# Pollution of the atmosphere, snow and soil cover of Novosibirsk

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Spatial and seasonal change in the chemical and microbiological pollution of the atmosphere, snow and soil cover of functional zones of Novosibirsk is considered. The specificity of elemental chemical composition of particle size fractions of technogenic and pedogenic substances contained in snow, soils, and dust on asphalt coverings is shown. Seasonal pollution of the urban atmosphere is estimated.

## Introduction

The city of Novosibirsk is a large industrial center of Russia where the chemical pollution and microbe infection of the environment present a serious ecological problem associated with the health of population and the state of urban ecological systems. Their important component is the soil. The soils are capable of absorbing and inactivating chemical and biological pollutants from different sources, on the one hand, and, on the other hand, the soils are capable of giving them back from the air and water to the vegetable and animal organisms. These biospheric functions of soils can be used for a precise control over their state and to assess it as well as the input and output parameters of migration of chemical elements and microorganisms in a complex interrelated system: soil – air – natural waters – vegetation – animals (human beings).

According to data of the West Siberian Center for the environmental pollution monitoring, more than 300000 tons of technogenic emissions are discharged into the Novosibirsk atmosphere every year, including (in percent): carbon monoxide – 59%; sulfur dioxide and nitric oxides – 12%; concretion – 7%. These emissions are formed due to (in percent) burning of fuels – 89%, technological processes – more than 8%; motor transport – less than 3%. The most part of solid discharges is deposited on the city territory, forming technogenic geochemical anomalies with high total content of heavy metals (HM) and arsenic (As) exceeding their maximum permissible concentrations (MPC) in soils.[1]

The anomalies cover not only industrial and transport but the development, recreation, and agricultural (gardens and truck gardens) functioning city zones. In some regions of Novosibirsk, polluted by the plants of non-ferrous metallurgy, the worsening of the population health was observed due to the increased HM and As content in the environment.[2]

It is known that toxic elements get into the human organism with food and water and with the air containing the enriched HM technogenic and soil particles. The studies made earlier in Novosibirsk of the truck–farm products, grown on the polluted soils, have shown that these products correspond to the sanitary–hygienic requirements, but only rarely an excess of lead and cadmium content is observed.[1] Taking into account the fact that the drinking water also corresponds to the sanitary-hygienic requirements, we can assume that the source of excess HM and As in the human organism is the air containing soil and technogenic particles, which are capable of producing serious disturbance of health of urban population[3] because of the enrichment with HM and As.

In the northern latitudes, investigation of the snow cover is a convenient method of estimating the spatial distribution of technogenic pollution in the urban atmosphere. Owing to high sorption power of snow, a considerable part of products of technogenesis is accumulated in it, that enable us to study in detail their composition and to consider the obtained values as averaged during a long winter period.[4]

Over a period of the lack of snow cover, both technogenic emissions and soils take part in the pollution of ecosystems of urbanized territories, whose role is difficult to assess as yet. This is caused by the fact that the standards used in Russia for maximum permissible concentrations (MPC) of pollutants in agricultural soils are inconvenient for estimating the soils of the functional zones of the cities.[5] The current standards accepted in the countries of European Union, USA, and Canada of critical content of pollutants in the soil take into account the functional role of soils and peculiarities of the pollutant effect on different groups of population.[6] However, these criteria do not give an idea of the participation of soils in the formation of chemical composition of atmospheric aerosols and the ecological situation on the polluted territories. A promising approach to the estimation of

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soil pollution in Russia and in the West European countries is the investigation of pollutant concentration in soil fractions of different size and density.[7] Based on these investigations, it is possible to develop new methods of ecological assessment of soils and their influence on the adjacent media, the atmosphere, and hydrosphere, the vegetation, and animals.

## Subjects and methods of investigation

To determine the content of technogenic pollutants of the environment in the functional zones of Novosibirsk and in the background territories in the end of winter periods of 2002–2004, more than 350 samples of snow cover were collected. Using these samples the following parameters were determined: the acid reaction of the medium (pH), the concentration of suspended material (SM), petroleum products (PP), bulk content of more than 20 macro- and microelements. In snow samples collected at five sites selected by the Institute of Atmospheric Optics (IAO) and the Institute of Systematization and Ecology of Animals (ISEA) of SB RAS for complex monitoring, the bacterial pollution and the content of HM and AS in granulometric fractions of suspended material were determined.

To reveal regularities of pollutant distribution in the soil cover of the city and to assess the effect of soils on the adjacent media, the content of HM and AS was determined in granulometric fractions of samples selected near the monitoring sites from the soil layers, surface soil layers, urban dust (on the asphalt pavements).

The extraction from snow and soils of fractions of muddy (< 1 μm), dusty (1–5, 5–10, 10–50 μm), and sand (50–250 and > 250 μm) particles was made by the method of granulometric fractionation in distilled water (by Gorbunov) allowing to preserve the native content of HM and As in fractions and to consider two characteristics of particles – their size and density.

The HM and As content was measured by the atomic-absorption method, after acidic decomposition of samples using Plasma and Kvant-2A instruments and also by direct determination from sample powders by the atomic-emission method using an arc double-jet plasmotron.

## Results and discussion

### Chemical pollution

The investigations revealed that the atmospheric pollution of different regions of Novosibirsk was affected by the specific technogenic emissions of industrial enterprises, the density of transport and its intensity. In spite of a high content of sulfur dioxides and nitric oxides in the composition of industrial emissions, they are mainly carried away outside the city, because of this the pH of the snow cover is, on the average, 7.1, while in the background territories the reaction is more acid (6.5). Owing to the accumulation of solid technogenic emissions in the city, the mean content of suspended material in its snow cover is six times higher than the background content, and near the main highways it exceeds the background by almost 50 times. The petroleum products concentration in the urban snow is ten times higher than outside the city, and near the main highways it can exceed the background by 200 times. On the average, within the limits of transport zones of the Novosibirsk districts, the snow pollution by suspended material and petroleum products is by 2 or 4 times higher than in the development zones (Fig. 1).

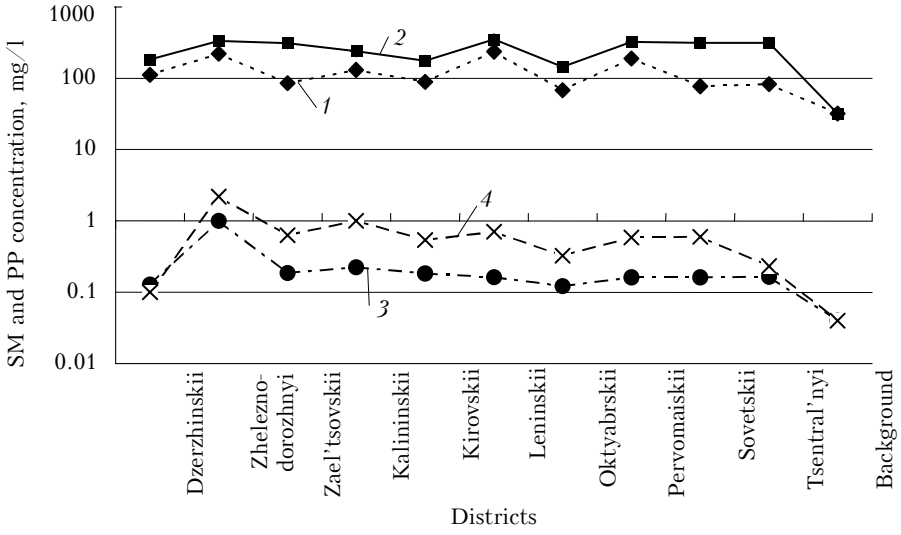


**Fig. 1.** Mean concentration of suspended material (SM) and petroleum products (PP) in snow water of different districts and functional zones of Novosibirsk: SM, development zone (*1*); SM, transport zone (*2*); PP, development zone (*3*); PP, transport zone (*4*).

**Table 1. Coefficients of correlation among the contents of petroleum products, suspended material, and chemical elements in the snow cover in Novosibirsk**

| | PP | SM | As | Bi | Cd | Co | Cr | Cu | Fe | Mn | Ni | Pb | Sn | Sr | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PP | 1 | 0.6 | – | – | – | – | 0.5 | 0.5 | 0.5 | 0.7 | 0.6 | 0.3 | –0.3 | – | – |
| SM | | 1 | 0.4 | – | – | – | – | 0.5 | 0.6 | 0.6 | 0.3 | 0.3 | –0.3 | – | – |
| As | | | 1 | 0.5 | 0.7 | 0.9 | 0.4 | 0.5 | – | 0.5 | – | 0.5 | 0.8 | – | 0.3 |
| Bi | | | | 1 | 0.7 | 0.8 | 0.3 | 0.3 | 0.3 | – | – | 0.8 | 0.3 | – | – |
| Cd | | | | | 1 | 0.9 | 0.4 | 0.6 | 0.3 | – | 0.3 | 0.7 | 0.8 | – | 0.6 |
| Co | | | | | | 1 | 0.6 | 0.3 | 0.3 | – | – | 0.8 | 0.7 | – | – |
| Cr | | | | | | | 1 | 0.4 | 0.3 | 0.6 | 0.7 | 0.4 | 0.8 | – | – |
| Cu | | | | | | | | 1 | 0.4 | 0.6 | 0.5 | 0.4 | – | 0.5 | 0.3 |
| Fe | | | | | | | | | 1 | 0.6 | 0.4 | 0.3 | – | – | – |
| Mn | | | | | | | | | | 1 | 0.8 | 0.4 | – | 0.9 | 0.4 |
| Ni | | | | | | | | | | | 1 | 0.4 | – | 0.4 | 0.4 |
| Pb | | | | | | | | | | | | 1 | 0.7 | – | 0.4 |
| Sn | | | | | | | | | | | | | 1 | – | 0.5 |
| Sr | | | | | | | | | | | | | | 1 | – |
| Zn | | | | | | | | | | | | | | | 1 |

N o t e . Weak or unreliable connections are denoted by dash. Given values of connections are reliable at $P = 0.99$.

Maximum differences between the snow pollution by the development and transport zones are observed in the regions with a rare network of highways (Sovetskii district), and the minimum differences are observed in the districts with highly developed network of highways (Zheleznodorozhnyi district). The most polluted housing estates are located in the Leninskii and Zheleznodorozhnyi districts, which are in the areas of precipitation of emissions from plants, heat and electric power plants, and motor transport. The effect of motor transport on the content of suspended material in snow and some chemical elements shows high values of correlation coefficients between the above-mentioned ingredients of snow composition and petroleum products (Table 1).

The calculations of coefficients of pair correlation among As, Bi, Cd, Co, Cu, Pb, Sn, and Zn have revealed significant and strong correlations indicating the general pollution sources of the environment – enterprises of nonferrous metallurgy. Of special interest is the Novosibirsk Tin Plant (NTP) – the main emission source in the Novosibirsk atmosphere of As, Bi, Sn, and other elements closely related to these elements. Emissions of this complex, even if very small in their mass due to the use of filters, have very high concentration of toxic elements exceeding the background concentration by 100 and 1000 times. The investigations have shown (Fig. 2) that arsenic and tin, emitted to the atmosphere with the NTP emissions, migrating mainly in the north-eastern direction, contaminate the snow and soil cover of Novosibirsk at the distance of 10 km and more.

General characteristics of the pollution of snow cover in Novosibirsk districts and the calculated estimates of the pollutant concentration in the atmosphere during winter period have been made by the authors earlier.[8] New data obtained at the sites of complex monitoring, allowed us to obtain the characteristics of chemical composition of fractions of suspended material in snow, soils, and dust accumulated on the asphalt-covered pavements (Table 2).

Given in Table 2 high SM concentrations in snow indicate their technogenic origin and point to greater toxicity of winter aerosols as compared with summer aerosols. In our opinion, the element composition of summer SM can show the element concentration in particles of less than 10 μm contained in the soil and dust on asphalt-covered pavements.

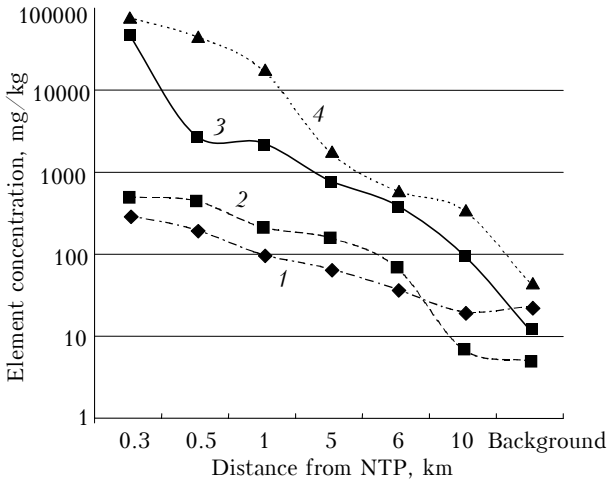


**Fig. 2**. Variation of As and Sn concentrations in the suspended material (SM) in snow and 0–10 cm soil layer depending on the distance from the Novosibirsk Tin Plant: As in soil (*1*); Sn in soil (*2*); Sn in snow SM (*3*); As in snow SM (*4*).

About 50 to 70% of the total mass of HM and As are grouped in the particles of coarse dust (10–50 μm) prevailing in snow (60%) and soils (35–50%).

In contrast to soil fractions, which differ significantly in the pollutant concentrations, in technogenic snow particles these distinctions are slight. The pollutant content in the suspended snow material can be much higher than in the soil particles. Coarse-dust and sand technogenic particles settling near the industrial centers, form mainly technogenic geochemical anomalies. These particles are mainly accumulated in the surface soil layer of 5-cm thickness in the city and slightly affect the pollutant distribution in the soil profile.

**Table 2. As and HM concentration in the SM of snow, fractions < 10 μm of soil and dust at the monitoring sites and background territories**

| Place | Object | Component | Element concentration, mg/kg of dry matter | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | As | Bi | Cd | Cr | Cu | Ni | Pb | Sn | Zn |
| *Area 1. The area and garden before airport "Severnyi" (Zaeltsovskii district)* | | | | | | | | | | | |
| Garden | snow | SM | 90 | 10 | 4.7 | 160 | 400 | 140 | 280 | 100 | 550 |
| | soil | < 10 μm | 24 | 9 | 1.5 | 120 | 140 | 100 | 350 | 24 | 430 |
| | | as a whole | 10 | 6 | 0.3 | 70 | 25 | 40 | 100 | 13 | 100 |
| Asphalt | dust | < 10 μm | 80 | 14 | n.d. | 160 | 160 | 120 | 180 | 31 | 900 |
| | | as a whole | 7 | 8 | n.d. | 70 | 25 | 50 | 45 | 16 | 240 |
| *Area 2. Central park of Culture and Rest (Central district)* | | | | | | | | | | | |
| Play area | snow | SM | 170 | 12 | 5.3 | 240 | 870 | 140 | 280 | 450 | 770 |
| | soil | < 10 μm | 36 | 8 | 2.0 | 150 | 140 | 110 | 145 | 45 | 390 |
| | | as a whole | 12 | 4 | 0.5 | 70 | 55 | 50 | 45 | 15 | 180 |
| Asphalt | dust | < 10 μm | 38 | 10 | n.d. | 180 | 150 | 105 | 170 | 53 | 470 |
| | | as a whole | 16 | 5 | n.d. | 60 | 35 | 45 | 60 | 15 | 175 |
| *Area 3. The Ob' Embankment at the hotel "Ob'" (Oktyabrskii district)* | | | | | | | | | | | |
| Lawn | snow | SM | 790 | 15 | 10.0 | 350 | 260 | 120 | 290 | 2760 | 430 |
| | soil | < 10 μm | 40 | 11 | 2.1 | 130 | 185 | 115 | 190 | 60 | 520 |
| | | as a whole | 11 | 8 | 0.7 | 110 | 80 | 100 | 100 | 30 | 260 |
| Asphalt | dust | < 10 μm | 35 | 13 | n.d. | 205 | 270 | 160 | 170 | 55 | 660 |
| | | as a whole | 10 | 4 | n.d. | 190 | 35 | 145 | 45 | 15 | 160 |
| *Area 4. Forest belt and bus stop at the NTP (Kirovskii district)* | | | | | | | | | | | |
| Forest belt | snow | SM | 42400 | 200 | 46.3 | 280 | 950 | 120 | 1100 | 14000 | 3030 |
| | soil | < 10 μm | 830 | 13 | 3.5 | 100 | 230 | 50 | 350 | 600 | 435 |
| | | as a whole | 235 | 12 | 1.2 | 85 | 140 | 40 | 180 | 475 | 350 |
| Asphalt | dust | < 10 μm | 60 | 10 | n.d. | 195 | 190 | 60 | 210 | 430 | 450 |
| | | as a whole | 15 | 4 | n.d. | 60 | 70 | 25 | 50 | 145 | 95 |
| *Area 5. Lawn and asphalted area at CC (Sovetskii district)* | | | | | | | | | | | |
| Lawn | snow | SM | 80 | 10 | 4.7 | 220 | 180 | 90 | 220 | 75 | 520 |
| | soil | < 10 μm | 10 | 6 | 0.5 | 90 | 55 | 60 | 60 | 11 | 250 |
| | | as a whole | 8 | 4 | 0.3 | 55 | 20 | 30 | 25 | 7 | 50 |
| Asphalt | dust | < 10 μm | 12 | 6 | n.d. | 110 | 250 | 85 | 135 | 25 | 535 |
| | | as a whole | 10 | 4 | n.d. | 40 | 40 | 25 | 40 | 15 | 125 |
| *Mean values at background territories (Toguchinskii and Ordynskii districts)* | | | | | | | | | | | |
| Meadow and forest | snow | SM | 50 | 5 | 2.3 | 120 | 160 | 70 | 70 | 20 | 180 |
| | soil | < 10 μm | 45 | 0.5 | 0.3 | 120 | 100 | 60 | 20 | 11 | 170 |
| | | as a whole | 20 | 0.5 | 0.1 | 90 | 35 | 40 | 18 | 6 | 80 |
| *MPC for soil at agricultural areas of Russia and Germany* | | | | | | | | | | | |
| Russia | soil | as a whole | 10 | n.d. | 2.0 | 130 | 132 | 80 | 130 | n.d. | 220 |
| Germany | | | 40 | n.d. | 2.0 | 200 | 50 | 100 | 500 | n.d | 300 |

Note. n.d. means not determined. For soil of Russia maximum concentrations are given; for soil of Germany – the admissible ones.[6]

The characteristics of spatial and profile distribution of technogenic pollutants of the environment in the soil cover of Novosibirsk readily demonstrate the variations of As content in soils and their granulometric fractions. In the vicinity of NTP, in gray forest soils of the "Bugrinskaya Roshcha" park the pollutants penetrate 20 cm deep, and the As concentration is high in all soil fractions. The most polluted are muddy particles (< 1 μm), and less polluted are sand particles (> 50 μm). Here the element distribution in the soil profile determines the change of content in it of coarse dust fraction and its As saturation. In the Inyushinskii pine forest which is at 5 km distance from NTP to the northeast, only in the upper 5 cm thick layer the As pollution of podzol soil is recorded; at a depth of more than 10–15 cm sand particles are practically not polluted. In the "Zaeltsovskii Bor" park, which is 10 km far from NTP the podzol soil, as a whole, is not polluted by As. Only muddy and fine-dust particles are enriched with As that points to the fact that polluted particles in size of less than 5 μm are transported to large distances. The described regularities of spatial and profile As distribution in soils are characteristic of the majority of heavy metals.

The assessment of the degree of saturation with heavy metals and As of suspended particles of the Novosibirsk snow cover by the concentration coefficient ($Kc$) and the index of total pollution ($Zc$) proposed by E.Yu. Saet[4,9] has shown that, on the average, the city snow is polluted only slightly (Fig. 3). The quantity $Zc$, showing the sum of excess (by 1.5 times) of concentrations of heavy metals and As in suspended material of the city atmosphere over their background quantities in soils of Novosibirsk Region,[10] is on the average less than the amount of low level of snow cover pollution ($Zc = 32–64$). However, near the NTP (Bugrinskaya Roshcha) the values of $Zc$ in the suspended material of snow are

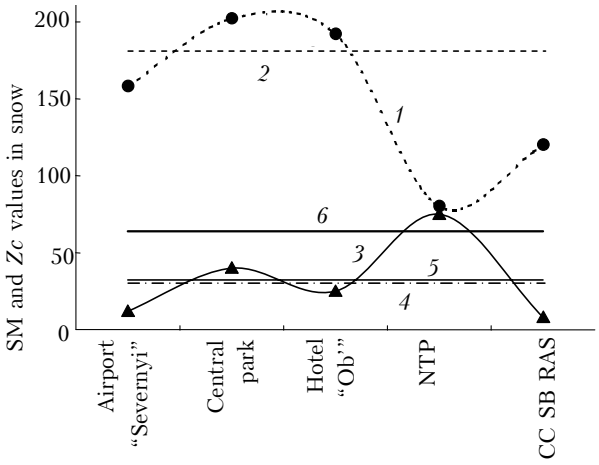


**Fig. 3.** Content of SM in the snow of Novosibirsk and its total contamination by heavy metals and As (*Zc*): SM content in snow, mg/l (*1*); SM mean content in snow, mg/l (*2*); total pollution of SM – *Zc* (*3*); mean value of *Zc* (30) in snow SM in Novosibirsk (*4*); low pollution (*Zc* in snow 32–64) (*5*); mean pollution (*Zc* in snow 64–128) (*6*).

within the limits of mean pollution level ($Zc$ = 64–128), and at some points the value of $Zc$ exceeds the level of very high pollution ($Zc > 256$) and even reaches 1300. Such high values of $Zc$ are indicative of essential anomaly of element concentration in urban atmospheric aerosols. Therefore, in spite of a relatively low dust content in the atmosphere in the NTP region, the concentration of HM and As in the suspended material here may be dangerous for the population.

The above data are confirmed by our calculations of the HM and As concentration ranges in the atmosphere during summer and winter periods for the monitoring sites (Table 3).

In these calculations we took into account the suspended material content in the atmosphere recorded during these periods at the stations of the State Observation Service of the Environmental Conditions and in our measurements as well as pollutant concentrations in the snow suspended material, in soil particles of 10 μm in size from the 5 cm thick soil layer and in the dust layer at the asphalt-covered pavements. The data presented in Table 3 point to the difference in HM and As concentrations observed in winter and summer in the suspended material of the Novosibirsk atmosphere and are indicative of the relative purity of the atmosphere. Only near the NTP in winter the excess of daily mean As and Pb concentration in the air is possible because of their very high content in technogenic emissions (77130 and 3000 mg/kg, respectively).

In these emissions the concentration of Bi, Cd, Sn, and Zn is very high (up to 600, 1230, 59350, 20000 mg/kg, respectively), but it is considered to be not dangerous due to high values of hygienic standards accepted in Russia. It should be noted that these standards allow for the suspended matter at the level of 1 MPC to contain microelements (including heavy metals) in excess of several tens and hundred thousands of the background content. On the contrary, the standards are tough for the macroelement content in the air. The excess of MPC for aluminum can occur even at its concentration in the suspended form, which is equal to the background one. Such a situation is observed in Novosibirsk.

## Microbiological pollution

In the snow cover at all of the monitoring sites the bacterial micromycetin complex was recorded with a wide ecologotrophic strategy of microbiota. Their bacterial spectrum is presented by aerobic, anaerobic, and thermophilous destructors of organic matter. Trophic variety is presented by proteolytic, amylolytic, and oligonitrophil microbes. Morphological organization

**Table 3. Calculated concentrations of pollutants for the monitoring sites in Novosibirsk**

| Season | SM, mg/m$^3$ | Range of minimum and maximum concentrations of elements in air, ng/m$^3$ | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | As | Bi | Cd | Cr | Cu | Ni | Pb | Sn | Zn |
| *Area 1. The area and garden before airport "Severnyi" (Zaeltsovskii district)* | | | | | | | | | | |
| Winter | 0.10–0.25 | 7–32 | 0.5–2.8 | 0.4–7.5 | 1–32 | 4–152 | 1–65 | 4–70 | 8–25 | 10–250 |
| Summer | 0.25–0.40 | 6–33 | 2.2–5.6 | 0.2–2.0 | 30–64 | 35–64 | 25–48 | 45–140 | 6–12 | 112–360 |
| *Area 2. Central park of Culture and Rest (Central district)* | | | | | | | | | | |
| Winter | 0.10–0.20 | 10–38 | 1.0–3.0 | 0.5–10.0 | 16–52 | 5–180 | 1–28 | 5–56 | 11–130 | 14–280 |
| Summer | 0.20–0.40 | 5–15 | 1.6–4.0 | 0.1–0.4 | 30–72 | 28–64 | 20–48 | 28–68 | 2–22 | 78–188 |
| *Area 3. The Ob' Embankment at the hotel "Ob'" (Oktyabrskii district)* | | | | | | | | | | |
| Winter | 0.10–0.2 | 8–158 | 1.0–3.0 | 3.0–16.0 | 4–70 | 3–52 | 3–24 | 8–58 | 10–560 | 12–240 |
| Summer | 0.20–0.40 | 7–16 | 2.0–5.2 | 0.1–0.4 | 26–84 | 36–108 | 22–64 | 34–76 | 6–24 | 104–272 |
| *Area 4. Forest belt and bus stop at the NTP (Kirovskii district)* | | | | | | | | | | |
| Winter | 0.10–0.20 | 3–**15420** | 8.0–120.0 | 0.9–246.0 | 10–240 | 15–620 | 2–300 | 4–**600** | 8–11870 | 15–4000 |
| Summer | 0.15–0.30 | 9–249 | 15.0–27.5 | 0.2–1.5 | 14–60 | 28–69 | 6–18 | 30–75 | 63–168 | 64–135 |
| *Area 5. Lawn and asphalted area at CC (Sovetskii district)* | | | | | | | | | | |
| Winter | 0.10–0.20 | 2–16 | 0.5–2.2 | 0.1–0.8 | 1–44 | 3–24 | 1–18 | 2–50 | 3–16 | 9–104 |
| Summer | 0.20–0.35 | 2–4 | 1.0–2.1 | 0.1–0.4 | 18–38 | 10–88 | 12–32 | 12–49 | 2–9 | 50–189 |
| *Maximum-permissible daily mean concentrations*[11] | | | | | | | | | | |
| | 0.15 | 3000 | 50000 | 300 | 10000 | 1000 | 1000 | 300 | 20000 | 50000 |

of bacterial complex is of coccus-type and confervoid. In the snow cover the sporeforming and nonsporeforming proteolytic bacteria are equally presented. The largest content of viable microflora is accumulated in spring in the snow of the airport "Severnyi" and near the NTP (Fig. 4) what is indicative of an essential microbiological pollution of these territories.

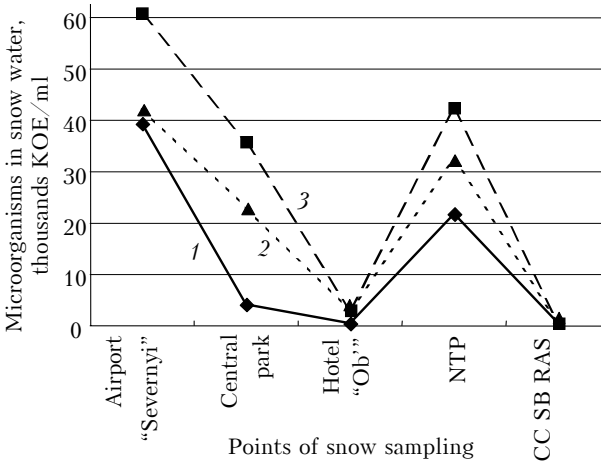


**Fig. 4.** Content of microorganisms in snow cover of Novosibirsk: amylolytic microbes (*1*); oligonitrophyl microbes (*2*); proteolytic microbes (*3*).

In summer high content of microorganisms is recorded in the dust (Fig. 5). The microflora consists of not only soil heterotrophic microorganisms but also of conditionally-pathogenic and pathogenic ones. The worst sanitary-microbiological situation is in the region of NTP, with high load of bacterial infection observed against the background of low pool of typical soil agents of self-cleaning.

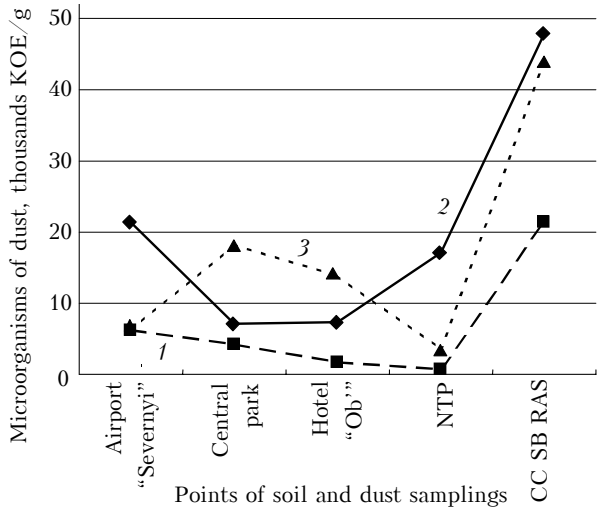


**Fig. 5.** Content of microorganisms in the soil dust of Novosibirsk: amylolytic microbes (*1*); oligonitrophyl microbes (*2*); proteolytic microbes (*3*).

In the soil fine earth the following matters are concentrated: a) physiologically active saprotrophic and heterotrophic utilizers of biogenic and mineral nitrogen, including the forms adapted to its deficit; b) sanitary-significant representatives: agents of mycosis, bacteriosis, toxicoses of vegetation and human beings; c) bacteria and micromycelium with a culture-morphological variability of colonies that points to their adaptation to toxicogenic conditions of life.

The estimation of the sanitary-microbiological state of soils in coli-titer, titer-perfringens, the level of content of thermophilous bacteria pointed to high level of bacterial infection of the territory with industrial emissions near the NTP. In different regions and functional zones of the city, the increased level of the intestinal microflora was also observed. Clostridium pollution of soils is universal in occurrence in summer period of maximum biological activity that is indicative of reduced rates of their natural microbiological self-cleaning.

The quantitative and qualitative composition of microorganisms in the surface atmospheric layer of Novosibirsk in most cases shows microbiological pollution of its soils. In winter, the peak content of viable microorganisms is observed during snowstorms, and the minimum content is observed during and after snowfalls cleaning the air from microorganisms and, also, from dust and heavy metals. In summer period in the atmospheric surface layer the microbe pool reaches its maximum in dry weather and its minimum – after rains, decreasing by a factor of 35, that provides temporary purity of the urban air.

The spatial distribution of microbiological pollution of soils in different functional zones of the city in general repeats the pattern of their chemical contamination. The soils of ecosystems of transport and industrial zones are polluted to the utmost by dangerous microorganisms, and the recreation zones are polluted slightly.

Thus, in the Novosibirsk territory we can observe dangerous to health of the population chemical and microbiological pollution of soils and atmosphere of its functional zones. Therefore in the city it is necessary to realize regular sanitary supervision of chemical and microbiological pollution of the environment because the combined pollution of biological and chemical nature provoke not only the soil depletion, and the increase of their toxicity, but the morbidity of vegetation, animals, and the population. In urban ecosystems, significant self-cleaning of soils from chemical and microbiological pollutants does not take place but their accumulation is observed. This is embodied in the increased delivery of HM and As in the food chain, in the development of phytomycoses, phytobacteriosis, intestinal and fungous illnesses of citizens.

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## References

1. V.B. Il'in and A.I. Syso, *Microelements and Heavy Metals in Soils and Vegetation of Novosibirsk Region* (Publishing House of SB RAS, Novosibirsk, 2001), 229 pp.
2. A.Ya. Polyakov, V.N. Mikheev, and K.P. Petrunicheva, in: *Modern Problems of Medicine of the Environment* (Moscow, 2004), pp. 209–210.
3. N.L. Baidina, Agrokhimiya, No. 3, 69–74 (2001).
4. *Methodical Recommendations on the Evaluation of the Degree of Atmospheric Pollution of Settlements by Metals in Their Content in Snow Cover and Soil*, Ecology, No. 9, 13–23 (1991).
5. V.N. Bashkin and A.S. Kurbatova, in: *Modern Problems of Soil Pollution* (MSU, Moscow, 2004), pp. 174–176.
6. Th. Eikmann and A. Kloke, UDLUFA–Mitteilungen **1**, 19–26 (1991).
7. N.A. Titova, S.S. Travnikova, Z.N. Kakhnovich, et al., Pochvovedenie, No. 7, 888–898 (1996).
8. A.I. Syso, M.I. Yatskov, A.A. Danilenko, et al., in: *Heavy Metals, Radionuclides and Elements – Biophylls in the Environment* (Semipalatinsk, 2004), Vol. 2, pp. 409–415.
9. Yu.E. Saet, B.A. Revich, E.P. Yanin, et al., *Geochemistry of the Environment* (Nedra, Moscow, 1990), 334 pp.
10. *Ecological-Geochemical Conditions of the Novosibirsk Industrial Region*, Report on the Geological-Ecological Investigations of Scale 1:200000 performed by Geoecocenter in 1991–1997 (Novosibirsk, 1997), 254 pp.
11. *Enumeration and Codes of Substances Polluting the Atmosphere* (Publishing House "St. Petersburg – XXI century", St. Petersburg, 2000), 320 pp.