Pollution of Moscow soils with potentially toxic elements: analysis of long-term monitoring data

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In megacities, the environment experiences a high anthropogenic press caused by emissions from vehicles and industrial enterprises. Soils are an important component of urban landscapes: they not only accumulate pollutants, but also can be a source of secondary pollution of atmosphere and groundwater. The aim of this work is to analyze the long-term dynamics of soil contamination with potentially toxic elements (PTEs) in Moscow, as Moscow is one of the most polluted cities of Russia.

The basis for assessing the pollution of soils with As, Cd, Pb, Zn, Hg, Cu, Ni, Mn was the annual monitoring data for 2007-2016, which is obtained by the «Mosecomonitoring» institution and include more than 2000 points of observation. The accumulation of PTEs was characterized by a technogenic concentration factor $K_c = C_{urb}/C_b$ relative to the background $C_b$, which differed by three physiographic provinces. The total geochemical load on soils was estimated as $Z_c = \sum K_c - (n - 1)$, where $n$ is the number of elements with $K_c > 1$.

An analysis of the changes in the pollutant content in the soils of Moscow over the decade showed a twofold increase in the accumulation of Cu, Cd, As in the Central District and Cd in the Western and Northwest ones, as well as As in the northeastern part of the city by 1.4–2.3 times. In all districts, a tendency toward a decrease in pollution with Zn, Pb, and Hg was revealed. Compared with 2007, in 2016, the average content of all PTEs in the soils of the city decreased or remained unchanged, except for As.

The spatial distribution of PTEs in Moscow soils is controlled by the intensity and geochemical specialization of pollution sources, and varies due to soil properties. Central, Eastern, South-Eastern Districts are leading in terms of Cu and Pb pollution. Central and South-Eastern Districts are distinguished by Hg pollution. Central, North-Eastern, South-Eastern, and Southern Districts are most polluted with Zn and Cd. Soils in the southern part of Moscow are most enriched in Ni. High concentrations of As are characterized by soils of light grain-size composition with a high content of organic matter.

The highest values of the total soil pollution index $Z_c$ are characteristic for the Central and South-Eastern Districts, the lowest ones – for the Western and North-Western Districts. Analysis of $Z_c$ maps for 2007-2016 showed a decrease in soil pollution. In 2007, uncontaminated soils occupied
35.3% of the city's area; slightly medium, and heavily polluted - 33%, 22.8% and 9.4% respectively. In 2016, this sequence was as follows: 65%, 22.7%, 11%, and 1.3%. This trend is associated with a decrease in industrial production in Moscow, the removal of harmful industries outside the city and the renovation of enterprises remaining in the capital, as well as with a reduction in emissions from vehicles. Changes in the location of man-made geochemical anomalies in soils reflect leveling in the pollution from vehicles due to the construction of new housing and the large-scale transformation of Moscow regions with a decrease in traffic in the center (Bityukova, Mozgunov, 2019).