

Technogenic Influence of Towns with Population less than 100000 People on Situation of Atmospheric Suspended Matter in the Place of State Reserve

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Abstract: The results of the research of nano- and micro-particles of atmospheric suspended matter, contained in the snow of Birobidzhan and State reserve "Bastak" in the winter of 2011-2012, are represented in this work. The distribution of suspended particles are revealed to be different sizes and origins in different parts of the town, varied Technogenic impact. Even a town with a population less than 100,000 people is shown to influence negatively influence on the protected area, located 15 km away from the town. This influence is found in detecting dangerous Technogenic microparticles in the atmosphere of the reserve (Fe, Cu, Pb, Ti and carbon black).

Key words: suspension, microparticles, toxic metals, environmental factor.

INTRODUCTION

According to the widely accepted definition, nature reserve is especially protected territory or water area wholly or partially excluded from economic usage in order to keep save natural systems, to protect species of animals and plants, as well as to supervise natural processes.

The purpose of this work is to find out to what degree anthropogenic influence of modern town can affect on relatively close located conservation area. The town of Birobidzhan was selected in the character of anthropogenic stress - administrative, economic and cultural center of the Jewish Autonomous Region (JAR). The town belongs to the medium-sized cities of the Far East, is located in a monsoon temperate climate zone and has an area of 150 km².

The population of Birobidzhan is 77.7 thousand of people. Within the territory of town about one hundred stationary sources of air pollution is located. Most if industrial factories are concentrated in the western and north-western parts of the town, and Birobidzhan

thermoelectric plant - in the center. In the structure of emissions for several years leading place belongs to heat energetics and motor transport. Also, the Trans-Siberian railway lies through the territory of Birobidzhan.

The only functioning protected areas of federal significance in the Jewish Autonomous Region - state nature reserve "Bastak" is considered in the character of conservation territory. It is located 15 km north than Birobidzhan and is also in the monsoon climatic region. The reserve is represented by a compact total area the of size nearly 92,000 hectares. Here the highway from Moscow to Vladivostok and the Trans-Siberian railway lies through. On the west side the park borders on Birs forest which timber is in active use. Northern and north-eastern limit borders with the Khabarovsk region territory, on the east side- the reserve Birobidzhan forestry [1].

This article continues our series of works devoted to collection the data of quantitative and qualitative composition of the atmospheric suspended matter the Far East towns [2-6].

EXPERIMENTAL PART

Snow samples were collected 26.12.2011 at 5 stations with different environmental conditions placed on the territory reserve "Bastak" (Fig. 1). Among the stations the most ecologically intense one is located near the federal highway Chita-Khabarovsk (1B), with the most active movement of motor transport. Points 2B, 3B, 4B are also located near the road, though Birobidzhan-Kukan highway is used infrequently, in connection with what is less environment stressful. Point 5B is 300 meters

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east of the Birobidzhan-Kukan highway, therefore is not the subject to anthropogenic influence of highway. However, exactly in 5B point of sampling drying of adult individuals of khingan fir is proven. Snow was collected according to our method [2] at the time of the snowfall of winter 2011-2012. Granulometric analysis was implemented on a laser particle analyzer Fritsch Analysette 22 NanoTech.

Also, snow samples were taken at five stations at 25.11.2011, located directly in the line of Birobidzhan (stations labeled D) (Fig. 2). Station 1 (D1) is located near the train crossing through the Trans-Siberian railway to the village Bricks (allows to consider the impact of emissions of rail transport on residential buildings). The second station (D2) is located in the area of ring road with a strong stream of vehicles, stop "Rainbow" (thermoelectric plant the impact of emissions of road transport in a residential area of the town). Station 3 (D3) is located in sanitary-protected zone of Birobidzhan thermoelectric plant of 500 m size, near the kindergarten № 44, which far removed from the thermoelectric plant to 450 m (thermoelectric plant the influence of organized emissions of the thermoelectric plant on residential buildings of the town).

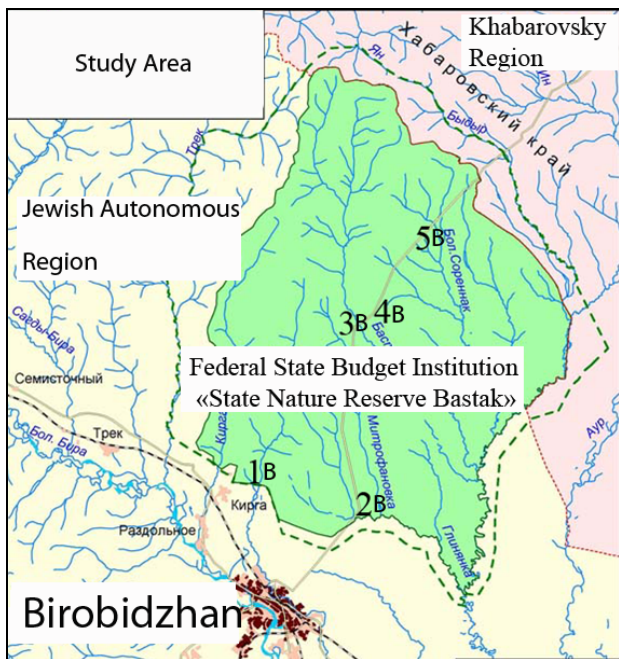


Fig. 1. Schematic map of the sampling locations of snow on the reserve "Bastak" (taken from [1] with permission) (sampling station transcribed in the text below)

The fourth station (D4) – Remontny Lane 5 - is also located within the sanitary -protected zone of Birobidzhan thermoelectric plant, but in contrast to station 3, it takes into account for the effect of disorderly emissions of the thermoelectric plant residential areas of

the town and is away from the main pipe to the thermoelectric plant to 500 m. Station 5 (D5) is a "reference point" and is located in a forested area near the mental hospital, away from urban areas and the private sector.

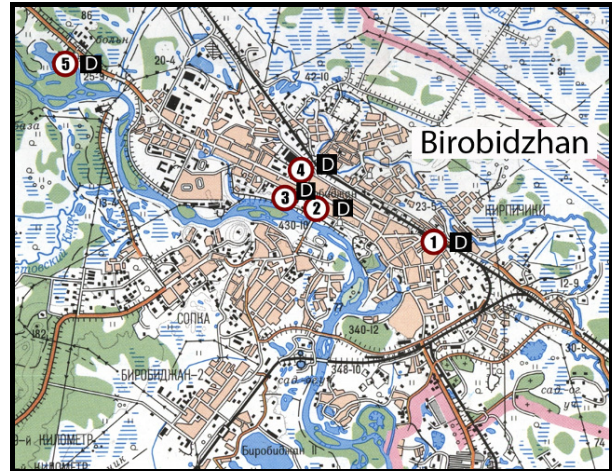


Fig. 2. Schematic map of the sampling locations of snow in the city of Birobidzhan (sampling station transcribed in the text below).

Substantial analysis of suspended matter is implanted on the light microscope Nikon SMZ1000 and scanning electron microscope Hitachi S-3400N with energy dispersive spectrometer Thermo Scientific. Spraying of samples for electron microscope was produced by platinum.

Analyzing the obtained results can be divided according to the size of aerosol particles into seven classes: 1) 0.1 to 1 mm (corresponding to PM1), 2) from 1 to 10 (corresponding to PM10), 3) from 10 to 50 microns, and 4) 50 to 100 m, 5) from 100 to 400 microns, 6) from 400 to 700 microns, and 7), more than 700 microns.

Size fractions and percentages in samples of suspended matter are shown in the following Tables 1 and 2, allows to see the picture in full.

Table 1. Distribution of particles in the snow on fractions at sampling stations in the reserve «Bastak»

Classes Ø, mkm, %	1B	2B	3B	4B	5B
1 0,1 - 1				0,2-0,5 52%	0,3-0,5 5%
2 1 - 10	4-8 25%	3-7 100%		5-8 48%	4 1%
					5-8 5%

3 10 - 50	10-30 75%				
					20-30 2%
					40-50 10%
4 50 - 100					70-90 20%
5 100-400					100-150 35%
6 400-700			450-550 7%		
7 700 and larger			800-1000 93%		700-1000 22%

Table 2. Distribution of particles in the snow on fractions at sampling stations in the Birobidzhan city

Classes ∅, mkm, %	1D	2D	3D	4D	5D
1 0,1 - 1			0,2-0,3 8%		
2 1 - 10	4-6 7%	5 1%			5 1%
			7-10 2%	8-10 4%	
3 10 - 50	10-20 50%				18-20 1%
	30-40 43%	20-30 20%	20-30 5%	20-30 8%	30-40 43%
			30-40 5%	30-35 4%	
4 50 -100		50-80 25%	50-60 7%	40-60 20%	
			70-90 8%		50-90 55%
5 100-400					100-200 8%
6 400-700		400-500 40%			400-500 75%
7 700 and larger		700-1000 14%	600-800 65%		

DISCUSSION OF RESULTS

The particles with a diameter less than 10 microns are seen to be in quite significant quantities in areas: 1B, 2B, 4B, 5B.

The greatest number of small particles suspended in the air, is found in areas 2B (3-7 microns) and 4B (0.2-0.5 and 5-8 microns). What might be the source of such particles in the atmosphere of the state reserve in the absence of technogenic origin (except Birobidzhan-Kukan highway) despite the fact that almost 60% of the territory "Bastak" reserve is covered by forest?

The suspended particles smaller than 10 microns are considered to be technogenic most of all, but the only man-made source of dusting – Birobidzhan-Kukan highway, is rarely used.

Several possible versions may be suggested to explain this fact. A possible source of nano-and micro-particles as small as 10 microns in air suspensions, according to some researchers [7], can be drilling or an explosion of rock. Such work was really carried out under the construction of mining plant in the urban settlement «Izvestkovy» (about 100 km from the reserve to the west) at the time of sampling.

In obedience to the meteorological data in the morning 26 of December, 2011 (day of sampling) in Birobidzhan and reserve "Bastak" west wind was blowing. The transfer of suspended particles size of 1-10 microns in troposphere up to 10 thousand metres [8] and on average, the presence suspended matter in the atmosphere for about 5 days [9] are the facts proving this version.

As a second potential version dust storms from the deserts of Mongolia and China is considered to be a source of dusting such dimensional particle shapes [10, 11]. It goes without saying, the source of dusting is unlikely to be determined without a detailed electron-microscopic and mineralogical analysis suspended particles qualitative composition.

At sampling stations 1B, 1D, 2D and 5D located near to the road and railway a rather high content of suspensions with a size of 10 to 50 microns were pointed, which are likely to be the particles of soot, asphalt and automotive rubber.

The largest particles of suspended matter (up to 1 mm) were observed in samples from areas of 3D, 5D, 3B, situated in relatively good ecological zone (sanitary protection, suburb and the territory within the reserve).

More detailed physical characteristics of suspended particles, found in the snow, are also obtained using a laser analyzer and given below (Tables 3 and 4).

It is worth paying attention to the fact that in terms of granulometry, the particles with smallest size have a

great specific surface area (up to 113,744.66 cm²/cm³ in 4B district) may absorb toxic substances on itself.

Table 3. Physical parameters of suspended particles contained in the snow in various parts of the reserve «Bastak»

Parameters /districts	1D	2D	3D	4D	5D
Arithmetic Mean Diameter, mkm	20,4 7	297,2 1	484,8 2	271,3 9	50,8 4
Moda, mkm	11,6 6	427,2 2	718,4 0	427,2 2	66,7 7
Mediana, mkm	13,0 1	393,4 9	667,0 0	401,4 7	59,3 3
Variance, mkm ²	130, 24	6994 1,21	1017 35,10	3923 9,94	310, 29
Mean Square Deviation, mkm	11,4 1	264,4 6	318,9 6	198,0 9	17,6 1
Coefficient of Variation, %	55,7 5	88,98	65,79	72,99	34,6 5
Spec. Surface Area, sm ² /sm ³	4114 ,23	1085, 72	2969 6,51	1010, 05	139 0,86

Analyzing the granulometric and morphometric characteristics of the particles investigated areas it is necessary to make some important conclusions.

The ratio and dimension of atmospheric suspended matter of Birobidzhan allows to ascribe the town among the environmentally advantaged ones, as the most dangerous particles (less than 10 microns) from the hygienic point of view are not detected in significant concentrations (up to 10%). Despite this, there are areas (1D, 2D, 4D and 5D), where fairly high concentrations of particles 3 size class (10-50 mm) were registered, which in terms of hygienic assessment are potentially hazardous due to the increased load on the respiratory system. Also worth noting the areas (1D and 3D), because of the presence of particles with a high specific surface area (up to 29696.51 cm² / cm³), which may be toxins carriers on it's surface.

An important result of this work can be considered detection in the reserve "Bastak" of high concentrations of particles the most hazardous to health in terms of dimension, fractions 1 and 2 class (up to 10 mm) and the composition (Pb, Fe, Cu, Ti and soot), which are technogenic in form and the type of surface (Fig. 3).

Table 4. Physical parameters of suspended particles contained in the snow in various parts in the Birobidzhan city

Parameters /districts	1B	2B	3B	4B	5B

Arithmetic Mean Diameter, mkm	11,93	4,77	932,24	2,99	268,7 4
Moda, mkm	14,04	4,78	1003,3 8	5,97	116,5 2
Mediana, mkm	12,85	4,73	968,00	0,40	108,6 3
Variance, mkm ²	17,73	0,49	14956, 92	8,65	1189 49,42
Mean Square Deviation, mkm	4,2	0,70	122,29	2,94	344,8 9
Coefficient of Variation, %	35,30	14,79	13,12	98,0 5	128,3 3
Spec. Surface Area, sm ² /sm ³	6048, 95	1286 2,93	66,17	113 744, 66	1147 3,20

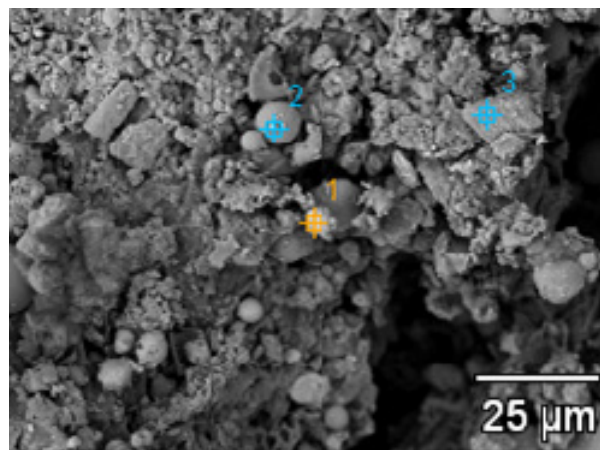


Fig. 3. Techno suspension (size less than 10 mm) was detected in the reserve Bastak at the point of selection 4B. The spectra are shown in Table 5 below. Electronic photo taken in reflected electrons.

Table 5. Composition of the particulate sampling point 4B according to energy dispersive analysis

Element	Spectrum 1	Spectrum 2	Spectrum 3
	Mass. %	Mass. %	Mass. %
O	28.09	25.05	33.39
Al	3.13		1.15
Si	5.13		63.08
C	1.41	1.30	2.38
Mg	0.73		
Fe	61.51	73.66	
Total	100,00	100,00	100,00

Especially the areas 2B and 4B are considered to provoke apprehension, as discussed above in results, which is aggravated by detection by type technogenic microparticles of metals and soot spherules size less than 10 microns. Areas 1B, 3B and 5B on granulometric ratio are relatively favourable in terms of ecological and hygienic assessment, because of containing the prevailing concentration of large particles. But even in these areas are found technogenic soot and metals (Fe, Pb and Cu) (Fig. 4).

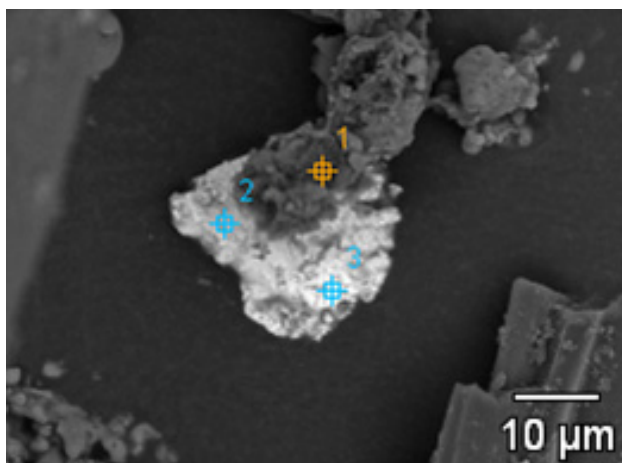


Fig. 4. Techno microparticle Pb (light in the center), found in the reserve Bastak at the point of selection 2B. The spectra are shown in Table 6 below. Electronic photo taken in reflected electrons.

Table 6. Composition of the particulate sampling point 2B according to energy dispersive analysis

Element	Spectrum 1	Spectrum 2	Spectrum 3
	Mass. %	Mass. %	Mass. %
O	15.16	12.86	
Al	3.12		0.44
Si	5.46		
S	1.37		
C	74.89	3.31	3.02
Pb		83.83	96.54
Total	100,00	100,00	100,00

CONCLUSION

In conclusion, it is worth noting that we have found a pronounced influence of Birobidzhan on composition of atmospheric suspended matter of reserve “Bastak”,

which appears to be in transfer of technogenic microparticles from urban atmosphere.

The obtained data allows to carry out primary environmental and hygienic zoning of Birobidzhan town and reserve "Bastak" on the content of atmospheric particulate suspensions, as well to rethink the influence of technogenic sources on natural protected areas.

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