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Journal of Hazardous Materials 61 (1998) 299–304

JOURNAL OF HAZARDOUS MATERIALS

Risk maps: theoretical concepts and techniques

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Abstract

The work deals with the creation of an experimental model of integrated planning based on the principles of sustainable development. The analysis and planning of the built environment focus on the improvement, reclaiming and requalifying of the urban environment and the protection of the landscape. The methodology combines the assessment of the natural risk of a territory with the process of mapping the area via a structured inheritance semantic system (SI Nets) which aims to determine, in detail, the capacity of land use. The application of the GIS system has been confirmed at the different levels of territorial planning.

Keywords: Risk map; SI Nets; Landscape

1. Introduction

The general purposes guiding the integrated planning can be summed up in the following principles/targets: protection of the natural environment even with necessary transformations; development of the role of local communities; and clash of degenerative processes.

The drainage basin of the Geirato torrent (Fig. 1) was chosen for study since it is representative of areas with the type of problems connected to dangerous natural phenomena. Its geology is characterized by the presence of flishoid sediments composed of: argillite, which constitutes the base layer and which outcrops along the streams which are generally impervious, subjected to the sharp changes and erosion; and marly limestone formation, which rests over the argillite and is found on the mountainsides and ridges. The different geotechnical, geomechanical and hydrogeological characteristics

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0304-3894/98/$19.00
PII S0304-3894(98)00136-8

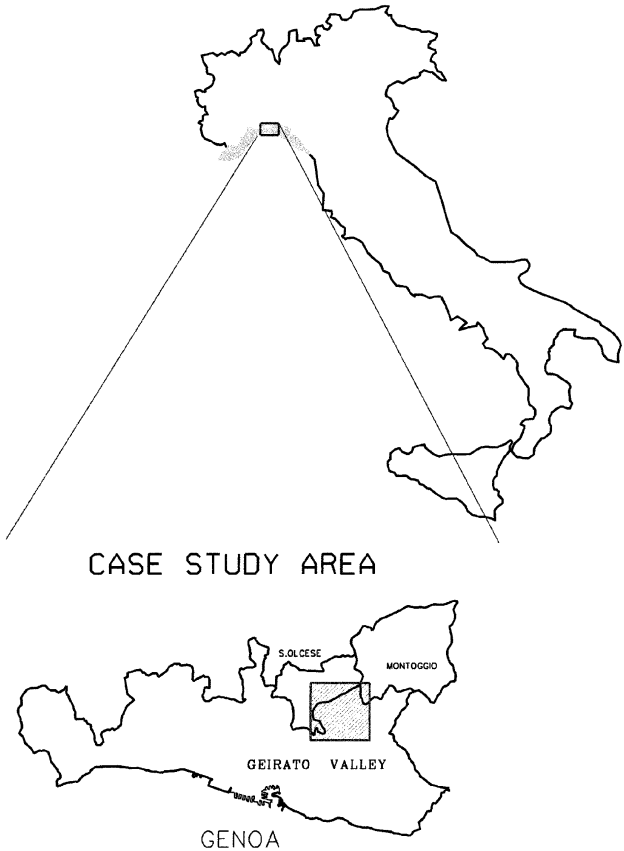

Fig. 1. Location of the case study area.

are the cause of the presence of landslides that occur almost homogeneously in the area along the strip that connects the two lithologies [1].

The occurrence of landslides is predominantly linked to prolonged rainfalls [2] and to human interventions.

2. Experimental

The method involves the individuation of the hydrological and geomorphological risk, intended as predictable loss of man lives, number of injured, damage to private property and industrial activities due to a specific natural event of a certain intensity [3,4].

The risk is therefore expressed by:
$R = H \times V \times E$, where: H = hazard, the probability that a potentially destructive phenomenon occurs with a determined period of time and within a determined area; E = element at risk: population, property, industry; V = vulnerability, the degree of loss

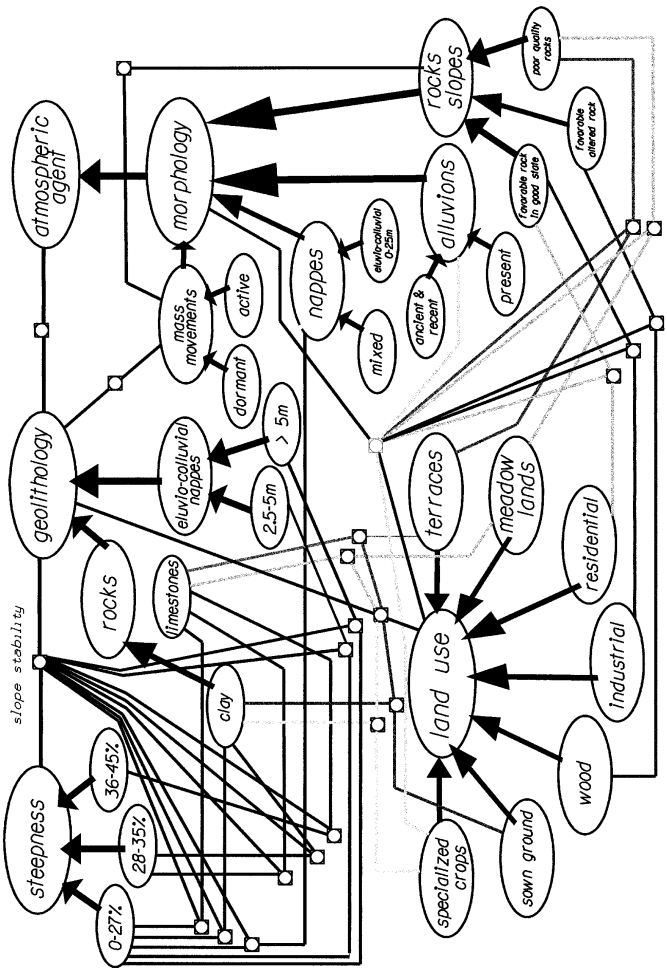

Fig. 2. Scheme used for natural risk evaluation.

sustained by a particular element or group of elements exposed to risk due to a natural phenomenon of a certain intensity.

The method employed in the assessment of risk is outlined in Fig. 2. The table illustrates the order of levels of study and their correlation. Individuating the areas prone to deluges and the areas of geological instability has made it possible to assess the risk. Passing across the danger (H) factor, the intensity of the occurring phenomena and the assessment of natural elements leads to a subdivision into three categories (low, medium and high risk) [5].

The map showing the predisposition to disruption and the risk map have been prepared following the above schema. The map concerning the predisposition to disruption has been drawn overlaying the thematic maps concerning acclivity, geolithology and geomorphology; the results obtained by queries in the Intergraph environment (Microstation, MGA, MGE and ORACLE) have been analysed and matched with a map showing the zones with a higher social, economic and environmental vulnerability (Fig. 3).

The environmental risk map is the synthesis of the results emerging from the overlay of the previously described maps. The conceptual representation of the phenomena related to environmental risk permitted to put in evidence meaningful criteria and indicators for the safeguard of the environment [6].

The aim of research is to make it so that the data, necessary for the creation of a Geographical Information System on the environment, is considered as a representation

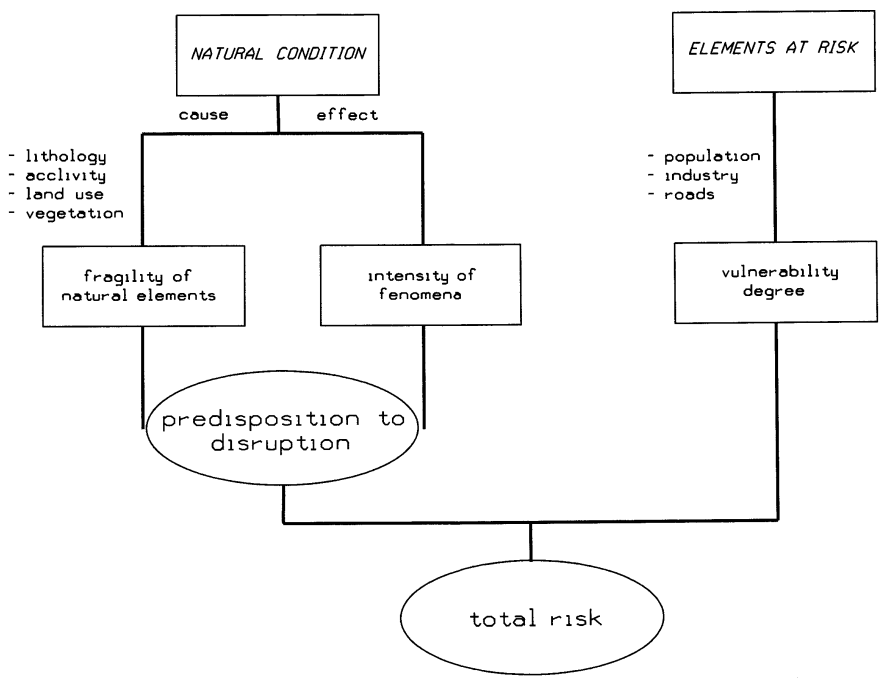

Fig. 3.

of the real world; it is, thus, necessary to ensure an accurate organisation of the data on the known facts [7].

The management of informations is made easier using the same association processes present in human mental organisation (formal ontology) [8].

Thus, a semantic net links environmental maps (considered at the same level as 'human concepts') and roles (which work in the same way of 'interrelation of concepts' in a human mind) [9].

In the present study, we used the semantic net in order to analyze a given area (Val Geirato), where space elements and structures are considered as the result of the development of a certain community with particular attention to its degree of interrelation with natural elements and landscape peculiarities [10].

3. Result and discussion

In the ambit of the research, a comparison between the various planning levels has made it evident that the risk analysis has been undervalued in the planning decisions on the ligurian territory, whether coastal or inland. With regard to the area of Genoa, in particular, the constant occurrence of catastrophic events (1991, 1992, 1994 and 1995), shows that the recent urban expansion, impelled predominantly along the narrow coastal plains and the alluvial valley floors, has had the effect of exposing human lives and property to hydrological and geomorphological risk, as well as augmenting the vulnerability of the environment, which is no longer able to withstand meteopluviometric occurrences slightly over the average. The use of the environmental GIS has two positive effects.

It allows a detailed evaluation of the natural risk of a territory to be made. It consequently offers the possibility, via the querying of the associate database, to define the socio-economic costs involved and thus to individuate the best planning strategies based on cost–benefit appraisals.

It elucidates the pre-industrials planning rules, characterised by a more careful management of the natural resources. The high level of detail, for example, that was attained in the thematic maps allowed for very accurate superimposition. The intersection between the steepness of the mountainsides, lithology and land use, shows how the settled centres were found in the stable limestone areas, while the specialised cultivation and sowable land occupied the clay terraced areas, which were usually areas prone to landslides and thus with a low level of use.

4. Conclusions

The cartography based on the methodology presented has made it possible to establish, with a high level of precision, the factors involved in the assessment of risk (H and V). The use of this tool is important for territorial planning in harmony with the principles of sustainable development and which allows for the prevention of natural disasters. Such a methodology is being consolidated in Liguria at different levels of

territorial planning, both on General Town Planning Scheme and the Basin Planning Scheme, with the aim to avoid the repetition of the land use errors of the post-war years.

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