ASPECTS OF THE EFFECT OF CONFINEMENT MEASURES IMPOSED AT THE BEGINNING OF THE COVID-19 PANDEMIC ON OUTDOOR AIR QUALITY

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ABSTRACT

Record levels of air pollution, leading to environmental degradation, deteriorating health and climate change, are affecting cities around the world. However, due to the confinement measures imposed at the beginning of the COVID-19 pandemic, reductions in nitrogen dioxide (NO_2) concentrations - one of the main traffic pollutants - have been reported in many cities in Europe and around the world: by over 50% in Barcelona as of March 21, 2020, 64% in other cities in Spain, about 40% in London or about 50% of carbon monoxide (CO) levels in New York. In this context, the paper presents the results of monitoring NO_2 concentrations within the INCERC Bucharest Branch, located in the eastern part of Bucharest, the capital of Romania.

Keywords: *outdoor air; COVID-19 pandemic; nitrogen dioxide; health*

REZUMAT

Nivelurile record de poluare a aerului, ce conduc la deteriorarea mediului, la alterarea stării de sănătate a populației și la schimbări climatice, afectează orașe din întreaga lume. Însă, din cauza măsurilor de izolare impuse la debutul epidemiei de COVID-19, în multe orașe din Europa și din lume au fost raportate reduceri ale concentrațiilor de dioxid de azot (NO_2) - unul dintre principalii poluanți produși de trafic - cu peste 50%, în Barcelona, începând cu 21 martie 2020, cu 64% în alte orașe din Spania, cu aproximativ 40% la Londra sau cu aproximativ 50% a nivelurilor de monoxid de carbon (CO) în New York. În acest context, lucrarea prezintă rezultatele monitorizării concentrațiilor de NO_2 în cadrul Sucursalei INCERC București, situată în partea de est a Bucureștiului, capitala României.

Cuvinte cheie: *aer exterior; pandemia COVID-19; dioxid de azot; sănătate*

1. INTRODUCTION

Air pollution continues to be a significant threat to health worldwide [1], recorded levels of it also leading to environmental degradation and climate changes. Nevertheless, the pandemic of coronavirus disease (COVID-19), declared by the World Health Organization (WHO) on March 11, 2020, has created challenges for governments around the world [2-5]. Due to this situation, confinement measures were imposed, mainly restricting social contact and the most economic activities, reducing the level of traffic [3], declined "non-essential" transportation [2].

Nitrogen oxide (NO_2), one of the main traffic pollutants, sulfur dioxide (SO_2), and carbon monoxide (CO), all considered air pollutants that are harmful to humans, because of the pulmonary diseases caused by short and long-term exposure, are among the most frequently monitored pollutants when assessing air quality [5]. However, in the pandemic conditions, by reducing the activities, and therefore the traffic, there was a

decrease in the concentration levels of the main associated pollutants.

In this respect, our studies aimed at the analysis and identification of changes in the NO_2 concentration levels, by monitoring and statistically interpreting them, before the state of emergency (ES), during of the first month of ES (ES1) and during of the second month of ES (ES2), which was declared by the President of Romania on the entire territory of the country for a period of 30 days, through Decree No. 195 of March 16, 2020 [6] and extended by Decree No. 240 of April 14, 2020 [7].

Because meteorological conditions can play an important role in air pollution, transport, deposition and transformation, we analyzed the influence of the main atmospheric parameters, temperature and relative humidity, on NO_2 concentrations.

2. MATERIALS AND METHODS

The monitoring of NO_2 concentrations was performed in three stages: the period before the onset of ES (18.02-15.03.2020), the first month of ES (16.03-15.04.2020) and the second month of ES (16.04-15.05.2020). The monitoring was conducted using outdoor air quality monitoring equipment, model HAZ-SCANNER EPAS (manufacturer SKC – UK), purchased under the project PN 19 33 04 02 - *Sustainable solutions to ensure the health and safety of the population in the concept of open innovation and preservation of the environment*. The principle of the monitoring consists of the qualitative and quantitative identification of the inorganic compound NO_2 and of the real time continuous recording of its concentrations, by the electrochemical method, at one-minute intervals.

The information about monitored parameters, measuring principle, range, accuracy, minimum and display resolution are presented in Table 1.

Table 1. Information about monitored parameters, measuring principle and other details

Parameter	Measuring principle	Range	Accuracy	Minimum Resolution	Display Resolution
Nitrogen dioxide	Electro-chemical	0 to 5000 ppb (0 to 5 ppm)	Greater of < ± 10% of reading or 2% full scale	5 ppb	1 ppb
Temperature	NTC thermistor	-20 to +60^{0}C	Greater of ± 3% ^{0}C of reading	1^{0}C	1^{0}C
Relative humidity	Thin-film capacitive	0 to 100%	± 2%	1%	1%

4. RESULTS AND DISCUSSIONS

The obtained results of this experimental study are summarized in Table 2. The daily variation of NO_2 concentrations and of the climatic parameters, namely the temperature and the relative humidity, during the three monitored periods, is shown in Figures 1-2.

The analysis of the values presented in Table 1 reveals that the minimum value of the NO_2 concentration decreased with 74,1% during ES1 and with 59,5% during ES2. Also, the maximum value of the NO_2 concentration decreased with 50,4% during ES1 and with 28,0% during ES2, while the average values decreased with 62,3% during ES1 and with 57,0% during ES2. These results are similar with other international studies, with a decrease of 40% in New York and 49% in Las Vegas [2], of 51% in Barcelona [3], about 40% in London [4].

Furthermore, the influence of temperature on NO_2 concentration was studied, before ES and during the two months of the state of emergency. The obtained results are presented in Figures 3 - 5.

The influence of relative humidity on NO_2 concentration, before ES and during the two months of the state of emergency, is presented in Figures 6 - 8.

Table 2 Summary of obtained results during the three monitored periods

Monitored parameter	Minimum value	Median value	Maximum value	Average value	Standard deviation
Before the onset of the state of emergency (18.02-15.03.2020)					
Nitrogen dioxide, ppb	11,6	35,5	57,9	36,1	11,9
Temperature, ^{0}C	5,6	9,5	15,0	10,0	2,4
Relative humidity, %	32,8	67,9	98,6	67,9	16,8
During the first month of the state of emergency (16.03-15.04.2020)					
Nitrogen dioxide, ppb	3,0	11,7	28,7	13,6	7,2
Temperature, ^{0}C	2,8	11,2	17,5	11,1	4,1
Relative humidity, %	15,4	32,6	88,4	35,3	16,8
Variation, %					
Nitrogen dioxide	-74,1	-67,0	-50,4	-62,3	-
During the second month of the state of emergency (16.04-15.05.2020)					
Nitrogen dioxide, ppb	4,7	15,1	41,7	15,5	8,4
Temperature, ^{0}C	9,7	16,5	24,1	16,5	3,1
Relative humidity, %	20,5	42,9	90,7	44,5	18,4
Variation, %					
Nitrogen dioxide	-59,5	-57,5	-28,0	-57,0	-

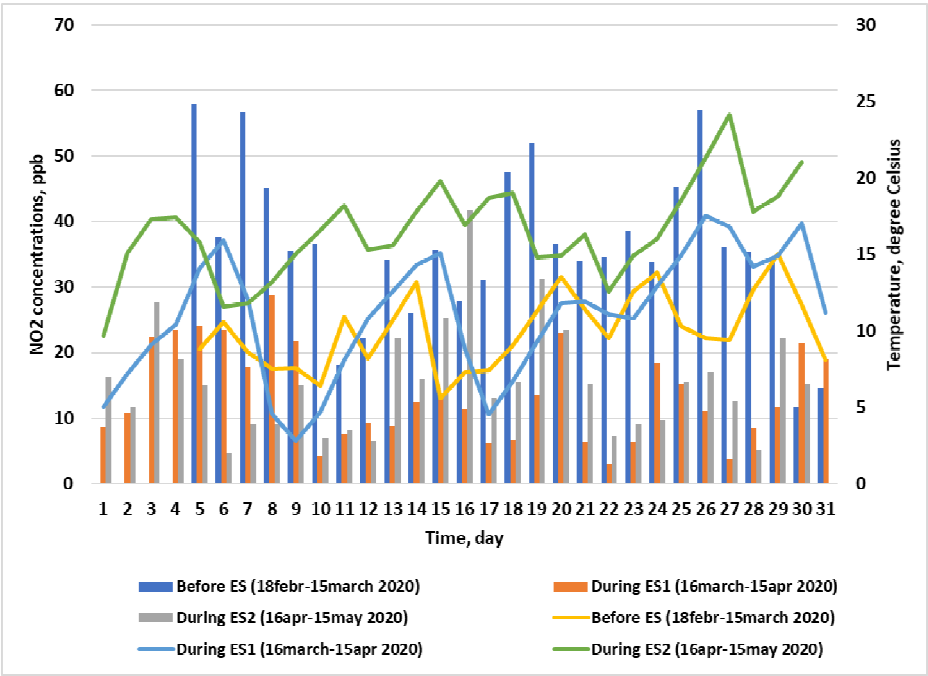

Fig. 1. Daily variation of NO_2 concentrations (24h average) and temperature

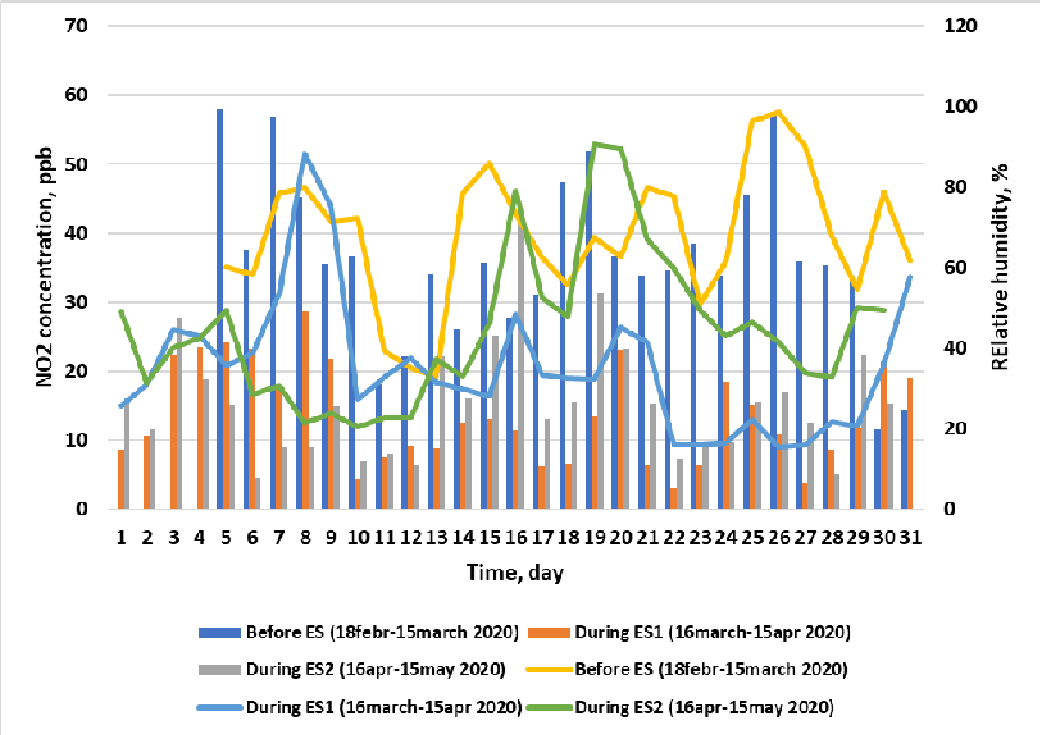

Fig. 2. Daily variation of NO_2 concentrations (24h average) and relative humidity

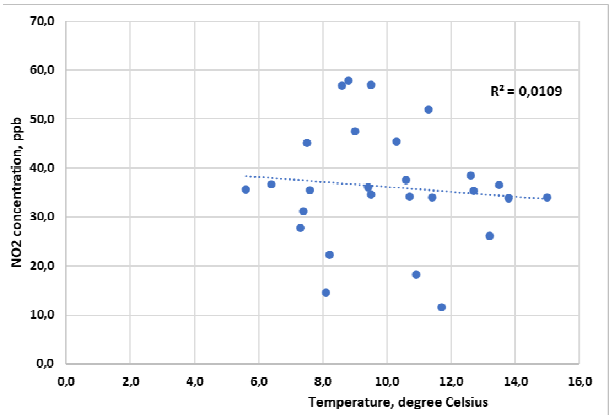

Fig. 3. No correlation between NO_2 concentration and temperature, before ES

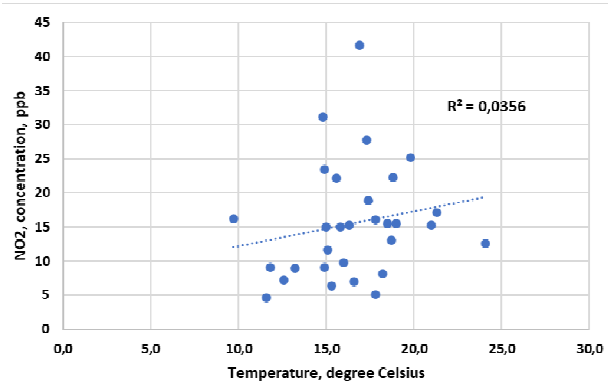

Fig.5. No correlation between NO_2 concentration and temperature, during ES2

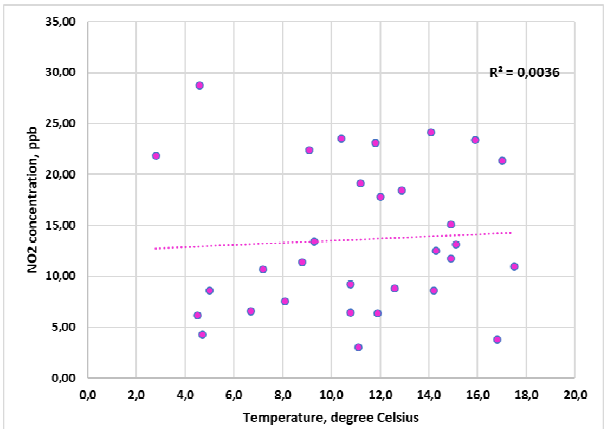

Fig. 4. No correlation between NO_2 concentration and temperature, during ES1

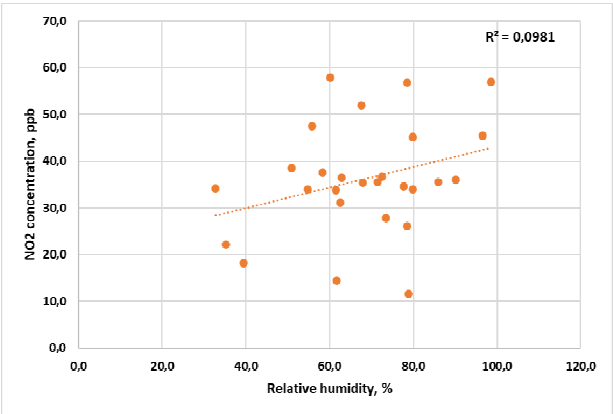

Fig. 6. Moderate correlation between NO_2 concentration and relative humidity, before ES

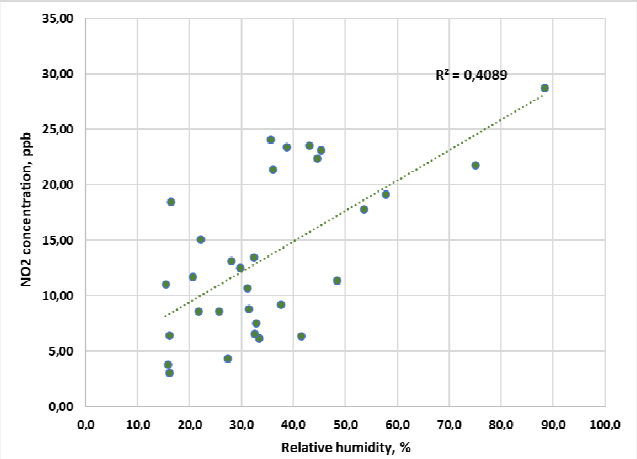

Fig.7. Moderate correlation between NO_2 concentration and relative humidity, during ES1

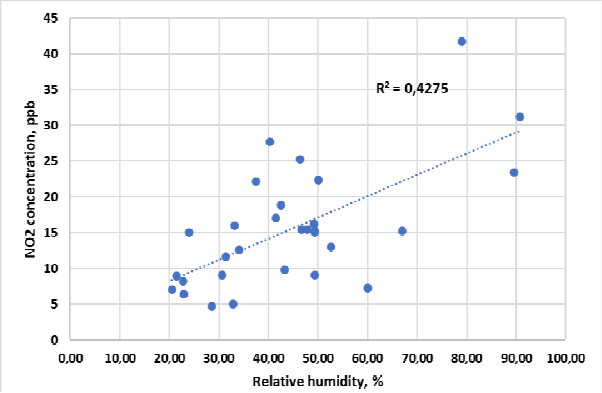

Fig.8. Moderate correlation between NO_2 concentration and relative humidity, during ES2

To discuss the influence of temperature and relative humidity on NO_2 concentrations, the Pearson correlation coefficients are summarized in Table 3.

Table 3 Pearson correlation coefficients for the three monitored periods

	Correlation coefficients, R^2 (-)	
	NO_2 concentration/ Temperature	NO_2 concentration/ Relative humidity
Before ES	- 0,0109	+0,0981
During ES1	+0,0036	+0,4089
During ES2	+0,0356	+0,4275

It can be observed that the Pearson correlation coefficients varies between -0,0109 and +0,0356, for NO_2 concentration and temperature, which leads to the conclusion that there is no correlation between the two parameters. However, the values of Pearson correlation coefficients for NO_2 concentration and relative humidity, between +0,0981 and +0,4275, show a moderate correlation between the two parameters.

5. CONCLUSIONS

The values of NO_2 outdoor concentration were recorded during three different periods of time:

- before the start of the state of emergency, when the values varied between 11.6 and 57.9ppb, with an average of 36.1ppb;
- during the first month of the state of emergency, when the values varied between 3.0 and 28.7ppb, with an average of 13.6ppb;
- during the second month of the state of emergency, when the values varied between 4.7 and 41.7ppb, with an average of 15.5ppb.

It can be observed a decrease in the NO_2 concentration during the two months of the state of emergency, both of the minimum values recorded and of the maximum and average values, the decrease of the average values being of 62.3%, in the first month and of 57.0%, in the second.

The influence of climatic parameters, such as temperature and relative humidity on the NO_2 concentration was also studied, the obtained results showing that there is no correlation between NO_2 concentration and temperature, in all three monitored periods, but there is a moderate direct interdependence between NO_2 concentration and relative air humidity, in the two months of the state of emergency.

Although the findings on declining concentrations of one of the major external pollutants may seem positive, air quality remains an issue that requires long-term attention from communities, as air pollution kills seven million people worldwide each year. A clear lesson is the revelation that it is possible to implement major interventions in cities for health reasons, as well as changing priorities so that maintaining clean air in the urban environment becomes a key concern.

ACKNOWLEDGEMENTS

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