Modelling urban climate in Bilbao (Spain) for planning purpose

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Introduction

From the social, economical and meteorological point of view, the urban areas are complex systems in which multidisciplinary agents should work together. Cities modify the regional climate and develop a particular urban climate. Climate variables are modified due to an alteration in surface energy balance and air flow dynamic. It is of special interest to provide climate information to urban planners and decision-makers in a suitable way so that they can use it for planning purposes. The Urban Climate Map (UC-Map) aims to solve the existing gap between urban climatologist and urban planners. It is considered an important tool that integrates both disciplines and is essential for urban development strategies, specially in a climate change context. The concept of UC-Map was first developed in Germany on the 1970s (Matzarakis, 2005). Actually, more than 15 countries are processing their own UC-Map, applying climate measures and guidelines to urban planning (Ren et al, 2010).

Bilbao is a medium city (355,048 inhabitants in year 2009) located in the north of the Iberian Peninsula. The urban area is located in an estuary, 16 km. from the sea. The urban area is oriented NW-SE direction following two mountain ranges (300-700 m. a.s.l.). Local climatology in the region is significantly influenced by complex topography and the proximity to the sea. Surface air flow is channelled through the valleys. Additionally, sea/land and mountain/valley breezes occur frequently, especially with stable atmosphere situation. Anabatic/katabatic winds are conditioned by mountain slopes and their orientation. The interaction of all these meteorological phenomena influence ventilation properties and, consequently thermal comfort in the urban area.

Recently the first UC-Map for Bilbao has been concluded. In this sense, the integration of urban climate in an urban planning tool (UC-Map) is a new perspective in Spain that should be extensive applied during the following years.

Methodology

The method to develop an UC-Map (Analysis Map + Recommendation Map) in Bilbao (Spain) is based on GIS calculations, specific climate measurements and urban climate expert knowledge.

For the Urban Climate Analysis Map (UC-AnMap) two parallel analyses: surface thermal load based on land use characteristics, and dynamic potential associated to ventilation patterns (Figure 1). Data used are: general land-use description (forest, farmland, urban…); building characteristics (location, surface, and height); urban vegetation (from NDVI index); air flow characteristics (regional winds and thermal induced circulations); and topography (elevation and slopes).

Results

Urban climate knowledge is essential to evaluate ventilation patterns in the area.

Three climate measurement campaigns are carried out combining stationary and mobile devices (Figure 3). Climate data (Ta, WS, Tmrt and RH) is used to adjust the weighting factors (WF) that combine the GIS layers (Ix), and validate UC-AnMap.

Conclusions

- Calculations with GIS layers plus climate measurements and urban climate knowledge can be used to derive an UC-Map with planning purpose.
- The method simplifies input data (5 information layers): UC-Map easy updating.
- Urban climate expert knowledge is essential to evaluate ventilation paths and urban climate impact, specially in areas with complex meteorological phenomena.
- UC-Map is presented as a tool (clear and easy to understand) for urban planners.

References