Coal Terminal in Urban Settlement Posyet (Primorsky Krai, Russia) Causes Micro-sized Pollution of the Atmosphere

Aleksei Kholodov[1,*], *Aleksei* Lebedev[1], *Vladimir* Drozd[2], *Sergey* Ugay[2], and *Kirill* Golokhvast[3]

[1] Far Eastern Federal University, 690000 Sukhanova st. 8, Vladivostok, Russia
[2] Vladivostok branch of the Center of Physiology and Pathology of Respiration - Research Institute of Medical Climatology and Rehabilitation, 690105 Russkaya st. 73g, Vladivostok, Russia
[3] Pacific Geographical Institute, Far-Eastern Branch, Russian Academy of Sciences, 690041 Radio 7, Vladivostok, Russia

Abstract. The paper presents the results of a study of micro-sized pollution of the atmosphere of the urban settlement Posyet caused by a coal terminal. It was shown that PM_{10} particles (under 10 μm) in fractions from 21.94 to 45.5% were found at all 20 sampling points in Posyet. It can be noted that, regardless of the distance from the terminal, a single profile of atmospheric particulates with a peak in hazardous micro-sized dimension range is observed at all points of the settlement, which indicates a pronounced negative effect of the open coal terminal on the air in the settlement. The prognosis for bronchopulmonary diseases in the urban settlement Posyet with the current dynamics of coal handling is negative.

1 Introduction

The issue of environmental risk caused by open coal terminals near settlements is extremely important and urgent, especially for Primorsky Krai, as we have discussed earlier [1-7]. Open coal handling and non-compliance with the sanitary norms lead to a pronounced micro-sized particulates contamination of the surface air [4].

Urban settlement and sea port Posyet is located in the southern part of the Primorsky Krai, Russia; several bays around the settlement are protected natural environments. However a large coal terminal polluting the environment is located within the settlement. The sea port is capable of handling 12 mln tons of coal per year. The pollution in the urban settlement Posyet near the open coal terminal is so obvious that it can be seen with the naked eye (Fig. 1).

*Corresponding author: kholodov.as@dvfu.ru

Fig. 1. Photographs of visible pollution in the urban settlement Posyet with coal dust. Photographs taken by the authors

As it is known from the literature, coal dust causes a number of diseases, among which we distinguish anthracosis and pneumoconiosis caused by rare-earth elements. Both these diseases are incurable and irreversible [8-12]. It is necessary to at least prevent a person from inhaling dust. But how can this be accomplished if it is a residential area and a person is constantly under the influence of dust?

The goal of this paper, unlike the previous ones, is to create a basis for an environmental map of the urban settlement Posyet, examining in detail the air pollution at 20 sampling points, including those directly adjacent to the coal terminal.

2 Materials and Methods

Snow samples were collected at 20 sampling point in the urban settlement Posyet during the 2018 winter season. According to our preliminary data [4, 5], the main source of dust pollution in the settlement is the coal terminal located at the territory of the seaport. In order to assess the pollution of the territory with the coal terminal emissions, snow samples were taken at 50 meter intervals, gradually moving away from the particle emission source. The snow samples were taken in three directions, five samples each. Additional 5 samples were collected in the residential area. These samples are labeled as RA. The map of the sampling area is shown in Fig. 2.

Atmospheric particulates were studied in the fallen snow that was collected during snowfalls in March 2018. In order to exclude secondary pollution with anthropogenic aerosols, only the top layer (5-10 cm) of freshly fallen snow was collected. It was placed in sterile containers (Fig. 3).

After the samples were delivered to the laboratory the melted snow was evaporated using a rotary evaporator at 40°C until its volume was reduced to 60 ml. The liquid was analyzed using laser particle sizer Fritsch Analysette 22 NanoTech (Germany). The measurements were carried out in the range from 0.08 to 2000 μm.

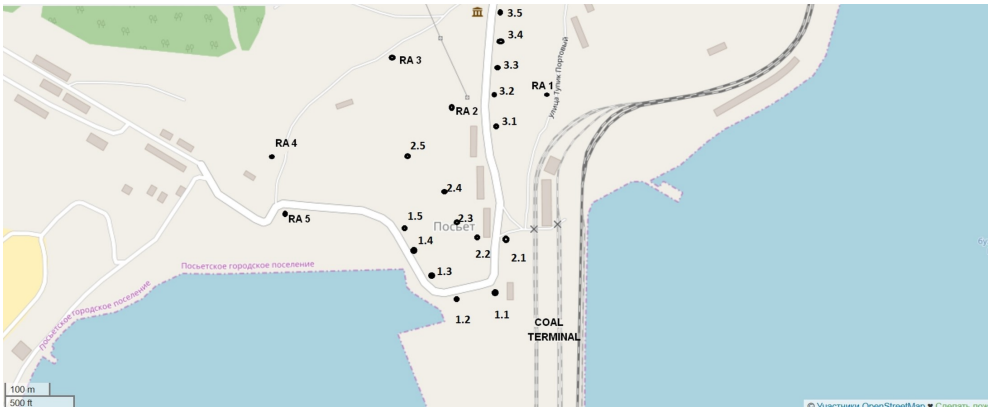

Fig. 2. The map of the snow sampling area in the urban settlement Posyet. © Openstreetmap contributors

Fig. 3. Photographs of containers with melted snow water from different sampling points in Posyet.

The research was conducted using the equipment of the Interdepartmental Center of Analytical Control of the State of Environment FEFU and Nanocenter FEFU

3 Results and Discussions

The particle size distribution data of atmospheric particulates in the urban settlement Posyet are summarized in Table 1 for convenience.

Table 1. Particle size distribution of atmospheric particulates at all sampling points in the urban settlement Posyet.

Fraction, μm, % / Sampling points	Under 1	1-10	10-50	50-100	100-400	400-700	Over 700
RA 1	2.77	42.73	19.86	0	0	4.75	29.88
RA 2	2.01	33.07	19.53	0	0	2.62	42.71
RA 3	0.8	22.02	16.75	0	0	5.07	55.95
RA 4	2.09	24.91	6.64	0	0	2.28	50.52

RA 5	0.52	21.63	7.56	0	0	4.97	65.19
1.1	3.1	30.58	23.79	0	0	2.3	40.16
1.2	2.16	19.78	13.43	0.02	13.85	28.02	22.4
1.3	1.61	28.06	27.03	0	0	2.76	40.48
1.4	2.96	38.61	19.76	0	0	3.34	35.29
1.5	2.84	35.98	17.48	0	0	2.93	40.72
2.1	5.94	39.92	26.48	0	0	0.85	26.73
2.2	3.18	37.67	27.55	0.21	1.83	14.64	19.91
2.3	1.24	15.42	19.91	0	0	4.12	59.21
2.4	2.7	37.45	23.54	0	0	2.8	33.45
2.5	3.06	39.06	25.43	0	0	1.96	30.44
3.1	2.55	38.29	29.94	0	0	1.49	27.68
3.2	1.55	31.1	34.73	0.83	9.64	7.35	14.78
3.3	4.45	45.35	19.44	0	0	6.28	24.46
3.4	2.58	33.22	19.83	0	0	2.98	41.33
3.5	4.41	35.16	20.8	0	0	3.94	35.66

The general profile of atmospheric particulates is presented in Fig. 4.

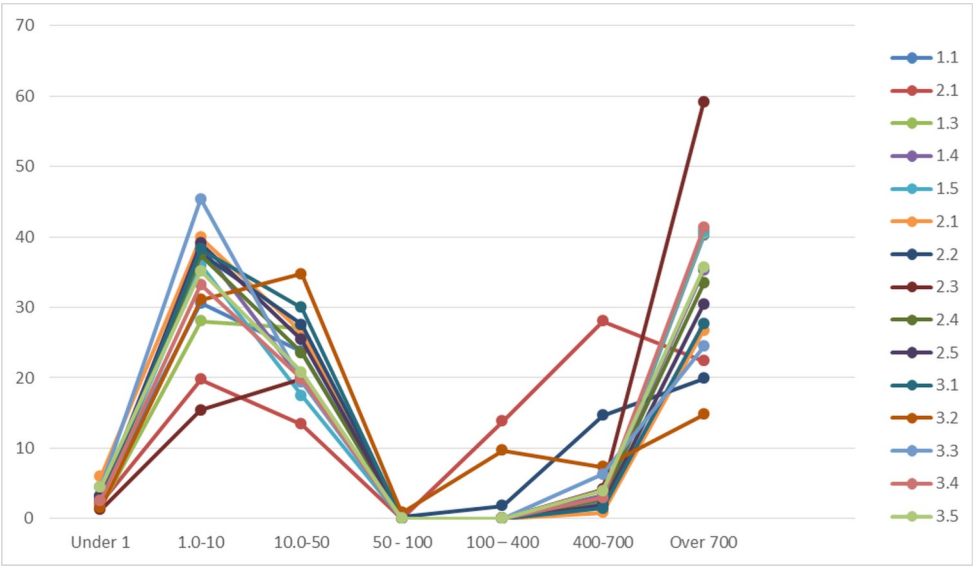

Fig. 4. Profile of atmospheric particulates of the urban settlement Posyet

According to data presented in Table 1 the entire territory of Posyet is under the influence of a dominant source of micro-sized particles emission.

Taking into account the wind diagram in the area (during the year western, southern and south-eastern winds prevail) and the location of the coal terminal in relation to the settlement, it becomes obvious that the terminal is the source of this pollution.

4 Conclusions

According to Figure 4 and Table 1 the surface air in the urban settlement Posyet is dominated by two classes of particles: 1) under 50 μm and 2) over 400 μm. This corresponds perfectly with the technological process of handling and loading coal. It was not possible to identify the principal absence of particles in the range from 50 to 400 μm in the majority of samples.

Regardless of the distance from the terminal, a single profile of atmospheric particulates with a peak in hazardous micro-sized dimension range is observed at all points of the settlement, which indicates a pronounced negative effect of the open coal terminal on the air in the settlement. The prognosis for bronchopulmonary diseases in the urban settlement Posyet with the current dynamics of coal handling is negative. The management of the stevedoring company urgently needs to take measures to eliminate this unfavorable environmental situation.

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