Chapter VII

FLADIS - A GIS Based System for Extending Air Pollution Point Data to Continuous Spatial Information

Goetz Wiegand and Volker Diegmann
IVU Umwelt GmbH, Germany

ABSTRACT

FLADIS is an extendable software system integrated in a Geographical Information System (GIS) for displaying temporal and spatial distributions of concentrations of pollutants such as SO_2, NO_2, NO, particles, and O_3 over whole areas. With the help of integrated statistical models, deposition of dust constituents can also be displayed over an area. FLADIS is designed for local authorities to fulfil the task of reporting. Furthermore it is a tool for combining and integrating information from measurements and models.

Because the data for FLADIS have a geographical reference, a GIS is an ideal project environment and user interface for the system. FLADIS is integrated both in the GIS ArcView and MapInfo. It takes full advantage of the functionalities of the respective systems such as consistent georeferenced data storage and handling, analytical functions, and map generation and display.

FLADIS consists of *interpolation methods* together with a *dispersion or a statistical model*. The interpolation is carried out by various methods such as, for example, Shepard, triangulation, and thin plate spline. The interpolation methods available can be expanded as needed through an interface for DLLs (dynamic link library). In the same manner, any available appropriate dispersion model or statistical model can be integrated into FLADIS. As output FLADIS calculates a weighted mean concentration for each grid point from the half-hourly or hourly results of the interpolation and the employed model.

INTRODUCTION

The political pressure on those institutions responsible for measurements to provide spatial information on concentrations has grown in recent years. This political pressure is expressed in the *EU Council Directive of 27 September 1996 on Ambient Air Quality Assessment and Management* (96/62/EC, 1996), that explicitly demands spatial information. The measurement data provided by the air pollutant concentration network, however, only provides point-based information. Theoretically, concepts trying to describe the representativity of the point-wise measurements in the sense of time-spatial random-fields are well understood (Christakos, 1992). In the practical application in authorities' daily work, however, they often fail because of the complexity of the theory or because the assumptions necessary for these methods are rarely met.

One does, however, have an idea of the concentration in areas where no measurements exist. These ideas do not necessarily stem solely from the measurement process itself, but can be derived from dispersion calculations or the use of analogies. FLADIS has been developed to incorporate this external information in the spatial representation of concentration measurements and thus derive scientifically sound spatial information from point-based measurements in a practical manner (see, for example, Diegmann, V., et.al., 1994; IVU, 1999). It is a system for model-based interpolation which makes only few assumptions on the input data. The development of FLADIS was financed by Hessische Landesanstalt fuer Umwelt (Diegmann, V., et.al., 1996). Further product-development and integration in GIS was financed by IVU Umwelt GmbH.

THE DATA

Concentration measurement data for the interpolation process

The data required for the interpolation are time series for the concentration measurements. These should be distributed as evenly as possible over the area in question and should not contain larger temporal gaps. Where there are topographical variations, the elevation distribution of the measurement sites should also be as even as possible. Any missing values in the concentration's time series can, if necessary, be replaced using a process that treats the concentration measurements as the result of a spatial-temporal stochastic process (Wiegand, G., et. al., 1991).

The estimation of uncertainties in measurements and models is currently in the process of being regulated in Germany (VDI 4280). These regulations concerning the uncertainty of the information will be integrated into FLADIS.

Data for the statistical or dispersion model
Digital elevation model

A digital elevation model (DEM) of the area in question is a prerequisite for the application of the statistical or dispersion model of FLADIS. DEMs are available worldwide and can be obtained, for example, from the US Geological Survey (GTOPO30). These digital data are available in equal increments of 30 angular seconds (approximately 1 km). DEMs with considerably higher resolutions are available for all those areas in which FLADIS has already been applied.