

ASSESSMENT OF PHYSICAL AND CHEMICAL SOIL PROPERTIES IN URBAN GREEN AREAS OF NOVI GRAD MUNICIPALITY, SARAJEVO CANTON*

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Preliminary communication

Abstract

Modern urbanization trends are increasing population density in cities and suburban areas, posing challenges to environmental quality. Urban soils play a crucial role in supporting ecological functions such as water filtration, carbon storage, and biodiversity maintenance. Despite this, they are often subject to anthropogenic pressures that degrade their structure and functionality. While soil research has traditionally focused on agricultural and forest lands, urban soils-particularly in Bosnia and Herzegovina-remain understudied, especially regarding contamination by heavy metals and other pollutants.

This study investigates the condition of soils at three urban green locations in the Novi Grad municipality, Sarajevo Canton, under different land uses (lawn, tree-covered, arable). The results show that soils are predominantly sandy and carbonate, with slightly alkaline pH. Humus content ranges from 3.3 to 4.19%, while carbon stocks vary from 6.8 kg/m² (lawn) to 8.1 kg/m² (tree-covered areas). The soils are moderately to well supplied with nitrogen (average C/N ratio of 13:1), moderately supplied with available potassium, and poorly supplied with available phosphorus. Filtration properties are generally poor to moderate, with an average water retention capacity of 43.96% vol. Importantly, all soil samples contained heavy metals below harmful concentration thresholds, as defined by national standards. These findings can inform improved urban soil management strategies in the Sarajevo Canton.

Keywords: *urban soils, soil ecosystem services, environmental quality, carbon storage, soil contamination*

INTRODUCTION

Modern trends reveal an increasing population in urban and suburban areas, presenting numerous challenges for maintaining environmental quality in these settings (Pavao-Zuckerman, 2008; Guiland *et al.*, 2018). Due to rapid urbanization, soils in urban areas, often referred to as Urbisols, become a crucial component of urban ecosystems, serving various ecological functions. These soils are formed through intensive anthropogenic

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activities that disrupt or entirely remove natural soil horizons, leading to the presence of distinct layers brought in from outside sources. Urban soils provide essential ecosystem services, such as storing soil organic carbon (SOC), filtering and retaining water—an essential function for mitigating urban floods-and supporting biomass production and biodiversity maintenance (Yang & Zhang, 2015; Pavao-Zuckerman, 2012). Urban soils also play a role in ecological restoration, where a thorough understanding of their functions can guide successful outcomes (Pavao-Zuckerman, 2012).

Nonetheless, urban soils experience substantial pressure from anthropogenic activities, which often lead to the degradation of their structure and functionality (Yang & Zhang, 2015). Traditionally, soil quality studies have focused on agricultural and forest lands, often neglecting urban soils. However, with the rise of urban agriculture and the intensifying fight against climate change, urban soils have become an increasingly important research focus. Urban soils also serve as sites for the deposition, transformation, and transfer of various substances, including contaminants, in urban-industrial zones. Additionally, as one of the largest terrestrial carbon sources, soil plays a vital role in the global carbon cycle by storing atmospheric CO₂ as soil organic matter, a critical contributor to carbon sequestration. Therefore, it is crucial to quantify the functions of urban soil and understand its role for the environment and society, especially in the context of sustainable urban development (Vasenev *et al.*, 2017).

In Bosnia and Herzegovina, research on urban soil conditions remains scarce, particularly in assessing contamination by heavy metals and other pollutants in industrial urban areas. Given these issues, it is essential to quantify the functions of urban soils and understand their role in the sustainable development of cities. This research aims to measure SOC storage, assess nutrient content (N, available P₂O₅, and K₂O) related to soil fertility and biodiversity conservation, evaluate water holding capacity and permeability, and analyze heavy metal concentrations in urban soils, which will give insights into urban ecosystem resilience. The research aims to assess the capacity of urban green spaces in Novi Grad Municipality to store carbon in soil, support biomass production and biodiversity, retain water to prevent flooding, and mitigate pollution by absorbing heavy metals. Given the rarity of such studies in Bosnia and Herzegovina, this research will analyze different types of urban green areas - lawns, cultivated land, and tree-covered zones - to determine their impact on urban soil properties and ecosystem functions.

MATERIAL AND METHODS

The study area includes three locations in the Novi Grad municipality of Sarajevo Canton: the "Safet Zajko" Sports (SRC „SZ“) and Recreation Center (43.8477° N, 18.3365° E), "Mojmilo" Park-Forest (43.8359° N, 18.3575° E), and the Flora Nursery in Nedžarići (43.8346° N, 18.3309° E). The SRC "SZ" offers sports and recreational facilities, the "Mojmilo" Park-Forest provides walking trails, and the Flora Nursery is a key site for growing ornamental plants distributed to other green spaces in Sarajevo

Canton. Three places in each mentioned location (about 30 cm deep) were dug, representing different land uses:

1. SRC „SZ“: grassland with mixture of grass, cultivated soil for ornamental plants - roses and deciduous trees covered area;
2. Park-Forest: grassland with mixture of grass, cultivated soil under shrubbery and deciduous trees covered area;
3. Flora Nursery: grassland with mixture of grass, cultivated soil under fruit nursery and deciduous trees and shrubs covered area;

Each location provides unique conditions and resources for research, contributing to a deeper understanding of the ecological and biological aspects of soils in Novi Grad and the Sarajevo Canton. The Safet Zajko Sports and Recreation Center and the Mojmiilo Park-Forest were selected due to their significance as popular urban green spaces frequently used for recreational activities by the citizens of Sarajevo. In contrast, the Flora Nursery was chosen because it is a managed and maintained urban area, serving as a representative example of how urban soils can be systematically utilized and maintained, offering valuable insights into soil management practices in urban environments.

It should be emphasized that the SRC “SZ” and the “Flora” nursery are located on alluvial deposits with the Miljacka and Dobrinja rivers nearby. The “Mojmiilo” Forest Park belongs to a mountainous area. The SRC “SZ” and the “Flora” nursery are located on lower exposures of the relief, on flattened alluvial deposits with rivers in the immediate vicinity of the Miljacka (SRC “SZ”) and Dobrinja rivers (the “Flora” nursery). The third research location in this paper, the “Mojmiilo” Forest Park in the context of the described relief, is located on the southern edge of the Canton in a transitional mountainous area, i.e. Mojmiilo Hill.

In March, site visits determined that these three locations are the most suitable for research, as they are close to one another and offer diverse land uses within the same geographical and climatic area under similar physical and chemical soil characteristics. Soil sampling for physical-mechanical and chemical analysis took place from May 8 to May 23, 2024. At each site, three pits (about 30 cm deep) were dug, representing different land uses: grassland, cultivated soil, and tree-covered area, totaling nine pits. Samples were taken from depths of 0–15 cm and 15–30 cm in disturbed and undisturbed states, with three replicates each. The paper used mean values from three analyses.

A soil samples were collected for physical, hydrogeological and chemical properties, including texture, bulk density, permeability, water holding capacity, pH, soil organic carbon (C) content, nutrient levels (N, P, K), and heavy metal concentrations (Table 1).

Table 1. All the analyzes that were done in the laboratory

Category	Method	Reference
Soil Organic Matter	Determination of C and humus content by colorimetric method	ISO 14235:1994
	Determination of soil carbon content (kg/m ²)	Hengl <i>et al.</i> (2018)
	Determination of total nitrogen using Kjeldahl method and C/N ratio	ISO 11261
Physical Properties	Determination of soil texture	Škorić (1982)
	Determination of soil structure according to Sekeri	Resulović <i>et al.</i> (1982)
	Determination of bulk density (BD)	ISO 11272
Water-Physical Properties	Determination of hygroscopic moisture by Mitscherlich method	-
	Determination of current moisture and soil water retention capacity	Gračanin (1977)
	Determination of filtration coefficient	Eijkkamp
Soil Chemical Properties	Determination of carbonate content (CaCO ₃)	ISO 10693:2015
	Determination of soil pH reaction	ISO 10390:2005
	Determination of available phosphorus and potassium by AL method	Resulović <i>et al.</i> (1982)
	Determination of heavy metal concentrations using AAS	-

To determine the maximum permissible values for heavy metal content, the table from Rulebook on determining permissible quantities of harmful and hazardous substances in soil and methods of their testing from Službene novine Federacije Bosne i Hercegovine (2022), which is used in our country (Table 2):

Table 2. Limit total values of pollutant content *

Heavy metals	Limit values by texture (mg kg ⁻¹)		
	Sandy	Silty and loam	Clayly
Cadmium (Cd)	0.5	1	1.5
Copper (Cu)	50	65	80
Nickel (Ni)	30	40	50
Lead (Pb)	50	80	100
Zinc (Zn)	100	150	200
Chromium (Cr)	50	80	100
Cobalt (Co)	30	45	60

*[16], the stated values refer to soils with an acidic reaction. In carbonate soils, the threshold for limit values can be increased by 25%

RESULTS AND DISCUSSION

The results in table 2 shows that carbon storage values for grass-covered areas in SRC "SZ" and Park-Mojmilo range between 5.8-6.4 kg/m² (to 30 cm depth), while at Flora Nursery, it reaches approximately 8.4 kg/m². Cultivated areas show slightly higher carbon storage, ranging from 5.9-8.2 kg/m². Tree-covered areas vary significantly, with carbon storage values of 5.5-6.1 kg/m² at the first two sites, but around 12 kg/m² at Flora Nursery. Also, the BD for alluvial soils in Great Britain was 0.92 g/cm³ (0.22 - 1.52 g/cm³) (Edmondson *et al.*, 2012) which is comparable to the results in this paper. Building on the previously mentioned fact that the SRC "Safet Zajko" and the Flora Nursery are located on alluvial deposits formed by the nearby Miljacka and Dobrinja

rivers, the observed soil properties-particularly bulk density-can be meaningfully compared to those of similar soils. For example, the bulk density (BD) for alluvial soils in Great Britain was reported as 0.92 g/cm^3 (range: $0.22\text{-}1.52 \text{ g/cm}^3$) (Edmondson *et al.*, 2012), which aligns with the values recorded at these sites in this study.

Table 3. Values for Bulk density, SOM, C%, and carbon stock for the locations

Parameters	Bulk density (g/cm ³)		Soil organic matter (SOM) (%)		C (%)		Carbon stock (kg/m ²)
	0-15	15-30	0-15	15-30	0-15	15-30	
Depth (cm)	0-15	15-30	0-15	15-30	0-15	15-30	0-30
Grassland							
SRC „SZ“	1.17	1.29	3.05	2.42	1.77	1.41	5.83
Park forest Mojmiilo	1.31	1.29	3.05	2.60	1.78	1.51	6.41
Nursery „Flora“	1.04	1.19	4.53	4.15	2.64	2.41	8.41
Cultivated soil							
SRC „SZ“	0.99	0.93	4.20	5.64	2.44	3.28	8.23
Park forest Mojmiilo	1.13	1.20	3.60	2.26	2.09	1.31	5.90
Nursery „Flora“	1.06	1.06	4.33	4.25	2.52	2.47	7.93
Soil under trees							
SRC „SZ“	1.35	1.30	2.86	2.50	1.66	1.45	6.17
Park forest Mojmiilo	1.19	1.34	2.23	2.81	1.30	1.63	5.58
Nursery „Flora“	1.22	1.15	8.43	6.32	4.90	3.67	12.47

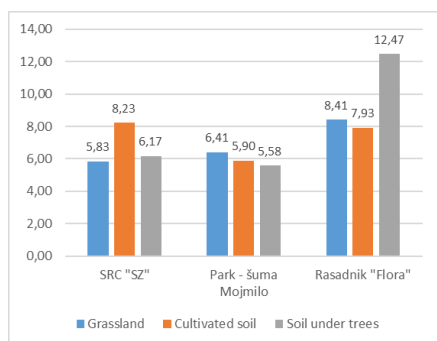


Figure 1. Carbon stock under 30 cm

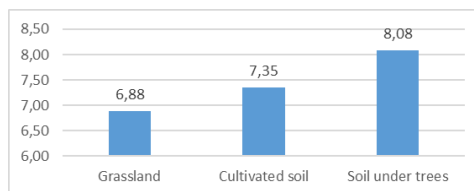


Figure 2. $\bar{X}$ of carbon stock from different land cover

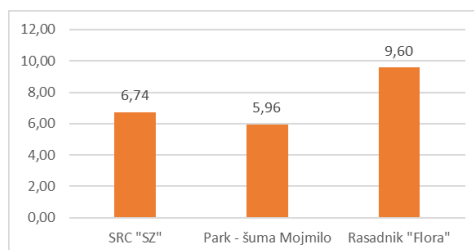


Figure 3. $\bar{X}$ of carbon stock for locations

Thus, Flora Nursery's soils are the most optimized for carbon storage through careful management and occasional fertilization, averaging around 9.6 kg/m², while SRC "SZ" and Park-Mojmilo range between 5.9 and 6.7 kg/m². The highest carbon storage values are associated with tree-covered areas, averaging 8.0 kg/m² across all three locations, compared to cultivated and grass-covered areas with averages of 6.8 and 7.3 kg/m², respectively (fig. 2 and 3).

Analyzing percentage of C (table 3) per land use type, grass-covered areas at SRC "SZ" and Park-Mojmilo have 1.5-1.7%, while Flora Nursery's grass areas hold slightly higher values around 2.5% due to less disturbance and occasional fertilization. Cultivated soils show C% above 2% in the top 15 cm, with varying values at 15-30 cm, while tree-covered soils at Flora Nursery contain the highest %C values (nearly 5% in the top 15 cm, and 4% at 15–30 cm). These values are likely due to the coniferous trees at Flora, which contribute higher organic input through needle fall.

Comparing these results with Gao *et al.* (2021), Zhang & Xu (2013), and Luo *et al.* (2015), who reported an average of 3.5 kg/m² carbon storage (up to 30 cm depth), it is evident that areas in Novi Grad exhibit higher carbon storage levels than those found in the literature. In their work, Tvica and Čustović (2010) (Table 4) analyzed the carbon stock in sandy loam in Nišići and loam in Sprečko polje in dominant soil type in Bosnia with similar texture and climatic conditions and found the following soil organic carbon stock in arable soils and soils under grass vegetation and forest.

Table 4. SOC stock under 30 cm depth (Tvica i Čustović, 2010)

Stock of SOC under 30 cm depth	Nišići - Dystric cambisol, sandy loam			Sprečko polje – Pseudogley, loam		
	Arable and	Grass	Forest	Arable land	Grass	Forest
kg/m ²	5.46	4.76	6.56	5.21	8.14	8.42

Similarly, in their research on the soil organic carbon stock in forest nurseries and in the nearby soil under grass vegetation in central Bosnia - Žepče (similar soil and climatic condition), up to 30 cm depth, Tvica *et al.* (2013) finds 7.57 kg/m² SOC in grassland and slightly less, 5.83 kg/m² SOC in the forest nursery itself.

Table 5. Values of N, K₂O, P₂O₅, carbonate content and pH for the locations under different land cover

Location	Land cover	Depth (cm)	pH in 1M KCl	W(CaCO ₃) (%)	N (%)	K ₂ O (mg/100g)	P ₂ O ₅ (mg/100g)
SRC „SZ“	Grassland	0-15	7.57	8.83	0.175	10.6	5.3
		15-30	7.57	8.09	0.179	19.7	4.6
	Cultivated soil	0-15	7.65	11.67	0.214	14.7	6.5
		15-30	7.66	9.72	0.240	13.5	6.1
	Soil under trees	0-15	7.52	4.22	0.208	12.5	1.6
		15-30	7.51	2.57	0.182	10.8	1.2
Park forest Mojmiilo	Grassland	0-15	7.30	6.45	0.220	12.0	0.0
		15-30	7.10	1.57	0.204	7.7	0.1
	Cultivated soil	0-15	7.50	8.95	0.213	12.2	1.3
		15-30	7.48	10.64	0.173	10.5	0.8
	Soil under trees	0-15	4.49	-	0.236	13.7	0.6
		15-30	4.27	-	0.174	10.1	0.0
Nursery „Flora“	Grassland	0-15	7.20	1.81	0.193	46.9	27.2
		15-30	7.29	2.84	0.176	46.9	24.4
	Cultivated soil	0-15	7.55	7.50	0.184	44.9	39.0
		15-30	7.57	8.44	0.181	35.9	37.2
	Soil under trees	0-15	7.19	3.58	0.359	46.9	23.3
		15-30	7.21	4.73	0.269	45.9	23.6

The analysis (table 5) indicates that pH and carbonate content in the soil are consistent across all locations. Lawn areas and cultivated surfaces have slightly alkaline pH values (7.2–7.5), while soil under trees is acidic, at the Mojmiilo site (pH 4.2-4.4) due to the influence of coniferous trees and forest vegetation. Gračanin (1948) notes that tannins from tree roots lower soil pH, which can lead to soil acidification below pH 5.

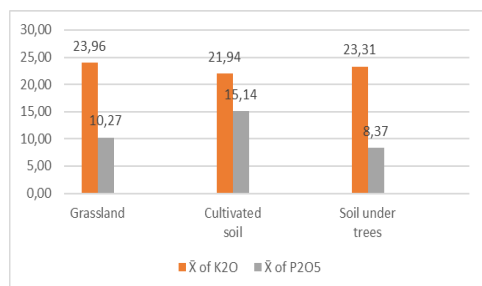


Figure 4. $\bar{X}$ for K₂O, P₂O₅ in mg/100 g soil, content in soil from different land cover

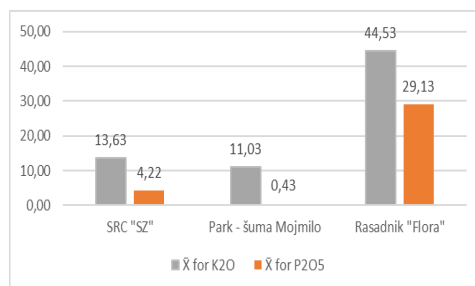


Figure 5. $\bar{X}$ for, K₂O, P₂O₅ content in soil for locations

The site "Flora" has a high supply of potassium and phosphorus, attributed to fertilization, while other sites have lower nutrient availability (fig. 4 and fig. 5). Pouyat *et al.* (2006) states that urban soils often contain elevated potassium and phosphorus concentrations due to artificial fertilizers, which is also evident at the "Flora" site.

Table 6. Soil texture according to the FAO triangle for determining soil texture

Land cover	Grassland		Cultivated Soil		Soil under Trees	
Depth	0 - 15 cm	15 - 30 cm	0 - 15 cm	15 - 30 cm	0 - 15 cm	15 - 30 cm
SRC "SZ"	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Loam	Loam
Forestry park Mojmiilo	Sand	Sand	Sandy loam	Sandy loam	Loam	Clay loam
Nussery "Flora"	Sandy loam	Loamy sand	Loamy sand	Loamy sand	Loamy sand	Loamy sand

The dominant soil textures (table 6) for the sites are as follows: SRC "SZ" is mostly sandy loam, with loam under trees; the second location has sand in the lawn area, sandy loam in cultivated land, and loam or clay loam under trees. The third location predominantly features loamy sand, with sandy loam in the 0-15 cm layer under lawn areas. This composition reflects the historical deposition of river materials in the Sarajevo Basin, resulting in soils with high sand, silt, and clay content.

Table 7. Values of flitration (permeability) for the locations under different land cover

Land cover	Grassland		Cultivated soil		Soil under trees	
	m/day		m/day		m/day	
Depth (cm)	0-15	15-30	0-15	15-30	0-15	15-30
SRC"SZ"	0.068261	0.035334	0.452130	0.079630	0.024009	0.540531
Permeability mark	Low	Low	Medium	Low	Low	Medium
Park forest Mojmiilo	0.422614	0.189147	0.047656	0.072504	0.334629	0.082081
Permeability mark	Medium	Medium	Low	Low	Medium	Low
Nursery"Flora"	0.130147	0.003770	0.162732	0.111569	0.056239	0.012632
Permeability mark	Medium	Very low	Medium	Medium	Low	Low

The filtration coefficient values in table 7 indicate that most soil samples exhibit low permeability according to the classification values of Vukašinović (1956). Turf areas mostly show low permeability at the first location, medium at the second and third locations, with the third location at 15-30 cm depth showing very low permeability. Cultivated areas have medium permeability at the first and third locations, while the second location has low permeability. Tree-covered areas exhibit low permeability at the first and third locations, with exceptions at 15-30 cm depth at SRC "SZ" and at 0-15 cm depth at Park-forest Mojmiilo. The second location ranges from medium to low permeability.

Table 8. Values of water holding capacity for the locations under different land cover

Land Cover	Grassland		Cultivated soil		Soil under trees		Average (location)
	%vol		%vol		%vol		%vol
Depth (cm)	0-15	15-30	0-15	0-15	0-15	15-30	
SRC"SZ"	42.6	41.63	39.73	46.50	42.47	39.05	42.00
Park forestry Mojmiilo	45.27	41.17	47.77	44.93	42.70	41.77	43.93
Nursery Flora	48.9	45.77	44.23	45.10	45.67	46.20	45.98
Average (land cover)	44.22		44.71		42.97		43.97

The water holding capacity values in table 8 for all three locations under turf surfaces are above 40% vol., with the highest values at the Flora nursery reaching up to 48.9% vol. Cultivated areas range from 39.7-47.7% vol., showing notable depth-related differences at the first location (39.7% vol. at 0-15 cm and 46.5% vol. at 15-30 cm). Tree-covered areas have similar values, with a depth variance of around 3% vol. Average retention moisture by land use type ranges from 42.97% vol. (trees) to 44.71% vol. (cultivated), and by location, from 42-45.9% vol.

Table 9. Values of heavy metals (ppm) according to land use methods

Location	SRC "SZ"					
Land cover	Grassland		Cultivated Soil		Soil under Trees	
Depth	0 - 15 cm	15 - 30 cm	0 - 15 cm	15 - 30 cm	0 - 15 cm	15 - 30 cm
Cu	10.93	9.08	22.23	24.66	11.32	12.98
Zn	40.07	41.29	43.64	44.15	33.6	37.61
Cd	0.05	0.04	0.03	0.03	0.04	0.04
Pb	17.42	21.77	30.33	27.86	15.53	21.12
Ni	22.73	24.26	30.64	25.66	34.77	41.21
Cr	2.38	21.54	17.3	17.26	21.63	24.31

Location	Forestry park Mojmiilo					
Land cover	Grassland		Cultivated Soil		Soil under Trees	
Depth	0 - 15 cm	15 - 30 cm	0 - 15 cm	15 - 30 cm	0 - 15 cm	15 - 30 cm
Cu	4.29	4.40	23.76	16.59	3.44	4.91
Zn	31.09	32.98	37.39	34.65	29.63	36.47
Cd	0.06	0.05	0.05	0.04	0.05	0.05
Pb	15.09	21.62	20.61	19.74	24.38	31.64
Ni	35.83	49.61	27.97	36.51	27.11	37.11
Cr	0.44	18.72	29.4	30.55	29.49	31.94

Location	Nussery "Flora"					
Land cover	Grassland		Cultivated Soil		Soil under Trees	
Depth	0 - 15 cm	15 - 30 cm	0 - 15 cm	15 - 30 cm	0 - 15 cm	15 - 30 cm
Cu	7.80	9.89	8.85	11.16	13.29	15.14
Zn	39.91	42.46	45.34	47.06	43.24	44.42
Cd	0.04	0.03	0.04	0.04	0.03	0.03
Pb	8.13	16.84	13.35	19.16	16.69	20.61
Ni	0.62	26.66	24.83	26.26	24.29	27.17
Cr	0.35	17.75	21.37	20.31	17.22	20.13

Additionally, all soil samples contain heavy metals at concentrations below the threshold values considered harmful (table 9), as defined by the official guidelines of the Official Gazette of the Federation of Bosnia and Herzegovina (Službene novine Federacije Bosne i Hercegovine, 2022).

CONCLUSIONS

The study results indicate that carbon stocks up to 30 cm of soil depth vary across the three locations, with an average value of 7.44 kg C/m², reaching the highest levels (8.08 kg C/m²) under tree-covered soils. Similarly, water holding capacity averaged 43.97% vol, while permeability ranged from low to medium intensity. The C/N ratio averaged 10.6 : 1. Available phosphorus and potassium levels varied from low to high, influenced by the fertilization practices of green areas. Notably, the concentrations of heavy metals were within permitted limits at all locations.

However, it is evident that results differ significantly between locations, primarily due to the notably higher values recorded at the "Flora" site. This discrepancy is likely due to the historically high soil quality at this particular location, combined with good land management practices and the influence of fertile fluvial soil from the Dobrinja River, making direct comparisons between locations challenging.

These findings have important practical implications for the management and sustainability of urban green spaces. The results emphasize the significant role of urban green areas in storing carbon, contributing to climate change mitigation through soil organic matter. Additionally, the study highlights the importance of green spaces in water retention, which is crucial for regulating the local water cycle, particularly in the context of increasing urbanization and extreme weather events.

However, the study also reveals limitations in the permeability and filtration capacity of these areas, which could hinder their potential role in flood prevention. While water retention is effective, further improvements in filtration processes may be necessary to fully optimize the ecological functions of urban green spaces in flood-prone areas. The variation in soil quality and ecological functions between locations, especially the superior results at the "Flora" site, underscores the importance of site-specific management practices. The high soil quality at "Flora" demonstrates how good land management, combined with favorable environmental factors, can significantly enhance the ecological functions of urban green spaces. Therefore, "Flora" can serve as a model for effective green space management in Novi Grad Municipality.

In conclusion, the study underscores the value of urban green spaces, particularly the "Flora" nursery, in supporting ecological functions such as carbon sequestration, biodiversity conservation, and water retention. Nevertheless, to optimize their role in urban flood management, future strategies should focus on enhancing soil permeability and filtration capacity. These findings provide valuable insights for sustainable urban planning and the continued improvement of green spaces in urban areas.

REFERENCES

- Edmondson, J.L., Davies, Z.G., McHugh, N., Gaston, K.J., & Leake, J.R. (2012). Organic carbon hidden in urban ecosystems. *Scientific reports*, 2(1), 963.
- Gao, L., *et al.* (2021). Spatial variations and distributions of soil organic carbon in urban areas: A case study in Xi'an, China. *Journal of Environmental Management*, 280, 111798.

- Gračanin, M. (1948). Tipovi šumskih tala Hrvatske. Glasnik za šumske pokuse: Annales pro experimentis foresticis, 9., str.113.
- Gračanin, M., & Ilijanić, L. (1977). Uvod u ekologiju bilja. Zagreb, Školska knjiga.
- Guilland, C., *et al.* (2018). Urban soils and their management: A review. Environmental Science & Policy, 89, 20-29.
- Hengl, T., Kempen, B., Sanderman, J. (2018). Spatial prediction and assessment of soil organic carbon.
- Luo, S., Zhu, L., Liu, J., Bu, L., Yue, S., Shen, Y., & Li, S. (2015). Sensitivity of soil organic carbon stocks and fractions to soil surface mulching in semiarid farmland. European Journal of Soil Biology, 67, 35-42.
- Pavao-Zuckerman, M. (2008). Urbanization, soils, and ecosystem services. Soil Science Society of America Journal, 72(2), 297-312.
- Pavao-Zuckerman, M. (2012). The importance of urban soils in the ecological restoration of cities. Ecological Restoration, 30(3), 196-199.
- Pouyat, R. V., Yesilonis, I. D., & Nowak, D. J. (2006). Carbon storage by urban soils in the United States. Journal of environmental quality, 35(4), 1566-1575.
- Resulović, H., Jovandić, P., Bisić-Hajro, Dž. (1982). Mali pedološki priručnik, Poljoprivredni fakultet UNSA, Sarajevo 1982.
- Službene novine Federacije Bosne i Hercegovine (2022). Pravilnik o utvrđivanju dozvoljenih količina štetnih i opasnih tvari u zemljištu i metode njihovog ispitivanja. Sarajevo.
- Škorić, A. (1982). Priručnik za pedološka istraživanja. Zagreb, Fakultet poljoprivrednih znanosti.
- Tvica, M., Čustović, H. (2010). The affects of land use change on storage of carbon in different physical fractions of soil organic matter. Radovi Poljoprivrednog Fakulteta Univerziteta u Sarajevu, Vol. 55, No. 60(1), 201-213.
- Tvica, M., Hukić, E., Ičanović, M., Čustović, H. (2014). The influence of land use change on some soil parameters, 25th International Scientific-Experts Congress on Agriculture and Food Industry – Turkey, Izmir 2014
- Vasenev, V., *et al.* (2017). Urban soil research and management in the context of global sustainability. Science of the Total Environment, 603-604, 1132-1145.
- Vukašinović, S. (1956): Prilog terminologiji poljskog kapaciteta i predlog metodike njegovog odredjivanja. Zemljište i biljka. Vol. V, No 1-3.
- Yang, J., & Zhang, G. (2015). Ecological functions and sustainability of urban soils. Urban Ecosystems, 18(1), 289-305.
- Zhang, X.W., & Xu, M.X. (2013). Soil organic carbon sequestration rate and its influencing factors in farmland of Guanzhong Plain: a case study in Wugong County, Shannxi Province. Huan Jing ke Xue= Huanjing Kexue, 34(7), 2793-2799.

PROCJENA FIZIČKIH I KEMIJSKIH SVOJSTAVA TLA U URBANIM ZELENIH POVRŠINAMA OPĆINE NOVI GRAD, KANTON SARAJEVO

Sažetak

Savremeni trendovi urbanizacije povećavaju gustoću naseljenosti u gradovima i prigradskim područjima, što predstavlja izazov za kvalitetu okoliša. Urbana tla igraju ključnu ulogu u održavanju ekoloških funkcija poput filtracije vode, skladištenja ugljika i održavanja bioraznolikosti. Uprkos tome, često su izložena antropogenim pritiscima koji degradiraju njihovu strukturu i funkcionalnost. Dok su se istraživanja tla tradicionalno usredotočila na poljoprivredno i šumsko zemljište, urbana tla - posebno u Bosni i Hercegovini - ostaju nedovoljno proučena, posebno u pogledu onečišćenja teškim metalima i drugim zagađivačima. Ova studija istražuje stanje tla na tri urbane zelene lokacije u općini Novi Grad, Kanton Sarajevo, pod različitim načinima korištenja zemljišta (travnjaci, šumovitost, obradivo zemljište). Rezultati pokazuju da su tla pretežno pjeskovita i karbonatna, s blago alkalnim pH. Sadržaj humusa kreće se od 3,3 do 4,19%, dok zalihe ugljika variraju od 6,8 kg/m² (travnjak) do 8,1 kg/m² (područja prekrivena drvećem). Tla su umjereno dobro opskrbljena dušikom (prosječan omjer C/N od 13:1), umjereno opskrbljena dostupnim kalijem i slabo opskrbljena dostupnim fosforom. Svojstva filtracije su općenito loša do umjerena, s prosječnim kapacitetom zadržavanja vode od 43,96% vol. Važno je napomenuti da su svi uzorci tla sadržavali teške metale ispod štetnih pragova koncentracije, kako je definirano nacionalnim standardima. Ovi nalazi mogu informisati o poboljšanim strategijama upravljanja urbanim tlom u Kantonu Sarajevo.

Ključne riječi: *urbana tla, usluge ekosustava tla, kvaliteta okoliša, skladištenje ugljika, onečišćenje tla*