps poses serious ecological damage because of deposition of sediments and migration of polluting substances;
- dredging works have impact on intakes’ working conditions.

Anthropogenic pollution is the main one in the process of heavy metals formation in ground, water and bottom deposits [17].

4. Methods
Problem of bottom deposits pollution is a result of human impact on natural environment. Because of the fact that bottom deposits have high sorption properties they can be considered as integrating indicator of human impact on water resources. During quantitative and qualitative examination of bottom deposits for the presence of heavy metals the real samples of bottom deposits in water bodies
of Rostov region were taken. The samples were taken from two testing sites in Rostov region. Bottom deposits’ toxicity determination was made according to GOST 17.1.5.01-80, CD 52.18.191-89 by atomic-and-absorption analysis.

For chemical analysis 3 samples from each testing site were taken. Total amount of soil samples for all the testing sites is 6. Bottom deposit samples were sent to the laboratory. Analytical studies were made in Chartered Testing Laboratory Centre FSBI State Centre of Agrochemical services “Rostovskiy”.

5. Results
Composite samples of bottom deposits from water bodies of Rostov region were examined for heavy metals determination. Results indicated that there are toxic heavy metals such as cuprum, lead, zinc, nickel and cadmium in the composition of bottom deposits of water bodies of Rostov region. Results are shown in Table 1. Heavy metal values by every measure is out of proportion of limiting concentration in grounds according to health standards ГН 2.1.7.2041-06 and ГН 2.1.7.2042-06. Data of heavy metals average grade in grounds of our region were used as baseline data [18].

Heavy metal values in samples examined are in the following limits (mg/kg dry mass): cuprum (Cu) 33.5 - 70.3, lead (Pb) 39.7 - 71.3, zinc (Zn) 65.4 - 244.0, nickel (Ni) 23.4 - 54.2, cadmium (Cd) 0.82 - 1.21.

For the present time, there is no approved rate of trace element content in bottom deposits. In the results we used the values of MAC approved for soils ГН 2.1.7.2041-06 "Maximum allowable concentration (MAC) of chemical agents in soil "[19, 20].

| Index      | Water body 1 | Water body 2 | MAC ГН 2.1.7.2041-06 | Analysis method |
|------------|--------------|--------------|-----------------------|-----------------|
|            | sample 1 | sample 2 | sample 3 | sample 1 | sample 2 | sample 3 | 3        | CD 52.18.191-89 |
| cuprum (Cu)| 37.7      | 47.9       | 43.8       | 42.6       | 33.5       | 70.3       |          |                 |
| Lead (Pb)  | 64         | 58.8       | 71.3       | 68.8       | 39.7       | 52.7       | 32       |                 |
| Zink (Zn)  | 244        | 112.8      | 108.8      | 172.2      | 65.4       | 106.6      | 23       |                 |
| Nickel (Ni)| 54.2       | 40.8       | 39.6       | 29.8       | 23.4       | 43.6       | 4        |                 |
| Cadmium (Cd)| 1.13     | 0.87       | 1.21       | 1.1        | 0.82       | 0.92       | 0.5      |                 |

Table 1. Heavy metals values in samples of bottom deposits examined.

Research showed that real value of heavy metals in bottom deposits is out of MAC (Table 2). Upon that as shown in Table 2 value of chemical elements is not above TAC (Tentative allowable concentration) approved for soils CD 2.1.7.2042-06, but is out of average proportion in the soils of region [18].

By WHO definition lead, mercuric and cadmium are the most dangerous heavy metals in natural environment [12]. The overage of dangerous pollutants values in bottom deposits over MAC is the index of their impact intensity on natural ecosystems[19, 20] As MAC is a sensitive index of human impact.
Table 2. Benchmarking analysis of heavy metals concentration in samples of bottom deposits.

| Element      | Heavy metals concentration in samples (average) | TAC, mg/kg | Average concentration in world soil (by Vinogradov A P) | Average concentration in regional soil (by Zakrutkin V E) |
|--------------|-----------------------------------------------|------------|--------------------------------------------------------|--------------------------------------------------------|
| cuprum (Cu)  | 45,96                                         | 132        | 20                                                     | 57,1                                                   |
| lead (Pb)    | 59,21                                         | 130        | 10                                                     | 27,0                                                   |
| Zink (Zn)    | 134,97                                        | 220        | 50                                                     | 62,0                                                   |
| Nickel (Ni)  | 38,57                                         | 80         | 40                                                     | 23,2                                                   |
| Cadmium (Cd) | 1,01                                          | 2,0        | 0,05                                                   | 0,5                                                    |

6. Conclusions

Undertaken studies found that there are toxic heavy metals in the composition of bottom deposits in water bodies of Rostov region. The value of heavy metals in bottom deposits is out of MAC approved for soils and is out of is out of average proportion in the soils of region. This is the result of human impact and it makes irreversible effect on natural environment. According to data found, the main pollutants are cuprum, lead, zinc, nickel and cadmium.

Thus, economical methods and techniques of heavy metals recovery and bottom deposits detoxication are needed to research [21-23]. This problem’s solution is important not only for Rostov region but for the whole Russia.

7. References

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