HEAVY METALS IN ILLEGAL LANDFILL SOIL

Marijana Apić[1] Tatjana Taušanović[2] Nataša Stojić[3] Mira Pucarević[4] Dunja Prokić[5]

Abstract: Heavy metals are natural constituents of the environment, but indiscriminate use for human purposes has altered their geochemical cycles and biochemical balance. This results in excess release of heavy metals such as cadmium, copper, lead, nickel, zinc etc. into natural resources like the soil and aquatic environments. Prolonged exposure and higher accumulation of such heavy metals can have deleterious health effects on human life and environmental. For this paper, samples from wild landfills were analyzed for the presence of heavy metals.

Key words: heavy metals, wild landfill, soil, environment

1. INTRODUCTION

Chemical substances that can be found every day in nature (soil, air, water) are becoming more numerous. They can be natural products, synthetic or products obtained by chemical transformation of natural products. These substances are almost always found in the soil, but in different amounts, which is why they are called "trace elements", or microelements. Some of them participate in small amounts in plant nutrition and are called micronutrients. Other trace elements that are not necessary in the soil, can be harmful and dangerous for plants, humans and animals. This group of elements consists of toxic elements, and both groups of elements consist mainly of the so-called. heavy metals. The epithet "heavy" comes from the fact that most of these elements have a bulk density greater than 6 kg/dm3, however, due to their known toxicity, this group also includes some metals with a lower bulk density, (eg Be) then metalloids (As and At).Both of these terms encompass a group of metals that can pollute the environment. The origin of heavy metals in natural soils comes from the decomposition of rocks and minerals on which the soil is formed (parent substrate). The content of elements in the soil depends on their content from which the parent substrate originated. Therefore, the sources of the mineral part of the soil are the rocks and minerals that make up the Earth's crust. Soil contamination with heavy metals differs from soil type. In addition to natural sources of heavy metals in the soil, a significant source are anthropogenic factors (application of organic and mineral fertilizers, mines, metal smelters, metal industry, roads, urban waste, landfills, etc.). Soil pollution with heavy metals leads to disruption of natural geochemical cycles and the balance of ecosystems. Heavy metals whose emission from natural and / or anthropogenic sources is significant include Hg, Cd, Co, Cr, Pb, Ni, Mn, Fe, Cu, Zn and others.

2. HEAVY METALS IN THE SOIL

The contamination of soils by heavy metals is significant problem, which leads to negative influence on soil characteristics and limitation of productive and environmental functions[1]. The soil microbial community has a fundamental role in the process of organic matter degradation and mineralization, which allows the recycling of nutrients (Castaldi et al. 2004). Heavy metals affect the number, diversity and microbial activity of soil microorganisms[2]. They can cause slow down speed of growth and reproduction of microorganisms, in the soil then prevail slower growing microorganisms with lower diversity and higher resistance to heavy metals, but decreased biological activity (Šimon 1999).

[1] MSc, University Educons, Faculty of Environmental Protection, Sremska Kamenica , email: marijana.ns@gmail.com
[2]BSc, University Educons, Faculty of Environmental Protection, Sremska Kamenica email: tatjanatausanovic@gmail.com
[3] PhD, University Educons, Faculty of Environmental Protection, Sremska Kamenica, email: natasastojic7@gmail.com
[4] PhD, University Educons, Faculty of Environmental Protection, Sremska Kamenica, email: mirapucarevic@gmail.com
[5] PhD, University Educons, Faculty of Environmental Protection, Sremska Kamenica, email: dunjaprokic@educons.edu.rs

A significant input of heavy metals in the soil is antropogenic factors (agricultural materials, atmospheric deposits, sludge, pesticides, fertilizers, etc.).

2.1. Illegal landfills in AP Vojvodina

Major problem in the Republic of Serbia and AP Vojvodina represent ilegal landfils. They are defined as places where it is performed or has been performed disposal of waste at a previously unprepared location. In some cases, it is not suitable for waste disposal, it does not have the basic requirements criteria of the location where it is possible to build a landfill. Their number is variable, because occur at high speed, and even attempts to remove them, or to waste, if it is possible to transfer it to a sanitary landfill, they often do not have significant ones effect. [3]

3. MATERIAL AND METHOD

For the purposes of preparing this paper, and in order to monitor non-agricultural land in AP Vojvodina, land sampling was initially performed at 113 illegal landfills in the area of AP Vojvodina. Soil sampling was performed by the Institute of Field and Vegetable Crops Novi Sad, by taking soil samples from five measurement profiles at each site. One measuring profile is at the position of the old illegal landfill, ie at the place where the mineralization occurred, while the other measuring profiles are evenly distributed along the perimeter of the illegal landfill. Two samples were taken for each measuring profile, one from a depth of 0 to 30 cm and one from a depth of 30 to 60 cm. In this way, a total of 1130 soil samples were collected.

The unit for results is mg/kg.

The soil samples were air-dried and ground to size particle <2 mm (ISO 11464: 1994). To determine the total heavy metal content of As, Cd, Cr, Cu, Ni, Pb, Zn samples were prepared by microwave digestion according to EPA 6010C methods (Image 1). The metal content was determined by induction coupled plasma (ICP-OES) (Image 2).

Image 1 - Microwave digestion

Image 2- ICP-OES

Mercury (Hg) is determined with a mercury analyzer DMA-80(Image 3).

Image 3- mercury analyzer DMA-80

3.1. Results

The results shown in the table 1 show the percentage of samples with limit and remediation values of metals (As, Cd, Co, Cr, Cu, Ni, Pb, Zn, Hg) higher than the allowable. Limit values of metals Cd, Co, Cu are higher in more than 90% of samples.

Table 1 – Percentage of samples with limit and remediation values higher than allowed

Metal	Limit values (%)	Remediation values (%)
As	1,94	0,17
Cd	99,11	0,53
Co	94,24	0,26
Cr	9,29	/
Cu	93,09	3,89
Ni	86,37	2,21
Pb	0,17	/
Zn	43,45	0,70
Hg	39,38	0,35

4. CONCLUSION

Heavy metals are present in all tested samples. In 90% of samples, metals Cd, Co and Cu exceed the limit values. High concentrations (ovrer prescribed remediation value) of Ni were measured in the municipality of Irig. At four cadastral municipalities (Subotica, Kovilj, Budisava and Kisac) concentration of Cu was over legally remediation value. In order to make the environment healthier for human beings, contaminated water bodies and land need to be rectified to make them free from heavy metals and trace elements. There are several techniques to remove these heavy metals, including chemical precipitation, oxidation or reduction, filtration, ion-exchange, reverse osmosis, membrane technology, evaporation and electrochemical treatment. But most of these techniques become ineffective when the concentrations of heavy metals are less than 100 mg/kg [4]. Additionally, physico-chemical

methods are ineffective or expensive when the concentration of heavy metals is very low. Alternately, biological methods like biosorption and/or bioaccumulation for removal of heavy metals may be an attractive alternative to physico-chemical methods [5]. Use of microorganisms and plants for remediation purposes is thus a possible solution for heavy metal pollution since it includes sustainable remediation technologies to rectify and re-establish the natural condition of soil. However, introduction of heavy metals into the soil causes considerable modification of the microbial community, despite their vital importance for the growth of microorganisms at relatively low concentrations [6]. The modification of the microbial make up is mainly brought about by exerting an inhibitory action through blockage of essential functional groups, displacement of essential metal ions or modification of active conformations of biological molecules [7].

5. ACKNOWLEDGMENT

The present work is part of a Study on quality assessment and assessment of the degree of vulnerability of land, "Monitoring of non-agricultural land in AP Vojvodina" funded by the Provincial Secretariat for Urbanism and Environmental Protection in year 2020.

6. REFERENCES

[1] Ubavić M, Bogdanović D: *Teški metali u zemljištima Vojvodine, Poglavlje u monografiji: Teški metali i pesticidi u zemljištu,* Poljoprivredni fakultet, Institut za ratarstvo i povrtarstvo, Novi Sad, 1993, 217–222.

[2] Castaldi S., Rutigliano F.A., Virzo De Santo A. (2004): *Suitability of soil microbial parameters as indicators of heavy metal pollution.* Water, Air and Soil Pollution, 158: 21–35.

[3] Šimon T. (1999): *The effect of increasing rates of nickel and arsenic on the growth of radish and soil microflora*. Rostlinná výroba, 45: 421–430.

[4] Vujić G, Ubavin D, Milovanović D, Adamović D, Bačlić S, Štrbac D, Maoduš N, Batinić B, Stanisavljević N, Manović N (2008). *Identifikacija i kategorizacija divljih deponija, procena finansijskih sredstava za njihovu sanaciju - remedijaciju na teritoriji AP Vojvodine.* Fakultet tehničkih nauka, Departman za inženjerstvo zaštite životne sredine: Univerzitet u Novom Sadu.

[5] Ahluwalia, S.S.; Goyal, D. *Microbial and plant derived biomass for removal of heavy metals from wastewater.* Bioresour. Technol. 2007, 98, 2243–2257.

[6] Hussein, H.; Farag, S.; Moawad, H. *Isolation and characterization of Pseudomonas resistant to heavy metals contaminants.* Arab. J. Biotechnol. 2004, 7, 13–22.

[7] Kapoor, A.; Viraraghvan, T. *Fungal biosorption—An alternative treatment option for heavy metal bearing wastewater:* A review. Bioresour. Technol. 1995, 53, 195–206.

[8] Doelman, P.; Jansen, E.; Michels, M.; van Til, M. *Effects of heavy metals in soil on microbial diversity and activity as shown by the sensitivity-resistance index, an ecologically relevant parameter.* Biol. Fertil. Soils 1994, 17, 177–1784.