



University of Belgrade  
Technical Faculty in Bor

EcoTEK

31<sup>st</sup> International conference

# Ecological Truth & Environmental Research

Editor

Prof. Dr Snežana Šerbula

## PROCEEDINGS

Hotel Sunce, Sokobanja, Serbia  
18–21 June 2024

## PROCEEDINGS

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## **PREFACE**

*The 31<sup>st</sup> international conference Ecological Truth & Environmental Research – EcoTER'24 focuses on showing the latest research findings and innovations in the field of ecology, environmental protection and sustainable development. The conference will be held in Sokobanja (Serbia) in hotel Sunce in the period of 18–21 June 2024.*

*The aim of the conference is to connect the experts in various fields in order to transform attitudes and behaviors in everyday practices, as well as in the industry and economy sector which is essential for achieving the desired changes that our society must undergo.*

*The 31<sup>st</sup> international conference Ecological Truth & Environmental Research – EcoTER'24 is organized by the University of Belgrade, Technical Faculty in Bor, and co-organized by the University of Banja Luka, Faculty of Technology; the University of Montenegro, Faculty of Metallurgy and Technology – Podgorica; the University of Zagreb, Faculty of Metallurgy – Sisak; the University of Pristina, Faculty of Technical Sciences – Kosovska Mitrovica and the Society of Young Researchers – Bor.*

*These Proceedings encompass 119 papers from the authors coming from the universities, research institutes and industries in 15 countries: Brazil, Norway, USA, Spain, Austria, Libya, Italy, Israel, Slovenia, Croatia, Romania, Bulgaria, Montenegro, Bosnia and Herzegovina, North Macedonia, and Serbia. It is a great honor and pleasure to cordially wish a warm welcome to all the participants of the conference.*

*As a part of this year's conference, the 6<sup>th</sup> Student Section – EcoTERS'24 will be held. We appreciate the contribution of the students and their mentors who have also participated in the conference and hope that students will continue to explore and to be curious, since education is a never-ending process, and knowledge is continuously growing.*

*The organization of the EcoTER'24 conference has been financially supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia.*

*The support of the Donors and their willingness and ability to cooperate has been of great importance for the success of the EcoTER'24 conference. The organizing committee would like to extend their appreciation and gratitude to the Platinum donors of the conference – Serbia ZiJin Copper doo Bor and HBIS SERBIA, to the Gold donor of the conference – Elixir Group, as well as to the Silver donor of the conference – Serbian Chamber of Engineers.*

*We would like to express our sincere appreciation to all the authors who have contributed to the Proceedings. We would also like to express our gratitude to the members of the scientific, organizing and honorary committees, reviewers, speakers, chairpersons and all the conference participants for their support of the EcoTER'24. Sincere thanks go to all the people who have contributed to the successful organization of the EcoTER'24.*

*Prof. Snežana Šerbula,*

*President of the scientific and organizing committee*



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## NAPHTHALENE SCREENING IN BOR'S MUNICIPALITY BASED ON ITS CONCENTRATIONS IN LEAVES AND STEMS OF *Hedera helix* L.

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### Abstract

*Naphthalene (Nap) belongs to the group of polycyclic aromatic hydrocarbons, and is considered as the simplest compound (it consists of two benzene rings). The aim of this work was to determine the content of Nap in the unwashed leaves and stems of poison ivy (PI). The samples were collected from nine locations in the area of Bor municipality, situated at different distances from the main source of pollution, i.e. from the metallurgical complex in the city of Bor, containing also the city heating plant. The highest concentration of Nap was found in stems of PI at the site S (66.63 µg/kg), while in the leaves was at site BN (45.89 µg/kg). Obtained results for the concentration of Nap in PI samples from each location were processed using factor R. Based on the calculated values for factor R, it can be concluded that at the sites FJ (2.05) and BN (1.39) closest to the metallurgical complex, and at rural sites SN (1.28), and O (1.70), the pollution of atmospheric origin was the greatest; also, it can be supposed that the proximity of the city heating plant and smelter was responsible for the increased R values ( $R>1$ ) at the sites from the urban/industrial zone, while increased R values in the rural zone were the result of domestic heating. In both zones, the traffic was also one of the possible sources of Nap. There is a possibility that plants absorbed Nap not only from the atmosphere but also from the soil.*

**Keywords:** naphthalene, *Hedera helix*, PAHs, factor R.

### INTRODUCTION

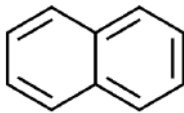
Polycyclic aromatic hydrocarbons (PAHs) are highly persistent in the environment, toxic and represent significant health risk to humans [1]. In recent years, there has been increasing concern about the negative impact of PAHs on terrestrial and marine ecosystems, because for several of them are known to exhibit toxic, carcinogenic, and mutagenic effects [1].

The behavior of PAHs in the environment is greatly influenced by the physical and chemical properties of the individual compounds, such as their molecular weight, water solubility, vapor pressure etc. [2]. They are chiefly defined by the number of benzene rings [2]. The simplest PAHs compound is naphthalene (Nap) [3], comprised of two fused benzene rings [4,5], with molecular weight of 128.2 g/mol [6]. In Table 1 are given physical and chemical properties of Nap. Based on the value for water solubility, Nap can be considered as very low soluble [3,7].

Because of its tendency to biodegrade and volatilize/evaporate relatively easily, Nap has a short half-life in soil. The estimated half-life of Nap in soils with 0.2–0.6% organic carbon and 92–94% sand was 11–18 days [8]. The half-life of a three-ring phenanthrene molecule in soil can be from 16 to 126 days, while the half-life of a five-ring benz(a)pyrene is 229–1400 days [3]. In the atmosphere Nap has a relatively short half-life of 3–8 hours [9]. Therefore, comparing with other PAH compounds, Nap has a relatively low tendency to accumulate in the environment. Outdoor concentrations of Nap are low in Europe, typically ranging from 1 to 4  $\mu\text{g}/\text{m}^3$ . Generally, concentrations of Nap in the air are lower in rural than in urban areas [9].

The pollution sources responsible for the presence of PAHs in the environment are numerous. The origin of Nap is associated with fossil fuels; it is naturally found in petroleum and coal tar [7,10]. The indirect source responsible for releasing Nap into the environment is vehicle emissions [7]. Naphthalene is released into the environment via the incomplete combustion (pyrolysis) of organic compounds, oil spills, oil processing, household waste disposal, and use of fumigants and deodorants [3].

**Table 1** Physical and chemical properties of Nap [4,7]

Property	Value
Molecular formula <sup>[4]</sup>	$\text{C}_{10}\text{H}_8$
Structural formula <sup>[7]</sup>	
Molecular weight <sup>[4]</sup>	128.19 g/mol
Melting point <sup>[7]</sup>	80.0–80.3°C
Boiling point <sup>[7]</sup>	217.9–218°C
Density <sup>[7]</sup>	1.175 g/cm <sup>3</sup>
Henry's Law Constant <sup>[4]</sup>	$4.83 \cdot 10^{-4}$ atm m <sup>3</sup> /mol
Vapor pressure <sup>[4]</sup>	0.0087 mm Hg
Water solubility <sup>[4]</sup>	31.69 $\mu\text{g}/\text{L}$
Log $K_{ow}$ <sup>[4]</sup>	3.36
Log $K_{oc}$ <sup>[4]</sup>	2.97

Naphthalene is classified and listed among the sixteen priority pollutants by the United States Environmental Protection Agency (USEPA) [2,5,6]. According to the International Agency for Research on Cancer (IARC), Nap can be considered as possible carcinogenic to humans and animals [5,6].

In humans, exposure to Nap through dermal contact, inhalation and ingestion can lead to toxic manifestations such as: liver and lung damage, eye sensitivity, and neurological damage in infants. In the human body, high concentrations of Nap can destroy red blood cells, causing hemolytic anemia [5,6].

In this paper, the concentrations of Nap were determined in the unwashed stems and leaves of *Hedera helix* L., i.e., poison ivy (PI), as a way to monitor the level of this hazardous compound in the municipality of Bor (East Serbia). Given that Nap represents one of rare low

molecular weight (LMW) PAHs that can be absorbed through leaves but also through root and transported into the aboveground parts [4], the focus of this paper was on the estimation of atmospheric pollution, using the unwashed stems and leaves and calculating the so-called factor R [11].

## MATERIALS AND METHODS

Sampling of PI plant material (stems and leaves) was carried out at nine locations in the area of the city of Bor and its surroundings. Sampling sites (four urban and five rural sites) were chosen at different distances from the primary source of pollution – smelter and the heating city plant in the centre of metallurgical complex in the Bor town. The urban zone included the following locations: Flotacijsko jalovište (FJ) – at a distance of 0.7 km from the main pollution source, Bolničko naselje (BN) at a distance of 1.3 km, Slatinsko naselje (SN) at a distance of 3.2 km and Naselje Sunce (NS) at a distance of from 3.6 km. The rural zone included: Oštrej (O) at a distance of 4.5 km, Slatina (S) at a distance of 6.5 km, Borsko jezero (BJ) at a distance of 7.0 km, Krivelj (K) at a distance of 8.0 km and Gornjane (G) at a distance of 19 km.

PI material was collected as described in detail in Papludis *et al.* [12], as well as the manner of its preparation and analysis (using gas chromatographic-mass spectrometric, GC/MS method); exception was that stems and leaves were analyzed as unwashed.

Obtained results for the concentrations of Nap in PI samples from each location were processed using the factor R, i.e., the ratio of Nap concentrations in the unwashed leaves and stems:  $R_{\text{leaf/stem}} = C_{\text{leaf}}/C_{\text{stem}}$  ( $C_{\text{leaf}}$ , and  $C_{\text{stem}}$  are the concentrations of Nap in the equivalent plant organ). Factor R bigger than 1 indicates the sites where the atmospheric pollution had the greatest influence [11].

## RESULTS AND DISCUSSION

The concentration of Nap in the leaf and stem samples of PI are given in Table 2.

*Table 2 The content of Nap ( $\mu\text{g}/\text{kg}$ , dw) in the leaf and stem samples of PI*

Location	Leaf	Stem
FJ	24.14	11.79
BN	<b>45.89</b>	33.06
SN	<b>45.20</b>	35.42
NS	25.44	43.45
O	<b>44.84</b>	26.35
S	<b>42.47</b>	<b>66.63</b>
BJ	4.57	25.72
K	8.89	40.98
G	6.38	23.99

Bold values indicate Nap highest concentrations

The highest concentration of Nap was in stem of PI at the site S (66.63  $\mu\text{g}/\text{kg}$ ), while in the leaves, the highest, and very similar Nap concentrations were found at several sites: BN (45.89  $\mu\text{g}/\text{kg}$ ), SN (45.20  $\mu\text{g}/\text{kg}$ ), O (44.84  $\mu\text{g}/\text{kg}$ ) and S (42.47  $\mu\text{g}/\text{kg}$ ).

The lowest concentration of Nap in ivy leaves was at one of the farthest locations from the industrial complex, namely, BJ (4.57  $\mu\text{g}/\text{kg}$ ), while the lowest concentration in stems was at the site FJ (11.79  $\mu\text{g}/\text{kg}$ ), which is the closest to the industrial complex. These discrepancies were the first signals that the main source of pollution in the complete municipality (metallurgical and the heating plant) cannot be considered as the only source of Nap pollution in the investigated area.

At 4 out of 9 locations the values for factor R were greater than 1: FJ (2.05), BN (1.39), SN (1.28), and O (1.70) (Figure 1). In the case of phenanthrene, in the study of Papludis *et al.* [11] at the same locations, R factor was also elevated at the sites SN and O, which confirms the greatest atmospheric influence of both compounds at depicted sites. Other sites had very low values for the calculated R factor. All these facts further point that PI from the investigated area may assimilated Nap from different spheres – from the atmosphere, but also from the soil. Further, pollution of atmospheric origin can be ascribed (in different extents) not only to the metallurgical and heating plants but also to domestic heating in rural sites, as well as to the traffic, which is in constant increasing in recent years.

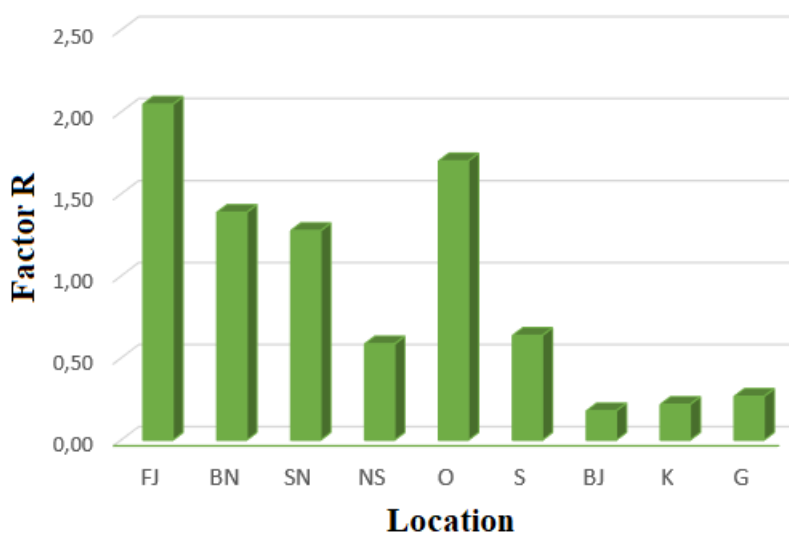


Figure 1 The calculated values for factor R at examined sites

## CONCLUSION

The most important conclusions of this work are as follows:

1) Based on the obtained values for the factor R, it can be said with certainty that Nap content in the investigated plant parts came not only from the atmosphere but also from the soil. The biggest atmospheric contribution was confirmed in the case of sites such as: FJ (R=2.05), BN (R=1.39), SN (R=1.28), and O (R=1.70).

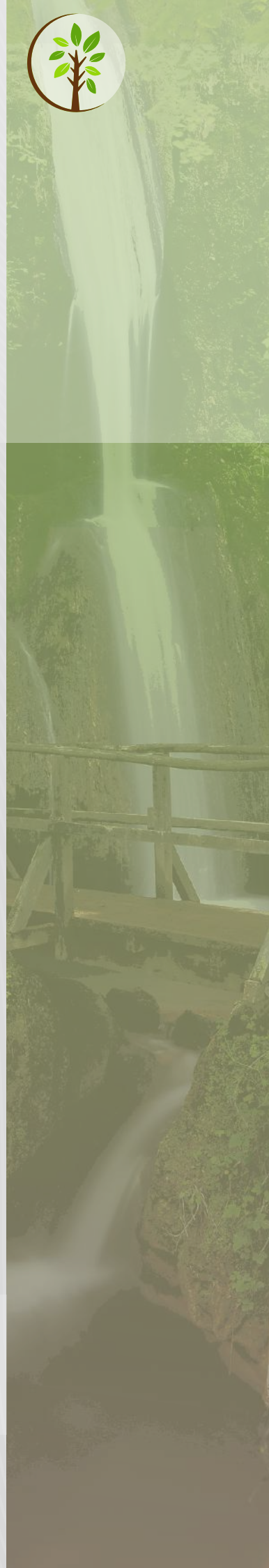
2) The mining and metallurgical complex (smelter and city heating plant) cannot be considered as the only source of pollution in the area of the town of Bor and its surroundings; other sources are most likely: domestic heating and traffic.

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## REFERENCES

- [1] Tuhuloula A., Altway A., Juliastuti, S.R., *et al.*, Earth Environ. Sci. 175 (2018) 012014.
- [2] Paraíba L.C., Queiroz S.C.N., Maia A., *et al.*, Sci. Total Environ. 408(16) (2010) 3270–3276.
- [3] Travkin V.M., Solyanikova I.P., Processes 9(11) (2021) 1862.
- [4] Alagić S.Č., Maluckov B.S., Radojičić V.B., Clean Technol. Environ. Policy 17(3) (2015) 597–614.
- [5] Agoun-Bahar S., Djebbar R., Nait Achour T., *et al.*, Environ. Technol. 40(28) (2019) 3713–3723.
- [6] Mendes G.P., Magalhães V.M.A., Soares, L.C.R., *et al.*, J. Environ. Sci. 90 (2020) 67–77.
- [7] ECB, 2003. European Chemicals Bureau, “Naphthalene, Summary Risk Assessment Report” Institute for Health and Consumer Protection, European Communities (2003).
- [8] Available on the following link: <https://www.atsdr.cdc.gov/ToxProfiles/tp67-c6.pdf>.
- [9] Buckpitt A., Kephelopoulos S., Koistinen K., *et al.*, WHO Guidelines for Indoor Air Quality: Selected Pollutants, World Health Organization, Geneva (2010), p.157, ISBN: 978 92 890 0213 4.
- [10] Yost E.E., Galizia A., Kapraun D.F., *et al.*, Environ. Health Perspect. 129(7) (2021) 76002.
- [11] Papludis A.D., Alagić S.Č., Milić S.M., *et al.*, 11<sup>th</sup> International Conference on Renewable Electrical Power Sources, November 2–3. 2023, Belgrade, Serbia (2023) 239–243.
- [12] Papludis A., Alagić S., Milić S., *et al.*, Zaštita materijala 64(1) (2023) 13–21.



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