URBAN CLIMATE IN RELATION TO LAND USE, PLANNING AND COMFORT

Marie K. Svensson

ABSTRACT

The increasing numbers of people living in urban areas emphasise the importance of studying the spatial and temporal variations in the urban climate. The varying urban landscape creates differences in the local climate which are important for energy consumption and human comfort. Thus this knowledge is useful in urban planning. This thesis deals with the work of an urban climatologist with a view to establishing an urban planning perspective. It contributes to a better understanding of the local climate in urban areas during different weather situations at both night and day.

Measurements were conducted in Göteborg (57°N11°E), a city of approximately 500,000 inhabitants, situated on the west coast of Sweden. A dense network of thirty-one (31) air temperature stations was set up for a period of twenty-nine (29) months in addition to four wind masts which were set up for a period of approximately one year. Additional data from eight meteorological stations and car measurements were used. The continuously updated Master Plan of the urban district of Göteborg, used by planners and architects, was used as a land use database. Three methods for the characterisation of the surface cover based on the Master Plan, aerial and fish-eye photographs were compared.

The spatial air temperature pattern was studied thoroughly during different weather situations and the relative importance of altitude, distance from the coast, distance from the centre of the city and sky view factor (SVF) were examined by means of regression analysis. The importance of land use/land cover parameters were also determined. Statistically significant air temperature patterns were found between several land use categories during different weather situations.

A detailed study of the relationship between air temperature and SVF was performed and a relatively strong relationship was found. The SVF differs depending on the height above ground at which fish-eye images are captured; the results showed that it is better to use the SVF calculated from fish-eye images captured at ground level in urban climate studies.

A maximum urban heat island intensity during clear, calm nights of 8.5 °C, with a mean value of 4.2 °C, was observed. The measurement also showed a cool island during approximately 30 per cent of the days, with maximum magnitudes of up to 4 °C.

For regional and local applications the spatial distribution of local climate parameters are important but the number of climatic stations available are usually limited. Two empirical models for the simulation of air temperature patterns and the assessment of human comfort are presented. The local climate model is based on meteorological data from one station in the area, digital information on local climate and land use (Master Plan). The output is verified with data from the air temperature stations and the general pattern is good. In the human comfort model meteorological data are linked with geographical information about land use, elevation and distance to the coast in order to generate the spatial distribution of the physiologically equivalent temperature (PET). Variations in PET of up to 8 °C were calculated during a clear, calm day at 1200 h. The two models have the GIS approach in common. This gives the advantages of easily modified databases and the application is important for incorporating climate in the planning process. Simulations with both models are presented in the thesis.

Keywords

Air temperature, land use/land cover, GIS, sky view factor, urban heat island, local climate mapping, empirical modelling, human comfort, urban planning, Göteborg