

# Assessment of environmental conditions in the Southwestern Region of Moscow

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**Abstract.** Air pollution is a leading factor affecting the health of the population residing in the capital. The primary source of air pollution in the city is automobile transport, accounting for over 90% of emissions. The number of vehicles on the roads increases annually, resulting in traffic congestion and elevated levels of exhaust fumes and pollution in residential areas and neighborhoods. Industrial enterprises also contribute significantly to pollution. Surface and groundwater in Moscow experience considerable stress, primarily due to intensive and irrational use of water resources, as well as the discharge of inadequately treated industrial and storm wastewater. Within Moscow's historical boundaries, artificially created or heavily transformed soils, known as urban soils, predominate. Differences between these soils, inherited from natural parent soils, consist of the mechanical composition of upper horizons and physicochemical characteristics of underlying rocks. These differences affect the soil's resistance to anthropogenic impacts and, consequently, determine the extent of necessary intervention to maintain satisfactory quality (volume of work and financial costs for maintenance and rehabilitation).

## 1 Introduction

Atmospheric air quality monitoring is conducted using automatic air pollution control stations (AAPCS), including mobile AAPCS and AAPCS in the territory of Troitsky and Novomoskovsky Administrative Districts. These stations operate continuously in real-time, measuring the concentration of 26 substances characteristic of anthropogenic emissions in Moscow's atmospheric air. The monitored substances include particulate matter with diameters less than 10  $\mu\text{m}$  and 2.5  $\mu\text{m}$  (PM10 and PM2.5 respectively), organic compounds, and carbon dioxide [1].

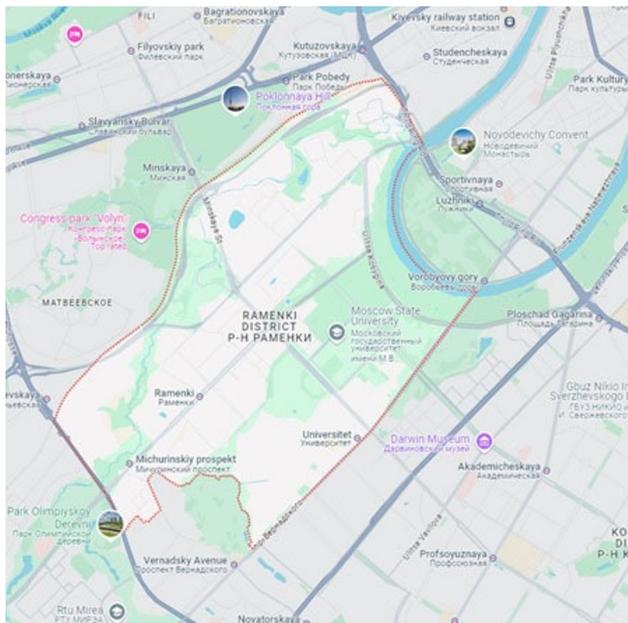
The soil monitoring network covers the entire city and consists of numerous permanent monitoring sites. Soil quality assessment is conducted annually across various types of territories, including residential areas, natural and green spaces, public areas, transport highways, and industrial zones. The evaluation encompasses 24 parameters to provide a comprehensive analysis of soil conditions.

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## 2 Materials and methods

Spatial framework for conducting engineering and environmental surveys: the object is located at the following address: Moscow, Western Administrative District, Ramenki district (Figure 1).



**Fig. 1.** Ramenki study area.

Pollutants characteristic of emissions from most anthropogenic sources, such as carbon monoxide, nitrogen dioxide, nitric oxide, total hydrocarbon compounds, ozone, PM10 and PM2.5, and sulfur dioxide, are monitored throughout the entire city area.

The content of specific substances (H<sub>2</sub>S, NH<sub>3</sub>) is monitored near their sources. For example, on the third transport ring, 16 pollutants are measured (including formaldehyde, phenol, benzene, toluene, styrene, ethylbenzene, etc.) [2].

The volume of work performed during the research is presented in Table 1.

**Table 1.** Volume of work performed.

No	Contents	Volume of work
1	Determination of heavy metal compounds, pH <sub>sol</sub> , 3,4-benzo(a)pyrene and petroleum products in soil samples	14 samples
2	Microbiological and parasitological studies of soil samples	10 samples
3	Entomological studies of soil samples	10 samples
4	Toxicological studies of soil samples	10 samples
5	Atmospheric air measurements (5 substances)	1 point

## 3 Results and discussion

The atmospheric air pollution level in the urban environment is assessed as elevated based on observational data. This characterization applies to the entire city. The priority air pollutants determining the sanitary situation in the city include nitrogen dioxide, total hydrocarbons, formaldehyde, ammonia, hydrogen sulfide, and suspended particulate matter.

An increase in the proportion of unsatisfactory water samples from underground water supply sources has been observed, with sanitary-chemical indicators rising from 28.4% to 58.7%. The majority of non-standard water samples from underground sources in terms of sanitary-chemical indicators are due to elevated levels of iron, turbidity, fluoride, and other chemical elements characteristic of the aquifers feeding artesian wells.

The soils in the study area are represented by technozems, lacking fertile and potentially fertile layers. These soils are unsuitable for reclamation purposes.

Within the survey area, soil samples from different depths exhibit petroleum hydrocarbon concentrations exceeding the permissible limit of 1000 mg/kg by 5.59 and 2.00 times, respectively. All other analyzed samples do not exceed this limit. Consequently, the petroleum hydrocarbon content in soils up to a depth of 11.0 m is classified as "permissible," except for the 1.0-2.0 m layer, where it is categorized as "very high" level of contamination, and the 2.0-3.0 m layer, which is classified as "medium" level of contamination.

In the studied area, samples revealed exceedances of the maximum permissible concentration (MPC) for benzo(a)pyrene by 1.25 and 1.15 times, respectively.

Heavy metal content is an important indicator of the ecological state of soils. The primary criterion for assessing the level of chemical contamination in soils is the MPC or approximate permissible concentration (APC) of chemical elements. In the study area, a sample from a depth of 0.2-1.0 m showed an exceedance of the APC for zinc by 1.17 times.

Laboratory analysis results indicate that soils and grounds in the study area up to a depth of 11.0 m and in layers 0.0-0.2 m and 3.0-8.0 m are classified as having a "permissible" level of contamination based on sanitary-chemical indicators. Soils in the northern part of the study area in the 1.0-2.0 m layer are characterized by a "very high" level of contamination, while the 2.0-3.0 m layer exhibits a "medium" level of contamination.

Consequently, soils and grounds in the southern part of the site up to a depth of 11.0 m and in the northern part of the survey area in layers 0.0-0.2 m and 3.0-8.0 m can be used without restrictions, excluding high-risk objects [3,4]. Soils in the northern part of the survey area in the 1.0-2.0 m layer require removal and disposal at specialized landfills. For soils in the northern part of the survey area in the 2.0-3.0 m layer, limited use is recommended for filling excavations and pits, with a clean soil layer cover of at least 0.5 m.

Atmospheric pollutants are emitted through exhaust gases from fuel combustion in engines, welding operations, and dust generation during earthworks and equipment movement. The most significant air pollutants include combustion products from diesel fuel used in electric generators and road construction machinery, gasoline combustion products from carburetor engines of vehicles, welding aerosols, and dust from earthworks [4]. The chemical composition of most air pollutants is represented by nitrogen and sulfur oxides.

These substances readily enter the atmosphere and can, under certain conditions, lead to the formation of acid precipitation, resulting in soil acidification and leaching of calcium and magnesium salts. Acid precipitation also directly enters water systems, causing undesirable acidification processes. Their negative impact is also manifested in plant organisms through defoliation, necrotic changes in plant tissues, and disruption of physiological processes.

It should be noted that the priority pollutants in urban soils remain lead, zinc, chromium, cadmium, and cobalt. Unsatisfactory samples based on microbiological indicators show elevated levels of coliform bacteria and enterococcus index, while pathogenic microorganisms (including *Salmonella*) were not detected. Parasitological indicators occasionally revealed helminth eggs.

The majority of urban soils in Moscow require replacement of the top layer approximately every 10 years in courtyard areas and every 3-4 years in areas adjacent to major roads. If these soil replacement works are not performed after the specified time, vegetation begins to suffer from an excess of harmful substances and lack of moisture. Moscow soils are

predominantly characterized by slightly alkaline to neutral pH and high content of plant-available nutrients (phosphorus and potassium).

## 4 Conclusion

The comprehensive survey yielded extensive recommendations and proposals for improving the ecological situation and promoting environmental restoration [6]. The assessment results identified negative factors impacting the environment and facilitated the development of effective measures for their mitigation. This approach will ensure the protection of ecological interests of the population and the conservation of natural resources [7].

Technological measures to reduce pollutant emissions into the atmosphere include:

- utilization of natural, environmentally safe materials;
- implementation of hermetically sealed technological equipment that prevents the release of pollutants into the working area's air.

The impact on soil stability in the studied area is localized, with varying degrees of intensity across different sections. The most significant effects on soil are caused by earthworks and the movement of heavy machinery during the construction period and in the initial years of site operation. Landscape transformation is limited to an area dependent on the volume of work at the operational sites.

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