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A CASE STUDY OF ENVIRONMENTAL POLLUTION IN RELATION TO PARTICULATE MATTER

BY

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Abstract. Environmental pollution influences human health resulting in respiratory, cardiovascular or cancer disease. The presence of pollutants such as PM particles containing carbon (CO, CO_2), nitrogen (NO, NO_2) and sulphur oxides (SO_2) is the consequence of anthropogenic emissions of liquid, gaseous and solid substances into the air, through technological activities (industrial), urban transport. PM 2.5 and PM 10 particulate matter are small enough to remain suspended in air for long periods (hours or days), being able to travel longer distances. Also, various acids (HCI, HNO_3, and H_2SO_4) can be formed by atmospheric particles with a strong negative impact on health and other constructions (bridges, buildings etc.). In addition, water is also one of the most effective degradation agents, participates directly in numerous chemical reactions that lead to the alteration of stone materials. The aim of this paper is to present some measurements on the distribution of urban pollutants.

Keywords: particle matter; PM2.5; PM10; pollution reduction; deposit.

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1. Introduction

Among the greatest uncertainties about understanding climate change are the effects of aerosols, natural and anthropogenic sources of atmospheric pollution, meteoric dust intrusions and alien ionizing radiation etc. It is known that the dynamics of atmospheric compounds (dust particles, pollutants, etc.) in interaction with solar radiation contribute to significant meteorological changes that, under special conditions, produce severe weather phenomena accompanied by electrical discharges, spikes and major rainfalls disastrous consequences for the population.

The multiplication of anthropogenic pollutants and those entering the earth's atmosphere is an important signal for the development of technologies that ensure the environment's safety and the health of the population. The diversity of systems that penetrate the atmosphere, differentiated by chemical composition, mass, speed, sphericity, etc., lead to the use of increasingly sophisticated technologies. An issue induced by these factors is also related to the spatial and temporal resolution of the systems used. The issue of the dynamics of cloudy formations and aerosols in the Earth's atmosphere is one of the major themes supported by the European Space Agency (ESA) through its numerous satellite missions (Calipso, Envisat, Merlin, Meteosat Second Generation, MetOp). These missions provide data for a wide range of applications, such as operational meteorology, monitoring of volcanic eruptions, air quality forecasts, climate studies, and support for environmental policymaking.

Suspended particulate matter (PM) emissions greatly affect human health (especially PM10 and PM2.5, which can cause various diseases such as cardiovascular disease, cardiorespiratory, respiratory and cerebral accidents, etc. These include also nitrates, sulphates, organic carbon, elemental carbon, dust and salt, which can come from various sources and have a number of specific morphological, chemical and physical properties. Because aerosols have lower lifetimes (minutes - days) and distributions more varied than greenhouse gases, the net effect on global climate or health is still difficult to investigate. Changes in atmospheric concentrations of greenhouse gases and aerosols contribute to the radiation budget, so that the energy balance of the climate system changes, leading to climate change and influencing the absorption, scattering and emission of radiation inside the atmosphere and the surface of the Earth (Andreae and Crutzen, 1997; Finlayson-Pitts and Pitts, 1997; Lary, 2005; Hoffmann *et al*., 2011; Matthias-Maser and Ruprecht, 2000; Mihesan *et al*., 2008).

Recent studies show that Romania ranks 3rd at European level on the number of deaths per 100000 inhabitants. According to these statistics, because of the high concentrations of PM2.5 particles, Romania annually accounts for about 200 deaths per 100000 inhabitants (Lelieveld *et al*., 2019). The main

cities in the country where the pollution reaches alarming rates are: Ploiești, Iași, București, Cluj and Brașov. Each region has distinct peculiarities regarding the nature and concentration of the pollutants, predominantly either large particles (PM10 dust particles) or combustion particles (PM2.5), benzene, toluene, oxides of nitrogen, cyanides, hydrogen sulphate, ozone, etc. These pollutant compounds originate in several categories of local pollution sources (road transport, public or private transport vehicles, industry, construction sites, etc.) but can be brought from nearby areas or from a long distance (compounds from fires vegetation, Saharan dust, volcanic ash, etc.). All of these compounds undergo chemical transformation over time, some of which can be more harmful, all depending on their concentration, season, relief, and climatic conditions. Furthermore, the introduction of new technologies to investigate physicochemical phenomena related to Earth's climate change is highly necessary, not only because of the increased number of sources of pollutants (potentially significant in terms of global warming effect) but also of adverse effects of their greenhouse effect caused by compounds such as carbon dioxide, nitrogen oxides, sodium chloride, methane and potential global warming gases such as perfluorocarbons, sulfur hexafluoride, ozone substances, etc. (Ciuraru *et al*., 2011). In this paper, preliminary investigations have been initiated to analyze the dynamics of air pollutants, particularly in Romania, Iasi county region. The dynamics of PM10 particles and nitrogen oxides in several points in Iasi were investigated for 2018 entire period.

3. Experimental Set-Up

Measurements were made using a piece of equipment called the HT-9600 Particle Detector (Fig. 1), which is a rapid dust detector used to measure the amount of PM2.5 and PM10 separable particles (inhalable particles) in the air.

Fig. 1 – Particle detector.

The measurements processing, meaning the chemical composition analyze on the air quality in Iași were made with LIDAR facilities with space and temporal resolution at the "Alexandru Ioan Cuza" University of Iași, the

LOASL laboratory, presented in the paper (Cocean *et al.*, 2018). The measurements made in a 500 m thick air blanket showed the presence in the atmosphere above the city of Iasi of chemical species such as: CO_2, HCN, CO, N_2, O_2, NO_2, NO_3, SO_2 dioxin, furan, amides, sulfonic acid etc. In this paper the measurements were limited to observing and analyzing spatial and temporal distributions of PM_{10} and NO_2 in Iași using portable monitoring tools and the database of the Environmental Protection Agency (resource web,) through the IS-1 (Stone Bridge) and IS-3 (Tătărași) monitoring points.

3. Results and Discussions

Fig. 2 and Fig. 3 show the distributions of the PM10 particle concentrations and the NO_2 concentration at two stations in Iasi averaged per hour for 2018 (Resource web).

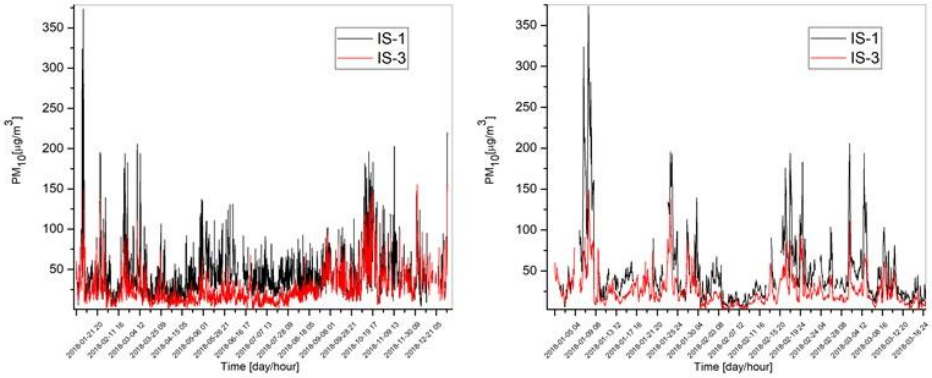

Fig. 2 – The concentrations of PM10 for 2018 at IS-1 and IS-3 stations.

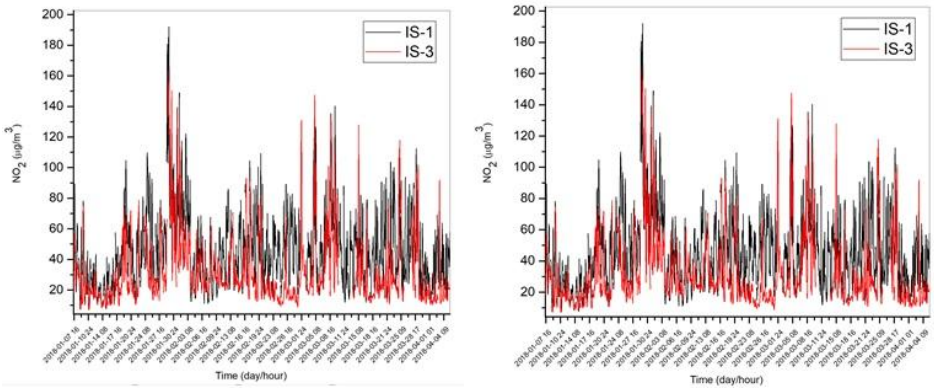

Fig. 3 – The distribution of NO_2 concentrations at IS-1 and IS-3 stations.

The preliminary analysis of these data shows that the thresholds beyond which these pollutants can harm human health are exceeded.

Table 1 lists these statistics. The measurements carried out in parallel with the mobile instrument revealed similar results during the monitoring period in Iași (Ștefan cel Mare Boulevard). These results show that the measurements are still sensitive to the area investigated, due to the different nature of the pollutants, the sources of pollution, the meteorological parameters, etc.

In Fig. 4 the measurements performed with the specific equipment above mentioned are given.

Table 1
Pollutant Statistics

Station	Number of days exceeded by PM10 (>50 µg/m3)	Number of hours exceeded at PM10 (>50 µg/m3)	Number of days exceeded by NO_2 (>40 µg/m3)
Stone Bridge (IS-1)	62	1918	180
Tătărași (IS-2)	11	817	41
Station	Number of days exceeded by PM10 (>50 µg/m3)	Number of hours exceeded at PM10 (>50 µg/m3)	Number of days exceeded by NO_2 (>40 µg/m3)

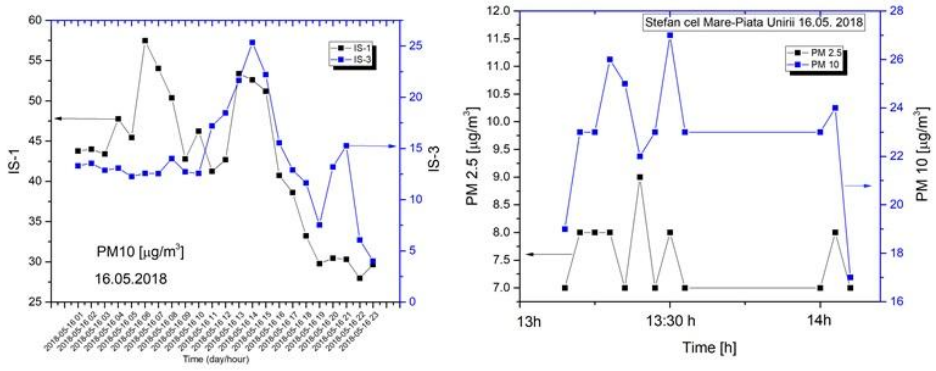

Fig. 4 – Comparative study of the concentration of PM10 at two fixed APM stations in Iași with the measured mobile instruments on Bvd. Ștefan cel Mare (Iași).

4. Conclusions

Preliminary measurements show that at least a series of pollutants (classical) compounds are extremely high. Monitoring shows that there is a slight variation over time but also with investigation stations. Moreover, the lack of monitoring of these pollutants in altitude makes it almost impossible to produce a depth studio on their distribution throughout the area. It is also found that one of the major sources of pollution is car traffic and burning in households (pollutants found especially at the outskirts of the city, especially at 10 am and 9 pm respectively). To correlate the intensity of the pollution peaks, the nature of the pollutants and the car traffic (types of machines, their degree of wear and number, etc.), rigorous analyzes must be made which consist in the multiplication of the measurement points and the correlation of the data with the meteorological parameters, respectively with laboratory studies on the chemical composition of the dust and soot collected by on cars, on vegetation, on statues, etc.

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STUDIU DE CAZ A POLUĂRII MEDIULUI DE CĂTRE PARTICULE

(Rezumat)

Poluarea mediului înconjurător influențează sănătatea umană, care provoacă boli respiratorii, cardiovasculare și canceroase. Prezența poluanților, cum ar fi particulele PM conținând carbon (CO, CO_2), azot (NO, NO_2) și oxizi de sulf (SO_2), este consecința emisiilor antropice de substanțe lichide, gazoase și solide în aer prin activități tehnologice, transport urban. PM 2,5 și PM 10 sunt suficient de mici pentru a rămâne suspendate în aer pentru perioade lungi (ore sau zile), fiind capabile să circule pe distanțe lungi în acest moment. De asemenea, diferiți acizi (HCL, HNO_3 și H_2SO_4) pot fi formați din particule atmosferice cu un puternic impact negativ asupra sănătății și a altor construcții (poduri, clădiri etc.). În plus, apa este, de asemenea, unul dintre cei mai eficienți agenți de degradare, participă direct la numeroase reacții chimice care duc la modificarea materialelor din piatră. Concluziile preliminare se referă la unele măsuri pentru reducerea poluării în zonele studiate.