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PARTICLE AIR POLLUTION (PM10) MONITORING AND PUBLIC OPINION ON AIR QUALITY. A CASE STUDY IN NORTHEASTERN ROMANIA

BY

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Abstract. Air pollution continues to be a concern for both the scientific community and the general population. Promoting pollution events and the impact they could have on the environment and human health must be an ongoing challenge.

This paper presents a case study on ambient air quality by monitoring particle concentrations (PM10) in the northeastern part of Romania. The analysis of a survey on the opinion of the general population regarding air quality is also presented. The research began with our concern about the data issued by the WHO (World Health Organization) which shows that tens of thousands of people are lost, annually, prematurely due to pollution.

Experimental data show that in some areas the concentration of PM10 is much exceeded. Moreover, in some areas this concentration is exceeded no less than 82 times in 7 months. At the same time, the survey shows that people

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believe they are responsible for the well-being of the environment but are not sufficiently informed about the quality of the air they breathe.

Keywords: PM10; air quality; survey.

1. Introduction

One of the major components of polluted air are the material particles (PM). These are a mixture of liquid particles and solid particles dispersed in the air. Depending on the source, their shape, size and composition may vary. PM can come both from natural sources (pollen, volcanic activity, etc.) and from anthropogenic sources (car traffic, industry, home heating). Depending on the dimensions, they were classified as follows: ultra-fine (≤ 0.1 μm), fine (≤ 2.5 μm) and coarse (≤ 10 μm) (US EPA, 2019).

Suspended particles (PM2.5, PM10), ozone and nitrogen dioxide present at the ground level are currently considered to be the pollutants that cause the most damage to human life and health (Bernatsky *et al.*, 2011; Van Eeden *et al.*, 2001). Prolonged exposure to these pollutants and their maximum values varies in impact and severity. They may have minor effects on the respiratory mechanism but may also lead to premature death (Adar *et al.*, 2015; Feng *et al.*, 2016; Hart *et al.*, 2009; Shoenfelt *et al.*, 2009; Zhang *et al.*, 2019).

The World Health Organization (WHO) ranks air pollution, attributing it to the highest risk of disrupting the normal functions of the environment and human health throughout Europe (http://apps.who.int/iris/bitstream/; http://apps.who.int/data/gho/).

At the level of the European Union (EU), air pollutants are the cause of more than 400000 deaths of people who would have had the chance to survive if there were no complications due to improper breathing air. This impressive number of deaths exceeds 10 times the deaths resulting from road accidents (http://europa.eu/rapid/press; US EPA, 2019).

In 2005, the WHO set out guidelines for air quality and provided global guidance on the thresholds and limits to be observed for the most powerful pollutants that pose a major risk to human life and health. These guidelines highlight the fact that a reduction of PM10 particles that contributes to air pollution from 70 micrograms to 20 micrograms per cubic meter ($\mu g/m^3$), has the effect of reducing deaths that are caused by air pollution by about 15% (http://apps.who.int/iris/bitstream/; http://apps.who.int/data/gho/).

In 2015, the European Environment Agency (EEA) stated that the population in the urban area, and here referred to a quarter of the total number of inhabitants, were in areas with a red code of air pollution (https://www.eea.europa.eu/).

The level of pollutants set by the EU, the pollutants responsible for air quality, was far exceeded and 96% of EU citizens were prone to complications

and diseases that pollutants above the limit allowed in the atmosphere can produce.

A study by Duan *et al*. says that exposure to PM 2.5 can affect and alter the lungs' immune responses, making them susceptible to infections (Duan *et al*., 2013).

In 2017, it was estimated that outdoor pollution, reported in both urban and rural areas, is the cause of 4.2 million deaths considered premature globally per year (Cohen *et al*., 2017).

The end of 2019 brings a negative change on all social and economic levels around the world. When panic erupts in downtown Wuhan, China, the first official information is given about pneumonia, which has unknown causes and a global epidemic. This black episode in universal history continues today under the close supervision of the WHO (http://apps.who.int/iris/bitstream/; http://apps.who.int/data/gho/).

It has been shown that an increase of only $1\mu g/m^3$ of PM2.5 causes an 8% increase in the mortality rate in the case of COVID-19 infestation (Wu *et al*., 2020).

According to the European Environment Agency, exposure to PM has a major impact on health as it can cause: eye, nose and throat irritation, asthma and lung failure, chronic obstructive pulmonary disease (COPD), cardiovascular disease, impact on the central nervous system and together with benzo(a)pyrene can even cause lung cancer (https://www.eea.europa.eu/; http://www.who.int/mediacentre/).

The official data registered by the World Health Organization show that in Romania in 2016, 16644 people lost their lives due to pollution, of which: 936 due to lower respiratory tract infections, 908 due to trachea, bronchus and lung cancer, 9702 due to diseases ischemic heart disease, 4016 by stroke and 1082 by COPD. According to the same source, in the same year the number of potential years of life lost due to premature death and years of life lost due to disabilities is 327866 (World Health Organization, Ambient air pollution attributable deaths).

Concerns for cleaner air in everyday life have led the scientific community to conduct studies and monitoring of pollution in the large intersections of Iasi. Theoretical models for estimating the dispersion of air pollution (especially NOx and PM), were used and tested in addition to GIS interpolation. Car traffic has been identified as the main source of air pollution in congested urban areas. The problem is not only related to the total number of cars crossing the city, it is also related to the lack of traffic flow, sometimes even traffic jams, which increase pollution and thus threaten the health of the population near large intersections. The circulation of air masses contributes to the increase of the concentration of pollutants. Thus, the concentration of NOx and PM differs significantly from one case to another (Banica *et al*., 2017; Sfîcă *et al*., 2018).

This paper presents a case study of ambient air quality from the Moldova region (Northeastern Romania) for the period September 2017 - March 2018, a period specific to the cold season. Due to the need to raise public awareness of the danger due to air pollution on health, the results of an opinion poll will be presented also.

2. Methodology

Between September 2017 and March 2018, 40,688 data were processed (representing the hourly values for PM10) from 8 air quality monitoring stations in Botoşani, Iaşi, Neamţ, Suceava and Vaslui, part of the National Air Quality Monitoring Network (www.calitateaer.ro). For each station, the daily average and the monthly average were calculated. Based on the values of the monthly averages and the geographical coordinates for each analysed station, maps were made to highlight the distribution of ambient air quality at regional level, using the online utility GPS Visualizer.

During the same period, a survey was conducted on the level of public awareness of environmental air pollution. This survey was conducted based on a questionnaire (https://goo.gl/forms/L3GI4GgTFWk32cJc2) comprising 11 questions, among which we mention:

• *Do you think it is your responsibility to care for the well-being of the environment?*

• *Will the next generations suffer the consequences of uncontrolled human actions on the earth's resources?*

• *Do you think you are well informed about the quality of the air you inhale/'consume'?*

• *Is the air in your locality polluted?*

The questionnaire was completed by 418 people, and the results and discussions are presented below.

3. Results and Discussions

Following the data processing and their verification on the graphs, we noticed exceedances of the daily limit value for December and January for the APM-IS-01 station, Podul de Piatra [47.16N, 27.57E], of the National Environmental Protection Agency. According to law 104/15.06.2011, the daily limit value for the protection of human health of suspended particles of PM10 type is 50 $\mu g/m^3$. Furthermore, it is specified that this value has not to exceed more than 35 times in a calendar year.

In Table 1 we can see that at the IS-1 station the daily limit value is exceeded 82 times in 7 months and at the IS-6 station 60 times in the same time interval.

As can be seen from Figs. 1-7 and Table 2, the values with the highest concentration of PM10 are present at station IS-1 - traffic station that monitors the influence of car traffic on air quality and at station IS-6 - traffic station that monitors air quality in the border area with the Republic of Moldova. Also, the other stations do not show encouraging results.

Table 1

Number of Exceedances of the Daily Average Values for the Period September 2017 - March 2018 for North-Eastern Romania

Station	*The number of exceedances of the daily average values*						
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
BT-1	0	4	5	3	4	2	2
IS-1	9	12	15	18	14	8	6
IS-3	0	2	0	2	4	1	0
IS-6	7	9	8	12	12	6	6
NT-1	0	1	10	4	11	3	5
SV-1	0	0	0	0	0	0	0
SV-2	3	1	5	4	4	3	2
VS-1	0	0	1	3	3	5	4

IS-3 and SV-2 stations are industrial type stations that monitor air quality in the residential area that is under the influence of emissions from the industrial area and BT-1, NT-1, SV-1, VS-1 are urban background stations. Figs. 1-7 show the distribution of the monthly average values of the PM10 facing for the APM stations which are also detailed in Table 1.

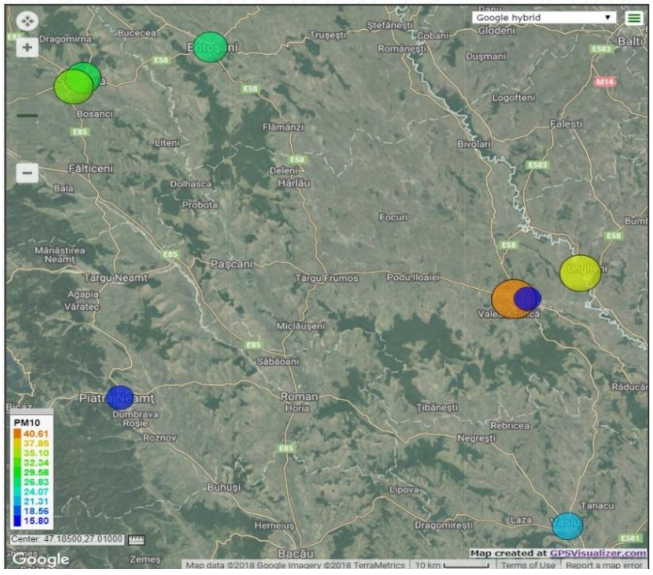

Fig. 1 – Monthly average values of PM10 concentrations (μg/m^3) - September, 2017.

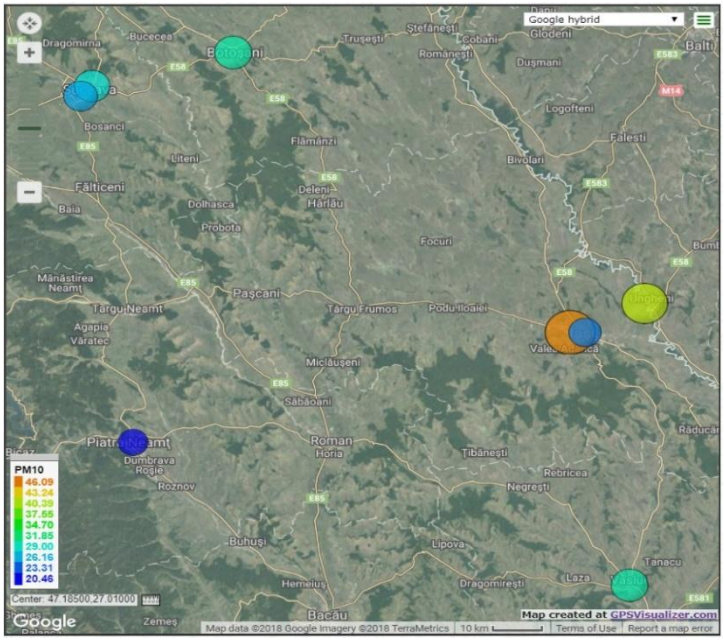

Fig. 2 – Monthly average values of PM10 concentrations (μg/m^3) - October, 2017.

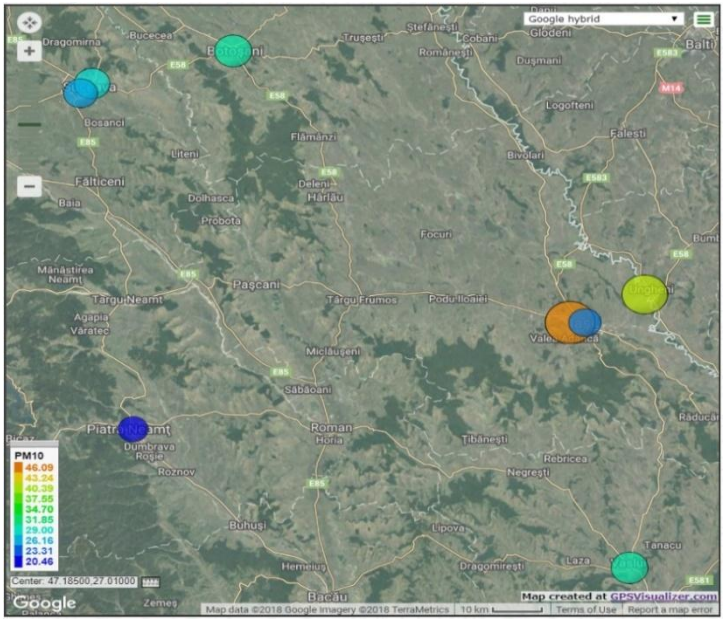

Fig. 3 – Monthly average values of PM10 concentrations (μg/m^3) - November, 2017.

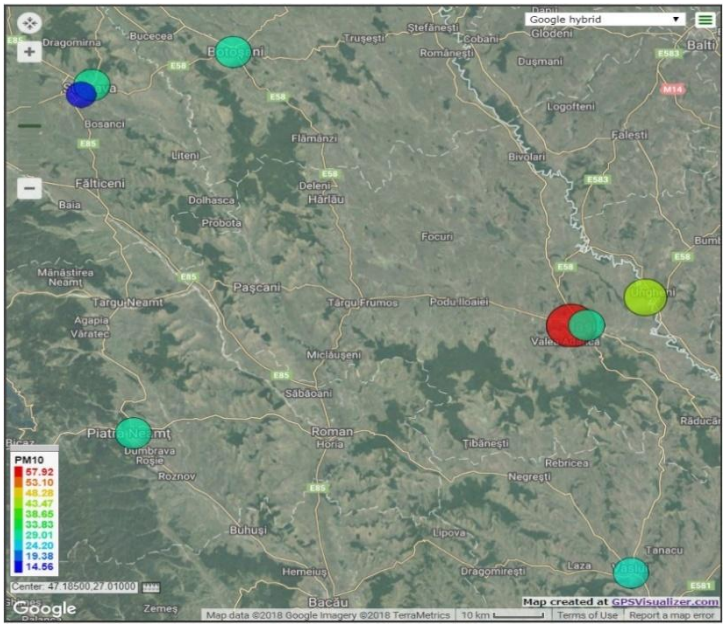

Fig. 4 – Monthly average values of PM10 concentrations (μg/m^3) - December, 2017.

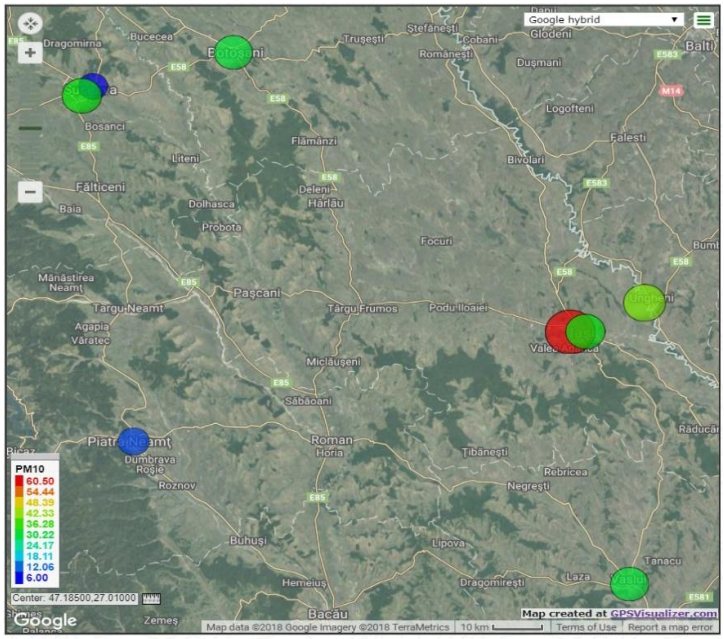

Fig. 5 – Monthly average values of PM10 concentrations (μg/m^3) - January, 2018.

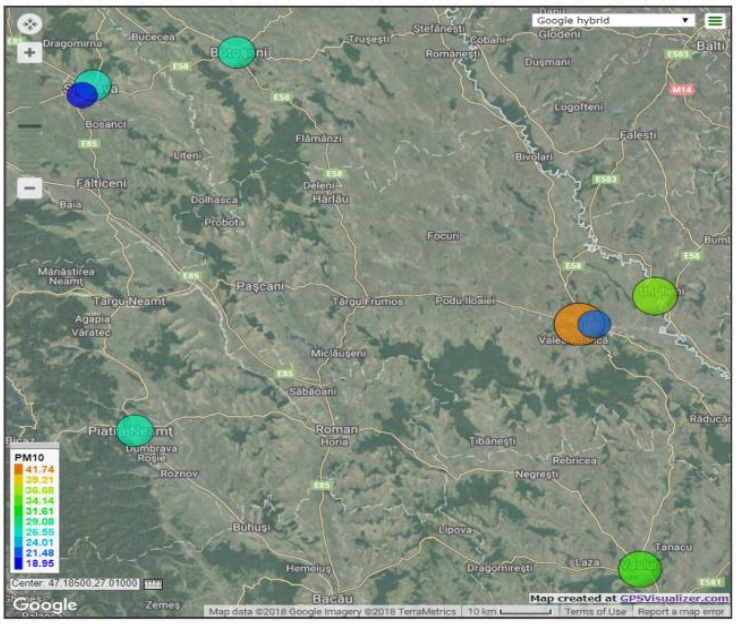

Fig. 6 – Monthly average values of PM10 concentrations (μg/m^3) - February, 2018.

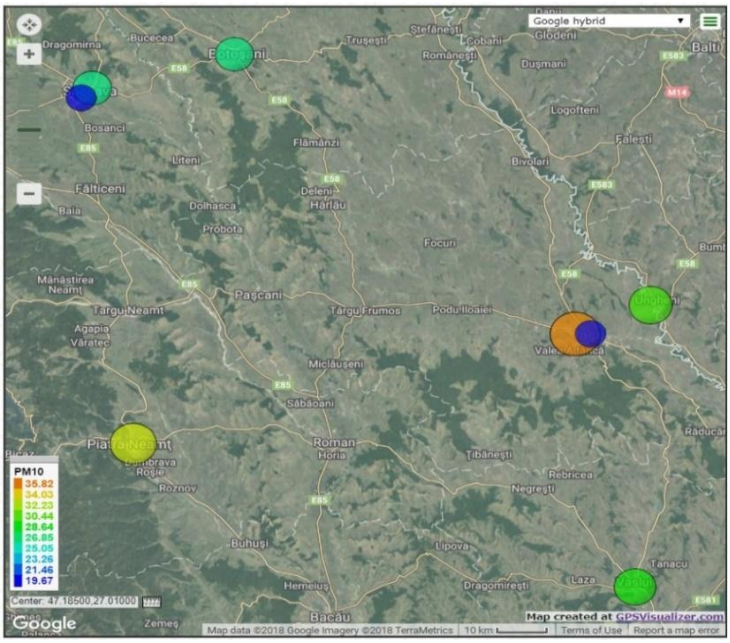

Fig. 7 – Monthly average values of PM10 concentrations (μg/m^3) - March, 2018.

Table 2
PM10 Monthly Mean Values for the September 2017 – March 2018 Period

	Station [longitude N & latitude E]	PM10 monthly mean values [μg/m^3]						
		Sep. 2017	Oct. 2017	Nov. 2017	Dec. 2017	Jan. 2018	Feb. 2018	Mar. 2018
1	BT-1 [26.66, 47.74]	26.51	30.26	35.25	29.06	30	27.32	26.39
2	IS-1 [27.57, 47.16]	40.61	46.09	48.45	57.92	60.5	41.74	35.82
3	IS-3 [27.61, 47.16]	15.8	23.74	26.68	28.89	32.6	21.8	19.91
4	IS-6 [27.77, 47.22]	36.25	41.03	39.92	43.04	40.2	35.38	30.11
5	NT-1 [26.39, 46.93]	16.8	20.46	43.35	28.56	10	27.47	32.94
6	SV-1 [26.25, 47.65]	33.57	25.72	19.73	14.56	33	18.95	19.67
7	SV-2 [26.28, 47.67]	27.93	28.11	37.07	29.27	6	26.48	26.6
8	VS-1 [27.73, 46.63]	21.6	29.79	29.75	27.04	30	33.32	29.11

The colours in the Table 2 have the same meaning as those in the legend of Figs. 1-7.

Considering the type of station, it could be defined which source of pollutant would be predominant, but this is not certain. For this reason, these monitoring points should be correlated with low-cost sensors to consider the trend of the values they measure. Currently, such types of equipment cannot be taken into account by the county commissioners of the National Environmental Guard for warning and sanctioning the polluter. By the cooperation of the county commissioners of the National Environmental Guard with representatives of the civil society with legal and/or natural persons, within the limits of the legal provisions in force and by using these types of equipment, the detection of pollution source would be much improved and would help commissioners of the National Environmental Guard to apply the law.

An opinion poll was launched at the same time as the above analysed data. Some of the results of the questionnaire showed that 93.5% of those interviewed consider themselves responsible for the well-being of the environment (Fig. 8) and expressed concern about the impact of pollution on future generations, in proportion of 96.7%.

At the same time, only 27.8% of those surveyed believe that they are informed about the air quality they breathe (Fig. 9)!

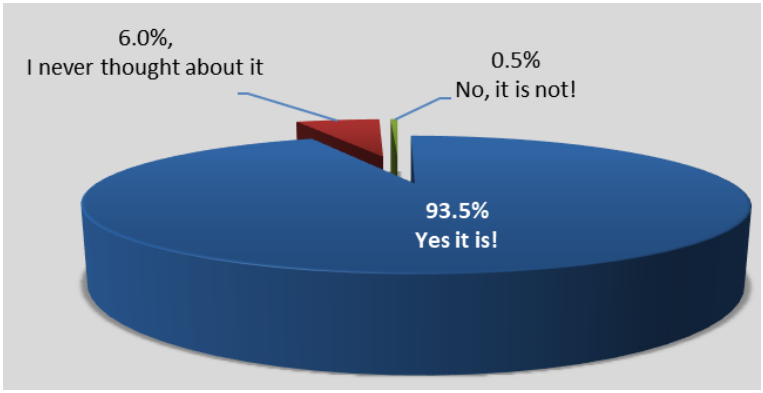

Fig. 8 – Circular statistical illustration of the question: *"Do you think it is your responsibility to care about the well-being of the environment?"*

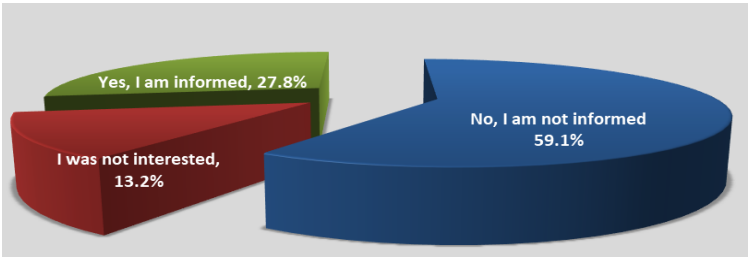

Fig. 9 – Circular statistical illustration of the question: *"Do you think you are well informed about the quality of the air you inhale/consume?"*

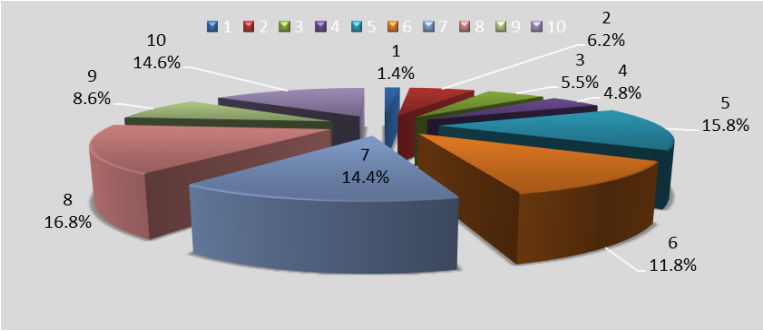

Fig. 10 – Circular statistical illustration of the question: *"Is the air in your locality polluted?"*

The plausible conclusion at first sight of the answers to the question 'Is the air in your locality polluted?' (Fig. 10) is that the highest percentages in assessing air quality start from grade 5 to grade 10. Thus, respondents still

consider that the air in their locality is increasingly polluted, grade 5 being associated with a percentage 50% of the degree of pollution that a respondent can consider.

4. Conclusions

This study shows the results of a case study on the distribution of PM10 concentration in the cold season, from September 2017 to March 2018 in the North-East of Romania. Measuring the impact on the population, the survey shows that people feel the lower air quality, but they are not quite informed about this phenomenon and do not know the causes and how their health may be affected. The air deserves to be given a special importance through a good information of the impact it has on man. The population must be aware of the quality of the air they breathe, and that air pollution has effects on health. Moreover, even the population must contribute to reducing air pollution with the support of the authorities.

As a perspective, air quality must be monitored even with the help of low-cost sensors, which can show the increasing or decreasing tendency of the air quality. Thus, the population will be more interested in the air they breathe and the detection of the main sources of pollution would be early detected.

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MONITORIZAREA POLUĂRII AERULUI CU PARTICULE (PM10) ŞI OPINIA PUBLICĂ CU PRIVIRE LA CALITATEA AERULUI. STUDIU DE CAZ ÎN NORD-ESTUL ROMÂNIEI

(Rezumat)

Poluarea aerului continuă să fie o preocupare atât pentru comunitatea ştiinţifică cât şi pentru populaţia generală. Promovarea evenimentelor de poluare şi impactul pe care l-ar putea avea asupra mediului înconjurător şi asupra sănătăţii umane trebuie să fie o provocare continuă.

În această lucrare este prezentat un studiu de caz privind calitatea aerului ambiental prin monitorizarea concentraţiilor particulelor (PM10) în zona de nord-est a României. De asemenea este prezentată analiza unui sondaj privind opinia populaţiei generale cu privire la calitatea aerului. Cercetarea a început odată cu îngrijorarea noastră despre datele emise de OMS (Organizaţia Mondiala a Sănătăţii) care arată că zeci de mii de oameni îşi pierd, anual, viaţa prematur din cauza poluării.

Datele experimentale arată că în unele zone concentraţia PM10 este cu mult depăşită. Mai mult decât atât, în unele zone această concentraţie este depăşită de nu mai puţin de 82 de ori in 7 luni. În acelaşi timp sondajul ne arată ca oamenii cred că sunt responsabili de bunăstarea mediului înconjurător, dar nu sunt suficient de informaţi cu privire la calitatea aerului pe care îl inspiră.