Analysis of heavy metals in the soil in the Ibar river valley in the district of Kosovska Mitrovica

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Abstract: Soil, air, and water pollution is emerging as a major problem in many cities because of industrialization and fast-paced lifestyles. The main sources of pollution in such environments are combustion products originating from industry, traffic, city heating plants, individual fireplaces, and construction activities, but also improper storage of industrial and communal waste. Soil is a complex and specific layer of the earth's crust that represents a geochemical "accumulator" of pollutants and plays an important role in environmental processes where it acts as a natural buffer that controls the transport of chemical elements and compounds to the atmosphere, hydrosphere, and the living world. Most of the industry in its production processes uses various mineral resources, the burning and melting of which results in the emission of dust, smoke, and suspended particles containing heavy metals, which are deposited in the soil from the air. The greening of urban areas through the construction of parks and green oases is of great importance for the reduction of soil pollution and the rest of the environment and for the preservation of urban ecosystems.

Keywords: soil pollution, heavy metals, environmental

1. Introduction

Intensive urbanization and industrialization led to the development of new and expansion of existing cities and industrial basins, where today, for the first time in history, more than half of the human population lives. Even though cities occupy only 2% of the Earth's surface, they are responsible for as much as 75% of resource consumption globally [1]. Pollution of air, water, soil, and vegetation occurs as a basic problem in cities and industrial zones, which are most often in or near large cities. The main sources of pollution in such environments are combustion products originating from industry, traffic, city heating plants, individual fireplaces, construction activities,

but also improper storage of industrial and communal waste. The conditions of emission of pollutants, climatic conditions and the method of greening have a great influence on soil pollution with various organic and inorganic pollutants and on changing its physical and chemical characteristics.

Soil is a complex and specific layer of the earth's crust created because of the joint and mutual action of the lithosphere, atmosphere, hydrosphere, and biosphere. [2] In addition to being a geochemical "accumulator" of pollutants, soil plays an important role in environmental processes where it acts as a natural buffer that controls the transport of chemical elements and compounds to the atmosphere, hydrosphere, and living world. [3] Of all natural bodies, the soil is the most inert, but in cities, it is constantly exposed to various anthropogenic influences, and direct and indirect human activity, which is why compared to soil in natural environments, it often has a damaged structure, altered physical and chemical characteristics, including a reduced content of nutrients, but also depleted fauna.

Soil quality is of crucial importance for the environment, which in urban and industrialized environments is damaged due to the release of various pollutants originating from mobile and stationary sources. Without a doubt, traffic represents one of the main sources of pollutants in urban areas that negatively affect the condition and quality of land, vegetation, and population. Heavy metals (HMs) are a special type of pollutant in urban soils. [4] The risk of HMs pollution lies in the fact that they are persistent and do not undergo biological degradation, which is why when they reach the soil they remain there for a very long time and are available for uptake by plants.

HMs in natural soils mainly originate from rocks and minerals that make up the Earth's crust, while in urban soils they are often of anthropogenic origin. [5] In urban soils, the main anthropogenic sources of HMs are pollutants originating from industry, traffic, and industrial and urban waste. Traffic-related activities also lead to the emission of metals in the form of dust and suspended particles from car exhaust or particles created by the wear and tear of various vehicle parts and the friction of tires on road surfaces. [6] Metals whose origin in urban soils is related to traffic and whose concentrations are most often measured and monitored are Pb, Cu, Zn, Cd, and Cr. [7] Municipal waste has a heterogeneous chemical composition and often contains large amounts of Cd, Pb, Zn, and Cu. Careless disposal of municipal waste in small areas can lead to the accumulation of very high concentrations of HMs in the soil. Due to all the above, numerous studies have been conducted on the topic of determining their overall content and behavior in the soil, as well as their potential impact on the environment [8-9]. The results of such research contribute to the characterization of contamination and enable the finding of adequate ways to protect and restore polluted urban soils.

2. Study area and sample collection

The Ibar is a river in the southwestern part of Serbia and the eastern part of Montenegro, with a total length of 276 km and a catchment area of 8,059 km². The Ibar springs from a strong spring under Mount Hajla in eastern Montenegro, 10 km upstream

from Rožaj, then flows east to Kosovska Mitrovica in Kosovo, then north to Kraljevo where it flows into West Morava. The basin lies between 42°21' and 43°44' north latitude and 19°55' and 21°29' east longitude. Relief, altitude, climate, and geological composition played a significant role in the formation of the pedological cover. The study area is located in Northern Kosovo in the district of Kosovska Mitrovica in the lower flows of the Ibar River.

2.1 Preparation of soil samples for analysis

The preparation of a representative sample was carried out using the method of random squares, which were taken from several measurement points, and then a composite sample was prepared. 5-10 g of soil was weighed on an analytical scale and poured with 20 mL of aqua regia. The sample was left to stand for 24 h, then heated in a water bath at 95 °C for 2 h. The cooled sample was strained into a volumetric flask of 100 mL and topped up with water to the line. The test was performed using the NITRON XRF ANALYZER method.

2.2 Results of measurements of HMs in the soil

The results of the measurement of HMs in the soil are shown in the Table 1. Measurements were made at four measuring points: Measuring point 1 "Žitkovac", Measuring point 2 "Vojni remont", Measuring point 3 "Česmin lug" and Measuring point 4 "Kablar".

Table 1. Results of measuring HMs at four different measuring points.

	Measuring point 1	Measuring point 2	Measuring point 3	Measuring point 4
HMs	Measured value (ppm)	Measured value (ppm)	Measured value (ppm)	Measured value (ppm)
Mo	Ø	Ø	Ø	2.3
Zr	137.74	250.24	296.58	Ø
Sr	172.96	147.71	168.86	298.6
Rb	36.37	23.71	73.8	Ø
Pb	16811.97	9829.06	2100.26	27152.14
As	408.18	540.76	36.22	825.0
Hg	Ø	Ø	Ø	Ø
Zn	4426.38	2351.8	552.54	4998.08
Cu	1491.12	147.64	38.32	6894.65
Ni	537.68	163.98	162	Ø
Co	36.64	Ø	Ø	Ø
Fe	51543.82	35455.25	31458.01	11836.99
Mn	469.21	653.92	252.13	797.2
Cr	646.63	282.04	340.22	89.6

The measured values are in accordance with the expected results for this area and type of soil, as well as with the degree of its pollution.

3. Conclusions

The most abundant elements are lead, zinc, and iron, which are in accordance with anthropogenic sources of soil pollution originating from industry, traffic, industrial and urban waste. The presence of the most dangerous HMs such as mercury, molybdenum, and chromium are at minimum values, which indicates that the pollution is at a level where there is a possibility of recultivating the soil in order to return it to an uncontaminated form.

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