Impact factory assessment on the air on the Pekhorka river basin

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Abstract The background ecological situation on Pekhorka river of the Balashikha district is determined by its location in the eastern part of the Moscow agglomeration. Most of the neighboring industrial centers are located to the west of it, from the side of the prevailing winds. Enterprises harm the air state during construction works. The vast majority of the enterprises are concentrated on the territory of Balashikha. The article discusses an example of calculating air pollution from the enterprise influencing the environmental pollution on the river Pekhorka basin. Air samples were taken and data on emissions of substances into the atmosphere were obtained. The calculation of the impact of the enterprise on atmosphere pollution was carried out with a specialized program. As a result, calculation of the dispersion of pollutants concentrations were carried out, the schematic map of the concentrations of substances nitrogen dioxide and sulfur dioxide was created and measures for the state of atmospheric air were suggested. Studies had shown that substances’ emissions slightly exceed the MPC and or did not exceed the MPC at all. However, it was necessary to carry out the regular atmosphere state monitoring to prevent damage to the environment.

1. Introduction

With rapid economic development and energy consumption in the past decades, air pollution has been experienced increasingly. In the article it is noted that pollution of atmospheric air of cities emissions of the motor transport in many regions of our planet is the major ecological problem [1-2]. The assessment of environmental impact on river catchments must include an assessment of the state of atmospheric air [3-4].

There are about 74 cities in the Moscow region. Balashikha occupies one of the first places in the region for its economic development. Science and industry traditionally determine the dynamics of development, as well as the socio-economic position of the city.

The city's industry is highly developed and mainly produces cranes, aircraft, precast concrete, various metal structures, wood products, water filters, paints, food products and much more. There are such enterprises as Open JSC "345 Mechanical Plant" which is engaged in the production of non-returnable reinforced concrete shielding containers for the storage of radioactive waste, automated
cement warehouses, concrete mixing equipment, and also implements treatment plant projects; Open JSC Balashikha Woodworking Plant, which specializes in the construction of log houses, as well as in the production of various wood products, from furniture to windows and doors and others.

Industry damage the environment. Therefore, it is important to carry out calculations of the technogenic impact on the environment in advance, namely the impact of the object during construction work.

The aim of the research is to assess the impact on the atmospheric air in the Pekhorka river basin from the enterprise during the construction work.

2. Material and methods
The area has been sufficiently studied in meteorological terms. The average January temperature is minus 7.8 °C, the average July temperature is 18.7 °C. Annual precipitation is 640 mm.

The general transfer of air masses in this area occurs in the latitudinal direction. The prevailing wind direction is westerly (21%). The frequency of southeasterly winds is also great, especially in the cold period (figure 1).

![Figure 1. Wind Rose in Balashikha for January and July months.](image)

The main sources of air pollution are identified and presented on figure 2.

![Figure 2. The main sources of air pollution during the construction period.](image)

The analysis of construction production showed that there are works on almost all construction sites. Besides, transport enhances air pollution. Liquid fuel, exhaust emissions, emissions of harmful substances into the atmosphere affect the health of the [5-7].

Data were used from the Center for Hydrometeorology and Environmental Monitoring to assess the
state of atmospheric air. Air sampling was carried out using the device «PU4». Air samples were analyzed with indicator tubes in laboratory conditions.

Calculation of UPRCA is Unified Program for Calculation of Atmospheric Pollution. This program allows to take into account many integral factors of emissions into atmospheric air; perform a comprehensive assessment of the state of objects with detailed awareness of the situation.

It was chosen for the calculation due to the fact that it is capable of calculating, taking into account such important factors as: zoning of territories adjacent to production; "wind rose" (wind direction and strength); taking into account the toxicity of each of the considered pollutants and accounting for summation and complex chemical interactions of pollutants emitted by the production.

Calculations were made for each production department separately. For example, the gross emission of paint aerosol (only with the pneumatic method of applying paintwork materials), tons per year, is determined according to the next formula:

\[ M_{B.CKP}^a = 0.01 \times B \times \delta_a \]  

3. Assessment of the atmosphere state from the enterprise

The source of impact on the surface layer of the atmosphere is road transport and construction equipment during construction. When the engines of cars and road-building machines operate on a construction site, the following are emitted into the atmosphere: carbon oxide, nitrogen oxide, nitrogen dioxide, gasoline, kerosene, soot, sulfur dioxide.

The level of air pollution with the main harmful substances (nitrogen and sulfur dioxide, suspended solids, carbon monoxide), according to average statistical data, in the Balashikha region can reach 2MPC (in our territory 1MPC).

A large number of overwhelming majority of industrial enterprises are located on the territory of the district, which can significantly pollute the atmosphere. Transport is also one of the main sources of pollution.

3.1. Laboratory research of atmospheric air samples.

The data of laboratory analyzes of atmospheric air samples and the maximum permissible concentration of substances are given in the table 1.

The concentration of sulfur dioxide in atmospheric air samples in the survey area is at the background level (sample No. 1) or exceeds the background concentrations of pollutants (samples No. 2-4) provided by the Federal State Budgetary Institution "Central Department of Hydrometeorology and Environmental Monitoring". The values in samples 2 and 4 are higher than the MPC. Based on background concentrations, the level of air pollution at the survey site is estimated as medium.

3.2. Settlement part of the study of the influence of the plant on the atmosphere of the Pekhorka river basin.

Calculations for carbon monoxide, nitrogen dioxide, hydrocarbons, sulfur dioxide, and soot are made taking into account the power of construction mechanisms and the number of simultaneously operating machines.

Initial data for calculating air pollution:

- Expediency threshold for the contribution of emission sources: 0.05;
- City area (for background extrapolation), km²: 20000;
- Settlement year: 2020.

Meteorological characteristics and coefficients:

- Coefficient depending on the temperature stratification of the atmosphere: 140;
- Average outside temperature, ° C: 25.9;
- Relief coefficient: 1.
Busting wind parameters:

- Direction, weather °: 237 - 14 (step 1);
- Speed, meters per second: 2.5 - 10 (step 0.1).

Table 1. Results of the study of pollutants in the air.

| Sampling points | Pressure, mm | Defined indicator                  | Concentration, mg/m³ | MPC, mg/m³ |
|-----------------|--------------|------------------------------------|----------------------|------------|
| 1               | 758          | nitrogen dioxide (NO₂)             | 0.01                 | 0.2        |
|                 |              | sulfuric anhydride (SO₂)            | 0.004                | 0.5        |
|                 |              | suspended solids                    | 0.031                | 0.5        |
|                 |              | carbon monoxide (CO)                | 1.19                 | 5          |
| 2               | 760          | nitrogen dioxide (NO₂)             | 0.012                | 0.2        |
|                 |              | sulfuric anhydride (SO₂)            | 0.51                 | 0.5        |
|                 |              | suspended solids                    | 0.52                 | 0.5        |
|                 |              | carbon monoxide (CO)                | 5.18                 | 5          |
| 3               | 759          | nitrogen dioxide (NO₂)             | 0.01                 | 0.2        |
|                 |              | sulfuric anhydride (SO₂)            | 0.005                | 0.5        |
|                 |              | suspended solids                    | 0.04                 | 0.5        |
|                 |              | carbon monoxide (CO)                | 1.18                 | 5          |
| 4               | 759          | nitrogen dioxide (NO₂)             | 0.025                | 0.2        |
|                 |              | sulfuric anhydride (SO₂)            | 0.54                 | 0.5        |
|                 |              | suspended solids                    | 0.53                 | 0.5        |
|                 |              | carbon monoxide (CO)                | 5.02                 | 5          |

The main coordinate system is right-handed with the OY axis oriented to the North. When calculating in the security zone, the coefficient 0.8 to the MPC was taken into account. The number of pollutants in the calculation is 12 (including solid - 3; liquid and gaseous - 9), summation groups - 1.

Emissions of pollutants from machinery during the construction period were determined according to the ATP-Ecolog program (version 4.0). The results of calculations of emissions from technology are shown in the table 2.

When moving and transporting sand and gravel mixture and crushed stone, emissions of inorganic dust were determined.

The maximum single emission of inorganic dust (SiO₂ 70%) is:

- M = 0.013440 gram per second;

Gross dust ejection is:

- P = 0.003553 tons per year.

Calculations of dispersion of harmful substances in the atmosphere were carried out according to the program "Ecolog", version 4.0.

Dispersion data show that the concentration of all substances at the border of residential buildings will not exceed the standards.
Table 2. Emissions of harmful substances from equipment during the construction period.

| Name of substance                      | Max. ejection (gram per second) | Gross ejection (tons per year) |
|----------------------------------------|---------------------------------|-------------------------------|
| Nitrogen oxides (NOx)                  | 18.6097122                      | 1.406121                      |
| Including:                             |                                 |                               |
| Nitrogen dioxide                       | 14.8877698                      | 1.124897                      |
| Nitrogen oxide                         | 2.4192626                       | 0.182796                      |
| Soot                                   | 3.0642478                       | 0.194497                      |
| Sulfurous anhydride                    | 1.7988489                       | 0.123401                      |
| Carbon oxide                           | 14.4707456                      | 1.279564                      |
| Hydrocarbons                           | 4.0958367                       | 0.319003                      |
| Including:                             |                                 |                               |
| Petroleum                              | 0.0491111                       | 0.025698                      |
| Kerosene                               | 4.0911700                       | 0.293305                      |

The calculation assumes the worst-case scenario of simultaneous operation of all emission sources, therefore, in a part of the construction site, the permissible concentration of nitrogen dioxide is expected to be exceeded; for other substances, excess is not expected.

Thus, the emissions of all substances, except for nitrogen dioxide, can be considered permissible and taken as the standards for maximum permissible emissions (MPE). Accept nitrogen dioxide emissions as temporarily agreed.

4. The result analysis
Assessing the impact of enterprises and transport on the state of air basin includes the following important factor is the emissions of pollutants, thermal effects, steam and aerosols. The thermal effect, temperature regime and other external natural factors affect the state of the atmospheric air as strongly as the emissions of pollutants [8-12].

Air pollution occurs due to the ingress of fuel combustion products from vehicles into the air, the release of substances from enterprises, as well as in the event of emergency situations. In the woodworking industry, dust pollution of the atmosphere is of great importance.

As a result of the impacts, air pollution increases, the temperature and humidity regime of the air basin changes, drizzling precipitation occurs, cloudiness increases, illumination and insolation parameters of the territory decrease, and ice phenomena intensify in winter.

At the stage of the work, the impact on the atmospheric air is short-term. Air pollution has the greatest excess of the maximum permissible concentration exclusively in the area of the enterprise itself. Air pollution in the group of indicators of sulfate dioxide and nitrogen dioxide is minimal and does not exceed the standard indicators in the residential area.

5. Discussion
The level of pollution of the surface layers of the atmosphere largely depends on meteorological conditions. In some cases, meteorological conditions contribute to the accumulation of harmful substances in the air of the construction and planning area. When unfavorable weather conditions occur, first of all, low, diffuse and cold emissions of pollutants should be reduced, while there should not be a significant reduction in the productivity of construction and planning works. As a mean of transportation materials transport is an additional source of air pollution [13-15].

Effective and efficient control of air pollution relies upon an understanding of the pollution sources and their relative environmental impacts [16-20].

Calculation in the UPRCA program allows to assess the state of atmospheric air and prevent the pollution in time. The scale development of the air pollution zone is calculated from emissions during construction and planning work is determined on the basis of calculations of ground-level concentrations of pollutants in the air of the territory under consideration from plant emissions.
To reduce and prevent air pollution by pollutants, the following technical measures are assumed:

- Prohibition of the operation of equipment with faulty or unregulated engines;
- Maintenance in good condition due to carrying out at the set time technical inspection;
- Maintenance and scheduled preventive maintenance;
- Using a cleaner type of fuel;
- The use of flue gas recirculation;
- Refuel vehicles and special equipment at specially designated areas.

Special measures aimed at reducing the volume and toxicity of emissions and reducing surface concentrations of pollutants include:

- Reduction of fugitive emissions;
- Improved dispersion conditions.

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