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Application Of Physical And Chemical Methods In The Assessment Of The Ecological State Of The Environment Of Urbanized Areas.

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ABSTRACT

The article presents the results of studies of the ecological state of the surrounding city of Stavropol on the basis of physicochemical studies of soil samples and water samples from small rivers, and a comparison of the current state of soils and surface water bodies with data from 1995 is made. It is established that significant soil pollution in urban areas with heavy metals, a negative anthropogenic impact on the state of the waters of the small rivers Mamaika and Tashla.

Keywords: soil contamination with heavy metals, small rivers, maximum permissible concentrations, physical and chemical studies.

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INTRODUCTION

In modern conditions, the natural environment is subject to active man-made pollution, which is more evident in urban areas. The growth in the number of vehicles, intensive construction, the activities of industrial enterprises contribute to the accumulation of pollutants in the biosphere.

A variety of compounds of anthropogenic origin, accumulating in the soil, in water bodies determine their contamination and toxicity. Among the numerous pollutants, heavy metals occupy a special place, they bind to mineral and organic compounds, which increases the overall level of soil toxicity (O.V. Borisova, 2009, E.Yu. Alhutova, 2009).

In urban areas, a large volume of untreated or conditionally clean sewage is diverted to the riverbeds, which leads to a change in the hydrological regime, with a greater degree being affected by changes in the water of small rivers.

Obviously, in urban conditions, the assessment of the ecological state of soils and aquatic ecosystems is an urgent task.

MATERIALS AND METHODS

Justification for the selection of accounting sites was both functional zoning and landscape zoning of the city territory. According to the type of anthropogenic impact in the city of Stavropol, the following zones are distinguished: residential, industrial, agricultural, forestry, transport, water management, recreational, as well as the steppe, reserve and cemetery zone.

Residential landscapes of the city of Stavropol occupy the historically central part of the city, the slopes of the Tashla and Mamaika rivers, and also adjoin the North-West and South-West industrial zones.

The selection, transportation, storage, preparation for analysis and analysis of soil samples was carried out in accordance with the approved regulatory documents (GOST 17.4.4.02-84, GOST 17.4.3.01-83), taking into account the functional zones of the city.

When conducting the assessment of hydrochemical indicators, the "Guidelines for the chemical analysis of surface waters of the land" were used, as well as the methods introduced into the State Register of methods for quantitative chemical analysis and assessment of the state of environmental objects approved for state environmental monitoring and monitoring. The studies were carried out taking into account the hydrological conditions of the city of Stavropol, which are determined by the geomorphological structure and lithological composition of the water-bearing sediments, taking into account the fact that the water quality of the vast majority of water bodies in the Stavropol Territory is normalized according to the parameters of the fishery category.

RESULTS AND DISCUSSION

According to the results of physicochemical studies of soil samples, it was concluded that the soils in much of the city are heavily polluted with heavy metals - the total content of heavy metals is 8 to 16 times the maximum permissible concentration.

Only on the outskirts of the city it is sometimes reduced to 4-8 MPC, and on the territory of the Russian forest from 0 to 4 MPC. But on the eastern outskirts of the city the content of heavy metals rises to 64-128, which corresponds to a threatening ecological condition. In the central part of the city, soil contamination almost everywhere reaches 32 MPC, i.e. On the content of heavy metals in soils, the situation here is unfavorable.

Compared with the "Ecological passport of the city of Stavropol" for 1995, the total content of heavy metals remained on the same counts in the same ranges (areas of the plant "Krasnyy metallist", JSC "Lyuminafor", old dump). But in some areas there is an increase in pollution due to increased transport load and expansion of the city.

The average content of zinc in soils is about 78 mg / kg (3.4 MPC). On separate sites, it varies within very wide limits - from 0 to 35 g / kg, exceeding the maximum permissible concentration by 1500 times. The main areas with high soil contamination with zinc are concentrated along the Staromarevskoye Highway, in the district of Kh. Vyazniki and the central part of the city (district of the station and industrial zone). The most contaminated soils are in zinc in microdistricts 12, 13, where the entire area (100%) contains more than 30 times the MAC content.

The average content of nickel in soils is 15.9 mg / kg, reaching 100 MPC. A significant part of the western and eastern zones of the city has soils with a nickel contamination index from 4 to 8 MPC. A very high nickel content is noted in the area of the old landfill. Here the pollution index exceeds 30 MPC.

The average content of cobalt in the city soils is 11.3 mg / kg (2.5 MPC). With a fairly uniform distribution across the territory, it varies from 0 to 40 mg / kg, but concentrations of more than 20 mg / kg (4 MACs) are rare.

The average copper content in the city soils is 7.2 mg / kg (2.4 MACs). In different parts of the city, it varies from 0 to 250 mg / kg (0-83 MPC). The most common values are 5 mg / kg (1.7 MACs).

The largest areas of soil contamination with copper are noted in the area of the eastern industrial zone, near the treatment facilities and the old city dump, along the Staromarevskoye Highway. Here, the copper content reaches 33.7 and more mg / kg. The spots with a high copper content are noted in the upper reaches of the «Tretya Rechka» gully, south of the crossroads of L. Tolstoy and Shpakovskaya streets, in the Strelbishcha area.

The average lead content in the city soils is 20.3 mg / kg (0-10 MPC) at the most frequent values of 10 mg / kg. However, the lead is distributed unevenly across the area: for most of the city its content does not exceed the MPC, but in some areas it ranges from 0 to 1500 mg / kg (0-75 MPC).

With lead, the soils of the central part of the city and the area of the eastern industrial zone are significantly polluted. Local spots, heavily soiled by lead, are located in the upper reaches of the «Tretya Rechka» gully and in the upper reaches of the Mamaika River.

Local spots of soil contamination with cadmium are noted, the pollution index in which reaches 77 and more MPC. Maximum cadmium contamination is found in the area of the old landfill. This site is a source of secondary distribution of cadmium in the form of an aerosol.

In the course of the research, the physicochemical parameters of the waters of the small rivers of the city of Stavropol were assessed.

The diagnosis of the state of the ecosystems of the Mamaika and Tashla rivers is based on the establishment of negative consequences of anthropogenic impact on water bodies.

The general hydrochemical characteristics of small rivers of the Stavropol Upland are given in the table.

Samples of water with slightly alkaline pH values were noted during the study period. The deviation of pH from the characteristic values for the waters of a given landscape zone indicates anthropogenic load. In samples taken in the spring period, water is marked by alkaline values, this is due to the presence of water receivers in the zone of influence of settlements. There were no significant fluctuations in this indicator.

The color of water is one of the indicators of the presence of dissolved allochthonous organic matter. The chromaticity of natural waters is mainly due to the presence of humic substances and compounds of ferric iron, ranging from units to thousands of degrees.

A considerable range of chromaticity values was revealed for the investigated watercourses. Especially clearly this is observed in the autumn period, when the maximum values are noted. This is explained, first of all, by a decrease in the water level with simultaneous concentration of organic matter.

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Suspended substances of the in-depth of the rivers are represented by mineral particles, insoluble organic matter, planktonic forms of hydrobionts. Minimum concentrations of suspended solids with a minimum range of values were obtained during the period of high water, which is due to the diluting role of water.

The highest concentrations of suspended solids were obtained in September, which corresponds to the period of autumn interflow, during this period, for water flows, a decrease in water consumption, an increase in the amount of dead organic matter. In our opinion, in addition to the natural dynamics of chromaticity, significant changes in this indicator are also associated with anthropogenic load.

Table 1: Hydrochemical characteristics of small rivers in Stavropol city

№	Index	MPC	Mamaika			Tashla		
			march	june	september	march	june	september
1.	pH, un.	6,5-8,5	8,3	8,3	8,1	7,9	8,16	7,42
2.	Color, deg.Pt/Co	-	27	46	65	41	54	80
3.	Suspended substances, mg / dm^3	-	156,0	168,0	1114,0	89,2	161,0	3327,0
4.	Dry residue, mg / dm^3	-	987,0	1304,0	809,0	844,0	834,0	1249,0
5.	Oxygen, mg / dm^3	6,00	8,9	7,4	8,5	8,6	7,2	6,0
6.	BOD 5, mg / dm^3	2,00	5,5	3,7	4,8	6,7	6,5	6,6
7.	Temperature Cº	-	14,5	25,00	10,00	9,0	25,0	10,0
8.	Oxidizing capacity, mg / dm^3	15,00	2,88	3,20	3,36	3,84	4,64	6,4

The dry residue is determined by the concentration of dissolved substances in water samples during the study period. As can be seen from the data of the table, there is no significant fluctuation of the indicator.

Literary data indicate that the greatest variability of values can be observed during the period of high water. This is due to two differently directed processes: on the one hand, during a period of high water a large number of dissolved substances enter streams with surface-slope waters: on the other hand, during this period the maximum water flow is observed, which ensures the dilution of the solutes present in the inlet with low mineralized, fresh and atmospheric waters.

The average value of the oxygen concentration along the rivers was 8.6 mg / dm^3, which is higher than the MPC. In the summer period and the period of the autumn inter-geny, the concentration of oxygen in water samples regularly decreases. The oxygen concentration in the Tashla River decreased from 8.6 mg / dm^3 to 6.0 mg / dm^3, which corresponds to the MPC value.

In general, seasonal dynamics in the rivers of the Stavropol Upland corresponds to the natural process of aquatic ecosystems (O. Pospelova and co-authors, 2011).

The data of the table indicate that the permanganate oxidation index varies from 2.88 mg / dm^3 to 6.4 mg / dm^3, but does not exceed the MPC. Such a dynamics of indicators indicates the arrival of domestic and industrial wastewater, as well as surface runoff.

In the course of research, a number of indices of inorganic substances were established.

The results of analyzes of the iron content in the waters of the rivers belonging to the rivers showed an increase in this index in the autumn period. A slight excess in September of the MPC was on the Mamaika

River. Samples from the Tashla River exceeded the maximum permissible concentration for the standard content of iron by 16.4 times.

Analysis of the indicators indicates that the level of ammonium ions in the month of June in the waters of the Tashla River exceeded the maximum permissible concentration.

The presence of ammonium ions in surface waters is mainly due to the processes of biochemical degradation of protein substances, deamination of amino acids, decomposition of urea under the action of urease. In surface waters, nitrites are in a dissolved form. In acidic waters, small concentrations of nitrous acid may be present. The increased content of nitrites indicates an intensification of decomposition processes of organic substances in conditions of slower oxidation, which indicates contamination of the water body, i.e., it is an important sanitary indicator.

The presence of phosphates in the introduction of rivers is caused by the processes of transformation of organic matter on the other hand, and on the other hand by the flow of industrial settlements, industrial sites, technological platforms with sewage.

Throughout the entire period of research, the normative concentrations of nitrite ions in all watercourses and phosphates in the waters of the Tashla River were exceeded.

The maximum content of nitrite ions was noted in summer in the Mamaika River was 7.5 MPC, in the Tashla River, respectively, 12.0 MPC.

The maximum phosphate content was noted in the waters of the Tashla River in September, which amounted to 14 MPC.

Excess indicators for nitrites and phosphate are largely due to the receipt of these substances with runoff from the private sector farmhouse containing poultry, in some cases growing pigs, as well as with untreated domestic wastewater. The water flow in the area of private buildings is carried out without cleaning and in most cases is not even regulated.

One of the most important microelements for the aquatic ecosystem is copper. The physiological activity of copper is mainly due to its inclusion in the active sites of oxidation-reduction enzymes.

Manganese is a polyvalent metal; therefore, in water it can be present in various degrees of oxidation: Mn (II), Mn (III), Mn (IV). The composition and forms of the manganese compounds in the water are influenced mainly by the pH value, as well as by the content of dissolved oxygen, hydrogen sulfide, carbon dioxide; The presence of microorganisms, oxidizing and reducing manganese.

The concentration of manganese in river waters is subject to seasonal fluctuations ranging from one to hundreds of μg / dm^3.

On all rivers there is an excess of the maximum permissible concentrations of copper. The maximum copper content was noted in the waters of the Tashla River in September. To a greater extent, the excess of this indicator is associated with seasonal changes in water flow.

CONCLUSIONS

The conducted researches of the environment of the city of Stavropol make it possible to determine the priority directions for improving the quality of the urban environment in accordance with the principles of sustainable development; this is the development of a project for optimizing road and transport flows, especially in the central part of the city; restoration of the flowability of small rivers in the city, in order to restore river ecosystems and reduce the flooding of adjacent territories; restriction of the use of pesticides of the first and second hazard class on personal plots with the aim of reducing pollution of soils, groundwater and surface waters by pesticides.

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