AIR QUALITY ANALYSIS IN THE CITY OF SETUBAL – SCENARIOS GENERATION TO SUPPORT MUNICIPALITY DECISIONS.

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INTRODUCTION

Nowadays, the impact of some real time or planning decisions, that the municipalities have to make in modern cities, are difficult to evaluate in terms of the future quality of life to the citizens. The environmental, social and economic impact consequences in a community must to be taken in account by the municipality authorities when they make decisions. It is known that the sustainable development of an urban community is strongly connected with the current decisions that the municipality has to work everyday. So, all decisions that are direct or indirect related with the localisation, schedules and activity regimes of industries, traffic, residential areas, streets, roadways and others, will conduct to good or bad consequences in the future of a community. This study was promoted by the municipality of Setúbal, and is about generating air quality scenarios, under different meteorological and emission conditions (mainly traffic and industry) in the city of Setúbal. This scenarios that pretend to characterise the main possible combinations of most frequent or common situations of emissions and meteorology conditions in the city, were prepared to be included in an Environmental Monitoring and Information System developed by a Portuguese SME named IrRADIARE Ltd. An atmospheric pollution dispersion model was used as a tool to produce the generated scenarios. Different meteorological conditions, using meteorological data of a 30 years database of the region were considered along this study, with different emission conditions. Values from the industry operating conditions and from several traffic conditions using data on the number and classes of vehicles were considered. The combination of meteorological and emission (industry and traffic) conditions leads to a number of scenarios stored in a dedicated data basis. The Environmental Monitoring and Information System includes a search engine that compares the model predicted output scenarios with the meteorological and air quality real data supplied to the system. The municipality of Setúbal promoted this study in order to use the results for city planning decisions and for public information.

CITY OF SETUBAL

Setúbal is a city in the middle south of Portugal, located in the district of Setúbal, 50km South of Lisbon at the margins of river Sado. Setúbal have a large resident population, important industrial activity and traffic activities. Setúbal has also two very important natural reserves in its neighbourhood. On the South side there is a river delta with important fauna and flora and in the Southwest there is a mountain, which is a natural protected area (National Park of Arrábida). The main industries in the city are a power plant (CPPE) fuel-oil fired, 1 GW_e, a paper mill industry (PORTUCEL), a cement industry (CECIL) and a fertiliser factory (SAPEC).

CHARACTERISATION OF THE EMISSIONS

In this study, the main pollution sources of the city are related with its industrial activities and with roadway traffic. It has also been considered some area sources related with the type of activity for some parcels of terrain. The main pollutants considered in this study was SO_2, Particles, NO_x and CO.

Figure 1. Localisation of the Air Quality Stations, Line Sources, Area Sources and Point Sources.

The values of industrial emissions for the pollutants considered (SO_2, Particles, NO_x, CO and VOC) are shown in the next table.

Table 1. Maximum and medium emission values considered for the point sources.

Source	MAX					MED				
	SO_2	**PM**	**NOx**	CO	**VOC**	**SO_2**	**PM**	**NOx**	**CO**	**VOC**
CPPE1	883.8	13.9	167.2	N/A	N/A	778.8	7.5	95.2	N/A	N/A
CPPE2	931.0	12,4	148.2	N/A	N/A	806.1	6.2	99.3	N/A	N/A
PORTUCEL1	1.9	N/A	0.9	N/A	N/A	0.6	N/A	0.7	N/A	N/A
PORTUCEL2	71.3	N/A	12.3	N/A	N/A	63.8	N/A	12.1	N/A	N/A
PORTUCEL3	2.1	N/A	0.9	N/A	N/A	1.3	N/A	0.9	N/A	N/A
SECIL 1	14.8	7.9	160.3	237.1	5.6	2.6	0.8	58.4	53.7	1.0
SECIL 2	4.3	4.5	103.8	119.9	5.5	0.9	0.6	33.7	32.4	1.1
SECIL 3	N/A	0.5	N/A	0.3	N/A	N/A	0.1	N/A	0.1	N/A
SECIL 4	N/A	2.3	N/A	0.9	N/A	N/A	0.4	N/A	0.2	N/A
SECIL 5	N/A	1.3	N/A	0.0	N/A	N/A	0.2	N/A	0.0	N/A
SECIL 6	N/A	11.0	N/A	0.2	N/A	N/A	2.1	N/A	0.0	N/A
SECIL 7	N/A	1.1	N/A	0.0	N/A	N/A	0.2	N/A	0.0	N/A
SECIL 8	N/A	6.0	N/A	0.0	N/A	N/A	1.2	N/A	0.0	N/A
SECIL 9	N/A	1.1	N/A	0.1	N/A	N/A	0.2	N/A	0.0	N/A
SECIL10	N/A	2.0	N/A	0.1	N/A	N/A	0.4	N/A	0.0	N/A
SECIL11	4.0	1.0	0.5	8.4	0.0	0.8	0.2	0.1	1.6	0.0
SECIL12	0.5	0.1	0.2	0.1	0.0	0.1	0.0	0.0	0.0	0.0
SAPEC	0.5	0.0	0.2	0.0	0.0	0.1	0.0	0.0	0.0	0.0

Note – All values in g/s

METEOROLOGICAL CHARACTERISATION

The meteorological data considered in this study were supplied by the Portuguese Meteorological Institute, using climatic acquisition stations located in Setúbal, and considering meteorological data of 30 years. Different meteorological conditions were considered and combined with the emission data and the meteorological variables considered were wind speed and direction, temperature and cloud cover.

THE AQME

The AQME ***Air Quality Monitoring Excelsior*** is an Environmental Management System that uses a atmospheric pollutant dispersion model, considering industrial, domestic and road traffic

sources, and using point, line and area sources sub-models. It's a user-friendly modular system, that used GIS (Geographical Information Systems) tools to visualise and manage the input and output data. The AQME also uses a search engine that compares the simulated scenarios and the real data information.

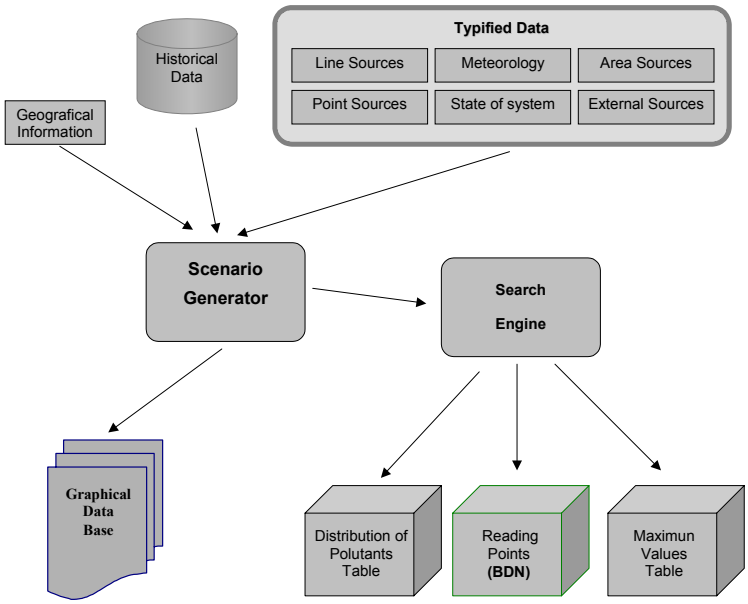

Figure 2. AQME Structure.

GENERATING SCENARIOS

The main objective of this work was, as refereed earlier, the generation of the largest number as possible output scenarios that could anyway characterise the different air quality conditions in the city region. These output scenarios could later be compared with real time air quality data conditions, acquired by a public *Air Quality Acquisition Net*, and real time meteorological data. Then, conclusions about the emissions done in the city can be made. So, the characteristic values from the industry operating conditions (reported earlier) and from several traffic conditions, using measurements of the number of vehicles and type of vehicles, were considered. It as also considered the values of the area emissions due to the urban, industrial and agricultural activities. The combinations of this emission conditions and meteorological conditions, were considered in the runs of the dispersion model. Combinations of the operating conditions (medium and maximum values of emissions) of all sources (industry, traffic and area sources), with the meteorological conditions (wind speed, wind direction, temperatures, day and night conditions) were made, considering the most representative cases. The outputs of the model were combined to generate a large number of scenarios (320 in a first phase, number that will increase in time) stored in a dedicated data basis. To search and compare this output simulated scenarios with the real time acquired data, *IrRadiare* developed a search engine using combined Visual Basic and Access applications.

RESULTS

The AQME produces, in the first phase 320 different scenarios, some examples of the output results are shown following.

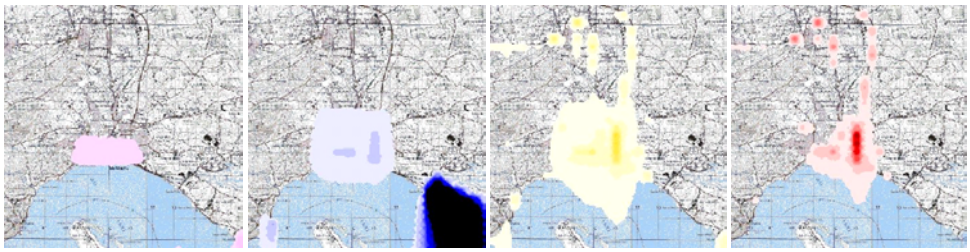

Figure 3. Typical summer meteorological conditions with north wind direction and medium values of emissions in all sources.

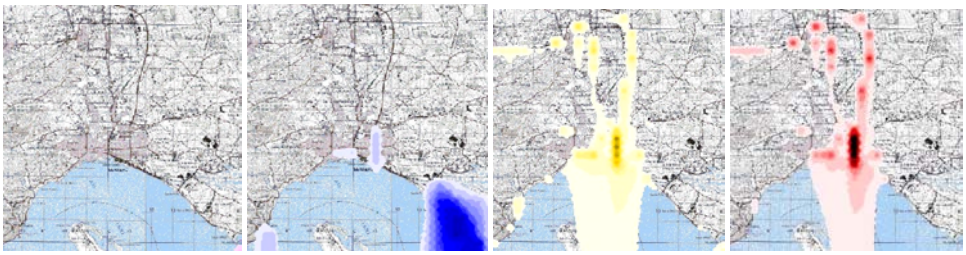

Figure 4. Typical winter meteorological conditions with north wind direction and medium values of emissions in all sources.

Figure 5. Typical summer meteorological conditions with north wind direction and line traffic emissions in rush traffic hour.

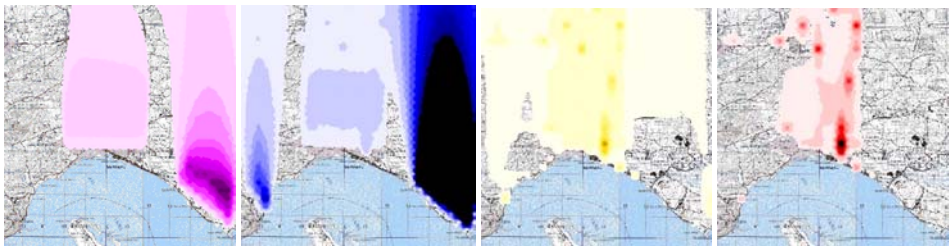

Figure 6. Typical summer meteorological conditions with south wind direction and maximum values of emissions in point sources.

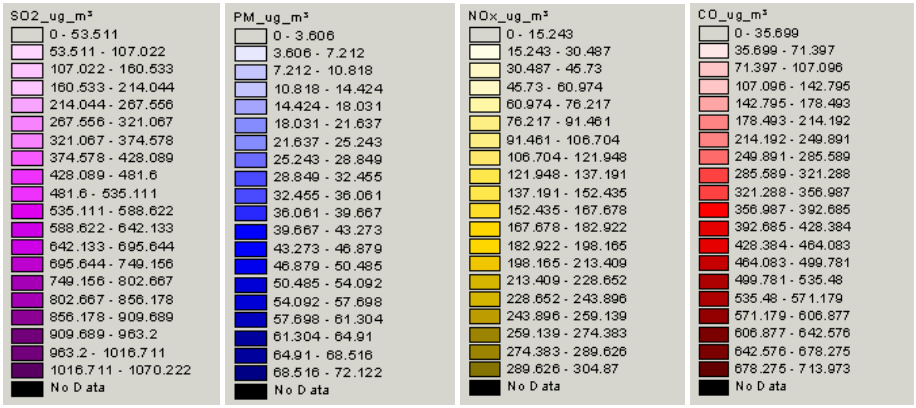

Figure 7. Concentration legends for different pollutants.

CONCLUSIONS

By the analysis of the obtained scenarios it is possible to observe that under certain conditions the air quality of the city is very affected by the pollutant emissions from the industries and traffic, especially with winds from south or low speed winds. This situation is worst under certain conditions of high level emissions from industries. Also, in some situations (rush time hours) the emissions from traffic can also achieve important values. The predominance of the wind direction is from North mainly during the summer (about 45% of occurrence). Therefore the city is not strongly affected by the pollution for almost of the summer days. Nevertheless South and Southwest wind directions are the second predominant directions, about 25%. This fact means that for a few summer days the city can be strongly affected by the pollution. During the winter the occurrence of North wind decreases, maintaining the higher occurrence, but during this period the air quality is in general better than during the summer, for the same wind directions. Therefore for the city, the worst air quality occurs for a few summer days when the wind blows from South. The river delta is more affect when the wind blows from the North. Therefore these natural reserve is very affect by the pollution, manly during a large range of summer days. The Natural Park of Arrábida is not very affected due to its location relatively to the pollutant sources. The natural reserve is located at West of the city. Therefore this reserve is mainly affected when the wind blows from East, or Northeast, but the occurrence of these directions is very low for both summer and winter days. By a general way, meteorological summer conditions lead to worst concentrations of pollutants and air quality than winter conditions. This is strongly related with higher temperatures and particular wind conditions that occur in this period of year. By the analysis of the obtained scenarios, it is also visible that important values of concentration of pollutants can also be achieved in the natural reserves, manly for the river delta for some combined meteorological and operating conditions. This work of generating and analysing scenarios, will continue and will the future be related with the study of the impact of air quality in the city, with the level of public health, especially for children and older people. Also the definition and calculation or air quality indices and sustainability indices will be made. These indices and its relation with public health will help the municipality in future planning decisions for the city.

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Keywords: Urban Air, Decision support system, air quality scenarios, air quality model.