UNIVERSITY OF NOVI SAD
Technical Faculty "Mihajlo Pupin"
Zrenjanin, Republic of Serbia

PROCEEDINGS

of the XV International Conference on

Industrial Engineering and Environmental Protection IIZS 2025

Zrenjanin, Serbia, October 2-3, 2025.

CIP Classification:

CIP - Каталогизација у публикацији
Библиотеке Матице српске, Нови Сад

62:005.3(082)(0.034.4)
502/504(082)(0.034.4)

INTERNATIONAL Conference Industrial Engineering and Environmental Protection (15 ; 2025 ; Zrenjanin)
Proceedings [Elektronski izvor] / XV International Conference on Industrial Engineering and Environmental Protection (IIZS 2025), Zrenjanin, 2-3 October 2025 ; [organizer Technical Faculty "Mihajlo Pupin", Zrenjanin]. - Zrenjanin : Technical Faculty "Mihajlo Pupin", 2025. - 1 elektronski optički disk (CD-ROM) : tekst, ilustr. ; 12 cm

Nasl. sa naslovnog ekrana. - El. publikacija u formatu pdf opsega 483 str. - Bibliografija uz svaki rad.

ISBN 978-86-7672-393-5

a) Индустријско инжењерство -- Зборници b) Заштита животне средине -- Зборници

COBISS.SR-ID 183409673

DOI:10.5937/IIZS25432I

EVALUATION OF SETTLEABLE PARTICULATE MATTER IN TIMISOARA AND ZRENJANIN. FIRST STEPS AND PERSPECTIVES

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Abstract: This work presents the first steps taken in assessing the SPM – Settleable Particulate Matter pollution in cities of Timisoara (Romania) and Zrenjanin (Serbia). The study began by deploying identical non-directional deposition gauges (samplers) in 7 locations in Timisoara and 3 locations in Zrenjanin. The samples were collected monthly and analyzed in laboratory in full compliance with ASTM D1739 international standard. In this step only concentrations of SPM were determined, in the next steps of the study the assessment of heavy metals content of settleable atmospheric dust will be conducted.
Key words: SPM, Air Quality, Settleable Particulate Matter, Gravimetric Method

INTRODUCTION

The atmosphere contains much more than just "air". Besides gases, the lower atmospheric layers contain large amounts of particulate matter (or aerosols) with different diameters and shapes. A particle is frequently and mistakenly referred to as an aerosol. However, the term aerosol describes a mixture of gas, typically air, and fine solid or liquid particles that are suspended within it. Particulate matter is just one of the components of an aerosol. For these particles to stay suspended in the gas, their rate of descent must be low. It is generally understood that the spherical particles in an aerosol have a diameter of less than 100 µm. Aerosols span a wide range, from just a few tens of nanometers (smaller than a virus) to several tens of micrometers, comparable to the thickness of human hair. Their size and chemical makeup determine how far they can travel through the atmosphere, how they interact with solar and thermal radiation, and what impacts they may have on human health. When released directly into the air, they are called primary aerosols, such as sea spray, mineral dust, smoke, and volcanic ash. In contrast, secondary aerosols form in the atmosphere when gases or other substances undergo chemical reactions, as seen with sulfate aerosols produced from volcanic activity or industrial pollution. Over time, all aerosols can continue to change through additional chemical transformations, a process known as aging. [1]
The particulate matters (aerosols) are emitted from two major group sources, natural and anthropogenic and their lifetimes range from hours to years, depending on the size of the particles and the height at which they are injected into the atmosphere. The main global sources are the natural ones, from sea spray aerosols, mineral dust (from deserts and degraded soils), biomass burning and volcanic eruptions to biogenic aerosols. For example, the Saharan dust injected into atmosphere is estimated between $400 \cdot 10^6$ and $700 \cdot 10^6$ tons per year and is transported globally affecting air quality. [2] The second group is represented by anthropogenic generated (of affected by industrial/agricultural pollution) aerosols, mainly from energy sector, cement industry, industrial processes and agriculture. The latest methodology distinguishes 392 source categories for particulate matter. [3]
Particulate matter is classified in three size classes, fine fraction (PM2.5) abbreviated PM2.5, coarse fraction (PM10) and settleable (or suspended) fraction (SPM or TSP). The corresponding aerodynamic particle diameters are ≤ 2.5 µm, ≤ 10 µm and ≤ 100 µm. If the PM2.5 and PM10 fraction are of direct interest for impact on human health due to direct alveoli or thoracic aspiration, the SPM fraction is more or less an indication on annoyance levels.

Numerous studies showed that low particles deposition levels of 5 [$g/m^2 \cdot 30$ days] is perceptible and cause health and annoyance issues. [4]

MATERIAL AND METHODS

Settleable Particulate Matter (SPM) is of particular concern because it can deposit onto surfaces, accumulate in the environment, and contribute to long-term impacts on air quality and human health. SPM consists of relatively large particles that settle primarily by gravity and can serve as carriers of environmental contaminants, especially metals released from industrial, mining, and urban activities. For instance, metals such as Pb, Cd, Ni, and Cr have been detected in SPM collected from both urban and industrial sites, raising serious environmental and public health issues. Similarly, research conducted in a mining and smelting region of southwestern China found elevated concentrations of Cd, Cr, Cu, Pb, and Zn in settleable particles, with values surpassing the limits set by the World Health Organization (WHO). [5]
The study area corresponds to two urban areas in Banat region, in the cities of Timisoara (Romania) and Zrenjanin (Serbia). Ten sampling points were established, covering industrialized, high traffic and urban/rural background types of land use, as shown in figures 1 and 2.

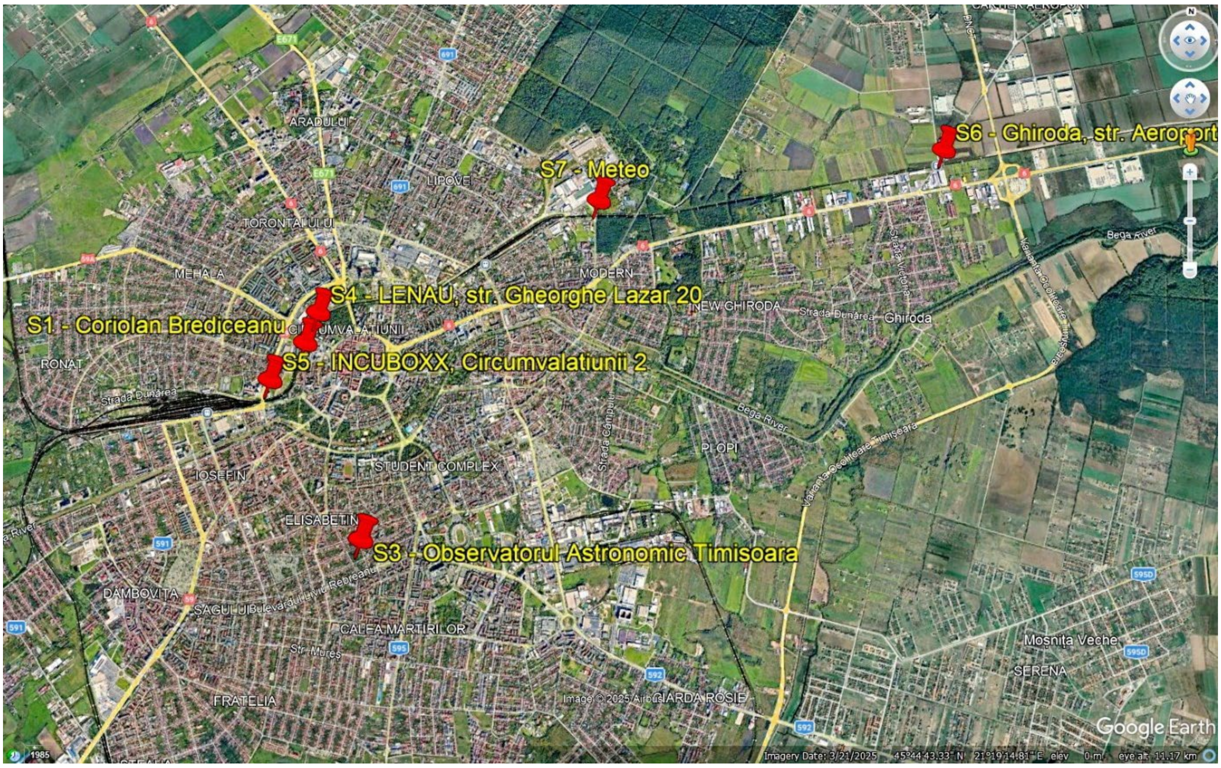

Fig. 1. *Location of SPM monitoring points in Timisoara*

For the location of sampling points different potential sources were considered and recorded: road traffic, railway and tramline traffic, industry, agriculture and commerce. One location was established in Timisoara as urban background (S3) in a low traffic, green area and a second one in Cornesti village (S2) as rural background.
The SPM passive, non-directional samplers were constructed at University Politehnica laboratory, in full compliance with ASTM-D1739-98(R17) reference standard: Standard Test Method for Collection and Measurement of Dustfall (Settleable Particulate Matter). The sampling vessel was made from glass and the holder from steel with aluminum wind screen deflector surrounding the vessel. All samples stand have a height of about 1.7 m. The sampling vessel diameter is 0.16 m, with a SPM collection area of 0.02 m^2.

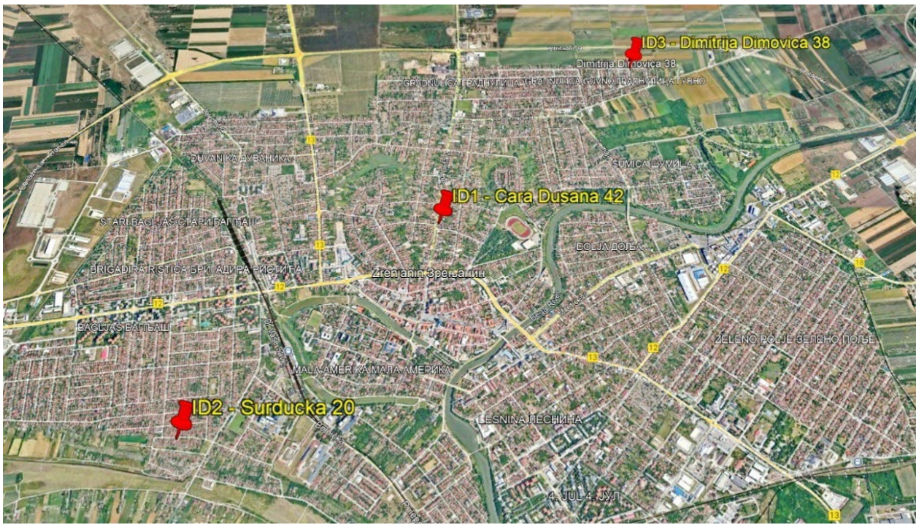

Fig. 2. *Location of SPM monitoring points in Zrenjanin*

All samplers were exposed for 30 days (one month) and SPM samples were collected on site by washing the glass vessels with type II distilled water. In laboratory, the samples were first passed through a 1 mm mesh stainless steel sieve for impurities/insects' removal. The samples were then filtered through a fast filtering 47 mm No.10 glass fiber filters with a retention rate of 99.97 % in a Buchner funnel, separating the soluble to insoluble fractions of SPM. Both fractions were dried at 105 °C in a drying oven and desiccator. The weight of SPM was carried out by a 0.01 mg precision analytical balance.
In figure 3 an example of sampler placed on a sampling site is given.

Fig. 3. *SPM sampler in Timisoara, at INCUBOXX site with industry, rail & road traffic sources.*

RESULTS AND DISCUSSION

The calculation of SPM deposition rate was done following ASTM-D1739-98(R17) rules:

$$C_{SPM} = \frac{m_{SPM}}{A} \cdot \frac{30}{n} \quad [\frac{g}{m^2} \cdot month] \tag{1}$$

In equation 1, C_{SPM} and m_{SPM} represent the concentration respectively the mass of Settleable Particulate Matter; *A* is the area of the vessel in m^2; *n* is the number of days of exposure and *30* is a factor for normalizing the results to a month time.

The results obtained for a period of three months are presented in table 1.

Table 1. *SPM concentrations, in [g/m^2·month]*

	Timisoara							Zrenjanin		
2025	S1	S2	S3	S4	S5	S6	S7	ID1	ID2	ID3
April	16.6975	0.8175	5.9205	17.82	6.6865	6.523	3.24	3.399	1.7	2.206
May	15.8852	1.0927	5.2138	9.5245	6.1183	6.2807	3.108	2.104	1.795	1.054
June	16.4918	1.94	6.0324	5.978	4.2831	5.688	3.5157	2.508	1.68	2.642

As expected, the SPM concentrations were significantly higher in Timisoara sites than in Zrenjanin, as the city is more developed, with more industry and much more. In Romania, the limit for SPM in ambient air is 17 [g/m^2·month] but is applicable only for mining activities. Recorded SPM concentration at S1 (Brediceanu 23) is extremely high, but from all sampling points one should observe that for S1, located in the central Timisoara, all sources (except direct industry) are present: commercial, road, rail and tram traffic.

CONCLUSION

Even if PM2.5 and PM10 fractions are important to assess anthropogenic impact on public health, this study shows that SPM fraction is also relevant for large and dense urban agglomerations, for both annoyance and health consequences. However, the concentration is not of major interest for our future study, but the analysis of the SPM chemical composition. Thru this "first steps" we showed that SPM concentration in Timisoara and Zrenjanin are significant, the following steps would be to analyze the collected particles through graphite oven atomic spectrometry for targeted trace elements of heavy metal pollution: Pb, Hg, As, Al, Cd, Zn, as we expect them to be prevalent due to constant vehicular traffic and industrial zones.

ACKNOWLEDGMENT

This research was partially supported by the cross-border cooperation project AEPS (http://aeps.upt.ro) "Academic Environmental Protection Studies on surface water quality in significant cross-border nature reservations Djerdap/Iron Gate national park and Carska Bara special nature reserve, with population awareness raising workshops", RORS-462, project funded by the INTERREG IPA-CBC Romania-Serbia Programme.

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