GEOGRAPHICAL INFORMATION SYSTEM FOR NATURAL RESOURCES IN ASTURIAS

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ABSTRACT

A GIS for Thematic Environmental Cartography in the Principado of Asturias is presented. The system is applied to solving problems related to management and territorial distribution of natural resources.

1. INTRODUCTION

The lack of a detailed and precise environmental cartography has been one of the traditional problems encountered by many studies of management and territorial distribution of natural resources in the Cantabrian Mountain Range. This situation led the INDUROT (Instituto de Recursos Naturales y Ordenación del Territorio) in 1988 to begin developing a Thematic Environmental Cartography of the Principado of Asturias with financing from the Ministry for Agriculture, through the European LIFE funds [1]. The project continues its development under the sponsorship of the Principado of Asturias, and is the basis for the Environmental Geographical Information System of the Principado of Asturias (GISPA).

As in other regional environmental information projects, the idea was to collect useful information for the management of natural resources, at an adequate scale and with enough speed to allow rapid utilization of data. An additional goal was that the storage and management system must allow efficient handling of georeferrenced data (the system should permit handling of cartographical data). Versatility was also sought, allowing simultaneous use of information on different "layers" or themes. It should also be powerful and speedy, given the large volume of data to be handled.

The design of GISPA was launched with these aims in mind. A 25000 scale was elected, since it would not be possible to conclude other more precise scales within a reasonable time period, and the 50000 scale exceeds minimum precision limits required for many foreseen applications.

Following an initial study of the most interesting aspects of natural resource management, inclusion of information on the following themes was decided: vegetation, bedrock geology, geomorphology, wildlife, topography, infrastructures, rocky areas, boundaries of protected natural areas, population nuclei and rivers.

In addition to scale and themes, it is very important to elect an adequate handling system. Given the cartographical nature of the data and the enormous volume available, a GIS was selected as the ideal tool. This decision is supported by many national and local experiences showing that GISs are the best currently available tool for storage, management and utilization of environmental geographical information ([2,3,4]).

2. DATABASE DESCRIPTION

The 25000 database is organized on the basis of work spaces corresponding to the same scale sheets from the National Geographic Institute (IGN). Each sheet includes several thematic maps which in turn include one or more levels of information stored in the form of map table items or tables related to each other through a common map item.

Different types of thematic information are described. On the one hand we have pre-existent information from official bodies (IGN, ITGME, MOTMA, etc.); this is the case with topography, a significant part of the bedrock geological information and infrastructures.

In other cases, it was necessary to generate data directly through field work supported by aerial photography, followed by data reinstatement on the map. This area involved the greatest deal of effort and higher costs, since GIS information always requires a high level of detail and precision. Such was the case of data related to vegetation, geomorphology, rocky areas, and an additional part that complements infrastructure or bedrock geology information.

In addition, there exists a third type of cartographical information generated within the system itself on the basis of primary data or data derived form other information layers, either directly or through the incorporation of new field data. Such is the case with layers related to slope, orientation or altitude data derived from the topographical map, from soil maps including geological, slope and vegetation information, or wildlife quality maps that are created on the basis of the soil use map (derived from vegetation), with the addition of field data collected by the team of zoologists.

3. GIS STRUCTURE

3.1 DIGITAL GROUND MODEL

The above heading includes one of the main layers, the Digital Elevation Model, and all models derived from the latter.

3.1.1 Digital elevation model

This is a numeric model of the topographical surface. Information is collected in vectorial format, from the 1:25,000 topographical base used for the subsequent generation of all information layers. Digitalized level curves are equidistant by 50 m; this linear information is complemented by support dots in the lower slope or more irregular areas, in which master curves do not offer adequate definition of the topographical surface, with a view to obtaining precision in accordance with the work scale in the derived models. Associated alphanumeric information includes altitude in metres both for lines and dots.

3.1.2 Digital slope and orientation model

A Triangulated Irregular Network (TIN) and a regular dot net (matrix) are generated from this model, with data every 50 m, on the basis of which pending models and orientations are obtained. Other more particular applications are created for certain zones within the context of specific projects.

3.2 GEOLOGICAL INFORMATION

3.2.1 Bedrock geology:

This layer represents contacts between the geological substrate formations, which in the case of Asturias correspond almost exclusively to Paleozoic or Mesozoic formations. This information is taken mainly from the MAGNA plan 1:50,000 cartography [5], previously reinstated in the 1:25,000 topographical base while reviewing and complementing its thematic contents.

Descriptive information pertaining to this layer is included under a numeric code made up of four digits describing, from first to fourth, the geological unit, age, stratigraphic formation, and the lithologic levels or sections contained within each formation.

3.2.2 Superficial formations:

A cartography of quaternary deposits partially covering bedrock formations. This is a detailed cartography created on the basis of field work, since no previous work exists and we consider it an essential element for evaluating edaphic potential or in terms of characterizing external geomorphological processes, among other relevant aspects of the physical medium characterization [6].

Associated to each deposit are stored two information fields corresponding to two three-digit numeric codes. These include dominant lithology and genetic type of the superficial formation.

3.2.3 Rocky areas:

This includes the cartography of areas in which the substrate's rocky formations come to the surface without superficial formations or continuous soil to cover them.

The only descriptive information initially associated with this layer divides rocky areas in two types, depending on their higher or lower quality as shelter areas for certain animal species.

3.2.4 Hydrological information:

This basically includes main rivers, digitalized from the 1:25,000 topographical base, and some other elements of interest, such as subterranean drainage basin limits, and, in some cases, limits between the larger superficial drainage basins.

3.2.5 Lithologic map:

This is a derived layer reflecting links between substrate geology and superficial formations, which are superimposed on the graphic output [7].

3.3 VEGETATION INFORMATION

3.3.1 Vegetation map

This shows the vegetal units located in the territory, mapped as a result of intense field work on the basis of physiognomic and phytosociological criteria, with a view to subsequently deducing phytogeographical and potential vegetation units.

3.3.2 Soil uses

A simplified representation of vegetation on the basis of physiognomic criteria. It allows simple interpretation and easier use in many applications not requiring the enormous complexity that the vegetation layer involves.

3.4 *INFRASTRUCTURES AND INFORMATION SOCIO-ECONOMIC*

3.4.1 Linear infrastructures:

These represent communication networks, from main roads to tracks accessible to all-terrain vehicles. The cartography of these infrastructures is created on the basis of pre-existing information in the case of main road networks [8], with the addition of most recent modifications, while tracks are mapped through field work and recent aerial photography when available.

3.4.2 Administrative boundaries and toponymy:

This layer includes administrative boundaries down to Concejo (county) level; boundaries of Protected Areas, existing or pending Principado of Asturias approval; villages and toponymy of the main geographical formations and population nuclei included in each sheet.

In accordance with the general database approach, these layers permit a much wider development. More intense work on these data has only been performed in certain specific areas, where currently implemented applications have made it necessary.

4. APPLICATIONS

The present work only offers details about two of the more complex applications developed at the Institute, while enumerating some others.

4.1 *SOIL MAPS*

Soil cartography has always posed many problems, since this is a physical characteristic that depends on numerous interacting factors and is subject to significant spatial variability. This approach has led to a soil cartography proposal on the basis of some of the layers that make up the database [9].

Lithologic map information has been given priority when assigning types of soil. The material's calcareous or siliceous nature and clayish mineral content have been considered essential. This information is complemented with the slope map, since soil distribution in a mountainous region like Asturias is strongly influenced by topography and material transportation processes, which provide edaphic alteration products with a greater or lower level of stability. Finally, rocky areas and some data derived from the vegetation map, such as cultured soils, are superimposed upon the soils determined on the basis of lithology and slopes.

4.2 *WILDLIFE HABITAT EVALUATION MAPS*

Many wildlife applications have been developed with a view to automatically mapping --with the addition of specific information on relevant animal species to the database-- the potential for a habitat to support certain given species. To this end, an environmental unit map is created on the basis of the vegetation and slope and orientation maps, together with altitudes, in order to establish homogeneous habitat types in terms of use by certain species. Field sampling of these types is then performed to obtain precise analysis information. Results are tabulated and correlated with each environmental unit.

We have created environmental quality maps for the brown bear in almost all its distribution area [10], as well as for passerines, considered by some authors as a good indicator for evaluating wildlife quality.

4.3 *OTHER APPLICATIONS*

Many other areas have been automatically mapped on the basis of GIS data. Some of the more significant examples are: environmental evaluation aimed at defining interest areas; intervisibility studies, integrated in wildlife or environmental impact studies; hydrological maps including definition of special protection units; vegetal species productivity, coverage and distribution evaluations; zoning of natural spaces, etc.

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