The avalanche cadastre management using G.I.S. in the Catalan Pyrenees.

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Abstract

The avalanche mapping programme, carried out in the "Servei Geològic" of the "Institut Cartogràfic de Catalunya" has the aim of locating and describing all the areas exposed to avalanche hazard in the Catalan Pyrenees.

The obtained documents are the Avalanche Paths Maps and the Avalanche Registry related to each avalanche represented in the map. The integration of both documents constitutes the Avalanche Cadastre.

The Geographic Information Systems appear to be a good tool to treat avalanche information. The objective to be reached is to constitute an Automatic Avalanche Cadastre which will allow a better consultation and to exploit the avalanche information.

1. Introduction

Avalanches are recurrent natural phenomenon which can be located geographically (so mapped) by observing the slopes characteristics where they occur.

The avalanche mapping program was started in 1986 as a consequence of the important expantion in winter tourism in the Pyrenees. This fact implies an increase of avalanche risk due to a change of land use in high mountain areas. The aim of the project was to carry out a spatial prediction by mapping and describing the areas affected by avalanches with the target of producing an useful information for land-planning. The obtained document is the avalanche cadastre which implies a lot of information that has to be managed.

The Geographic Information System is a computer system capable of holding and using data describing places on the earth's surface (E.S.R.I., 1990). Due to its capabilities the use of G.I.S. and other software associated to it are the best tools to manage and query avalanche data.

2.The avalanche cadastre

The avalanche cadastre constitutes the document or set of documents which contains the whole available information related to avalanches. In the Catalan Pyrenees the avalanche cadastre is composed of the map of avalanche paths, the avalanche data registry which is composed at the same time of the avalanche paths data and the avalanche events data, and oblique photographs (figure 1).

Every avalanche represented in the map is codified by appointing the same code that this avalanche has in the avalanche registry. So the relation between both document is direct.

2.1 Map of avalanche paths

The avalanche paths map is a thematic map where all the areas affected by avalanches are represented. It means the maximum boundary affected by avalanches.
The methodology used to determine avalanche paths is: first photointerpretation and field recognition by observing the characteristics of the slope for avalanche release and the avalanche effects on vegetation. The most important items are: altitude, topography, morphology, rugosity, vegetation and orientation to sun and to the prevailing winds. The information obtained by this method is represented in orange colour in the map. The second step consists of inquiry to population which represented in violet color.

The avalanche paths are represented in a topographical base reduced at 1:25.000 coming from an original scale of 1:5.000

2.2 Avalanche data Registry

The avalanche data registry consists of the information containing description of the characteristics of each avalanche represented in the map. It is composed of the avalanche paths descriptive data and the avalanche events data.

During field recognition an oblique photograph and an avalanche description of the path is realized. The information collected is about morphological description, damaged vegetation and human properties affected of the starting, track and run-out zones. The result constitutes the avalanche paths data base.

During population inquiry historical avalanche events and avalanches events during winter season are recorded in order to obtain information about magnitude and recurrence of the phenomenon, the type of avalanche, weather conditions when the avalanche fell, personal and property damages etc. The other obtained documents constituted the avalanche event data base.

3 Avalanche data management using the G.I.S.

The avalanche cadastre constitutes a great volume of information composed of georreferenced data (avalanche paths maps) and tabular data (avalanche registry) which have to be managed all together .
The capabilities of a G.I.S. allow to store, update, manipulate, analyze and display georreferenced data. So that it seems to be a good tool to treat avalanche information by linking a set of data related to the same geographical area. This link is made through a common item referred to the valley where the avalanche is located and the number of order of the avalanche; i.e. the code NER001 is the first avalanche path of the Nere valley. (figure 1).
The avalanche data automation consists of: digitizing process and implementation in a database, generation of coverages and topology, generation of regions and expansion of the data base.

3.1 Digitizing process and implementation in a database

The avalanches represented in the maps are stored as a set of coordinates that draws polygons, lines and points. All those features are digitized directly on a screen or on a

digitizing board. In the other hand all the avalanche registry is stored in DBASE III and ORACLE files.

3.2 Generation of topology and coverages

The files generated in the above described process can be converted in ARC-INFO files. It means the generation of coverages.

Coverages consist of topologically linked geographical features (arcs, polygons and points) an their associated descriptive data stored as an automated map (E.S.R.I. 1990). Topology are the spatial relationships (connectivity, area definition and contiguity) between coverage features (E.S.R.I. 1990).The avalanche paths map features are stored in a coverages associated to an attribute table which contains some characteristics of each feature like area, perimeter, length, identifier, etc. So the original map is converted into a georeferenced database.

3.3 Generation of regions and codification

The region feature class offers an extended approach to modeling complex areas like avalanche paths. Regions can represent and handle noncontiguous, nested and overlapping areas, so data management is more efficient, as each region only requires one attribute record, (ESRI, 1990).

Regions are very useful in avalanche paths maps because frequently there are noncontiguous polygons which must represent exclusively one avalanche. Regions allows to identify i.e. two different avalanches even when they overlap generating three polygons.

The codification consists of assigning one avalanche code for each region .So the avalanche registry is related to each region represented in the map. The automatic avalanche cadastre concerns not to the polygon but to the region feature class.

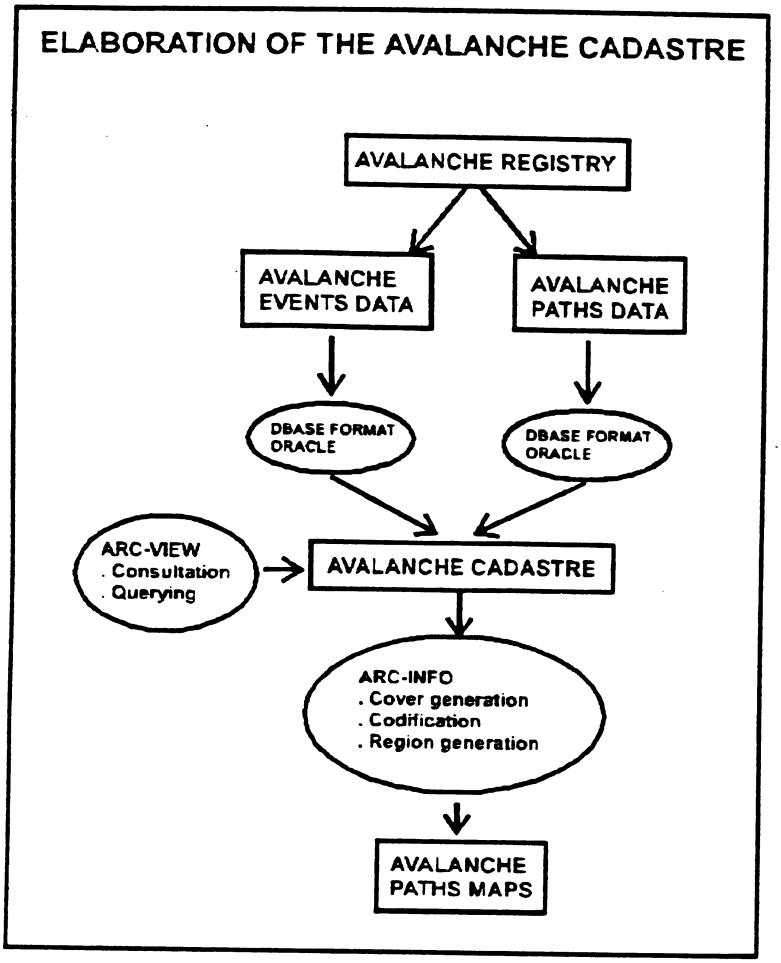

Figure 1: Avalanche cadastre frame work

4. Avalanche data consultation and querying

For realizing avalanche registry and avalanche paths maps querying is necessary to have a good knowledge in ARC-INFO and ORACLE. This request is difficult to reach for people not introduced in informatic subject. The aim of the S.G.C. is to built an avalanche cadastre which will be consultable for every body interested in this phenomenon. To get this goal we have chosen ARC-VIEW (ESRI). This programme (object-oriented) allows to visualize, explore, query, and analyze data spatially. It allows to display and link spatial and tabular data. In addition Avenue (ARC-VIEW language) is able to create custom ARC-VIEW applications for other people to use. Data management and analysis are flexible. ARC-VIEW can read data coming from ARC-INFO, satellite imagery, scanned, aerial photographs, INFO files, external data basis such us ORACLE (Razavi 1995).

Concerning to avalanche cadastre, ARC-INFO coverages (with its information associated) which contain avalanche polygons and regions have been imported to ARC-VIEW. The avalanche registry stored in ORACLE has been imported too. As this

information has a related item they can be easily associated by ARC-VIEW (figure 2). Besides it has been built some easy-to-use menus with Avenue. It allows to query the map and its data base associated.

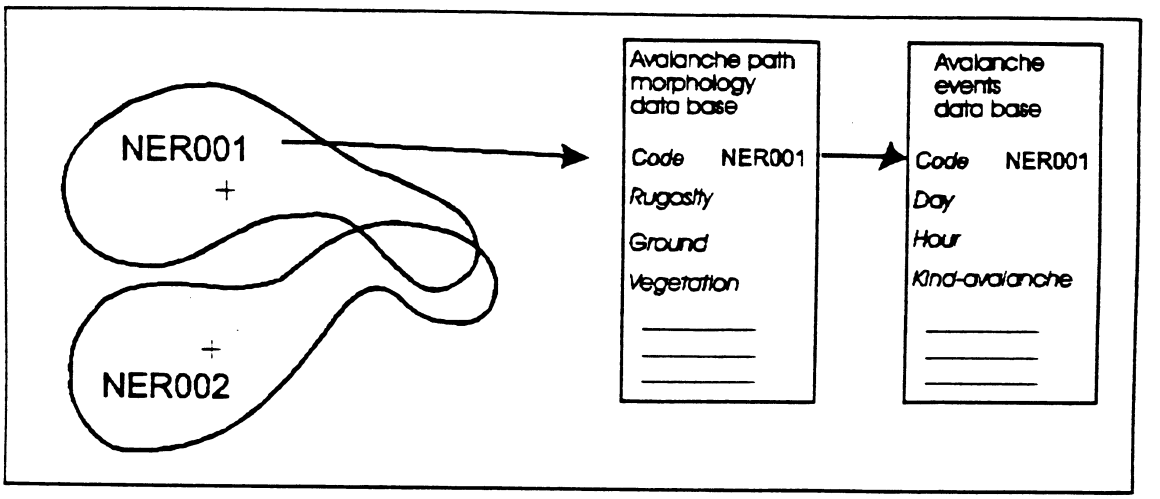

Figure2: ARC-VIEW allows to visualize and query the avalanche paths map and its avalanche database associated.

5. Conclusions

The use of an automatic consultation for the avalanche database constitutes an interesting spatial analysis tool.

The use of a Geographic Information System allows a good management of the avalanche data and the use of ARC-VIEW makes an easy disposal of the information for the user allowing a good and easy consultation

6. BIBLIOGRAPHY

Armstrong, R. & Armstrong, L. 1987. Avalanche Atlas. Ouray Country, Colorado.I.A.A.R. Univ. of Colorado. Occasional paper n. 25.

E.S.R.I. 1990 Understanding GIS. The Arc-Info method. Environmental System Research Institute. Inc., Redlands, CA, USA

Gavaldà, J., Martí, G., Oller, P., Martínez, P. and García, C. 1994. Project for studying the avalanche risk in the Catalan Pyrenees: Present and Future. I European Congress on Regional, Geological Cartography and Information Systems. Bolonia.

Furdada, G.; Martí, G.; Oller, P.; García, C.; Mases., M. and Vilaplana, J.M. 1994. Avalanche mapping and related G.I.S. applications in the Catalan Pyrenees. Surveys in Geophisics.

Martí, G.; Oller, P.; Bisson, B.; Gavaldà, J.; García, C. and Martínez, P. 1995. Project of elaboration of a cadastre of avalanche paths in the Catalan Pyrenees. Symposium A.N.E.N.A. 1995. 6 pp. Chamonix.

Martinelli, Jr.M. 1974. Snow avalanche sites, their identification and evaluation. U.S. Government Printing Office. 27 p.

Razavi, H. ArcView developper's guide.OnWord Press. U.S.A. 274 pp.