Advanced systems for environmental assessment and control

N. Quaranta

Department of Environment, Lombardy Region, Milan, Italy

abstract

Advanced systems information staff at the Department of Environment of Lombardy regional Administration have been developing two packages for on line decision and analytical processing.

ARIANNA is a powerful, stand-alone, PC based tool for the geographical navigation on air quality monitoring data, that allows the operator to acquire data via modem and use them locally for both a spatial evaluation and a time analysis.

AURORA is a package providing a software architecture for the environmental analysis and assessment at regional level that guarantees the largest opening and flexibility to integrations and future expansions in terms of technological improvements, new functionalities for the user and integration with other systems.

The central elements of this system are two: the man-machine interface that is based on an ingenious geographical navigation system; the environmental “services” that furnish the information and the analytical processes (about different topics), which are distributed on different server machines in the network.

1. Introduction

The department of the environment of the Lombardy Region has an own e.d.p. center that manages the systems of acquisition of
environment monitoring data and the files and databases with the territorial information.

Traditional databases are surely useful for the management of the administrative transactions, but they have come out unsuitable for the on-line analysis oriented in line to the territorial planning.

The use of a G.I.S package is usually considered from the experts to be the most effective solution for such a kind of problem; but in practice this solution has shown a set of operational difficulties:

- the available GIS tools on the market are very complex, difficult to configure and use in a distributed software environment;

- is very difficult to connect effectively in a net of distributed services the GIS workstations with remote files and databases;

- to insert the "intelligent" applications (like mathematical models, simulation models, expert systems, neural nets, multimedia documents) in a G.I.S preconstituted software environment is a very hard job;

- the man-machine interface that usually these systems provide is valid for an experienced computer operator but not adequate to the mentality and to the requirements of a territorial operator;

- the cost of license and management of a GIS is usually very high.

Another usual technique in the “d.s.s.” (decision support systems) circle and between the so-called “OLAP” (on-line analytical processing) systems is that of the “datawarehousing”, that allows the access to huge files containing the transversal information about all domains and topics that could interest planning activity. Unfortunally, to tell the truth, this technique suits well those companies that have consolidated methodologies for the own “business process” analysis (like the financial societies, banks, the manufacturing industries), and therefore in the field where have outcome the so-called “e.i.s.” (executive information system) tools, while for what concerns the analysis of environment evaluation and planning doesn't exist standard methodologies or consolidated technologies.

For these reasons already for years the information systems staff of the Department Environment has started the study and the realization of any tools expressly conceived for the support of the
environmental operators at every level of activity; two lines of products particularly have been identified:

- "stand alone" packages for a remote user that must analyze and visualize a particular situation in real time, or a series of local data already elaborated at synthetic level;

- systems for the user that needs to assess the state of the environment, in a certain geographical context, weighing the conditions of the different environmental variables (air, water, ground, subsoil) for estimating the "stress" of the territory either from the point of view of the human settlement either of the animal and vegetable one.

2. Arianna

Arianna (v. 3.0) is a program carried out to solve the problem of the acquisition and the knowledge in real time of the data concerning the distribution of the atmospheric pollutants in all the Lombardy region.

This tool doesn’t have comparison of hits kind either in terms of performances than of versatility and simplicity of use. Arianna is a program “plug & play” self configuring on personal computer, that is composed of two separate modules:

- a communication module that acquires the data in real time from a remote server;
- an integrated module for the management, presentation and elaboration of the acquired data.
Computer Techniques in Environmental Studies

The user interface is provided of a powerful geographical navigation system in the territorial regional context, with information about each monitoring station and its characteristics; it is possible to select a parameter (pollutant or meteo), a type of elaboration, the required period of sampling, and to get an output of spatial type (thematic map) or of temporal type (linear or bar graph).

User has a large number of available functions and he could shape either the scale of the graphic either the background or representation colors.

By this way from any site it is possible to connect (by means of a modem and a telephone line) to the regional center, acquire the data of the day and check the level of reached pollution.

Arianna is a program developed in C++ that requires at least a 486 PC with 8 MB RAM.

3. Aurora

In the field of the environment analysis the early question of the lack of data has been replaced from that of the organization of the data: in fact, if people are not able to define precise environment indicators oriented to the planning of the choices and of the interventions, it is not possible to realize a data model and some "business rules" for the evaluation of the environment condition.
The control of the environment and the environmental impact assessment require the availability of many different tools like: DBMS, simulation models, image processing, GIS, expert systems, graphic and statistics libraries, forecasting models et cetera.

The need of the territorial operators is to have an integrated tool that allows a ‘crosswise’ analysis of the different variables and environmental indicators.

The EDP staff of the Department Environment has therefore projected and realized an integrated system of analysis, control and planning of the environment, that allows to get synthetic reports on the state of the territory, either in tabular form either on graphics, cartographic (thematic maps) or like images.

The starting objectives for the plan were:

- user interface very simple, provided with “intelligent” software functions able to manage very complex processes for the user;
- same methodology for the access to the more heterogeneous applications also, in such a way to furnish an homogeneous base in the investigation from different point of view;
- access to the applications and databases both local and remote by means of the implementation of "services" for the final user. "Services" are either single data elaboration either homogeneous application fields either a set of homogeneous output forms concerning an environment topic.

The system, called Aurora, is provided of a graphic interface that is a real G.I.S., able to manage both vectorial and raster maps for the user “navigation” on the territory.

The man-machine interface was on purpose projected to guarantee the greatest simplicity with the most efficiency as possible; the functionalities of the interface have been expressly designed for the needs of people that must analyze environmental problems and of impact on the territory.

Software architecture is of type ‘three tier’ client-server using a full “object oriented” environment:
client console supports the man-machine interface and manages the windows of textual output, graphic, multimedia; besides it receives every request for the more or less complex data elaborations (called "services") and information to furnish with reference to the selected objects (an "object" could be a city, a Commune, a Province, an industry, a river, a road, and therefore an entity geographically definable).
the application server(s) is able to connect the user to the different software applications on the phenomena concerning the environmental pollution (atmospheric pollution, waste management, evaluation of the industrial risk, water quality, simulation models, etc.), and also to communicate with data files and distributed database.
• the database server(s) contain the data necessary to do the elaborations, but also information of various kinds, like statistic data, meteorological data, data about the state of the parks, on the roads and generally on the structure of the territory and on environment condition.

Using the paradigm of the "services" several applications have been implemented on different topics, like:
• thematic maps on the distribution of socioeconomic variable;
• graphic and thematic maps on the quality of the air;
• reports and thematic maps on the distribution of the emissions;
• expert system on the analysis of the traffic emissions;
• diffusion models of the atmospheric pollution (in phase of development);
• analysis of the industrial risk;
• statistic analysis of the production and distribution of the industrial and urban waste;
• characteristics of the natural parks (in phase of study);
• analysis and multimedia presentation of the alpine glaciers (in phase of study).
At the present the architecture of the system seems very strong, and a phase of experimentation and evaluation has started beside the users of the Department Environment.

4. **Nebula project**

Currently many regional Administrations are developing and/or using their own system for environment planning and control. These systems are not compatible each other, so that for getting an overview on data coming from different administrations it must to implement specific, more or less complicated, program interfaces.

The Lombardy Region and the Emilia-Romagna Region have reached an agreement on a common project (called “Nebula”) that aims to promote and realize a whole of network services necessary to the public authorities and Administrations involved in the management of the environment.

For this purpose the system AURORA will constitute software architecture and connectivity tool between “clients” and “services”.

By this way, to give an example, a user will be able to analyze air quality across several regions, doesn’t matter which site the data come from (the system will combine data acquired on line from
Computer Techniques in Environmental Studies

different servers); or a user could to use a mathematical model running on a remote server, combining meteo data provided by a specialized center with emission data coming from another db server, to evaluate air pollution over selected territory.

While the client-server software is always the same of Aurora, the novelty is the attempt to create, on a virtual network, several centers specialized to furnish thematic information accessed and displayed in a 'transparent' way by Aurora.

**NEBULA - AURORA architecture**