DSS AND GIS TOOL FOR CIVIL PROTECTION PLANNING IN CASE OF FLOODING HAZARD

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INTRODUCTION

The Civil Protection purpose is to better protect people, their environment, property and cultural heritage in case of major natural events or man-made disasters (Foster, 1980, Alexander, 1998, Alexander, 2000). The management of a critical event has precise goals: people safeguard, taking care of the injured, coordination of first aid activities, recovery of primary public services, management of personnel, organization of resources and communication with public and private institutions, government agencies, authorities and citizens (Cate, 1994; Daines, 1991; Drabek et al., 1991).

In a broader view, the role of Civil Protection is carried out through three key modes of action: prevention, preparedness and response. These actions encompass:

a) the prevention of risks and damage to people, properties, infrastructure and in so doing environment, in the event of disasters, detecting and studying causes of disasters, improving means and methods of forecasting, analysing the characteristics of the damaging event together with the vulnerability of the territory, respectively;
b) the increase of the degree of preparedness of people involved in Civil Protection, in order to raise their ability to quickly and effectively respond to an emergency; the cooperation requires a rapid mobilisation of intervention teams, experts and other resources in the event of major emergencies in order to alleviate the effects of a disaster during the first days. The Civil Protection is entrusted to facilitate these actions as well to offer technical or technological support, if required;
c) the improvement of the techniques and methods of response and taking care emergencies;
d) the enhance of the public information, education and awareness, helping citizens to protect themselves more effectively. Information is the key to successful co-operation in Civil Protection matters. The dissemination of information can be carried out in advance or during the emergency;
e) the granting of financial assistance to the affected areas via the Solidarity Fund.

STUDY AREA

The methodology proposed herein was settled and tested in a local Mountain Consortium of Municipalities in Valtellina di Tirano, an area of about 450 km2 located on the Italian Central Alps (Lombardy Region, Northern Italy). The territory is subdivided among 12 municipalities and it has about 29,000 inhabitants (prevalently sited on the valley floor).

Valtellina has an unenviable history of intense and diffused landsliding: it represents one of the primary causes of life injury and property damage, resulting in enormous casualties and huge economic losses. Field surveys allow to map mainly rainfall-induced, small size and thickness slides soil slips and/or soil slip-debris flows and slumps affecting Quaternary covers; their volumes range from few up to some hundreds cubic metres These phenomena remove portions of cultivated areas, often causing the interruption of transportation corridors and disruptions in inhabited areas, sometimes determining the temporary evacuation of people.

METHODOLOGY

According to the Italian legislative framework (National Law 225/92, D.Lgs. 112/1998; D.Lgs.

267/2000; D.P.R. 194/2001; D.P.C.M. 12/12/01; D.P.C.M. 24/07/02) contingency plans have been carried out to identify and prepare in advance people in charge to take actions, and define the activities to perform in case a damaging event occurs, on the base of available resources. A workflow based on decisional processes and rules was set up and uploaded in a Decision Support System (implemented in a Geographical Information System) for a real-time management of prospective emergency situations.

The requirement to protect people and to correctly manage resources during a crisis phase is strictly linked to the capability to profile the potential damaging events in advance (Sterlacchini et al., 2007). For that reason, we suppose that the crisis phase can be related to a prospective flooding event, whose physical characteristics are supposed to be well-known in advance, being derived from the application of a 1D-2D hydrological model (hazard scenario, Figure 1). On the base of the geographical distribution and type of vulnerable elements and the physical and economic consequences due to the occurrence of the damaging event, a risk scenario has been defined, describing the possible effects on the social, economic and infrastructural affected system.

This paper is primarily intended to describe the last step of our methodology targeted to manage a crisis phase, due to the occurrence of a flooding event (as described in the hazard and risk scenario), in a real-time by GIS and DSS.

In detail, contingency plans were prepared and managed by PETer® (Protection and Emergency TERritorial plans), a software developed by the cooperation between an Italian ESRI® Business Partner (Globo® inc.) and researchers applied in the Institute for the Dynamic of Environmental Processes (National Research Council, Milan, Italy) and in the Department of Environmental and Territorial Sciences (University of Milano-Bicocca, Milan, Italy). The software was developed by using Microsoft® Visual Basic® 6.0; the geographical features are managed by ESRI® MapObjects® and the database is available in a standard release (with Microsoft® Access database and ESRI® Shapefile™ for features) or in an enterprise release (with Oracle® or SQLServer™ database and ESRI® Shapefile™ for features by ESRI® ArcSDE™). The application couples data processing capabilities by GIS tools with workflow management modules by Decision Support System; it automatically performs organizational and operational activities within a Civil Protection Plan, in line with the regulations in force.

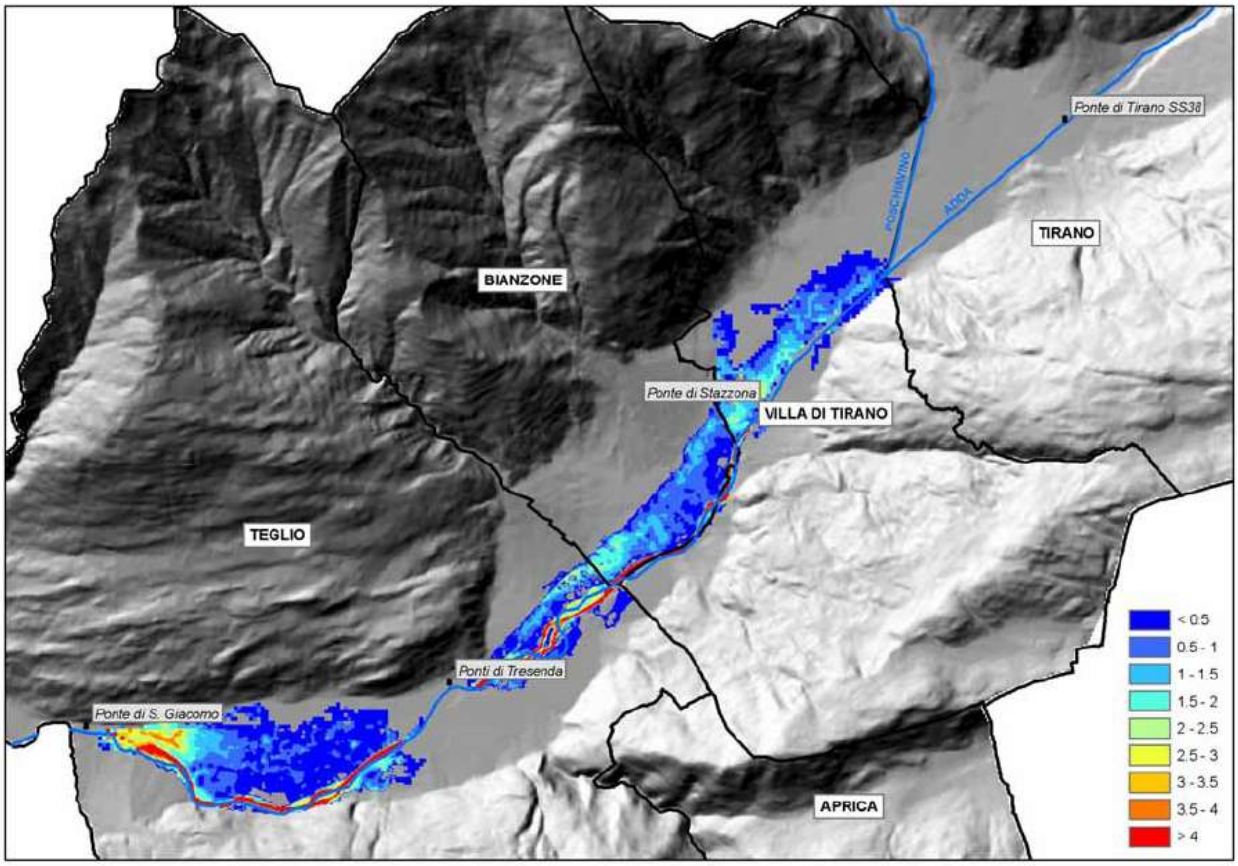

Figure 1 – Flooding hazard scenario characterised by a return period of 100 years

PETer accomplishes an integration between GIS tools (for storing, managing, analysing and representing geographical data), Decision Support Systems, and Information and Communication Technology (ICT) for defining and controlling decisional processes in terms of:

- definition of the procedures and actions (workflows) to be sequentially executed for the management of emergency situations (according to the laws in force);
- identification of the people (individually or aggregated in agencies, companies, squads, etc.) responsible for each procedure;
- description of the instructions to be followed to perform each action;
- list of the documents to be drawn up during or immediately after each action;
- transfer of the procedures to people in charge of taking actions;
- management of the resources really available for coping with each phase of the emergency.

PETER APPLICATION STRUCTURE

PETer allows a well-informed management of data and resources during a crisis phase, ensuring the connectivity and interoperability of the expected Civil Protection tasks. In our specific case, it was used to prepare, apply, and coordinate Civil Protection Plans by accessing data stored at a municipal and/or centralised level.

Each municipality can access the system of the neighbouring municipalities but only for consultation purposes (changes are not allowed). On the contrary, the Central Office of the Consortium of Mountain Municipalities of Valtellina di Tirano has read/write rights on data stored in each municipality. By this cooperative structure, the individual plans can operate in a combined and integrated way. The possibility to access municipal or centralized data from remote terminals in multi-user mode plays an important key-role in the management of emergency situations. By this way, data transfer among administrative entities and people involved in the management of the emergency situation, is based on new tools which makes use of more efficient and well organised technological methods (web and mobile tools).

The architecture of the software provides two different applications, designed to meet the needs of different users:

- PETer Site: allows the complete management of a Civil Protection plan. Data and workflow can be stored, managed, and analysed.
- PETer Net: allows the consultation via Web of each individual plan.

Different functionalities were offered to manage information at different level of emergency:

- Uploading and management of data (at a municipal and inter-municipal level) to be used in emergency situations
- Management in real-time of resource, people and institutions potentially involved in the emergency
- Designing procedural workflows and running simulations of emergency events
- Printing and plotting reports; automatic filling and posting of documents; management of communications
- Assessing data security and integrity (by means of different passwords for different types of users)
- Allowing the publication of the Civil Protection Plans by Web

The application was thought for a complete chain of information, linking all the people in charge of taking actions: crews in the field, the mobile command post and control rooms. It is targeted to manage the aftermath of critical hydrogeological events and it is based on a cooperative organizational structure (Figure 2), by which information may be provided and managed at different administrative levels.

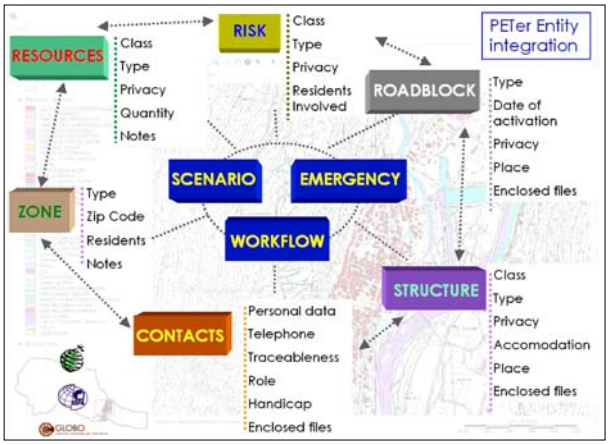

Figure 2 – Organizational structure of Peter

DATABASE STRUCTURE

A multi-scale database (whose content is published on the website www.cmtirano.so.it) was prepared to collect, integrate, manage and analyse new and existing data, derived from different

sources characterized by different degree of accuracy, from a basin scale (1:50,000; 1:25,000) to a local scale (1:10,000; 1:1,000).

Database content can be accessed by PETer for supporting civil protection activities.

Data were organized in a database for the 12 municipalities, encompassing::

- 44 risk scenarios
- 290 contacts (personnel, groups, volunteers, first aid support, fire brigades, police, etc.)
- direct links to Registry Office database of the Consortium (age, gender, telephone number, disabled people, etc.)
- 554 structures (warehouses, hospitals, barracks, etc.)
- 239 resources (materials, vehicles, instruments, etc.)
- 148 roadblocks
- 11 Workflow models for guiding Civil Protection activities and entity management (during PRE-ALARM, ALARM, EMERGENCY, and POST-EMERGENCY phases)
- Documents to be used in each phase above mentioned available in digital format for a prompt use (rtf, doc)

All georeferenced information stored in the database as maps (both in vector and raster format) and related tables were completely available on demand (creation, maintenance and updating).

CONCLUSION

The increasing frequency of natural hazards, combined with a higher urbanisation and growth in economic activities, has significantly raised the vulnerability of our society. As a consequence, losses are growing rapidly. Programmes targeted to the prevention, preparedness and response to natural disasters are continuously developed and updated by government agencies, public and private institutions and authorities at a national, regional, and local level.

In this study a methodology for a real-time management of emergency situations was suggested. It may assist local and regional planners, regulators and land surveyors, in optimising the management of a crisis phase, mitigating their consequences, and accelerating the recovery phase. The methodology suggests an appropriate course of actions, combining generic and time varying site-specific information (via electronic links from field and from data sources stored in specific databases). The integration of GIS tools with workflow management modules and information and communication technology may be considered as an effective support for the definition of emergency planning and management strategies, permitting a real time monitoring of activities, procedures and information communication and sharing.

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