



ASSESSMENT OF THE RECREATIONAL ZONES IN MOSCOW USING NEUTRON ACTIVATION ANALYSIS AND ATOMIC ABSORPTION SPECTROMETRY

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4. Kuzminki-Lublino

Methods

Moss, vegetation and soil were analyzed.

The content of more than 30 chemical elements (Na, Mg, Al, Cl, Si, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Zn, As, Br, Rb, Sr, Mo, Sb, Cs, Ba, La, Sm, Tb, Hf, Ta, W, Au, Th, Ce, Nd, Em, Tm, Yb and U) in samples was determined by neutron activation analysis and atomic absorption spectrometry (Cu, Pb and Cd).

The ecologico-geochemical assessment:

The contamination factor (CF) (atmospheric deposition, vegetation, soil)

CF = Csample/Ccontrol

The relative accumulation factor (RAF) (atmospheric deposition)

RAF = (Cexposed – Cunexposed (4))/Cunexposed

The total pollution index (TPI)

The obtained results for TPI were compared with the established categories of pollution proposed by the «Methodological Recommendations for assessing the degree of atmospheric air pollution with metals in settlements, 1990 »

To calculate CF for **moss** the concentration in the unexposed moss sample was used as background

To calculate CF for **leaves** elements concentration in «reference plant» [1] was used as background

To calculate CF for **soil** elements contents from [2,3] was used as background.

The obtained TPI results for atmospheric deposition and leaves were compared with categories for snow cover

(taking into account the temporary nature of the impact)

level of pollution	Zc value for soil	Zc value for snow
low level	8-16	32-64
moderate pollution	16-32	64-128
high levels of pollution	32-128	128-256
very high levels	>128	>256

1. Markert, B. (1992). Establishing of "Reference plant" for inorganic characterization of different plant species by chemical fngerprinting. Water, Soil and Air Pollution, 64, 533–538.

2. Resolution of the Government of Moscow of July 22, 2008 No. 589-PP «On approval of the Methodology for assessing the amount of damage caused to the environment as a result of pollution, littering, disturbance (including sealing) and other deterioration of the quality of urban soils».

3. Sudnitsyn I.I. Krupenina I.I., Frontasyeva M.V. et al. Chemical composition of soils in Moscow and Dubna / Agrochemistry. - 2009. - No. 7. - P. 66-70.



1-1 site- Losiny Ostrov, 2-2 site- Losiny Ostrov, 3 site- Losiny Ostrov, 4-1 site- Izmailovo, 5-2 site- Izmailovo, 6-3 site-Izmailovo, 7-1 site- Victory Park, 8-2 site- Victory Park, 9-3 site- Victory Park, 10-1 site- Tsaritsyno, 11-2 site- Tsaritsyno, 12-3 site- Tsaritsyno, 13-1 site- Kuzminki-Lyublino, 14-2 site- Kuzminki-Lyublino, 15-3 site- Kuzminki-Lyublino, 16-1 site- Ostankino, 17-2 site- Ostankino, 18-3 site- Ostankino, 19-1 site- Sokolniki, 20-2 site- Sokolniki, 21-3 site- Sokolniki



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Exposure sites and TPI value



Cluster analysis

Cluster Dendrogram



V, W

A total of 32 chemical elements in moss samples exposed in the parks were identified, including heavy metals belonging to 1, 2 and 3 hazard classes.

At most sites, after three months of exposure, a decrease in the concentrations of alkali elements K, Rb and Cs in the samples was observed, which may be due to damage of the moss cell membrane under the influence of air pollutants and ion exchange processes.

The most polluted sites on the territory of the parks under study include the territory of the Tsaritsyno located near the road and railways, the territory of the Izmailovo located next to the North-Eastern Expressway, and the territory of the Losiny Ostrov close to the Moscow Ring Road.



The content of elements in leaves of all studied species, collected on the territory of 7 parks in June and September, mg/kg





This index has 6 categories (Fernández & Carballeira, 2001): no contamination (CF=1); suspected (1<CF<2); slight (2<CF<3.5); moderate (3.5<CF<8); severe (8<CF<27) – As, Pb, Cd, Mn; extreme contamination (CF>27) – Sb.

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no contamination (CF=1); suspected (1<CF<2); slight (2<CF<3.5); moderate (3.5<CF<8); severe (8<CF<27) – Ta, La, Th, Al; extreme contamination (CF>27).

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Exposure sites and TPI value



Cluster analysis

Cluster Dendrogram



Ni, Co, Zn, Ba, W, U, Sr, Mn, V, Pb

Element	Excessive or toxic [1]	«reference plant» [2]
Со	15-50	0.2
Mn	300-500	200
	normal-20-300	
	deficient-15-25	
Mo	10-50	0.5
	normal-0.2-5	
	deficient-0.1-0.3	
Ni	10-100	1.5
	normal-0.1-5	
V	5-10	0.5
	normal 0.2-1.5	
Zn	100-400	50
	normal 27-150	
	deficient-10-20	
Ba	500	40
As	5-20	0.1
	normal-1-1.7	
Sb	150	0.1
	normal 7-50	

- 1. Kabata-Pendias, A. Trace Elements in Soils and Plants / A. Kabata-Pendias, H. Pendias. Boca Raton, USA: CRC Press, 1984. – 315 p.
- 2. Markert, B. (1992). Establishing of "Reference plant" for inorganic characterization of different plant species by chemical fngerprinting. Water, Soil and Air Pollution, 64, 533–538.

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7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

0

2 3 4 5 6

1

- 1. Deficiency of Mo in leaves was observed on territory all parks, also the trend of decrease in elements content in samples collected in September was noticed.
- 2. The level of Mn in leaves samples on territory of Losiny Ostrov, Kuzminki-Lyublino, Izmailovo, Tsaritsyno, Ostankino and Sokolniki is toxic for plants.
- 3. Average pollution levels were observed on the territory of Losiny Ostrov, Ostankino, Sokolniki, Victory Park and Izmailovo parks.

SOIL

Mixed soil samples were collected at 3 location in each park at depth: **0-10** cm.

The maximum permissible concentrations (MAC) of gross forms for Mn, V, Sb and the MAC for Cd, As, Pb, Zn, Cu, Ni were adopted as sanitary and hygienic standards, taking into account the granulometric composition and pH.

Comparison of the obtained values with MAC and **approximate permissible concentration** (APC) revealed excess of As at all studied sites in Sokolniki (1.1 - 1.7 APC), the first and third sites in Izmailovo (1.3 and 1.4 APC), the second site in the Ostankino (1.3 APC) and the first site in Losiny Ostrov (1.1 APC). A slight excess of APC for Cd (1.6 APC) and Zn (1.3 APC) was observed at the first site of Sokolniki. The content of Pb, Ni, V, Mn, Cr and Sb in the studied soils does not exceed sanitary and hygienic standards.



The contamination levels may be classified based on their intensities on a scale ranging from 1-6 (0 = none, 1 = none to medium, 2 = moderate, 3 = moderately to strong, 4 = strongly polluted, 5 = strong to very strong Cd, Sb, W, 6 = very strong (Muller, 1969).

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The total pollution index (TPI)

- 1) Calculated taking into account the CF of elements of hazard classes
- 2) Calculated taking into account the CF of elements of hazard classes 1,2,3 and their toxicity
- 3) Calculated taking into account the CF of all potentially toxic elements, except macroelements

1 site	2 site	3 site		
Losiny Ostrov				
12/8/36	8/6/29	5/3/11		
Izmailovo				
11/8/29	25/23/46	15/12/34		
Victory Park				
11/9/34	20/20/42	15/16/44		
Tsaritsyno				
8/6/36	3/2/10	7/5/31		
Kuzminki-Lublino				
6/4/18	5/3/10	7/6/10		
Ostankino				
11/7/34	11/8/36	7/4/26		
Sokolniki				
25/26/32	20/17/41	11/9/19		

Exposure sites and TPI value



Cluster analysis

Cluster Dendrogram



1. On territory of the Sokolniki, Izmailovo, Ostankino and Losiny Ostrov a minor excesses of the approximate permissible concentration of elements of the 1st hazard class (As, Cd, Zn) was obtained.

2. According to the total pollution index calculated taking into account elements of hazard classes 1–3, the soils of Losiny Ostrov, Ostankino, Tsaritsyno and Kuzminki-Lublino are characterized by low level of pollution. A moderate level of pollution was identified on some sites on the territory of the Sokolniki, Izmailovo and Victory Park.

3. The total pollution index calculated taking into account all identified elements increased by average of 15 units, thus more than 50% of the studied area is characterized by the hazardous level of pollution.

The low level of pollution for all studied components was obtained on the territory of the **Tsaritsyno** and **Kuzminki-Lublino**; high and moderate levels of pollution were characteristic for the Losiny Ostrov, Tsaritsyno and Izmailovo. In other parks different degree of pollution levels for one or two studied components were identified.

The pollution levels obtained when calculating TPI for soils for more than half of the cases (57%) indicate high pollution comparing with moss and vegetation, that could be associated with the ability of the soil to accumulate pollutants and a longer period of pollutants release into the soil by aerotechnogenic way.

In addition, a high level of soil pollution with insignificant aerotechnogenic impact may be associated with the other source of pollutants release, beside atmospheric deposition.

Thank you for your attention!

