

ASSESSMENT OF PM₁₀ AND PM_{2.5} AIR POLLUTION IN TÂRGOVIȘTE MUNICIPALITY, ROMANIA

Florina – Roxana DUMITRU ¹, Lucica BARBEȘ ^{1,2*}, Alina BĂRBULESCU ^{3*}

¹ Doctoral School of Biotechnical Systems Engineering, National University of Science and Technology Politehnica Bucharest, Romania, florina.dumitru0204@stud.mec.upb.ro (F.-R.D.);

² Applied Sciences and Engineering Department, Ovidius University of Constanța, Romania, lucica.barbes@365.univ-ovidius.ro (L.B.);

³ Department of Civil Engineering, Transilvania University of Brașov, Romania, alina.barbulescu@unitbv.ro (A.B.);

* Correspondence: lucica.barbes@365.univ-ovidius.ro (L.B.); alina.barbulescu@unitbv.ro (A.B.);

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Urban air quality is influenced by multiple emission sources and local meteorological conditions, and characterizing the spatial and temporal variations of suspended particles is important for assessing the urban environment in Romania. This study investigates the distribution of PM₁₀ and PM_{2.5} concentrations in a medium-sized municipality in Romania, based on a monitoring campaign carried out between November 2025 and April 2026. Measurements were made at twenty-six sites, selected for their different functional characteristics and local conditions, and the spatial distribution of concentrations was analyzed by interpolation with the IDW (Inverse Distance Weighting) method. The results revealed spatial and temporal variations of particle concentrations, with higher levels in certain locations characterized by road traffic, industrial activities, and other local sources of fine particles. Short-term maximum values were also recorded and should be differentiated from the daily or annual averages used to assess compliance with the legislative reference values. The distribution of pollutants highlights the heterogeneous nature of particle pollution and the use of local monitoring to identify areas with high levels of particulate matter. The study provides relevant information for local air quality assessment and for guiding future air pollution monitoring and management actions in urban areas in Romania.

Keywords: PM_{2.5}; PM₁₀; air pollution; portable device; statistical and modeling.

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1. Introduction

Air pollution is one of the most important global environmental and public health problems, associated with millions of premature deaths annually and significant effects on quality of life in urban areas and extensive areas [1]. Although policies implemented at the European Union level have contributed to reducing emissions and, implicitly, to decreasing the concentrations of some air pollutants,

episodes of high pollution continue to be recorded, especially in cities in Central and Eastern Europe. In these regions, meteorological conditions, the characteristics of the built environment and local anthropogenic sources can favor the accumulation of suspended particles in the atmosphere [2]. Romania is part of this regional context, with numerous urban areas recording, in certain periods, concentrations of air pollutants that exceed the values in the dataset by Directive 2008/50/EC and Law no. 104/2011 on ambient air quality [3,4]. Among atmospheric pollutants, particulate matter (PM) is of particular interest due to its small size, which allows it to penetrate the respiratory tract and is associated, according to numerous epidemiological and toxicological studies, with adverse effects on human health [5,6]. The PM_{10} fraction includes particles with an aerodynamic diameter of less than $10\text{ }\mu\text{m}$, which are predominantly retained in the upper respiratory tract. In contrast, the finer fraction, $PM_{2.5}$, can reach the pulmonary alveoli and even the bloodstream, thereby favoring the development of cardiovascular, respiratory, and oncological diseases [7,8]. A study conducted in Tehran found that long-term exposure to high concentrations of PM_{10} and $PM_{2.5}$ poses increasing risks to public health, with the average annual levels exceeding the WHO 2021 recommendations by more than twice. Numerous epidemiological studies have demonstrated the existence of a direct relationship between long-term exposure to $PM_{2.5}$ and the increase in the incidence of lung cancer, chronic obstructive pulmonary disease, and myocardial infarction [7,9-12]. The Mann-Kendall test assesses the presence of different or similar trends for the particle pollutants ($PM_{2.5}$ and PM_{10}). An annual increase in PM_{10} concentrations and a moderate decrease in $PM_{2.5}$ concentrations were observed, suggesting the influence of different emission sources and control factors on the particle categories [13]. One research study performed in Lithuania indicated the usefulness of spatio-temporal investigation for assessing the specific effectiveness of air pollution reduction measures [14]. The authors reported significant decreases in PM_{10} and $PM_{2.5}$ concentrations after 2013, associated with reduced liquid fuel consumption and modernization of the energy sector. Still, they also observed increases in PM_{10} concentrations in rural areas, attributed to intensified agricultural activities. Other similar studies have highlighted that air pollutants from urban and industrial activities, including particulate matter and volatile organic compounds, require integrated monitoring and modeling programs to characterize their spatial distribution and assess the impact on the environment and also public health [15,16].

In the urban environment of Romania, PM_{10} and $PM_{2.5}$ concentrations are influenced by both primary emission sources and secondary aerosol formation processes in the atmosphere. Motor traffic is one of the main sources, through emissions generated by fuel combustion, tire and brake wear, and resuspension of road dust [17,18]. During the cold season, residential heating systems using solid

fuels can contribute to increased PM_{2.5} concentrations, especially during periods of atmospheric stability and reduced ventilation [19,20]. The literature also mentions uncontrolled waste burning as a possible source of toxic aerosols and polycyclic aromatic hydrocarbons, especially in developing countries and emerging economies [21,22].

PM₁₀ and PM_{2.5} concentrations in Târgoviște were investigated over a six-month monitoring period extending from November 2025 to April 2026. Measurements were carried out using a portable analyzer at the selected sampling locations, after which the collected data were processed by inverse distance weighting (IDW) interpolation to obtain spatial distribution maps. These data were used for (a) characterizing the spatial variability of concentrations across the study area; (b) identifying hotspots and monitoring periods associated with elevated particulate matter levels; and (c) evaluating the influence of local environmental characteristics or potential emission sources, and prevailing meteorological conditions on the observed distribution patterns.

2. Data and Methods

2.1. Location description and data

Târgoviște municipality, located in Dâmbovița County, in the southern part of Romania, is situated at the intersection of the Ialomița Subcarpathians and the Romanian Plain. With a population of approximately 70,000 inhabitants, the municipality is one of the main urban and economic centers of the Muntenia region, the southern part of Romania. Industrial development over time, together with the expansion of road infrastructure and residential areas, has led to multiple sources of atmospheric emissions characteristic of a medium-sized city.

Air quality in Târgoviște is influenced by residential heating systems, motor traffic, and industrial activities carried out in peripheral areas. In particular, in the cold season, meteorological conditions characterized by low wind speeds and limited atmospheric ventilation can favor the accumulation of suspended particles near the ground surface. Under these conditions, high concentrations of PM₁₀ and PM_{2.5} can be recorded, especially near busy thoroughfares and in areas with industrial or residential activities. The literature indicates that sources such as road traffic, residential heating, and uncontrolled waste burning can contribute to increased concentrations of suspended particles in the urban environment [20,21,23]. In the present study, no analyses were performed to identify or quantify the contribution of each emission source, so any association between the spatial distribution of concentrations and potential sources should be interpreted as a possible explanation based on the characteristics of the sites and on the information available in the literature. Also, the influence of meteorological conditions on pollutant dispersion is discussed based on the available meteorological data,

without assuming the existence of atmospheric phenomena that were not directly measured [24]. In this context, high-spatial-resolution monitoring provides useful information on the distribution of PM_{10} and $PM_{2.5}$ concentrations and allows identification of episodes characterized by high concentrations of suspended particles. The sampling protocol was designed to capture both spatial and temporal variability of suspended particle concentrations in the urban environment.

The monitoring points were chosen in representative areas of different land use categories and potential emission sources (including former industrial platforms, busy intersections, and residential neighborhoods where housing is predominantly heated with solid fuels). The twenty-six monitoring points (TG1-TG26, with their characteristics are presented in Table S1), located between longitudes $25.43201^{\circ}E$ and $25.432149^{\circ}E$ and latitudes $44.92277^{\circ}N$ and $44.922578^{\circ}N$, are shown in Figure 1 and were grouped into the following categories: areas with heavy road traffic (TG1-TG5), urban background (TG06 - TG12, and TG15); areas located near industrial sites (TG16-TG20), and peripheral or peri-urban areas (TG13, TG14 and TG21-TG26).

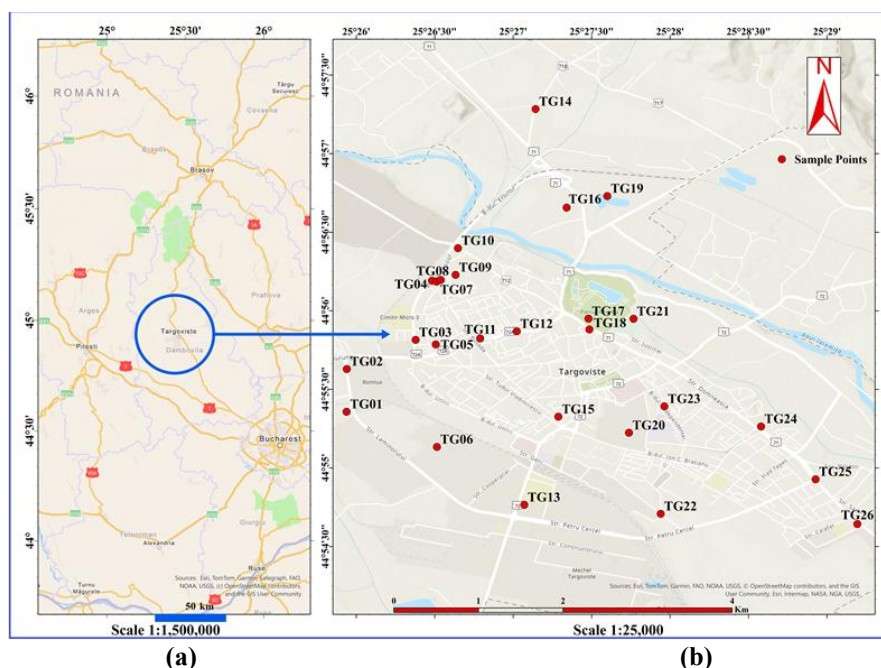


Figure 1. Study area and monitoring locations: (a) Location of Târgoviște; (b) Distribution of the monitoring sites (TG1-TG26) included in the PM_{10} and $PM_{2.5}$ monitoring campaign

The monitoring of particle concentrations was carried out using a portable Casella Microdust Pro monitor (CEL-712, Casella, Bedford, UK), based on the principle of optical light scattering, which allows the rapid determination of aerosol concentrations in the field [25]. Before each monitoring session, instrument

stability verification procedures were performed using a *zero check*, and concentration values were corrected using calibration factors specific to the type of aerosols analyzed. For all measurements, the instrument inlet was positioned at a height of 1.5 m above the ground, corresponding to the human respiratory zone. The equipment can determine concentrations between 0.001 mg/m³ and 250 g/m³, has a resolution of 0.001 mg/m³, a zero point stability of less than 2 µg/m³, and allows automatic data recording at intervals ranging from 1 second to 60 minutes [25]. Technical specifications of the monitoring instrument are shown in Table S2.

To ensure data quality, the instrument was calibrated according to the characteristics of aerosols specific to the urban environment, and in situations where the relative humidity exceeded 90%, the manufacturer's corrections were applied to reduce the influence of hygroscopic growth of particles on the measurements. Very high concentration values, over 15.0 mg/m³, were verified by repeated measurements at 5-minute intervals to exclude possible interferences caused by inappropriate particles or condensation in the measurement chamber. The measurement protocol is also presented in Table S3.

The data obtained were subjected to a statistical processing stage, in which successive recordings were aggregated using short-term moving averages to reduce random signal fluctuations and highlight episodes of high concentrations. These results were analyzed together with information on the activities carried out in the investigated areas and compared with the reference values by Directive 2008/50/EC [3]. The monitoring carried out with the portable analyzer allowed the characterization of the spatio-temporal variability of suspended particle concentrations in the investigated locations and the completion of information that cannot be obtained through fixed monitoring networks.

2.2. Spatial Interpolation

The spatial distribution of the experimental data was assessed using the Inverse Distance Weighting (IDW) interpolation method. It allows estimation of registered values associated with a process/phenomenon at points where records are not available, based on known quantities measured at neighboring locations [26]. The influence of nearby points is greater, and it decreases with distance. In an abstract manner, the weights of nearby points are greater than those of distant ones.

Thus, the evaluation of the weight will be by the relationship (1):

$$\lambda_i = \frac{1}{d_i^2} \quad (1)$$

where d_i is the Euclidean distance from the target point to the neighbor point i . The value to be assigned for point x , $z(x)$, is calculated with the relation (2):

$$z(x) = \frac{\sum_1^k \lambda_i z_i}{\sum_1^k \lambda_i} \quad (2)$$

where k is the number of points in the vicinity of the target point, and z_i is the value recorded at the point i .

The interpolation performance was assessed using the cross-validation tool available in ArcGIS Pro [26]. A leave-one-out cross-validation procedure was applied to all monitoring points, and the resulting Mean Error (ME), Mean Absolute Error (MAE), Mean Squared Error (MSE), and Root Mean Square Error (RMSE) were used to evaluate interpolation bias and prediction accuracy.

3. Results and Discussion

The monitoring campaign revealed substantial spatial variability in particulate matter pollution, reflecting the uneven distribution of local anthropogenic emission sources together with limited atmospheric dispersion. The descriptive statistics for pollutant concentrations measured during November–December 2025 are summarized in Tables 1 and 2. The complete monitoring dataset, for the same period, is available in Tables S4–S6.

Table 1. Hourly PM₁₀ and PM_{2.5} concentrations (November 2025).

Points	Statistics	Day						
		22	23	24	25	26	27	30
TG01 - TG26	PM ₁₀ (mg/m ³)							
	max	1.736	1.906	2.24	2.36	2.6	2.32	17.98
	min	0.18	0.20	0.14	0.20	0.16	0.18	0.16
	mean	0.48	0.74	0.93	1.04	0.92	0.86	1.52
	median	0.42	0.62	0.6	0.62	0.56	0.55	0.56
	stddev	0.45	0.37	0.74	0.79	0.75	0.72	3.43
	skew	0.13	0.51	0.65	0.49	0.96	1.07	4.76
	kurtosis	0.97	0.26	-1.29	-1.6	-0.57	-0.46	23.57
	PM _{2.5} (mg/m ³)							
	max	1.614	1.850	1.776	2.325	2.016	1.160	17.760
	min	0.080	0.100	0.070	0.100	0.080	0.090	0.080
	mean	0.605	0.598	0.500	0.709	0.525	0.444	1.204
	median	0.290	0.310	0.265	0.300	0.280	0.275	0.280
	stddev	0.646	0.560	0.433	0.704	0.463	0.352	3.350
	skew	1.394	1.089	1.282	1.420	1.555	1.005	4.718
	kurtosis	1.522	0.225	1.360	1.139	2.796	-0.461	25.378

Table 2. Hourly PM₁₀ and PM_{2.5} concentrations (December 2025)

Points	Statistics	Day							
		01	02	03	04	05	06	07	08
TG01 - TG26	PM ₁₀ (mg/m ³)								
	max	19.41	2.3	2.36	2.24	2.36	2.38	2.32	2.26
	min	0.18	0.18	0.18	0.14	0.2	0.16	0.18	0.06
	mean	1.54	0.89	0.86	0.88	0.87	0.85	0.86	0.84
	median	0.55	0.55	0.55	0.53	0.57	0.53	0.55	0.51
	stddev	3.71	0.71	0.72	0.72	0.72	0.73	0.72	0.72
	skew	4.82	0.93	1.07	0.85	1.08	1.09	1.06	1.01
	kurtosis	23.97	-0.72	-0.44	-0.9	-0.47	-0.4	-0.47	-0.56

Points	Statistics	01	02	03	04	05	06	07	08
	PM _{2.5} (mg/m ³)								
	max	18.21	1.27	1.62	1.37	1.18	1.19	1.16	1.27
	min	0.09	0.09	0.09	0.07	0.10	0.08	0.09	0.07
	mean	1.92	0.49	0.63	0.46	0.45	0.44	0.44	0.49
	median	0.28	0.28	0.32	0.26	0.29	0.27	0.28	0.28
	stddev	4.68	0.38	0.49	0.39	0.35	0.36	0.35	0.38
	skew	3.15	0.88	0.80	1.06	1.01	1.02	1.00	0.85
	kurtosis	10.06	-0.76	-0.66	-0.23	-0.47	-0.40	-0.47	-0.79
	Statistics	Day							
	09	10	11	12	13	14	15	16	
TG01 - TG26	PM ₁₀ (mg/m ³)								
	max	2.34	2.30	2.34	2.36	2.30	2.36	2.70	2.04
	min	0.20	0.16	0.18	0.2	0.11	0.18	0.18	0.10
	mean	0.86	0.88	0.86	0.86	0.92	0.84	0.94	0.93
	median	0.55	0.56	0.55	0.57	0.56	0.53	0.56	0.62
	stddev	0.72	0.71	0.72	0.72	0.76	0.73	0.80	0.54
	skew	1.07	0.94	1.06	1.08	0.85	1.13	0.96	0.68
	kurtosis	-0.47	-0.64	-0.46	-0.46	-0.97	-0.37	-0.65	-1.26
	PM _{2.5} (mg/m ³)								
	max	1.17	1.15	1.17	1.18	1.40	1.18	2.20	1.87
	min	0.10	0.08	0.09	0.10	0.08	0.09	0.09	0.04
	mean	0.45	0.47	0.45	0.45	0.49	0.45	0.53	0.69
	median	0.28	0.28	0.28	0.29	0.28	0.28	0.28	0.24
	stddev	0.35	0.36	0.35	0.36	0.39	0.36	0.49	0.28
	skew	1.01	0.79	1.00	1.01	0.94	0.95	1.75	0.48
kurtosis	-0.47	-0.99	-0.46	-0.46	-0.44	-0.58	4.03	-0.66	

The recorded values indicate systematic exceedances of the safety thresholds, with hourly concentration peaks exceeding the daily limits imposed by Directive 2008/50/EC [3] (Table 3) by more than three orders of magnitude, as well as those of the WHO guidelines [5].

Table 3. Comparison of PM concentrations with air quality standards

Pollutant	Period	Max. value	Mean value	WHO daily	UE/RO daily average*	WHO annual	UE/RO annual average
(mg/m ³)							
PM ₁₀	Nov–Dec2025	19.41	4.755	0.045	LL ** (0.025) UL *** (0.035)	0.150	LL ** (0.020) UL *** (0.028) (0.040) ^a
	Jan 2026	6.42	2.05				
	Feb 2026	3.25	1.184				
	March 2026	3.32	1.108				
	April 2026	1.70	2.430				
PM _{2.5}	Nov–Dec2025	18.21	1.920	0.015	NA	0.005	0.025
	Jan 2026	5.26	1.96				
	Feb 2026	4.35	1.305				
	Mar 2026	4.42	1.221				
	Apr 2026	2.41	0.182				

*Daily average *not to be exceeded more than 35 times in a calendar year*; ** LL (Lower Limit);

***UL (Upper Limit); ^a Annual Limit value; NA - No daily limit value

An example of each recorded PM_{10} and $PM_{2.5}$ concentration is provided in Figures S1 – S2, illustrating the higher concentrations measured in the residential area on November 30, 2025, at monitoring point TG9. For the monitoring points with heavy traffic (e.g., TG04 on Eroilor Boulevard and TG07 on Tighina Street, respectively, and TG25– TG26 located on Calea București), the data confirm a clear prevalence of the $PM_{10} \gg PM_{2.5}$ fraction, with a profile characteristic of the deposition of road dust and mechanical wear from vehicles transiting the monitored areas [8,18].

This footprint, observed in particular on November 23, 2025 (PM_{10} peak of 1.906 mg/m^3) and on December 1, 2025 (PM_{10} peak of 19.410 mg/m^3), frequently exceeds by more than 300 times the daily limit of 0.050 mg/m^3 , as provided for by Law 104/2011 [4]. The urban canyon architecture, together with an average wind speed of 1.5 m/s , favors the accumulation of these pollutants in the human breathing zone (1.5 m above ground), effectively transforming the major arteries into corridors of acute exposure.

One of the critical situations was observed at the TG09 station on Cernăuți Street (examples that are provided in Figures S1–S2), where, on November 30, 2025, a momentary $PM_{2.5}$ concentration of 17.760 mg/m^3 was recorded, exceeding the safety thresholds set for human health by several hundredfold [5]. The near-unit $PM_{2.5}/PM_{10}$ ratio observed at this point is a clear empirical tracer of fossil-fuel and biomass combustion processes [18,19].

In contrast to aerosols of crustal origin, this toxic cloud is largely composed of elemental carbon and ultrafine particles resulting from the thermal degradation of polymer waste, such as tires and plastics [21,22]. In addition, the combustion of copolymer-based waste in the open air, in particular rubber tires, is a source of zinc and PAH (Polycyclic Aromatic Hydrocarbons), while the combustion of plastic-coated cables favors the passage of copper and lead in the form of ultrafine particles into the urban atmosphere [22].

A significant factor was the considerable fluctuation in pollutant levels measured at locations TG01 and TG02 adjacent to the industrial equipment factory NIMET SRL (e.g., spikes nearing 2.0 mg/m^3 for $PM_{2.5}$) on Laminorului Street (western sector of Târgoviște municipality). In this vicinity, there have been sporadic occurrences of combustion from point sources, during which the emission levels substantially surpass the self-purification capability of the local atmosphere under conditions of thermal stability [19].

The PM_{10} and $PM_{2.5}$ concentrations measured at points TG01 and TG02 are not exclusively associated with direct emissions from nearby sources. Secondary pollutants formed in the environment from different precursor gases, e.g., NO_x (nitrogen oxides) emitted by road traffic and perhaps SO_x (sulfur oxides) released by industrial activities, are also expected to contribute to the recorded concentrations.

All of these contributions are consistent with the background PM₁₀ and PM_{2.5} levels observed across the Târgoviște municipality. Extremely high levels were recorded at TG07, situated on DN 72 (Gopo area), which frequently surpassed 17.0 mg/m³, signaling a dense accumulation of suspended particles in the urban boundary layer.

Due to the heterogeneity of the recorded data, a proper assessment is difficult to achieve with a simple statistical analysis. Thus, for the geospatial analysis of PM concentrations, we used the IDW interpolation method. The results of the IDW interpolation for the days with the highest pollutant values are shown in Figures 2–5.

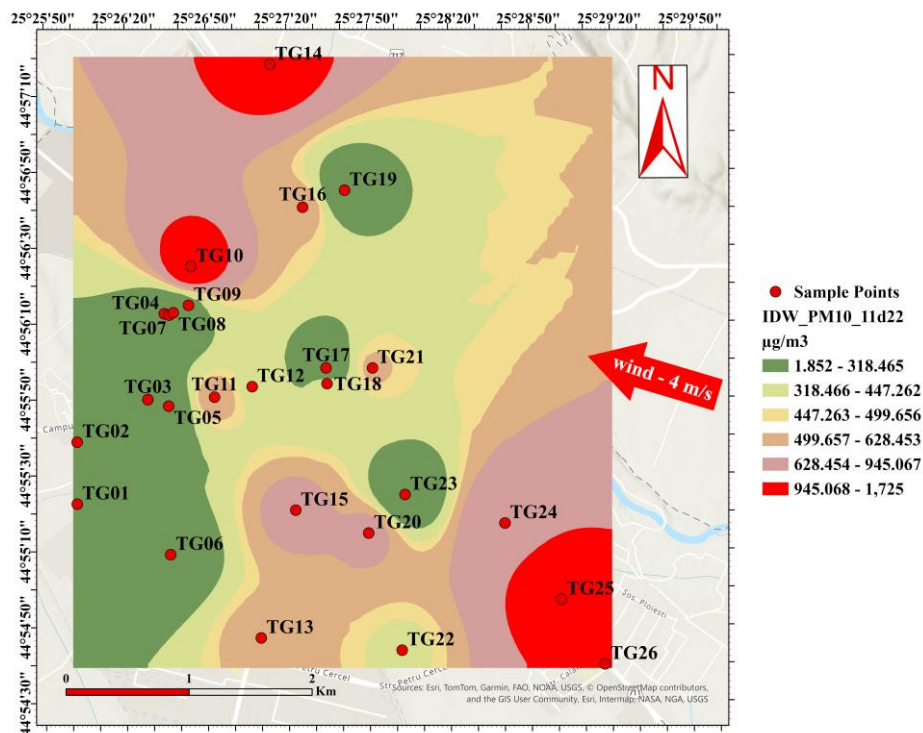
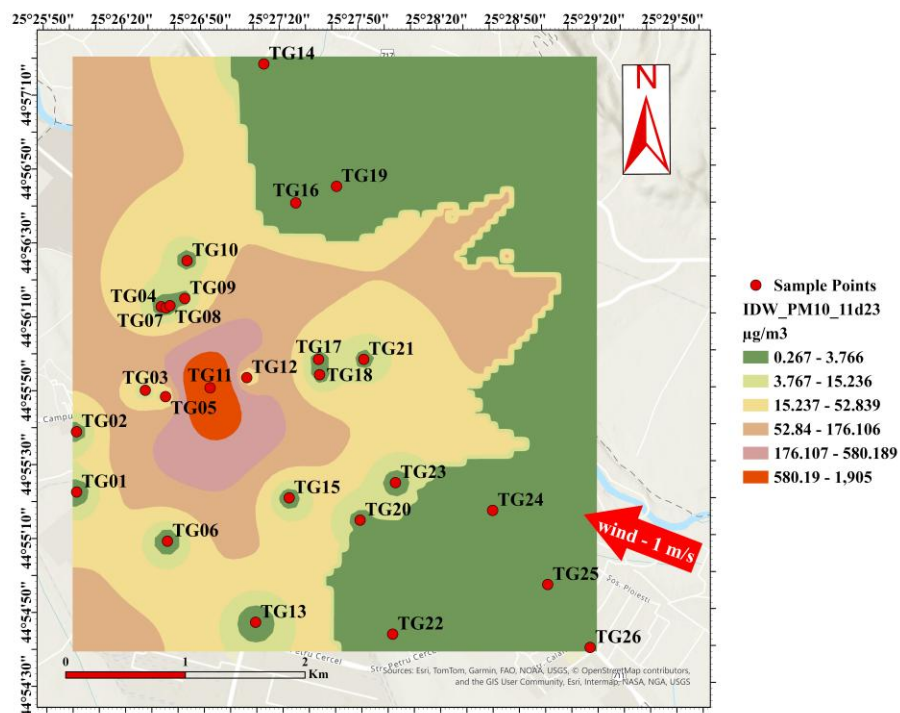
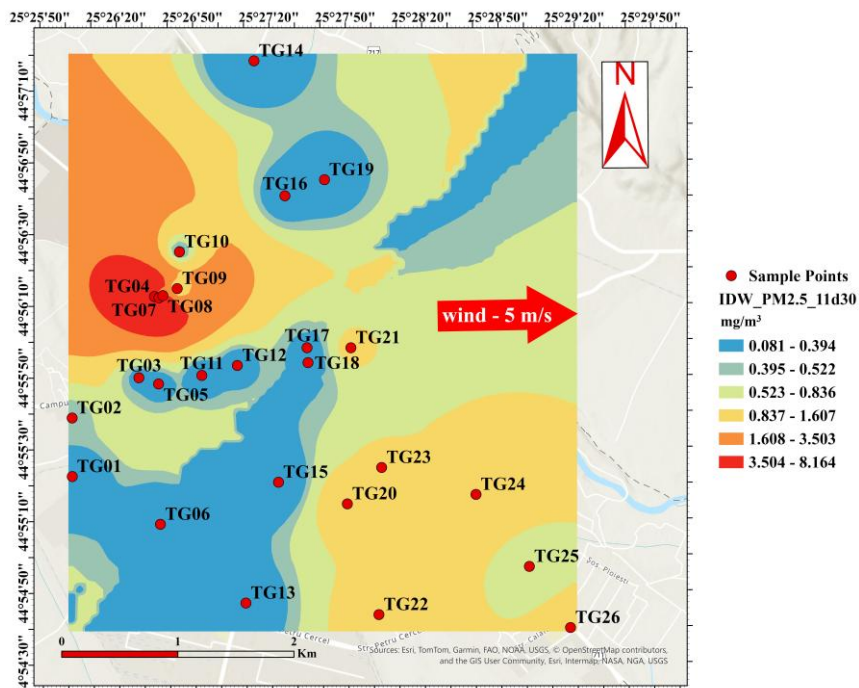


Figure 2. PM₁₀ interpolation map on November 22, 2025

Figure 3. PM₁₀ interpolation map on November 23, 2025Figure 4. PM_{2.5} interpolation map on November 30, 2025

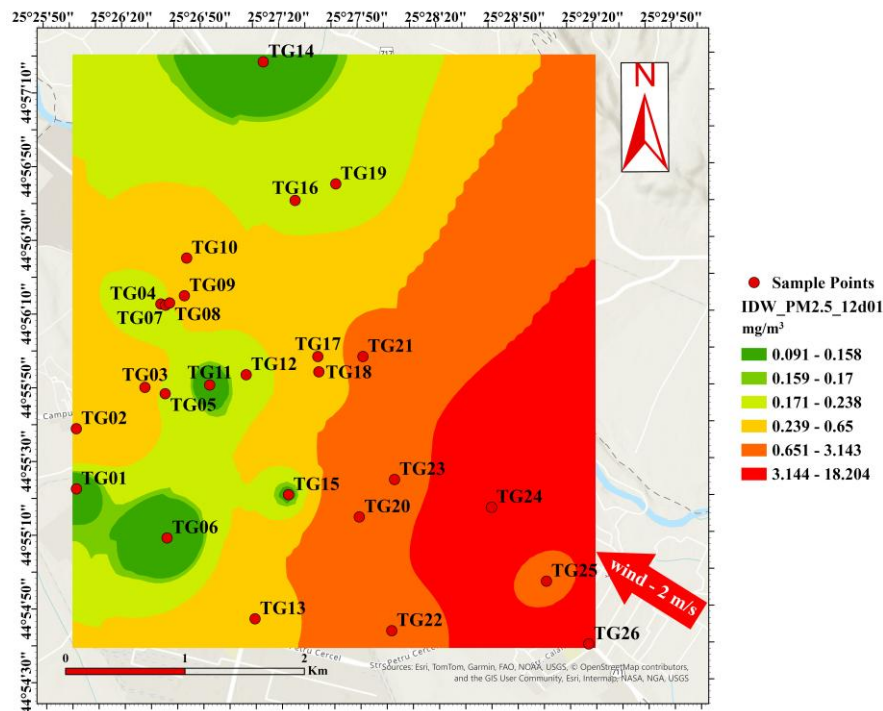


Figure 5. PM_{2.5} interpolation map on December 1, 2025

Figure 6 shows PM₁₀ and PM_{2.5} peaks from November 2025 to April 2026.

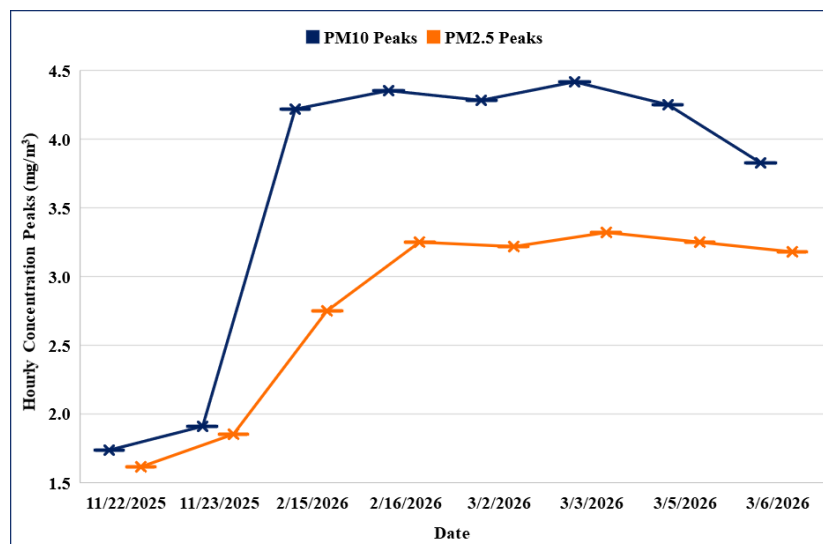


Figure 6. PM_{2.5} and PM₁₀ peaks from November 2025 to April 2026

Cross-validation indicated low interpolation bias for all datasets (Table S7), with ME values ranging from -0.012 to 0.041 . For PM₁₀, RMSE values ranged

between 0.781 and 0.850, while for $PM_{2.5}$ they ranged from 0.760 to 0.950. The best interpolation performance was obtained for $PM_{2.5}$ on November 30, 2025 (RMSE = 0.760; MAE = 0.472), whereas the highest prediction error was observed for $PM_{2.5}$ on December 1, 2025 (RMSE = 0.950; MAE = 0.611). Overall, the cross-validation results indicate low prediction bias and satisfactory interpolation accuracy for both particulate matter fractions.

In December 2025, high atmospheric humidity (over 85%) favored smog formation. The fine $PM_{2.5}$ particles from the Cernăuți Street area acted as condensation nuclei for the water vapor in the air. Thus, the invisible particles produced by combustion, combined with atmospheric moisture, formed a dense, visible smog. Under the influence of local topography and the displacement of cold air into the lowlands, this smog spread to the lower parts of the city. Detailed analysis of Cernăuți Street concentration peaks, which frequently exceeded 15.0 mg/m^3 , indicates the practical repeatability of the same event between 14:00 and 18:00. For several hours, PM_{10} and $PM_{2.5}$ concentrations showed little variation and remained at elevated levels. Such behavior is not typical of traffic-related emissions and suggests a continuous emission source.

One possible explanation is the combustion of industrial waste or waste tires, although this could not be confirmed from the available measurements. The daily variation observed on Eroilor Bulevard was different. PM_{10} reached its first maximum between 08:00 and 09:00, at the time of the morning traffic peak, indicating the contribution of road dust resuspended by vehicle movement, and between 17:00 and 19:30 there was a convergence between PM_{10} and $PM_{2.5}$, in which mechanical dust mixes with vehicle exhaust emissions in conditions of atmospheric stagnation.

Along this arterial road, the high roughness of the building facades and the presence of trees favor the dry deposition of dust and facilitate the rapid resuspension of particles triggered by vehicle-generated turbulence.

In other situations, such as the atmospheric calm frequently observed during the study (at wind speeds $< 1 \text{ m/s}$ and in variable directions), exponential increases in PM_{10} and $PM_{2.5}$ concentrations were recorded. The wind rose during the monitoring campaign is presented in Figure S3. For example, persistently high values were recorded in 1 Mai Square, located in the central-southern part of Târgoviște, in an intensely trafficked urban area near residential neighborhoods and local commercial areas, a relevant node for urban traffic and public transport in the municipality of Târgoviște.

Thus, the recorded PM_{10} and $PM_{2.5}$ concentrations indicate limited atmospheric dispersion during the monitoring period, allowing particulate matter to accumulate near the emission sources. This behavior is reflected in the high concentrations measured with the Casella Microdust Pro monitor. Because residential areas are located nearby, the repeated occurrence of elevated $PM_{2.5}$

levels between 18:00 and 22:00 suggests an increased short-term exposure of the local population. The results obtained at the TG1–TG26 monitoring sites provide a valuable basis for the development of the Integrated Air Quality Plan for the municipality of Târgoviște.

The spatial distribution of particle matter concentrations identified several priority areas where mitigation measures should be focused on the exceptionally high PM_{2.5} concentrations recorded during several monitoring campaigns, which substantially exceeded guideline values and therefore represent a potential concern for public health. Previous epidemiological studies have linked both short- and long-term exposure to different particulate matter with increased respiratory and cardiovascular morbidity [7,8]. Although health outcomes were not evaluated in the present study, the measured concentrations indicate that residents living near major roads and industrial areas may experience increased exposure during pollution episodes. The Tribunal – Bulevard Eroilor sector, characterized by dense traffic and limited atmospheric dispersion, represents a critical location where traffic management strategies, including temporary restrictions on heavy-duty vehicles during stagnation events, could help reduce short-term particulate accumulation.

In addition, vegetative barriers established along the DN72 national road and around industrial facilities may help limit particulate transport toward nearby residential areas. The present results also highlight the importance of complementing the existing monitoring network with mobile monitoring technologies. Periodic surveys using uncrewed aerial vehicles equipped with particulate sensors could improve the identification of localized emission sources, including illegal biomass or waste burning, and support rapid environmental inspections.

4. Conclusions

The PM₁₀ and PM_{2.5} monitoring campaign conducted in the municipality of Târgoviște highlighted clear differences in suspended particle concentrations across the twenty-six locations investigated. The highest PM_{2.5} concentrations recorded using a portable Casella Microdust Pro monitor were associated with several short-term pollution episodes, including values exceeding 17.0 mg/m³. These measurements indicate episodes of intense local pollution, although the available data do not allow for a direct and complete assessment of population exposure or toxicological effects.

However, the observed PM_{2.5} concentrations are a cause for concern from the point of view of environmental quality and provide useful information on the local distribution of suspended particles in the municipality of Târgoviște. Thus, higher concentrations of suspended particles were repeatedly recorded in certain areas, especially on Cernăuți Street and near industrial areas.

The spatial distribution of PM_{10} and $PM_{2.5}$ concentrations using the IDW interpolation method indicates that local emission sources contribute significantly to particulate matter levels in Târgoviște municipality. However, the results should be interpreted within the limits of the monitoring campaign, as the measurements describe the air quality conditions recorded in Târgoviște municipality during the investigated periods and do not provide a complete assessment of daily or seasonal pollution variability.

Higher concentrations of $PM_{2.5}$ were recorded in several locations, especially peri-urban, where local combustion activities were also identified during the monitoring campaign. Suspected waste burning in peripheral areas may have contributed to some of these episodes, but the available measurements do not allow quantifying the individual contribution of the sources. Confirming the origin of the particles would require chemical characterization and specific source identification methods.

Similarly, a different spatial distribution of PM_{10} was observed. Higher concentrations of PM_{10} were mainly associated with areas influenced by road traffic, especially along Bulevardul Eroilor, where road dust, particle resuspension, and traffic emissions may contribute to the values recorded at different diurnal time intervals.

Certain spatial patterns identified in the study indicate several areas where additional monitoring would be useful. The installation of fixed monitoring stations in peripheral areas, including on Cernăuți Street and in the Gopo area of Târgoviște municipality, could improve spatial coverage and allow for continuous measurements. Longer monitoring periods would also allow for the determination of the extent to which the high concentrations observed during the campaign are persistent or occur only under certain conditions.

The study results also support the need for better targeted environmental inspections in areas where high concentrations of particulate matter and suspicious combustion activities have been observed. Combining continuous measurements of suspended particulate matter with video surveillance systems or IoT-based sensor networks could help identify short-term emission episodes and their more precise localization.

Measures to reduce particle resuspension should also be considered in areas heavily influenced by road traffic. Periodic wet cleaning of high-traffic thoroughfares, including Bulevardul Eroilor and Calea București, could help reduce the contribution of deposited dust, justified by the PM_{10} concentrations recorded in the monitoring campaign. Traffic management measures, including the possible restriction of heavy vehicles during meteorological conditions unfavorable to pollutant dispersion, can also be assessed based on longer-term measurements and local-specific meteorological data.

Supplementary Materials

Additional experimental data are provided in Tables S1 – S7 and Figures S1 – S3 in the Supplementary Materials.

Author Contributions

Conceptualization, F.–R.D. and L.B.; methodology, L.B. and A.B.; validation, F.–R.D., L.B., and A.B.; formal analysis, A.B. and L.B.; investigation, F.–R.D.; writing—original draft preparation, F.–R.D. and L.B.; writing—review and editing, A.B. and L.B.; supervision, A.B.; funding acquisition, F.–R.D. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

The original contributions presented in this study are included in the article. Further inquiries can be directed to the corresponding authors.

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Conflicts of Interest

The authors declare no conflict of interest.

Artificial Intelligence Disclosure

Artificial intelligence-based tools were used solely for language editing, grammar checking, and stylistic refinement of the manuscript. The tool used was Grammarly (AI Writing Assistant, version 14.1313.0). The authors remain fully responsible for the content of this work.

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Supplementary materials

Table S1. Monitoring locations and site characteristics

Monitoring Point	Latitude	Longitude	Land-use Type	Category
TG01	44.922629	25.432305	Western urban entrance road	Heavy traffic
TG02	44.927165	25.432333	Urban residential area adjacent to a main road	Heavy traffic
TG03	44.930252	25.439641	Central urban intersection	Heavy traffic
TG04	44.936527	25.441373	Main boulevard	Heavy traffic
TG05	44.929769	25.441784	Commercial urban area	Heavy traffic
TG06	44.9364388	25.4418655	Residential neighborhood	Urban
TG07	44.9189	25.4419	Central-west residential area	Urban
TG08	44.936606	25.442306	Mixed urban area	Urban
TG09	44.93714	25.443878	Residential area	Urban
TG10	44.93998	25.444141	Northern residential district	Urban
TG11	44.9304	25.4465	Mixed residential-commercial area	Urban
TG12	44.931161	25.450383	Mixed urban area	Urban
TG13	44.91276	25.45118	Southern urban fringe	Peri-urban
TG14	44.954611	25.454222	Northern urban fringe	Peri-urban
TG15	44.9221	25.4548	Residential neighborhood	Urban
TG16	44.944275	25.455681	Industrial vicinity	Industrial
TG17	44.9325	25.458	Industrial access road	Industrial
TG18	44.93135	25.458093	Industrial zone	Industrial
TG19	44.9455	25.46	Industrial platform	Industrial
TG20	44.9204	25.4623	Industrial perimeter	Industrial
TG21	44.932483	25.462778	Urban-industrial transition zone	Peri-urban
TG22	44.911663	25.465058	Peripheral residential area	Peri-urban

TG23	44.923203	25.466062	Eastern urban edge	Peri-urban
TG24	44.921071	25.476329	Eastern outskirts	Peri-urban
TG25	44.9168504	25.4817597	Rural-urban fringe	Peri-urban
TG26	44.91072	25.48656	Rural	Peri-urban

Table S2. Technical specifications and instrument calibration of the monitoring instrument Casella CEL-712 Ltd. (Microdust Pro, Serial No. 6543210987), Bedford, UK

Parameter/Conditions	Specification
Particle fractions	PM10 and PM2.5 using optional size-selective impactors
Measurement principle	Real-time optical aerosol monitor based on forward light scattering using a visible red semiconductor laser (635–638 nm, Class 1 laser)
Measured parameter	Real-time mass concentration of suspended particulate matter
Measurement range	0.001 mg/m ³ – 250 g/m ³ (automatic or manual range selection)
Measurement resolution	0.001 mg/m ³
Zero stability	< 2 µg/m ³
Span stability	±0.2% of reading per °C
Logging interval	1 s – 60 min
Memory capacity	86,000 data points (approximately 500 measurement runs)
Factory calibration	ISO 12103-1 A2 Fine Test Dust with default photometric calibration factor of 1.0
Zero verification	Zero Check performed before each monitoring session using the integrated HEPA purge filter
Span verification	Optical response verified using the manufacturer-supplied Calibration Insert (Cal Insert)
Field QA/QC	Inspection of optical chamber cleanliness, probe integrity, and stabilization before measurements
Sampling configuration	PM10 and PM2.5 measured sequentially using interchangeable size-selective impactors
Instrument stabilization	1–3 min after changing the impactor; 10–15 min thermal acclimatization when required
Humidity correction	Hygroscopic correction applied during post-processing for measurements performed under elevated relative humidity, according to the adopted correction procedure
Extreme value verification	Concentrations exceeding the expected environmental range were verified by duplicate measurements before acceptance
Data validation criteria	Measurements failing Zero Check, affected by condensation or optical contamination, or identified as transient artifacts were excluded from the final dataset

Table S3. Measurement protocol, sampling schedule and quality assurance procedures

Measurement procedure	Period	Time	Measurement Objectives
1. Device set up (visual inspection of the instrument and sampling accessories; zero check using the HEPA purge filter; optical response verification using the calibration insert; installation of the PM10 or PM2.5 size-selective adaptor; thermal stabilization). 2. Sampling measurement (positioning of the inlet at 1.5–2.0 m above ground; instrument stabilization (1–3 min); sequential PM10/PM2.5 measurements by replacing the corresponding PUF filter between measurement runs. The PUF size-selective inlet system is operated at a flow rate of 3.5 L/min; 10–15 min measurement for each particle fraction) 3. Meteorological observations (temperature, wind speed and direction, relative humidity recorded simultaneously). 4. Data validation and statistical processing (duplicate measurements for unusually high concentrations; outliers' removal)	November 2025 (7 days)	2 – 4 p.m.	Monitoring campaign of PM10 and PM2.5 concentration at twenty-six points from: - areas with heavy road traffic (5 points); - urban background (8 points); - areas located near industrial sites (5 points); - peri-urban areas (8 points).
	December 2025 (19 days)	4 – 6 p.m.	
	January 2026 (15 days)	2 – 4 p.m.	
	February 2026 (9 days)	12 a.m. – 2 p.m.	
	March 2026 (16 days)	10 – 12 a.m.	
	April 2026 (12 days)	8 – 10 a.m. or 10 – 12 a.m.	

Table S4. Meteorological conditions during the monitoring campaign (November – December 2025)

Date	Sampling Time	Wind Direction	Wind Speed (m/s)	Average Air Temperature (°C)	Relative Humidity (%)	Atmospheric Pressure (mbar)
22.11.2025	14 – 15	SE	4	8	82	1020
23.11.2025	14 – 15	E	1	6	93	1022
24.11.2025	15 – 16	SE	1	5	93	1020
25.11.2025	14 – 16	N	5	5	85	1016
26.11.2025	14 – 16	NW	6	3	85	1015
27.11.2025	15 – 16	N	4	5	78	1018
30.11.2025	14 – 15	W	5	8	75	1016
01.12.2025	14 – 15	SE	2	4	85	1019
02.12.2025	12 – 15	SE	1	2	88	1020
03.12.2025	14 – 15	SW	3	5	80	1018
04.12.2025	14 – 15	E	2	3	85	1019
07.12.2025	17 – 18	SE	1	-1	92	1021
08.12.2025	17 – 18	SE	2	1	90	1019
09.12.2025	17 – 18	NW	4	0	85	1017
10.12.2025	16 – 17	NE	2	-2	90	1019
11.12.2025	17 – 18	NW	3	-3	82	1019
12.12.2025	17 – 18	SE	1	-2	90	1021
13.12.2025	17 – 18	SE	2	-1	88	1017
14.12.2025	17 – 18	SW	3	2	90	1015
15.12.2025	17 – 18	SW	3	4	85	1013
16.12.2025	17 – 18	ESE	2	3	88	1016
17.12.2025	17 – 18	Variable	1	0	92	1018
18.12.2025	17 – 18	NE	3	-2	85	1019
19.12.2025	17 – 18	N	3	-3	80	1020
20.12.2025	17 – 18	NE	2	-4	85	1022
21.12.2025	17 – 18	NE	1	-5	80	1023

Table S5. PM10 concentration (mg/m³) dataset on November – December 2025

Month/Day	TG01	TG02	TG03	TG04	TG05	TG06	TG07	TG08	TG09	TG10	TG11	TG12	TG13
11d22	1.838	98	101	189	150	120	85	94	270	1736	620	420	560
11d23	0.26	0.94	2.108	0.38	0.42	0.2	0.32	0.56	0.66	0.6	1906	0.36	0.52
11d24	0.22	0.88	0.66	0.34	0.46	0.16	0.28	1.784	0.7	0.54	0.2	0.4	0.48
11d25	0.24	0.92	0.58	0.4	0.4	0.22	0.34	0.58	0.64	0.62	0.26	0.34	1.938
11d26	0.28	0.86	0.62	0.36	0.44	0.18	0.3	0.54	0.68	0.58	2.6	0.38	0.5
11d27	0.26	0.9	0.68	0.34	0.48	0.2	0.32	0.56	0.66	0.56	0.24	0.36	0.52
11d30	0.24	0.88	0.62	0.36	0.44	0.18	17.98	0.54	0.68	0.58	0.22	0.38	0.5
12d01	0.26	0.92	0.66	0.38	0.42	0.2	0.32	0.56	0.66	0.56	0.24	0.36	0.52
12d02	0.24	0.9	0.62	0.36	0.44	0.18	0.3	0.54	0.68	0.56	0.22	0.38	0.5
12d03	0.22	0.94	0.64	0.38	0.46	0.2	0.32	0.56	0.66	0.6	0.24	0.36	0.52
12d04	0.26	0.88	0.66	0.34	1.588	0.16	0.28	0.52	0.7	0.54	0.2	0.4	0.48
12d07	0.24	0.92	0.58	0.4	0.4	0.22	0.34	0.58	0.64	0.62	0.26	0.34	0.54
12d08	0.28	0.86	0.62	0.36	0.44	0.18	0.3	0.54	0.68	0.58	0.22	0.38	0.5
12d09	0.22	0.9	0.68	0.34	0.48	0.2	0.32	0.56	0.66	0.56	0.24	0.36	0.52
12d10	0.26	0.96	0.6	0.38	0.42	0.056	0.28	0.52	0.7	0.6	0.2	0.4	0.48
12d11	0.24	0.92	0.64	0.4	0.46	0.2	0.3	0.58	0.64	0.54	0.26	0.34	0.54
12d12	0.24	0.9	0.62	0.36	0.44	0.18	0.34	0.54	0.68	0.58	0.22	1.2	0.5
12d13	0.22	0.94	0.66	0.38	0.42	0.2	0.32	0.56	0.66	0.56	0.24	0.36	0.52
12d14	0.24	0.88	0.6	0.34	0.46	0.22	0.28	0.58	0.64	0.62	0.26	0.34	0.54

Month/Day	TG01	TG02	TG03	TG04	TG05	TG06	TG07	TG08	TG09	TG10	TG11	TG12	TG13
12d15	0.28	0.92	0.62	2.23	0.4	0.18	0.34	0.54	0.68	0.58	0.22	0.38	0.5
12d16	0.26	0.39	0.64	0.36	0.42	0.2	0.32	0.56	0.66	0.56	0.24	0.36	0.52
12d17	0.26	0.88	0.68	0.34	0.48	0.2	0.32	0.56	0.66	0.56	0.24	0.36	2.7
12d18	0.22	0.39	0.58	0.34	0.4	0.056	0.28	0.52	0.64	0.54	0.2	0.34	0.48
12d19	0.32	5.3	5.26	9.02	7.29	5.63	4.96	4.86	12.91	79.46	115.14	19.48	26.11
12d20	1.84	98	101	189	150	120	85	94	270	1736	1906	420	560
12d21	0.25	0.9	0.64	0.36	0.44	0.2	0.32	0.56	0.66	0.58	0.24	0.36	0.52
Month/Day	TG14	TG15	TG16	TG17	TG18	TG19	TG20	TG21	TG22	TG23	TG24	TG25	TG26
11d22	1215	750	580	2.482	470	120	720	530	410	1.838	915	1200	1005
11d23	1.363	0.3	0.44	0.64	0.54	0.36	2.36	2.02	2.06	1.78	2.3	1.56	1.74
11d24	0.14	0.26	1.784	0.68	0.5	0.32	2.24	1.784	2.14	1.7	2.2	1.48	1.82
11d25	0.2	1.938	0.46	0.62	2.069	0.38	2.28	2.06	2.069	1.82	2.36	1.6	1.72
11d26	0.16	0.28	0.42	0.66	0.52	0.34	1.732	1.98	2.1	1.74	2.26	1.52	1.78
11d27	0.18	0.3	0.44	0.64	0.54	0.36	2.32	2	2.08	1.76	2.28	1.54	1.76
11d30	0.16	0.28	0.42	0.66	0.52	0.34	2.3	1.92	2.1	1.74	2.24	1.52	1.78
12d01	0.18	0.3	0.44	0.64	0.54	0.36	2.34	2.02	2.08	1.76	2.28	1.54	19.41
12d02	1.363	0.28	0.42	0.66	0.52	0.34	2.3	1.96	2.1	1.74	2.24	1.52	1.78
12d03	0.18	0.3	0.44	0.64	0.54	0.36	2.36	2.02	2.06	1.78	2.3	1.56	1.74
12d04	0.14	0.26	0.4	0.68	0.5	0.32	2.24	1.9	2.14	1.7	2.2	1.48	1.82
12d07	0.2	0.32	0.46	0.62	0.56	0.38	2.28	2.06	2.04	1.82	2.36	1.6	1.72
12d08	0.16	0.28	0.42	0.66	0.52	0.34	2.38	1.98	2.1	1.74	2.26	1.52	1.78
12d09	0.18	0.3	0.44	0.64	0.54	0.36	2.32	2	2.08	1.76	2.28	1.54	1.76
12d10	0.14	0.26	0.4	0.68	0.5	0.32	2.26	1.94	2.12	1.72	2.22	1.5	1.8
12d11	0.2	0.32	0.46	0.62	0.56	0.38	2.34	2.04	2.06	1.8	2.3	1.58	1.74
12d12	0.16	0.28	0.42	0.66	0.52	0.34	2.3	1.92	2.1	1.74	2.24	1.52	1.78
12d13	0.18	0.3	0.44	0.64	0.54	0.36	2.34	2.02	2.08	1.76	2.28	1.54	1.76
12d14	0.2	0.32	0.46	0.62	0.56	0.38	2.28	2.06	2.04	1.82	2.36	1.6	1.72
12d15	0.105	0.28	0.42	0.66	0.52	0.34	2.3	1.92	2.1	1.74	2.24	1.52	1.78
12d16	0.18	0.3	0.44	0.64	0.54	0.36	2.36	2.02	2.06	1.78	2.3	1.56	1.74
12d17	0.18	0.3	0.44	0.64	0.54	0.36	2.3	2	2.08	1.76	2.28	1.54	1.84
12d18	0.105	0.26	0.4	0.62	0.5	0.32	1.732	1.784	2.04	1.7	2.2	1.48	1.72
12d19	55.5	34.44	26.84	0.73	21.94	5.79	34.91	25.98	20.63	1.76	43.76	56.02	48.17
12d20	1215	750	580	2.48	470	120	720	530	410	1.84	915	1200	1005
12d21	0.18	0.3	0.44	0.64	0.54	0.36	2.3	2	2.08	1.76	2.28	1.54	1.78

Table S6. PM_{2.5} concentration (mg/m³) dataset on November – December 2025

Month/Day	TG01	TG02	TG03	TG04	TG05	TG06	TG07	TG08	TG09	TG10	TG11	TG12	TG13
11d22	1.979	0.45	0.31	0.18	0.22	0.09	0.15	0.27	0.34	1.979	0.11	0.19	0.25
11d23	0.13	0.47	1.862	0.19	0.21	0.1	0.16	0.28	0.33	0.3	1.849	0.18	0.26
11d24	0.11	0.44	0.33	0.17	0.23	0.08	0.14	0.26	0.35	0.27	0.18	0.2	0.24
11d25	0.12	0.46	0.29	0.2	0.2	0.11	0.17	0.29	0.32	0.31	0.13	0.17	2.325
11d26	0.14	0.43	0.31	0.18	0.22	0.09	0.15	0.27	0.34	0.29	2.016	0.19	0.25
11d27	0.13	0.45	0.34	0.17	0.24	0.10	0.16	0.28	0.33	0.28	0.12	0.18	0.26
11d30	0.12	0.44	0.31	0.18	0.22	0.09	17.76	0.27	0.34	0.29	0.11	0.19	0.25
12d01	0.13	0.46	0.33	0.19	0.21	0.15	0.16	0.28	0.33	0.28	0.12	0.18	0.26

12d02	0.12	0.45	0.31	0.18	0.22	0.09	0.15	0.27	0.34	0.28	0.11	0.19	0.25
12d03	0.11	0.47	0.32	0.19	1.515	0.13	0.16	0.28	0.33	0.3	0.12	1.557	0.26
12d04	0.13	0.44	0.33	0.17	0.23	0.08	0.14	0.26	0.35	0.27	0.1	0.2	0.24
12d07	0.12	0.46	0.29	0.2	0.2	0.11	0.17	0.29	0.32	0.31	0.13	0.17	0.27
12d08	0.14	0.43	0.31	0.18	0.22	0.09	0.15	0.27	0.34	0.29	0.11	0.19	0.25
12d09	0.11	0.45	0.34	0.17	0.24	0.11	0.16	0.28	0.33	0.28	0.12	0.18	0.26
12d10	0.13	0.48	0.3	0.19	0.21	1.268	0.14	0.26	0.35	0.3	0.1	0.2	0.24
12d11	0.12	0.46	0.32	0.2	0.23	0.1	0.15	0.29	0.32	0.27	0.13	0.17	0.27
12d12	0.12	0.45	0.31	0.18	0.22	0.09	0.17	0.27	0.34	0.29	0.11	1.02	0.25
12d13	0.11	0.47	0.33	0.19	0.21	0.1	0.16	0.28	0.33	0.28	0.12	0.18	0.26
12d14	0.12	0.44	0.3	0.17	0.23	0.11	0.14	0.29	0.32	0.31	0.13	0.17	0.27
12d15	0.14	0.46	0.31	1.4	0.2	0.09	0.17	0.27	0.34	0.29	0.11	0.19	0.25
12d16	0.13	0.63	0.32	0.18	0.21	0.1	0.16	0.28	0.33	0.28	0.12	0.18	0.26
12d17	0.13	0.44	0.34	0.17	0.24	0.1	0.16	0.28	0.33	0.28	0.12	0.18	2.2
12d18	0.08	0.10	0.07	0.10	0.08	0.09	0.08	0.09	0.09	0.09	0.07	0.10	0.08
12d19	0.61	0.60	0.50	0.71	0.52	0.44	1.20	1.92	0.49	0.63	0.46	0.45	0.44
12d20	2.46	1.85	1.78	2.33	2.02	1.16	17.76	18.21	1.27	1.62	1.37	1.18	1.19
12d21	0.29	0.31	0.27	0.30	0.28	0.28	0.28	0.28	0.28	0.32	0.26	0.29	0.27
Month/Day	TG14	TG15	TG16	TG17	TG18	TG19	TG20	TG21	TG22	TG23	TG24	TG25	TG26
11d22	0.08	0.14	0.21	2.461	0.26	0.17	1.15	0.98	1.05	0.87	1.12	0.76	0.89
11d23	1.85	0.15	0.22	0.32	0.27	0.18	1.18	1.01	1.03	0.89	1.15	0.78	0.87
11d24	0.07	0.13	1.776	0.34	0.25	0.16	1.12	0.95	1.07	0.85	1.1	0.74	0.91
11d25	0.1	2.325	0.23	0.31	0.28	0.19	1.609	1.03	2.268	0.91	1.18	0.8	0.86
11d26	0.08	0.14	0.21	0.33	0.26	0.17	1.19	0.99	1.05	0.87	1.13	0.76	0.89
11d27	0.09	0.15	0.22	0.32	0.27	0.18	1.16	1.02	1.04	0.88	1.14	0.77	0.88
11d30	0.08	0.14	0.21	0.33	0.26	0.17	1.15	0.96	1.05	0.87	1.12	0.76	0.89
12d01	0.09	0.15	0.22	0.32	0.27	0.18	1.17	1.01	1.04	0.88	17.63	0.77	18.21
12d02	1.274	0.14	0.21	0.33	0.26	0.17	1.15	0.98	1.05	0.87	1.12	0.76	0.89
12d03	0.09	0.15	0.22	0.32	0.27	1.619	1.18	1.01	1.03	0.89	1.15	0.78	0.87
12d04	0.07	0.13	0.2	0.34	0.25	0.16	1.12	0.95	1.07	0.85	1.10	1.374	0.91
12d07	0.1	0.16	0.23	0.31	0.28	0.19	1.14	1.03	1.02	0.91	1.18	0.8	0.86
12d08	0.08	0.14	0.21	0.33	0.26	0.17	1.19	0.99	1.05	0.87	1.13	0.76	0.89
12d09	0.09	0.15	0.22	0.32	0.27	0.18	1.16	1.25	1.04	0.88	1.14	0.77	0.88
12d10	0.07	0.13	0.2	0.34	0.25	0.16	1.13	0.97	1.06	0.86	1.11	0.75	0.9
12d11	0.1	0.16	0.23	0.31	0.28	0.19	1.17	1.02	1.03	0.9	1.15	0.79	0.87
12d12	0.08	0.14	0.21	0.33	0.26	0.17	1.15	0.96	1.05	0.87	1.12	0.76	0.89
12d13	0.09	0.15	0.22	0.32	0.27	0.18	1.17	1.01	1.04	0.88	1.14	0.77	0.88
12d14	0.1	0.16	0.23	0.31	0.28	0.19	1.14	1.03	1.02	0.91	1.18	0.8	0.86
12d15	0.08	0.14	0.21	0.33	0.26	0.17	1.15	0.96	1.05	0.87	1.12	0.76	0.89
12d16	0.09	0.15	0.22	0.32	0.27	0.18	1.18	1.01	1.03	0.89	1.15	0.78	0.87
12d17	0.09	0.15	0.22	0.32	0.27	0.18	1.15	1.64	1.04	0.88	1.14	0.77	0.92
12d18	0.09	0.07	0.10	0.08	0.09	0.07	0.10	0.08	0.09	0.10	0.08	0.09	0.09
12d19	0.63	0.46	0.45	0.44	0.44	0.49	0.45	0.47	0.44	0.45	0.49	0.45	0.53
12d20	1.62	1.37	1.18	1.19	1.16	1.27	1.17	1.15	1.17	1.18	1.40	1.18	2.20
12d21	0.32	0.26	0.28	0.27	0.26	0.29	0.28	0.30	0.28	0.29	0.26	0.24	0.28

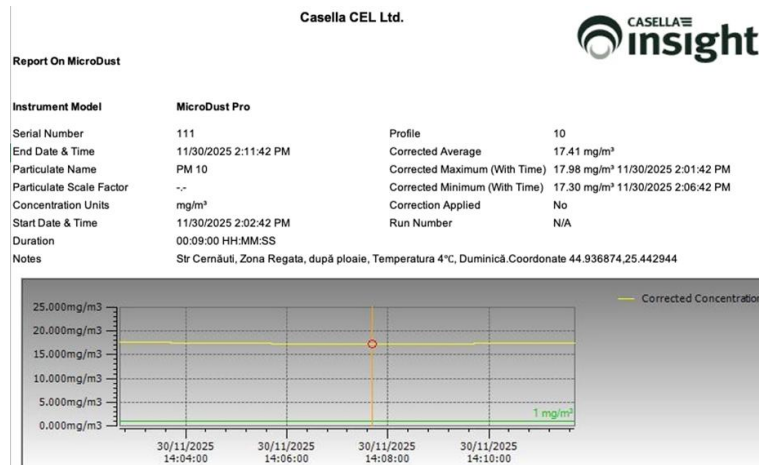
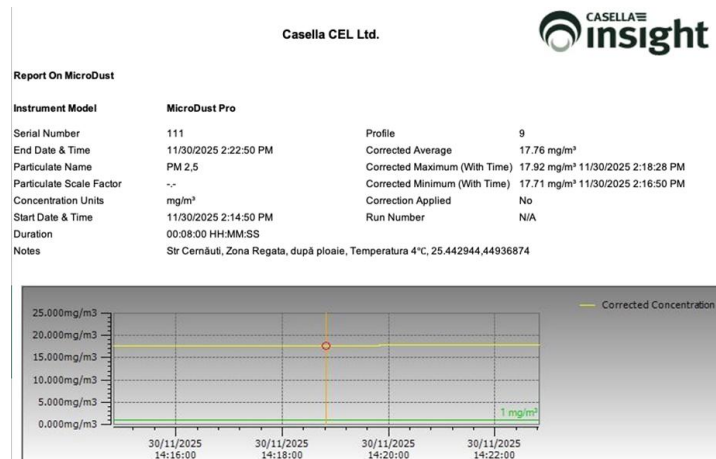
Figure S1. PM₁₀ concentration recording at TG9 (residential area) on 30 November 2025Figure S2. PM_{2.5} concentration recording at TG9 (residential area) on 30 November 2025

Table S7. Leave-one-out cross-validation statistics for the IDW interpolation*

Statistics	PM10		PM2.5	
			Date	
	22.11.2025	23.11.2025	30.11.2025	01.12.2005
Mean Error (ME)	-0.0081	0.018	-0.012	0.041
Mean Absolute Error (MAE)	0.4860	0.545	0.472	0.611
Mean Squared Error (MSE)	0.6094	0.723	0.577	0.903
Root Mean Square Error (RMSE)	0.7806	0.850	0.760	0.950

*Number of monitoring points (n) = 26 (neighbors to include = 15, include at least = 10)

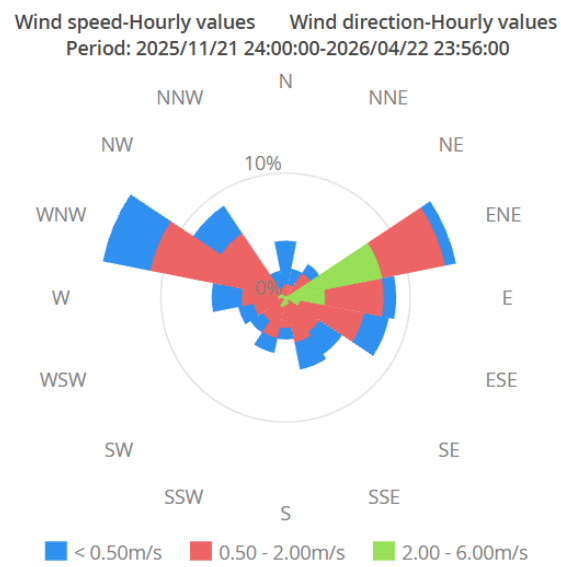


Figure S3. Wind rose during monitoring campaign