

## A Study Regarding the Air Pollution in Cluj-Napoca City

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**Abstract:** In this paper, a study regarding the air pollution in Cluj-Napoca City has been conducted. Thus, the SO<sub>2</sub>, NO<sub>x</sub>, NO and NO<sub>2</sub> parameter values were monitored using modern apparatus of air quality monitoring station, located in Cluj-Napoca city. The values were measured daily at 14 o'clock during March, 2011. Using the analyzed data, the maximum and minimum limits of air pollutants were quantified. Thus, it was assessed that the pollution is higher from Monday till Friday and it decreases during Saturday and Sunday. According to the analyzed data, a series of proposals to Cluj-Napoca city management were elaborated in order to reduce air pollution.

**Keywords:** monitoring, air quality, air pollutants, analyzed data, Cluj-Napoca City hall.

### INTRODUCTION

In Cluj-Napoca City, the same as in the big cities of the world, the air pollutions, in the last years, has increased significantly.

One of the main air pollution sources, in the large cities are transport activities. Thus, the main pollutant elements are sulfur oxides and nitrogen oxides. In this paper, a study regarding the air pollution in Cluj-Napoca City has been conducted, using modern apparatus of air quality monitoring station, located in Cluj-Napoca city. The study has monitored the values of SO<sub>2</sub>, NO<sub>x</sub>, NO and NO<sub>2</sub> parameters.

### MATERIALS AND METHODS

Regional Environmental Protection Agency Cluj, in a European Union sponsored project, benefited of five automated monitoring station of air quality, four of them located in Cluj-Napoca and one located in Dej. The measurements of air pollution were carried out in March 2011, daily at 14 o'clock, at CJ4 monitoring station located in Cluj-Napoca, Dambovită Street, in the area of SC EXPO TRANSILVANIA. The monitoring station is located near (25 m) a road large junction with a traffic roundabout, located on Aurel Vlaicu Street, Marasti district.

### RESULTS AND DISCUSSION

The values of SO<sub>2</sub>, NO<sub>x</sub>, NO si NO<sub>2</sub> parameters, measured in March 2011, in CJ4 station are presented in Table 1. Also, the weekly variation of monitored parameters are presented in Figure 1-4.

The analysis of SO<sub>2</sub> variation identified the maximum (9.170 µg/m<sup>3</sup>) and minimum (3.260 µg/m<sup>3</sup>) measured values. The maximum measured value is very close to the upper

allowed limit, but still below it. Also, a high value of SO<sub>2</sub> has been measured on working days and a lower values on Saturdays and Sundays.

Tab. 1

The values of SO<sub>2</sub>, NO<sub>x</sub>, NO and NO<sub>2</sub> parameters, measured in March 2011, in CJ4 station.

Parameter M.U. day	SO <sub>2</sub> µg/m <sup>3</sup> value	NO µg/m <sup>3</sup> value	Nox µg/m <sup>3</sup> value	NO <sub>2</sub> µg/m <sup>3</sup> value	
1	4.089	3.258	14.010	9.019	Tuesday
2	3.924	2.543	10.945	7.046	Wednesday
3	3.757	2.132	11.869	8.604	Thursday
4	3.653	2.883	10.498	7.077	Friday
5	3.675	2.340	9.610	6.020	Saturday
6	3.260	2.336	9.147	5.567	Sunday
7	8.057	7.765	17.728	11.984	Monday
8	7.920	7.143	17.017	10.840	Tuesday
9	7.743	6.854	16.223	10.143	Wednesday
10	7.493	6.218	15.173	10.996	Thursday
11	7.221	5.771	15.262	10.009	Friday
12	6.323	4.713	13.664	9.301	Saturday
13	3.811	1.889	11.389	8.475	Sunday
14	9.170	12.188	41.169	22.481	Monday
15	8.619	13.128	47.465	27.318	Tuesday
16	7.318	13.117	46.455	26.368	Wednesday
17	5.506	9.205	37.027	22.922	Thursday
18	4.863	11.527	42.959	25.282	Friday
19	3.864	6.295	26.721	17.058	Saturday
20	3.441	3.978	18.547	12.450	Sunday
21	7.260	7.977	30.030	17.783	Monday
22	6.936	6.560	29.338	16.263	Tuesday
23	6.439	3.424	28.536	15.988	Wednesday
24	6.192	3.391	27.931	15.339	Thursday
25	5.953	3.502	27.473	14.035	Friday
26	5.508	3.221	22.084	12.121	Saturday
27	3.790	1.786	13.695	10.957	Sunday
28	4.697	3.377	21.302	16.120	Monday
29	4.191	3.181	18.368	13.487	Tuesday
30	4.986	5.001	23.699	16.033	Wednesday
31	5.571	5.832	28.565	19.621	Thursday
Average	5.175	5.713	23.626	14.881	
Minimum	3.260	1.786	9.147	5.567	
Maximum	9.170	13.128	47.465	27.318	
No. of values	31	31	31	31	

Based on these values, one can observe that during weeks 2, 3 and 4, the SO<sub>2</sub> value varies in quite wide intervals. The highest value (9.170 µg/m<sup>3</sup>) was measured on Monday 14<sup>th</sup> of March and the lowest on Sundays 20<sup>th</sup> of March. In first week this parameter has showed the smallest variation, between 3 and 4,5 µg/m<sup>3</sup>.

The analysis of the NO concentration reveals that, the minimum value was 1,786 µg/m<sup>3</sup> and the maximum value was 13,128 µg/m<sup>3</sup>. This value is below the upper limit allowed. Also, the highest value of NO has been recorded in the third week.

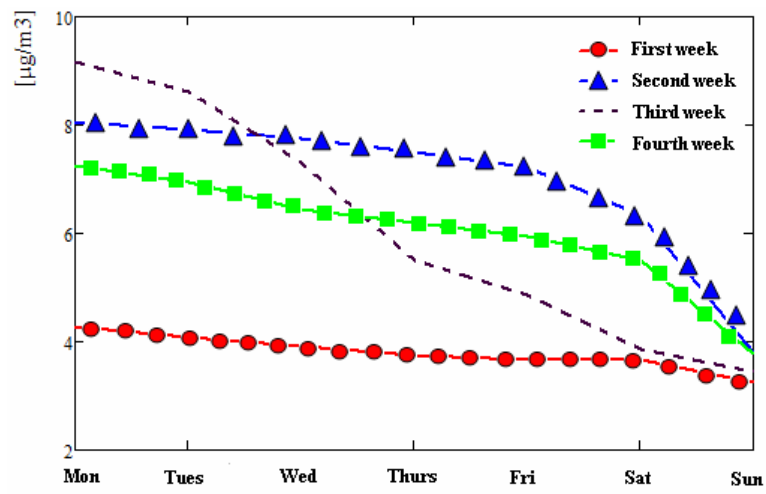


Fig. 1. Variation of SO<sub>2</sub> value during March 2011

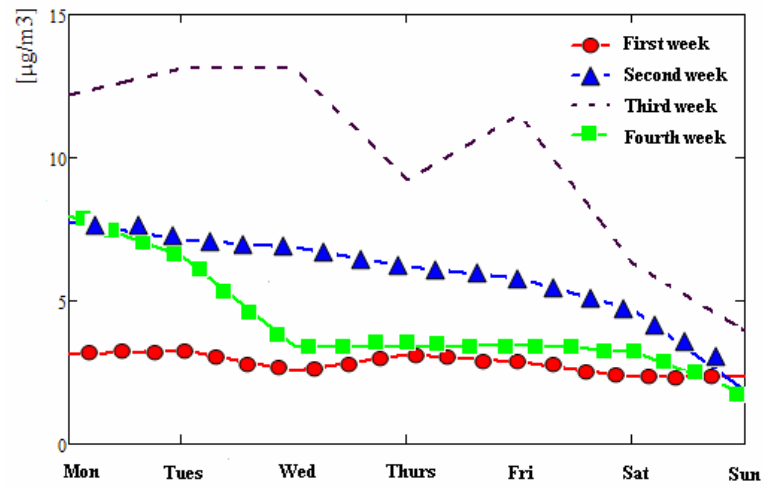


Fig. 2. Variation of NO value during March 2011

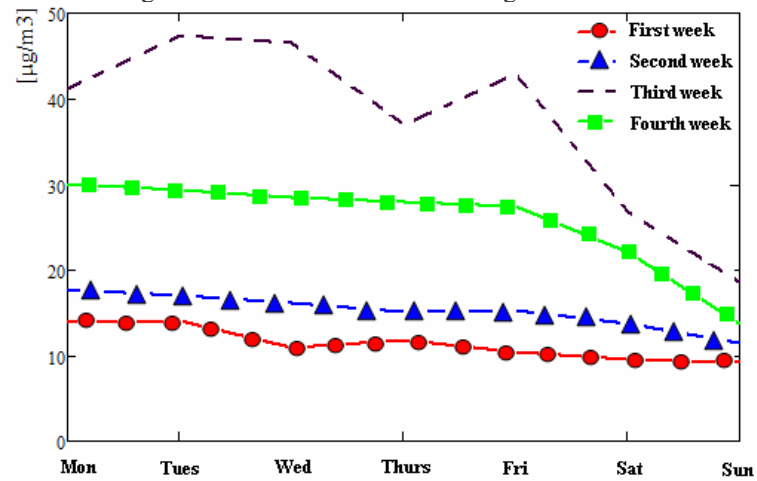


Fig. 3. Variation of NO<sub>x</sub> during March 2011

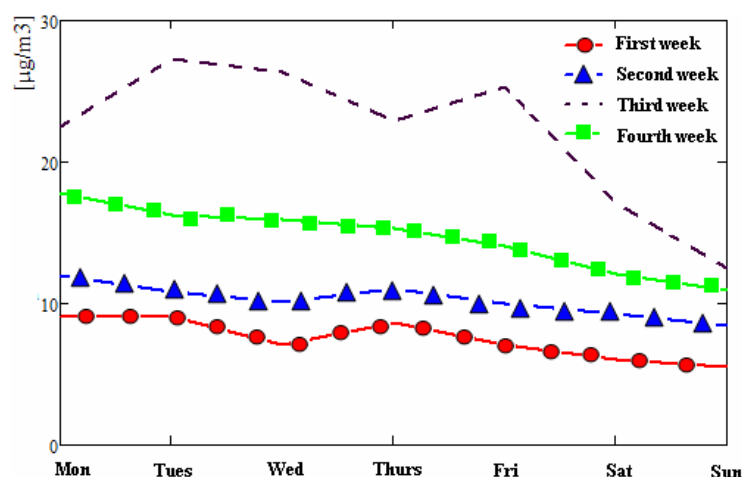


Fig. 4. Variation of NO<sub>2</sub> during March 2011

In the other weeks the NO value was below 10 µg/m<sup>3</sup>. The smallest variation was measured in the first week, the value of NO concentration was between 2,5 and 4 µg/m<sup>3</sup>. In this case higher values were measured in working days and the lowest values were measured in week-end.

Analyzing the concentration of NO<sub>x</sub>, we can assess the minimum value of 9,147 µg/m<sup>3</sup> and the maximum value of 47,465 µg/m<sup>3</sup>. The third week of the March was the week with the highest values of NO<sub>x</sub> concentration, of more than 15 µg/m<sup>3</sup>. The most stable week in term of this pollutant is the first week, the recorded values were between 9 and 17 µg/m<sup>3</sup>. In the other weeks of March, the NO<sub>x</sub> recorded values ranged between 9 µg/m<sup>3</sup> and 30 µg/m<sup>3</sup>.

In the first week of March 2011, the smallest value for NO<sub>2</sub> pollutant has been recorded. In the second week the concentration of NO<sub>2</sub> has increased to 12 µg/m<sup>3</sup>. The maximum value (30 µg/m<sup>3</sup>) of the NO<sub>2</sub> concentration was measured on Tuesday, the third week of March. The value of NO<sub>2</sub> concentration increased slowly in the last week of March, but it didn't rise to the upper limit allowed of 20 µg/m<sup>3</sup>.

Analyzing the above charts, we can conclude that the highest values of the monitored parameters were measured Monday, Tuesday and Wednesday, and the minimum value was measured in the weekend, Saturday and Sunday. The variation of the monitored parameters was similar in every week of March 2011.

## CONCLUSIONS AND RECOMANDATIONS

The study regarding to the pollutant emissions in Cluj-Napoca City reveals that the concentration of main pollutant emissions (SO<sub>2</sub>, NO<sub>x</sub>, NO and NO<sub>2</sub>) were higher in the working days of the week, usually they are highest in the first three days of the week, due to heavy traffic throughout the city. In weekend the concentration of air pollutants decreases, in accordance to the decreasing of the heavy traffic in the city.

The maximum and minimum values of the main monitored parameters recorded in March 2011 were: 3,260- 9,170 µg/m<sup>3</sup> for SO<sub>2</sub>, for NO<sub>x</sub> 9,147 - 47,465 µg/m<sup>3</sup>, for NO, 1,786 and 13,128 µg/m<sup>3</sup> and 5,567 -27,318 µg/m<sup>3</sup> for NO<sub>2</sub>. All the maximum values were below the upper limit allowed.

We recommend improving environmental management by the Cluj-Napoca City Hall using some measures taken and already in practice in other cities of the world:

- increasing comfort of public transport;
- subsidizing a part of the cost of public transport;
- reducing the intervals in the public transportation timetable;
- electronic display of time until the next bus;
- designating, where possible, a route reserved for public transport;
- parking signs and free parking places;
- imposing a minimum of Euro 4 or Euro 5 pollution norms for cars that are used for taxi;
- designation of suitable bicycle tracks;
- informing people on the benefits of using public transport onto the environment. Pollution generated by a bus carrying 30 people is much smaller than that produced by 30 vehicles with 30 people moving into town.
- increasing green spaces areas for green spaces;
- approval of housing construction only after the utilities in those areas, including public transport, the necessary conditions exist in all cities, a distance of about 5 minutes walk from the station house.

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