# THE AIR POLLUTION WITH PARTICULATE MATTER IN THE CITY OF ORADEA AND ITS INFLUENCE ON THE HUMAN HEALTH

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***Abstract***
*In the present work, the analysed data come from measurements made by the Environmental Protection Agency of Bihor, on the following indicators: total suspended particulate matter (TSP), $PM_{10}$ fraction and sedimentable particulate matter. The studied time interval was 2006-2010. The monthly and annual average concentrations of these pollutants have analysed and compared to the maximum permissible concentrations, in accordance with STAS 12574/1987. For the monthly values, we kept track of their tendency over a year, by calculating the polynomial tendency. The air pollution level is a very good indicator of people health since the chronic exposure to PM agents contributes to the risk of developing cardiovascular and respiratory diseases, allergy and irritation of the respiratory tract as well as of lung cancer.*

**Key words:** monitoring, total suspended particulate matter, $PM_{10}$, sedimentable particulate matter, human health.

## INTRODUCTION

Nowadays, the air pollution is a major environmental health problem affecting the population in developed and developing countries alike. Among the most frequently known air pollutants such as ozone ($O_3$), nitrogen dioxide ($NO_2$), sulfur dioxide ($SO_2$), suspended particulate matter (PM) etc., PM affects more people than any other pollutant.

PM or fine particles is a complex mixture of tiny particles of solid and liquid organic and inorganic substances suspended in the air. Some PM are naturally made by wind-blown dust from agricultural processes, uncovered soil, unpaved roads, evaporation of sea spray, by natural hazards such as volcanoes activity, forest fires, dust storms etc., but also the anthropogenic activities generate significant amounts of suspended particulate matter.

The suspended particulate matter is characterized by their aerodynamic diameter, as $PM_{10}$ (particles with an aerodynamic diameter smaller than 10 μm) or $PM_{2.5}$ (aerodynamic diameter smaller than 2.5 μm).

The larger particles, because of their heavier masses, fall out from the air to the ground. These sedimentable particles with a diameter > 20 μm

could be find in areas close to sources of emission (sources: WHO, 2008; http://en.wikipedia.org; WHO, 2005).

## MATERIAL AND METHODS

In the present work, the analysed data come from measurements made by the Environmental Protection Agency of Bihor, on the following indicators: total suspended particulate matter (TSP), $PM_{10}$ fraction and sedimentable particulate matter. The time interval analyzed was 2006-2010.

The Environmental Protection Agency of Bihor (E.P.A. Bihor), based in the city of Oradea, coordinates presently a network that monitors the air quality at two immobile sampling points: the E.P.A. headquarters and Children's Hospital (Rogerius neighbourhood). Until 2007, there were three sampling points, one of them located at the headquarters of the Faculty of Environmental Protection. At the E.P.A. Bihor headquarters, daily measurements are taken on $PM_{10}$ fraction and at the Children's Hospital, samples of total suspended particulate matter are also taken daily. Samples of total suspended particulate matter were taken daily at the sampling point Faculty of Environmental Protection.

Sampling of sedimentable particulate matter are taken at 14 monitoring points, located in Bihor county, with a monthly sampling frequency, as follows: area I (Biharia, Tărian, Sălard, Episcopia Bihor), area II (E.P.A. Bihor headquarters, Oradea Weather Station, 1 Mai Baths), area III (Telechiu, Peştera, Chistag, Aleşd, Aştileu, Subpiatră, Țețchea) (according to E.P.A. Bihor).

In the present work, the monthly and annual average concentrations of these pollutants have analysed and compared to the maximum permissible concentrations (noted as C.M.A. in the present paper), in accordance with STAS 12574/1987. For the monthly values, we kept track of their tendency over a year, by calculating the polynomial tendency (we chose the $6^{th}$ order polynome).

## RESULTS AND DISCUSSIONS

### The air pollution with particulate matter

Within the municipality of Oradea, the main sources of air pollution with particulate matter are the burning of fossil fuels – either for industrial or household purposes – and road traffic. So, the main polluting sources are those located on the city industrial platform: the thermoelectric power plant CET I (which works on coal, oil and methane gas); the ash dumps CET I and II; the red sludge dumps of the S.C. Cemtrade S.A industrial plant. To those are added private households, that burn wood for individual heating (sources: E.P.A. Bihor; Linc et al., 2006).

At the Children's Hospital monitoring site, during 2006-2010, the average values of the monthly concentrations of suspended particulate matter were between 0.0226-0.0501 mg/m$^3$ (fig.1). The multiannual average reached the value of 0.0341 mg/m$^3$. During this time interval, the maximum value of the monthly average concentrations occurred in January 2006 (0.0734 mg/m$^3$), and the minimum in July 2010 (0.0185 mg/m$^3$). January was a month with precipitation amounts below the multiannual average and the rainfalls did not contribute to air purification. The year 2010 was, in exchange, a very rainy year, which led low values of suspended particulate matter.

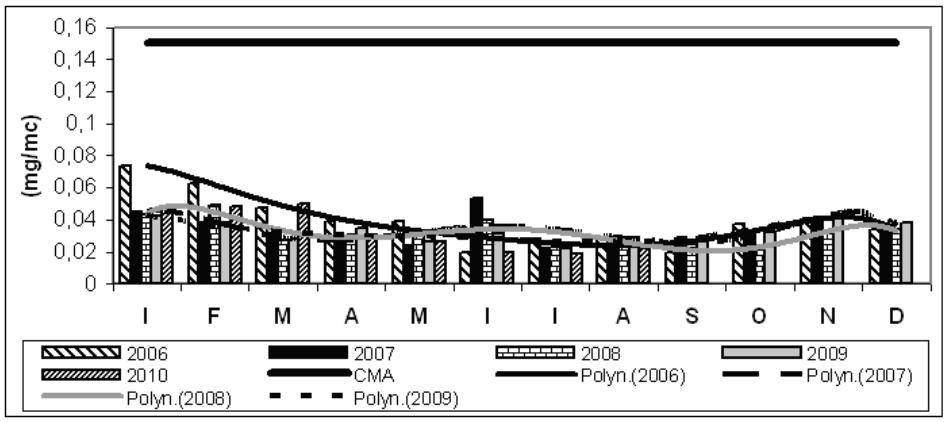


Fig. 1. The monthly average concentrations of suspended particulate matter and their polynomial tendencies, at the Children's Hospital monitoring site (2006-2010).

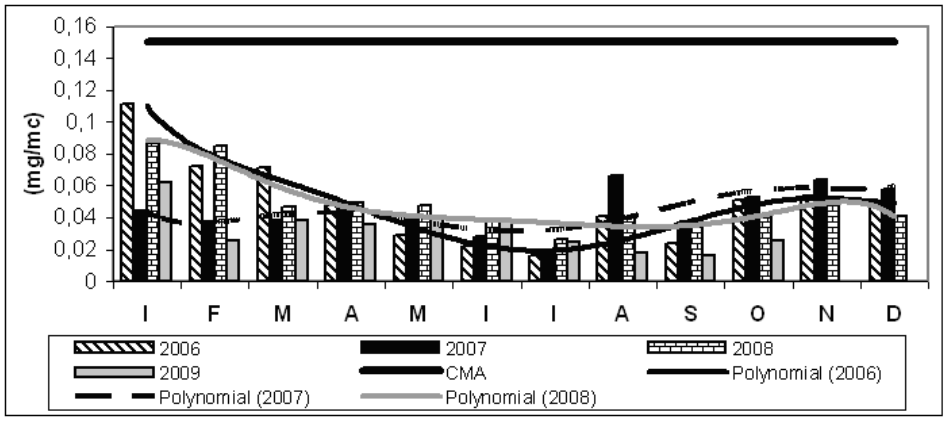


Fig. 2. The monthly average concentrations of $PM_{10}$ fraction and their polynomial tendencies, at the monitoring site E.P.A. Bihor headquarters (2006-2009).

The monitoring site E.P.A. Bihor headquarters has higher values than the former, as it is located near the intersection between the Boulevards Decebal and Dacia, where the road traffic is very heavy, but also because of the many households which use their own thermic energy made by the wood

burning (according to E.P.A. Bihor). So, the average monthly concentrations of $PM_{10}$ were between 0.0213-0.0761 mg/m$^3$ and the multiannual average rose to 0.0444 mg/m$^3$ (fig.2). Like the previous case, the maximum value of the monthly concentrations occurred in January 2006 (0.1114 mg/m$^3$) and it is the highest monthly value of the analysed period, from the three monitoring sites. The minimum values occurred in July 2006 and September 2009 (0.0166 mg/m$^3$).

At the monitoring site Faculty of Environmental Protection, the values are the highest, but just because of the short analysis period, 2006-2007, when the concentrations were generally higher; also because of the heavy road traffic, specific to the Gen. Magheru Boulevard and the central area of the city. So, the average monthly values of suspended particulate matter are between 0.0315-0.0710 mg/m$^3$ and the multiannual average is 0.0455 mg/m$^3$ (fig.3). The maximum value was recorded in January 2006 (0.0965 mg/m$^3$) and the minimum in September 2006 (0.0247 mg/m$^3$).

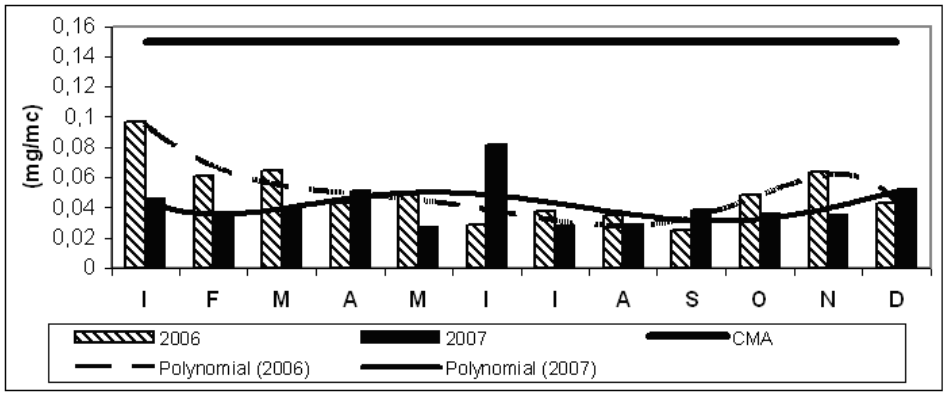


Fig. 3. The monthly average concentrations of suspended particulate matter and their polynomial tendencies, at the monitoring site Faculty of Environmental Protection (2006-2007).

During the year we can notice, at all monitoring sites, that the polynomial tendency generally presents a decrease from the cold months to the months of the warm semester, followed by an increase towards the months of the late fall and early winter. Particulate matter in high quantities occurs in the cold semester months, due to the consumption of fossil fuels and wood burning for heating. High values recorded in January-February are also due to the frequent thermal inversions recorded in Oradea, which favour the atmosphere stability, and consequently, maintains the cold air and pollutants in the lower air layers, close to the ground.

The lowest average monthly values are recorded in the interval April-September, when heating is no longer necessary. The low values in July are due to light road traffic, given by the influx of the urban population

out of the city, during holidays. Higher values for lighter particulate matter of $PM_{10}$, recorded in August occur because of the advections of tropical continental air masses, coming from North Africa, very frequent in this month. They carry a very hot, dry and dusty air, from the Sahara. Those masses generate frequent droughts which, due to lack of rain that cleans the streets and atmospheric air, as well as of the citizens` return from holidays, increases the amount of dust in the air (especially towards the end of the month, when the heavy road traffic is back).

The distribution of the average annual concentrations of the total suspended particulate matter and $PM_{10}$ shows a general decrease tendency from 2006 to 2010, for all monitoring sites (fig.4). It is attributed to the increasing tendency of the annual precipitation amounts, which purified the atmospheric air, as well as to the reduced pollution as a result of lower pollution level vehicles put on the national market (Euro 3-5).

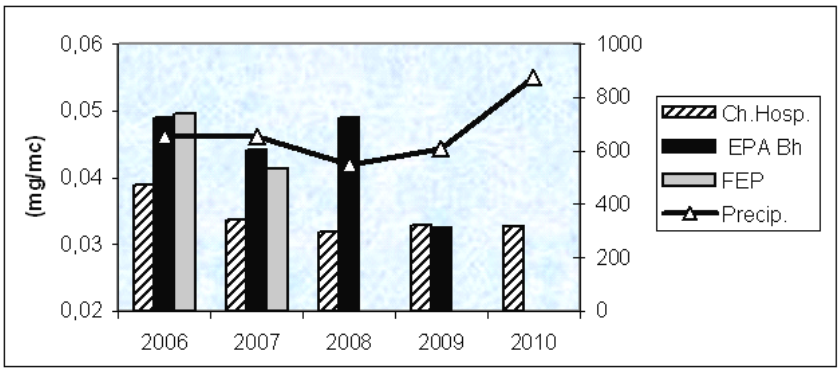


Fig. 4. The annual average concentrations of the total suspended particulate matter and $PM_{10}$ in Oradea, compared to the annual precipitation amounts (2006-2010).

Maximum permissible concentrations were not exceeded at any of the monitoring sites, both for the monthly and annual average values, over the time interval.

The sedimentable particulate matter presents the lowest annual average concentrations in the area II of the county (fig.5), corresponding to the monitoring sites in Oradea city. Here, the values did not exceed the C.M.A., being situated between 4.7-5.5 $g/m^2$/month. The highest value is recorded in 2007, a dry and very hot year, with frequent advections of tropical continental air masses. The same maximum values of 2007 (6.87 $g/m^2$/month), come out for the average annual concentrations for the entire county (fig.6). A tendency of decrease can also be noticed for the annual values, towards the end of the analysis period.

Even if no exceeding of the C.M.A was recorded for the above mentioned pollutants in the studied period, however, at the three automatic

monitoring stations placed by the E.P.A. Bihor in the city, overcomes of the measured $PM_{10}$ fraction were recorded here. The stations have been active since November 2007. So, the daily average concentrations of $PM_{10}$ exceeded the daily C.M.A. for the protection of the human health (50 $\mu g/m^3$) in about 21-46 cases in 2008 and 0-49 cases in 2009. Most overcomes are recorded for the industrial station BH2 (according to the E.P.A. Bihor: "A Report Concerning the Environment Condition in Bihor County/Raport privind starea mediului în județul Bihor", 2007, 2008, 2009).

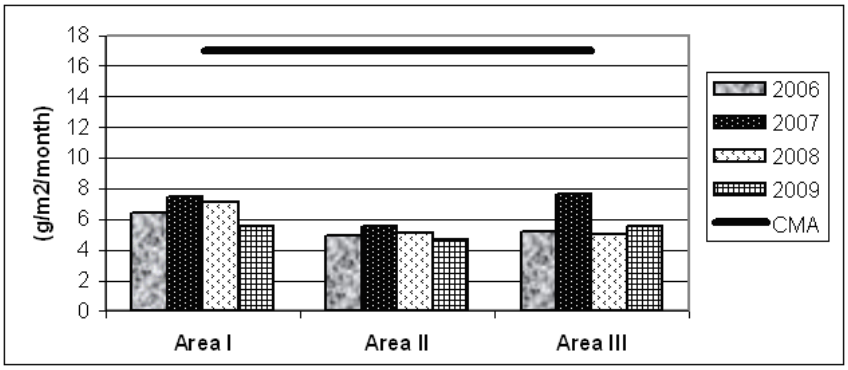


Fig. 5. The annual average concentrations of sedimentable particulate matter, at the three monitoring areas in the Bihor County (2006-2009).

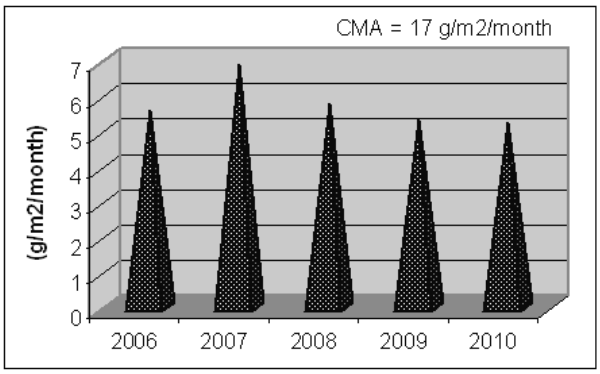


Fig. 6. The annual average concentrations of sedimentable particulate matter in the Bihor County (2006-2010).

**The influence of particulate matter pollution on the human health**

There is a quantitative relationship between the pollution levels and people' health since even relatively low concentrations of air pollutants have been related to a range of adverse health effects. Most of the quantitative information available on the health effects of PM comes from studies in which particles in air have been measured as $PM_{10}$, even if the fine particulate matter $PM_{2.5}$ generally better predicts health effects than does

$PM_{10}$. The most dangerous, $PM_{2.5}$, may reach the peripheral regions of the bronchioles after inhalation, and interfere with gas exchange inside the lungs (sources: WHO 2005; WHO 2008; http://en.wikipedia.org).

Thus, the chronic exposure to PM agents contributes to the risk of developing cardiovascular and respiratory diseases, allergy and irritation of the respiratory tract as well as of lung cancer. The air pollution increases the risk of chronic obstructive pulmonary disease and of acute respiratory infections in childhood, the most important cause of death among children younger than 5 years in developing countries. There is also an association of air pollution with low birth weight, increased infant and prenatal mortality, pulmonary tuberculosis, nasopharyngeal and laryngeal cancer, cataract and asthma. Asthma and allergy, or chronic upper respiratory obstructive diseases may have less severe acute symptoms, but are important because of their lengthy (often life-long) duration. The quality of air not only has a bearing on health, but also on the quality of life (sources: WHO 2000; WHO 2005; WHO 2008).

The prevalence rates of bronchitis symptoms in children and of reduced lung function in children as well as adults are associated with exposure to particulate matter. These effects have been observed at annual average PM concentrations bellow 20 $mg/m^3$ (as $PM_{2.5}$) or 30 $mg/m^3$ (as $PM_{10}$) (source: WHO 2005).

Each year, more than 2 million premature deaths can be attributed to the effects of urban air pollution caused, especially, by the burning of solid fuels. The mortality in cities with high levels of pollution exceeds that observed in relatively cleaner cities by 15–20%. Even in the EU, average life expectancy is 8.6 months lower due to exposure to $PM_{2.5}$ produced by human activities (sources: WHO 2000; WHO 2005; WHO 2008).

About 25% of Romania's population is suffering from allergic rhinitis, and 70-80% of these people having also respiratory diseases such as asthma caused by air pollution and the incidence of these kinds of diseases increased very fast in the last years. There are also many Romanian people (about 600,000-800,000) suffering from chronic obstructive pulmonary disease, but because many of them do not pay enough attention to the symptoms, only about 25% of them follow a proper medication (source: http://m.adevarul.ro).

**CONCLUSIONS**

Within the Oradea area, in the period 2006-2010, the particulate matter did not exceed the maximum permissible concentrations for none of the monitoring sites, whether it's the monthly or annual average values. The highest concentrations of pollutants are recorded at the monitoring sites Faculty of Environmental Protection and the E.P.A. headquarters, due to the

heavy road traffic and usually, during the cold semester months. The air pollution level is a very good indicator of people health since the chronic exposure to PM agents contributes to the risk of developing cardiovascular and respiratory diseases, allergy and irritation of the respiratory tract as well as of lung cancer.

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