TWO CITIES, DIFFERENT RESULTS, SAME EUROPE. FACTS CONCERNING AIR QUALITY MONITORING

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ABSTRACT

The paper focuses on the main problems of environmental air quality monitoring aspects, and describes results offered by two monitoring systems of two different cities of the EC: Graz and Timisoara. The online measurements attest different results, despite the fact that the approaches are referring to the same legislation and the cities are of comparative size, industrial development and traffic intensity. Timisoara is a city in situated in a plain, Graz is surrounded by hills and mountains, which are in special situations, restricting the dispersion of pollutants. Despite these similar and non-similar conditions, comparative results are presented and commented.

Keywords: *Air quality, online monitoring, air quality concentrations in urban areas*

1. INTRODUCTION

Mankind lives in a confusing and rapidly changing world. Trends are appearing and disappearing in arts, fashion, lifestyle and ideas, at breathtaking speed. New information and communication technologies open new cultural and commercial opportunities. At the same time economic and social inequalities are growing. One also faces challenges of another kind, never experienced before. A world population of over six billion people with unprecedented technology capacity now has been an impact on the global natural system. This has led Paul Crutzen and Eugen Stoermer to argue that one lives in a geological period, the *Anthropocene* era. Humans have become a force of nature, triggering changes in immense ecosystems – changes which could rebound, threatening our livelihoods, and the lives of future generations.

Climate change is the prime example of this process. Global warming is caused by greenhouse gases being released into the atmosphere, where no national borders exist. The most important greenhouse gas, carbon dioxide, is emitted in energy production and transportation – which have jointly formed the basis of industrial development over the last 200 years. Industrial production, based on cheap energy, has enabled recent generation to enjoy luxuries of life never before experienced. For almost all of us in the developed world, the private car became a symbol of freedom and new opportunity.

The climate change is a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate change may be due to natural internal processes or external radiative forcing, or to persistent anthropogenic changes in the composition of the atmosphere or land use. The United Nations Framework Convention on Climate Change (UNFCCC) in its Article 1 defines it as: "a *change of climate* which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural *climate variability* observed over comparable time periods".

Basic information offered by K. Dow and Th. Downing [1] are analysing main data responsible and resulted from the effect on the climate changing data. They are extracted in Table 1 for some countries representing the EU as well as from outside the union. One comes to the conclusion that, despite the differences in population there is a direct dependency between the gross national income per capita and the man made emitted pollutants. The explanation is considered to be determined by: (i) industrial development with less or major support – proportional with the level of national development maturity – offered by the application of clean combustion technologies and ecological transportation system, (ii) regional human developing, considering that each human being has a right to be part of the civilisation and state of art development in its house-holding and natural & industrial environment.

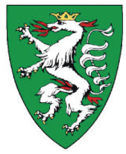
Table 1: Comparison between Austria, Romania and others countries [1]

		Countries				
		Austria	**Romania**	**Russia**	**China**	**United States**
Population, 2004 [thousands]		8,115	21,858	142,814	1,296,500	293,507
Gross National Income per capita, 2004, [US$]		32,300	2,920	3,410	1,290	41,400
Human Development Index Rating, 2003		0.936	0.792	0.795	0.755	0.944
Water withdrawn, 2002 or latest, [as % of renewable water resources]		3 %	12 %	2 %	19 %	17 %
Coastal population, 1995 [as % of total population]		2 %	6 %	15 %	24 %	43 %
Weather related Disasters	Number 2000-05	8	28	58	135	146
	Average annual deaths per million people 1980-2000	-	0	0	2	1
Carbon dioxide emissions	From burning fossil fuels, 2002, [million tones]	65	90	1,488	3,307	5,635
	2002, [Tones per person]	8.9	4.5	11.2	2.7	20.0
	1950-2000, [Tones per person]	2,514	5,882	77,120	71,766	212.826
	From transportation, 2003, [Million tones]	21	13	194	267	1,794
Methane emissions	2000, [Million tones CO_{2e}]	7.8	25.7	312.3	778.4	614.4
	2000, [tones CO_{2e} per person]	1	1.1	2.1	0.6	2.2
	From agriculture, 2003, [million tones CO_{2e} including N_2O]	7.7	11.6	97.6	1,008.50	469.9
Carbon intensity, [tones of CO_2 per $1,000 GDP]	2003	0.37	2.33	5.24	2.58	0.56
	Change 1993-2003	-0.01	-1.14	-0.98	- 1.85	-0.13

The most evident changes, that are proving certain effects determining climate transformation, are occurring in the air quality in urban areas that are facing both industrial developments of industry and private homes, not mentioning the ever growing traffic intensity. Developed countries and cities in Europe already have environmental inventories and statistic data for approaching different scenarios, either for present day situations or forecasts. Romania, as a Balkan country, also belonging to the former socialist bloc, has to face major environmental problems, air quality being dominant.

In this paper two substantially different European cities (each one being representative of two member states) are compared on basis of online air quality monitoring results. Main information considering both cities is given in Table 2 [4], [5], [6]. It has to be remarked that although different national laws concerning air quality monitoring and standards are applicable, no significant differences exists, as the framework is given by the major jurisdiction of the European law [2], [3]. The conversion to national law is given in [7] and [8].

Table 2: Short data for comparison between Graz and Timisoara [5], [6]

	Timisoara, known since 1212 as „Castrum Temesiense"	**Graz, known since 1128**
Emblem of the city		
Area	127.56 km^2	129.29 km^2
Altitude	80 m	353 m
Geographic coordinates	45°44'58"N, 21°13'38"E	47º05' N, 15º22' E
Population	317660 (2002)	287723 (2006)
Population Density	2452 inhabitants / km^2	1960,49 / km^2
Geographic surroundings	Plain with maximum 2 – 3 m variations	Surrounded by mountains

2. RESULTS AND DISCUSSIONS

Graz is a developed city and can be considered as a a model concerning air quality monitoring and presentation of the air quality data base [4]. It has a mesh of stations that contributes to a good survey of the online situation, in respect to national standards [5]. The general rules and methods for air quality investigations as well data about air quality in Graz are described by Sturm et al. ([6], [7]).

Timisoara has not such a dens local monitoring network, despite the efforts made in the last years concerning the installation of three online monitoring stations. Thus, monitoring is achieved by independent labs, such as that of the University *"Politehnica"* that is recording in real time all data according to the national legislation [8]. The management and competence are respecting the international standards SR EN ISO/CEI 17025:2005 (general features and competences), according to the fundamentals imposed by SR EN ISO 9000:2006 (fundamentals and definitions).

Following instruments have been used, in accordance to the regular Romanian standards for air quality that are in close correspondence to the EU legislation. Detailed description is offered in Ionel et al. [10], [11], and [12]:

- Monitor Labs 8840 for NO_x detection from ambient air, working based on the chemiluminescence's principle, according ISO 7996/1985,
- Monitor Labs 8850S for the SO2 ambient air concentration, working in UV by applying the fluorescence method, according ISO/FDIS 10498,
- HORIBA APMA-350E for CO detection applying ND spectroscopy in IR, according ISO 4224,
- Sampling analyser LVS3 for the PM10 specie, based on the filtration and mass determination of a specific suspension by means of gravimetric principles, according EN 12341.

It has to be mentioned that these indicated methods are general European standards and all the AQ monitoring devices must comply with them, all over the EU (in Graz as well as in Timisoara). Basic features for the measurement monitoring campaigns in urban areas, with special concern for the traffic influence & dispersion modalities are given in [9]. The correlation between traffic intensity and AQ was demonstrated by Ionel et al. [13], [14]. The scheme of the mobile AQM Laboratory belonging to University "*Politehnica*" of Timisoara is depicted in Figure 1. The calibration system as well the data acquisition system and meteorological sensors are also accessible. For some special purposes additional monitoring systems are in use.

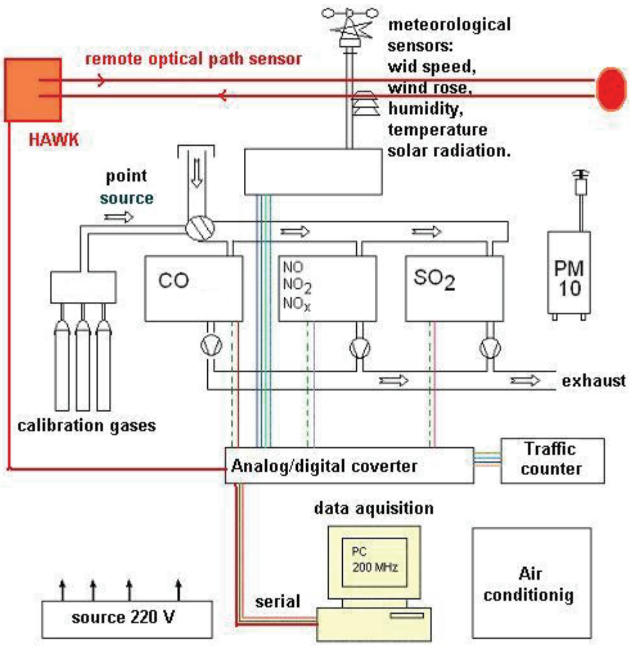


Figure 1: Scheme of the entire monitoring station

Figure 2: Timisoara locations for air comparative quality monitoring (left - Timisoara Green Forest sticking point, center- inside of the monitoring van, right – Timisoara Central Park)

Figure 3: Graz locations for air quality monitoring (left- Graz Don Basco, right - Graz Süd Tiergartenweg)

Figure 2 and 3 are presenting the locations that have been compared concerning the AQ monitoring results. The episodes are of same extension, refer to similar meteorological episodes and respect appropriate traffic and industrial source density. The measurements have been accomplished in May 2003 respectively in September – October 2007, the Graz data was downloaded from the public air quality network server (http://umwelt.steieremark.at). The Timisoara data was measured by the aid of the instruments from the AQM lab, by the authors.

The air quality monitoring (AQM) station Graz Don Bosco represents the hot-spot location of the city of Graz. The high traffic density is a major contributor to air pollution at this location. The monitoring station Graz-Süd is representative for an urban background, dominated by emissions from private households and nearby small and medium size enterprises.

The selection of the Timisoara AQM locations was made with the purpose of having comparable emission characteristics (dominated by high traffic induced pollution but also influenced by industrial emissions). Timisoara has no ring road, thus most of the heavy traffic is supposed to pass Timisoara trough the city's main roads. Two of them are passing the monitoring locations. The locations are called Green Forest, and Central Park.

In the following sessions the main differences in air quality between the two cities will be discussed.

2.1. Hourly average values, comparative episode Graz Don Basco (GDB) versus Timisoara Green Forest sticking point (TM).

When considering carbon monoxide (C0) the maximum hourly mean value shows differences in the order of five to ten (Figure 4). As Graz Don Bosco is already the traffic hot spot of Graz the main reason of this difference can only be found in the difference of the technical standards of the vehicle fleet. The Austrian vehicle fleet consists of gasoline vehicles with three way catalytic converters and of diesel cars. Both groups have very small CO concentrations. This is not the case for the vehicle fleet of Timisoara. Cars and domestic heating contribute strongly to the high CO level.

Figure 5 depicts the NO, NO2 and SO2 concentrations; again the maximum hourly value is shown. NO and NO2 are in most – but not all – cases in Timisoara higher than in Graz Don Bosco. A clear picture is given only for SO2 – which is a tracer for emissions from industry and private households. In Graz there is almost no SO2 concentration measured, whereas Timisoara shows levels up to 50 µg/m³, but well below the threshold of 200 µg/m³.

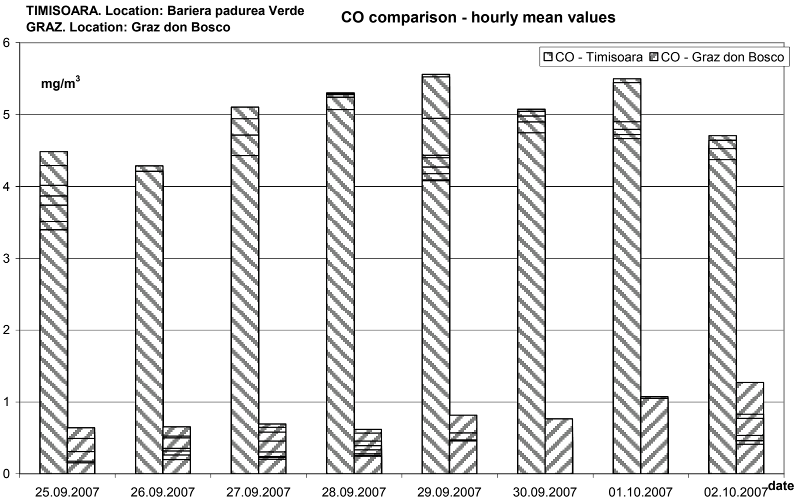


Figure 4: Comparative CO hour mean values

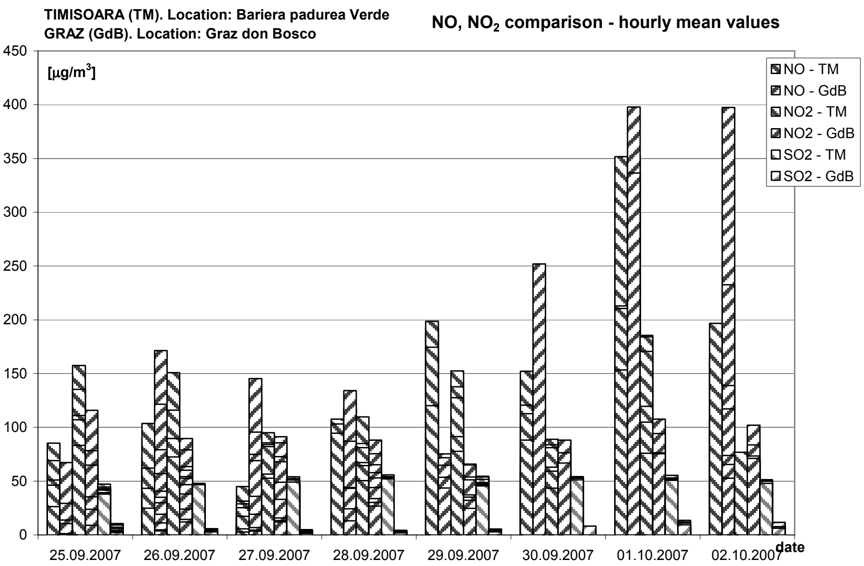


Figure 5: Comparative NO, NO_2, SO_2 hour mean values

2.2. Daily average values, comparative episode Graz Don Basco (GdB) versus Timisoara Central Park (TM)

When looking on daily mean values the situation becomes more pronounced. For NO2, SO2 and PM10 a clear difference between Timisoara and Graz can be observed. The picture is indifferent when looking on NO. From 25th to 27th the NO concentrations were remarkably lower in Timisoara than in Graz. From the 28th on the situation turned to the expected one, having much higher concentrations in Timisoara than in Graz.

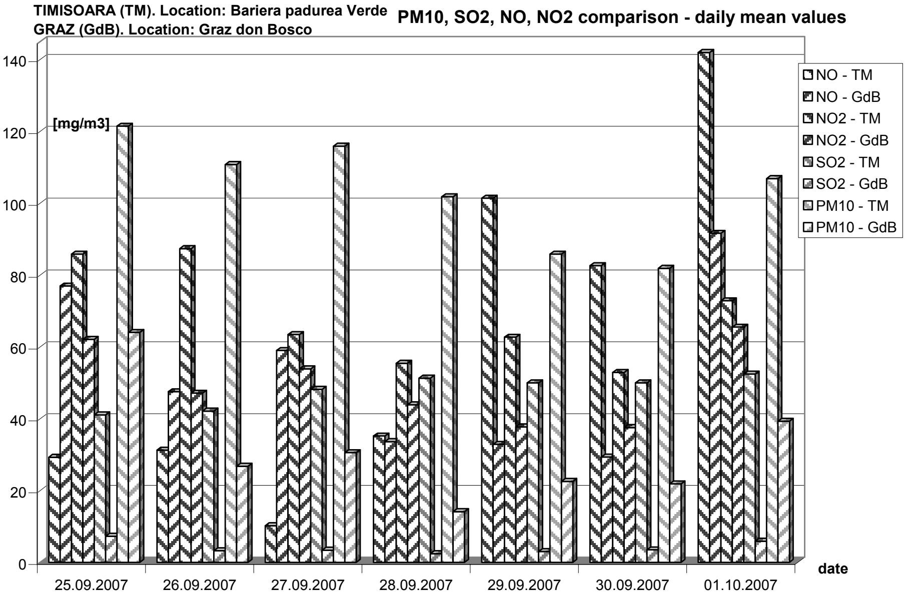


Figure 6: Daily mean comparative values of the concentration of NO, NO_2, SO_2 and PM10

The NO_x differences are explainable by the older traffic fleet in Timisoara in comparison to Graz. The SO_2 differences are due to the fact that in the Timisoara power plant no desulphurization system exists, as well as the diesel fuel is not yet in all cases respecting the EU composition.

2.3. Half hour average values, Graz Süd Tiergartenweg (GST) versus Timisoara Green Forest sticking point (TM)

In this case, the urban background station Graz Süd was compared to the Timisoara monitoring site Green Forest sticking point. Figure 7 shows the results for the maximum half hour value of CO and **Figure 8** the results for NO, NO2 and SO2. Depending on the pollutant the results are indifferent. Peak values, like the maximum half hour value, depend very strong on short term events and are not very representative for general air quality statements.

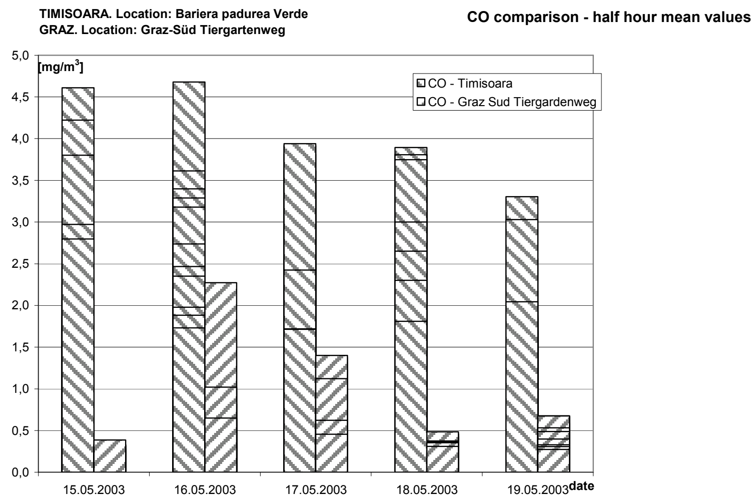


Figure 7: Half hour mean values of the CO comparative concentrations

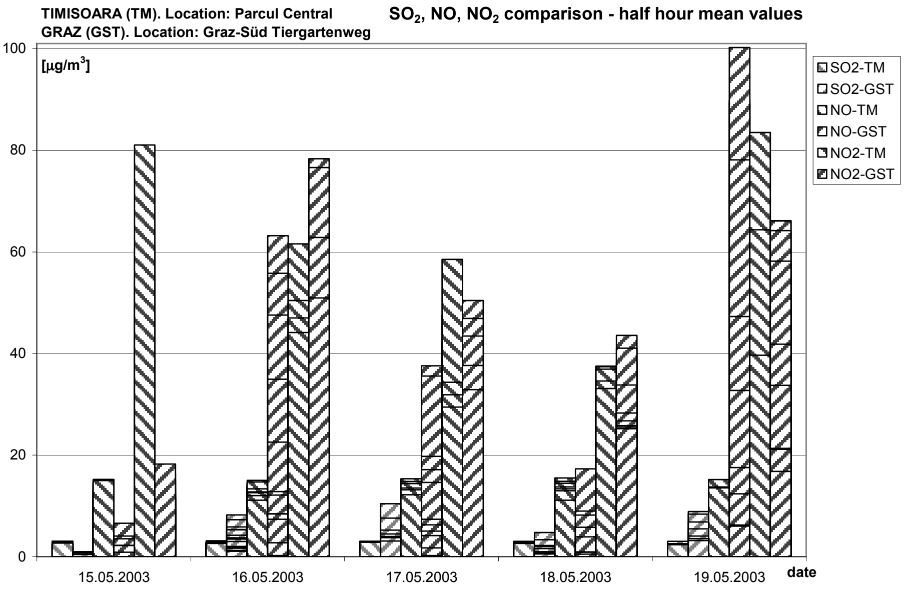


Figure 8: Half hour mean comparative values of the concentration of NO, NO_2, SO_2

3. CONCLUSIONS

Air pollution is a global environmental problem that represents a measure of the potential of the climate change rate, although its scale has a strong regional or local orientation. A comparison between AQ online monitoring data in two European cities (even no mega-cities) proofs that despite the fact that the same EU legislation and monitoring methods are applied, the results are quite different. Improvements in technology supported by policy measures have lead to reduced pollution levels, but still especially in new member states more activity is needed. In developed countries advanced low pollution technique is applied in order to reduce the pollution levels However, in developing countries the relatively high economic growth rates increase the incomes but also the global (regional or local) pollution level, and hence contribute as long range transported pollution to air quality problems in regions far away. Reaching the stringent AQ levels remains to be the challenge for all countries and especially for urban areas. This calls for an intensive cooperation between all cities, in developed or developing countries, in terms of research collaboration, technology transfer, knowledge exchange and dissemination.

4. ACKNOWLEDGEMENT

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