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Atmospheric pollution

METHOD TO DEPICT THE BEST AVAILABLE POSITION, WHEN RELOCATING MONITORING STATIONS

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Abstract. The paper presents results of on line air quality campaigns recently accomplished in the metropolitan city of Timisoara, Romania, by 2016. Main target was to depict a best suitable location/position/ for the air quality monitoring station, in order to conclude about the exceeding of the maximum admitted values, with best probable accuracy. The episodes focus on a traffic and residential zone from Timisoara. Comments and conclusions, highlighted by figures and tables, are original and data based.

Keywords: air quality, monitoring, dispersion modelling, traffic monitoring stations.

AIMS AND BACKGROUND

Data on ambient air pollution concentrations are routinely collected by national or local monitoring networks. Information must be available on site location and area type (e.g. industrial, transport oriented or residential)[1].

Cities are seen as both the source and solution of economic, environmental and social challenges: they are home to an increasing share of the EU population, they account for the largest share of its energy use and they generate about 85% of its GDP. Therefore, cities are central to achieve the Europe 2020 targets of smart, sustainable and inclusive growth[2].

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High population density in urban areas and the concentration of industry exert great pressures on local environments. Air pollution (being of anthropogenic origin, such as households industry, power plants and transportation (based on internal combustion systems with fossil fuels), is often a major problem contributing essentially to an increased human exposure to ambient air pollution and subsequent, health problems occur. Improving air quality is a significant aspect of promoting sustainable human settlements. Data[1] may be used to:

1. To monitor trends in air pollution as a basis for prioritizing policy actions;
2. To map levels of air pollution in order to identify hotspots or areas in need of special attention;
3. To help assess the number of people exposed to excess levels of air pollution;
4. To monitor levels of compliance with air quality standards, in order to assess the effects of air quality policies;
5. To help investigate associations between air pollution and health effects.

Generally speaking, a worldwide tendency is to reduce the concentrations of pollutants owing to the increasingly strong restrictions, imposed by local governments and international organisations. However, in poor countries and in those with low average incomes, concentrations of air pollutants remain high and the tendency will be to increase their emission levels as they develop, making the problem worse[3].

The stations are classified, the most important being the traffic stations. Generally all cover major intersections, and hourly patterns of concentrations on different days of the week are investigated. Normally, the data proof that hourly pollutants concentrations resemble to the traffic pattern of the area. Also long memory and seasonality effects are considered to influence the recorded air quality data[4].

Air quality is also strongly dependent on weather and is therefore sensitive to climate change, as most of the air quality stations record. Recent studies have provided estimates of this climate effect through correlations of air quality with meteorological variables and perturbation analyses in chemical transport models (CTMs), and CTM simulations driven by general circulation model (GCM) simulations of the 21st-century climate change[5].

For very large cities, it is impossible to mount all over representative monitoring national stations; thus a procedure was proposed and tested to derive pollution levels, using short-term measurements, such as those of passive samplers and mobile-station data[6].

Air quality in Europe is slowly improving. However, between 2000 and 2014, a significant proportion of the urban population in the EU-28 was exposed to concentrations of certain air pollutants above the EU limit or target values. Even more people were exposed were even higher in relation to the more stringent World Health Organisation (WHO) air quality guideline values set for the protection of human health[7].

Table 1. Urban population (in % from total) exposed to air pollutant concentrations above selected limit and target values[7]

Year	PM2.5	PM10	O_3	NO_2
2000		32.3	17.9	26.0
2001		29.4	30.2	23.3
2002		31.2	20.7	23.4
2003		41.6	54.9	31.4
2004		27.7	19.6	20.4
2005		33.7	22.3	21.7
2006	16.9	37.8	45.7	18.6
2007	11.6	30.2	21.8	22.0
2008	12.9	23.3	15.1	12.1
2009	8.8	23.6	15.8	15.0
2010	10.6	23.5	17.2	12.6
2011	13.6	28.9	15.9	12.0
2012	11.5	21.2	15.5	9.3
2013	8.6	18.9	16.7	9.3
2014	8.0	16.0	7.5	7.2

In all major cities in Romania, a national governmental grid of monitoring, through fixed air quality monitoring stations, is developed[8]. Standard CEN methods were introduced (developed by the European Committee for Standardisation) for the main pollutant concentration measurements (air quality control according Romanian Law 104/2011, Directive 2008/50/CE of the EU parliament and its Council from 21 May 2008, officially published in the Journal of the EC L152/11.06.2008) and presented on line as average results, in correlation with the hour/timing and date of the investigation, including a data base composition, with different mean values, that is transmitted to the officials (national Ministry, EU Commission)[9].

Locations of such fixed monitoring stations must be adequately selected, in order to depict the best position, offering best probable conditions for measuring and depicting the most representative episodes. Nevertheless, as cities are in continuous development, it is necessary to analyse, in time, if the relocation of such stations is not critical, meaning the station must be moved to another place.

In the National Network of Air Quality Automatic Monitoring the following pollutants are measured: SO_2, NO, NO_2, NO_x, suspended dusts – PM10 and PM2.5, CO, O_3, benzene and lead. Currently, in Romania the National Network of Air Quality Monitoring (RNMCA) comprises permanent air quality monitoring stations, and 17 mobile labs, endowed with automatic equipments to measure the concentrations of major air pollutants. RNMCA includes 41 local centers, which gather and disseminate to public information panels data from stations and transmit them after primary validation for certification of the Bucharest National Reference Laboratory (LNR) (Ref. 10).

Currently, in most EU countries, such automated networks are operating, with information available on the Internet. Monitored pollutants, measurement methods, limit values, alert thresholds and criteria information and location of monitoring spots are determined accordingly to national laws on atmosphere protection and requirements stipulated by European regulations[11].

RESULTS AND DISCUSSION

The scope of the analysed case study is to determine a novel position for an existing monitoring station from the national monitoring system of Romania, situated in Timisoara, as a traffic station and named TM1. The development of the city needs the prolongation of the public transport lines, in terms of a extension of the tram line, that is supposed to pass over the present position of TM1. Thus the relocation of the traffic station is analysed, critically, from the point of view of: (i) respecting the current EU legislation, and (ii) in respect to offering the most beneficiary and representative opportunities for monitoring.

In Ref. 12 it is mentioned that: *Compliance with the limit values directed at the protection of human health shall not be assessed at the following locations: (a) any locations situated within areas where members of the public do not have access and there is no fixed habitation; (b) in accordance with Article 2(1), on factory premises or at industrial installations to which all relevant provisions concerning health and safety at work apply; (c) on the carriageway of roads; and on the central reservations of roads except where there is normally pedestrian access to the central reservation.*

Based on the above paragraph it is clear that the relocation of the station is also necessary, in order to meet the air quality standards SI No 180/2011, as currently it is located (Fig. 1) in between two lanes (entering and exiting Timisoara). These rules clearly indicate that the new position for the relocation must not be situated between lanes, but on one of the sides of the cross road, but corresponding totally to the general rules (distances, representation, effectiveness, etc.).

Fig. 1. Analysed case study – location of the traffic monitoring station TM1, and potential relocation positions (position 1 and position 2)

Figure 2 shows the schematics of the measured pollutants and the flow of the air probes, in respect to the RENAR (Romanian accreditation body) accredited mobile lab of the Politehnica University of Timisoara (UPT) (www.mediu.ro).

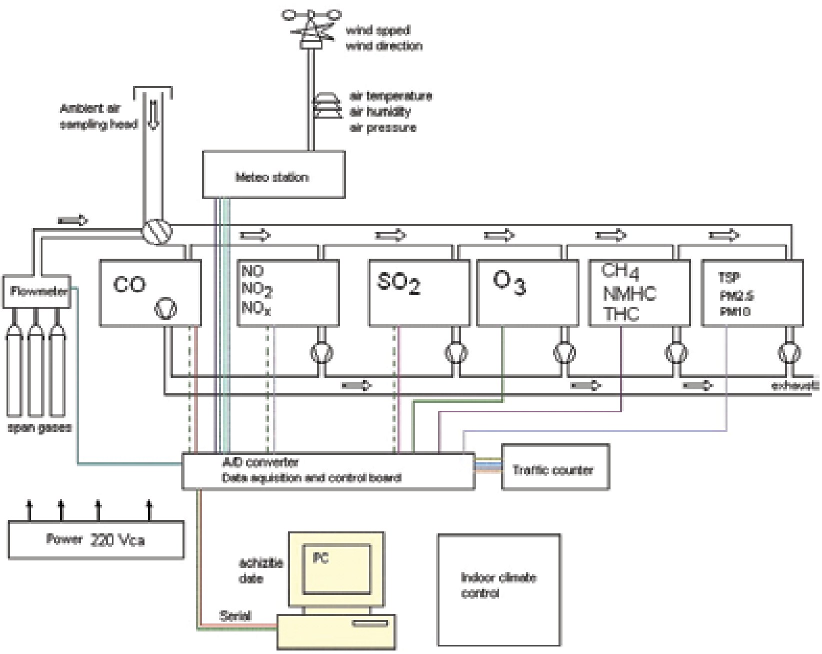

Fig. 2. Scheme of the mobile RENAR accredited laboratory for air quality control[13,14]

In Fig. 3 the comparative recorded data are presented. Figure 4 indicates the correlation between the NO data recorded by the UPT mobile station, versus the data officially indicated by TM1. The peaks recorded are specific and correspond to the traffic intensification, occurring twice a day.

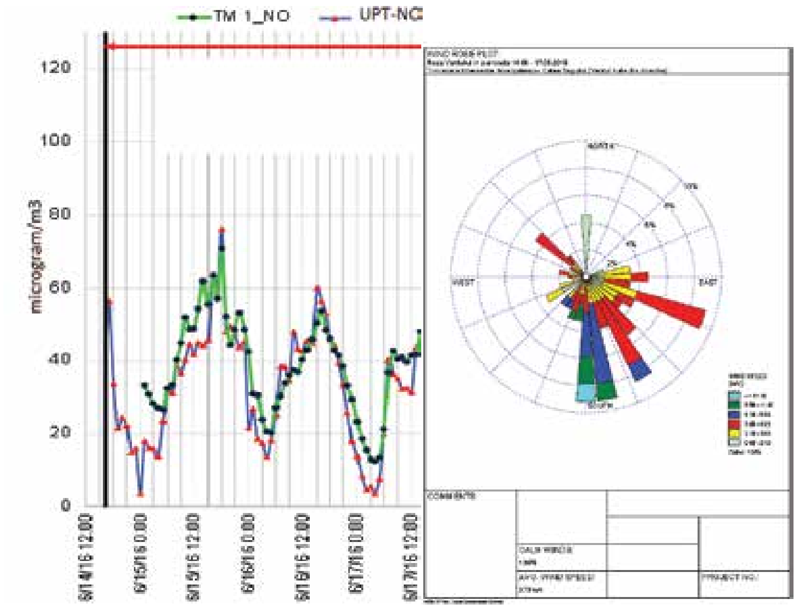

Fig. 3. Comparative data recorded by the official monitoring station TM1 and the mobile lab of UPT, for position 0 (wind rose during the case study)

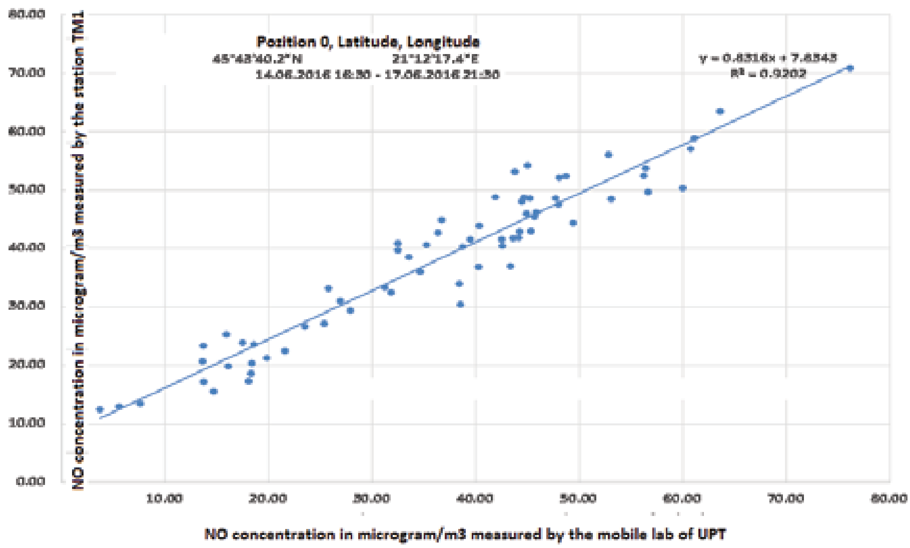

Fig. 4. Correlation analysis of the NO concentrations of the two stations, the mobile lab being situated in position 0

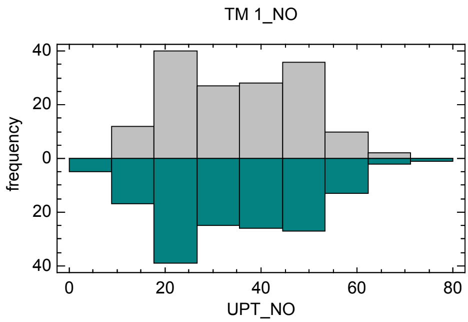

Fig. 5. Stat Advisor statistics for both NO concentrations measured by the UPT mobile lab and those from the TM1 official station

Table 2 shows the summary statistics for the two samples serial of data. Other tabular options within this analysis can be used to test whether differences between the statistics from the two samples are statistically significant. Standardised skewness and standardised kurtosis here are of particular interest, which can be used to determine whether the samples come from normal distributions. Values of these statistics outside the range of –2 to +2 indicate significant departures from normality, which would tend to make invalid the tests, which compare the standard deviations. In this case, both standardised skewness values are within the range expected. TM 1_NO has a standardised kurtosis value outside the normal range.

Table 2. Summary statistics for the NO concentrations measured

Statistical characteristics	TM 1_NO	UPT_NO
Count	155	155
Average	35.4366	33.7631
Standard deviation	13.1891	14.8646
Coefficient of variation	37.2188%	44.0262%
Minimum	12.43	3.69908
Maximum	70.85	76.1492
Range	58.42	72.4501
Standard skewness	0.631471	1.04149
Standard kurtosis	–2.56237	–1.74644

Based on the significant correlation coefficients received, a further measurement was performed when placing the mobile lab in positions 1 and 2. Of course, the corresponding wind rose and generally the meteorological conditions were considered. The results, analysed in the frame of the meteorological conditions, can stand for the probable values, measured by the official TM1 station, in one of the relocated positions. Another option is to run dispersion modelling, similar to the technique proposed in Ref. 15, to assess the air quality impact of major traffic emission sources in Skopje by using different dispersion models. Another solution may also be performed, namely to combine measurements of the pollutant concentrations in a limited number of points with mathematical modeling of air pollution, as the mathematical models provide information in a virtually unlimited number of date points[16].

CONCLUSIONS

The paper deals with a proposal of concluding about possible relocation positions of official monitoring stations from the national monitoring grid. The case study is based on NO concentration values measured in a traffic influenced zone in Timisoara. The official data from TM1 official station are analysed and compared to those of an accredited mobile laboratory of UPT. Finally, based on the data measured in other possible locations by this mobile lab, a final decision can be drawn on the best possible relocation of the monitoring station.

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