7.11 GENERATING SCENARIOS TO PREDICT AIR QUALITY IMPACT IN PUBLIC HEALTH

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INTRODUCTION

This study intends to associate air quality with public health by generating air quality scenarios, under different future perspectives in Barreiro. This city is located in middle south of Portugal nearby Lisbon and it has a large resident population, an important industrial area and intense traffic. In this study ADMS-Urban was used to simulate the possible scenarios of future air quality in this city, taking into consideration the probable city development and future activities. Special attention was given to the future evolutions of traffic, industrial activities, demographical and geographical expansion. The new EU directives about air quality and the CAFE program were also considered. To correlate the impact of the future air quality of the city and public health, a children population sample was used. This study team is also composed by paediatric doctors from Hospital Nª. Sª. do Rosario that contribute with public health information and helped to identify air quality related diseases.

BARREIRO CITY

Barreiro is located in the district of Setúbal, 30 km south of Lisbon at the margins of river Tagus. The city is almost plane with its highest point at approximately 10 meters higher than sea level. The actual resident population is approximately 80000 habitants. The major economic activities of the city are metal mechanical and chemical industries.

POLLUTANT SOURCES

The main air pollution sources of the city are related with its industrial activities (point sources), roadway traffic (road sources) and urban activities (area sources). The region of Barreiro is one of the biggest and oldest industrial areas of Portugal and the main industries are: a combined heat and power fuel oil fired power station (2*32.5 MW_e); the industrial complex of Quimigal; one phosphate factory and one sulphate aluminium factory of Quimitecnia, an alimentary oils factory of Lusol and the acrylic fibres factory of Fisipe. To reach the industrial area an intense heavy traffic flows nearby the city centre. Due to the nearness from capital, light traffic is another important pollutant source. Other less important sources included on road sources type are the railway and waterway traffic.

Area sources are used to represent residual, poorly-defined or diffuse emissions released from domestic heating sources and minor roads. In the case of Barreiro, were only considered minor roads because domestic heating consumption, due to the pleasant meteorological conditions, is restricted to a few days per year.

In these study two different sources scenarios were considered: The present scenario (scenario 1) considering all sources previously described. The future scenario (scenario 2) considering the deactivation of one industrial area, differences in traffic roads sources (increases in traffic flows, decreases of car emissions) , a new road along the river, a new bridge between Barreiro and Lisbon (road and electrical railway), and electrification of the existing railway. These two scenarios are represented in Figure 1.

Air quality monitoring stations are installed in Barreiro where air pollutants like SO_2, NO, NO_2, CO, PM_{10} and O_3 are measured according with EU directives. These stations are represented in Figure 2 as receptor points as well as the hospital location.

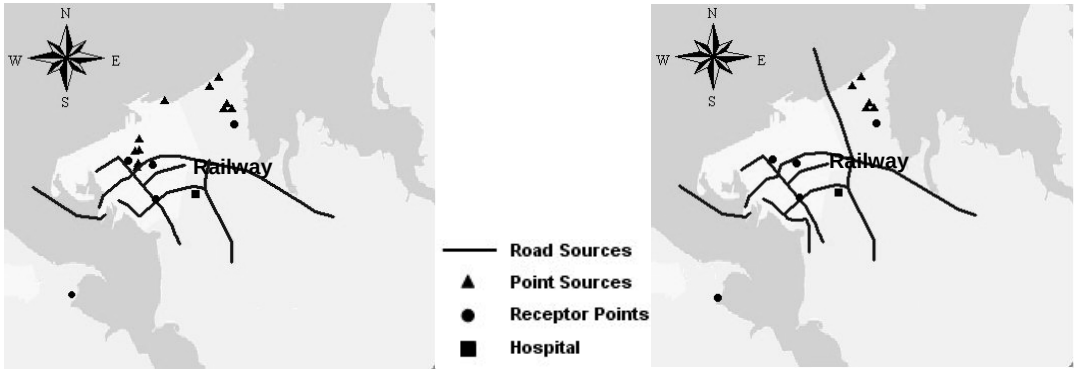

Figure 1. Location of the industrial and road sources considered (scenario1 and scenario 2).

The main pollutants considered as input were SO_2, NO_x and PM_{10} to industrial sources and NO_x, VOC, PM_{10} and CO to road and area sources. The industrial emissions characterizations were provided by a study from Barreiro municipality (*C.M.B.*, 1997) and road sources by *Garcia, J* (2001). In the present work reference values were estimated for each pollutant due to the absence of background data. These reference values were based in measurements made by air quality monitoring stations for conditions simulated.

METEOROLOGICAL CHARACTERISATION

The meteorological data to this study was supplied by the Portuguese Meteorological Institute, with is climatic acquisition station of Lavradio and considering meteorological data covering the period of 1967-1980. We have a predominance of winds from the NW quadrant with a medium frequency of occurrence of 35,1%, followed by the SW quadrant with 15,1% and quadrant NE with 12,7%. We have also a media of 27 days per year with fog, with highest frequency in winter mouths (5 days in January). Barreiro is characterised by strong fog, due to the proximity of the river Tagus, resulting in bad conditions to the dispersion of pollutants, especially during winter. Besides the dominant winds are from north, favouring the transport of pollutants to the direction of the residential zones in the surroundings of the industrial area.

TOPOGRAPHY CHARACTERISATION

The Portuguese Geographic Army Institute supplied the topographic data to this study in VPF format. The data was transformed to the corrected coordinates and performed the selected area in *ascii* format, using ArcView Software. The area selected for this study is presented in Figure 2 and represents an area of 10kmx10km. The grid is regular, with 200 meters of spacing in both directions and the data was obtained from contours spaced by 100 meters.

With the aim to describe accurately the study area, was performed a roughness length matrix for the study area. For this purpose, was used the Corine Land Cover Maps provide by the Portuguese CNIG. These Maps were building using satellite information and they provide land use information, classified in 44 categories. These categories was combined in 5 classes and for each class was attributed a value of roughness length, according to the Table 1.

Table 1. Land use classes and roughness length.

Class	Land Use	Roughness Length
A	Rural	20 cm
B	Forests	50 cm
C	Sub-urban	100 cm
D	Urban	200 cm
E	Water	0.1 cm

THE CHILDREN'S HEALTH DATA

The children's health data sample used in this study was obtained from the paediatric service of Nª.Sª. do Rosário Hospital in Barreiro. The data has being collected since June 2000 in the Barreiro Public Hospital, with children with ages up to 15 years old, supported by doctors. And were considered all identified cases with symptom otology of asthma or respiratory difficulties in the paediatric urgency of the referred hospital.

RESULTS AND DISCUSSION

Figure 2 and figure 3 shows the results to winter conditions in present (scenario 1) and future situations (scenario 2) to NO_x and PM10. Figures show the difference in air pollutant concentrations due to the evolution in Barreiro activities and emissions. Analysing the results it was observed that the worst situation in the city centre are the winter conditions for both present and future scenarios. In the future the NO_x in the city centre will increase manly due to the load traffic increase. A strong impact of the new bridge is observed in terms of NO_x concentration. This analysis is extended to other pollutant species (CO, and SO_2) In the case of PM10 it is possible to observe a concentration decreasing on the city centre manly due to the disappearance of the industrial area in this zone.

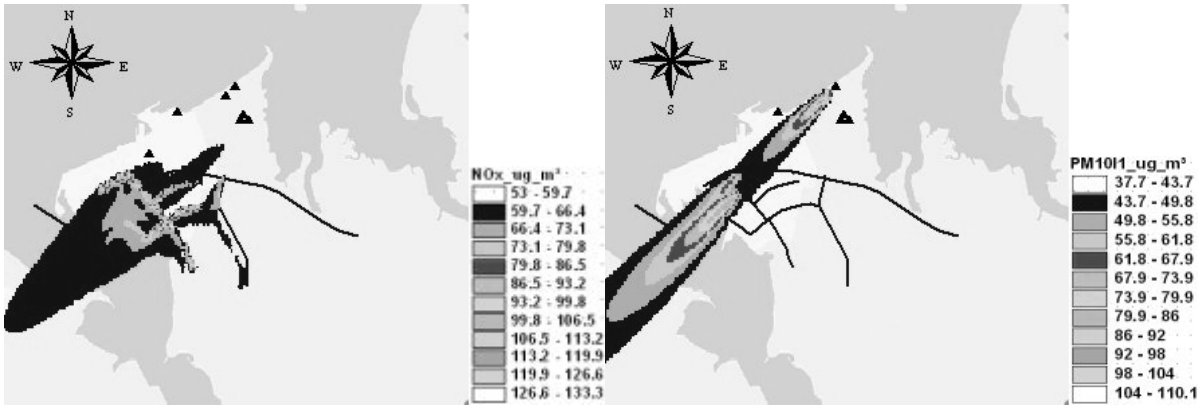

Figure 2. NO_x and PM10 concentration to winter present conditions (scenario1)

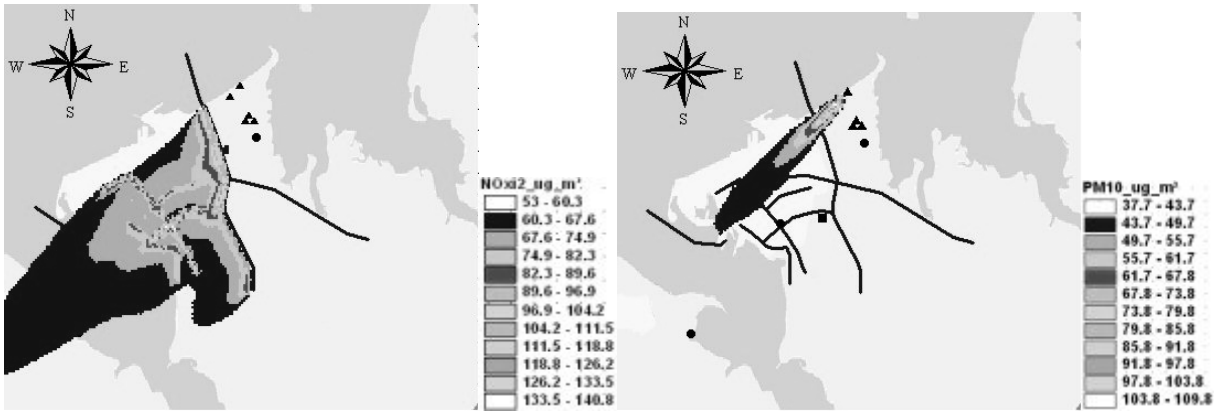

Figure 3. NOx and Particle concentration to winter future conditions (scenario2)

A statistical characterization of the data from air quality monitoring stations was performed. The average of the 5 monitoring stations was computed, for the pollutants concentrations and the meteorological data (maximum and minimum temperature (ºC), relative humidity (%) and maximum relative humidity (%)). An histogram of children frequency in the paediatric service of Nª.Sª. do Rosário Hospital in Barreiro is presented in Figure 4, as well as the distribution of children numbers by the study period. Figure 4 shows that the most common classes of children frequency are the correspondents to the small frequencies.

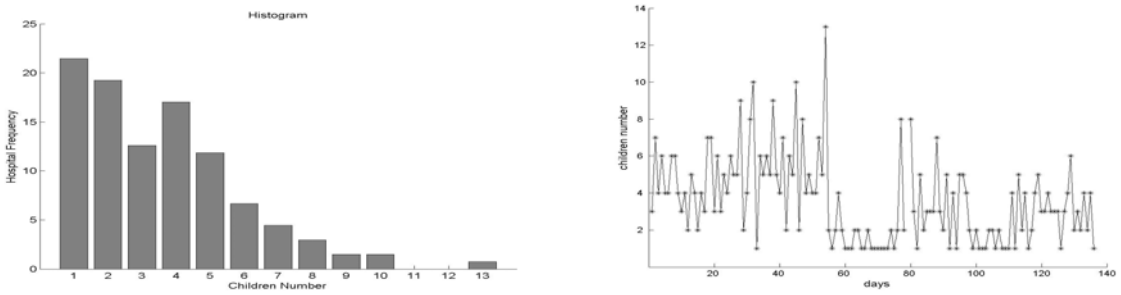

Figure 4. Children frequency in paediatric service of Nª.Sª. do Rosário Hospital in Barreiro

The frequency of different classes for different parameters was evaluated for the usual situation that corresponds to the complete range of health data and for the extreme situation that correspond to days with children frequency in paediatric service superior than 4 cases. This evaluation was performed for all the parameters (pollutants and meteorological parameters) and its possible to verify a relation between children frequency and some parameters. The most significant relations were found for Relative Humidity, Minimum temperature and Maximum CO. Note the extreme class of Relative Humidity responsible for 55% of the cases for usual situation becomes responsible for 80% of the cases in extreme situation. For minimum temperature the three upper classes (14, 18 and 22) increases from 80 to 88% and for maximum CO increases from 8 to 21 %. However these first results are very preliminary, due the reduced size of the sample.

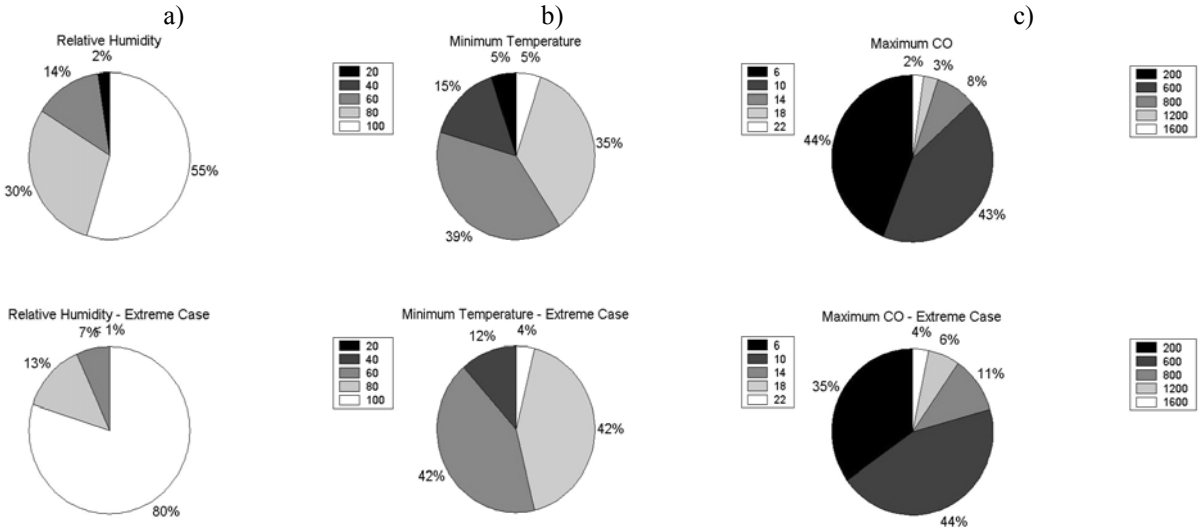

Figure 5. Classes Frequency for 3 different parameters: a) Relative humidity, units in %; b) Minimum temperature, units in ºC and c) Maximum CO, units in μgm^{-3}. The pies in top represents the usual situation with all range of children frequency in paediatric service of Nª.Sª. do Rosário Hospital and pies in bottom represents the extreme situation corresponding to days with more then four children in paediatric service.

CONCLUSIONS

In terms of air quality the worst scenario in the city centre is for winter conditions. In the future the air quality will become worst due to the load traffic increase. This is manly due to the new bridge. The disappearance of one industrial area will reduce the PM10 concentration on the city centre. The reason for this is the stronger influence of the industry comparing with the traffic in terms of PM10 emissions.

It is possible to conclude that this decreasing in air quality in the city centre, will conduct in this zone to an increasing number of observed children in Barreiro Hospital specially for extreme cases of more that 4 children observed. To quantify how this will affect public health, it is important to continue this study, namely with the acquisition of more data and with the extension of the period considered.

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