4.4 DEVELOPMENT OF A SOFTWARE TO DESCRIBE THE CITY MORPHOLOGY AND TO COMPUTE AERODYNAMIC PARAMETERS FROM AN URBAN DATA BASE

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1. INTRODUCTION

The Urban Boundary Layer (UBL) is structured by the heats fluxes and drag of the earth surface. The city represents a complex obstacle in the air flow. Consequently, a precise description of urban area is needed to calculate the aerodynamic parameters representing the resistance offered by the urban structure to the flow.

In this objective, the software DFMap is developed within a partnership of ECN, USTL and the society Siriatech. It allows to compute not only some statistical parameters describing the morphology of the buildings but also aerodynamic parameters like roughness length and displacement height, needed for micro-meteorological and air quality numerical simulations. This study is a contribution to UBL-ESCOMPTE project. A campaign of measurements was performed in the summer 2001, in Marseille (Fance), with objectives to carry out a three-dimensional data base of pollutant emissions and a study of the atmospheric composition and dynamics.

This presentation of DFMap is followed by the first results of calculations and their validation.

2. A SOFTWARE, DFMAP

2.1 The data base

DFMap uses a data base, BDTopo, produced by the National Geographic Institute from aerial photographs. This data base is composed of information in vectorial mode about the cover of the earth surface, including vegetation, hydrographic network and buildings. The topography is also included in this data base as contours and spot heights. Information are referenced in the projection system Lambert III with an accuracy is better than 1 meter (m). The outline of buildings is drawn by a poly-line including elevations as attributes.

2.2 DFMap

The software DFMap converts the initial data into raster mode. It computes over a grid different functions:

- functions describing the morphology of buildings like the height, the surface, the volume, the perimeter, …;
- functions describing the cover mode with density calculation;
- functions providing aerodynamic parameters like rough-ness length and displacement height with Bottema's and Raupach's models (Bottema, 1997, Raupach, 1992).

The user can choose a cell size, fix the wind direction to compute frontal and lateral surface densities used in the roughness calculation. The results are presented in cartographic form with an associated numerical file.

3. RESULTS

To evaluate the DFMap calculation, typical european urban quarters are delimited in Marseille. Only the results of the city center, immediately south of "Vieux Port", are presented here. In figure 1b, the building mean heights are computed on a cell grid of 50 m. This resolution permits to describe building heights precisely. Results are compared with the initial values (figure 1a). We can note a variation between 1 or 3 m for the maximum for certain buildings but in general the order of magnitude of heights seems correct. This errors are not solved for the moment and some tests on the BDTopo must be realized before calculating some functions because some errors are noted in the data base.

The results for other functions describing the morphology of buildings are validated. The density of buildings, for example, varies between 0.4 and 0.98 in this area.

Hence, we are testing the accuracy and the sensitivity of the software. The optimal size of the grid cells is not determined yet. In figure 2a, the roughness length is computed with a wind from north and a cell grid of 250 m and in figure 2b with a cell grid of 100 m (Figure 1 is the central part of Figure 2). Results vary between 0.3 and 2.0 m for the first resolution. The order of magnitude is approximately the same for the second resolution (except one cell). Stull (1988) proposes roughness length around 1 meter for town center and Oke (1987) between 1.5 and 2.5 m for high density and buildings height of 15 m.

The optimal size of grid cell must keep a statistical meaning for the calculation of aerodynamic parameters. The cell must represent a part of the urban structure and not yet a fragment of "urban fabric". On the contrary, if the cell size is too large, the

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smoothing of the urban features may be too important, blurring the urban heterogeneity.

Other data base are being exploited in this study like the urban data base carried out by Marseille town hall services or aerial and satellite photographs to compare the initial data to the calculation results.

4. CONCLUSION

The objective of DFMap development is generated data in raster mode to describe the urban structure and to identify the different organization and cover mode of this area. A scientific knowledge of the urban land uses and of the three-dimensional morphology of the cities will allow to improve micro-meteorology and air-quality numerical simulations

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5. REFERENCES

Bottema, M. (1997) Urban roughness modelling in relation to pollutant dispersion, *Atmospheric Environment* **31 (18)**, 3059-3075.

Raupach, M.R. (1992) Drag and drag partition on rough surfaces, *Boundary-Layer Meteorology* **60**, 375-395.

Oke T.R., 1987: Boundary layer climates, 2nd edition, Edition Methuen, London, 435 p

Stull R. B., 1988: An introduction to boundary layer meteorology, Kluwer Academic Publishers, the netherlands, 666 p

a. b.

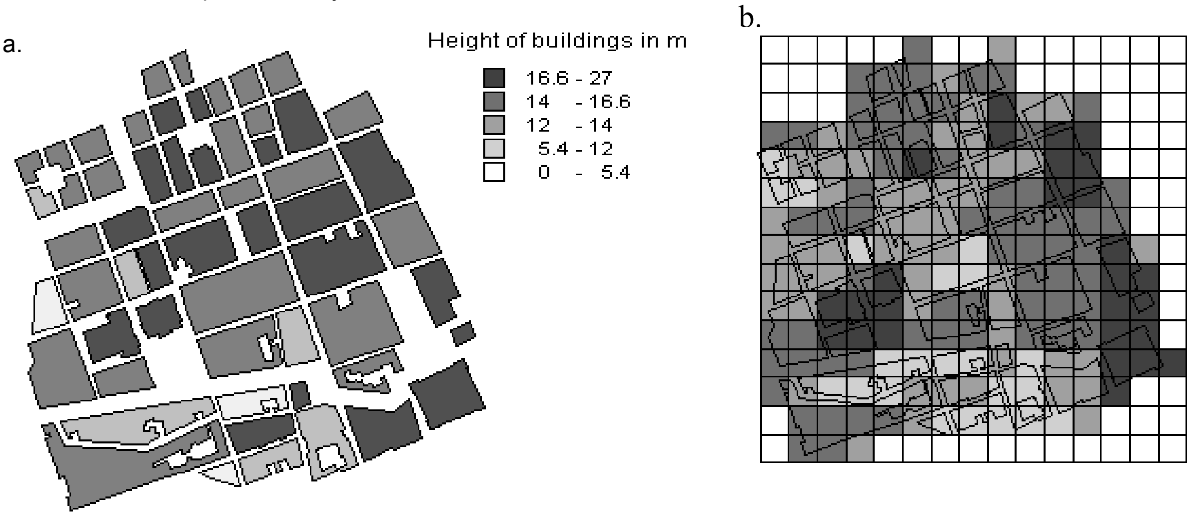

Figure 1 : Building height in Marseille city center : (a) data base initial values, (b) raster mode mapping

a. b.

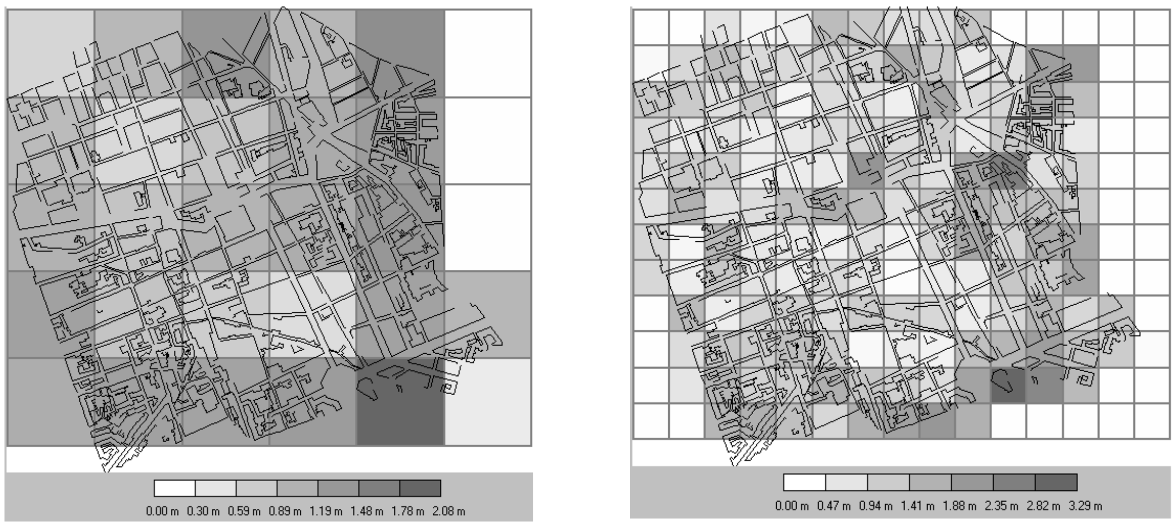

Figure 2 : Roughness length computed by Bottema's model in Marseille city center with a cell size of 250m (a), and, with a cell size of 100m (b)