USE OF GIS ON THE ANALYSIS OF LANDSLIDING IN SAMPLE AREA OF THE APPENNINO EMILIANO (ITALY).

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Abstract.
The objective of this experimentation is to estimate the contributing factors on landsliding especially with regard to farm land.
The cartographic processing will involve both the making of thematic maps and the statistical processing of the land data.
The job is composed of the following stages:
1) Making of thematic maps both from photointerpretation of aerial shots (1976) such as natural vegetation and geomorphology, and from base cartography processing such as hydrography and slope orientation.
2) Digitazion of the obtained maps: a CAD working on personal computer, DOS operating system, have been used for the experimentation.
3) Developing of a land information system: to create the data base we choose some software interfaced with the CAD used for the digitization.

1. Introduction

This study is included in a large research on the environmental characterisation of torrent Benedello sample basin in its different features (geomorphology, lithopedology, soil use., etc...) and, by the development of a land informative system, on the study of the relationships between the different parameters and their evolution in time. The project is financed by the Assessorato Agricoltura della Regione Emilia Romagna.
The objective of the research is the assessment of the relationships between the soil use and the geomorphologic events by a methodology permitting the statistical processing and manipulation of the land data..

2. Localisation and characterisation of the studied area

The studied area is the basin of Rio Benedello, tributary of Fiume Panaro (Prov. di Modena) represented in the table I.G.M. F.86 IISE of the Map of Italy; the area included between the parallels 44°20' and 44°25' latitude North, and the meridians 1°30' e 1° 38' longitude West from Rome (M.Mario).
The basin extends on almost 2000 ha., the extreme levels reach 200 Mt. on the sea level in the valley bottom and 870 Mt. on the sea level in the Montenero.

3. Materials and methods

3.1 Maps and aerial shots

The maps used as a base for the job are the Carta Tecnica Regionale(CTR) on the scale of 1 to 10000, relative to the sheet "Coscogno", and the geologic map on the scale of 1 to 10000 made by the Regione Emilia Romagna. As far as the aerial shots are concerned, we acquired the colour shots made in 1976 by the Regione Emilia Romagna, on the scale of 1 to 13000. The aerial shots have been studied with photointerpretation techniques.

3.2. Making of maps

The soil use map and the geomorphology map have been made by photointerpretation of aerial shots. The definition of the soil use classes is represented in table 1.

Origin (natural anthropic)	Group	Class	Code
Natural vegetation	Barren	Rock emergence	1
		Degraded (bad lands)	2
	Uncultivated	Grassland	4
		Bushy grassland	5
	Wood	Woodland	9
Soil use	Arable land	Arable land	3
	Arable land with trees	Arable land with trees	6
	Orchard	Vineyard	7
		Orchard	8
	Unproductive	Reservoir	10
		Built-up area	11

Table 1. Soil use classes.

In the geomorphologic map the following shapes have been singled out:
a) concavities, convexity, irregularity and escarpment causing irregularity in the slope due both to old or apparently stabilised mass movements and to small dimension movements
b) water erosion shapes due to superficial waters both canalised in ditches and streamlets and in diffused rill on the slope;
c) The mass movement shapes have been divided into: recent or still active landslides, old landslides, landslips and superficial flows. In the mass movements a further dimensional discriminant, equal to 0.005 sq km, has been introduced in order to separate geolithologic and stratigraphic events from the ones affected and/or caused also by anthropic factors such as the superficial waters distribution and the soil use.
The are affected from the specific event and their number have been taken into consideration in the processing.

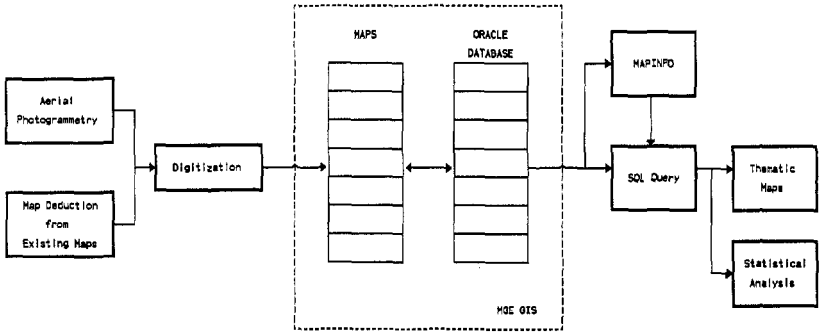

Figure 1: Information system design schematic.

3.3 Organisation and processing of geographic information.
The information system to manage the land data has been developed according to the structure schematised in Fig. 1, through the combination of different software modules.
The available land information input (from photointerpretation of aerial shots and from the existing cartography) has been made using the software MGE Intergraph (DOS version), a GIS needing CAD

MicroStation as graphic interface and a link to ORACLE database to file alphanumeric information associated to map elements.
The features associated to these elements are linked to attributes tables, within the categories assigned to the different types of maps and organised according to the modalities of the relational database ORACLE..
The archives (graphic-alphanumeric) have been exported in Mapinfo 3.0 for Windows environment. This choice permits the processing of land data as objects. The resulting data have been analysed using Statgraphics software.

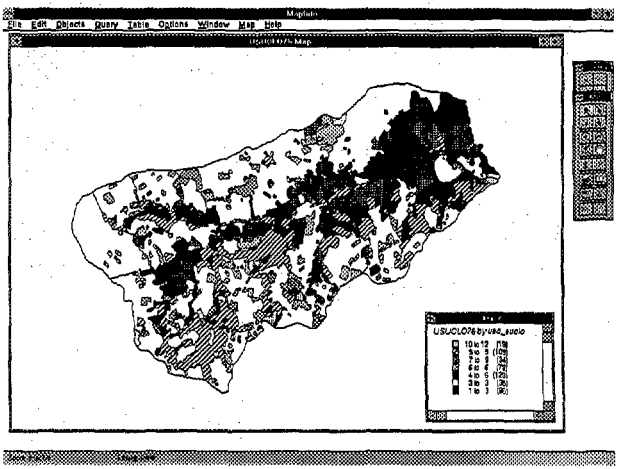

Figure 2: Soil use map.

4. Results and discussion.

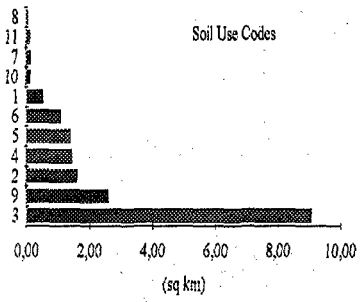

Figure 3: Soil use Classification in sample area.

La digitisation and the processing of map information brought to the making of the "soil use map 1976" (fig.2) and of the geomorphologic events map". The soil uses distribution in sq km is represented in the histogram of fig. 3: the arable land is the main use, with almost 9 sq km. equal to about 50 % of the whole basin, followed by woodland with more than 3 sq km., the gullies, classified as degraded land and rock emergence, cover more than 2.5 sq km. , the uncultivated lands including grassland and bushy grassland is almost 4 sq km.
The area interested from old and recent landslides superior to 0.005 sq km is equal to 2.68 sq km corresponding to 31 events, the area interested from small landslides inferior to 0.005 Sq km., is 0.095 sq km corresponding to 41 events.

Old and/or stabilised and active landslides distribution according to their dimensions is represented in fig. 4a and 4b: we can observe that old events have mainly big dimensions, while recent movements have mainly a surface inferior to 0.01 sq km.
Introducing a dimensional discriminant of 0.005 sq km almost all the active landslides have been singled out. This data file together with landscape events type a) and b) permitted to make the histogram in fig. 5 where the relationship between the total degraded area divided according to the soil use and the surface of the different classes of soil use is represented: we can observe that landscapes are concentrated in the bad lands (code 1-2) with 21% of their surface, about 8% of the uncultivated land (code 4-5) is interested by landscapes, while in the arable land 1.8% of the surface is subject to landscapes. In the remaining areas these events are very moderate or absent.

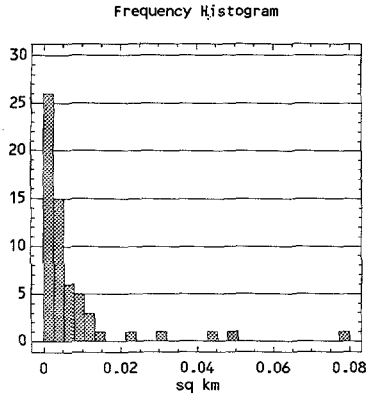

Figure 4a: Active landslide disrtibution

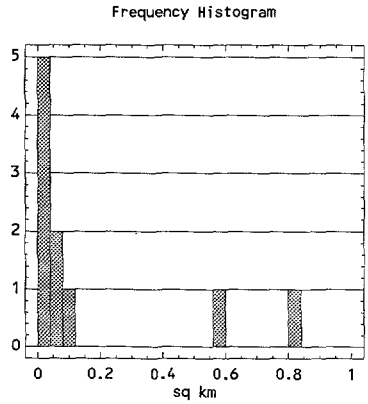

Figure 4b: Stabilized landslide distribution.

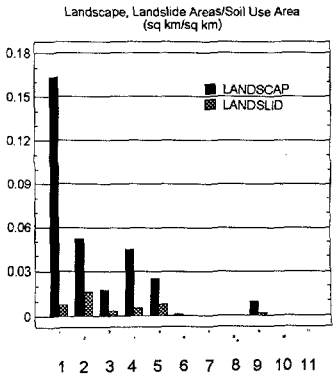

Figure 5: Landscape and landslide distributions concerning soil use.

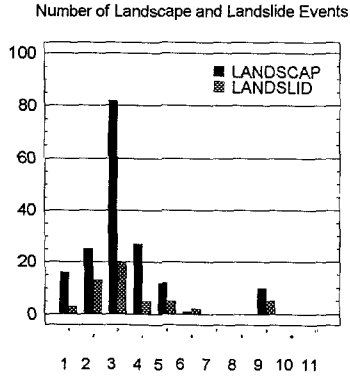

Figure 6: Number of landscape and landslide events concerning soil use.

As far as landslide events type a-b are concerned, we can observe that the bad lands (1-2) reach the maximum value with 2.5% of the surface interested in the event, followed by the uncultivated land with 1.4%. In the arable lands 0.5 % of the surface is interested from this event.
In fig 6 the number of landslide and landscape (type a and b) events concerning soil use is represented: the higher value is reached in the arable lands and, in a lesser extent, in the uncultivated lands. In the barren area the escarpments are prevailing since in these areas the superficial water erosion shapes are included in the definition of gullies and degraded areas. According to what said above and to the graphic in fig. 5, we can observe that the arable land is characterised by a considerable number of small dimension events, while the uncultivated land and, in a greater extent, the barren areas are interested by a limited number of big dimensions events.

5. Conclusions

The use of Land Information Systems in the study of geographic land parameters seems to be an useful, but insufficient instrument to obtain quantitative information on the relationship linking the different elements, so it is indispensable to use programs permitting the identification of the different land areas as objects in order to use statistical analysis.
In this research we tried to plan a methodology of land study in order to be able to process the land data without the artificial introduction of factors or weights.
This procedure allows to manage the land data files both as number of events per single soil use or per group of uses and as surfaces interested by a single event or by selectioned groups of events.
Graphic and statistical processing has been carried out on these files: the surfaces of every single soil use and of the different landscape events have been valued and the soil use has been compared with these events according to their surface, number and relationship.
An interesting result is that the arable land is interested by a remarkable number of small events of degrade, proportionally superior compared to the other uses. As far as considerable landscape events are concerned, they are mainly concentrated in gullies. The arable lands with trees, the orchards and the woodlands are interested by a small number of degrade events. the uncultivated lands, including grasslands and bushy grasslands, have a high percentage of degrade and a considerable number of degrade events, even if inferior to the arable lands.
According to these data we can state that in the studied basin there is a relationship between the soil use and the instability events: as a matter of fact in the herbaceous crop areas, in the grasslands and, in a lesser extent, in the bushy grassland we can find the maximum number of landscape events characterised by their small dimensions. In the arable lands with trees, in the orchards and in the woodlands the degrade events decrease in a in a progressive way.
The degraded areas, typical in the gullies, are mainly interested by big dimensions events .

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