Effects of wind speed, relative humidity, temperature and air pressure on PM10 concentration for an urban background area

S Paraschiv and L S Paraschiv
Faculty of Engineering, “Dunarea de Jos” University of Galati, Romania
E-mail: sparaschiv@ugal.ro

Abstract. The paper analyses PM10 concentration data collected in Galati at the urban background type station from 1 January 2018 till 31 December 2018. The trend of PM10 concentration during the year was investigated considering the influence of recorded meteorological factors (temperature, wind velocity, pressure and relative humidity). Hourly PM10 concentrations ranged from 0.03 to 223.51 μg/m³ and exceeded the EU standard limit of 40 μg/m³. An analysis was carried out to identify the most important meteorological variables that influence the seasonal dynamics of PM10 concentrations. The highest correlation was obtained for wind speed. On average, there are approximately 308 hours annually when the threshold of 40 μg/m³ is exceeded, 58.44% of those occur in autumn.

1. Introduction
Air pollution with particles can have both anthropic and natural sources [1-3]. Anthropogenic sources include combustion, secondary particles formed in the air by chemical reactions of gaseous pollutants and re-suspension of soil and dust [4-7].

The PM10 includes inhalable particles that are small enough to penetrate deep into the respiratory system and affect human health. Effects of exposure to PM10 pollution, both in the short-term (hours, days) and long-term (months, years) are: worsening of asthma, mortality due to cardiovascular and respiratory diseases and lung cancer. The people most susceptible to illness are those with pre-existing pulmonary or cardiac conditions, as well as the elderly.

2. Data and methods
This paper analyses the evolution of the PM10 concentration for the year 2018 in Galati, Romania. The data were collected at the GL - 2 air quality monitoring station (Figure 1). The site is classified as an urban background site, located near a pedestrian street and a parking zone (Figure 1). The data for PM10 (μg/m³), pressure (mbar), temperature (°C), wind speed (m/s), wind direction and relative humidity (%) were collected from January 2019 to December 2018. More than 93% of the available data for PM10 and meteorological parameters for the study period were valid.

On average, there are about 308 hours annually when the 40 μg/m³ threshold is exceeded, being distributed over the year as follows: 14.61 % occur in winter, 5.84 % occur during spring, 21.1 % occur in summer and 58.44 % of these occur during autumn.

The following data were recorded in Galati at the urban background station: the average annual humidity was 79%, the average air pressure was 1013.6 mbar and the average wind speed was 0.4 m/s.
The average annual temperature in Galati in 2018 was 13.18°C, the lowest temperature has been recorded in March with a temperature of -11.41°C and the maximum temperature of 33.88°C has been recorded in August.

![Location of the Galati and the measurement station inside the city.](image1)

**Figure 1.** Location of the Galati and the measurement station inside the city.

![Time variations of PM10 (µg / m³) (lower-line) and relative humidity (%) (upper-line) from January 2018 to December 2018.](image2)

**Figure 2.** Time variations of PM10 (µg / m³) (lower-line) and relative humidity (%) (upper-line) from January 2018 to December 2018.

Figure 3 shows the time variation of the meteorological parameters: pressure, temperature and wind speed.

![Figure 3.](image3)
Figure 3. The hourly data of air pressure (mbar), air temperature (°C) and wind speed (m/s) from January 2018 to December 2018 in Galati.

The following graphs illustrate the direct correlation between wind speed and PM10 concentration in the selected urban background monitoring site selected from Galati in 2018. In order to better...
visualize the impact of wind speed on PM10 concentration variation a shorter period of time was selected, 15 November - 23 December, 2018.

It can be noticed that during this period, the fluctuations in hourly concentrations in figure 4 show a positive correlation with the wind speed, especially with the stronger winds or with windless periods.

Hourly weather conditions (wind direction and wind speed at 10 meters above ground level) and hourly PM10 concentrations were obtained from local monitoring networks. Wind direction data were divided into sixteen classes.

In order to analyse the distribution of the PM10 concentration during the year 2018, the values recorded during 8735 hours were used, of which 8074 were valid data, invalid data 544 and 117 missing data, the result is presented in figure 5.

Figure 4. The relationship between PM10 and wind speed.
To analyse distribution of the wind direction we have used the data recorded over 8735 hours, out of which 8635 valid data, 94 invalid data and 6 missing data, which were presented in figure 6.

![Figure 6: Distribution of wind direction.](image)

### 3. Conclusion

Research has shown the dependence of daily PM10 concentration on meteorological conditions, mainly on wind speed variation. The highest concentration of PM10 was observed in summer and autumn, and in all seasons of the year, the strongest impact on PM10 pollution was exerted by wind speed.

The PM10 concentration in the air has shown annual seasonal variability. The concentration of PM10 in winter and spring was lower due to higher wind speeds than in summer and autumn. In Galati, increased PM10 levels in the air during the summer and autumn occurred in conditions with high air temperatures, low relative humidity and low wind speed, mainly from the NE direction.

### References

[1] Souzana A, John S E, Panayiotis K Y, Savvas K, Joel S and Petros Koutrakis 2014 PM10 Concentration levels at an urban and background site in Cyprus: The impact of urban sources and dust storms, J Air Waste Manag Assoc. D 64 (12): 1352–1360

[2] Kalbarczyk R, Kalbarczyk E and Raszka B 2015 Temporal changes in concentration of PM10 dust in Poznań, middle-west poland as dependent on meteorological conditions Applied ecology and environmental research 16 (2):1999-2014.

[3] Lokman H T, Pinar S, Omar A, Ferhat K and Gürdal T 2008 Effect of Meteorological Parameters on Fine and Coarse Particulate Matter Mass Concentration in a Coal-Mining Area in Zonguldak, Turkey Journal of the Air & Waste Management Association, 58 4, 543-552

[4] Jianhua W and Susumu O 2015 Effects of Meteorological Conditions on PM2.5 Concentrations in Nagasaki, Japan Int. J. Environ. Res. Public Health 12 9089-9101

[5] Paraschiv S, Constantin D E, Paraschiv S L and Voiculescu M 2017 OMI and ground-based in-situ tropospheric nitrogen dioxide observations over several important European cities during 2005–2014, Int. J. Environ. Res. Public Health 14 11 1415

[6] Paraschiv S and Paraschiv S L 2017 A review on interactions between energy performance of the buildings, outdoor air pollution and the indoor air quality Energy Procedia 128 179-186

[7] Alahmadi S, Al-Ahmadi K and Almeshari M 2019 Spatial variation in the association between NO2 concentrations and shipping emissions in the Red Sea Science of The Total Environment 676 131