

SESSION E: THERMAL TECHNIQUE AND ENVIRONMENTAL PROTECTION**Chemical pollutants in the soil of Novi Pazar and ecological risk assessment**Jovana Belošević^{1*}, Svetlana Belošević², Maja Đukić³¹ University of Belgrade, Faculty of Pharmacy, Belgrade, Serbia² University of Pristina in Kosovska Mitrovica, Faculty of Technical Sciences, Kosovska Mitrovica, Serbia³ State University of Novi Pazar, Department of Natural Science and Mathematics, Novi Pazar, Serbia**ARTICLE INFO*** Correspondence: jovanabelosevic2@gmail.comDOI: <https://doi.org/10.46793/ET26.E07B>**PAGES:** E55 – E60**ABSTRACT**

Soil pollution by chemical pollutants poses a critical threat to environmental quality and human health. This study investigates the concentration, composition and spatial distribution of selected chemical pollutants - including heavy metals (Pb, Cd, Ni, Hg, Zn) and organic matter in urban soil of the city of Novi Pazar. Its analysis is based on data collected by the Environmental Protection Agency of the Republic of Serbia (SEPA), during year of 2023. Sampling was carried out at 7 representative locations (city park, recreation center, kindergartens, water supply source, industrial zone) at a depth of 50 cm. The results obtained were compared with the normative limit values for Serbia, and it was determined that the concentrations of heavy metals in some locations exceeded the limit values. This especially applies to Pb and Ni. The research confirms that the soil in Novi Pazar is under moderate anthropogenic pressure. Risk assessment based on international soil quality guidelines indicates potential ecological and health hazards. These findings highlight the need for continuous soil monitoring and stricter regulatory controls to mitigate pollutant accumulation and safeguard soil ecosystem.

KEYWORDS

Heavy metals; Organic contaminants; Anthropogenic sources, Soil pollution, Environmental risk.

1. INTRODUCTION

Soil is an essential component of terrestrial ecosystems and plays a crucial role in maintaining environmental quality, biodiversity, and human health. Urban soils are increasingly exposed to contamination due to industrialization, urbanization, traffic emissions, waste disposal, and intensive anthropogenic activities. Heavy metals are among the most significant pollutants because of their persistence, toxicity, bioaccumulation potential, and non-biodegradable nature [1].

Urban soils are particularly vulnerable to contamination due to intensive anthropogenic activities such as vehicular traffic, industrial emissions, combustion of fossil fuels, construction activities, municipal waste disposal, and atmospheric deposition. Pollutants deposited in urban soils may enter the food chain, affect groundwater quality, and pose potential risks to human health and ecosystems [2].

Novi Pazar is an urban center located in southwestern Serbia characterized by dense traffic, rapid urban development, industrial activities, and increasing population pressure. These factors may contribute to the accumulation of pollutants in urban soils, particularly in recreational zones, residential areas, and locations near industrial facilities [3].

The assessment of soil contamination and ecological risk is important for environmental management and sustainable urban planning. Ecological risk assessment enables the evaluation of potential adverse effects of pollutants on ecosystems and human health. In recent years, numerous studies have focused on the evaluation of heavy metal contamination in urban soils using pollution indices and comparative analysis with regulatory limits [4].

The main objectives of this study were:

1. Determination of the concentrations of selected heavy metals and chemical pollutants in soils from Novi Pazar;
2. Assessment of the spatial distribution of heavy metals and chemical pollutants in different urban locations;

3. Assessment of the ecological risk associated with detected pollutant concentrations.
4. Identification of the potential anthropogenic sources of contamination.
5. Provision of baseline data for future environmental monitoring and soil protection strategies.

2. MATERIALS AND METHODS

2.1. Study Area

Novi Pazar is situated in southwestern Serbia at approximately 43°N latitude and 20°E longitude and represents an important administrative, industrial, and commercial center. The city is characterized by moderate continental climate conditions, intensive urbanization, and increasing traffic density. Sampling locations included recreational zones, educational facilities, water supply protection areas, and public green spaces [5].

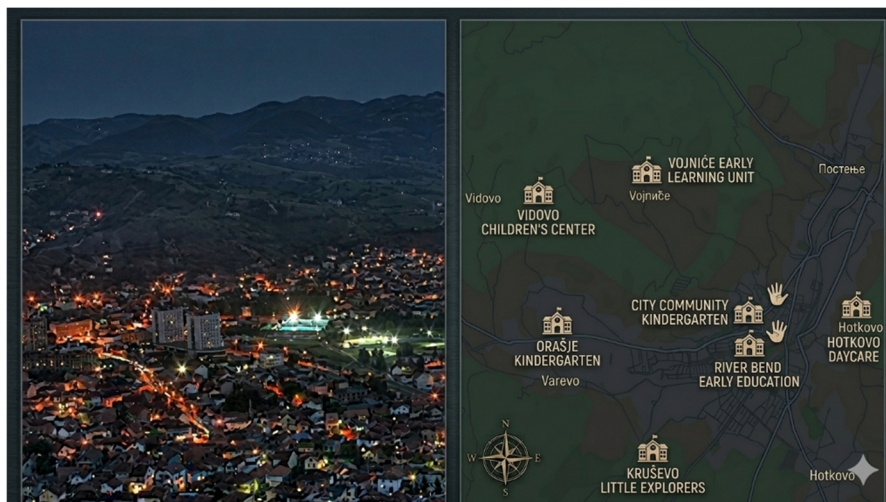


Figure 1: Novi Pazar city

2.2. Soil Sampling

Soil samples were collected during 2023 from seven representative locations within the urban area of Novi Pazar. The sites investigated included:

- City Park
- Recreational Center
- Kindergarten “Mladost”
- Pazarište – vicinity of water source
- Kindergarten “Naše dete”
- Kindergarten “Dečja radost”
- Industrial zone.

Samples were collected from the surface soil layer (sampling depth was 50 cm), according to standard environmental monitoring procedures. Geographic coordinates and physicochemical soil characteristics were recorded for each sampling point. Sampling points were selected to represent different anthropogenic influences including traffic density, recreational activities, and urban infrastructure [6].

2.2. Laboratory Analysis

The analyses were performed by the Belgrade Institute of Public Health according to standard environmental analysis procedures. The following soil parameters were determined:

- Organic matter content (%);
- Clay content (%);
- Soil moisture (%);
- Active and potential pH values;
- Sulfates, nitrates, chlorides, and fluorides;
- Heavy metals: Cu, Zn, Pb, Cd, Ni, Cr, As, and Hg.

Heavy metal concentrations were expressed in mg kg^{-1} dry soil. [6]

2.4. Ecological Risk Assessment

Ecological risk assessment was performed using descriptive statistical analysis and comparison with commonly accepted soil quality guidelines. Mean and maximum concentrations were used to evaluate contamination intensity and potential ecological effects.

The ecological significance of heavy metals was evaluated considering their toxicity, persistence, and mobility in soil ecosystems. Particular attention was focused on Pb, Cd, Ni and Hg because of their high toxicological importance.

3. RESULTS AND DISCUSSION

3.1. Physicochemical Characteristics of Soil

The investigated soils were generally alkaline, with active pH values ranging from approximately 8.0 to 8.3. Alkaline soil conditions generally decrease the mobility and bioavailability of heavy metals because higher pH values promote their adsorption onto clay minerals, organic matter, and metal oxides present in the soil matrix. Under alkaline conditions, many metal ions form stable hydroxides, carbonates, or other poorly soluble compounds that precipitate from the soil solution. As a result, the concentration of free metal ions available for plant uptake, leaching, or migration into groundwater is reduced. Consequently, heavy metals tend to remain more strongly bound within the soil structure, limiting their environmental mobility and reducing their potential toxicity to plants, microorganisms, and humans [7].

Organic matter content varied significantly among sampling locations, indicating differences in vegetation cover, land use, and anthropogenic influence. Clay content ranged from approximately 15% to 32%, suggesting moderate adsorption capacity for metallic pollutants.

3.2. Heavy Metal Concentrations in Soil

The concentrations of analyzed heavy metals at different sampling locations are presented in Table 1.

Table 1: Concentrations of heavy metals in soils of Novi Pazar

Location	Elements mg kg ⁻¹							
	Cu	Zn	Pb	Cd	Ni	Cr	As	Hg
City Park	26.3	62.2	46.1	0.60	36.9	32.2	7.45	0.28
Recreational Center	27.9	79.8	86.5	0.79	73.5	44.1	7.06	0.20
Kindergarten “Mladost”	19.2	53.8	97.2	0.65	52.6	35.7	3.94	0.20
Pazarište-watersource vicinity	15.9	40.8	10.4	0.60	20.0	11.1	6.53	0.20
Kindergarten “Naše dete”	20.8	55.7	34.1	0.60	33.7	33.1	6.86	0.20
Kindergarten “Dečja Radost”	20.2	58.5	22.3	0.64	38.6	24.7	4.94	0.20
Industrial zone	19.1	54.3	30.9	0.60	34.9	20.0	5.86	0.20

The obtained results indicate spatial variability in heavy metal concentrations among the investigated sites. Zinc showed the highest average concentration (57.87 mg kg⁻¹), followed by lead (46.79 mg kg⁻¹) and nickel (41.46 mg kg⁻¹). Elevated concentrations of Zn are commonly associated with vehicular traffic, tire wear, galvanized materials, and urban runoff [8].

Lead concentrations showed substantial variability among locations. The highest Pb concentration was detected at the “Mladost” kindergarten location (97.2 mg kg⁻¹), suggesting strong anthropogenic influence. Elevated lead concentrations in urban soils are commonly associated with traffic emissions, combustion processes, and industrial activities. Although the use of leaded gasoline has been reduced, historical deposition may still contribute to elevated Pb levels in urban environments [9].

Nickel concentrations ranged from 20.0 to 73.5 mg kg⁻¹, with the highest value recorded at the Recreational Center. Elevated Ni concentrations may originate from the geological background as well as from anthropogenic activities (industrial emissions, fossil fuel combustion, etc.).

Cadmium and mercury concentrations were relatively low at all sampled locations, which indicates a limited industrial impact in the investigated area. Cadmium concentrations ranged between 0.60 and 0.79 mg kg⁻¹. In the City Park, a maximum mercury concentration of 0.28 mg kg⁻¹ was recorded.

Chromium and arsenic concentrations were also below commonly accepted intervention values for urban soils [10].

The lowest concentrations of most analyzed metals were observed at the Pazarište location near the water source, indicating lower anthropogenic pressure compared with densely urbanized zones.

3.3. Statistical Overview of Heavy Metal Concentrations

Table 2 shows the mean, maximum and limit values of heavy metal concentrations in the soil of Novi Pazar.

Table 2: Mean, maximum and limit value concentrations of heavy metals

Concentrations of heavy metals mg kg ⁻¹	Mean	Minimum	Maximum	Limit value
Cu	21.34	15.90	27.90	100
Zn	57.87	40.80	79.80	300
Pb	53.49	10.40	97.20	100
Cd	0.67	0.60	0.79	3.0
Ni	46.13	20.00	73.50	50
Cr	31.03	11.10	44.10	100
As	6.09	3.94	7.45	25
Hg	0.21	0.20	0.28	1.0

The statistical overview confirms that Zn, Pb, and Ni were the dominant pollutants in the investigated soils [11,12]. Variability in pollutant concentrations among sampling locations reflects differences in local anthropogenic activities, traffic intensity, and land use.

Recreational zones and areas exposed to traffic generally exhibited higher concentrations of Pb, Zn, and Ni. In contrast, the water supply protection zone showed lower concentrations of most analyzed metals [13].

The elevated concentrations observed in urban recreational zones may be attributed to:

- Increased traffic density;
- Atmospheric deposition of particulate matter;
- Urban construction activities;
- Accumulation of contaminants in surface soils.

3.4. Ecological Risk Assessment

Ecological risk assessment showed that most analyzed metals were present at low to moderate contamination levels. However, elevated Pb and Ni concentrations at specific urban locations may represent a potential ecological concern.

Lead is particularly hazardous because of its neurotoxic effects and long-term persistence in soil. The presence of elevated Pb concentrations in areas frequented by children, such as kindergartens and recreational zones, requires special attention because children are more vulnerable to heavy metal exposure [4,14].

Nickel and chromium may affect soil microbial communities and reduce soil fertility when present in elevated concentrations. Although Cd and Hg concentrations were comparatively low, their toxicological significance should not be neglected due to their bioaccumulative behavior.

The results suggest that anthropogenic activities are the dominant source of contamination in urban soils of Novi Pazar. Traffic emissions, industrial processes, domestic heating, atmospheric deposition, and improper waste management are likely contributing factors.

The alkaline pH conditions of the investigated soils likely reduced the mobility and bioavailability of metals, thereby limiting their ecological impact. Nevertheless, continuous accumulation of pollutants may increase environmental risks in the future, especially in densely urbanized areas [15].

3.5 Environmental Implications

Urban soil plays an important role in maintaining ecological balance and environmental quality. Contaminated soils may act as secondary sources of pollution through dust generation, leaching, and uptake by plants. The obtained results emphasize the need for:

- Continuous environmental monitoring;
- Improved urban waste management;
- Reduction of traffic-related emissions;
- Development of green urban infrastructure;
- Public awareness regarding environmental protection.

Implementation of preventive measures is especially important in sensitive locations such as parks, schools, and kindergartens.

3.6 Comparison with Other Urban Areas

The concentrations measured in Novi Pazar were generally lower than values reported for heavily industrialized urban centers in Southeast Europe. The absence of major heavy industry in the region may explain the relatively moderate contamination levels.

However, the detected enrichment of Pb, Zn, and Ni confirms the influence of urbanization and traffic-related activities on soil quality. Similar trends have been reported in other Balkan cities where traffic emissions and atmospheric deposition represent dominant sources of urban soil contamination.

4. CONCLUSION

The present study evaluated the concentrations of selected chemical pollutants in urban soils of Novi Pazar and assessed their ecological risk. The results demonstrated spatial variability in heavy metal concentrations among sampling sites.

The investigated soils were predominantly alkaline, which may reduce heavy metal mobility and bioavailability.

Zinc, lead, and nickel were identified as the dominant pollutants. The highest Pb concentration was detected at the “Mladost” kindergarten site, while the highest Ni concentration was recorded at the Recreational Center. The lowest contamination levels were observed near the Pazarište water source.

Lead concentrations showed localized enrichment in urban and recreational areas influenced by anthropogenic activities.

Cadmium and mercury concentrations were relatively low at all sampling locations.

Ecological risk assessment indicated generally low to moderate ecological risk; however, elevated concentrations of Pb and Ni at several locations suggest the influence of anthropogenic activities and the necessity for regular environmental monitoring.

Although current contamination levels do not indicate severe pollution, continuous monitoring is recommended because urbanization and traffic intensity may contribute to future accumulation of pollutants.

The findings of this study provide important baseline information for environmental protection and sustainable urban planning in Novi Pazar.

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