

## CLIMATE AND AIR HYGIENE INVESTIGATIONS FOR URBAN PLANNING

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**Összefoglalás** - A tanulmány az alkalmazott városklimatológia bizonyos aspektusaival foglalkozik, majd a tudományág feladatainak, céljainak leírása után különböző vizsgálati módszereket mutat be. A továbbiakban a hőmérsékleti és levegő higiénia értékek mobil mérésére összpontosít és a levegő higiénia helyzetek szintetikus klíma-funkciós térképek segítségével történő bemutatását és kiértékelését tárgyalja.

**Summary** - This paper deals with certain aspects of applied urban climatology. Following a description of the objectives of this branch of science, various investigation methods are presented. The paper concentrates on the use of mobile measurements of temperature and air hygiene values and concludes with a discussion of the possibilities of presenting and evaluating air hygiene situations using synthetic climate function maps.

**Key words:** urban climate, mobile measurements, synthetic climate function maps

### 1. INTRODUCTION

The microclimatic and mesoclimatic features which distinguish cities from their environment are caused by a number of factors. These include the conversion of the natural ground surface into a three-dimensional space consisting largely of artificial materials, the resulting reduction in the proportion of the surface covered by vegetation and the impact of industrial processes, causing waste heat, waste gases, dust and soot.

The climatic and air hygiene features characterizing conurbations are normally referred to as "urban climate" (*Landsberg, 1981*). They can be observed both in small towns and in large cities (*Unger, 1996*). The factors mentioned above affect the radiation and energy balance of near-surface layers of the atmosphere, the possibilities of evaporation and the wind field to such an extent that urban areas are generally characterized by higher air temperatures, lower relative humidities, poorer ventilation and accumulations of particulate and gaseous contaminants (*Kuttler, 1997*). These features of urban climate can be modified both by small-scale factors such as relief and by the location of cities at different latitudes.

## 2. APPLIED URBAN CLIMATOLOGY

Applied urban climatology (Kuttler, 1996) is the science concerned with investigating aspects of urban climates relevant to planning purposes. The tasks of applied urban climatology include the analysis, evaluation and modelling of existing conditions, and, to an ever increasing extent, planned situations. The purpose of such investigations is to give decision-makers in cities and communities the guidelines they need as a basis for land utilization recommendations. In order to solve these problems, which are by no means always simple, a wide range of measurement and analysis tools are now available for use when the need arises.

## 3. INVESTIGATION METHODS

Various techniques are used for urban climate investigations depending on the question in hand. These include field measurements, mathematical modelling, infrared image analysis and wind tunnel tests. This article briefly discusses the problems of field measurements.

Both stationary and mobile measurement stations are used to gather data on relevant climate elements such as dry and wet air temperatures, radiation components and air quality with as effective a coverage of the area as possible.

As the effects of urban climates are especially pronounced in meteorological situations characterized by low wind and high radiation, measurements are mainly made in such conditions. The main emphasis in urban climate studies is on recording the thermal behaviour of the city body and the resulting distribution of air temperatures, on investigation air composition in terms of the quality and quantity of trace substances and finding evidence for local wind systems. Such wind systems may arise as a result of the temperature differences between open and built-up areas and are referred to as country breezes (Barlag and Kuttler, 1990/91). In an ideal case, these near-surface air movements, mainly intermittent and of low velocity, can be observed to flow towards the centre of the city centripetally from all directions. The depth of penetration into the urban area also depends on the ventilation channels available. The quality of the air carried into the city from its surroundings is also a function of any prior contamination with pollutants. Normally, investigations of these aspects are conducted over a period of at least one year using networks of special stations in areas of special climatic and air hygiene importance. However, it must be remembered that even data gathered from such special networks initially only give an indication of conditions at the actual station sites. It is still necessary to evaluate these data in order to establish a connection to an area. Fixed-station measurements can be related to areas using a mobile measurement laboratory, normally a laboratory van. *Fig. 1* shows a vehicle of this type operated by the Institute for Ecology of Essen University, Germany. With the aid of this vehicle, it is possible to



*Fig. 1* The mobile measurement laboratory van in action

measure important climatological and air hygiene parameters within a closely meshed network almost simultaneously. High-density data gathering produces results which allow for a well-founded interpretation.

In this case, air temperatures and humidity are measured, together with concentrations of various substances (NO, NO<sub>2</sub>, CO, O<sub>3</sub>) on predetermined routes during the test trip. In the case of longer test trips through large cities, it may be necessary to make some chronological corrections to the data collected as time differences between the measurements may otherwise distort the results. With the methods available, data corrected to one reference time form the basis for an area-wide assessment. The measurement results obtained can be used for generating synthetic climate function maps and for planning guideline maps based on them.

#### 4. SYNTHETIC CLIMATE FUNCTION MAPS AND PLANNING GUIDELINE MAPS

Applied urban climate studies are based on a large volume of data which must be processed in such a way that they can be used for planning purposes. Maps are an important tool in this respect as they are of considerable practical use to planners and allow the

presentation of climatological and air hygiene data over an area (Barlag, 1993). Synthetic climate function maps and planning guideline maps based on them create a spatial frame of reference for climatological and air hygiene values. These maps not only interconnect the individual data and present them in a more or less generalized form depending on the scale of the map but also contain assessments of bioclimatological and air hygiene values. In this way, it is possible to distinguish areas which are favourable and unfavourable in terms of climatic conditions. Following the performance of the investigations required, maps of this type can be prepared for any urban area and are an important tool not only for basic research work but also for urban planning decisions.

In the near future, it is expected that there will be an increasing demand for data of this type by urban planning authorities aiming for sustainable urban development with conservation of resources, especially in connection with the application of environmental impact studies. For this purpose, intensive cooperation and basic research work will be needed, especially with a view to developing standardized measurement methods for use throughout Europe. Initial contacts with some climatological institutes in other European countries have already been established. Work on the establishment of further contacts is in progress.

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