Cross-analysis between variability of the urban climate and the landscape heterogeneity at the scale of a neighborhood in the city of Toulouse (France)

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ABSTRACT

In cities, the phenomenon of Urban Heat Island (UHI) is well known and its strength can be attenuated using different strategies dealing with urban architecture and design, building materials, presence of vegetation and urban governmental policies. UHI management involves having precise knowledge on urban microclimate related to urban fabrics, and its variation at very urban fine-scale, in order to predict the impact of future city planning.

It is quite often studied at the scale of the entire city by measuring the maximum temperature difference between the city center and the countryside or by differentiating its effects according to homogeneous neighborhoods. However, the variability of the urban microclimate is rarely analyzed at very local scale whereas some studies showed that the temperature variations could be of the same order of magnitude than that of the city-scale UHI. The neighborhood is however a relevant study scale both for the inhabitants, with an idea of thermal comfort, and the urban planners.

To understand the subscale variability of urban microclimate over a neighborhood in the city of Toulouse (France), an interdisciplinary field experiment was carried out, covering an area measuring 1 * 0.5 km², and including different urban fabrics. Meteorologists, but also scientists looking for sound and pollutants propagation, sociologists, and architects participate to this study.

The experimental design included two types of climate measurements.

First, a permanent network of ten weather stations was installed, measuring temperature, wind strength and direction, and air humidity during six months (from January to July 2014). Moreover, another weather station was instrumented on a roof to measure the same parameters as well as incoming and long wave solar radiation at the top of the urban canopy.

Secondly, three intensive measurement periods were defined in winter, spring and summer 2014. Each seasonal measurement campaign lasted for one week and consisted to walk along a defined itinerary in the chosen district, along which temperature, humidity and wind were continuously measured, with a GPS recording associated. Moreover, black and grey globes were used to appreciate the "perceived" temperature, with an idea to link physical measurements to humans feelings. A walking trail was organized every three hours, and carried on one hour (Figure 1).

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Figure 1. Studied area (a) and walking trail (in blue, 3 km) followed with movable weather station (b).

a)

b)

Finally, the cross-analysis between the large urban meteorological database thus acquired, taking into account spatial and temporal variability, and geographical data (GIS), including information on building and soil occupation, lead to a quantified understanding of the urban microclimate variation relatively to urban fabrics. The subscale chosen is adapted to focus on inhabitants thermal comfort and is, consequently, important for thoughts dealing with future urban planning.

More widely, scientists working on noise and air quality also participate to this study. Moreover, some of the walking trails were made with inhabitants who filled in a questionnaire related to their perception of environmental quality. Thus, this study was thought to understand the urban environmental quality in a global point of view.