# GIS TECHNOLOGY FOR THE PUBLISHING OF A REGIONAL THEMATIC ATLAS

Valerio Zunino

Istituto di Geografia

Università di Genova (I)

This work intends to analyse and value the contribution offered by Geographical Information Systems to the evolution of data management and mapping techniques. In particular, our attention turns to the potentialities of a little workstation, that, with quite low expenses and by means of an adequate software, may permit the execution of sophisticated thematic maps, the elaboration of spatial, numerical and alphanumerical data, everything aimed at the publishing of an advanced regional thematic atlas. In this context, we treat some interesting options of an attribute database, as data capturing, creation of statistical ratios, SQL research. As regards mapping, the examination of all those possibilities that GIS technology can offer to the practical carrying out of cartographic thematizations have been focused; with this object in view, it's important to consider some distinctive features of a spatial database (the geocoding or the buffer areas creation, for example), as well as the overlay technique and, limitedly to a few software, the representation of thematic objects on tridimensional maps.

## 1 Introduction and methodological approach

The application and evolution of Geographical Information Systems indicates a gradual reduction tendency in the cartographic field, when considered as ultimate purpose of a research project; this, obviously, on a percentage basis on the whole GIS environment[1], while, in absolute values, the growing of all the derived application fields has been nearly continuous since the coming of these systems (5). However, as a matter of fact, we must remember that cartographical outputs are among the foundamental instruments for almost all the other GIS surroundings, for which mapping, at any level elaborated, represents a basic support to the research strategies. Then, modern cartography gets benefits from such situation, showing numerous progresses that are powerfully performable into a thematic atlas. At the same time, atlases can also take advantage from the recent development of some functionalities in the data management field, another key component of a GIS. The rapid realization of varied statistical indexes (static or dynamic), considerably facilitates the task of researchers, always driven by GIS to look for new applicative solutions and opportunities.

With this contribution, we substantially intend to emphasize the changes in course within the Geographical Research, crossed by the introduction of sophisticated, versatile and economically reasonable hardware and software instrumentations. A little workstation, inclusive of personal computer, laser printer, electrostatic plotter, scanner, digitizer, allows the capture of enormous quantities of numerical, graphical and cartographical data, their quick elaboration and the return of equally quick and aesthetically valuable printing results.

After having acquired hardware structures, researchers have to face the question of what functional approach to chose for the growing of the various research projects. The hardware/software oriented approach conditions every application to the available informative system and to its performances, that, when inadequate, do not permit a correct development of a research project; the application oriented approach concentrates all the hw/sw and personnel investments of a research

[1] The expectations for 1997 give Cartography a 2% of GIS software revenue.

body[2] on a single project or application, but it seems evident that, when we try to examine a completely different kind of problem, the system will show a remarkable operative negligence; finally, the data oriented approach, no doubt the most versatile one: devoting our attention to the data capture, maximizing its speed, introducing a standardization of the data management process, we let the research body limit everytime its efforts to adapt its structures to the numerous applications projectable with a GIS (5).

## 2 Attribute databases for the Geographical Research

To create a Modern Thematic Atlas is required the development of a suitable elaborated data system. In the main GIS softwares there are control sequences to make a lot of data management operations. Users can apply these controls for making formulae and establishing statistical indexes, that concern a phenomenon (mean, standard deviation, variance) or different connecting levels of a number of phenomena (specialization, connection, correlation): the first ones are useful to measure a changeable event (for example) in a territorial area, and, being sometimes automated, you don't have to make any calculus; the second ones can be obtained from checking the objective connection among different database columns and have a significant role in the analytical Geographical Research. The query options, conditioned selections that may be done on the records, are other attribute database possible operations. They are of great utility for cartographic purposes; in particular, users can make a selection choosing gathered data - in function of one or more variables - and, according to predereminate variables, make data conditioning and selecting operations: in a wealth data analysis, the simplest conditioning comes from selecting, for example, all the records that show values superior to 500 in correspondence with the "population density" column, or all the coastal, sub-littoral or mountain municipalities of a regional data analysis. The more complex selecting forms make it possible to consider many conditions at the same time ("and" option), alternately two or more of them

[2] It may be represented by University departments, local authorities, etc..

("or" option), the condition to deny ("not" option), to make "true-false" surveys and elaborate (if....then option) simulated models in perspective with present data.

At the end, we examine closely, for a while, the SQL (Structured Query Language) extension, that some GIS softwares have: it makes it possible, by the way, to create new data files, putting together already existing files; to create new columns, putting together records of homogeneous classes; in a word, to compare and connect a number of numerical and alphanumerical values.

### 3 Spatial data and cartographic thematizations

The main characteristic of a GIS software is represented by the possibility, offered to users, of linking any cartographed object to a multitude of numerical, alphanumerical, graphical and photographical information; this occurs through "geocoding", a procedure of attribution of the mentioned information to the elements of a spatial database representing territorial features and created with a vector data model[3], then separately editable and selectable on the screen.

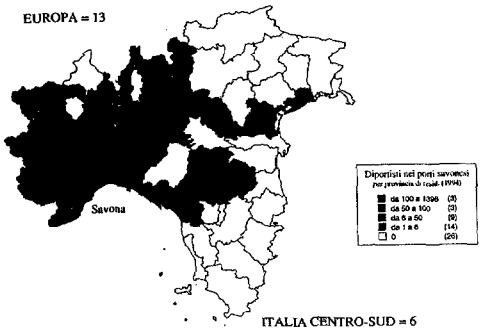


Figure 1: Thematic map

Vectorized cartography, or redrew on a digital support by means of a digitizing tablet, lends itself to numerous utilizations. With the purpose of realizing a thematic atlas, the creation of thematic

[3] Through points (topographical symbols), lines (communications networks, contour lines) and areas (administrative boundaries).

maps stands clearly out; a large part of softwares allow the execution of all the existing thematizations, from color shades to grayscale half-tone maps, from dots density to user-defined proportional symbols maps: for everyone of them, there is the possibility of thematizing absolute values, medium, minimum and maximum values, range of values (by default or user-defined) (figure 1). Every thematic representation can be easily enriched with the addition of toponymy and through a powerful toolkit for drawing and editing (e.g. smoothing polygons) operations on any cartographed object.

A Geographical Information System can manage, in case of small or medium map scale, some representation models based on cartesian and geographical co-ordinates, referring to hundreds of different map projections.

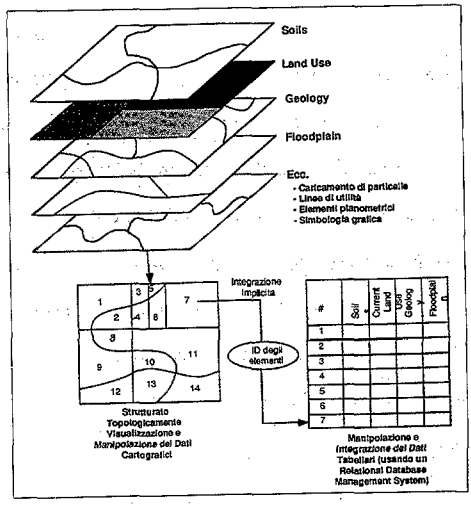


Figure 2: Overlay technical characters

As regards topographical maps, the usefulness of a GIS results absolutely interesting; besides allowing the immediate return of areas, perimeters and distances values inside the digitized area,

there are some other options, strictly connected to the printing operations, that are linked to the concepts of "layer", "buffering", "objects within radius". In a spatial database, layers are just like tracing sheets placed one upon another, each containing a level of spatial information, which can be printed alone or in conjunction with the others[4]. The overlay technique (figure 2) works exactly on the random superimposition of the layers concerning a particular territorial area: through this method we can print charts stressing everytime the different elements of a topographical map (administrative boundaries, contour lines, symbolism, toponymy, etc..)

"Buffering" is an extremely efficacious option to evaluate the distribution of physical and socio-economical phenomena over a region, as well as to help territorial and urban planning politics. From a strictly cartographical point of view, with the buffering option we select all the objects, belonging to a specific layer, located inside or outside of a polygon created around[5] a line or an area (representing a building, a road, a river, respectively). The "objects within radius" command works in the same way, but it allows the creation of a circle centered on a point representing (according to the map scale) a village, a monument or a semaphoric block, and with a predetermined radius.

It is important to remind that all these operations are possible by means of the geocoding procedure, that, in a sense, make "active" all the vectorized objects. However, the main GIS softwares can also run raster data model images, composed by a grid of cells (pixels) of different dimensions depending on the data capture source: satellite images (Landsat, SPOT) have cells with average side (and then resolution) of 20 to 30 meters in scale, while in case of scannerized images, resolution is calculated in hundreds of dpi (dots per inch) with a much higher definition and aesthetical quality (a very important feature of a publication). Images may be used in conjunction with digitized maps, then any of them can layer over as much as one likes; so, it becomes easy to superimpose, for example,

[4] For example, a cadastral map can be digitized on a multiple layers basis, each including urban cadastre, land cadastre, hydrography respectively.

[5] On a topographical map, for instance, we can create some "respect areas" at a predetermined distance from the heaviest traffic road, in order to visualize the site of the hotels located less or more than 1 km. from it.

maps concerning local networks over raster images representing a neighbourhood or a city, then having an excellent graphical tool, for its expositive quality and wealth, at one's disposal.

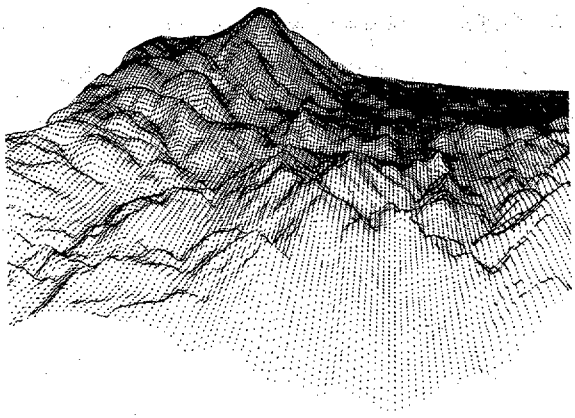

Figure 3: Example of a 3D view

In conclusion, another powerful opportunity offered by GIS softwares allows users realizing tridimensional cartographic models. There are two methods for the construction of these elaborations: the creation of a TIN (Triangulated Irregular Network), based on the availability of loose height values, the formulation of a DTM (Digital Terrain Model) or a DEM (Digital Elevation Model), based on a group of height values arranged in regular step grids (2). Both methods permit the contour lines interpolation, the setting of topographical sections and the genesis of 3D views (figure 3).

**References**

(1) Blakemore, M., 1992, Cartography, in "Progress in Human Geography", vol. 16, n° 1, pp. 75-87.

(2) Cortellessa, C.M., Breve introduzione ai Sistemi Informativi Geografici. Franco Ziviani Editore, Milano.

(3) Costa, M., 1993, Geografia col PC. La Nuova Italia Scientifica, Roma.

(4) Maguire, D.J., 1989, Computers in Geography. Longman Scientific & Technical, Harlow, Essex.

(5) Mogorovich, P. - Magnarapa, C., 1992, Un Sistema Informativo Territoriale per applicazioni turistiche: prime esperienze, in "Rassegna di Studi Turistici", n° 1/2, pp. 37-57.

(6) Parsons, E., 1994, The essential guide to GIS. Longman Geoinformation, Cambridge.

(7) Roccatagliata, E., - Primi, A., 1994, A survey on GIS education in Italy, EGIS '94 Proceedings, EGIS Foundation, Genoa, pp. 563-571.