ANALYSIS OF AIR POLLUTANTS IN IASI TOWN

ANALIZA POLUĂRII AERULUI DIN MUNICIPIULUI IAŞI

OISTE Ana - Maria[1]
e-mail: anamaria.oiste@yahoo.com

Abstract. *Immissions of carbon monoxide (CO), sulphur dioxide (SO_2) and nitrogen oxides (NOx) were measured in five points (automatic air quality monitoring station) of Iasi municipality, since January 2006 until December 2011. The aim of this study is to present the air quality and the connection between concentrations and tendencies of gaseous pollutants in the climatic conditions and in anthropic activities specific of the Iasi City. Yearly averages of carbon monoxide (CO), sulphur dioxide (SO_2) and nitrogen oxides (NOx) for the period 2006 to 2011 varied between: 0.194 µg/mc and 0.458 µg/mc; 4.95 µg/mc and 6.85 µg/mc, respectively 36.99 µg/mc and 43.75 µg/mc, with maximum values registered at station Iasi 1, and the lowest at station Iasi 4. The maximum monthly averages of the pollutants immissions are registered in the cold semester of the year, and the minimum monthly averages of the immissions, in the warm semester.*
Key words: *pollutants, carbon monoxide, nitrogen oxides, sulphur dioxide, air quality, Iasi town*

Rezumat. *Emisiile de monoxid de carbon, dioxid de sulf şi oxizi de azot au fost măsurate în cinci puncte (staţiile de monitorizare a calităţii aerului) din municipiu Iasi, în perioada 2006-2011. Scopul prezentului stadiu este să prezinte calitatea aerului şi corelaţiile dintre concentraţiile şi tendinţele de evoluţie ale poluanţilor gazoşi în contextul condiţiilor climatice şi a activităţile antropice specifice oraşului Iaşi. Concentraţiile medii anuale de monoxid de carbon, dioxid de sulf şi oxizi de azot în perioada 2006 – 2011 au variat între 0.194 µg/mc şi 0.458 µg/mc; 4.95 µg/mc and 6.85 µg/mc, respectiv 36.99 µg/mc si 43.75 µg/mc, valorile maxime fiind înregistrate la staţia Iaşi 1, iar cele minime la staţia Iaşi 4. Valorile lunare maxime ale emisiilor sunt înregistrate în semestrul rece al anului şi cele minime în semestrul rece.*
Cuvinte cheie: *poluanţi, monoxid de carbon,oxizi de azot, dioxid de sulf, calitatea aerului, oraşul Iaşi*

INTRODUCTION

The quality of the air experiences significant diurnal, weekly and yearly variations depending on various factors (Apostol, 2007) which can be: natural (the atmospheric calm, the thermal convection, thermal inversions, the vegetation – the process of photosynthesis, the topography, the soil, aerosols, etc.) and anthropogenic (the nature of the activities in the town, the variation in the number of cars, urban factors – the topography of the buildings and the air flow change, the colours that alter the natural albedo, the heat coming from the heating

[1] "Alexandru Ioan Cuza" University of Iasi, Romania

systems, the transport, industrial units, the shading caused by buildings, thermal conditions and dust particle charging etc.).

For the classification of the concentration levels according to the limit values and to the critical levels of concentration of the main categories of pollutants analyzed in the ambient air, we used the reference legislation, Law no. 104 of 15 June 2011 and OM. 592/2002.

The air quality monitoring network in Iasi has five automatic stations located in areas which are representative of the types of stations existing in the national network for monitoring the air quality; it was premade in the PHARE RO 2002 project comprising five automatic monitoring stations which have been functional since 18.11. 2005, and the recorded data are made available to the public by two information panels, i.e. an exterior one, located outside Tudor Vladimirescu Boulevard – the parking lot of the Supermarket IULIS Mall, as well as an interior one located inside the Town Hall in Iasi. IASI 1 Station – Podu de Piatră – traffic station located on road crossing N.Iorga Boulevard and Nicolina Avenue, on the site of the old food market in Podu de Piatră, in a residential area; IASI 2 Station – Decebal – Cantemir – urban background station, located inside the Department of Nurseries – Nursery No.6, across from D. Cantemir High School monitor the level of pollution in urban areas, the influence of "human settlements" without being directly influenced by traffic or industry; IASI 3 Station - Oancea – Tătăraşi - industrial station, located on the Oancea-Tătăraşi Esplanade, IASI 4 Station – Copou – Sadoveanu – regional background station, located in the area of the Research and Development Station for Viticulture and Winemaking located away from sources of pollution, IASI 5 Station – Tomeşti – suburban station, located inside D. D. Pătrăşcanu school.

MATERIAL AND METHOD

The database was elaborated from the annual reports for the environmental status issued by APM Iasi, for the monthly and annual average values, as well as the daily average values for the three pollutants under analysis. The database was analyzed and processed statistically and the annual and monthly average values were determined, and correlations (Chersan et al., 2012) were made for the daily average values (Pearson correlation coefficient was calculated, and the graphs with linear regressions were realized).

RESULTS AND DISCUSSIONS

Because of their implications on the health of humans, plants and animals, a series of limit values for air pollutants was set (table 1).

The main sources of SO_2 in the town of Iasi are the fossil fuel in the energy industry – the production of electricity and heat in SC CET Iasi – operator in the town of Iasi with a contribution of 94.8%. The SO_2 emissions in 2011, as reported by SC CET Iasi SA, increased by 63% as compared to 2010, from 1255 t to 1993.9 t (Annual report of EPA Iasi, 2011).

The activities of burning solid fuel (wood) in low power stationary sources – residential heating / cooking – represent 2.8% of the total SO_2 emissions, followed by the manufacturing of bricks, tiles and ceramics, with a contribution of 2.25%.

Table 1

Limit values for CO, SO_2 and NOx concentrations in the air of urban agglomeration, according to the 141/2011 Law for air quality

Specification	CO (µg/m³)	SO_2 (µg/m³)	NO_x (µg/m³)
Critical Level	-	20	30 ***
Daily limit value for the protection of human health	10 *	125	-
Hourly limit value for the protection of human health	-	350	-
Alert threshold		500 **	400 **

* maximum daily average – every 8 hours

** measured for 3 consecutive hours at locations representative of air quality over an area of at least 100 km2 or of an entire zone or agglomeration, whichever alert is smaller.

*** critical level for vegetation protection, calendar year

Thus, the annual average concentrations for the period 2006 – 2011 recorded the highest annual average for Iasi 1 Station, representing the urban traffic station with a concentration of 6.2µg/m³; this was followed by Iasi 5 Station located in the suburbs, in Tomeşti, with elevated values due to the spreading of fixed sources of pollution, the multi-annual average being of 6 µg/m³. There is a downward trend from 2007 until now, due to the regulations for traffic pollution reduction (introduction of catalysts, fuels with smaller quantities of sulfur, etc.). The lowest annual average concentrations were recorded at Iasi 4 station, a regional background station.

The monthly average concentrations recorded the highest values during the cold season, i.e. in January and February, when there are immissions caused by heating sources operating at full capacity due to low temperatures, and high frequency thermal inversions which do not favour the dispersion of pollutants; the lowest concentrations were recorded in May due to the increased activity of plants. All the concentrations recorded do not exceed any critical level, nor that of the limit values.

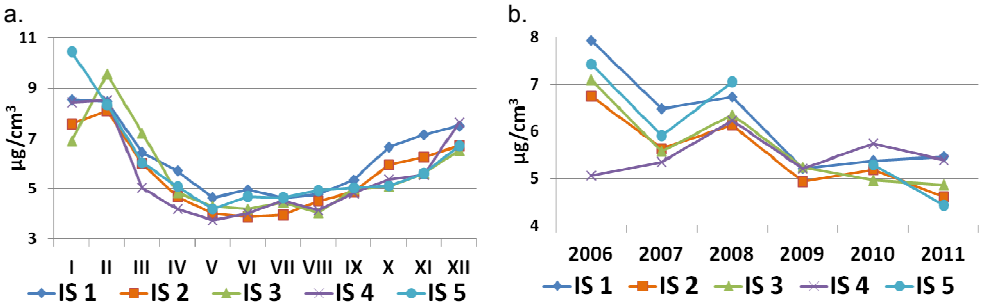

Fig. 1 - a. Monthly medium concentrations of SO_2 (µg/m3), b. Yearly medium concentrations of SO_2 in period 2006 - 2011 (µg/m³) in Iasi

Nitrogen oxides (NOx) are a group of highly reactive gases containing nitrogen and oxygen in varying amounts as follows: nitrous protoxide, nitrogen monoxide, nitrogen dioxide, dinitrogen trioxide, etc., but only NO and NO2 are easier to monitor in the air pollution and are represented by the formula NOx (Apostol et al, 2012).

For 2011, of the major sources of NOx, the highest percentage - 89.8% (11658.05 t) – comes from road transport, an activity which is associated with exhaust emissions due to fuel combustion in heat engines that equip vehicles and were calculated by the ANPM by means of Cover 4 program and with data provided by the Romanian Auto Registry; this percentage is followed by another one of 6.35% (824.7 t NOx) from fossil fuel combustion in the energy industry – the production of electricity and heat in SC CET Iasi SA, followed by 2.26% (293.736 t) of the total NOx emissions from solid fuel combustion activities (wood) in low power stationary sources – residential heating / cooking (Annual report of EPA Iasi, 2011).

The annual average concentrations for the period comprised between 2006 and 2011 for air quality monitoring stations reveal exceeding of critical levels for the protection of the vegetation and reaching the annual maximum limit value for the human health protection in stations Iaşi 1 and Iaşi 2, with the highest values for the station located in Podu de Piatră, with an average value of 91.6 µg/m for the period under discussion, traffic station, which confirms that road traffic is the main source of NOx pollution in the city. For Iasi 5 station, which is a suburban station, only the critical level is exceeded due to the proximity of the unity CET II Holboca.

The monthly average concentrations for 2006-2011 once again shows Iaşi 1 station as being the station with the highest concentrations that exceed both the critical threshold and the limit value. For the other stations, the evolution of monthly concentrations and the exceeding of the limit values show clear correlations with the air temperature, so that for the months of May to August the limit threshold is exceeded, while for the period from March to September, the annual limit value for the protection of the public health is exceeded, the highest values being recorded in winter.

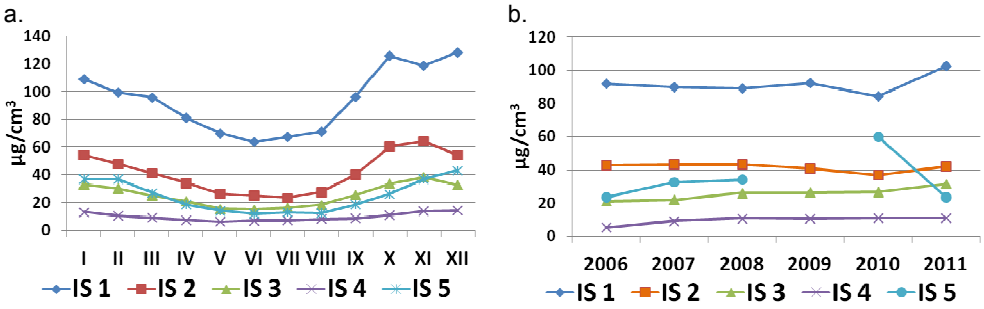

Fig. 2 - a. Monthly medium concentrations of NO_x (µg/m3), b. Yearly medium concentrations of NO_x in period 2006 - 2011 (µg/m³) in Iasi

Carbon monoxide is responsible for generating the greenhouse effect, its formation being caused by incomplete combustion of fossil fuels, the main sources being industrial activities and traffic by road, railways and air.

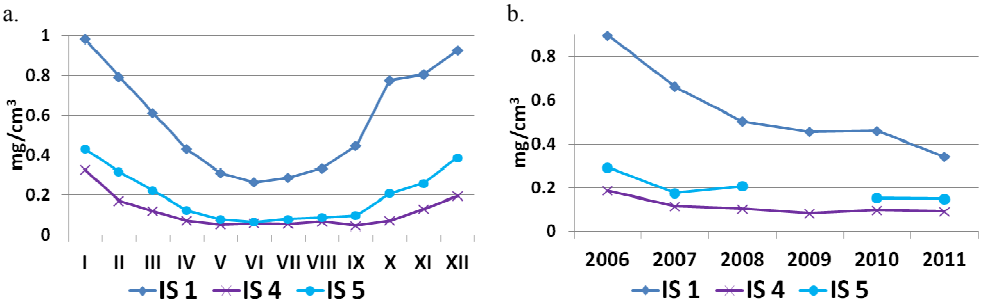

Fig. 3 - a. Monthly medium concentrations of CO (µg/m3), b. Yearly medium concentrations of CO in period 2006 - 2011 (µg/m³) in Iasi

Monitoring of this parameter is done only for three stations, and the annual average concentrations emphasize again the highest values for the urban traffic station Podu de Piatră (0,6 µg/m³), compared to the other stations with annual average values of 0,2 µg/m³. The monthly average concentrations show higher values in winter and spring, when the use of fossil fuels is widespread and the atmospheric calm (Erhan, 1979) as well as the low temperatures favour the appearance of high CO concentrations.

The linear regression was performed in order to determine the correlations among the analyzed pollutants and how close they are, by calculating the Pearson correlation coefficient (1).

$$r_{xy} = \frac{\frac{1}{n}\sum_i (x_i - \bar{x})(y_i - \bar{y})}{S_x S_y} \quad (1)$$

Where:

- n is the size of the sample formed of pair measurements (xy);
- x_i represents the individual measurements of x variable (SO_2, NOx – independent values set)
- y_i represents the individual measurements of y variable (CO –dependent values set)
- x represents the arithmetic average of x variables;
- y represents the arithmetic average of y variables;
- s_x represents the standard deviation for x values;
- s_y represents the standard deviation for y values;

Standard deviations corresponding to the two variables is calculated with the help of the relation:

$$S_x = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n}}; \; S_y = \sqrt{\frac{\sum_{i=1}^{n}(y_i - \bar{y})^2}{n}}; \quad (2)$$

CO =19,331 SO_2 + 3,2379, R^2=0.5785

$CO = 41{,}802\ NO_x + 18{,}43$, $R^2 = 0.5206$,

The values the Pearson correlation coefficient are: r SO2,CO = 0.760, respectively r NOx, CO = 0.721, indicating a positive correlation between the three parameters under analysis.

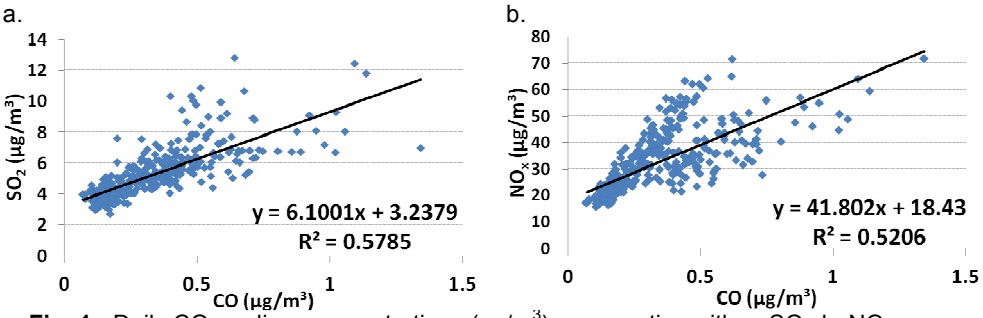

Fig. 1 - Daily CO medium concentrations (µg/m^3) comparative with a. SO_2 b. NOx ones (µg/m^3) in 2006-2011

CONCLUSIONS

The study of the main air pollutants shows the following aspects:

1. Exceeding the limit values provided by law for nitrogen oxides for which action must be taken, as they are the main component in the formation of the secondary ozone pollutant.

2. Strong positive correlations are established among the three pollutants under analysis, the Pearson coefficients having values higher than 0.7.

Acknowledgments: *This work was supported by the the European Social Fund in Romania, under the responsibility of the Managing Authority for the Sectoral Operational Programme for Human Resources Development 2007-2013 [grant POSDRU/CPP 107/DMI 1.5/S/78342].*

REFERENCES

1. **Apostol L., Vieru Nicoleta Delia, Vieru P.N., 2012 -** *Analysis of gaseous pollutants in the atmosphere of Botosani town.* Present Environment and Sustainable Development, Vol. 6, no. 1, p. 195-204.
2. **Apostol L, 2007** - *The role of the meteo-climatic factors in the dispersion of atmospheric polluants,* Present Environment and Sustenable Development, vol. 1, Editura Universității ,,Al. I. Cuza", Iaşi, p. 17-26,
3. **Chersan Corina-Ionela, Mironiuc Marilena, Robu I.B., 2012** - *The Influence of the Client's Financial Performance on the Audit Fees*, Audit financiar, no 94, p. 3 - 12
4. **Erhan Elena, 1979 -** *Clima şi microclimatele din zona oraşului Iaşi,* Editura Junimea, Iaşi.
5. ***, **2011** - Legea privind calitatea aerului înconjurător, n^o. 104/2011
6. ***, **2006 – 2011** - Annual report of environment state in Iasi county