SOILS FOR FUTURE UNDER GLOBAL CHALLENGES
SERBIAN SOCIETY OF SOIL SCIENCE
University of Belgrade, Faculty of Agriculture
Sokobanja, 21-24 September 2021
III International and XV National Congress
https://congress.sdpz.rs/

TOXIC ELEMENTS IN SOILS FROM VLASINA REGION

Sanja Sakan*[a], Aleksandra Mihajlidi Zelić[a], Sandra Škrivanj[b], Stanislav Frančišković Bilinski[c], Halka Bilinski[c], Dragana Đorđević[a]

[a] Centre of Excellence in Environmental Chemistry and Engineering – ICTM, University of Belgrade, Njegoševa 12 (Studentski trg 12–16), 11000 Belgrade, Serbia; [b] Faculty of Chemistry, University of Belgrade, Studentski trg 12–16, 11000 Belgrade, Serbia; [c] Ruđer Bošković Institute, Division for Marine and Environmental Research, 10000 Zagreb, Croatia;
*Corresponding author: ssakan@chem.bg.ac.rs

INTRODUCTION

The widespread contamination of soil with potentially toxic elements (PTE) represents currently one of the most severe environmental problems that can seriously affect environmental quality and human health. In order to assess the general pollution of soils from Vlasina region, the PTE contamination in this region were evaluated by using: the BCR sequential extraction procedure, the sediment quality guidelines, calculation of Igeo, and determination of magnetic susceptibility.

MATERIALS AND METHODS

In the presented study, 15 soil samples were collected in Vlasina region. Soil samples (Figure 1) were collected near the river Vlasina and its tributaries: Vlasina (6 samples), Gradska reka, Tegošnička reka (2), Ljuberađa (3), Pusta reka, Rastavnica and Zelenička reka. Soil samples were analysed by the optimized BCR three step sequential extraction procedure (Sakan et al., 2016). Magnetic susceptibility (MS) was measured using magnetic susceptibility meter SM30. The index of geoaccumulation (Igeo) has been applied to assess trace elements distribution and contamination in studied soils.

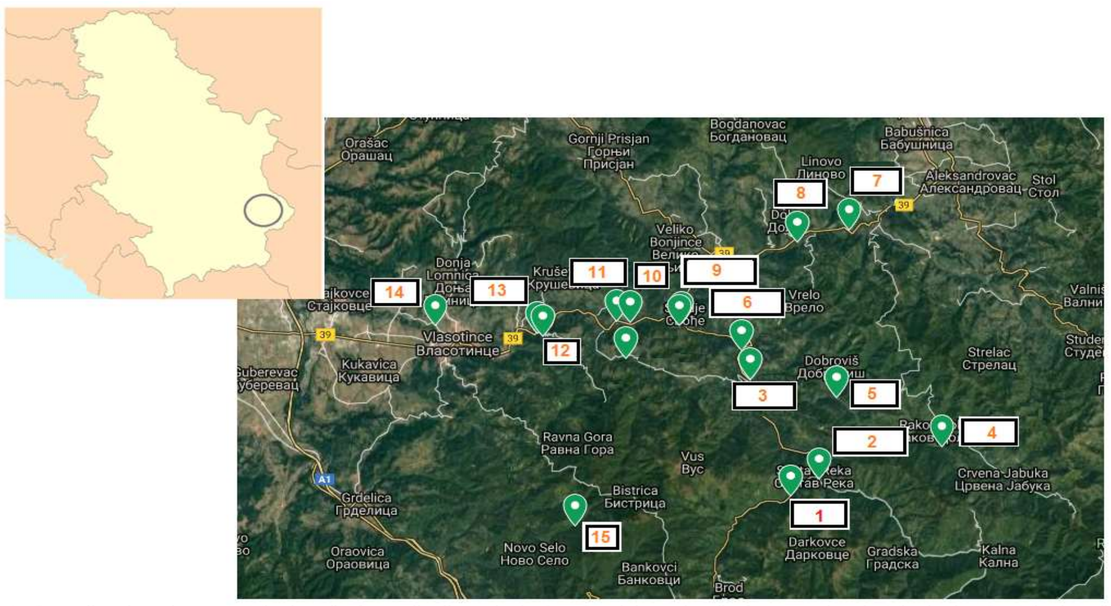

Figure 1. Sampling locations: 1- Vlasina (before all tributaries); 2 - Gradska reka (before casting in Vlasina); 3 - Vlasina (before the mouth of Tegošnica); 4 - Tegošnička reka (stone pit); 5 - Tegošnička reka (Dobroviš); 6 - Vlasina (below Tegosnica, upper walnut); 7 - Ljuberađa (medium flow); 8 - Ljuberađa (measuring profile); 9 - Ljuberađa (the mouth of Ljuberađa in Vlasina); 10 - Pusta reka;11 - Vlasina (under Pusta river);12 – Rastavnica; 13 - Vlasina (before the water intake); 14 - Vlasina (under Vlasotince);15 - Zelenička reka.

RESULTS AND DISCUSSION

Comparison of total element content with soil standard

The total content of the investigated elements (Table 1), extracted from the soil sample was compared with the limit and remediation values defined by the Serbian Regulation ("Official Gazette of RS", No. 30/2018 and 64/2019). An increased content of the following elements was observed: Cu in the soil sample near the Tegošnička river (Dobroviš), V in the soil sample near Vlasina (in front of the water intake, below the Pusta river), as well as Co in several locations. The values of copper and vanadium content are slightly higher than the maximum limits defined by the Serbian Regulation.

Table 1. Comparison of element content with soil standard [mg kg^{-1}]

	Content (studied soils)	MAV*	RV**
Cd	0.34-0.66	0.8	12
Cr	17.6-39.8	100	380
Cu	15.4-38.8	36	190
Ni	8.97-24.5	35	210
Pb	6.41-48.2	85	530
Zn	30.5-84.3	140	720
As	5.52-15.5	29	55
Co	5.12-22.2	9	240
V	16.1-45.1	42	250

* Maximum allowed values;** remediation value

These elements are predominantly bound in the residual, immobile, fourth fraction (about 50% of extracted Cu, 70% V and 50% Co), which indicates that the aforementioned elements do not represent a danger to the environment. Due to the influence of complex geological substrate, it is possible to expect increased cobalt contents in the soil and its origin is natural.

Index of geoaccumulation

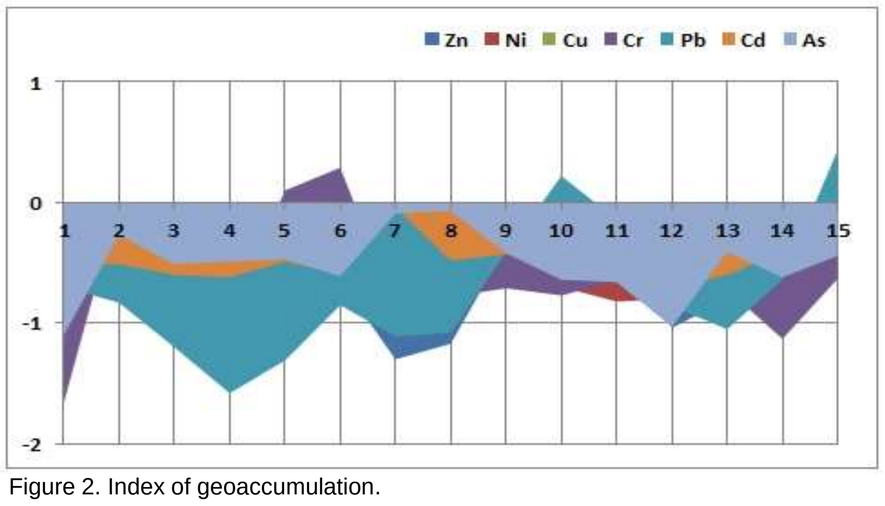

Figure 2. Index of geoaccumulation.

The majority of investigated soils (Figure 2) were in class 0 (background concentration), with the exception of samples 5 and 6 for Cr and 10 and 15 for Pb, which were in class 1 (unpolluted). This indicates that the soils in Vlasina region were practically uncontaminated regarding quoted elements.

Distribution of elements among fractions

Figure 3. Partitioning of studied elements in soils.

Metal fractionation (Figure 3) showed that easily mobile form is dominant for lead and manganese. Other elements (Zn, Ni, Cr, Co, As, Cu, Cd, and V), found dominantly in the residual fraction indicate that these elements may be an indicator for natural sources input.

Magnetic susceptibility (MS)

Table 2. Results of Boxplot analysis

Sample	Outlier
1	Cd, As
2	As
3	-
4	MS
5	MS
6	Cr, Co
7	-
8	-
9	-
10	Cu, Cr
11	-
12	-
13	-
14	Pb, Cd
15	Pb

Most of the studied elements does not show any statistical anomaly: Zn, Ni, Mn, and V (Table 2). Their distribution is completely regular and it is assumed that their origin is natural, without any anthropogenic influence. Also, it is important to mention that all other elements, which show some anomaly, mostly show weaker anomalies (outliers). Majority of these anomalies are most probably of natural origin and anthropogenic influence is obviously not significant in the studied area.

CONCLUSION

In this manuscript are studied the contents of micro- and macroelements in the soils from Vlasina region. Fractionation of Zn, Ni, Cr, Co, As, Cu, Cd, and V showed that the major portion of these elements was in the residual fraction, implying that these elements were strongly bound to the soils. Lead showed a different partitioning pattern than other studied metals, with a large percentage in Fe-Mn oxide fraction. The results of magnetic susceptibility measurements confirm the hypothesis of the dominant natural (geogenic) origin of the elements from the metamorphic rocks that predominate in this area. The calculated Igeo values indicated that the origin of elements are predominantly natural processes such as soil and rock weathering. Results of our research indicated that studied region is not under significant anthropogenic influence and that Vlasina is a clean area.

ACKNOWLEDGMENT

The authors would like to thank the Ministry of Education, Science and Technological Development of Republic of Serbia (Grant No: 451-03-9/2021-14/200026) for financial support.

REFERENCES

Sakan, S., Popović, A., Anđelković, I., Đorđević, D., 2016. Aquatic sediments pollution estimate using the metal fractionation, secondary phase enrichment factor calculation, and used statistical methods. Environ. Geochem. Health 38, 855-867.