

Environmental monitoring of natural waters in Krasnodar and Stavropol Territories

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Abstract. The environmental monitoring of natural waters in Krasnodar (Uspensky and Novokubansky districts) and Stavropol (Kochubeyevsky District) Territories was conducted. In the course of study, various elements and compounds harmful to animals and humans, which exceed maximum permissible concentrations, were identified.

1. Introduction

In the territory of large enterprises such as the Stavropol SRPS included in the United Energy System (UES) of the South, sites of mining and processing industries, and cattle-breeding complexes as well, the geochemical redistribution of elements and compounds takes place. It leads to their accumulation in natural waters, soils, and plants. It is known that the regions of the South are strategically important and of great priority for developing the agriculture and livestock industry in Russia. Plants, accumulating harmful elements from natural waters and soils, are used as feed for animals; therefore, these harmful elements get in crop and livestock products of the country.

2. Materials and Methods

The aim of this study is to assess the negative environmental impact of a number of factors on animals and humans. Accurate data of the study would be obtained only over a long period. For this purpose, the degree of precipitation in different seasons, different types of waters (drinking water, river water, water from underground sources), air pollution, and soil condition have to be identified and assessed. These data are essential for the monitoring, assessment and prospective measures to reduce emissions from anthropogenic sources as well as to support further ecological balance within the recommended standards of sanitary control in the border areas of Krasnodar and Stavropol Territories of Russia.

In Stavropol Territory there are a lot of small and large rivers, lakes, water reservoirs (i.e. artificial surface watercourses and reservoirs), whose water is used for drinking and household needs, industry and agriculture. The river system is unevenly distributed across Stavropol Territory. The main source of Stavropol rivers' inflow is the seasonal rainfall and snow melting. The rivers originating in the mountains are fed by high-melting snow and glaciers. Rivers of Stavropol and Krasnodar Territories have a mixed type of nutrition. There are many different rivers, reservoirs, and lakes in Stavropol Territory. They are used in agriculture and industry as well as for drinking and domestic purposes. The Kuban River is the largest river of Stavropol Territory and the Northern Caucasus. It rises from



glaciers of the western slope on Mount Elbrus. The Kuban River has its source at the confluence of the Rivers Ullukam and Uchkulan and is 970 km in length. Within Stavropol Territory it flows across Kochubeyevsky District and along the border of Novoalexandrovsky District near Krasnodar Territory. The main inflow sources of the river are the following: rain – 60%, melting snow and glaciers – 24%, groundwater – 16%. As snow and glaciers play a key role in the recharge of these rivers, it explains the high and long summer flood. The water of the Kuban River refers to a drinking one and can be diverted for irrigation as well. However, it is very polluted by wastes from enterprises. The highest flood levels are observed usually in late July – early August. The flood fall occurs slowly and ends in late September; but sometimes it lasts till the first ice [1].

Taking into account the atmospheric conditions, sampling was carried out in different seasons. The list of study substances had been proposed by Regional Committee of Nature Resources. The analysis was carried out in accord with state-approved methods and certified techniques [2-4]. JSC "Nevinnomyssk Azot", located in Kochubeevsky District of Stavropol Territory, called Nevinnomysskaya Industrial Zone, was chosen for the emission control. Samples were taken near the enterprise. The samples analysis gave the following results presented in Table 1.

Table 1. Emissions of pollutants in the area of JSC "Nevinnomyssk Azot".

| Determined substances | Emitted, tons/ year | Maximum permissible emission, tons/ year |
|---|---------------------|--|
| Sulphur dioxide (SO ₂) | 6624 | 27853 |
| Carbon oxide (CO) | 2946 | 3830 |
| Nitrogen oxides (NO, NO ₂) | 18098 | 15078 |
| Hydrogen sulphide (H ₂ S) | 91 | 1.2 |
| Ammonia (NH ₃) | 2085 | 1974 |
| Phosphoric anhydride (P ₂ O ₅) | 9.3 | 42.7 |

The presented data show that the excess of permissible emissions limit is observed in such indicators as nitrogen oxides, hydrogen sulphide and ammonia. The determined compounds were in the form of aerosol. It can be due to the intense movement of air masses in different seasons, especially in spring and summer.

The greatest excess was found in the samples taken in "Armavir corridor". It is connected with the average movement of air masses along the corridor: east wind - 58%, west wind - 14%, north wind - 16% and south wind - 12%. "Armavir corridor" is clearly visible on the physical map (Figure 1). It is ridges location that leads to a fixed annual movement of air masses.



Figure 1. Location of «Armavir Corridor».

3. Results and Discussions

The determined compounds are toxic. They cause changes in the blood circulation, effect badly the respiratory system and skin, and the nervous system as well. They can also lead to metabolic disorders and allergic skin lesions.

Sulfuric anhydride is formed by the gradual oxidation of sulfur dioxide in the air, involving the light. The final reaction product is sulfuric acid aerosol in the air, rain water and clouds. When precipitating, it acidifies the soil, forming the corresponding metal salts, and exacerbates the respiratory diseases. Chemical enterprises emit the sulphuric acid aerosol into the air. This emission is concentrated in the low clouds and high humidity. Plants around such enterprises are usually dotted densely with small necrotic spots. It proves the presence of sulphuric acid aerosol in the atmosphere in a great amount. Pyrometallurgical enterprises of nonferrous and ferrous industry, as well as TPP, annually emit dozens of millions of tons of sulfur dioxide [5]. Nitrogen oxides such as NO, NO₂, N₂O₃, N₂O₅ are easily dissolved in water contained in the air. They form the aerosol of nitric and weak nitric acid. Aerosol and water sampling was carried out along the corridor border. Sampling areas are shown in Table 2.

Table 2. Sampling areas in «Avamir corridor».

| Point number | Settlement | Distance from starting point, km |
|--------------|---------------|----------------------------------|
| 1 | Ivanovskoe | 7 |
| 2 | Kochubeevskoe | 10 |
| 3 | Vrevskoe | 32 |
| 4 | Barsukovskaya | 24 |
| 5 | Urupskiy | 57 |
| 6 | Uspenskoe | 46 |

Results of the determinations of volatile substances are shown in Table 3.

Table 3. Amount of volatile substances in aerosol emissions, mg/l.

| Determined substances | Sulphur dioxide (SO ₂) | Carbon monoxide (CO) | Nitrogen oxides (NO, NO ₂) | Hydrogen sulfide (H ₂ S) | Ammonia (NH ₃) | Phosphoric anhydride (P ₂ O ₅) |
|-------------------------|------------------------------------|----------------------|--|-------------------------------------|----------------------------|---|
| Point number | | | | | | |
| 1 | 0.07 | 0.27 | 0.43 | 2.06 | 4.12 | 0.25 |
| 2 | 0.09 | 0.47 | 0.92 | 2.49 | 4.35 | 0.35 |
| 3 | 0.08 | 0.45 | 0.78 | 2.48 | 4.25 | 0.27 |
| 4 | 0.08 | 0.44 | 0.78 | 2.46 | 4.22 | 0.27 |
| 5 | 0.07 | 0.39 | 0.73 | 2.24 | 4.05 | 0.23 |
| 6 | 0.08 | 0.27 | 0.45 | 2.10 | 4.02 | 0.25 |
| MPC, mg/dm ³ | 0.02 | 0.01 | 0.05 | 0.08 | 0.02 | 0.05 |

Results of the determinations of substances in water bodies are shown in Table 4.

Table 4. Amount of substances in water bodies, mg/l.

| Determined substances | Sulphur dioxide (SO ₂) in form SO ₄ ⁻² | Nitrogen oxides (NO, NO ₂) in form NO ₂ ⁻ and NO ₃ ⁻ respectively | Hydrogen sulfide (H ₂ S) | Ammonia (NH ₃) in form NH ₄ ⁻ | Phosphoric anhydride (P ₂ O ₅) in form PO ₄ ⁻³ |
|-------------------------|--|---|-------------------------------------|---|---|
| Point number | | | | | |
| 1 | 700 | 0.33-43 | 2.06 | 4.12 | 25 |
| 2 | 900 | 0.46-92 | 2.49 | 4.35 | 3.5 |
| 3 | 800 | 0.42-78 | 2.48 | 4.25 | 2.7 |
| 4 | 800 | 0.44-78 | 2.46 | 4.22 | 2.7 |
| 5 | 700 | 0.45-73 | 2.24 | 4.05 | 2.3 |
| 6 | 800 | 0.14-45 | 2.10 | 4.02 | 2.5 |
| MPC, mg/dm ³ | 500 | 0.1-45 | 0.05 | 2.5 | 3.5 |

According to the received data, at the Nevinnomyssk SRPS heating boilers operating on heavy fuel oil have been replaced with the boilers using gaseous fuels. The repeated sampling of aerosol and water was carried out in 2013 at the same border of the corridor. Sampling areas are shown in Table 2. Results of the determinations of substances in water bodies are shown in Table 5.

Table 5. Amount of substances in water bodies (research data, 2013), mg/l.

| Determined substances | Sulphur dioxide (SO ₂) in form SO ₄ ⁻² | Nitrogen oxides (NO, NO ₂) in form NO ₂ ⁻ and NO ₃ ⁻ respectively | Hydrogen sulfide (H ₂ S) | Ammonia (NH ₃) in form NH ₄ ⁻ | Phosphoric anhydride (P ₂ O ₅) in form PO ₄ ⁻³ |
|-------------------------|--|---|-------------------------------------|---|---|
| Point number | | | | | |
| 1 | 350 | 0.03-5 | 0.06 | 1.12 | 2.5 |
| 2 | 500 | 0.06-11 | 0.49 | 1.35 | 3.5 |
| 3 | 400 | 0.02-9 | 0.48 | 1.25 | 2.7 |
| 4 | 400 | 0.04-9 | 0.46 | 1.22 | 2.7 |
| 5 | 400 | 0.05-8 | 0.24 | 1.05 | 2.3 |
| 6 | 400 | 0.04-5 | 0.10 | 1.02 | 2.5 |
| MPC, mg/dm ³ | 500 | 0.1-45 | 0.05 | 2.5 | 3.5 |

The presented data show that the modernization of the Nevinnomyssk SRPS has led to the reduction of toxic emissions. Monitoring data demonstrate a gradual improvement in the ecological situation.

4. Summary and Conclusions

The urgency of the production development in the agricultural areas of Krasnodar and Stavropol Territories of Russia to maintain the dynamics of the national economy is out of question. However, a considerable damage to the environment of these areas, which are recognized as a national treasure, requires changes in the existing approaches to organizing these enterprises. It is necessary to study and

propose solutions to this problem through the adoption and consolidation of norms and rules for the operation of enterprises. Thus, the principles of enterprises' activities should be defined. The implementation of these principles should be based on the nature protection activities. Because of the negative impact on the nature of Krasnodar and Stavropol Territories, the rational approach to solution of environmental problems with the involvement of all levels of authorities is required. It affects not only the environment, but also, agriculture, which is of major priority for Stavropol and Krasnodar Territories.

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