

Zorana Hrkić Ilić, Nada Šumatić, Marijana Kapović Solomun (corresponding author: zorana.hrkic-ilic@sf.unibl.org)

Faculty of Forestry, University of Banja Luka, Vojvode Stepe Stepanovića 75a, Banja Luka

## Introduction

This study analyzed concentrations of three heavy metals (HMs), **nickel** (Ni), **chromium** (Cr) and **manganese** (Mn) in the urban soils and in the tree leaves, sampled in the several cities in the territory of Republic of Srpska, with the aim to identify urban tree species as potential bioindicators of urban pollution.

Although cities occupy only 3% of the total Earth's surface, they are home to over 50% of the world's population. As a result of rapid urbanization and population growth in urban areas, the amount of various urban wastes and pollutants, including HMs is highly increased, having a significant impact on the urban environment and human health.

**Urbosoils** are very heterogenic soils, significantly different of traditional soil types due to their properties changes linked with the urbanization processes in a way that those soils are highly loaded with waste materials used in the construction of buildings or traffic. Urbosoils usually contain high concentrations of many HMs with toxic environmental effects.

Woody plants, especially **tree species** may be used as biomonitors and bioindicators of urban pollution with HMs originated from traffic, atmospheric deposition, urbanization processes and inappropriate management of urban soils.

## Objectives

The aim of our paper is to present concentrations of Ni, Cr and Mn soils and tree leaves sampled in the parks, in cities of Banja Luka, Prijedor and Bijeljina.

Leaf material was sampled from two common tree park species: horse chestnut (*Aesculus hippocastanum* L.) and planetree (*Platanus × acerifolia* (Aiton) Willd.). Fully developed leaves, of about the same age, were sampled from the exterior part of the tree crown at 2 m height above the ground and at about 1-2 m from the traffic-loaded streets. Sampling was conducted in the vegetation period from May to June, 2019.

Soils were sampled on the depth of 20 cm, in two distances, 1 m and 20 m from the streets with the most frequent traffic and with the lowest traffic frequency.



Figure 1. Soil sampling



Figure 2. Planetree (*Platanus x acerifolia* (Aiton) Willd.)



Figure 3. Horse chestnut (*Aesculus hippocastanum* L.)

## Results

**Table 1.** Concentrations of three heavy metals (Ni, Cr and Mn) in urban soils across cities of Republic of Srpska (mg/kg of dry weight)

Locations	Traffic frequency	Depth of soil sampling	Heavy metals concentration		
			Ni	Cr	Mn
Banja Luka	low frequency	1-1	<b>84.3</b>	105.5	<b>1549.1</b>
Banja Luka	high frequency	1-1	72.7	94.9	<b>1627.3</b>
Banja Luka	low frequency	1-20	64.5	87.0	<b>1707.2</b>
Banja Luka	high frequency	1-20	63.6	93.5	<b>1867.4</b>
Prijedor	low frequency	1-1	<b>75.5</b>	104.4	<b>1979.6</b>
Prijedor	high frequency	1-1	<b>149.8</b>	<b>169.3</b>	<b>1040.9</b>
Prijedor	low frequency	1-20	<b>146.3</b>	<b>172.3</b>	<b>1155.4</b>
Prijedor	high frequency	1-20	<b>167.5</b>	<b>198.4</b>	<b>1061.5</b>
Bijeljina	low frequency	1-1	<b>178.8</b>	<b>233.7</b>	<b>1399.7</b>
Bijeljina	high frequency	1-1	<b>101.7</b>	117.5	<b>1074.8</b>
Bijeljina	low frequency	1-20	<b>120.7</b>	<b>156.6</b>	<b>1267.7</b>
Bijeljina	high frequency	1-20	<b>114.4</b>	<b>135.4</b>	<b>1123.1</b>

**Table 2.** Concentrations of three heavy metals (Ni, Cr and Mn) in *Aesculus hippocastanum* and *Platanus x acerifolia* across cities of Republic of Srpska (mg/kg of dry weight); \*average values of three samples are presented, <0.1 – value below detection limit

Locations	Plant species	Heavy metals concentration		
		Ni	Cr	Mn
Banja Luka	<i>Aesculus hippocastanum</i>	<0.1	0.7	54.4
Prijedor	<i>Aesculus hippocastanum</i>	1.5	1.1	22.3
Bijeljina	<i>Aesculus hippocastanum</i>	<b>5.2</b>	<b>3.2</b>	103.4
Banja Luka	<i>Platanus x acerifolia</i>	<b>1.8</b>	0.3	27.9
Prijedor	<i>Platanus x acerifolia</i>	<b>4.9</b>	1.0	44.3
Bijeljina	<i>Platanus x acerifolia</i>	<b>7.6</b>	0.8	29.5
-	„reference plant“	1.5	1.5	200

## Conclusion

Obtained data (Table 1) indicated that concentrations of analyzed HMs in urbosoils, depending on locations and cities, are significantly above mean values, indicating soil contamination. According to the *Rulebook on allowed quantities of hazardous and damage materials in agricultural soil and water for irrigation and methods for their testing* („Official Gazette of the Republic of Srpska“, no. 56/16), limit values of examined HMs are in range: 30-75 mg/kg Ni, 40-120 mg/kg Cr, but not specified for Mn. Average concentration of Mn in soils at world's level is 488 mg/kg. Also, significantly higher concentrations of Ni and Cr (Table 2) are found in leaves of analyzed tree species (above the “reference plant” values, the system that has been widely used to compare different plant species and different localities). Values above toxic levels for plants depended on locations and cities. Concentrations of Ni, Cr and Mn in the soil and plant samples reflected contamination originating from atmospheric deposition. Horse chestnut and planetree could be a good plant choice for refining and biomonitoring HMs pollution in urban areas.

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