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Preface

Geo-databases are repositories of geological information. These computer databases contain geographical, numerical and alphanumerical information in various digital formats, including vector and raster maps, terrestrial, aerial and satellite imagery, time series and tabular data, texts, documents and images. Information stored in geo-databases is compiled at different geographical and temporal scales, using a variety of methods and technologies.

Geo-databases are used by scientists, government agencies, policy makers, and professionals in various fields of the Environmental and the Earth Sciences, including geology, geomorphology, surface and sub-surface hydrology, seismology, and volcanology. For many scientists, geo-databases represent important sources of information for validating physically-based, statistical or conceptual models. In the last two decades, local, regional, national and international organizations have made considerable efforts to design, implement, and maintain digital inventories of geological and thematic information on natural hazards. As a result, geo-databases have established as an essential tool for any investigation aimed at assessing the risk posed by hazardous natural phenomena. Thematic databases, digital inventories and cartographic archives have become an important part of integrated strategies to assess natural and man-made hazards. Warning systems aimed at protecting the population, structures and the infrastructure from harmful natural events rely on geo-databases to provide accurate, reliable and timely forecasts. Geo-databases are used to estimate the extent of the potential damage produced by hazardous natural phenomena such as earthquakes, volcanic eruptions, landslides, floods and hurricanes. Civil protection personnel in national and regional defence agencies and risk managers working for insurance companies use geo-databases to estimate the frequency and the damaging characteristics of harmful natural events. Technical end-users, professionals, and private consultants use geo-databases to solve local hazard problems. Concerned citizens access publicly available geo-databases to obtain site-specific information on a variety of natural hazards and their consequences.

In the framework of the Joint Assembly of the European Geophysical Society (EGS), the American Geophysical Union (AGU), and the European Union of Geosciences (EUG), a unique event that was held in Nice, France, on April 2003, we convened a symposium on *Geo-databases for Natural Hazards and Risk Assessment*. The goal of the symposium was to discuss the design, implementation, maintenance, update, and use of geo-databases, with emphasis on applications for natural hazard assessments and risk evaluation. The symposium was an opportunity for an in-depth discussion among scientists interested in natural hazards, computer experts, and technical end-users on the applications, advantages and limitations of the existing geo-database technology, on the possible developments and the desirable improvements.

Eighteen contributions were presented at the symposium, of which eight were oral presentations and ten were posters. The abstracts are available on the EGU web site at http://www.copernicus.org/EGS/egsga/nice03/programme/overview.htm, in the Natural Hazards section of the programme. The content, quality and diversity of the applications of geo-databases presented at the symposium encouraged us to embark in the editing of a special issue of the EGU journal *Natural Hazards and Earth System Sciences*. This issue of NHESS contains four of the papers that were presented at the symposium.

The four papers largely reflect the variety of the topics presented and discussed at the symposium. Two papers describe local and regional applications of geo-databases for landslides and landslide hazard assessment; one paper presents a nation-wide information system on historical and bibliographical information on landslides and floods; and one paper discusses a regional geo-database for multiple hazards assessment and mitigation, including volcanic eruptions, earthquakes, and various types of landslides. The four papers describe investigations and hazard assessment applications at a large range of geographical scales, including site-specific and local, provincial or regional, and national scales. Hazard phenomena discussed in the four papers include slope failures, floods, volcanic eruptions and associated phenomena, and earthquakes. Most of the papers deal with one or two types of hazards, and one paper deals with multiple hazards.

Information and computer technologies applied by the authors and discussed in the papers include: database management systems (DBMS), geographical information systems (GIS), global position system (GPS), computer networking and Web technology. GIS technology, perhaps not surprisingly, has established as a fundamental element of geo-databases and their applications. GIS is used to collect, manage, update, and visualize geographical and geological information in conjunction with a variety of other thematic data. As a drawback, the analytical capabilities of a GIS are not yet fully exploited by users of geo-databases. Topographic and geodetic measurements aided by GPS technology are applied at different scales, from the local to the regional, to investigate landslide, earthquake and volcanic hazards. Internet, and particularly Web technology, has become the leading technology for the design of the user interfaces of many geo-databases, and not only for those dedicated to data dissemination.

We ordered the four papers in this special issue based on the type of natural hazards and the scale of the investigation. The first two papers describe applications of geo-databases to landslide monitoring and landslide hazard assessment. The third paper presents an information system on historical landslides and floods in Italy. The forth paper discusses the use of geo-databases for multi-hazard assessments in the Azores archipelago.

Jaboyedoff, Ornstein and *Rouiller* discuss the problems encountered and the solutions adopted in the design of a database for geodetic measurements. Measurements are made to monitor the Randa rock fall-rock slide, which occurred in 1991 in the Valais canton, Switzerland. The database of topographical measurements is part of a large, multidisciplinary effort aimed at monitoring the evolution of the rock slope and at evaluating the hazards posed by possible slope failures. Design of the database is the result of twelve years of monitoring of the upper part of the landslide escarpment. The authors describe the database and the software used to monitor the movements of a set of benchmarks conveniently located on the rock face. Repeated measurements allow determining the rate of movements of the benchmarks. This information is used in a GIS to prepare maps showing displacement vectors and rates of movement of individual or multiple targets. These maps portray the rate of displacement of the rock slope, and prove very useful in the assessment of the rock fall hazard. An attempt is made to use the available record of geodetic measurements to forecast potential catastrophic failures of the upper section of Randa landslide. Based on their experience, the authors suggest that specialized geo-databases aimed at facilitating the monitoring of slope movements are particularly useful in mountain areas where a hazard has been recognized, or where the need exists to use new land for urban and sub-urban developments.

Giardino, Giordan and *Ambrogio* discuss the application of GIS technology to the collection, storage, management and visualization of information on large mass-movements in the Susa and Aosta valleys, in the western Italian Alps. Two databases containing information on very large mass movements are presented. Information stored in the two databases include geomorphological, hydrological, lithological and structural data that were measured in the field, obtained from the analysis of remotely sensed images, including aerial photography, and by searching historical archives. To facilitate the storage and management of a large collection of thematic data compiled at different geographical and temporal scales, the authors propose to store the information in two separate databases. One database is used to store local (i.e., large scale) information, and a second database is used to collect the regional (i.e., medium to small scale) information. The advantage and drawbacks of the adopted solution is discussed, including optimization issues and a description of the functionalities of the two databases. Solutions are proposed that can improve the management of large amounts of multiple-scales data collected from multi-temporal studies on large slope instability phenomena.

Guzzetti and *Tonelli* present SICI, a nation-wide information system on hydrological and geomorphological catastrophes in Italy (http://sici.irpi.cnr.it). The information system is composed of ten modules, which contain historical information on landslides and floods in Italy in the period from 1700 to 2000, data on the extent and type of damage to the population produced by slope movements and inundations, bibliographical and reference catalogues, daily water discharge and daily sediment yield records for selected gauging stations, a catalogue of Italian legislation on geo-hydrological risk, and technical reports describing survey carried out in hazardous areas by experts working for the Italian Civil Protection Department. The authors examine the type and abundance of the information stored in each database, and discuss the hardware and software configuration adopted for the information system, including a description of a GIS-based Web application to publish thematic maps showing the location and abundance of sites affected by landslides and floods in Italy (http://sicimaps.irpi.cnr.it). Applications of the information system described in the paper include: the analysis of the geographical and seasonal distributions of historical landslides and floods in Italy, the recurrence of damaging events in the 8102 Italian municipalities, and the analysis of the extent of the triggering meteorological events which resulted in landslides and floods. This paper provides an example of how geo-databases containing information from multiple sources can be used to understand natural hazards at the national scale.

Gaspar, Goulart, Queiroz, Silveira and *Gomes* describe AZORIS, a GIS system for geological risk assessment in the Azores archipelago, Portugal. The Azores islands are subject to multiple geological hazards, including volcanic eruptions and associated phenomena, earthquakes, and landslides of various types. The AZORIS system, which is still under development, is designed to facilitate the interconnection of different thematic databases, which can be useful to assess multiple geological hazards, at the regional and the local scales. Information stored in AZORIS databases comprises: base maps, topographical data, the results of monitoring networks, and records of historical information. Thematic data layers include: topographical data, geodetic measurements, geologic, geomorphologic and slope failures data, volcanology and fluid geochemistry data, earthquake and seismological data, and meteorological information. Also included in the GIS databases is information on the geography, socio-economical setting, and civil protection structure in the Azores islands. The authors argue that AZORIS will allow for better hazard and vulnerability assessments, and will lead to a multiple-risk zonation of the islands. AZORIS will be used for emergency applications, including warning systems and crisis management, and for land-use planning in the Azores islands.

In conclusion, the four papers illustrate the significance of databases of geological information for a better, in depth understanding of the causes of natural hazards, and their often catastrophic effects on the population, the built-up environment and the infrastructure. The importance of geo-databases for Environmental and Earth Sciences is increasing, and we foresee that interest on geo-databases will continue to grow in the near future.

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