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RESEARCH BASED ON THE CONCENTRATION OF PARTICULATE MATTER FROM DIFFERENT LOCATIONS OF CONSTANȚA

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Abstract : In this paper, we propose to analyse the air quality in the urban environment, respectively in the city of Constanta. The sources of pollution are multiple, both for the air outside and for the air inside: solid and liquid particles, gas emissions from vehicle exhaust, from industrial sources, cleaning products. All these sources of pollution constitute a real danger for human health, some being even toxic. 4 locations were chosen for measurements and the concentrations of PM2.5, PM10 particles were measured, after which the risk level was established in the period April-May 2024, comparing the data with those provided by the National Environmental Protection Agency. The analysed results show that the quality parameters for PM2.5 and PM10 particles in the outside air have a moderate impact on the environment, while for the premises they are within accessible limits.

Key words : The air quality index, emission, impact, indoor, health, measurement, risk, particulate matter, outdoor.

1. INTRODUCTION

The Worldwide, air pollution causes the death of 6.7 million people annually [1]. And in Europe, air pollution is still above the levels recommended by the World Health Organization (WHO).

Reducing air pollution to the levels of WHO recommendations would prevent a significant number of attributable deaths in the EU Member States (EU-27), for example 253,000 from exposure to fine particles (PM2.5) [2].

Approximately 96% of Europe's urban population is exposed to health-damaging levels of fine particles [3].

In Europe, including Romania, important progress has been made in dealing with outdoor air pollutants [4].

Outdoor air quality is monitored throughout Europe and limit values have been adopted for the concentration of the most common pollutants. However, when referring to air pollution, it is important to consider both outdoor and indoor air.

Some indoor air pollutants come from outside air, but most are released inside the home, for example through the use of cleaning products, air fresheners, pesticides and cooking and heating fuel.

Emissions from building materials and furniture are another common source of indoor air pollutants.

In this paper, we propose to analyse the sources of air pollution in the urban environment, respectively indoors and outdoors, especially PM2.5 and PM 10 dust particles in suspension.

2. THE SOURCES OF AIR POLLUTION IN URBAN AREA

2.1 Particulate matter - sources and health risks

The term "particulate matter" describes solid or liquid particles of a size greater than that of single molecules, but less than 500 mm. Particles come from a wide variety of sources and are different in terms of morphology, chemistry, physical and thermodynamic characteristics [5]. These small particles are made up of a number of components including, for example, acids, nitrates and sulphates, as well as organic chemicals, metals and dust particles in the soil. Several elements such as Si, Al, Ca, Fe, Ti can be found in the particles, as well as transition metals V, Cr, Ni Cu, Zn, Pb and inorganic ions such as Na + and K + .

All these compounds together with volatile organic compounds are highly variable and depend on many factors such as climate, emission sources and geographical position [6].

2.2 Emissions from vehicles

The main sources of particulate emissions from vehicles are exhaust fumes and tire and brake wear. Emissions from diesel engines mainly contain soot, i.e. elemental carbon particles, volatile organic compounds and some sulphates from the sulfur content of the fuel. When organic compounds and sulfates are emitted by the vehicle into the environment, they are concentrated into

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particles with a size of 0.01 to 2.5 microns. The movement of vehicles causes the resuspension of road dust. Particulates are also emitted as a result of wear and tear on braking equipment and tires during use. These particles are estimated to be in the 3-30 micron size range.

2.3 Industrial emissions

Industrial emissions contribute to the production of particles, especially in urban areas, depending on the distance between the industrial and residential areas and the technology they use. Particles in industrial emissions generally range in size from 0.5 to 100 mm, depending on the particular characteristics of the source.

2.4 Forest and agriculture fires

Overall this type of pollution is temporary. However, in areas where there have been large forest fires, this source can become a very important one. Both direct emissions and resuspension of particles from burnt earth can be an important source of particles.

2.5 Sources of internal particle pollution

The most significant sources of internal particle pollution are : perfumes/deodorant sprays; gas from the stove; cleaning products; carpets; the candles. Sources of particulate matter in confined spaces are both external and internal [7].

Exposure to indoor pollutants can create a significant health risk. The toxicological studies carried out show that indoor pollutants have different toxicity and, therefore, the effects on health are different [8].

The main diseases caused by exposure to these pollutants are respiratory diseases (chronic cough, wheezing, feeling of suffocation, asthma, reduction of lung capacity, etc.) in children and sensitive people, various cases of cancer (lung cancer, leukemia, liver cancer, cancer of the skin, etc.) or diseases of the cardiovascular system. Some effects of exposure may appear in the short term, others in several years [10].

3. RESEARCH BASED ON THE CONCENTRATION OF PARTICULATE MATTER

3.1 Location of measurements

For this study, 4 locations were chosen: 2 outside – Neversea Beach and Boulevard Area and 2 inside, in the classrooms and in a residence location (an apartment). The measurements were carried out between 10.04 and 20.05.2024.

3.2 Data of measurements

Comparative data has been provided by the National Environmental Protection Agency regarding the measurements made in 2024 for PM2.5 and PM10.

In this study, was measured the concentration of particulate matter with a diameter of 2.5 µm (PM2.5) and 10 µm (PM10) using the air quality detector "Air Quality Detector PCE-RCM10". (Fig. 1)

Figure 1 Air Quality Detector PCE-RCM10

3.2.1. The concentration of particulate matter in the outside air:

- *Neversea Beach Area*

7 rows of measurements were performed. All values fell into category 1 (good) of the air quality index, both for PM2.5 and PM10 (Fig. 2).

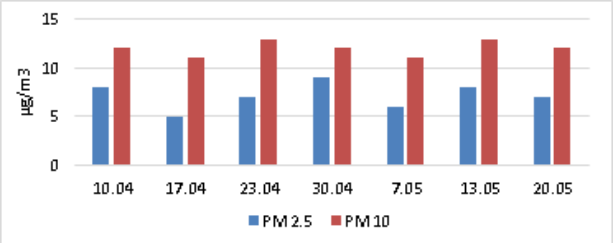

Figure 2 Concentration of particulate matter - values measured on Neversea Beach

For PM2.5 the values varied between 5 and 9 µg/m^3, with an average of 7.14 µg/m^3, and for PM10 they varied between 11 and 13 µg/m^3, the average being 12 µg/m^3.

- *Boulevard Zone*

In the boulevard area, the highest values were recorded in the 4th set of measurements, from April 27: 43 µg/m^3 for PM2.5 and 61 µg/m^3 for PM10 (Fig. 3).

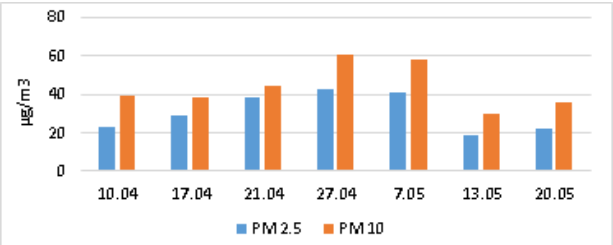

Figure 3 Concentration of particulate matter - values measured in the boulevard area

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The minimum value for both PM2.5 and PM10 was recorded on May 13, of 19 μg/m^3 and 30 μg/m^3 respectively . On average, particulate matter with a diameter of 2.5 μm had a value of 30.71 μg/m^3 and those with a diameter of 10 μm of 43.71 μg/m^3.

3.2.2. The concentration of particulate matter in the indoor air:

- *PM2.5 and PM10 values measured in the classroom*

Measurements were carried out, on April 12, 16 and 22, for each of which the concentration of particulate matter was recorded before, during and at the end of the course .

The lowest values were recorded before the course, respectively 8, 7 and 13 μg/m^3 for PM2.5 and 12, 17 and 21 μg/m^3 for PM10 (Fig. 4).

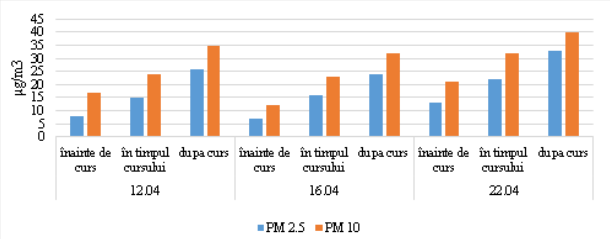

Figure 4 Concentration of particulate matter in classrooms

During the course hours, the concentration of particulate matter increased progressively, so that at the end of the sessions, increases between 254% and 325% were recorded for PM2.5 and between 190% and 267% for PM10.

This was achieved at the end of the course. for PM2.5 a maximum value of 33 μg/m^3 , and for PM10 of 40 μg/m^3 , both values being recorded on April 22.

Most guidelines regarding the concentration of pollutants in indoor air accept a maximum of PM2.5 between 35 and 50 μg/m^3 [9]. In the indoor air quality guidelines, the PM10 parameter is not taken into account, but the value of 50 μg/m^3 for outdoor air represents the daily limit for the protection of human health.

- *Values of PM2.5 and PM10 measured in the apartment*

7 sets of measurements of PM2.5 and PM 10 were carried out, in 2 bedrooms, living room, kitchen and bathroom (Fig. 5 and Fig. 6) .

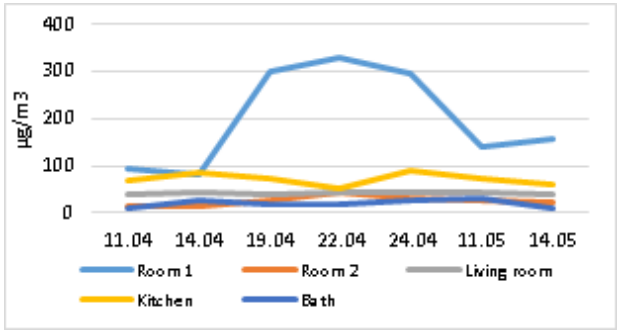

Figure 5 PM2.5 concentration in different rooms in apartment

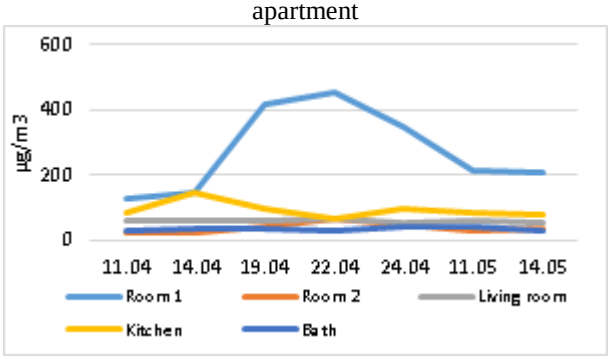

Figure 6 PM10 concentration in different rooms in apartment

For PM2.5, the lowest value was recorded in the bathroom, 11 μg/m^3 on May 14, and the highest in bedroom 1, 328 μg/m^3 .

4. RESULTS AND INTERPRETATIONS

For measurements of *concentration of particulate matter in the outside air* the results were:

- the values in the boulevard area belong to quality indices 2, 3 and 4 for PM2.5, respectively "acceptable", "moderate" and "bad". For PM10, the values fall into quality indices 2 and 4, respectively "acceptable" and "bad" (Table 1).

Table 1. Specific air quality indices for the boulevard area

	PM2.5	PM10
10.04	3	2
17.04	4	2
21.04	4	4
27.04	4	4
7.05	4	4
13.05	2	4
20.05	3	2

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Although particulate matter in the air are of particular importance for human health and the environment in general, being used as air quality indices, in the year 2024 in the city of Constanța there are no records of particulate matter until now (January - May) at none of the 3 continuous monitoring stations.

Comparative, in 2023, the concentration of particulate matter showed the following characteristics:

- PM10 had average daily values that varied between 3.18 μg/m^3 , a value recorded at the CT-1 station near the House of Culture and 114.92 μg/m^3, also found at CT-1 station, a value that places air quality in the very bad range (specific index 5); on average, the lowest values were recorded at station CT-5 in km 5 neighbourhood (10.33 μg/m^3) , and the highest at station CT-1 (35.01 μg/m^3). CT1 is a traffic-type station, which explains the values higher values of this indicator, as it is known that traffic has a major contribution to the increase in the concentration of particulate matter in the environment. At the CT-1 station, in 56 of the 332 days in which measurements were made in 2023, the average daily values recorded exceeded the daily human health protection limit of 50 μg/m^3. It should be noted that at stations CT-2 and CT-5 the measurements were not carried out for the whole year 2023 (Fig. 7).

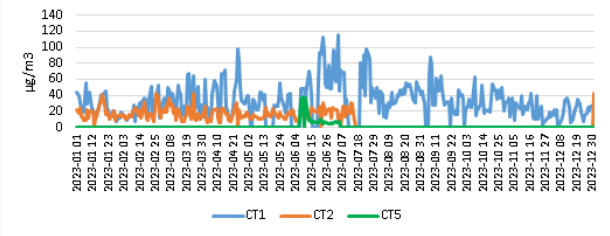

Figure 7 Daily variation of PM10 concentrations in Constanța in 2023

- PM2.5 were measured only at station CT-2 (Fig. 8), located in the park near the town hall, their values varying between 0.36 μg/m^3 and 28.12 μg/m^3, a value that places the air quality in the moderate range (specific index 3).

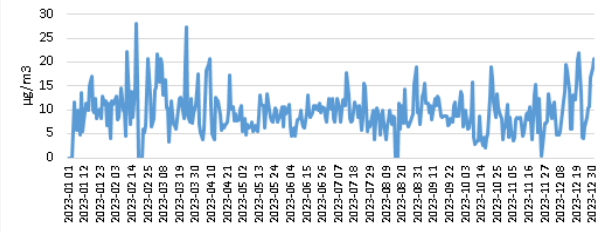

Figure 8 Daily variation of PM2.5 concentrations in 2023 (CT-2)

- The concentration of the 2 types of particles varies differently throughout the year 2023, which suggests their different sources: PM10 shows higher values in the months of April June, July, and PM2.5 in the February-March period.

For measurements of *particulate matter's concentration in the indoor air-PM2.5 and PM10 values measured in the classroom* the results were:

- Measurements were carried out, on April 12, 16 and 22, for each of which the concentration of particulate matter was recorded before, during and at the end of the course. The lowest values were recorded before the course, respectively 8, 7 and 13 μg/m^3 for PM2.5 and 12, 17 and 21 μg/m^3 for PM10 (Fig. 9).

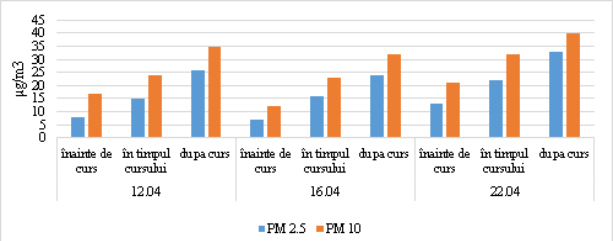

Figure 9 Concentration of particulate matter in classrooms

The concentration of particulate matter increased progressively between 254 % and 325 % were recorded for PM2.5 and between 190 % and 267 % for PM10 for period during courses hours. For PM2.5 was a maximum value of 33 μg/m^3 , and for PM10 5 was a maximum value of 40 μg/m^3 (on April 22).

Most guidelines regarding the concentration of pollutants in indoor air accept a maximum of PM2.5 between 35 and 50 μg/m^3 [9]. In the indoor air quality guidelines, the PM10 parameter is not taken into account, but the value of 50 μg/m^3 for outdoor air represents the daily limit for the protection of human health.

For measurements of v*alues of PM2.5 and PM10 in the apartment* the results were:

- On average, the values in bedroom 1 are about 9 times higher than those recorded in the bathroom. It should be noted that there was an accident in bedroom 1 a few months ago - a small fire that partially destroyed a bookcase. Compared to the minimums in the bathroom, values were recorded, on average, approximately 3.4 times higher in the kitchen, 2 times higher in the living room, and 22 % higher in the other bedroom.
- The concentration of PM10 varied similarly to PM2.5, on average the lowest values were recorded in the bathroom, and the highest in bedroom 1. The lowest value was recorded in bedroom 2 (22 μg/m^3), and the highest in bedroom 1 (456 μg/m^3). Values were recorded, on average, 3 times higher in the kitchen, 1.75 times higher in the living room, and 17% higher in bedroom 2 compared to the average value in the bathroom.

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5. CONCLUSIONS

The study carried out on the concentrations of particles in the outdoor and indoor air allowed us to highlight the following:

1. The outdoor air quality was in the "good" range for the Neversea Beach area for all measurements, for both parameters of particulate matter (PM2.5 and PM10).
2. For the boulevard area, the measurements placed the air quality in the "bad" range (specific index 4) for PM2.5 and in the "moderate" range (specific index 3) for PM10.
3. The average values of measurements of particulate matter carried out in 2023 by ANPM, place the air quality for PM2.5, in the area of the city hall, in the "good" range, and for PM10, at the city level, in the "acceptable" range.
4. The different variation in the year 2023 of the concentration of the 2 categories of particulate matter suggests that their source is different for the outside air.
5. The quality of outdoor and indoor air is largely influenced by human activities: the intense traffic in the boulevard and the Culture House areas has led to increased concentrations of suspended particles in these locations compared to the area of the park near the city hall or the beach area; also, the fire in one of the rooms of the apartment or the activities in the kitchen led to the recording of higher values compared to the other rooms in the apartment.
6. The values of particulate matter in the classrooms, although they increased 2-3 times during a session, fell within the limits of the indoor air quality guidelines.

6. ACKNOWLEDGMENTS

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7. REFERENCES

[1].World Health Organization, 2024 https://www.who.int/news-room/events/detail/2024/04/22

[2].European Environment Agency, 2023 Air quality in Europe 2023. https://www.eea.europa.eu/publications/europes-air-quality-status-2023.

[3].European Environmental Agency, 2022. Air Pollution and health. https://www.eea.europa.eu/publications/zero-pollution/health/air-pollution.

[4]. Rețeaua Națională de Monitorizare a Calității Aerului. https://www.calitateaer.ro/

[5]. Velentza, O., 2016, *Particular matters: a threat for human health*. Scientific Chronicles, p. 233. https://www.researchgate.net/publication/314040371Particular_mattersthreat_for_human_health

[6]. Pihlava, T., M. Uuppo și S. Niemi, *Health Effects of Exhaust Particles*, Proceedings of the University of Vaasa https://www.uwasa.fi/materiaali/pdf/isbn_978-952-476-479-7.pdf

[7] Vardoulakis,S., E Giagloglou, S Steinle, A Davis, A Sleeuwenhoek, K.S. Galea, K. Dixon, and J. O. Crawford, 2020. *Indoor Exposure to Selected Air Pollutants in the Home Environment: A Systematic Review*, Int J Environ Res Public Health. 2020 Dec; 17(23): 8972. doi: 10.3390/ijerph17238972

[8] Sourangsu Chowdhury, Ajay Pillarisetti, Alicia Oberholzer, James Jetter, John Mitchell, Eva Cappuccilli, Borgar Aamaas, Kristin Aunan, Andrea Pozzer, Donee Alexander, 2023. " A global review of the state of the evidence of household air pollution's contribution to ambient fine particulate matter and their related health impacts". Elsevier, Environment International, Volume 173, March 2023, 107835; https://doi.org/10.1016/j.envint.2023.107835

[9]. Dimitroulopoulou, S., M.R. Dudzinska, L.Gunnarsen, L.H¨agerhed, H. Maula, R. Singh, O. Toyinbo, U. Haverinen-Shaughnessy, 2023. *Indoor air quality guidelines from across the world: An appraisal considering energy saving, health, productivity, and comfort*. Environment International.J. Volume 178. https://doi.org/10.1016/j.envint.2023.108127

[10] Ghita S., Stanciu I., Sabau A., Zagan S., Sundri I., *Assessment of the quality of the aquatic environment in the areas bordering the development of fishing activities*, 2023, Journal of Marine Technology and Environment, vol. 2, p. 32-37, Nautica Publish House, Constanta, Romania.