Pollution scenarios through atmospheric dispersion modelling based on real measurements - impact on human health

MIHAIELLA CRETU, VICTORIA TELEABA, SILVIU IONESCU, ADINA IONESCU
Acoustics and Air Quality Laboratory
COMOTI Romanian Research and Development Institute for Gas Turbines
220D Iuliu Maniu Ave. 061126 Bucharest
ROMANIA
mihaela.cretu@comoti.ro   www.comoti.ro

Abstract: - Considering the fact that the exposure to ambient air pollution has been associated with a series of adverse health effects, it is important to predict the industrial air pollution in the populated areas. An easy and an inexpensive estimation can be performed through atmospheric dispersion modelling. This paper present a case study carry out at two pollution sources located near to an airport. Measurements at source and in the atmosphere were performed. The dispersion estimation was realized on specialized software using for input measured data for emission and meteorological data. The paper presents a short overview regarding adverse effects of different air pollutants (NO_x, CO, SO_2, THC, PM and O_3) on human health, which have been well studied worldwide. The work performed in this article aims to quantify the contribution of various pollution sources (incinerator and thermal power station), to the local air pollution from an airport area. In order to evaluate when the functioning of the sources will be considered dangerous for populations we elaborate the worst scenario regarding the CO, NO_x, SO_2, which can be applied by the authorities from both pollution sources. At the end of the paper conclusions and future plans will be presented.

Key-Words: - Air pollution, Dispersion, Emissions, Modelling, Scenario, Human Health

1 Introduction

Pollution is the act of environment contaminating that causes instability, disorder, harm or discomfort to the ecosystem i.e. physical systems or living organisms. Air pollution is one of the major urban environmental problems as a consequence of economic development, urbanization, energy consumption, air and urban road transport and rapid increase of urban population. Air pollution has been and continues to be a significant health hazard worldwide. Exposure to air pollutants is a problem of increasing concern due to the diversity of the pollutants in question, adverse effects observed in a broad range of air pollution levels, and the vast number of people at risk. The effects of air pollution can sometimes be observed even when the pollution level is below the level indicated by air quality guidelines.

Quantification of emissions from all sources has become a high priority and concerns about human health effects have led to the implementation of regulations to reduce emissions of harmful air pollutants and their precursors at international, national, regional and local levels [8].

Some air pollutants like nitrogen oxides (NO_x), carbon monoxide (CO), sulphur dioxide (SO_2), hydrocarbons (HC) and particulate matter (PM), that are released into the atmosphere by man-made directly affects the environment and present health risks.

Nitrogen oxides (NOx) are composed by nitrogen dioxide (NO2) and nitric oxide (NO). Nitric oxide (NO) is produced at high temperature during the process of fuel burning. Initially emitted into the atmosphere as a primary pollutant from traffic and power stations, nitric oxide is oxidized to nitrogen dioxide following dispersal.

Carbon monoxide (CO) is produced when fuels containing carbon are burned in small quantities of oxygen. Road transport is the major source of carbon monoxide atmospheric pollution. Also, smaller contributions come from the processes involving the combustion of organic matter, for example power stations and waste incineration.

The most common sources of sulphur dioxide (SO2) are: fossil fuel combustion, smelting, manufacture of sulphuric acid, paper industry, incineration process and production of elemental sulphur.

Hydrocarbons consist of methane (CH4) and other non-methane (NMHC) compounds. The methane environmental impact is principally related to its contribution to global warming and to the production of ground level or lower atmosphere ozone.

Organic and inorganic compounds present in the atmosphere as both liquid and solid substances particles represent Particulate matter (PM). Its diameter can differ between less than 2.5 micrometers (μm) and up to 10 micrometers. PM is the most critical pollutant and is emitted from a wide range of man-made sources, the most significant primary sources being road transport,

non-combustion processes, industrial combustion plants and processes and public power generation.

Ozone (O_3) is not usually emitted directly into the air, it is a secondary ambient air pollutant. At ground-level is created by a chemical reaction between oxides of nitrogen (NOx) and volatile organic compounds (VOC) in the presence of sunlight. O_3 has the same chemical structure whether it occurs miles above the earth or at ground-level and can be "good" or "bad," depending on its location in the atmosphere. In the earth's lower atmosphere, ground-level ozone is considered "bad." Motor vehicle exhaust and industrial emissions, gasoline vapors, and chemical solvents as well as natural sources emit NOx and VOC that help form ozone. Ground-level ozone is the primary constituent of smog. Sunlight and hot weather cause ground-level ozone to form in harmful concentrations in the air. As a result, it is known as a summertime air pollutant [9].

2 Links between atmospheric pollution and human health

The health of our lungs and entire respiratory system is affected by the quality of the air we breathe. In addition to oxygen, this air contains other substances such as pollutants, which can be harmful. There is a continuous and growing concern about the links between the environment and health. Worldwide, and probably also in Europe, one quarter to one third of the disease appears to be attributable to environment factors [6].

Short-term and long-term exposure to ambient air pollution has been associated with a series of adverse health effects, most of the recent evidence focuses on respiratory and cardiovascular effects. High-risk people categories with great vulnerability include young children, the elderly and persons with predisposed diseases [4].

Different groups of individuals are affected by air pollution in different ways. Some individuals (people with health problems such as asthma, heart and lung disease) are much more sensitive to pollutants than are others. The extent to which an individual is harmed by air pollution usually depends on the total exposure to the damaging chemicals: the duration of exposure and the chemicals concentration.

Examples of short-term effects include irritation to the eyes, nose and throat, and upper respiratory infections such as bronchitis and pneumonia. Other symptoms can include headaches, nausea, and allergic reactions. Short-term air pollution can aggravate the medical conditions of individuals with asthma and emphysema.

Long-term health effects can include chronic respiratory disease, lung cancer, heart disease, and even damage to the brain, nerves, liver, or kidneys. Continual exposure to air pollution affects the lungs of growing children and may aggravate or complicate medical conditions in the elderly. Short & long term effects of pollutants are presented in table 1.

Table 1 – Effects related to short & long – term exposure to the different pollutants

Pollutant	Effects related to short-term exposure	Effects related to long-term exposure
Particulate matter	-Lung inflammatory reactions; -Respiratory symptoms; -Adverse effects on the cardiovascular system; -Increase in medication usage; -Increase in hospital admissions; -Increase in mortality.	-Increase in lower respiratory symptoms; -Reduction in lung function in children; -Increase in chronic obstructive pulmonary disease; -Reduction in lung function in adults; -Reduction in life expectancy, owing mainly to cardiopulmonary mortality and probably to lung cancer.
Ozone	-Adverse effects on pulmonary function; -Lung inflammatory reactions; -Adverse effects on respiratory symptoms; -Increase in medication usage; -Increase in hospital admissions; -Increase in mortality.	-Reduction in lung function development.
Nitrogen dioxide	-Effects on pulmonary function, particularly in asthmatics; -Increase in airway allergic inflammatory reactions; -Increase in hospital admissions; -Increase in mortality.	-Reduction in lung function; -Increased probability of respiratory symptoms.

Commonly, the nitric oxide is non-toxic, but on long term and at high concentrations affects lung function. The nitrogen dioxide is also dangerous to health and the effects of people exposure include breath problems and chest pains.

CO is poisonous when inhaled because it combines with hemoglobin, the oxygen-carrying substance in red blood cells and block it. Therefore, the lack of oxygen makes cells and tissues to die.

Research has shown that for asthmatics, exposure to sulphur dioxide is significantly more damaging than for normal subjects. It may cause tightness in the chest and coughing, lung dysfunction for asthmatics and finally medical help is required.

PM with the diameter less than 10 μm can penetrate deep into the lung and cause more damage, as opposed to larger particles that may be filtered out through the airways' natural mechanisms.

Medical conditions arising from air pollution can be very expensive. Healthcare costs, lost productivity in the workplace, and human welfare impacts cost billions of dollars each year. That's why is very important to measure and to create scenarios to find out when we have a dangerous situation for human health.

3 Theoretical aspects regarding air pollution dispersion

In order to protect human health and the environment as a whole, it is particularly important to combat emissions of pollutants at source and to identify and implement the most effective emission reduction measures at local, National and Community level. Therefore, emissions of harmful air pollutants should be avoided, prevented or reduced and appropriate objectives set for ambient air quality, taking into account the relevant World Health

Organization standards, guidelines and programs [5]. To study atmospheric dynamics and chemistry that govern the transport and transformation of natural and man-made emissions are used Air Quality Models (AQMs).

Air dispersion modelling represents the computerized simulation of the movement and dilution of air pollutants from release points (sources) to environmentally-sensitive targets (receptors).

Dispersion models use mathematical formulations to characterize the atmospheric processes that disperse a pollutant emitted by a source. Using observations and/or simulated meteorological fields, dispersion models can predict concentrations at selected downwind receptor locations [2].

The basic Gaussian equation, a mathematical approximation that simulates the steady-state dispersion of pollutants from a continuous point source is given below.

The dispersion model for estimation of plume contaminant concentration at a point in space is based on Gaussian Dispersion Equation [1][3].

$$C(x, y, z, H) = \frac{Q}{2\pi \sigma_y \sigma_z u} \exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right]\left\{\exp\left[-\frac{1}{2}\left(\frac{z-H}{\sigma_z}\right)^2\right] + \exp\left[-\frac{1}{2}\left(\frac{z+H}{\sigma_z}\right)^2\right]\right\}$$

(1)

Where:

C = point concentration at receptor, in $\mu g/m^3$;

(x, y, z) = ground level coordinates of the receptor relative to the source and wind direction, in meters;

H = effective release height of emissions, in meters (m);

Q = mass flow of a given pollutant from a source located at the origin, in $\mu g/s$;

u = wind speed, in m/s;

σ_y = standard deviation of plume concentration distribution in y plane, in m;

σ_z = standard deviation of plume concentration distribution in z plane, in m.

The assumptions made in the development of the above equation are:

- The plume spread has a Gaussian (normal) distribution in both horizontal and vertical planes, with standard deviations of plume concentration distribution in the horizontal and vertical directions of σ_Y and σ_Z, respectively;

- Uniform emission rate of pollutants;

- Total reflection of the plume at ground ($z = 0$ conditions);

- The plume moves downstream (horizontally in the x direction) with mean wind spread, u;

- The stack gases emitted from the source in the atmosphere are not reactive i.e. there is no form of reaction between the pollutants.

Air Quality Models (AQMs) are an integral part of the current regulatory framework, and are likely to remain so in the foreseeable future. They are central to air quality management decisions, which can affect policies related to transportation, energy, industry, and public health.

Regional air pollution mapping gained additional importance with the arrival of EU's 1996 Air Framework Directive and the subsequent pollutant-specific Daughter Directives. Modelling is an assessment technique specifically referenced in the Daughter Directives. IMMI (the software used to predict air pollution dispersion in this case study) contains algorithms that can be used for small, medium and large-scale mapping and is thus suitable for pollution assessment in the vicinity of industrial polluting sources up to regional air pollution modelling of the Daughter Directives.

IMMI– the universal environmental pollution software – features a fully operational Gauss model in its base module [10]. The general idea of the IMMI software is presented in figure 1.
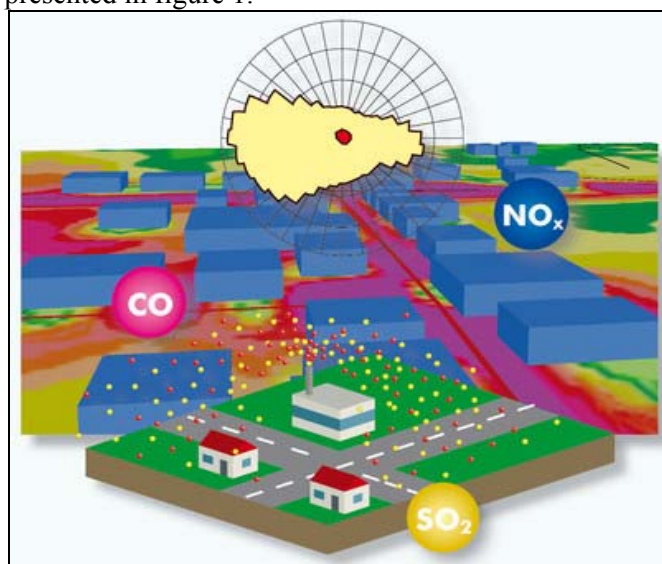

Fig. 1 – General idea of the IMMI air polluting software

In order to quantify the contribution of various pollution sources (incinerator and thermal power station) this paper presents a case study from an airport area.

The parameters considered for air pollution mapping in this study are Nitrogen Oxides (NOx), Sulphur Dioxide (SO2), and Carbon Monoxide (CO). The air quality profile consequences of emission are predicted using Gaussian Plume Dispersion Model.

4 Case study - Measurements in situ

The case study performed by COMOTI team between 12/04/2009 – 12/07/2009 has been conducted simultaneously in two directions: air quality monitoring and emissions measurements (at source).

4.1. Air quality monitoring

The work plan was to conduct the air quality monitoring in under study airport area, the mobile laboratory being placed near to two pollution sources:

 a) Thermal power station, operating with gaseous fuel, **S1**;

b) Incinerator of the household waste from the aircrafts, **S2**.

Air pollution and weather conditions data monitoring was continuously performed with a meteo station framed in the mobile laboratory, which is also equipped with automatic analyzers to measure concentrations of NO, NO_2, NO_x, CH_4, NMHC, THC, CO, SO_2, O_3 and PM10 in the ambient air. The polluted air sampling has been done at a height of 3.5 m from the ground. The mobile laboratory is equipped with a weather monitoring station measuring parameters: wind speed and direction, ambient temperature, pressure and humidity at a height of 10 m above the ground. It was located at a distance of 65 m to S1 and 62 m from S2, as shown in Fig.2.

Fig.2 – The location of emission monitoring point versus the emission sources.

The data values are acquired in real time and the averages at every 3 minutes are registered by each analyzer. In order to compare the measured values with the limit values (imposed by legislation) we have to average them at each 1 h. So obtained graphs with monitoring data for atmospheric pollutants over the entire period are presented in figures below (3 to 7). Figure 3 shows the correlation between NO_x and O_3, which underline the fact that NO compounds are precursor for ozone growing concentrations. Also we correlate all the hydrocarbons concentrations (methane, non-methane and total hydrocarbons) to underline the obtainment of the THC (figure 5). The PM10 values was obtained with the help of the Sven Leckel LVS3 analyzer based on special filters capturing and gravimetric measurement principle, according with European Norm 12341:2002. These results are presented in figure 7 near side having the limit value imposed by legislation.
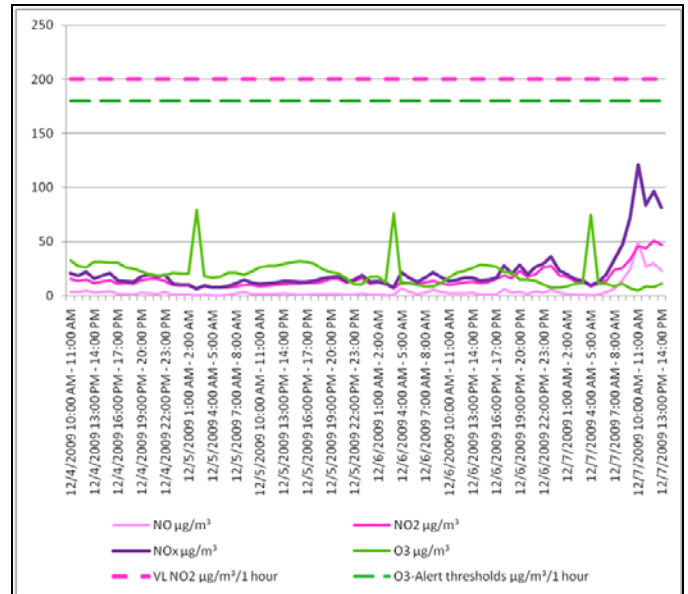

Fig.3 – The NO, NO2, NOx and O_3 measured concentrations and the limit values imposed by current legislation

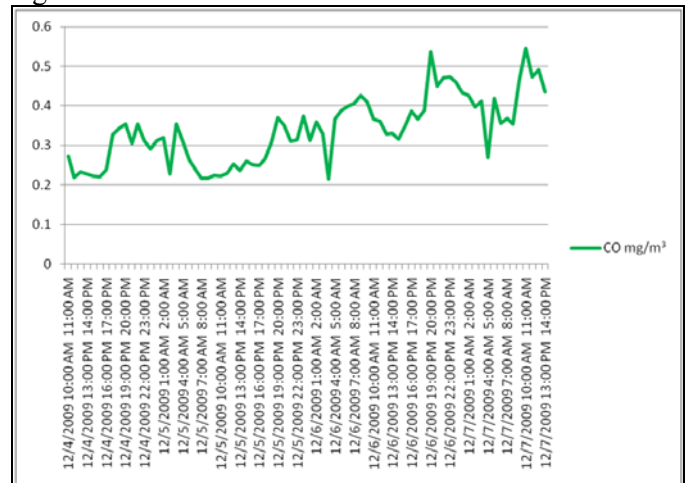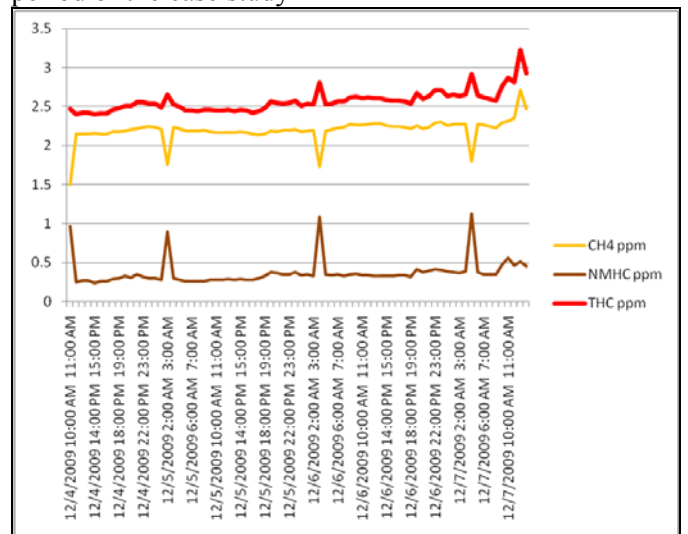Fig.4 – The CO monitored concentrations over the entire period of the case study

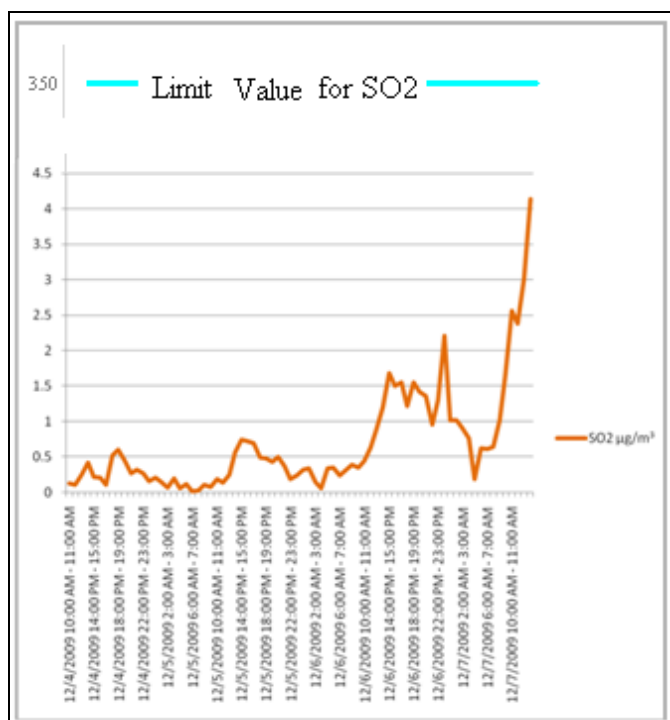Fig.5 – The CH4, NMHC and THC monitored concentrations over the entire period of the case study

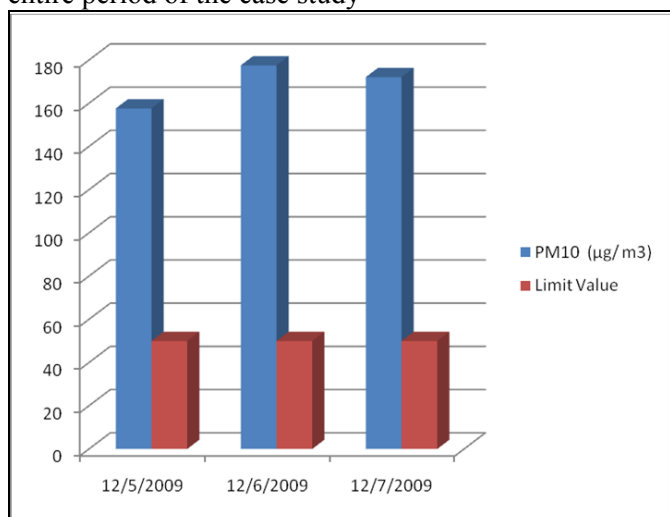Fig.6 – The SO$_2$ monitored concentrations over the entire period of the case study

Fig.7 – The PM10 measured concentrations

By analyzing the correlated meteorological data and the atmospheric pollutants concentrations we can conclude that the measured values have been majorly influenced by the undergoing activities from the measurement point vicinity:

- The measured concentrations of NO$_2$ underline the road/airport traffic contribution, even if the values are below the limit value of 200 μg/m3/1 hour, as stipulated in legislation;

- The SO$_2$ concentrations are much smaller than the imposed limit value of 350 μg/m3/1 hour, this being a prove for the fact that activities performed in the airport area did not cause significant SO$_2$ pollution;

- In the same time, the temporarily intensification of these activities has lead to peaks for CO and THC concentrations, the limit values being not exceeded (maximum daily eight hour average for CO is 10 mg/m3);

- Meanwhile, the PM10 fraction of suspended particulate matter measured values have been situated much more above the imposed limit value of 50 μg/m3/24 hour, due to the impact of industrial, road, airport and construction activities carried out in the area, correlated with the wind speed and direction from that period.

All the limit values are imposed by the DIRECTIVE 2008/50/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on ambient air quality and cleaner air for Europe [5].

4.2   Emissions monitoring

In order to identify the individual contributions, in the same period in which air pollutants have been monitored, measurements of emissions have been performed at the chimneys of the two industrial pollution sources from the studied area, S1 and S2.

Emission measurements were performed over a period of 30 minutes for each source, their average values being compared with the limits imposed by the specific legislation. Fig.8 shows "Vario Plus" portable analyzer, the equipment used to conduct the emission measurements.

Fig.8 "Vario Plus" analyzer for emissions measuring at S1 and S2 sources

During the emissions measurement and pollutants monitoring at source, the central power station functioned in a normal daily operating regime, 24 h of 24 h and the incinerator operated in a normal daily regime, every day for five hours in 24 hours.

In Figure 9 it is presented the temporal variation of CO, NO$_x$, SO$_2$ concentrations from the ambient air, respectively the wind direction WD over a 24 hours period, monitored with the mobile laboratory located at a distance of 65 m from S1 (thermal power station) and

62 m from S2 (incinerator), between 12/06/2009, 13.54 hour and 12/07/2009 13.57 hour.

Also shown (accentuated) in Figure 9 is the 5h period of incinerator functioning, on 12/06/2009, between 18.06-23.33 hours. It is clearly seen that in this period the concentrations of the monitored air pollutants increased, compared to other time intervals in which the incinerator was not working.
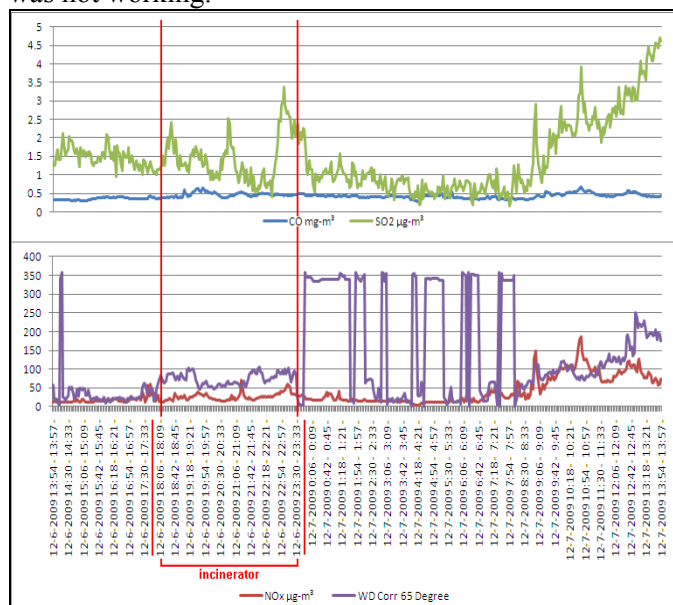

Fig.9 – Temporal variation of WD and CO, NO$_x$ and SO$_2$ concentrations

In Figure 10 is presented the wind rose for that period, between 12/06/2009, 13.54 hour and 12/07/2009 13.57 hour, indicating the wind direction.
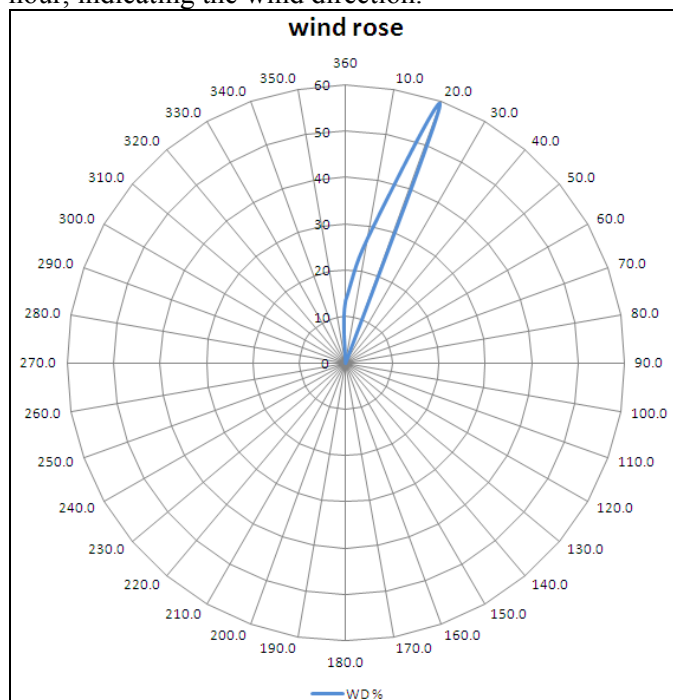
Fig.10 – Wind rose in monitoring period

It is noted that the wind blows from the incinerator (S2), this leading to increased levels of CO, NO$_x$, SO$_2$

concentrations, monitored with the mobile laboratory located at 65 m from it.

The wind is one of the most important meteorological parameters for the transport and dispersion of air pollutants. The wind acts both by speed and direction, its influence on air pollution being high variable, depending on the source position. Generally, the wind speed increases with altitude, the dispersion being facilitated by wind. More the wind will be stronger, the pollution level will be lower. In contrast, a low-speed wind favours the local accumulation of pollutants.

This air pollution is superposed over the local pollution caused by other sources from the area which is the subject of this case study: thermal power station, traffic, airport activities.

Following the measurements performed at the chimneys of the two sources of pollution and processing these data, we have obtained the values presented in Table 2.

Table 2 - Characteristic parameters for S1 and S2

Pollution sources	Average values of emissions measured 30 min		
	CO [mg/m3]	NOx [mg/m3]	SO2 [mg/m3]
Thermal Station	1.11	126.58	0.27
Incinerator	131.4	14.97	49.78

Pollution sources	Average values of the gas flow for 24 hours taking into account the effective working time at each pollution source, the exhaust chimney diameter and the gas velocity						
	time [h]	Φ [m]	v [m/s]	A [m2]	q CO [g/h]	q NOx [g/h]	q SO2 [g/h]
Thermal Station	24	0.7	1.9	0.3848451	0.002921898	0.333201659	0.000710732
Incinerator	5	0.5	1.5	0.196349541	0.029025371	0.003306772	0.010996065

5 Sources identification and dispersion of each of them, based on in situ emissions measurements

A modelling approach is sometimes useful. Existing models for estimating human exposure make use of data on time usage patterns, source presence, strength and use, and other relevant data. They need to be validated in studies in which exposure is actually measured. The advantage of modelling rather than measuring exposure is that modelling can usually be done at a fraction of the cost [8].

To quantify each source (S1 and S2) contribution and to highlight other possible pollution sources we predict the CO, NO$_x$ and SO$_2$ dispersion, using for input real values measured at the central power station and incinerator chimneys. Also we used meteorological data obtained by the mobile laboratory for the same period of 24 hours, between 12/06/2009, 13.54 hour and 07/12/2009, 13.57 hour and the real characteristics of the each chimney. The dispersion maps were realized using IMMI software version 6.3.1. Air pollution dispersion modelling is a specific technical evaluation method, indicated in the specific legislation in the field. The IMMI modelling software contains mathematical algorithms which can be used to realize the dispersion maps at small, medium or large scale, in order to evaluate the air pollution in the

vicinity of the pollution sources. The dispersion model used for estimating the concentration of pollutant plume to a point in space, or at ground level, is based on Gaussian Dispersion Equation (equation 1).

Generally, the main steps for dispersion modelling are:

- obtaining the concentrations values of the pollutants by measuring at source;
- implementing the necessary input data for the model (wind speed and direction, working sources operating conditions / parameters, functioning periods);
- preparing the 3D model of the interest area using the real sources dimensions and coordinates (figure 11);
- defining the real coordinates of the virtual receiver point (the same location with the mobile auto laboratory);
- configuring the grid resolution of the 3D model;
- Starting the calculation and obtaining the dispersion map.
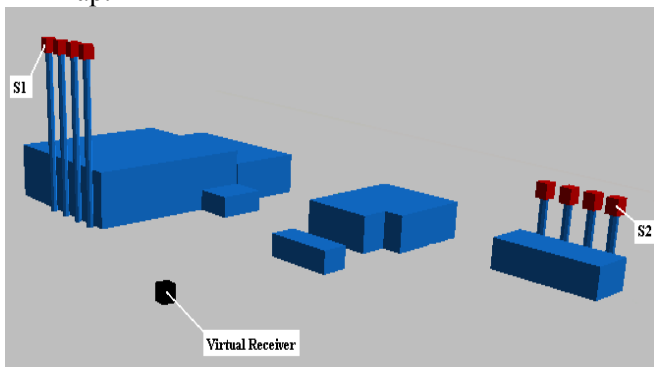
Figure 11 – Example of the 3D model for S1 and S2

Considering the hypothesis that only one exhaust chimney from each source is in service, we realized the following dispersion maps for all pollutants (Fig. 12 – Fig 20).
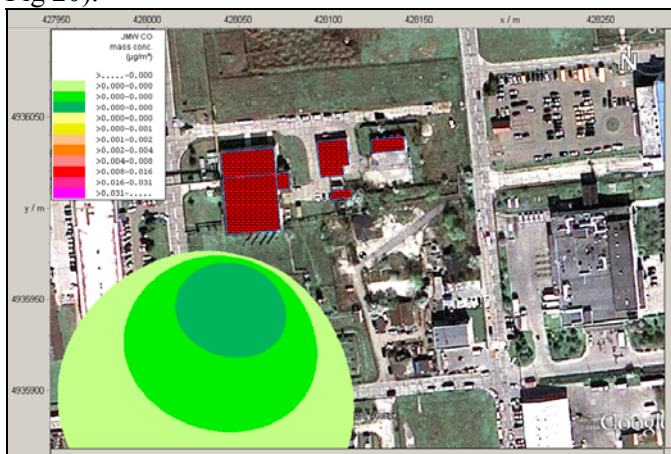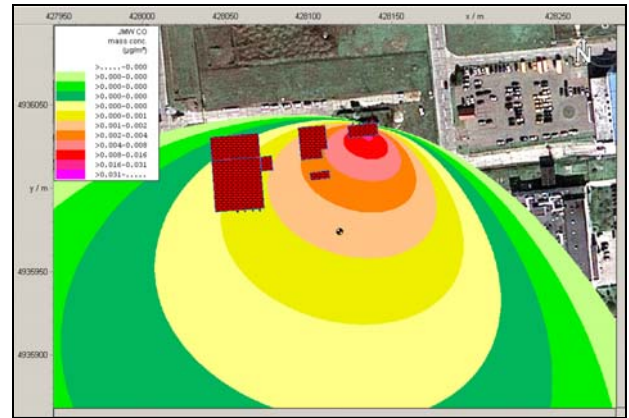

Fig.12 – CO dispersion map for thermal power station
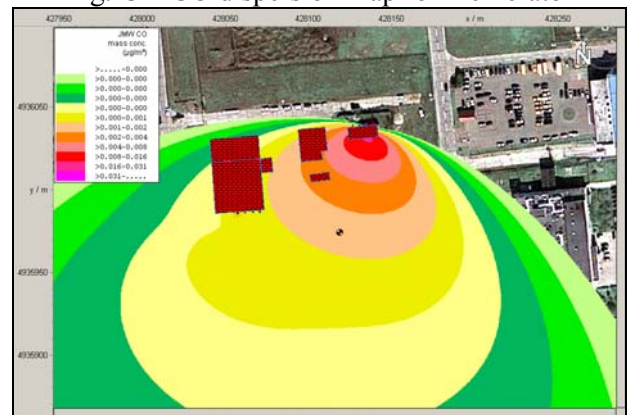

Fig.13 – CO dispersion map for incinerator

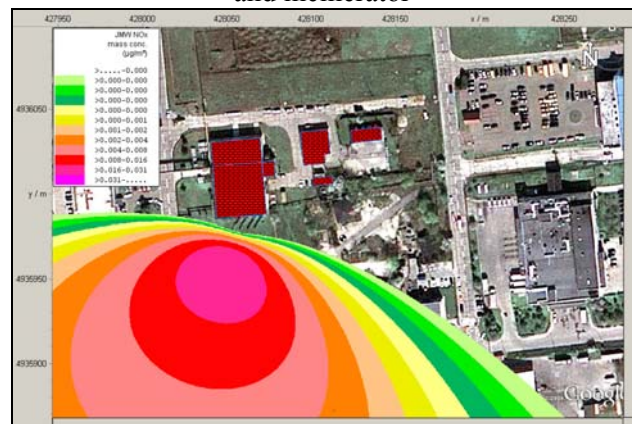Fig.14 – CO dispersion map for thermal power station and incinerator

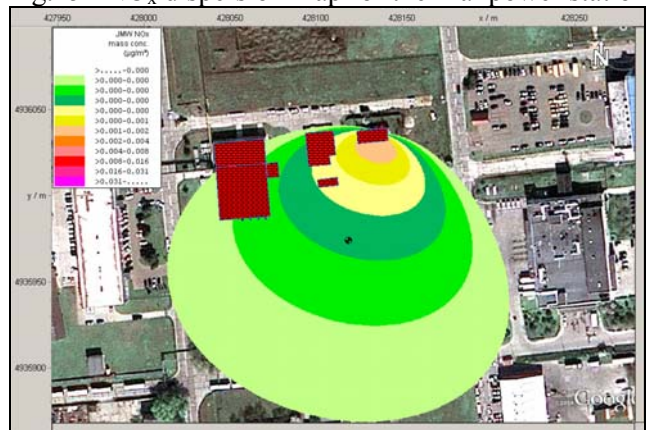Fig.15 –NO$_x$ dispersion map for thermal power station
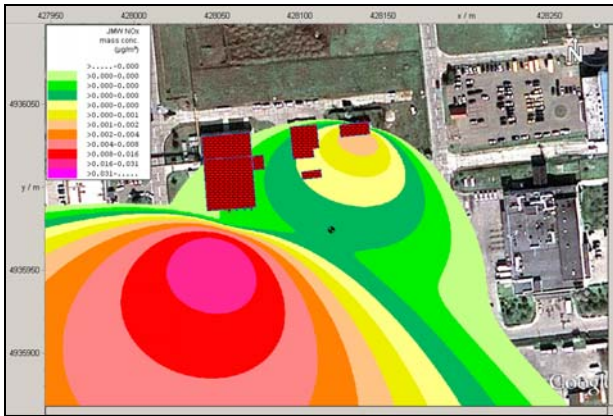

Fig.16 –NO$_x$ dispersion map for incinerator

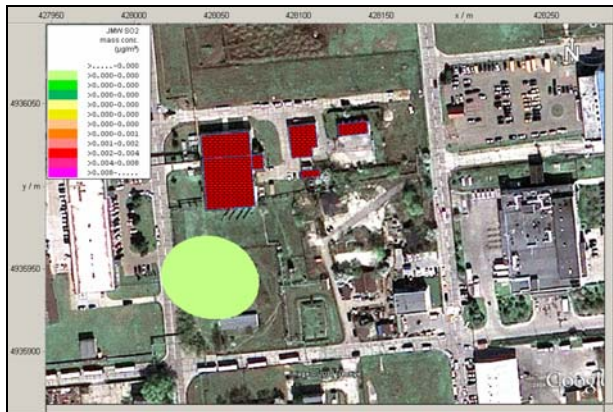Fig.17 –NO$_x$ dispersion map for thermal power station and incinerator

Fig.18 –SO$_2$ dispersion map for thermal power station

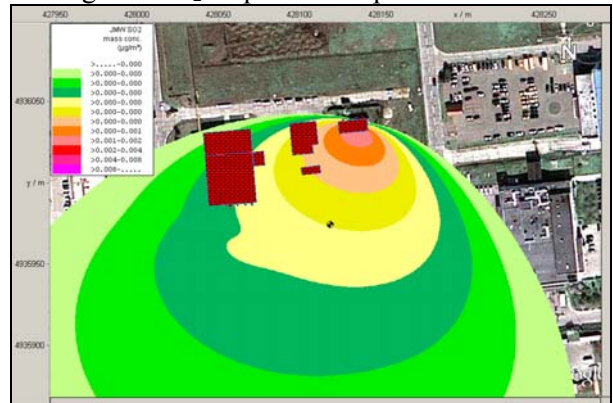Fig.19 –SO$_2$ dispersion map for incinerator

Fig.20 –SO$_2$ dispersion map for thermal power station and incinerator

Analyzing the dispersion maps and correlating them with Figure 10 which shows the direction of the wind, it can be concluded that the mobile laboratory was located outside the range of the pollutant plume from the thermal power station. The location was well chosen for the incinerator emissions dispersion.

6 Estimation of the air pollution degree creating scenario

In table 3 it is shown that through this prediction we find much smaller emissions values with the virtual receiver located in the same coordinates as the mobile laboratory than the monitored emissions, which proves the fact that the local pollution of the area is highly influenced by other pollution sources (not only by the thermal power station and incinerator). These sources can be: road traffic, aircrafts ground operations, aircrafts in approach or departing, etc.

Table 3 – Prediction emissions values versus emissions measurement values

		Thermal power station (S1)	Incinerator (S2)	S1 and S2
Values obtained using prediction for 24 hours, with the virtual receiver located in the same position as the mobile laboratory	CO [mg/m³]	0.000000	0.000002	0.000002
	NO$_x$ [mg/m³]	0.000000	0.000000	0.000000
	SO$_2$ [mg/m³]	0.000000	0.000000	0.000000
Measured values with the mobile laboratory (24 h average)	CO [mg/m³]	0.422320		
	NO$_x$ [mg/m³]	0.0356557		
	SO$_2$ [mg/m³]	0.001475		

Taking into consideration that the above presented results are inconclusive for the pollution sources considered in the present case study, we create the worst scenario by considering the following hypothesis:
- Both sources are working in the same time;
- Both sources are functioning at maximum capacity, using 4 exhaust chimney (in the previous prediction we simulate only 1 exhaust chimney);
- The meteorological data and the working schedule is the same that we used for the previous prediction.

Following are presented the dispersion maps for the second case, for the concentrations of CO, NO$_x$ and SO$_2$ pollutants emitted by S1 and S2 (Fig. 21 – Fig 24):
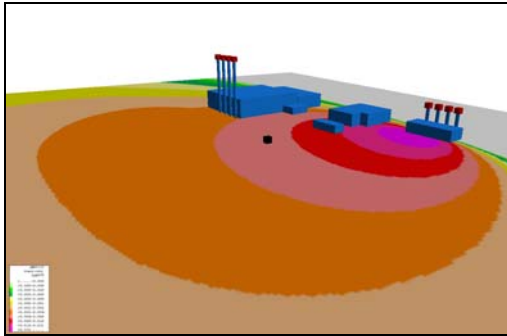
Fig.21 – CO dispersion map for thermal power station and incinerator (4 exhaust chimneys working) - 3D representation
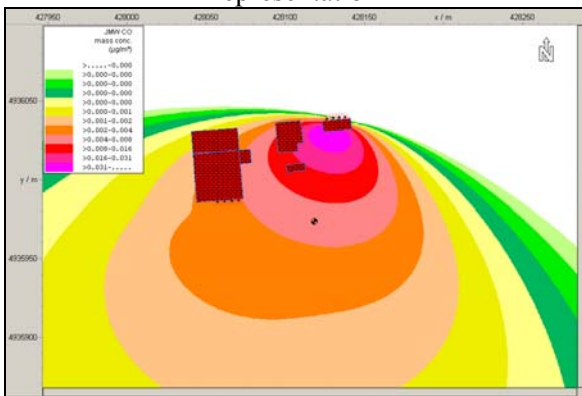

Fig.22– CO dispersion map for thermal power station and incinerator (4 exhaust chimneys working)
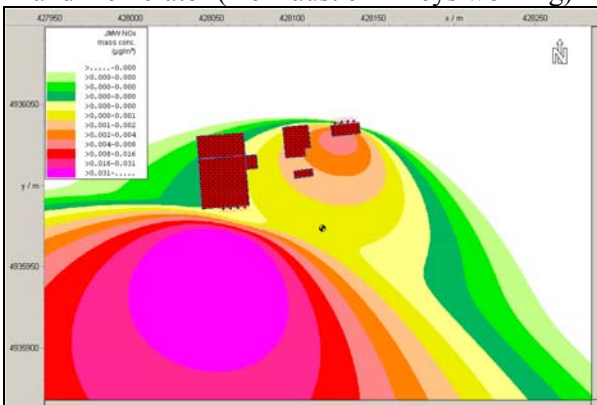

Fig.23 –NO$_x$ dispersion map for thermal power station and incinerator (4 exhaust chimney working)
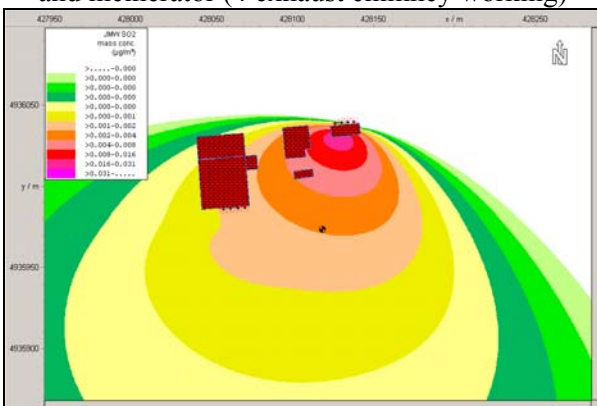

Fig.24 –SO$_2$ dispersion map for thermal power station and incinerator (4 exhaust chimney working)

In table 4 are presented the average values of the atmospheric pollutants in the same position of the mobile laboratory using the virtual receiver of the IMMI software. The prediction was realized considering the hypothesis of 4 exhaust chimney working in the same time.

Table 4 – Prediction values versus measured values for 4 exhaust chimney working

		Thermal power station (S1) and Incinerator (S2)
Values obtained using prediction for 24 hours, with the virtual receiver located in the same position as the mobile laboratory	CO [mg/m³]	0,004-0,008
	NO$_x$ [mg/m³]	0,001
	SO$_2$ [mg/m³]	0,004-0,008
Measured values with the mobile laboratory (24 h average)	CO [mg/m³]	0,422320
	NO$_x$ [mg/m³]	0,035656
	SO$_2$ [mg/m³]	0,001475

We can observe that in this particular situation only SO$_2$ values are higher than measured values and the CO and NO$_x$ values are smaller than measured values. We can conclude that in the same meteorological conditions in which we have performed measurements at source it is not recommended the functioning of the both sources at maximum capacity, mostly of the incinerator, what highly contributes to the average values of pollutants concentrations.

7 Conclusions

Combining the pressure from population with the one from the European Community, there is an increasing demand for environmental reporting. This study gives an opportunity to the airports to verify the airport pollution sources and analyze future scenarios for a sustainable development of the area [7].

The work performed in this article aims to quantify the contribution of various industrial pollution sources (incinerator and thermal power station), to the local air pollution from an airport area. We performed both air quality continuously measurements over a period of 4 days in airport area and emissions measurements at industrial sources from the above mentioned area.

Results and conclusions regarding the air pollutants concentrations (NO, NO$_2$, NO$_x$, CO, SO$_2$, CH4, NMHC, THC, PM10 and O$_3$) framing those into the limit values imposed by current legislation were offered all over the article.

For a better evaluation of each pollution source contribution it is necessary to perform the air quality monitoring in different points of the area involved in the study and at the different distances of the S1 (thermal

power station) and S2 (incinerator). In this way, by correlating the real values of the monitored pollutants with the meteorological data, especially the wind direction, we will have a clear image of the exposed area and pollution dispersion as function of the movement direction of the pollutant cloud.

The software used in this case study for emissions dispersion modelling is applicable to industrial area, in order to have more accuracy in the field approach (aviation and industrial) it will be useful to make prediction with software especially for aviation sources dispersion (aircrafts and ground operations). In such way we can specifically quantify sources contributions.

For a better correlation between central power, incinerator and airport activities we must take into account for a future plan to include the atmospheric monitoring in different areas from the vicinity of the airport. Such kind of positioning can be at: near to runway at take-off and approach points, near to the aircrafts testing zone and to monitor the ground operations. Also it will be useful to have data in the vicinity of populated area, to evaluate the impact on communities.

There are still large uncertainties and important gaps in knowledge regarding the relationship between exposure to different air pollutants and health effects. More research and periodic surveillance of health effects is needed in order to "fill" these gaps. Also a better standardization of routinely collected health outcome data is required.

Taking into consideration all this comments we can formulate a series of conclusions which can be helpful in the future to elaborate sustainable development plans of the urban assessed area. In our case study, the atmospheric dispersion modelling helps us to:

- predict the downwind concentration of air pollutants emitted from stationery sources such as industrial plants;
- determine whether existing or proposed new industrial facilities are or will be in compliance with the National Ambient Air Quality Legislation;
- demonstrate the effectiveness of emission control strategies aimed to reduce emissions of harmful air pollutants, to achieve compliance with regulatory standards;
- forecast air pollution events that might pose a health hazard for the general public, as well as sensitive groups (e.g., children, elderly);
- assess the impact of individual sources on air quality.

The future objectives of the COMOTI team – making scenarios, offering solutions - are in accordance with one of the environmental goals set at international level, which is to limit or reduce the effects of emissions from aviation on local air quality [11].

References:

[1] Turner, D.B., *Workbook of Atmospheric Dispersion Estimate*, PHS. Publication No. 999, Ap-26, Cincinnati, Ohio, 1994

[2] Maudood N. Khan, William L. Crosson, and Maurice G. Estes, Jr. Universities Space Research Association (USRA), *Land Use and Land Cover Characterization within Air Quality Management Decision Support Systems: Limitations and Opportunities*, NASA Applications Program Lead Program Manager for Air Quality Applications NASA Headquarters Washington, DC 20546, February 23rd 2007

[3] FAA-AEE-07-01 (Rev. 7 – 11/06/09), *Emissions and Dispersion Modelling System (EDMS) User's Manual*, CSSI, Inc., Washington, DC

[4] Bingheng Chen, Haidong Kan, *Air pollution and population health: a global challenge*, Environ Health Prev. Med (2008) 13:94–101, DOI 10.1007/s12199-007-0018-5

[5] Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on *ambient air quality and cleaner air for Europe*, Official Journal of the European Union

[6] European Environment Agency, 2003, *Europe's environment: the third assessment, Chapter 12 - Environment and human health*, http://www.eea.europa.eu/publications/environmental_assessment_report_2003_10

[7] Ayce Celikel, Delia Dimitriu, Nicolas Duchene, Ian Fuller, Vlad Martian, Dragos Preda, *ALAQS CASE STUDIES, Henri Coanda airport progress report*, EEC/SEE/2005, EUROCONTROL Experimental Centre

[8] World Health Organization - *Health Aspects of Air Pollution, Results from the WHO Project "Systematic review of health aspects of air pollution in Europe"*, June 2004

[9] U.S. Environmental Protection Agency, The Six Common Air Pollutants - http://www.epa.gov

[10] IMMI for dispersion calculation of gaseous, odorous and dust pollutants - http://www.woelfel.de/en/products/modelling-software/immi-air-pollution-mapping.html -

[11] Environmental Unit of the International Civil Aviation Organization (ICAO) in collaboration with FCM Communications Inc., *ICAO Environmental Report*, 2007