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CASE STUDY OF THE EVIDENCE OF PM1& PM2.5 CONTRIBUTION ON PM10 FROM PODUL DE PIATRA– IASI CITY

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Abstract: The importance of air quality monitoring has been strongly demonstrated in numerous scientific studies. This study, carried out in an intense circular intersection, brings additional arguments that the monitoring of the fine particles like PM1 and PM2.5 that influence in more than 80% the concentration of PM10 particles must be measured at several points. Few were the cases [approx. 20%] in which the increase of PM10 concentrations is given by particles with diameters from 2.5 to 10 μm, most likely caused by the re-suspension of dust particles. Grimm Aerosol Technik Germany and SC INOESY SRL conducted a campaign for monitoring the air quality [PM1, PM2.5, PM10] in Iasi, Stone Bridge area, from 8 to 22 February 2018. The monitoring point was located close (150 m) to the APM-IS-01 station of the National Environmental Protection Agency.

Keywords: PM1, PM2.5, PM10, air quality, mass concentration

1. Introduction

Environmental air pollution represents a major health risk which leads to an increase in respiratory and cardiovascular illness mortality. As seen in a recent study, the relatively high per capita mortality rate in Europe, 133 per year per 100.000 inhabitants, can be explained through the low air quality in densely populated areas, which leads to one of the highest exposure rates in the world [1].

This study mentions that "European citizens still breathe harmful air because of weak legislation and insufficient policy implementation". The increase in μg/m^3 of the annual PM2.5 average is associated with a significant hospitalization and mortality risk because of cardiac insufficiency [2, 3]. The EU applies an annual average limit for air quality, which is 25 μg/m^3 for PM2.5 starting with 2015, which is 2.5 larger than the 10 μg/m^3 stated by the World Health Organization [4, 5]. EU policies have formulated objectives to reduce exposure for the year 2020 associated with an annual level of 20 μg/m^3 PM2.5. In Romania, the concentration of such particles is not measured at all air quality monitoring stations where PM10 is being monitored [2, 5].

This study attempts to draw attention towards the fact that the majority of cases where the limit values for PM10 are crossed actually represent an increase of PM2.5 concentrations.

2. Methodology

In the interval 08.02.2018 – 22.02.2018, SC INOESY SRL [https://inoesy.com], with Grimm Aerosol Technik Germania [http://www.grimm-aerosol.com] organized a monitoring campaign regarding the ambiental air qualityin terms ofPM1, PM2.5 and PM10 concentrations in Podul de Piatra, Iasi city(geographical coordinates: 47.158027N, 27.575467E). The monitoring point was very close [~150 meters] to the APM-IS-01 station of the National Agency for Environmental Protection, so that a daily inter-comparison of mass concentrations of PM10 was performed, between sets of data collected by the instrument EDM164 (SC INOESY SRL) and those shown on the www.calitateaer.ro website, at the APM-IS-01 station. EDM164 has been built with respect to the standards of mass concentration determination of PM10 [EN12341] and PM2.5 [EN14907].

3. Results and discussions

Daily average values and hourly average values for PM10 throughout the measurement campaign are exposed in Fig. 1 and Fig. 2.

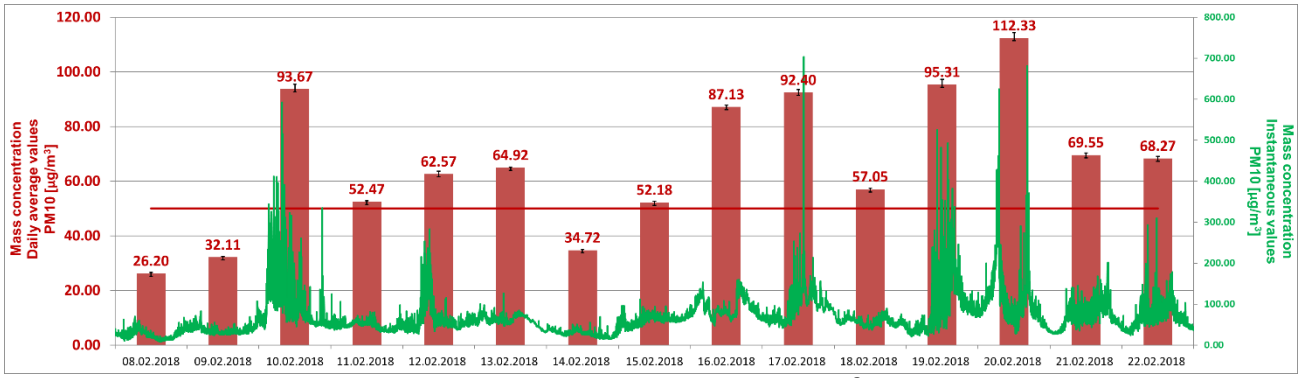


Fig. 1. PM 10 mass concentration [μg/m^3]
Daily average values vs instantaneous values [1 min] - 08/02/2018 - 22/02/2018

According to the law regarding ambient air quality, specifically 104/15.06.2011, the accepted daily uppermost average value of suspension PM10 particles, in view of the protection of human health, is 50 μg/m^3 and it is required that this value must not be exceeded more than 35 times yearly [4, 6]. From the above-mentioned figures, of the 15 monitoring days, exceeded values

were found in 12 of them, reaching a total of 228 exceeding cases, or 65% of the total hourly average data.

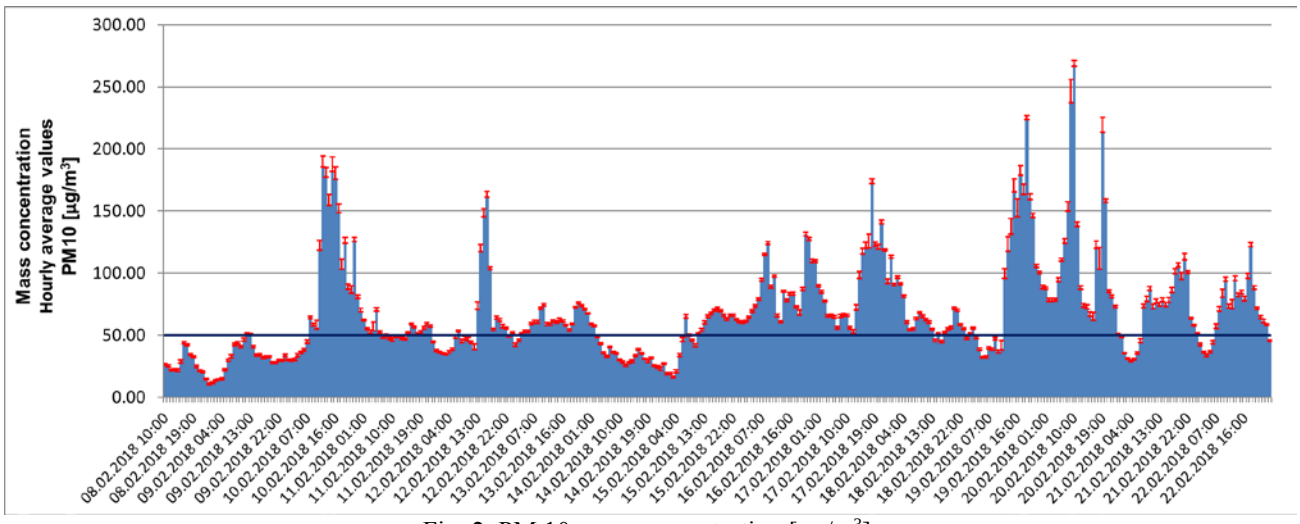


Fig. 2. PM 10 mass concentration [µg/m^3]
Hourly average values - 08/02/2018 - 22/02/2018

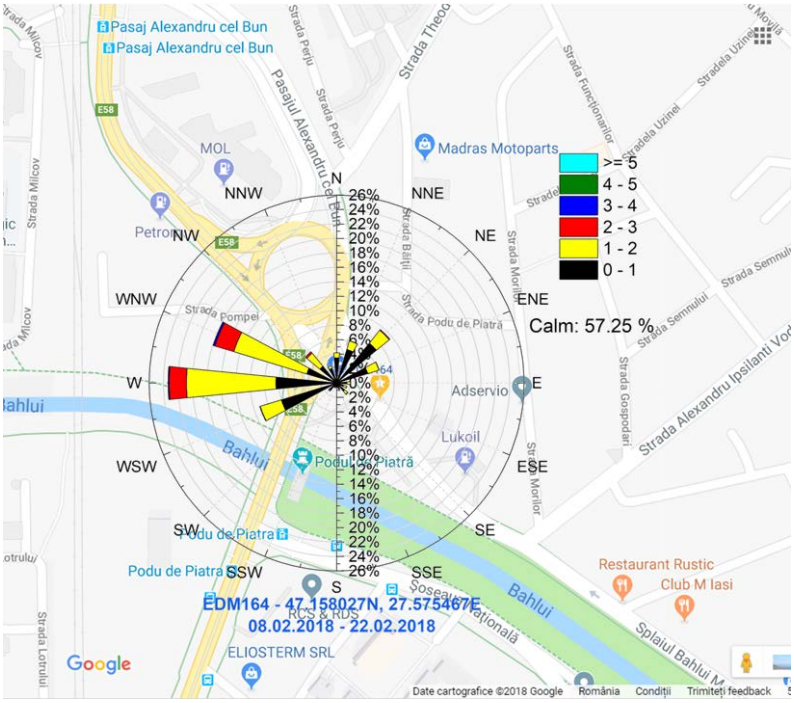


Fig. 3. Wind rose, 08/02/2018 - 22/02/2018

Considering the wind velocity and direction in the measuring point, in Fig. 3, it is possible to observe that the predominant direction was towards the west sector of the intersection. Also, in 60% of the cases, calm atmospheric conditions were recorded. The first conclusion is that PM10 suspension particles accumulate and stagnates in the atmospheric vicinity of the intersection during the pollution events.

The instantaneous values in Fig. 1 [registered every minute] are shown to highlight the contribution to daily average values and to evaluate mean value deviation. According to studies which are at the base of the current legal standards, maximum values of mass concentration of material particles with a dimension of up to 2.5 μm [PM2.5] were established through 24-hour averaging, given the fact that only after 24 hours of exposure a noticeable impact over human health was noticed. In the case of exposure with other types of pollutants, which can be more harmful, values are averaged on shorter intervals. For example, in the case of carbon monoxide averaging is calculated for every 8 hours [7].

For the present measurement campaign, the average values for PM2.5 [Fig. 4] and for PM1 (suspension particles with a dimension smaller than 1 μm - [Fig. 5]) are shown below.

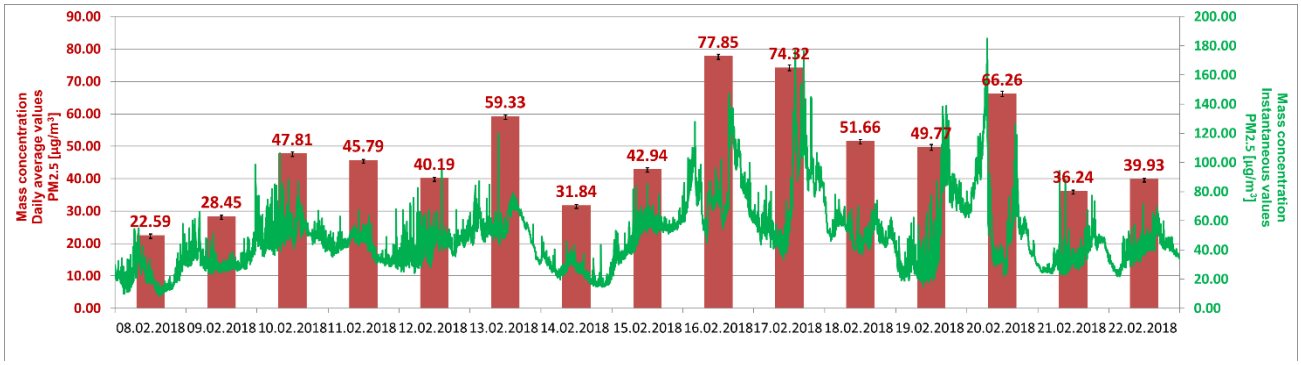


Fig. 4. PM 2.5 mass concentration [μg/m^3]
Daily average values vs instantaneous values [1 min] - 08/02/2018 - 22/02/2018

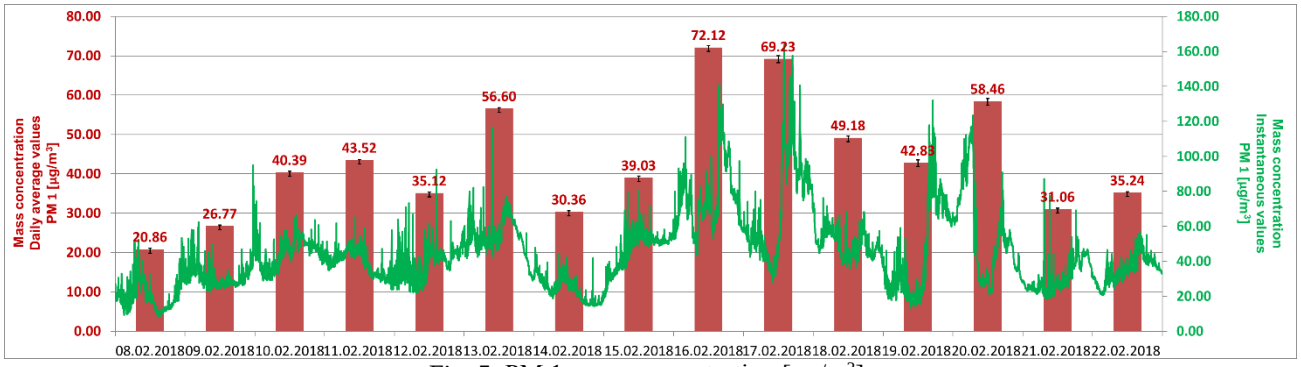
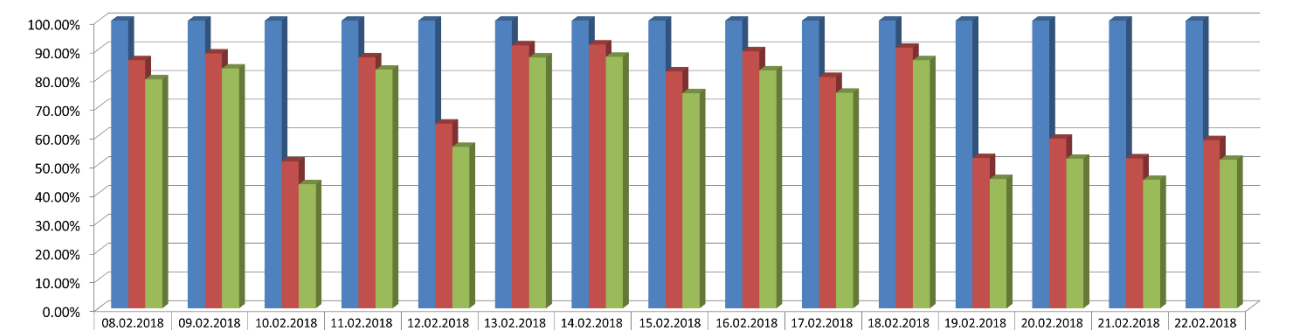


Fig. 5. PM 1 mass concentration [μg/m^3]
Daily average values vs instantaneous values [1 min] - 08/02/2018 - 22/02/2018

The contribution for the increase of PM10 concentration values throughout the measurement campaign is given by the increase of PM2.5 concentrations and especially by the increase in PM1-type particles concentration. Unfortunately, there is still not imposed standard for monitoring PM1 particles despite numerous studies regarding this type of aerosol.

Using EDM164 equipment, as seen in Fig. 5, it is possible to monitor PM1 concentrations. Comparing all concentrations, Fig. 6 highlights the fact that PM2.5 and PM1 concentrations have a major contribution on PM10 concentrations. Considering the mass values of PM10 as an integer [100%], in Fig. 6 it is possible to observe the percentages of the above-mentioned contributions. It is worth mentioning that concentration values for PM10 include values for PM1 and PM2.5.



	08.02.2018	09.02.2018	10.02.2018	11.02.2018	12.02.2018	13.02.2018	14.02.2018	15.02.2018	16.02.2018	17.02.2018	18.02.2018	19.02.2018	20.02.2018	21.02.2018	22.02.2018
PM10	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
PM2.5	86.23%	88.60%	51.04%	87.26%	64.23%	91.38%	91.70%	82.29%	89.34%	80.43%	90.56%	52.22%	58.98%	52.11%	58.48%
PM1	79.60%	83.39%	43.12%	82.95%	56.12%	87.19%	87.43%	74.81%	82.77%	74.92%	86.22%	44.93%	52.04%	44.66%	51.63%

Fig. 6: Percentual contribution of PM2.5 and PM1 particles over PM10 concentrations

Comparing hourly average values recorded by EDM164 with those recorded by APM IS – 1, it is possible to see in Fig. 7 that the trend is the same for both stations, which are 140 m apart, the difference in values being given by wind velocity and direction and by the fact that EDM164 was placed approximately 80 m from the center of the Podul de Piatra intersection. In 5 days out of 15, wind direction was NE, which is to say it was in the direction of the SplaiBahlui mal Stâng street, respectively from the ȘoseauaNațională. This has led to the APM-IS-01 station to record higher values than EDM164.

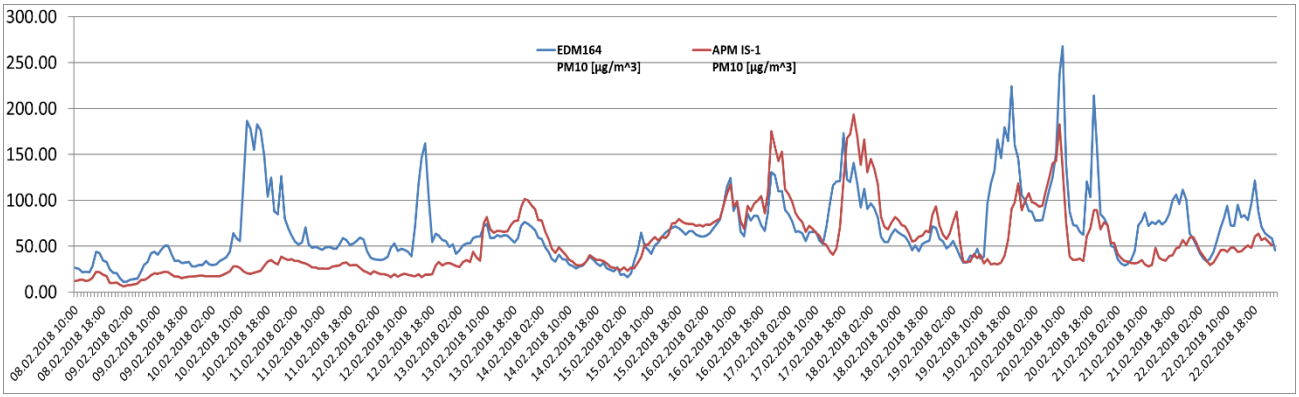


Fig. 7: Comparative representation [EDM164 vs. APM IS – 1] of hourly average values for PM10 particles

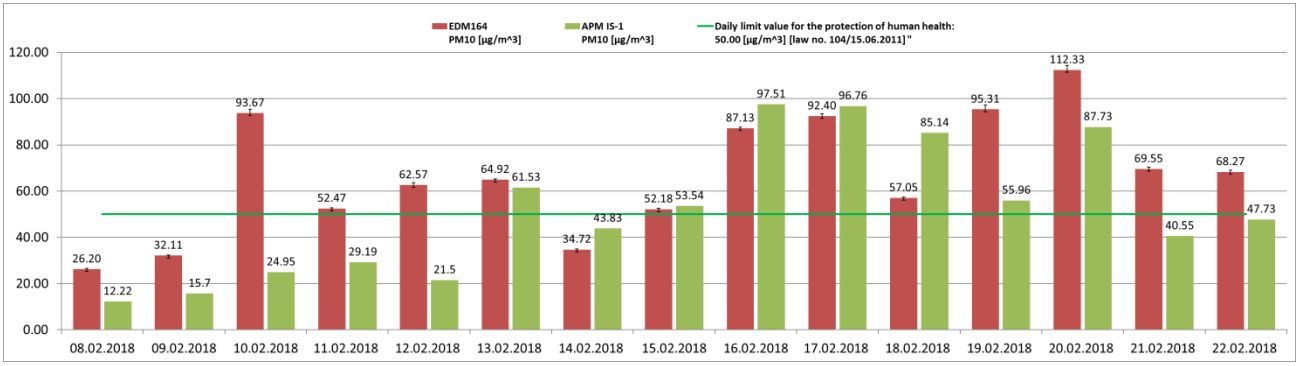


Fig. 8: Comparative representation [EDM164 vs APM IS – 1] of daily average values for PM 10

Comparing daily average values recorded by the equipment EDM164 with those recorded by APM IS – 1 [Fig. 8], APM IS – 1 recorded value over 50 μg/m^3 7 times, reaching a total of 149 exceeded instances of hourly average values, which is 42% of the total recorded hourly average values.

4. Conclusions

The EDM164 system measured the PM concentrations and we considered the PM10 daily averages values that exceed the concentration of 50 μg/m^3, in 12 out of 15 days. The hourly values of PM10 concentrations during this period were considerable influenced by the increase of PM1 and PM2.5 concentrations, most probably due to the combustion of fuels in this urban area.

Additionally, the influence of larger particles with diameters from 2.5 μm to 10 μm to the increase of PM10 concentration (representing 20% of hourly values) was most probable determined by the air resuspension of the dried road dust, prior moisturized and deposited on the ground by rainfall. As for the PM2.5 concentration, it was measured by the EDM164 station following the standard EN14907 [legally specified as a reference method]; the average value for PM2.5 in 15 days was 48 μg/m^3. There were not many cases [20%] in which the contribution for the increase in PM10 was because of larger particles with dimensions between 2.5 and 10 μm, episodes which were most likely due to resuspension of street dust after rain. In these cases, other probable sources are the urban construction sites and the residential areas developed around the city of Iasi, to which the fact that the roads are not composed of asphalt or concrete, can be added; plus, poor urban waste management.

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