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Measuring Air Quality in a Construction Site Biotope Using the AQM-65 Analyser

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Abstract. Activities related to the execution of construction works often exert pressure on the quality of environmental factors in adjacent habitat. In various stages of realization of the works if is the opening of the building site and access roads, borrow pits and the storage, or the construction itself, all the related activities will cause harm in various degrees of vegetation on the construction site and its surroundings. Large areas are rendered non-productive and, although they should be restored for use in the same place or elsewhere, sometimes they can lose their natural habitat baseline. The paper is presenting a case study of air quality monitoring using the AQM 65 analyser for a construction site located near Timisoara locality, Timis County, Romania.

1. Introduction

The sources of different emission pollutants in the atmosphere are multiple, but specific for a construction engineering site are the activity of construction machinery (excavation and storage of topsoil, excavation and filling of earth roads body and ballast), materials and transport operations. From construction activities a number of specific air pollutants are generated such as nitrogen oxides, CO_2, CO, SO_2, organic pollutants, particulate matter. In Romania air quality regulations are stipulated in Law No. 104/15.06.2011 [1] on ambient air quality, published in the Official Monitor of Romania, Part I, no. 452 of 28 June 2011. Worldwide air quality limit is required to ensure values by both the European Union and the World Health Organization based and on epidemiological studies effectuated in long term exposures to the following pollutants emissions.

Sulphur dioxide (SO_2), it is a colourless gas which, by reaction with other chemicals is the precursor to particulate matter. Hourly limit value for human health protection imposed by the EU is 350 mg/ m^3 and a daily average limit of 125 mg /m^3. From the World Health Organization [2] is recommended that the daily average should not exceed 20 mg /m^3, as it resulted from recent studies on the effects on the human health.

Nitrogen dioxide (NO_2), it is a precursor to particulate matter. Hourly limit value for human health protection imposed by the EU and recommended by the World Health Organization is 200 mg /m^3, and the annual average limit is 40 mg /m^3 [2].

Carbon monoxide (CO) is formed mainly from incomplete combustion of fossil fuels, it is highly toxic and difficult to detect by man, since it is colourless, odourless and tasteless. The limit value for human health protection is determined as an average of its concentration for 8 consecutively hours (sliding average), since it has been found that this is the time when exposure to high concentrations of

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carbon monoxide produces major disorders on lung capacity. The 8-hour limit value set by the EU is 10 mg / m^3, and is the same value recommended by the World Health Organization [2].

Particulate matter is made up of very small solid particles and liquid. The vast preponderance has soot particles emitted by diesel engines. For air quality are monitored powders with less than 10 micrometers (PM10) diameter and the smaller diameter of 2.5 µm (PM 2.5).

PM 10daily limit value for health protection is 50 mg /m^3, and the annual output is 20 mg /m^3.

For PM 2.5 World Health Organization [2] sets the daily limit of 25 mg /m^3, and annual average of 10 mg /m^3.

2. Materials and method

To analyze the workload of atmospheric different pollutants in a civil engineering construction site we measurements were made using the Test van of Hydrotechnical Department Construction Engineering Faculty, "Politehnica' University of Timisoara, Romania across the peri-urban areas from the locality of Mosnita-Noua, near Timisoara. The area was chosen since it represents a place very close to Timisoara with an increased interest for housing construction.

For measurements was used the device AQM 65, part of the Test Van endowment [3]. The Aeroqual AQM 65 is a compact air quality station designed for precise measurement of ambient pollution and environmental conditions. Its platform is configurable to measure a wide range of air pollutants such as ozone (O3), nitrogen dioxide (NO2), carbon monoxide (CO), Sulphur dioxide (SO2) PM 10, and PM 2.5 as well as meteorological parameters such as temperature, humidity, wind speed and direction. The AQM 65 is complete air quality station consisting of a custom made IP65 rated aluminium enclosure which houses a power module, thermal management system, embedded PC running Aeroqual Connect software and user configured analyser modules. The Aeroqual AQM 65 is calibrated according to the Calibration Certificate 10322, 10317, 103135, 10305 at The National Institute of Standards and Technology in New Zealand.

3. Results and discussions

In Figure 1 is shown the location of data capture points for air quality monitoring stations under the control of the National Agency for Environmental Protection [4]. Two air quality monitoring stations, TM1 and TM 4 are relatively close to the point where measurements were made with AQM 65 device. However TM1 and TM4 stations are urban background stands, which monitor industrial activity particularly in terms of traffic and air pollution.

To compare the measured data with the values recorded at monitoring stations in Timisoara, in the proximity of the study area, we used a set of data from the years 2008-2013 interval taken from the Report stage of the measures set out in the integrated quality management air [4]. The compared values are maximum daily values and annual averages of interest pollutants.

Table 1 Maximum concentrations for different pollutants hourly/daily (g/m^3) [4]

Station	Indicator	Maximum Hourly/8 hour/daily					
		2008	2009	2010	2011	2012	2013
TM 1 Calea Șagului	$SO_{2\ hourly}$	106.04	84.66	123.7	45.53	24.67	57.32
	$SO_{2\ daily}$	69.24	30.06	39.25	15.47	14.11	27.17
	NO_2	182.01	170.16	175.81	174.44	165.37	114.13
	CO	6.51	3.22	4.4	6.26	3.88	5.61
	PM_{10}	-	110.87	103.81	124.02	166.87	63.96
TM 4 Area Soarelui	$SO_{2\ hourly}$	147.22	105.51	96.26	35.10	42.46	27.16
	$SO_{2\ daily}$	58.79	40.57	28.7	23.35	19.72	14.82
	NO_2	197.07	199.32	138.49	130.08	150.56	185.34
	CO	1.9	2.42	2.08	3.68	3.06	5.68

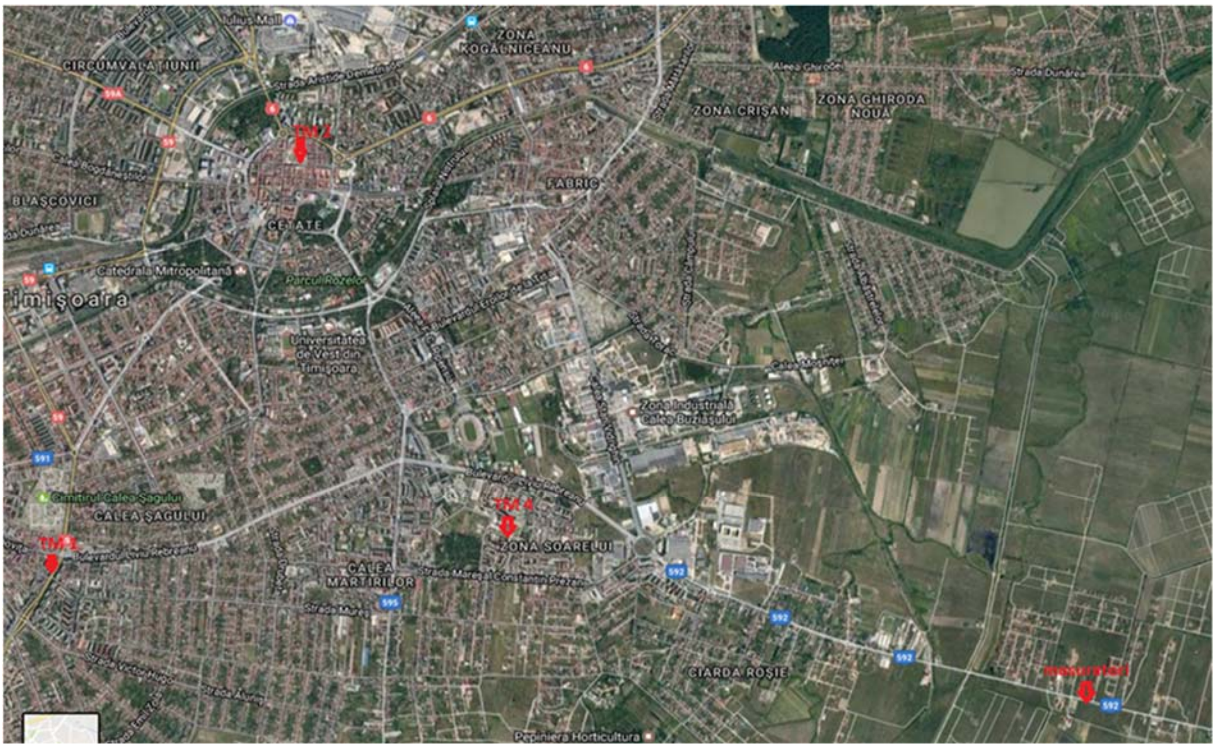

Figure 1. Location of air pollution monitoring stations and locations where determinations have been made using the AQM 65 device

For the SO_2 pollutant there were no breaches of the limit zones in the study period, according to Table 1. The same can be observed for the pollutant CO, whose sliding average value (on 8 hours) imposed by the World Health Organization was not exceeded.

For nitrogen oxides the hourly limit values, even if not exceeded within the time studied, are located at high levels, close to the limit of 200 mg/m^3 to 2008, 2009 to both monitoring stations. In the years 2010, 2011, 2012 there were elevated concentrations of NO_2 in station TM 1 situated in Calea Sagului, knowing that the area where the station is located is one with heavy traffic being a main thoroughfare in and out of the Timisoara locality (with large amounts of pollutants).

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Regarding the particulate matter pollution, especially PM10 fraction, things are concerning. Daily limit value of 50 mg/m^3 was exceeded by 2-3 times in all years studied.

Table 2 The annual average concentrations for various pollutants (g/m^3), [4]

Station	Indicator	Annual average					
		2008	2009	2010	2011	2012	2013
TM 1	$SO_{2\ hourly}$	15.71	7.85	5.11	5.60	6.84	11.15
	NO_2	39.13	32.41	37.99	35.46	23.44	41.25
	CO	0.77	0.58	0.62	0.62	0.54	0.47
	PM_{10}	-	46.02	38.67	41.87	29.85	25.81
TM - 4	$SO_{2\ hourly}$	15.3	9.7	7.17	7.29	7.44	9.81
	NO_2	27.51	26.14	22.29	19.39	19.90	26.28
	CO	0.6	0.27	0.25	0.29	0.25	0.22

The annual average for NO_2 values shows no alarming values in terms of overtaking, however the values recorded in 2008, 2009, 2010 and 2011 are approaching the threshold limit of 40 mg/m^3, while in 2013 this limit values is even exceeded.
In terms of average annual value for the fraction PM 10, they are exceeded each year.
The values recorded with the AQM 65, are graphically presented in the following.

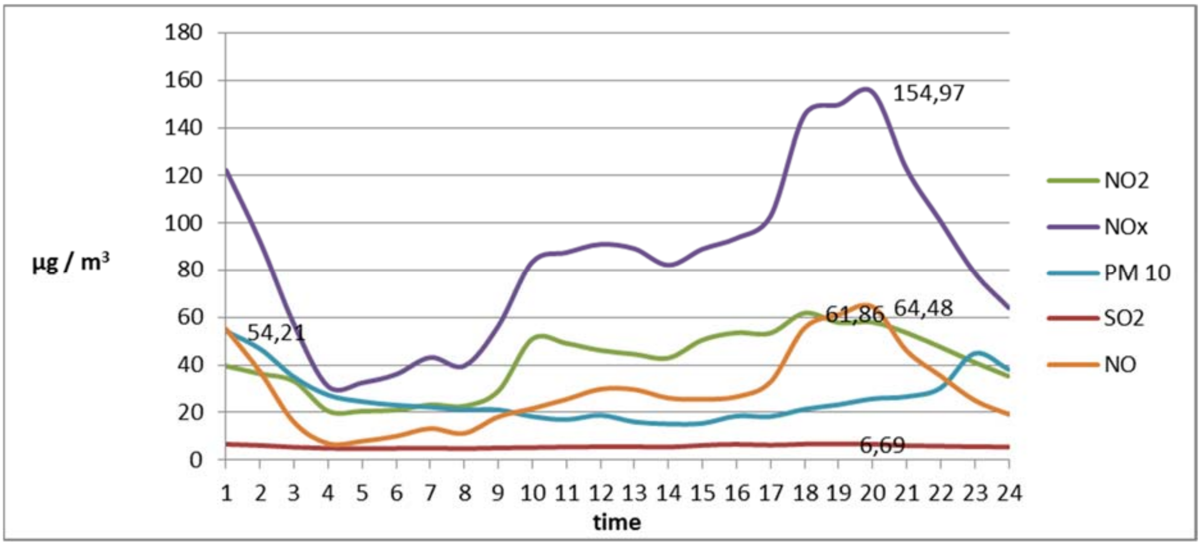

Figure 2 The values of monitored parameters recorded throughout the day, 18 July 2016

Daily average value for SO_2 = 5.71 µg / m3
Daily average value for NO_2 = 41.37 µg / m3
Daily average value for NOx = 85.23 µg / m3
Daily average value for PM10 = 25.98 µg / m3
Daily average value for NO = 29.18 µg / m3

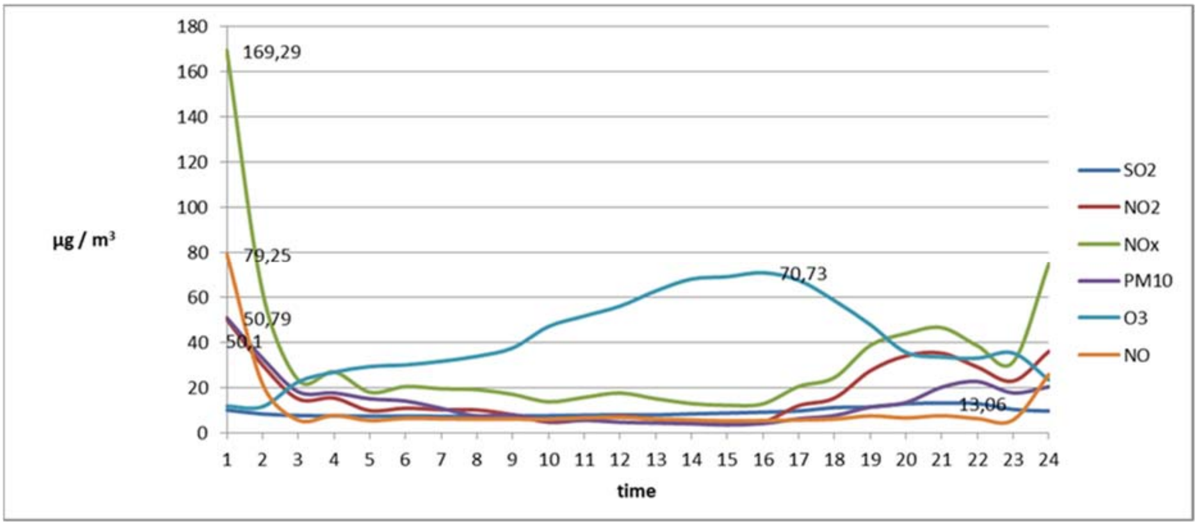

Figure 3 The values of monitored parameters recorded throughout the day, 30 September 2016

Daily average value for SO_2 = 9.07 µg / m^3
Daily average value for NO_2 = 16.98 µg / m^3
Daily average value for NOx = 33.06 µg / m^3
Daily average value for PM10 = 13.53 µg / m^3
Daily average value for O_3 = 41.39 µg / m^3, and the sliding average = 57.77 µg / m3
Daily average value for NO = 10.69 µg / m^3.

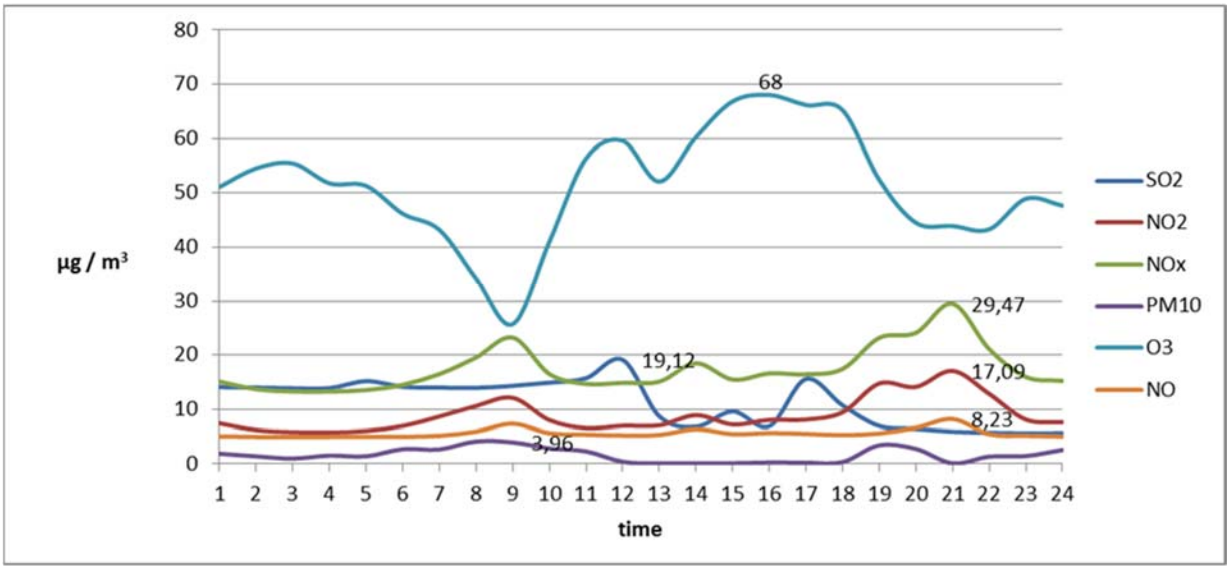

Figure 4 The values of monitored parameters recorded throughout the day, 16 February 2017

Daily average value for SO2 = 11.33 µg / m^3
Daily average value for NO2 = 8.95 µg / m3
Daily average value for NOx = 17.39 µg / m3
Daily average value for PM10 = 1.64 µg / m3
Daily average value for O3 = 51.24µg / m3, and the sliding average = 53.73 µg / m3
Daily average value for NO = 5.61 µg / m3.

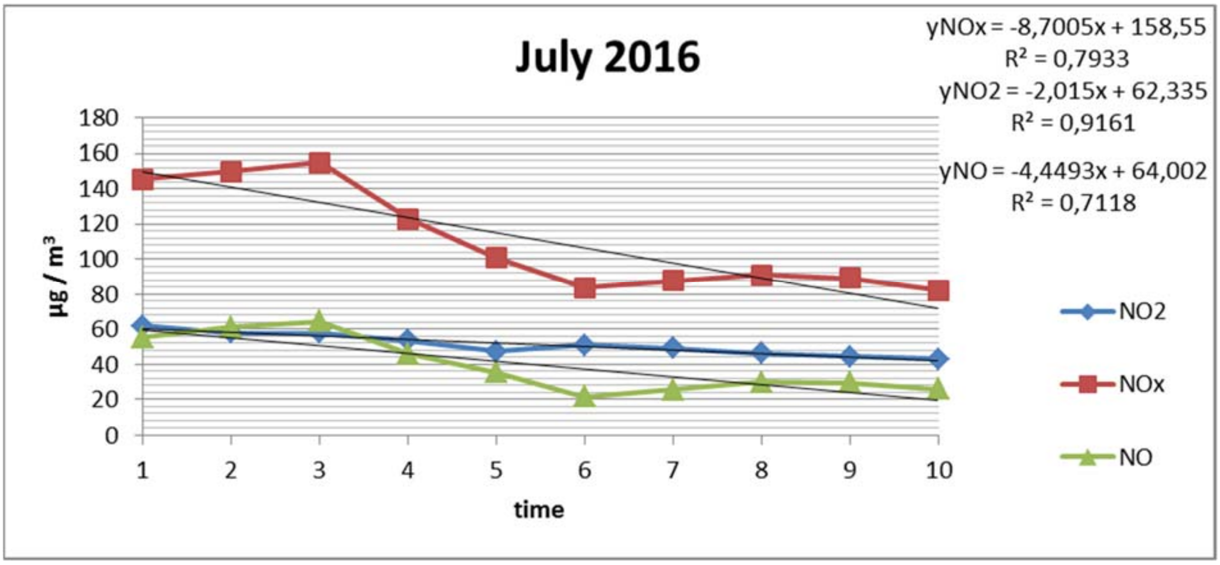

Figure 5 The Evolution NO, NO_2 and NO_x concentrations in the study period, 18 July 2016

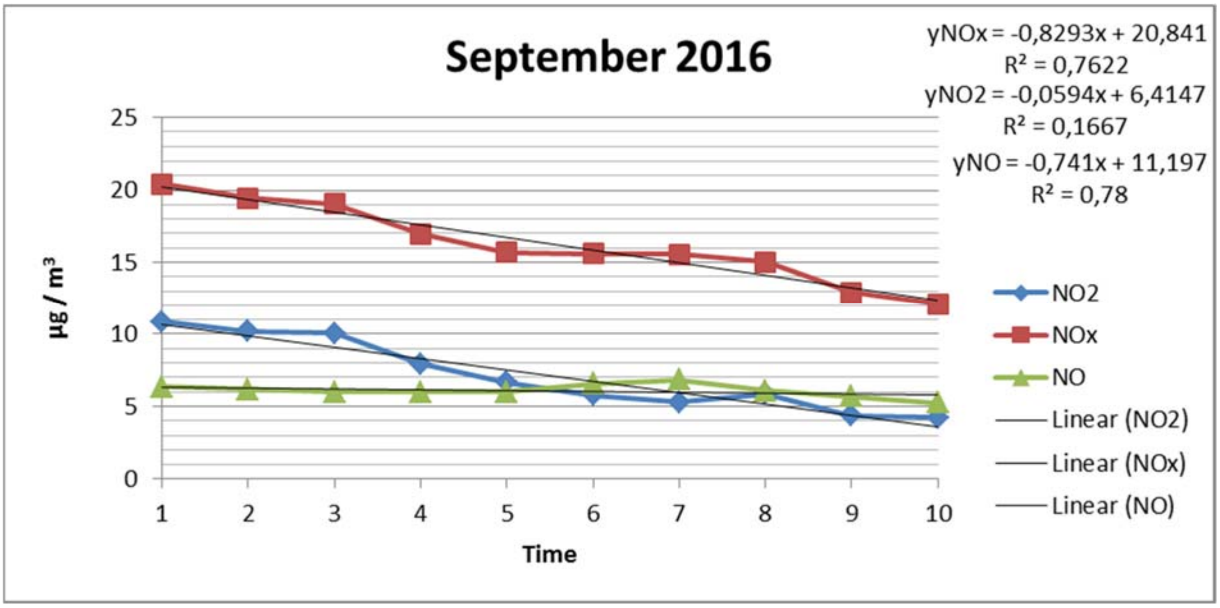

Figure 6 The Evolution NO, NO_2 and NO_x concentrations in the study period, 30 September 2016

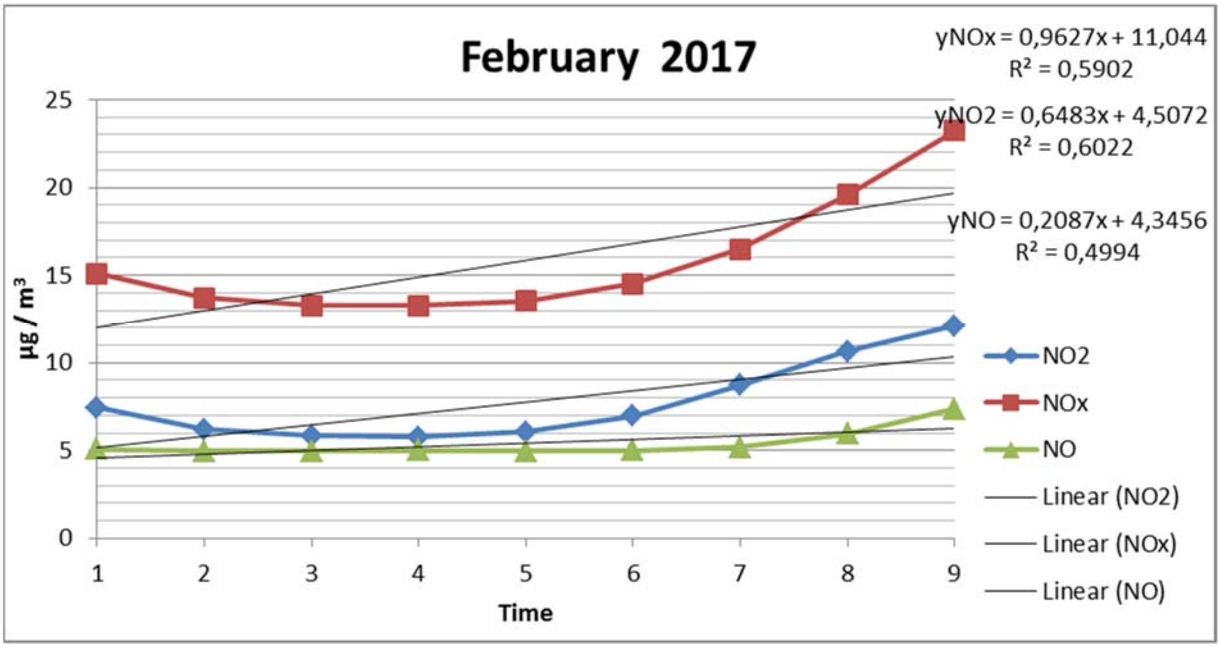

Figure 7 The Evolution NO, NO_2 and NO_x concentrations in the study period, 16 February 2017

From the Figures 5, 6 and 7 we can see that in the amount of nitrogen oxides NO_x, the largest contribution comes from nitrogen dioxide NO_2. There were found strong correlation coefficients between values for nitrogen oxides concentrations for the measurements recorded, both in July 2016 and in February 2017.

It has long been established that exposure to air pollutants can have a detrimental impact upon health. Particulate matter and ozone are thought to have the most significant effect. Air pollutants can also have wide-ranging environmental impacts, from localized effects including loss of biodiversity and reduced crop yields, to a potential contribution to climate change [5].

4. Conclusions

Measurements with the AQM 65 device have identified moderate to strong correlation between nitrogen oxides resulting from traffic pollution with nitrogen dioxide predominant in areas where diesel trucks are allowed. Still there has been NO serious pollution identified in areas seen within the studied time interval.

The most significant pollution is determined by the fraction of particulate matter PM 10 which was found exceeding the annual average value in all years of study.

Pollution in the execution phase of a civil engineering work has the largest effect on air quality. The impact of period is determined by the volume of work and organization. This pollution is temporary, dependent on the length of construction and can be reduced through appropriate measures adopted by the Entrepreneurs. Compliance project and monitoring in terms of air protection is an obligation of all stakeholders in limiting the adverse effects on air quality during construction engineering investments.

Further studies on pollution with nitrogen oxides in construction site areas will be useful in creating models for estimating the degree of air pollution in such habitats with excessive pollutants emissions, since this peri-urban area show an increased construction site development year after year.

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[1] Law No. 104/15.06.2011 on ambient air quality, published in the Official Monitor of Romania, Part I, no. 452 of 28 June 2011.
[2] World Health Organisation, Who Air quality guidelines for particulate matter, ozone, nitrogen dioxides, dioxide and sulphur dioxide. Global update 2005. Summary of risk assessment. WHO Press, World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland.
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[4] http://www.anpm.ro - Progress report on the implementation of measures in integrated program for air quality management for agglomeration Timişoara in Timis county 2015.
[5] Marcus Popplewell, Emma Robinson, Jonathan Bayliss, Louisa Shakos, Michael Donaldson and Jill Hearne Briefing for the house of commons Environmental Audit Committee, December 2009, National Audit Office, Press Office, 157-197 Buckingham Palace Road, Victoria London, SW1W 9SP.