ANTHROPIC IMPACT ON AIR QUALITY IN THE DANUBE REGION

VOINA A., ALECU G.L.
National Institute for R&D in Electrical Engineering INCDIE ICPE-CA, Bucharest, Romania
andreea.voina@icpe-ca.ro

Abstract - There were monitored by data acquisition both in summer and winter period, the concentrations of pollutants - SO_2, NO_2 and particulate matter (PM_{10}) – existing in air on the territory of 6 counties bordering the Danube. After processing and analysis of collected data have been found that: SO_2 pollution may be due primarily burning fuel with high sulfur content and / or industrial activities for carbonic products (anodes for obtaining the electrolytic aluminum, graphite electrodes etc.); pollution with NO_2 comes primarily from automobile exhaust gases; particulate matter pollution may be due both loess soil (high winds in dry periods) characteristic of the area investigated and dumps of ashes from coal power plant.

Keywords: air quality, pollutants, SO_2, NO_2, particulate matter, sources of pollution**.**

1. INTRODUCTION

In the perspective of sustainable development, the air quality is a priority issue. Following technological developments and excessive industrialization, take place massive emissions of noxious gases and / or powders - including greenhouse gases such as CO_2.

Emissions from human activities, of anthropogenic origin, are released into the atmosphere - their transport and deposition is strongly influenced by weather conditions such as wind speed / direction and atmospheric turbulences [1]. Under these circumstances, the migration of pollutants dispersed in the atmosphere is a dangerous phenomenon, difficult to assess and unpredictable.

The air is one of the most important natural resources on which the life on Earth depends. Effects of air pollution are felt directly and indirectly as humans, plants and animals and by other components of the environment (especially soil and surface water).

Artificial sources of pollution, by anthropogenic origin are more numerous than natural, and are a risk factor with high destructive potential on the environment.

The main sources of anthropogenic environmental pollution are industry, agriculture and transport, sources that may produce chemical, radioactive, noise, electromagnetic pollution, etc. [2].

The issue of air quality is a major concern for the European Union institutions. Thus, since 1970 it was developed a number of regulations addressing the issue of air pollution by toxic substances [3] such as:

- **Council Directive 96/82/EC** on the control of major accident hazards involving dangerous substances (Seveso II), amended by Directives 2003/105/EC and 2012/18 /EU and EC Regulations no. 1882/2003 and no. 1137/2008 (abrogated on 06.01.2015 by Directive 2012/18 /EU - Seveso III);
- **Directive 2008/1/EC** concerning integrated pollution prevention and control (IPPC), amended by Directive 2009/31/EC and Regulations no. 1882/2003 and 166/2006 (abrogated on 01/07/2014 by Directive 2010/75 / EU - IED). IPPC Directive establishes principles for the authorization and control of facilities and an integrated approach by applying best available techniques (BAT) to achieve a high level of environmental protection as a whole, taking into account costs and benefits.

In the context of EC directives, the main polluting sources can be:

- Facilities falling under the IPPC Directive in the following industries: metallurgy, mining, thermal energy, chemical, cellulose and paper, glass, wood, food, agriculture, animal husbandry, etc.;
- Non IPPC facilities (Asphalt stations and concrete prefabricated, etc.);
- Facilities falling under the VOC Directive of petrol and other fuels - storage and fuel distribution stations;
- Facilities falling under SEVESO Directive.

In Romania, under Law 104 of 15.06.2011 on ambient air quality [4], are set limit values for some pollutants such as:

- **SO_2 - 350 µg/m^3** - average hourly limit value, respectively **125 µg/m^3** - average daily limit value for human health protection;
- **CO - 10 mg/m^3 –** maximum daily value of 8-hour averages, limit value for human health protection;
- **PM_{10} - 50 µg/m^3** - daily limit value for human health protection;
- **NO_2 - 200 µg/m^3 –** hourly limit value for human health protection;
- **O_3 - 120 mg/m^3** - target value for the protection of human health (maximum daily value of 8-hour averages).

Thermal power industry with solid fuels (coal, biomass etc.) and / or liquid fuels (heating oil and other petroleum products) and transports by traction with internal combustion engines represent a significant source of local pollution with SO_2, CO, CO_2, NO_2 and particulate matter.

Given these considerations, *the aim of this paper* is to analyze the air quality by monitoring / data acquisition on the pollution level with pollutants specific to thermal power industry and / or transports in a representative geographic area.

2. EXPERIMENTAL PART – DATA ACQUISITION

In order to analyze the air quality has been selected as representative area, Romania-Bulgaria cross border area, respectively 6 counties from Romania (Calarasi, Giurgiu, Teleorman, Olt, Dolj and Mehedinti) and 8 counties from Bulgaria on the right and left banks of the Danube (Fig. 1.).

Fig. 1. Romania-Bulgaria cross border area [5]

Location of the potential major polluters in the analyzed area, with operating permits IPPC according to [6, 7] is shown in Fig. 2, and the SEVESO ones according to [6, 7] in Fig. 3.

Fig. 2. Map with IPPC objectives [8]

Fig. 3. Map with SEVESO objectives [8]

In order to analyze the air quality, have been acquired simultaneously, where there were records, hourly values from the locations specified in Table 1, for pollutants SO_2, NO_2 and PM_{10} [9] and processed in accordance with Law 104/2011 (averages over 8 hours or 24 hours, also monthly averages).

Table 1. Data acquisition – location of the monitoring stations [9]

Monitoring stations	Location
CL1	Orizont area, Călăraşi
CL2	Municipal Stadium area, Calarasi
GR1	Bucuresti street, Giurgiu
GR2	Parcul Elevilor, Giurgiu
GR3	Sloboziei highway, Giurgiu
GR4	Braniştea village, Oinacu commune, GR county
TR1	APM Teleorman, Alexandria
TR2	DN 51A Turnu Măgurele / Zimnicea
OT1	Industrial platform from Slatina
DJ1	Bucureşti street, Craiova
DJ2	City hall, Craiova
DJ3	Billa supermarket, Craiova
DJ4	Işalniţa, DJ county
DJ5	Breasta, DJ county
MH1	Băile Romane Street no. 3, Dr. Tr. Severin

3. EXPERIMENTAL RESULTS AND THEIR INTERPRETATION

The results recorded after monitoring of SO_2, in the investigated area, in November 2011 are shown in Fig. 4, NO_2 in Fig. 5 and PM_{10} in Fig. 6.

The analysis of Fig. 4 has been revealed that in November 2011, in the geographical investigated area, the daily limit value of SO_2 to the monitoring stations DJ1, MH1 and OT1 has been exceeded, on days 12, 20, 21, 23 and 27. To the other monitoring stations all daily average values were within the daily limit value for human health protection.

The analysis of Fig. 5 has been revealed that the daily average values to DJ1 are systematically higher (approx. two times) than in the other locations, which can be explained by intense traffic in the vicinity of DJ.

By analyzing the Fig. 6 it was found that in November 2011, air pollution with particulate matter has been considerable. There were significant exceedances (sometimes triple) of the daily limit value for human health protection, to DJ1, DJ3, MH1 and OT1. In TR1 have been only 3 exceedances of the limit, and to CL1 was not recorded any exceedance of the daily limit value for human health protection. The exceedance and relatively high fluctuations of the recorded values can be explained by persistent drought and winds in respective areas and days.

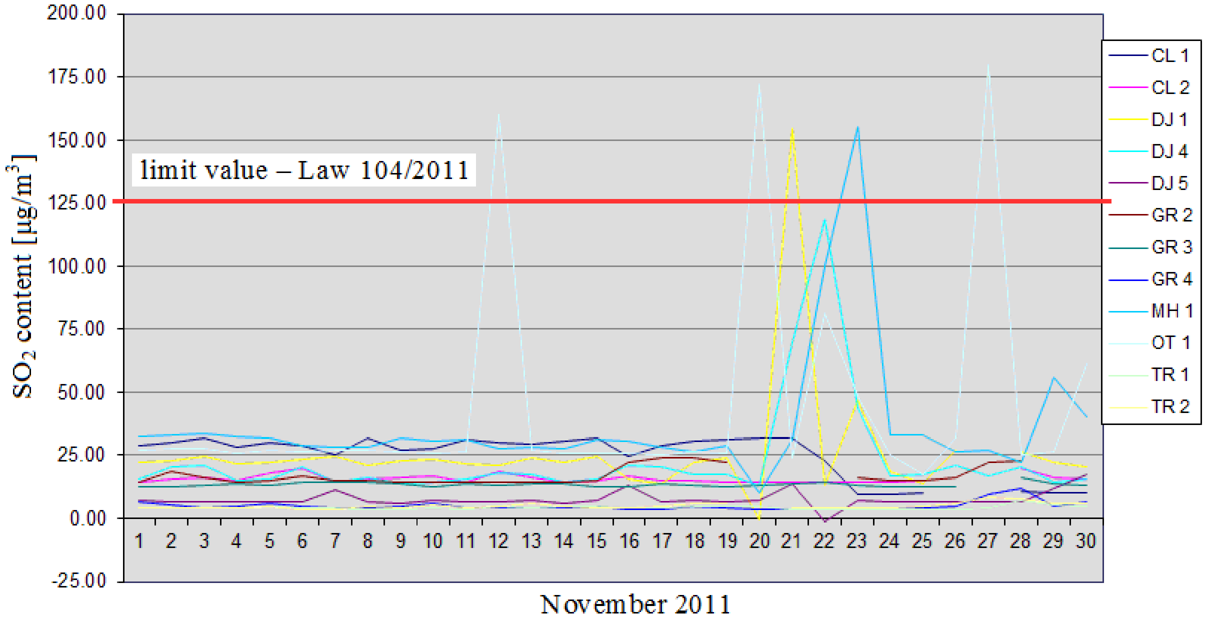

Fig. 4. Evolution of SO_2 in the investigated area - November 2011

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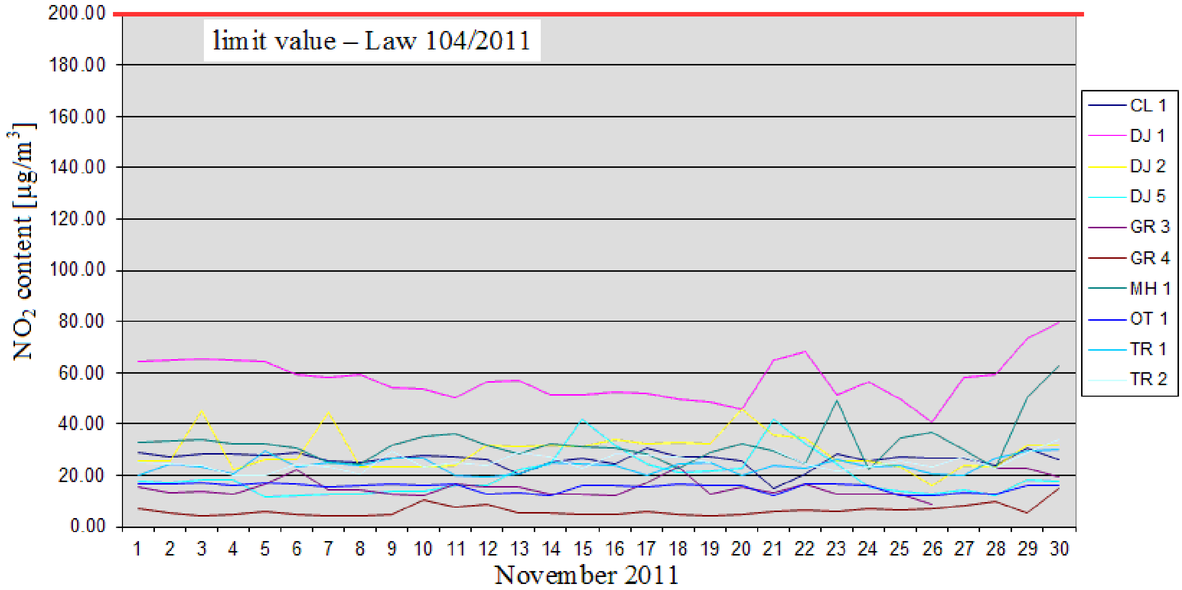

Fig. 5. Evolution of NO_2 in the investigated area - November, 2011.

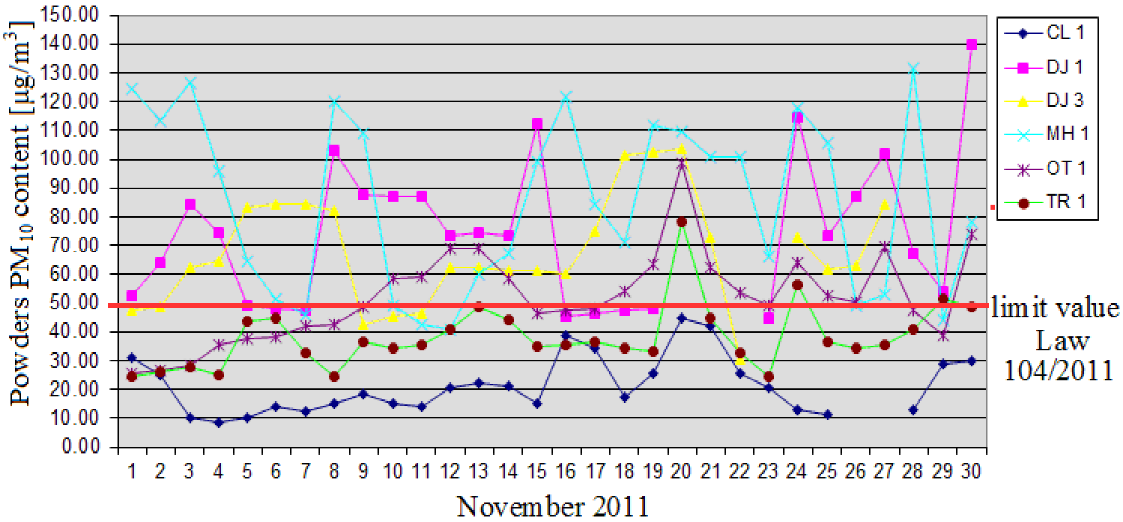

Fig. 6. Evolution of PM_{10} in the investigated area –November 2011.

Comparative analysis of Fig. 4 - Fig. 6 shows that the SO_2 parameter presents highest fluctuations. Therefore, in Slatina, there were recorded 3 peaks which exceed the monthly average value in the same days in which PM_{10} increased remarkably - but NO_2 evolved monotonous between 15 and 20 µg/m^3 – fact which may suggest that in those days have been discharged carbonic blocks batches from the anodes unit of aluminum factory (SO_2 - resulted from the sulfur content of coal processed).

It notes that the PM_{10} parameter presents high fluctuations in all monitoring points, except CL1, with monthly average over the legal limit of 50 mg/m^3. High fluctuations of PM_{10} to the monitoring stations from Craiova may be due to the thermal power plant ash deposited to Isalnita and randomly carried out by the wind in periods without precipitations.

The results recorded after monitoring of SO_2 in the investigated area from December 2011, are presented in Fig. 7, NO_2 in Fig. 8 and PM_{10} in Fig. 9.

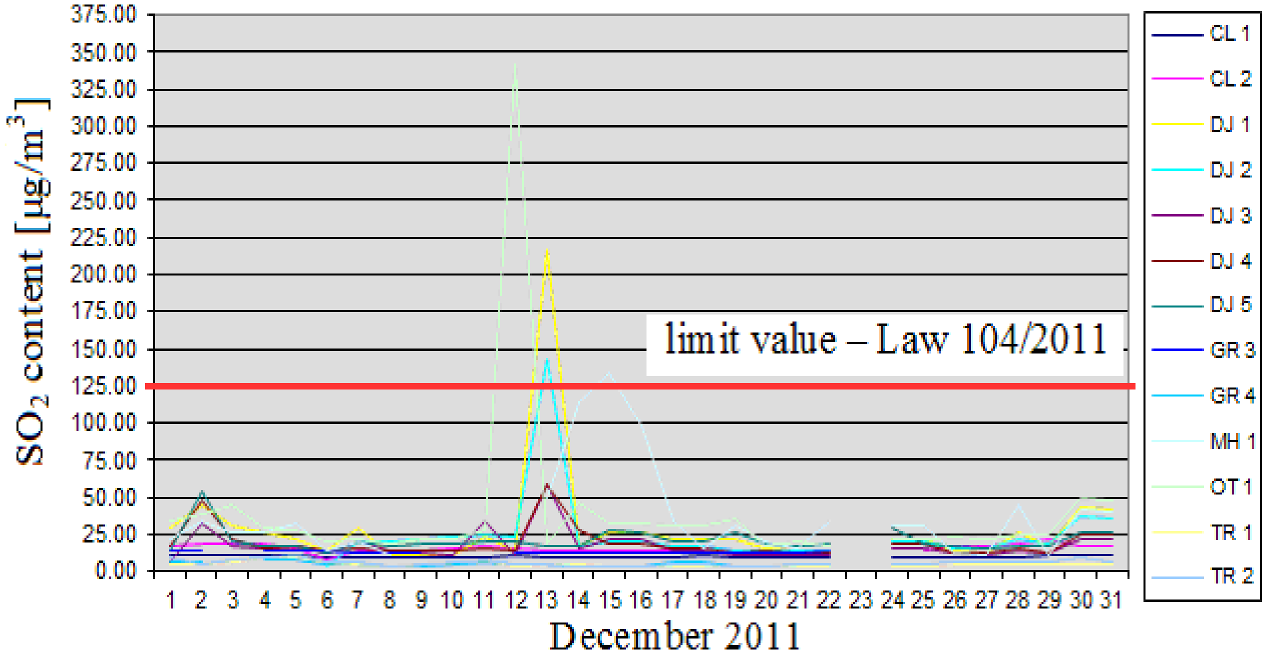

Fig. 7. Evolution of SO_2 in the investigated area – December 2011.

The analysis of Fig. 7 has been revealed that in December 2011, in the region there have been exceedances of the daily limit for SO_2 to DJ1, DJ2, MH1 and OT1 in days of 12, 13 and 16. In other monitoring locations the average values between 5 and 50 µg/m^3, were within the daily limit value for human health protection.

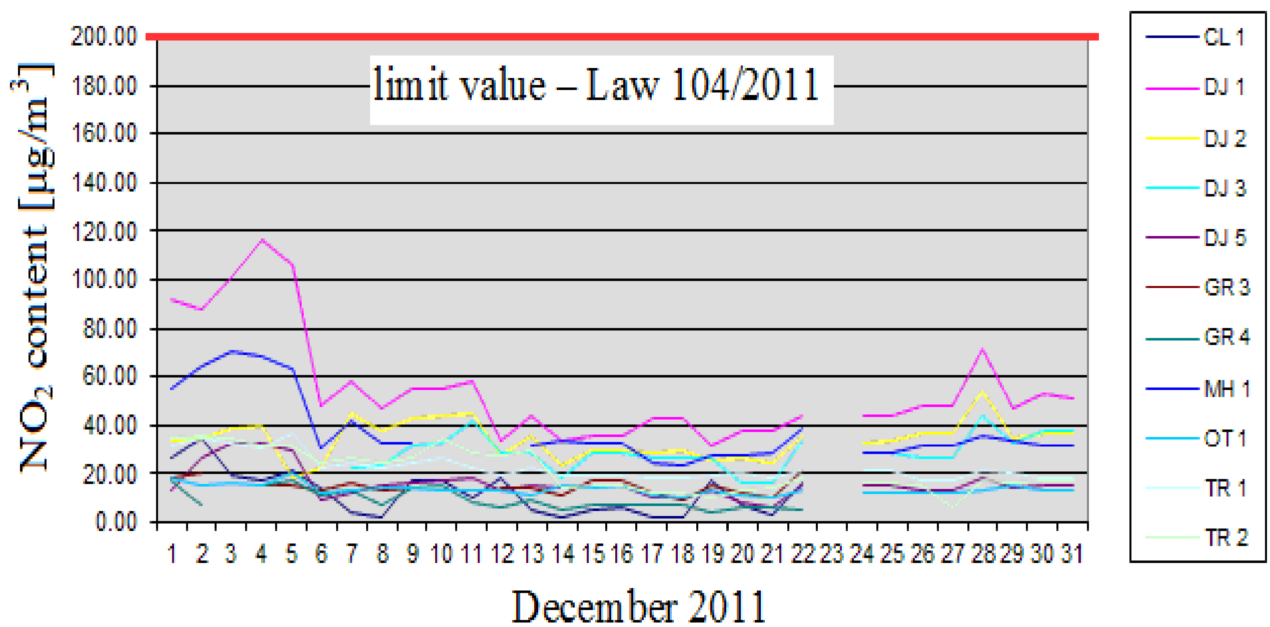

Fig. 8. Evolution of NO_2 in the investigated area – December 2011.

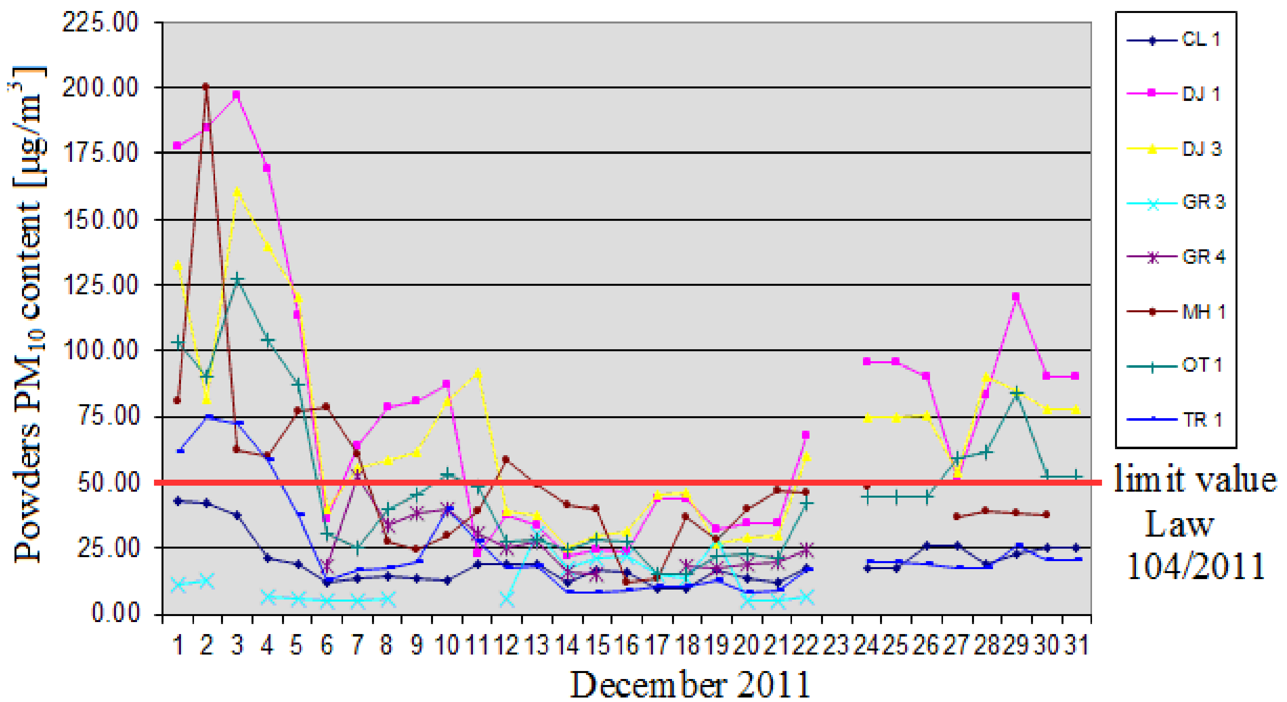

Fig. 9. Evolution of PM_{10} in the investigated area – December 2011.

The analysis of Fig. 9 has been revealed that, in all monitoring points, except GR3 and CL1 were recorded exceedances of the limit value for particulate matter. Significantly higher values were recorded during December, 1 to 5 and 24 to 31, when was dry weather with calm atmosphere. It is noted that in these periods, also for NO_2 (Fig. 8) were recorded values above the monthly average. It also was noted that during period 14 to 22 December 2011, when there were precipitations in the area (rain and snow), the content of particulate matter (Fig. 9) and NO_2 decreased significantly.

The results recorded after monitoring of SO_2 in the investigated area, in August 2012 are presented in Fig. 10, NO_2 in Fig. 11 and PM_{10} in Fig. 12.

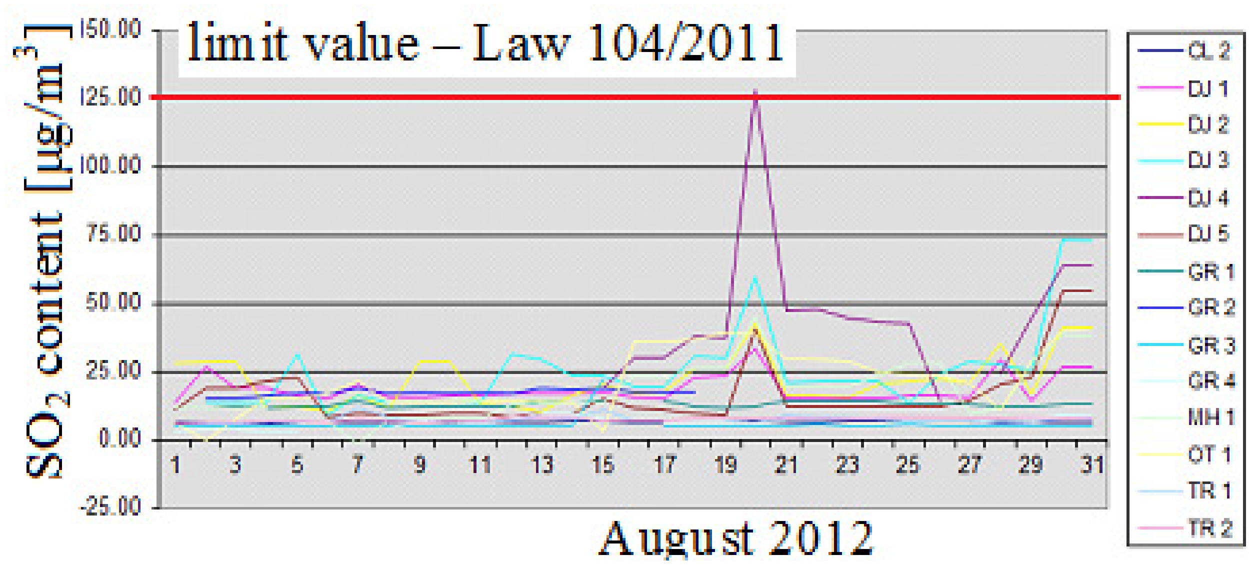

Fig. 10. Evolution of SO_2 in the investigated area – August 2012.

By analyzing the Fig. 10 has been found that in August 2012, the concentrations of SO_2 daily average have been increased significantly only in the days of 20 and 21 and only in locations from DJ – fact which suggests that pollution may be due to the thermal power plant from Isalnita.

The analysis of Fig. 12 has been revealed that in August 2012, except five concentrations recorded at the MH1 and GR1 stations (areas affected by drought and wind in the respective days/periods), the concentrations of daily average for PM_{10} were within the daily limit value of 50 µg/m^3.

The results recorded after monitoring of SO_2 in the investigated area, in September 2012 are presented in Fig. 13, NO_2 in Fig. 14 and PM_{10} in Fig. 15.

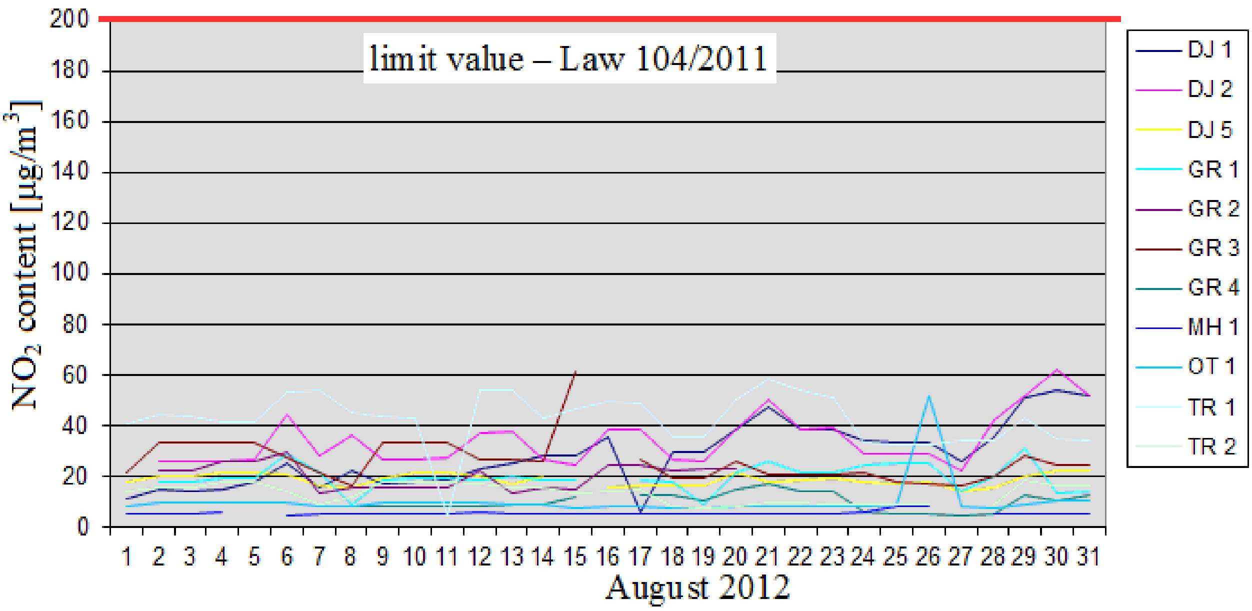

Fig. 11. Evolution of NO_2 in the investigated area – August 2012.

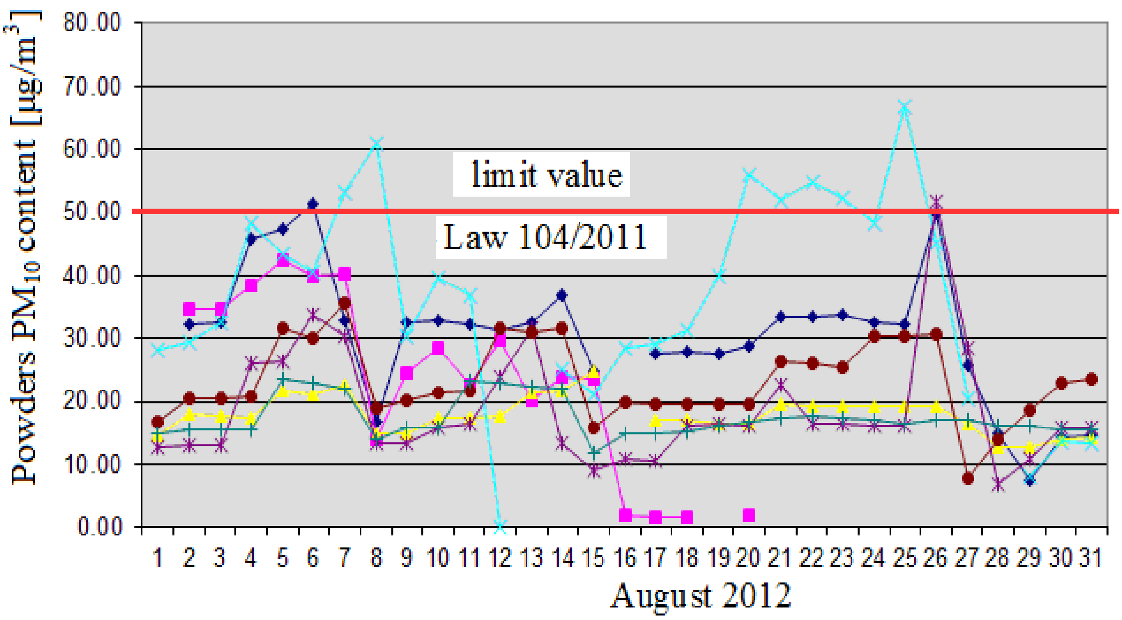

Fig. 12. Evolution of PM_{10} in the investigated area – August 2012.

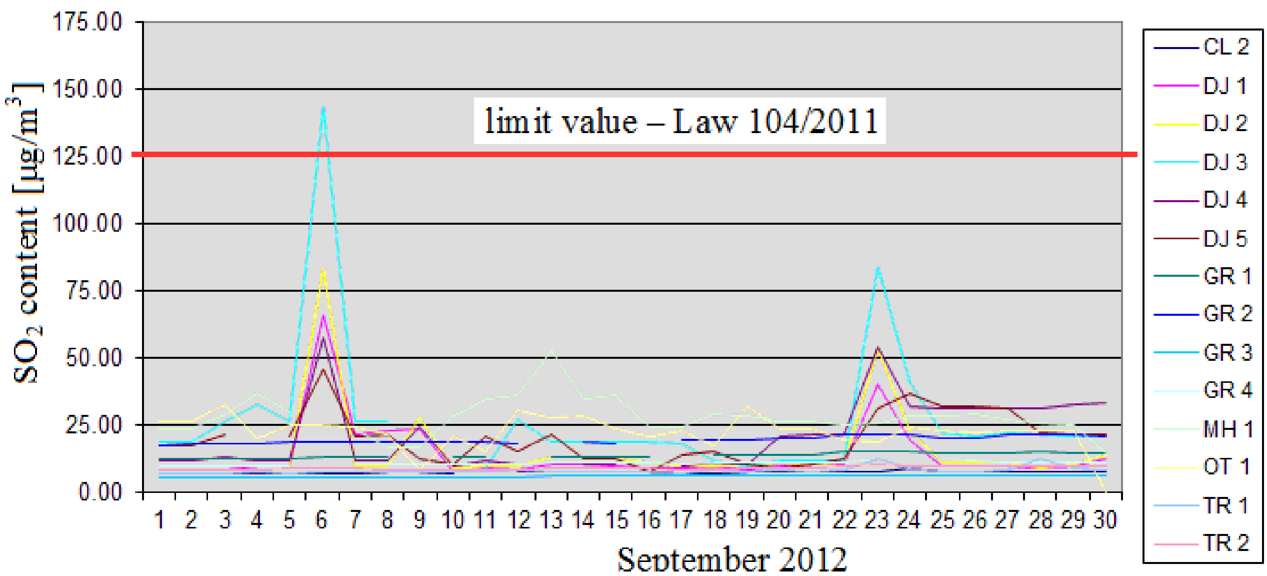

Fig. 13. Evolution of SO_2 in the investigated area – September 2012.

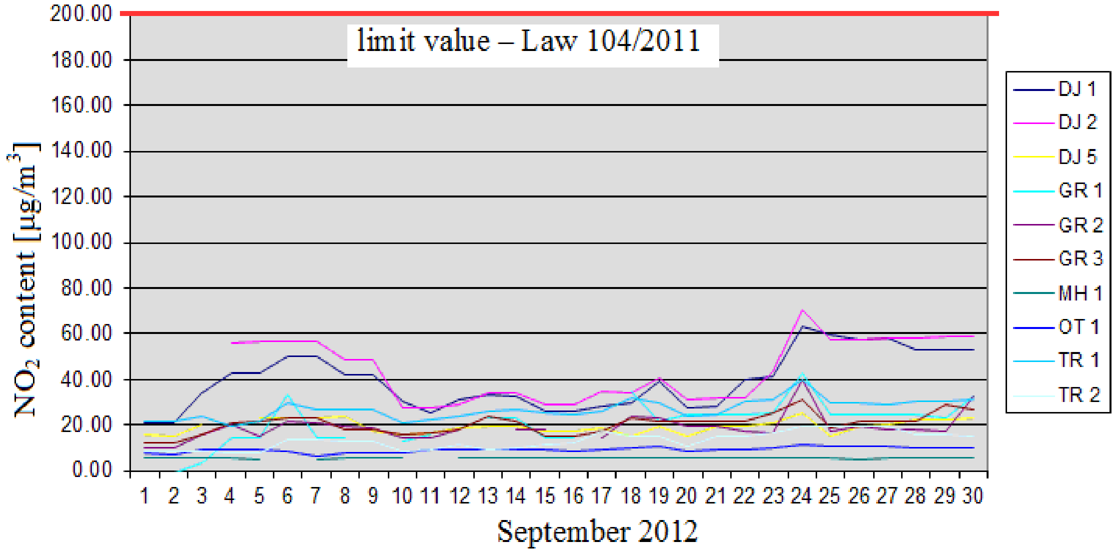

Fig. 14. Evolution of NO_2 in the investigated area – September 2012.

The analysis of Fig. 13 has been revealed that in September 2012, SO_2 concentrations increased significantly in days of 6 and 23 September in all monitoring points from DJ. This finding suggests that pollution may be the result of burning of fuels with high sulfur content in the Isalnita thermal power plant.By analyzing of Fig. 14 has been found that in DJ1 and DJ2 locations, the values recorded for NO_2 are systematically higher than in the other locations, which can be explained by the intense traffic in the vicinity of the monitoring points.

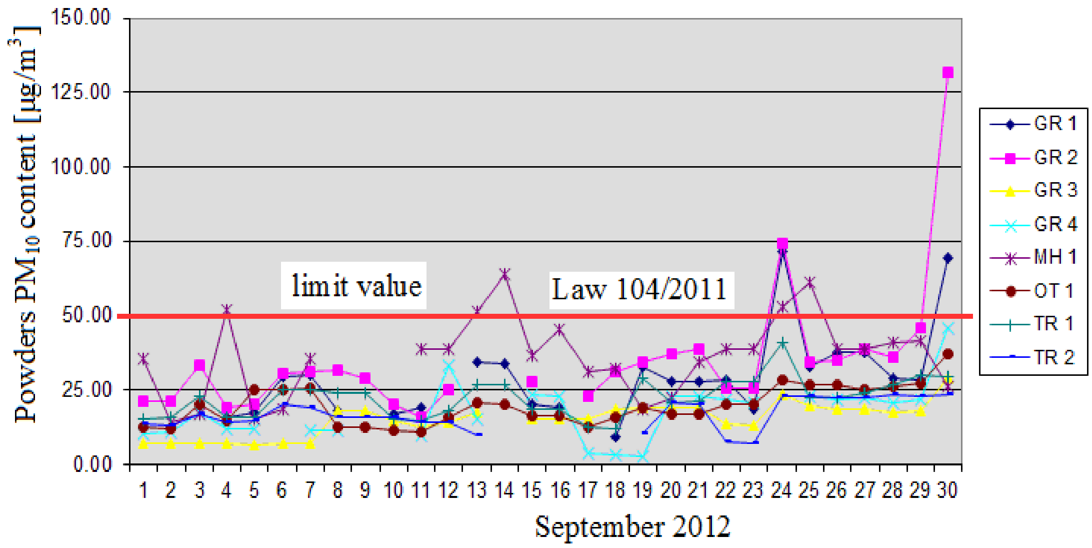

Fig. 15. Evolution of PM_{10} in the investigated area – September 2012.

The analysis of Fig. 15 has been revealed that in September 2012, there were several exceedances of the daily limit value at the monitoring stations GR1, GR2 and MH1 - which can be explained by pronounced drought and wind in respective areas and periods.

4. CONCLUSIONS

The monitoring in 15 locations of the concentrations of SO_2, NO_2 and particulate matter (PM_{10}) pollutants from air, in the area of 6 counties bordering the Danube, through data acquisition in both the summer period and the winter, has been revealed that:

- In November and December the values for SO_2 are systematically higher than in August and September, leading to the conclusion that the pollution with SO_2 may be due primarily to the burning of fuels with high sulfur content and/or certain industrial activities for obtaining of carbon products (anodes for the production of aluminum by electrolysis, graphite electrodes, etc.);
- The concentration of NO_2 in air shows relatively constant values (without significant daily variations), systematically higher values being recorded at the monitoring points located in the vicinity of the roads with heavy traffic;
- The concentration of particulate matter (PM_{10}) in air shows relatively high values, with frequent

exceedances of the limit imposed by Law 104/2011, values in the imposed limit being recorded just in the days with precipitations. Relatively high daily fluctuations have been recorded during turbulent weather (wind) and drought, especially in the area of dumps with thermal power plant ash.

Given the above, it is found that in counties bordering the Danube, thermal power objectives and industry of carbonic products may have an essential contribution to increasing of SO_2 content in the air. It also notes that NO_2 pollution is primarily due to the road transport.

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