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THE IMPACT OF ROAD TRAFFIC ON THE AIR QUALITY IN CLUJ-NAPOCA: CASE STUDY- NORTH RING ROAD FLOREŞTI – CLUJ-NAPOCA

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ABSTRACT. In this research, we analysed the impact of road traffic on air quality at the Cluj-Napoca border. For this purpose, the road traffic on the North ring road was monitored: Floreşti (Pădurii Street) - Cluj-Napoca (Donath Street) at the same time with the measurement of the particulate matter PM_{10}. The daily average road traffic was determined according to 'AND 584-2002 normative: "Normative for the calculation of the traffic for the design of the roads from the point of view of the carrying capacity and traffic capacity". For the measurement of particulate matter concentrations PM_{10}, two Dusttrak DRX Aerosol Monitor Model 8533 instruments were used, capable of simultaneously providing mass concentration data for all particle size fractions over a wide range of concentrations (0.001-150 mg/m^3) in real time. These were located in two different areas of the ring road: the first instrument was about 20 m from the road on Donath Street in Cluj-Napoca, and the second at a distance of about 80 meters from the road, outside the city.

Key words: *traffic, air quality, PM_{10}, Cluj-Napoca.*

INTRODUCTION AND STUDY AREA

Nowadays talking about air pollution has become trivial and many of us are thinking about countries like India or China when this topic comes up. This is a well-known problem that is getting worse day by day and many of us don't realize it, or simply ignore it (Hsu et at., 2013). It is not necessary for our imagination to carry us so far because pollution exists everywhere, in different forms and from different sources, but it is not to be neglected in a city where the number of inhabitants, constructions and the number of cars is worrying.

The urban air pollution is visible in the morning above the city and often mistaken for fog, which makes us ignore this topic. However, pollution in the urban environment is a serious problem and can lead to various complications and diseases (Donaldson et al., 2000; Pope et al., 2002; Münzel et al., 2017; Saygın et al., 2017; Paraschiv and Paraschiv, 2019). There are many factors that lead to air pollution in urban areas, the sources being multiple (Brunekreef and Holgate, 2002; Marć et al., 2015; Thornbush, M.J., 2015; Stefanie et al., 2015). In this study we analysed the influence of road traffic on particulate matter pollution in the study area.

The road traffic in Cluj-Napoca throughout the year, at different times of the day creates traffic jams on both the main arteries of the city and on ring roads that bypass it. An impressive number of people living in the so-called 'bedroom-localities' commute daily to the city centre, most of them using their own cars as means of transportation.

In previous researches focusing on traffic from Cluj-Napoca in connection with the neighbouring localities, the northern ring road was not taken into account, as it was given into use starting with 2015 (as an agricultural road), today being a vital alternative for the thousands of commuters who use it daily.

The northern ring road that connects Grigorescu neighbourhood from Cluj-Napoca with Florești village is one of the busiest streets in the city in the rush hours, due to a big share of the more than 10,000 commuters and students who go daily to Cluj-Napoca. The accelerated population growth in Floresti commune (35,118 official inhabitants in 2018) made it the largest peri-urban locality in Romania. Thus, Floresti has the biggest difference between the share of the active population working in another city than the one where they are residents (52.06% of the active population from Florești are working in Cluj-Napoca). In figure 1 the location of the measuring instruments is marked with a **+**.

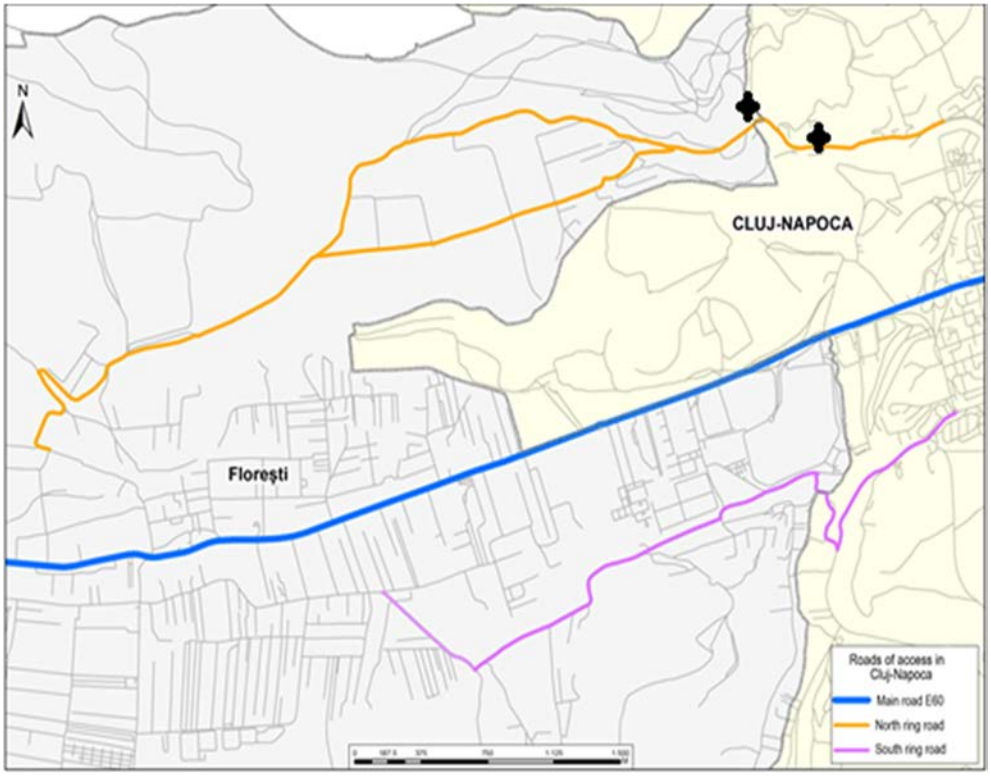

Fig. 1. *Location of the study area*

MATERIALS AND METHOD

The study's stages were divided into: bibliographic documentation (theoretical and mapping), monitoring the traffic and measuring the PM_{10} and $PM_{2.5}$, and data analysis. The traffic monitoring supposed the observation and counting the vehicles in traffic at certain time intervals for one week. The PM_{10} and $PM_{2.5}$ concentrations were measured between 14 and 30 of March 2019 using two Dusttrak DRX 8533 instruments at two different locations on the ring road as seen in Fig. 1: the first instrument was located about 20 m from the road, on Donath street in Cluj-Napoca, and the second at a distance of about 80 meters from the road, on Padurii street outside the city.

The DustTrak DRX 8533 optical instrument can simultaneously analyse PM_{10}, PM_4, $PM_{2.5}$, PM_1 and total fraction concentrations. The DustTrak DRX is a battery-powered analytical instrument providing real-time interpretation of aerosol mass. By using this instrument, the aerosol is drawn into the detection chamber in a continuous flow using a diaphragm pump. A part of the aerosol stream is separated before the detection chamber and passed through a HEPA filter to be re-injected into the chamber around the inlet nozzle. The remaining flux, called the standard flow, passes through the inlet nozzle into the detection chamber where it is illuminated by a laser consisting of a diode. In the first phase, the light emitted by the diode passes through a collimating lens and then through a cylindrical lens in order to create a thin layer of light. A golden spherical mirror retains a significant fraction of the light scattered by particles and concentrates it into a photodetector. However, signal processing is very different from an usual photometer. Although the voltage in the photodetector, which is proportional to the mass concentration, is used to determine the aerosol concentration, the individual pulses are also used for measuring the individual particles (TSI Incorporated, 2019).

For one week, the traffic was monitored on Donath Street to and from Floresti, every day, at certain hours between 7:00 and 21:00. In total there were 21 hours, of which 15 on business days and 6 hours on weekends. The daily average road traffic was determined according to 'AND 584-2002 normative: "Normative for the calculation of the traffic for the design of the roads from the point of view of the carrying capacity and traffic capacity".

RESULTS AND DISCUSSION

All the cars that crossed in both directions at the monitored timeline have been counted. Also the number of passengers in each car was considered. From the time interval during the weekend which overlapped with the one during the week (7:00 - 8:00, 8:00 - 9:00, 14:00 - 15:00, 17:00 - 18:00, 18:00 - 19:00, 19:00 – 20:00) it turned out that only 21% of the cars were circulating in weekend and 79% during the weekdays.

As assumed, the highest numbers of cars in traffic are in the morning and afternoon rush hours with a peak of more than 1000 cars/hour at 07:00 (see figure 2).

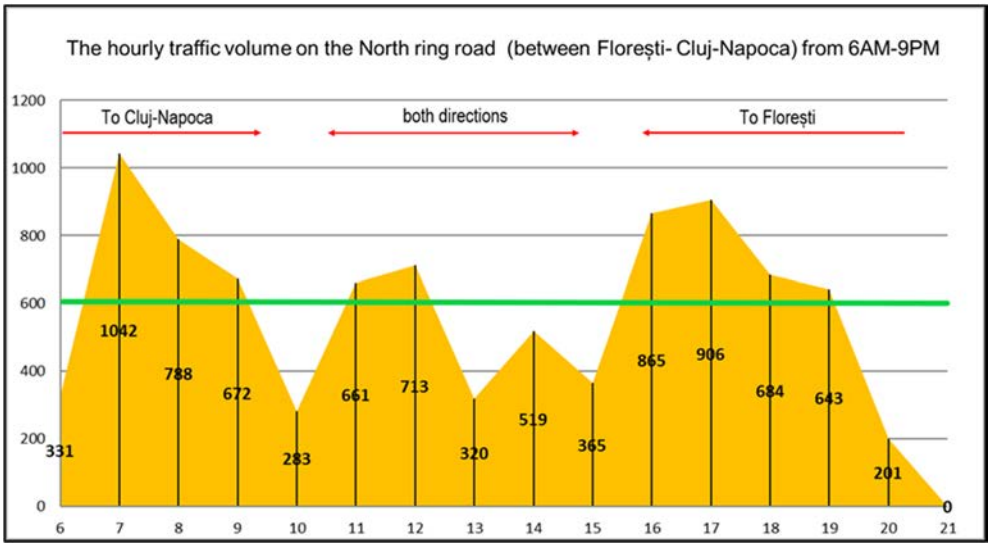

Fig. 2. *The hourly traffic volume observed in the study area*

Out of the counted cars, in working days in 54.3 % of the cars was only the driver, 33.7 % had two people, 8.6 % three people, 2.3 % with four people and 1% with 5 or more people. During the weekend, 41.8% of the cars had 2 people inside, in 40.9% was only the driver and the hierarchy then continues as in the first case. The low number of people in cars is one of the reasons of traffic jams but also of the high degree of pollution, not only in the studied area but perhaps worldwide. People choose to use their personal car in the first place for comfort, and also due to the insufficient means of public transportation with regular trips between the two localities (Cluj-Napoca - Florești) during the rush hours.

As seen in figure 3, on Donath Street, inside the city, the PM_{10} concentrations are higher than at the periphery of the city, on Pădurii Street for almost the entire monitored time interval.

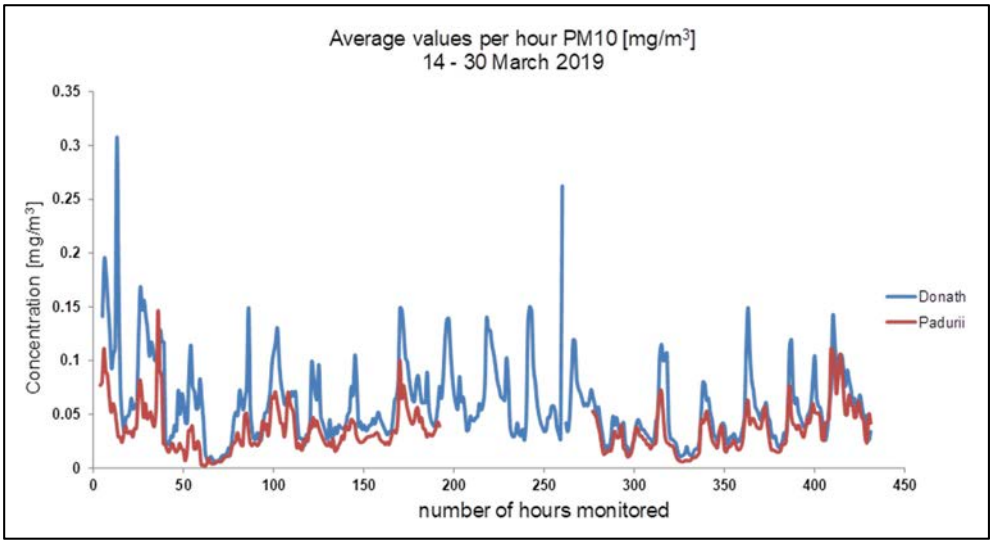

Fig. 3. *Average hourly values for PM_{10} particles measured between 14-30 March 2019*

The maximum PM_{10} daily limit value according to the European and national legislation for the protection of human health is 50 μg / m³ (Law no. 104/2011).

As seen in figure 4, the daily average values for the time interval in which the measurements were made are usually higher than the limit value of 50 μg/m³ on Donath Street and do not exceed the limit on Padurii Street. The lack of data at the second instrument is due to a power shortage affecting the instrument. Also 2 rainy episodes were observed on day 3 and on day 14, the PM_{10} concentration being lower after them.

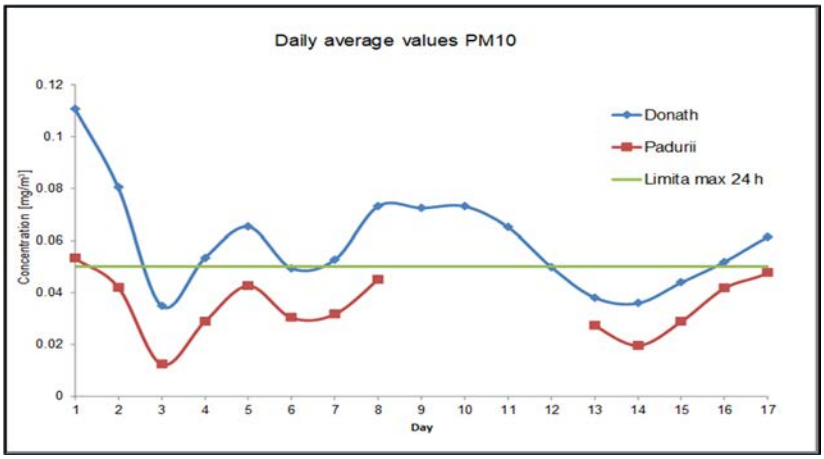

Fig. 4. *Average values of PM_{10} particles for the monitored period*

Figure 5 shows the variation of PM_{10} concentration for each hour monitored during the week in which the traffic was observed as well. Although an increase in concentrations can be observed in the morning hours and then towards evening, the correlation with the number of cars on the analysed route was low (r = 0.06.).

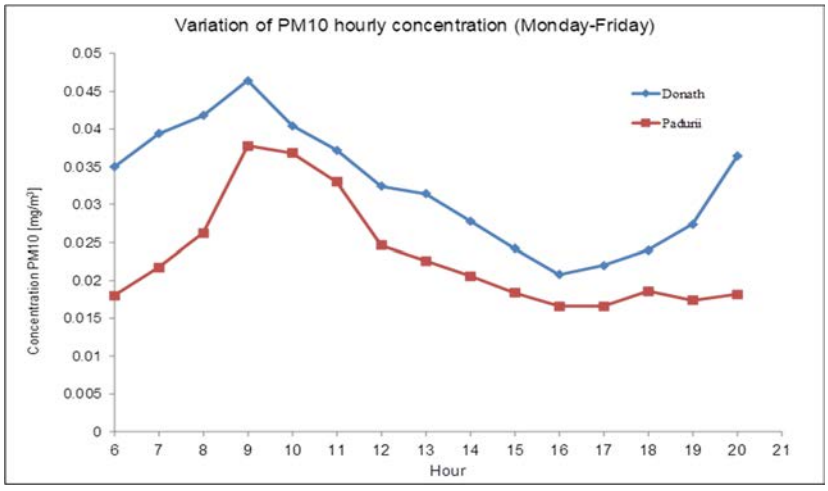

Fig. 5. *Variation of PM_{10} hourly concentration*

On the analysed route, at the sites where the instruments were located, it seems that the general urban background has a greater influence than the local traffic.

CONCLUSIONS AND PROPOSALS

In this paper we analysed the impact of road traffic on air quality at the North ring road between Floreşti (Pădurii street) and Cluj-Napoca (Donath street), Romania.

In this research, we analysed the impact of road traffic on air quality at the Cluj-Napoca border. For this purpose, the road traffic on the North ring road was monitored: Floreşti (Pădurii street) - Cluj-Napoca (Donath street) at the same time with the measurements of the particulate matter PM10. The north ring road was transformed from a simple agricultural road into an important artery of the city with more than 1000 cars/hour at the rush hours, having a negative impact in terms of time spent in traffic and agglomeration in the narrow adjacent streets and also on level of noise in the area.

We measured the PM_{10} concentrations between 14 and 30 of March 2019 at two sites near the road, one in the city and the second in the suburban area of the city. Also the traffic was monitored for one week overlapping the PM_{10} concentrations measurements. The results did not indicate any correlation between the road traffic and PM_{10} concentrations. Nevertheless, the values measured inside the city, on Donath Street are usually higher than the daily limit values. The main cause for the local pollution seems to be the urban background.

Given the fact that thousands of people need to travel daily from Florești to Cluj-Napoca and vice versa, to ban the use of this road for commuters is inappropriate. In order to reduce the local noise and PM_{10} pollution, several recommendations could be implemented, resulting in the time economy and improving the economic aspects. The first proposal refers to the use of car-sharing apps, considering that over 50% of the vehicles monitored were occupied only by the driver. Large scale using of such applications would reduce the costs, the number of cars, the time spent in traffic and also the noise and air pollution. Another proposal is to facilitate the entry on the market of private transport companies for students. One of the main reasons for traffic jams between 7:00 – 9:00 and 16:00- 19:00, is the displacement of thousands of students between Florești and Cluj-Napoca city.

The South Metropolitan Ring Road will ease the traffic and also reduce the pollution. It route starts from Gilău area and intersects the Transylvania Highway, then follows the Someș River, enters Cluj-Napoca in the Cora area, then reaches Bucium and St. Ion forest areas. It crosses the south of Mănăștur, Zorilor, Bună Ziua and Gheorgheni neighbourhoods, goes through Someșeni and enters the extension of Bulevardul Muncii, near the airport. In the Floresti area are planned three interchange points with the metropolitan road, in the area of Izlazului streets (entrance from Luna direction), Tudor Vladimirescu and Plopilor in order to catch the daily flows to Cluj-Napoca where there will be six interchange points. By implementing this project Cluj-Napoca and the western area of the municipality will be relieved of transit traffic, and the decongestion of traffic will lead to lower values of PM_{10}.

Other solutions that can be implemented by local authorities are referring at the setup of a separate lane for public transportation on the European road E60 and implementation of bike sharing-projects and at the same time building of the necessary infrastructure.

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