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1999 PROGRESS REPORT

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1 The AVI Project

1.1 INTRODUCTION

With the 1999-2001 program the CNR-GNDCI AVI project enters a new phase. After the inventory was carried out in the early nineties, and the historical archive organisation was completed between 1993 and 1998, the new phase of the project is aimed at the analysis and use of the historical information and at its integration with geological and hydrological data to assess flood and landslide risk at the regional scale, and to support regional planning.

The devastating mud and debris flows that occurred in May 1998 at Sarno and Quindici in Campania Region gave rise to new national legislation on hydrological and geological protection. This consists principally of the Decreto del Presidente del Consiglio dei Ministri (DPCM 267/1998) of 29-8-98, witch qualifies both DL no. 180 of 11-5-98 and L. 183 of 18-5-89, the main soil conservation law. The DPCM requires flood, landslide and erosion hazards to be mapped in detail and this information to be compared with elements at risk in the landscape in order to identify the locations of major risk to people, buildings and infrastructure.

Historical information on landslide and flood collected, organised and made available by the AVI project are among the data the new legislation suggests to be used to evaluate landslide and flood hazard, and to map areas at high risk. This is an important recognition for the value of historical data (and of historical research on natural catastrophes) and for the role of the AVI project; the first of its kind for flood and landslide risk assessment.

The various research and organisational activities carried out within the AVI project from 1991 to 1998 resulted in computer databases and catalogues of damaging landslide and flood events occurred in Italy in the 20th century. The archives and catalogues, far from being an hydro-geological risk map, represent the most accurate and updated map of the spatial and temporal distribution of landslide and flood events ever prepared for Italy. Research planned for 1999-2001 is mostly aimed at testing the possibility of using the AVI archives and catalogues to help assessing landslide and flood hazard, and to map areas at higher risk.

A brief description of the project goals will now be given.

1.2 THE 1999-2001 RESEARCH PROGRAM

The success obtained by the AVI products and in particular by the catalogues and the databases, and the recent institutional recognition of the value and role of the AVI project, clearly show that the collection, storage and analysis of historical information on hydrological and geological catastrophes must continue. A new question arises: *now that we have such a large database of historical information, how can we use it to improve our ability to forecast dangerous event and to define and map areas at risk*?

After the main inventory was completed in the early nineties, project's activities have focused on the digitisation of the available information and documents (mostly on paper), on the organisation and management of the database, and on strategies for the dissemination of the information using a variety of tools, including maps, books, CD-ROMs and the Internet. To these complex and costly tasks, that will certainly continue in the future, the 1999-2001 program adds new tasks aimed at extending (mostly in the past) the temporal extent of the AVI database, and at investigating possible applications and limits of the historical information for the evaluation and assessment of flood and landslide hazard and risk. Within this framework, the goals of the 1999-2001 program are:

- *to maintain, update and refine the database by collecting new information, by extending in the past the time-span of the archive, and by evaluating the database completeness, reliability and representativness;*
- *to upgrade the current capabilities of the AVI information system, improving the tools for an efficient interactive data-dissemination;*
- *to experiment with possible applications of the historical information, producing thematic catalogues, defining a list of the most severe hydro-meteorological events that resulted in catastrophic inundation or landslides; and devising guidelines for the use of historical information to assess flood and landslide hazard and risk.*

1.2.1 Database maintenance and upgrade

The value of an historical series is inherent to its length and completeness. For this reason maintenance and upgrade of the AVI database remain an important goal of the project. During the 1991-2001 program, the database will be extended to the year 1998, and an attempt will be made to experiment with a real-time update of the archive using information available on the Internet. The main source of information will remain the newspapers, and the same searching techniques used with success in the past will be exploited. The database will be upgraded also by searching libraries of newspapers, historical archives and repertoires on natural catastrophes that were not searched exhaustively during the previous phases of the inventory.

There are three reasons to upgrade the database and to try to extend it in the past. The first reason has to do with the fact that when the AVI inventory was planned it was decided to relay heavily on the newspapers of the 20th century (actually, from 1918 to 1990). This has allowed to collect in a limited time and with scarce resources an enormous amount of information that, as a drawback, is not homogeneously distributed (in space and time). The catalogue of landslide or flood events is therefore somewhat biased by the cultural and social situation in each region, and by the availability and diffusion of newspapers. The second reason refers to the technique used to carry out the inventory, that was completed by 14 groups with different experience and background. To an extent this has contributed to the lack of homogeneity of the database. The last reason refers to the decision to start collecting information from 1918, when the Italian State (a Monarchy at the time) was restructuring the technical services, including the hydrological service. Hence, if from about 1920 daily rainfall measurements and daily water levels at several gauging stations are available for comparison with information on catastrophic landslide and flood events, there is a loss of memory for all the events with a return period exceeding a century.

Searching repertoires and historical compilations, 19th century catalogues, and academic journals will extend the temporal coverage of the AVI database from the present 80 years to 150 years or more, limiting the problem due to the events with a return period close to a century. The integration of the AVI database with local, high quality sources (mostly chronicles) covering few or several centuries, is not meant to systematically improve the database, but rather to investigate the limitations of the AVI database in regions with different culture and various geo-morphological settings, to compare detailed historical chronicles available for limited areas, and to estimate the time and economic resources needed for a nation-wide upgrade of the AVI database.

1.2.2 Upgrade of the information system

The AVI information system was started as an experimental tool to disseminate historical data. The information system is now a complex and integrated tool aimed at a large variety of users interested in landslide and flood hazard and risk in Italy. Users include central, regional and local governments; scientists; geologists, engineers and planners; civil protection personnel; and concerned citizens. Following the DPCM n° 267, the requests of information, data and publications (in particular the *Catalogue of information on sites historically affected by landslides and floods* and its electronic version, the Mappavi software) have largely increased. The amount of data currently available and the information that it is foreseeable will be collected in the next few years, require proper technical support and professional expertise to improve the dissemination of the information, to help scientists in their effort to assess landslide and flood hazard, and to facilitate storage, maintenance and efficient use of an increasing amount of information.

With this respect, the "strategic" goal is to transform the information system in the core (or the "engine") of the entire AVI project. During the 3-years program we plan to increase the information available in digital form, to upgrade the system for data analysis and information dissemination; to prepare new synoptic maps and new catalogues, and to distribute them in both paper (hard) and digital (soft) copy.

1.2.3 Use of the historical information

The use of the historical information collected, stored and organised by the AVI project represents an innovation of the 1999-2001 program. During the 3-years program attempts will be made to test different applications of the available historical information on landslide and flood events, and on the new information that will be collected during the program. Experiments will be carried out on three subjects: the production of thematic catalogues of events with human consequences and of catalogues that caused damage to the infrastructures; the production of a catalogue of the strongest (i.e., most severe) meteorological events that resulted in landslides or floods; and the development of techniques for the integration of historical, mostly qualitative, information with geological and geo-morphological data to get a better assessment of landslide and flood hazard.

The production of catalogues of events with human consequences and of events that caused damage to the infrastructures will help defying the frequency and intensity (magnitude) of potentially damaging events. The catalogues will be helpful to insurance and re-insurance companies and, by comparison with already available data on human consequence caused by other catastrophic events (natural and human induced), will be used to assess the economic impact of landslides and floods, and to evaluate acceptable societal risk levels. If necessary, a new synoptic map showing the distribution of landslides and floods that caused human consequences or that resulted in damage to the infrastructures will be prepared for publication.

The production of a nation wide catalogue of the strongest (i.e., most severe) hydro-meteorological events that resulted in landslides and floods has the purpose to define the physical (meteorological, hydrological, geological, morphological) and social-economical (type and extent of damage) characteristics of the most damaging events. Based on the "Final Regional Reports" prepared by each research team at the end of the inventory, and on the analysis severe events, all major hydro-meteorological events will be identified and studied. For each event, the type and extent of all ground effects will be defined. If necessary the information currently available will be refined and integrated. Results will be compared with existing meteorological, hydrological, geological and morphological data.

Lastly, guidelines for a proper and thoughtful use of historical data for the evaluation of landslide and flood hazard and risk will be proposed. Guidelines are badly needed to prevent (or at least limit) the

abuse and the misuse (some of which recent) of the historical information on landslides and floods inventoried by the AVI project and distributed through the AVI information system.

2 Research teams

In 1999, 7 groups were given CNR-GNDCI grants within the AVI project. Three groups pertain to CNR Institutes or Centres, one to an inter-university research centre (CUGRI), an three to private outfits. Team 2.53 pertains to the GNDCI Research Theme 2 and is only partially financed by AVI. All groups were directly financed by CNR-GNDCI.

N°	*Research Team*	*CNR*	*University*	*Industry*
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3.29	**SGA, Genova** Team leader: Francesco Cipolla			†
3.30	**Co.Geo., Perugia** Team leader: Oliviero Lolli			†
3.51	**CNR IRPI, Torino** Team leader: Fabio Luino	†		
3.52	**SGA Storia Geofisica Ambiente, Bologna** Team leader: Emanuela Guidoboni			†
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3 Hydrological and geological risk assessment - Combination of historical information and geomorphologic data and tools

3.1 INTRODUCTION

Team 3.1 has been for several years focused on two main research activities: the management of the AVI historical archive and of the related information system; and the development of new techniques and tools for the acquisition, validation and use of thematic data for the assessment of landslide and flood hazard and risk at various scales. The former includes tests to evaluate the database completeness and reliability, possible applications of the historical information, the design and implementation of tools for the dissemination of the available historical data; and the management of the activities of the other teams involved in the AVI project. The latter activity is carried out in close co-operation with the CNR-CSITE research centre in Bologna, and it includes the production of landslide inventory maps and landslide hazard maps for large areas in the Umbria and Lombardy regions.

During 1999 the two activities were pursued jointly, with experiments aimed at evaluating the possible integration of techniques and methods pertaining to the realms of geomorphology and history. In natural hazard and risk assessment, a field in which despite the efforts no agreement exists on the scopes to be pursued and on the techniques and methods to be used, experimenting the integration of tools pertaining to quite different cultural and methodological areas (such as geomorphology and the study of recent history) may provide fruitful results from both the scientific and the applied point of view.

3.1 RESEARCH ACTIVITY

Research efforts were focused on four main topics:

- management of the program activities and co-ordination of the 7 research groups working within the project;
- maintenance and upgrade of the AVI information system;
- production of thematic catalogues of landslide and flood events;
- assessment of landslide hazard at various scales and in different physiographic environments through the combination of geomorphologic and historical data and techniques.

3.2.1 Program management

Managing the AVI program and co-ordinating the efforts of the various research groups was a major task. The larger number of groups (and of people) working on the program, the new expertise (particularly historian) added the project, the increasing demand for a performing information system, the shift of some of the activities between the groups and to external units (hardware and software maintenance and upgrade), all demanded for a better and more efficient co-ordination of the project. This includes also the routine maintenance and upgrade of the AVI archive, and in particular a renewed effort to improve the consistency between the database and the existing catalogues and maps.

3.2.2 Information system maintenance and upgrade

The large amount of the available historical data, the complexity of the database, and the continuous request of information from the national, regional and local governments, from scientists, geologists, engineers and planners, and from civil protection personnel and concerned citizens, has guided the transition of the AVI database from a simple storage of historical data into an information system on landslide and flood events, capable to respond to requests of different users.

Recently, we had the opportunity to add to the AVI archive other databases containing information, mostly historical, on landslides and floods. The new databases are:

- a database of information on landslides, floods and snow avalanches occurred in Italy from 1700 to 1900. Data were obtained from a report on the effects of natural events completed in the late eighties by ENEA and named "GIANO" (ENEA-SGA, 1990) (GIANO module);
- a database on landslides and floods for the Po River, complied by the River Basin Authority (ABPO module); and
- a database of information on landslide and flood events, including debris flows, occurred in Valtellina and Valchiavenna (Lombardy Region), collected and assembled by Govi and Turitto and published by the CNR-IRPI in Torino, in 1992.

Instead of embarking into a troublesome and error prone effort to merge the new databases into the AVI archive, we decided to keep the databases separate, and to treat them as different sources of information within a single information system. Of the information system the AVI "module" remains the largest and most important (at least for the period 1918-1996), but the other modules provide more detailed, local insights or extend the time-interval of the AVI database.

The GIANO module contains information on landslide, flood and snow avalanche events occurred in Italy from 1700 to 1900, including the original sources of information, derived from an historical investigation completed in the eighties by ENEA (ENEA-SGA, 1990). Information for the period 1700-1900 refer to almost 800 flooding events (388 in the 18th century and 405 in the 18th century) and more than 350 landslide events (56 in the 18th century and 300 in the 19th century). Testimonies (i.e., information) on landslide are more than 2100, 884 for the 18th century and 1248 for the 19th century). Testimonies on floods are more than 500, 126 for the 18th century and 402 for the 19th century. Information was collected form 177 bibliographical references, including catalogues, repertoires, historical sources, scientific reports, etc. (see Chapter 7.2, p. 22). The value and information content of the GIANO module are still to be fully investigated. At present we can say that the major contribution to the information system is the extension of two centuries (in the past) of the AVI archive (mostly limited to the 20th century). The GIANO module, even without the same completeness and accuracy of AVI archive due to the difficulty in collecting information from historical sources and testimonies, provides a multi-secular perspective on the extent of landslide and floods that can prove very useful for planning purposes. If additional resources will be available, the GIANO module could be further extended to cover the period 1000-1700.

The ABPO module contains information on landslides and floods collected by the Po River Basin Authority during the preparation of the "Piano di Assetto Idrogeologico". Information was collected from a variety of sources, including historical and archives sources. At present the ABPO module contains 4171 records that refer to 5990 sites affected by floods landslides or snow avalanches. The information refers to 1647 floods, 1995 landslides and 536 snow avalanches. Where available, information on damage is provided.

Lastly, the module on landslide and flood events occurred in Valtellina and Valchiavenna (Lombardy Region), collected and assembled by Govi and Turitto and published by the CNR-IRPI (1992), contains information on more than 1600 sites affected by landslides or floods. Information was obtain from 590 bibliographic and archive references. In the information system, the module is the only database referring to a very small geographical area and obtained from a very detailed analysis of

historical sources. The possibility of including in the information system other databases prepared through detailed historical analyses is currently being investigated.

3.2.3 Production of thematic catalogues: landslide fatalities

A database of landslides which occurred in Italy between 1279 and 1999 and caused deaths, missing people, injuries and homelessness was compiled from a variety of different sources. These included the archive of the AVI project, reports on historical landslide investigations for the whole of Italy, Alpine areas, the Apennines, various regions or provinces, and for single sites.

Although the exact number of casualties remains unknown, analysis of the historical catalogue indicates that from 1410 to 1999 in Italy there were at least 996 landslide events that caused a total of 12,421 deaths and injuries (including victims who were remained unaccounted for). Dead or missing persons (Figure 3.1) have totalled 10,555 in 840 events. During this 590-year period the worst year was 1963 with 1943 casualties, 1917 of whom were people killed by the Vajont rockslide. The second worst year was 1618, when 1200 deaths in the Piuro landslide, followed by 1765 with about 600 deaths at Montepiano. In the 20th century the years in which more than one hundred people died were 1910 (254 deaths), 1924 (256 deaths), 1925 (354 deaths), 1951 (151 deaths), 1954 (337 deaths), 1963 (2365 deaths), 1966 (113 deaths), 1978 (114 deaths), 1985 (299 deaths) and 1998 (161 deaths).

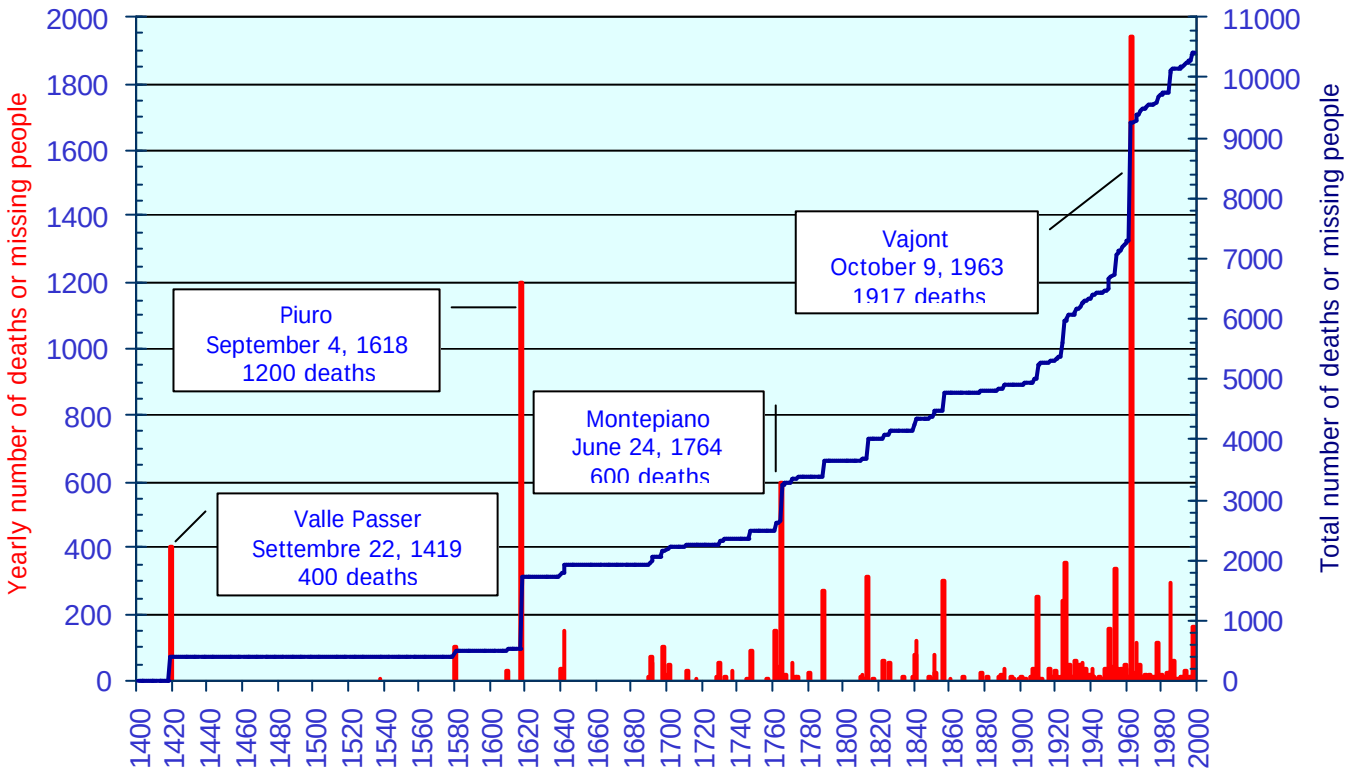

Figure 3.1 – Historical distribution of landslide events that resulted in deaths or missing people in Italy for the period 1410-1999.

An attempt was made to evaluate the completeness of the database. As might be expected, the cumulative numbers of landslide deaths and missing people has increased largely since 1411 (Figure 3.1), but this may largely be a result of variations in the completeness of the historical catalogue. The more remote the period considered, the larger the number of events that probably remained

unrecorded. This is especially evident for events that caused fewer than three deaths. In the catalogue such events rarely appear before 1800, but in the 20th century they represent about 70 per cent of the total number of recorded events. Even considering the increases in population that have occurred, there is no reason for the distribution of less catastrophic events to be so skewed, except for the incompleteness of the catalogue.

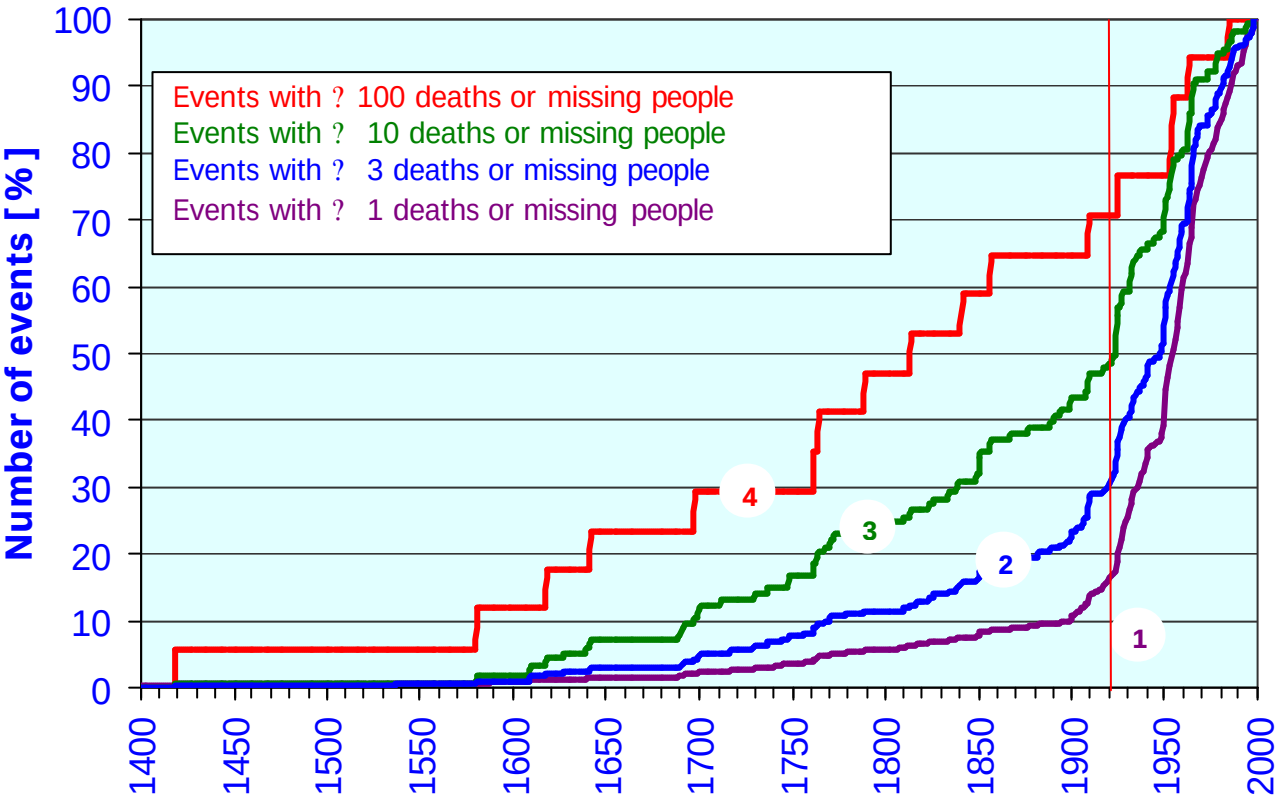

Figure 3.2 – Cumulative distribution of landslide events that resulted in deaths or missing people in Italy from 1410 to 1999. 1 - All landslide events. 2 - Low intensity landslide events that resulted in 3 or more deaths or missing people. 3 - Medium intensity landslide events that resulted in 10 or deaths or missing people. 4 - High intensity landslide events that resulted in 100 or more deaths or missing people.

Curve 1 in Figure 3.2 shows the yearly cumulative distribution of all events that resulted in one or more deaths or missing people. The slope of the curve increases sharply after 1900, a few years before 1918, the first year covered by the AVI database. A second, less definite change in the shape of the curve occurs around 1690-1700. The other curves shown in Figure 3.2 represent cumulative distributions of landslide events that resulted respectively in three or more (curve 2), ten or more (curve 3), and 100 or more (curve 4) deaths or missing people. The change in slope around 1900 is present in both curves 2 and 3, but not in curve 4; however, it is less distinct in these curves than it is in curve 1. This indicates that the completeness of the catalogue varies with the intensity of the events. For large-intensity events with at least 100 casualties the catalogue is probably complete for the period 1600-1999. For medium-intensity (= 10 deaths and missing persons) and low-intensity (= 3) events the catalogue is reasonably complete only after 1920. If all events are taken into account, the catalogue can be considered almost complete for statistical purposes starting in 1920, and complete after 1950.

Analysis of the database indicates that fatal landslide events were more frequent in the Alpine regions of Northern Italy and in Campania (southern Italy), and most casualties occurred in the Autumn. Fast-moving landslides caused the largest number of deaths. They included rockfalls, rockslides, rock

avalanches and debris flows. The cumulative frequency of landslide events was plotted against their consequences and the plots were compared to similar curves for the whole Alps and for Canada, Japan, China and Hong Kong (Figure 3.3). Frequency in Italy was found higher than in the Alps, Canada and Hong Kong, but lower than that of Japan and China.

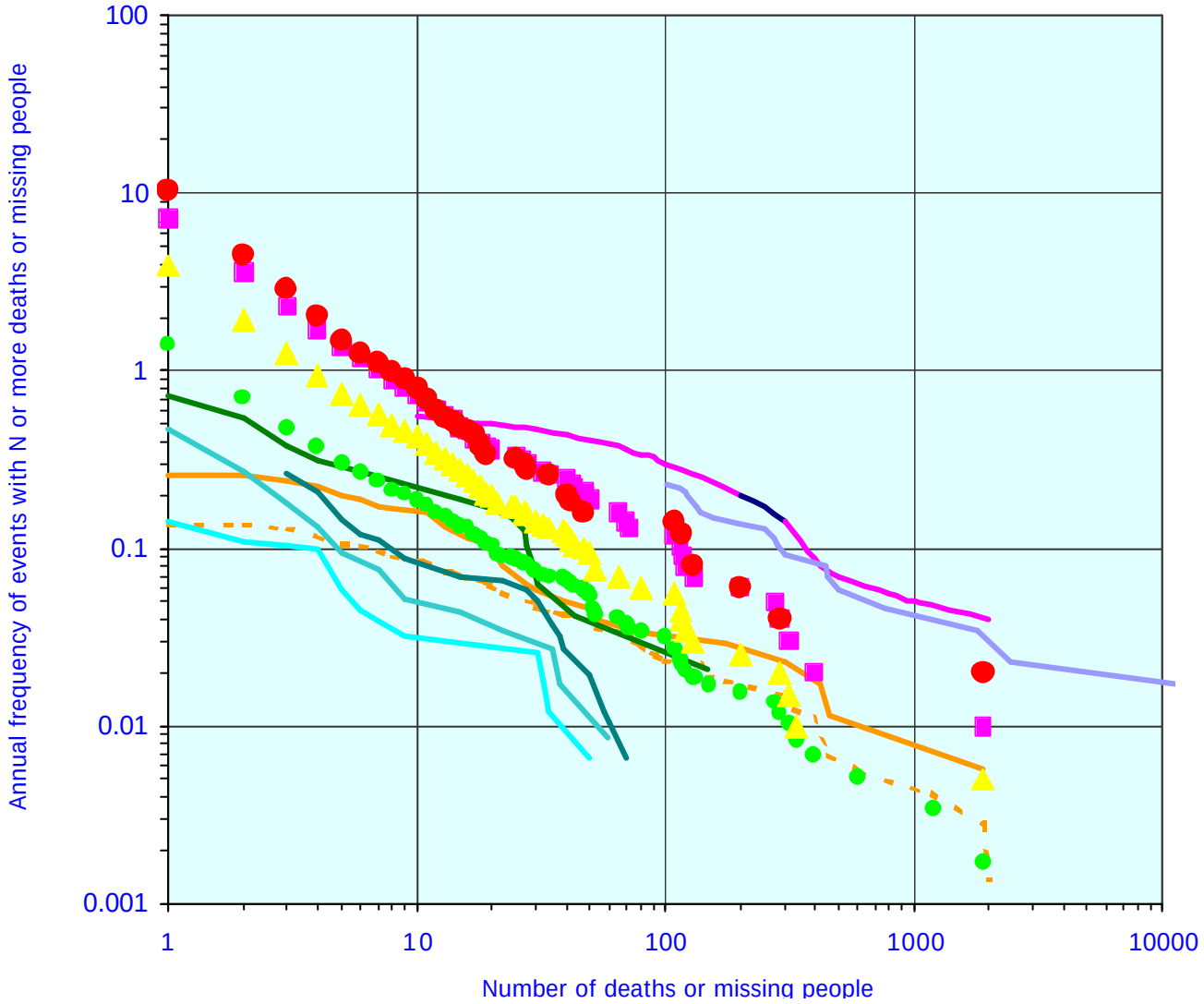

Figure 3.3 – Frequency vs. consequences (F-N plot) curves for landslide events in Italy that caused deaths or missing people, and comparison with world-wide data. Legend: Italy - Symbols indicate different time spans, from 50 to 590 years. Red dots, 1950-99; violet squares, 1990-99; yellow triangles, 1800-1999; green dots, 1410-1999. Other countries – violet line, Japan (1948-1996); light brown line, the Alps (1800-1974); light brown dashed line, the Alps (1248-1974); dark blue line, Canada (1860-1996); blue line, British Columbia (1860-1996); light blue line, Quebec (1840-1996); dark green line, Hong Kong (1948-1996); blue-grey line, China (1900-1987).

3.2.4 Assessment of landslide hazard

Research activities aimed at assessing and mapping landslide hazard were financed jointly by CNR-GNDCI (within the AVI project) and by the Umbria and Lombardy Regions. The latter for mapping landslides and for assessing landslide hazard in 4 areas of the Region, for a total of more than 2000 km^2. Research was aimed at designing and testing techniques and tools for the definition and mapping of landslide hazard and risk at various scales and in different physiographic environments, and was carried out jointly with research team 3.22, at the CNR-CSITE centre in Bologna (see Chapter 4).

Landslide inventory and hazard maps were prepared for two areas of the Lombardy Region: the River Staffora basin (Pavia Province) and the Lecco Mountains. For both areas, in co-operation with the Univeristy of Milano Bicocca, landslide, morphometric, geologic and land-use data obtained from aerial photo-interpretation, field mapping and from existing maps were digitised and stored in a GIS. For the Staffora basin an experiment aimed at evaluating the possible integration of geomorphologic data and historical information on landslide events occurred in the basin in the 20^{th} century was completed. A description of the results of the experiment is given on Chapter 4.2, p. 15-19. For the Lecco Mountains preliminary debris flow hazard maps prepared though the statistical (discriminant) analysis of thematic data were prepared.

In the Umbria Region activities aimed at preparing a new and detailed, large scale landslide inventory map for the entire region continued with the production of inventory maps for the Nestore River basin and the territory surrounding the Trasimeno Lake. With the collaboration of Prof. David Alexander, University of Massachusetts Amherst - USA, an effort was undertaken to critically evaluate current methods for the assessment of landslide risk, and to propose a method for the assessment of landslide risk in urban, sub-urban and rural areas in Umbria.

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4 Integration of historical information and geomorphologic data to assess landslide hazard

4.1 INTRODUCTION

Team 3.22, at the CNR-CSITE centre in Bologna, has started a 3-years research program aimed at:

- preparing landslide hazard maps based on the integration of geomorphologic and historical data; and
- extending the temporal coverage of the AVI database by searching repertoires and historical compilations, 19th century catalogues of natural events and academic journals and proceedings.

4.2 COMPARATIVE ANALYSIS OF LANDSLIDE HAZARD MAPS BASED ON GEOMORPHOLOGIC AND HISTORICAL DATA: THE STAFFORA BASIN CASE STUDY

The Geological Survey of the Lombardy Region has promoted a research initiative aimed at mapping landslides and the associated hazard in four areas of the Region (Figure 4.1, Table 4.1). The aim of the project is twofold: to prepare detailed landslide inventory maps; and to assess landslide hazard at the basin scale. Landslide inventory maps were prepared through the interpretation of aerial photographs of different types (colour, black & white), scale and vintages. Limited field surveys were carried out to test the reliability of the interpretation. In producing the inventory maps, all the available information on pre-existing studies on mass-movement and technical investigations carried out at specific sites was collected and carefully evaluated. For two of the study areas (Staffora basin and Lecco Mountains) historical information on landslide events occurred in the 20th century was also acquired.

For each study area thematic maps, including rock type, structural setting and land use (Table 4.2) were prepared by compiling or processing existing maps and data. Digital terrain models (DTM) with a ground resolution of 20x20 m were prepared by interpolating contour lines digitised from the 1:10,000 scale regional technical maps. For the Seriana valley area, a DTM is currently being prepared using photogrammetric techniques and high-altitude photography. All thematic information, including DTM data, was stored into a widely-used GIS for further processing and analysis.

Figure 4.1. Location of the study areas

- A = Staffora basin
- B = Lecco Mountains
- C = Camonica Valley
- D = Seriana Valley

Table 4.1 – Physiographic and geological settings of the study areas.
Symbols: † = present, †† = abundant.

	Staffora basin	Lecco Mountains	Camonica Valley	Seriana Valley
Physiography	Apennines	Alps	Alps	Alps
Area extent	300 km^2	730 km^2	1480 km^2	270 km^2
Elevation range	150 – 1500 m	200 – 2600 m	400 – 3500 m	600 – 3000 m
Rock types				
Clay	††			
Marl	††	†	†	†
Sandstone	†			
Limestone		††	††	††
Metamorphic		†	††	†
Shallow failures				
Soil slip	††	††	††	††
Debris flow	†	††	††	††
Debris avalanche		††	††	††
Rock fall	†	††	††	††
Rock slide		†	†	†
Deep failures				
Slide	††	†	†	†
Earth flow	††			
Complex	††	†	†	†

Table 4.2 – Themes for hazard assessment. Symbol: † = task completed.

Theme	Staffora basin	Lecco Mountain	Camonica Valley	Seriana valley
DTM	20x20 m grid from contour interpolation	20x20 m grid from contour interpolation	20x20 m grid from contour interpolation	in preparation by digital photogrammetry
Terrain subdivision	†	†	†	†
Terrain morphometry	†	†	†	†
Landslide map	†	†	†	†
Lithologic map	†	†	in preparation	in preparation
Structural map	†	†	in preparation	in preparation
Land use map	†	†	in preparation	†
Historical data	†	†		
Hazard map	†	†		

For the Staffora basin a predictive model of landslide occurrence was developed. To accomplish this task, the basin area was automatically partitioned into main slope-units (i.e. right/left sides of elementary sub-basins) through a specifically-designed software module which, starting from a high-quality DTM, generates fully connected and complementary drainage and divide networks, and a wide spectrum of morphometric parameters of channels and slopes. Main slope units were then subdivided according to the main rock types cropping out in the basin. In this way, the study basin resulted partitioned into 2245 mapping-units. Forty geological-morphological factors were selected, by a stepwise procedure, as predictors, and the presence/absence of landslide deposits within each mapping unit as predicted (dependent) variable of a discriminant function. The outcomes of the analysis indicate that such a mix of environmental factors is capable of predicting, with a reliability of the 77%, which mapping units are affected by or free of landslide deposits (Figure 4.2). This model, which can be called geomorphologic, is essentially founded upon the data provided by of the landslide inventory map and the other environmental maps.

Among many public administrators, natural catastrophes, such as landslides, are primarily evaluated on the basis of historical records which can fairly accurately dates slope-failure events, but in general allow for detecting not the landslide itself, but the damage produced.

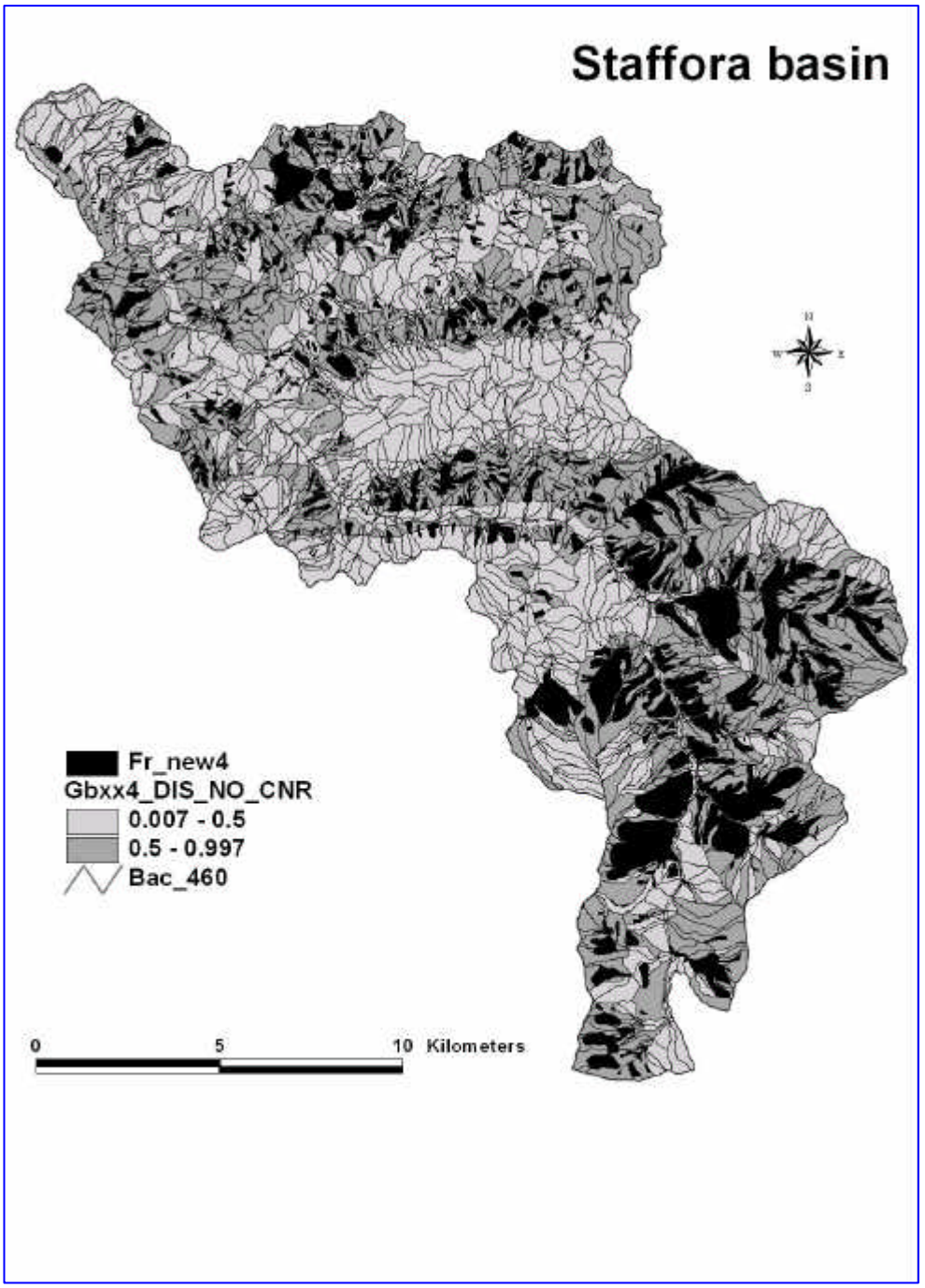

Figure 4.2. Staffora basin. Multivariate model of landslide occurrence based on a discriminant function where 40 geological-morphological factors were selected as predictors, and the presence/absence of landslide deposits (solid black) within each mapping unit as predicted (dependent) variable. Light and dark grey colours indicate mapping units with a probability of landslide occurrence less and greater than 0.5, respectively. Landslide deposits in solid black.

Owing to the substantial difference in the structure and spatial frequency of these two types of information, their directed comparison constitutes a difficult or impossible task. However, the comparison can be much better performed between the statistical models that predict landslide deposits (Figure 4.2) or the location of sites where historical information recorded a damage induced by landsliding (Figure 4.3). The second model, which can be named historical, was generated using the same set of predictors and the presence/absence of historical sites within each mapping unit as predicted variable of the discriminant function (Figure 4.3).

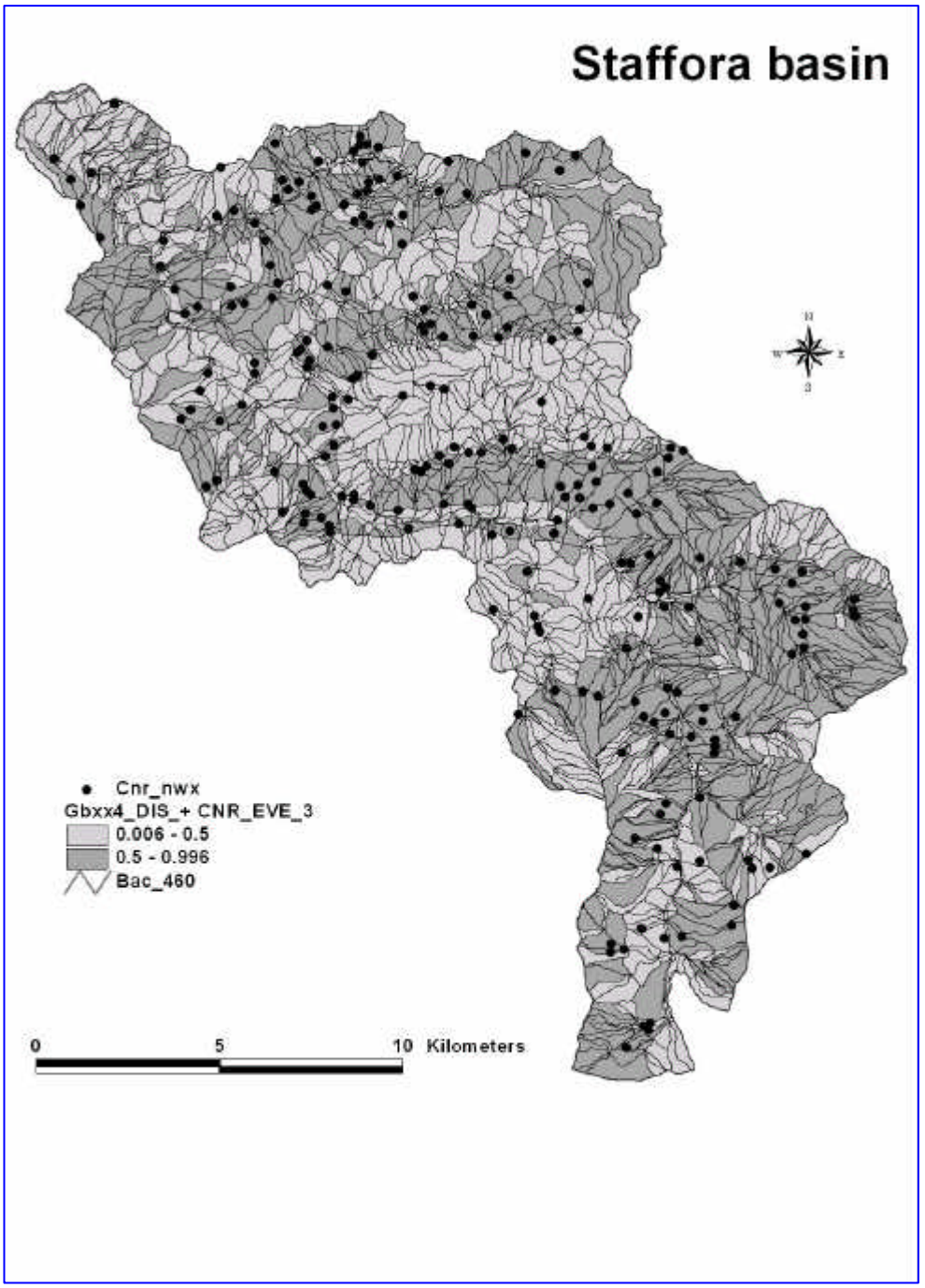

Figure 4.3. Staffora basin. Multivariate model of sites historically affected by landsliding based on a discriminant function where 39 geological-morphological factors were selected as predictors, and the presence/absence of sites (solid black dots) within each mapping unit as predicted variable. Light and dark grey colours indicate mapping units with a probability of site occurrence less and greater than 0.5, respectively.

By overlying the maps of Figure 4.2 and Figure 4.3, it comes out that their level of mismatch is almost equal to 30% with a relevant number of mapping units classified as unstable and stable by the geomorphologic and historical models, respectively.

Such a model discrepancy may be referred to different sources of error both in the landslide inventory map and in the historical records. In particular, it is poorly known the extent to which the inventory reflects the actual landslide distribution, and the extent to which the available historical records report the actual number of events that caused damage to man-made structures. In addition, the time window of the inventory map (say over 1,000 years) can be readily confronted with the time window of the historical data (100 years). All these issues will require further investigations and analyses to achieve a coherent framework within which these two sources of landslide information can be fully compared and subsequently integrated.

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5 Maintenance, update and analysis of the AVI archive

5.1 INTRODUCTION

Research activities financed with the 1999 CNR-GNDCI grant were started on January 2000, and pertain to the 1999-2001 AVI program. Within the 3-years program, the activities of both teams (3.29 and 3.30) are focused on the maintenance and update of the AVI archive. Various products based on the analysis of the archive are foreseen.

Current research activities include:

- verification of the consistency and correspondence between the AVI database and the catalogue of sites affected by landslides or by floods; and
- the upgrade of the AVI database, adding new information obtained by searching some of the recent most CNR-GNDCI publications and reports.

5.2 ANALYSIS OF THE COHERENCE BETWEEN THE DIGITAL DATABASE AND THE CATALOGUES OF EVENTS AND OF SITES AFFECTED BY LANDSLIDES AND FLOODS

As a result of the validation and errors correction performed on the digital database completed in 1998, the catalogues of landslide and flood events and the map of sites affected by landslides and floods became obsolete. This occurred mostly because of an improved geographic positioning of the landslide and flood sites, and because of the availability of new information for several events. Hence, an effort was started to re-align in a coherent way the information content of the digital database, of the catalogues and of the maps of sites affected by landslides and floods. The revision process will be completed by the end of the year 2000, and will result in a new and updated version of the catalogues characterised by: a unique (at the national level) numbering of all landslide and flood sites; an improved geographical location of all landslide and flood sites; and the definition of confidence (uncertainty) levels for each record (i.e., event) in the catalogues.

Site numbering is based on the ISTAT code of the municipality in witch the landslide or the flood was reported. The site number is obtained adding to the right of the 8 digits ISTAT code (2 for the Region, 3 for the Province, and 3 for the Municipality), a 3 digits number for the site. Numbering of the sites within each municipality is progressive, from 1 to 998. Site number 000 represents an uncertain location due to insufficient information for a proper geographical localisation. Site number 999 represents an uncertain location due to insufficient or inadequate detail in the map used for the localisation.

Geographical positioning of landslide and flood sites was performed in digital form using the IGMI maps at 1:100,000 scale (Fogli), available in raster format. Experiments carried out in the Umbria Region using 1:25,000 scale topographic sheets (Tavolette) have shown an overall improvement in the geographical positioning, and an increase of as much as 20% in the number of sites correctly mapped.

To provide a measure of the level of uncertainty (confidence level) associated to the information in the catalogue, a code system was devised to express the uncertainty; in the geographical positioning, due to incomplete or missing information in the original source; and in the date of the event. In particular, the following codes were used for the uncertainty in mapping the site:

- G where the information on the exact location exists, but the detail of the available map is inadequate or insufficient;
- I where the name of the river is known, but it can not be found on the map; and
- H where it is not possible to locate on the map a sub-site, within a larger site (i.e., a street or a block in a town).

Uncertainty due to incomplete or missing information in the original source refers to the:

- R Region;
- P Province;
- C Municipality;
- L Site; and
- F River.

Lastly, uncertainty in the date of the event refers to the:

- A Year; and
- M Month.

Minor differences exist in the way the various codes are used (or interpreted) for the landslides and the floods catalogues.

The upgrade of the catalogue, a particularly complex operation, was performed jointly by the two research teams. In particular, team 3.29 worked on the catalogues for the Basilicata, Lazio, Liguria, Lombardia, Piemonte, Puglia, Sardegna, Toscana, Trentino-Alto Adige and Valle d'Aosta regions, whereas team 3.30 worked on the catalogues for the Abruzzo, Calabria, Campania, Emilia-Romagna, Friuli-Venezia Giulia, Marche, Molise, Sicilia, Umbria and Veneto regions.

Results can be summarised as follows (Table 5.1):

Team 3.29

- 18 new catalogues (landslides and floods) extracted from the AVI database. Catalogues for the Piemonte Region to be completed;
- mapping at 1:100,000 scale of landslide and flood sites in the Sardegna, Basilicata and Puglia Regions (in digital format) and in the Lombardia Region;
- validation of the landslides and floods catalogues for the Sardegna, Lombardia, Puglia and Basilicata Regions, with the addition of uncertainty codes.

Team 3.30

- 19 new catalogues (landslides and floods) extracted with the AVI database. Flood catalogue for the Campania Region to be completed;
- mapping at 1:100,000 scale of landslide and flood sites in the Umbria, Sicilia, Calabria, Molise and Abruzzo Regions (in digital format);
- validation of the landslides and floods catalogues for the Umbria, Sicilia, Calabria, Molise and Abruzzo Regions, with the addition of uncertainty codes.

Table 5.1 – Number of sites and number of events in the new landslides and floods catalogues prepared by teams 3.29 and 3.30.

Region	Team	FLOODS		LANDSLIDES	
		N° of sites	N° of events	N° of sites	N° of events
Abruzzo	Co.Geo. Umbria	159	217	1113	1729
Basilicata	SGA Genova	212	316	721	1196
Calabria	Co.Geo. Umbria	426	707	675	988
Lombardia	SGA Genova	1029	1472	1264	1681
Molise	Co.Geo. Umbria	56	75	294	514
Puglia	SGA Genova	616	1085	216	261
Sardegna	SGA Genova	578	1582	268	306
Sicilia	Co.Geo. Umbria	437	663	791	1569
Umbria	Co.Geo. Umbria	562	1193	884	1146
TOTAL (May, 31st 2000)		4075	7310	6226	9390

5.3 ACQUISITION OF NEW INFORMATION ON LANDSLIDES AND FLOODS FORM SCIENTIFIC PAPERS AND TECHNICAL REPORTS

The acquisition of new information on historical landslide and flood events was pursued through the analysis of scientific papers and technical reports published after 1990 and not considered during the previous AVI inventories. Hopefully, the acquisition of new information from scientific papers and technical reports started in 1998 and continued in 1999 will become a permanent activity of the AVI program. This will contribute to the evolution of the AVI archive into an Information System on hydrological and geological catastrophes, allowing for regional and even local studies.

To upgrade the AVI database the same criteria used during the previous integration activity were followed, namely:

- information on landslides and floods found in the papers and documents studied will be inputted in the database, as new S4 forms, only if the event is not already present in a S4 form. If the event already exists in the database, the corresponding S4 form will be upgraded with the new information;
- the acquisition in digital format of all maps, figures and drawings found in the papers and documents considered;
- for each new location or event, the upgrade of the corresponding catalogue and of the maps of affected sites.

The list of scientific papers and technical reports used for the integration of the AVI database include:

- Eventi alluvionali e frane nell'Italia settentrionale (periodo 1975-1981) – CNR-GNDCI Publication n° 1927
- Eventi alluvionali e frane nell'Italia settentrionale (periodo 1972-1974) – CNR-GNDCI Publication n° 1897
- Studi sui terreni e sull'erosione del suolo in Lucania di Bernard Kayser
- La frana di Darfo-Boario Terme (BS): un caso di studio – Geologia Tecnica ed ambientale n° 2/99
- Le calamità naturali nelle Alpi di G.B. Castiglioni
- Le piogge dell'agosto 1995 nel Compartimento calabro lucano.

At present, only the first two reports have been completely analysed. Due to the large number of information on landslide and flood events found in the two reports, the integration activity proceeds quite slowly.

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6 Identification of flood prone area using historical information and geomorphologic data for planning purposes

6.1 RESEARCH ACTIVITY

Team 3.51, at the CNR-IRPI Institute in Torino, collected historical information on floods along the Tanaro River, mostly near the city of Alba. The *historical archive at the CNR-IRPI Institute* in Torino was the first source of organised information used for the investigation. The archive contains mostly unpublished documents collected in the past 30 years from a variety of Public Institutions and Organisations, including the *Ministry of Public Works*. A second source of information was the large collection of local and national newspapers with information on landslides and flood events occurred in northern Italy in the 19th and 20th Centuries available at the *CNR-IRPI Institute* in Torino.

The *CNR-IRPI Library* provided bibliographical references and technical reports published by the Ministry of Public Works, several Consortia, and other Organisations. Particular care was taken to the analysis of the Yearly Water Reports published by the Water Service, the office collecting hydrological data. In particular, rainfall data for Alba (since 1914) and water levels at the Pollenzo Bridge, 12 km upstream of Alba, (since 1890) were analysed.

Important documents, mostly reports of damage to the agriculture due to flooding, were found at the *State Archive in Torino*.

A detailed inventory was completed at the *Alba Municipality Library*. The review of more than 100 documents, including photographic reports and books, on the history, architecture, geography, agronomy and urban setting of the city of Alba, allowed to collect a wealth of information on flooding events. Descriptive and historical books quite frequently include a few pages to a chapter describing natural catastrophes (i.e., floods, earthquakes, famine, black deaths, droughts, etc.) occurred in the municipality or in the surrounding areas. After all this information was collected and inventoried, a specific investigation was started at the *Alba Municiplaity Archive* (Fig 6.1).

The unique opportunity to work in the large room of the archive in the townhall made it easier to find useful documents and historical data. The archive contains abundant and valuable information. Unfortunately the archive catalogue is not available in digital format, slowing down the search of information. The first catalogue of the archive that we know of was completed in 1846 and was used for the more recent inventories. Originally the *Alba Municipality Archive* was one of the largest and best furnished of the region. Several documents were then lost, stolen during robberies and war sacks, transferred to other archives for example by the Monferrato Dukes, or not returned by local citizens. Catalogues in the *State Archive in Torino* refer to documents in Alba Municipality Archive, that do not exist anymore. For the present study all the available book shelves in the archive were carefully searched, looking also into set of papers and dossiers that did not have anything to do with floods or natural hazards. The oldest documents found are manuscripts dating to the 16th and 17th Centuries. These are well preserved but often very difficult to read.

Figure 6.1 – The main room of the Alba Municipality Archive.

To the period between 1600 and 1700 pertain the interesting "Atti di Corrusione". These were inspection reports prepared by a representative of the Kingdom estimating the extent of damage due to the Tanaro River an its tributaries, for exemption from taxation. Some of the documents of the 18th Century are printed and easy to read. Toward the end of the 18th Century, due to the arrival of Napoleon, for a period of about 15 years documents were written in French. At that time large scale, colour maps were prepared. These pertain to the famous Napoleon Register of landed property (Figure 6.2), now kept in wooden thecae.

From 1810 the "Ordinati del Consiglio" and occasionally documents of the "Cosiglio d'Ornato" are available. For the more recent years Municipality resolutions and Council minutes are also available. Such documents are collected in large volumes and are usually easy to understand. Occasionally they are difficult to read due to the poor handwriting of the writer. In the same shelves can be found technical reports on bridges, roads, harbours and the works completed to repair the damage of flooding events. A single dossiers may contain several documents, covering a period of 10-20 years.

Starting from 1870-80 a few documents are typewritten, and easy to read. Nevertheless the majority of Municipality resolutions and Council minutes are still hand-written. Quite interesting is the correspondence between the Alba Municipality, the Cuneo Province Administration ad the Cuneo Office of the Genio Civile on the works to repair roads, levees and bridges. For the 20th Century these documents are collected in thematic dossiers, allowing for an easier retrieve of the information. In particular the dossier n. 10, named "Public Works", contains all documents and information on remedial works completed on structures and infrastructures after catastrophic events (Figure 6.3).

Useful information was found also in dossiers that did not strictly refer to remedial works. As an example, historical information on flood events were found in the set of documents for the design of levees and bridges requiring government approval.

Figure 6.2 – Map of the city of Alba, from the famous Napoleon Registry of landed property.

Particularly useful was the analysis of newspapers and magazines that were systematically searched for information on flood events. The most important source of information was the Gazzetta d'Alba, published since 1882. The entire collection is not available in Alba. At the journal headquarter issues of 1882, 1883, 1917, 1920, 1921 and from 1923 onward are available. The Cherasco Public Library stores the issues from 1882 to 1893, available as microfilm also at the Alba Public Library. The library of the Bishop Seminary of Alba stores the issues form 1885 to 1889, from 1891 to 1899 and some issue for the years 1901, 1902, 1906 and from 1910 to 1917. Apparently, the missing issues can be found a the Florence National Library, where some of them were probably damaged by the November 1966 flood.

Other journals, no more published today (such as "LA Sentinella delle Alpi", "Lo Stendardo", "La Vedetta") , were found in the Cuneo, Fossano and Saluzzo Public Libraries and provided other information on flood event.

While the inventory of historical information was under way, a geomorphologic investigation based on the analysis of the available topographic map, was started. All the different editions of the IGMI maps at 1:25,000 scale and the recent 1.10,000 scale Regional Topographic maps were compared. Analysis of the differences in the Tanaro River has shown a distinct simplification of the main river course. In the past the Tanro River was characterised by several channels separated by large and vegetated islands. Today the river has a single, narrow channel with only few islands.

Field investigations and interviews to local citizens allowed to collect important information on water levels, discharge channels and erosion phenomena, and to describe the effects of the November 1994 flood. Aerial photographs taken after the event were compared with aerial photographs of previous vintages. A geomorphologic map was prepared allowing for a description of the flooding event.

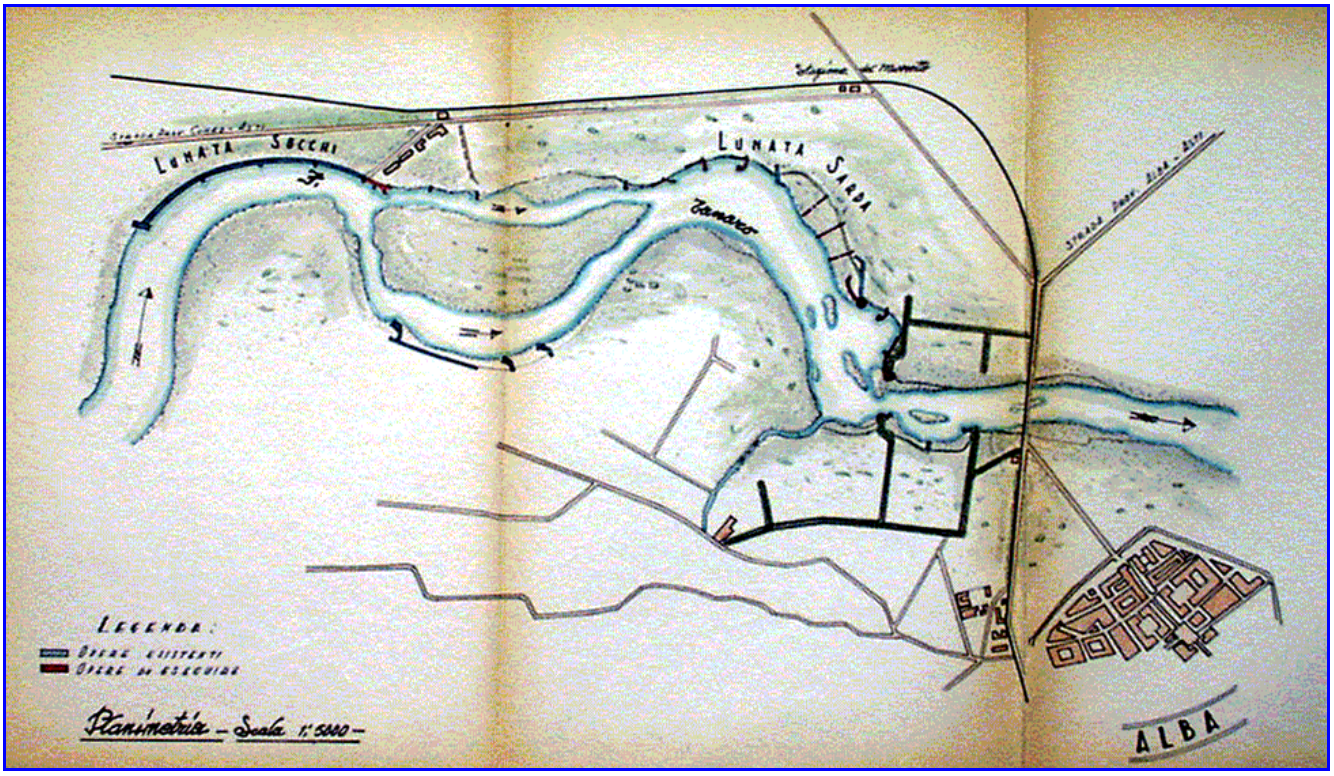

Figure 6.3 – Map at 1:5,000 scale published by the Ministry of Public Works, Office of the Genio Civile in Cuneo, showing remedial works to protect the river from bank erosion.

7

U.O. 3.52 - SGA Storia Geofisica Ambiente, Bologna
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Earthquake induced landslide phenomena in Italy (13th–20th Centuries)

7.1 INTRODUCTION

The activity of the unità operativa 3.52, depending on SGA Storia Geofisica Ambiente srl of Bologna, was started in 1999 and it was until now developed on two themes:

- elaboration of the historical data relevant to landslides and floods contained in the project GIANO (ENEA-SGA 1987-90); and
- elaboration of the data relevant to landslides associated with historical seismic events.

7.2 LANDSLIDES AND FLOODS IN GIANO

Regarding the first theme, SGA has analysed again, on the basis of the specifications of the project AVI, the testimonies regarding landslides and floods that occurred in Italy during the eighteenth and nineteenth centuries indexed for the GIANO project of ENEA. The project, realised by SGA for ENEA (PAS-ISP) in the period from 1987 till 1990, included historical research, the classification of testimonies of extreme natural events in Italy from the year 1000 till 1985.

The database of GIANO, at its turn made up by SGA to manage the results of the historical research, was an organised gathering of geo-referenced and classified testimonies according to a table of about hundred phenomena and effects and according to a scale of damaging effects to things and persons. In that phase the project did not foresee an aggregation of the testimonies of the effects for the creation of a catalogue of events.

The aim of the elaboration of the data of GIANO entrusted by GNDCI to the u.o. under SGA foresaw the selection and rereading of the testimonies related to landslides and floods that occurred in Italy in the eighteenth and nineteenth centuries, with the aggregation of all the information interesting to the project AVI in two catalogues on the considered historical period: one on landslides, the other on floods.

Until now 2796 geo-referenced testimonies have been elaborated out of a total (floods and landslides together) of 177 bibliographic references (catalogues, inventories, sources, scientific bibliography etc.) which concern the entire Italian territory. The catalogues produced by the chronological and geographic aggregation of the testimonies contain respectively 356 landslides and 793 floods, divided over the different centuries as follows:

	18th century	19th century
Landslides	56	300
Floods	388	405

According to the original classification developed by SGA the analysed historical testimonies are distributed according to their type of information and value (Table 7.1).

Table 7.1 – Distribution of historical information on landslides and floods for the 18th and 19th centuries according to the value of the testimony as defined by Guidoboni E., 1995. Dati di base e metodo di indagine: una navigazione fra effetti sismici e contesti storici. In: E. Boschi, G. Ferrari, P. Gasperini, E. Guidoboni, G. Smriglio and G. Valensise, *Catalogo dei forti terremoti in Italia dal 461 a.C. al 1980*, pp. 20-57, Bologna, Italy.

Value of the testimony	*%*
Primary sources	21
Indirect sources	10
Catalogues	68
Bulletins	1

As support to the elaboration we have provided 1245 files in PDF format of the images of the cards with the analysed testimonies. In order to understand the relation between the number of files and the other numbers previously mentioned, keep in mind that each file can contain testimonies of more than one locality and event.

7.3 LANDSLIDES AND EARTHQUAKES

As far as landslides and earthquakes are concerned, unità operativa 3.52 is working on a research contract for the elaboration of the information contained in the *Catalogue of Strong Italian Earthquakes* (Catalogo dei Forti Terremoti in Italia) (CSIE2), ING-SGA of which SGA took care of the research, elaboration and computerised realisation of the data base, relevant to landslides that occurred in coincidence with historical seismic events from the eighteenth till the twentieth centuries.

The research intends to extend the experience obtained on the Umbrian–Marchigian earthquake of 1279 (Boschi E., Guidoboni E., Ferrari G., and Valensise G., I terremoti dell'Appennino umbro-marchigiano. Area sud orientale dal 99 a.C. al 1984, Bologna 1998, pp. 32-38), to all those situations in which the earthquake induced landslides can be geo–referenced and are still recognisable on the field, starting from the descriptions of the historical sources.

As for the current contract, of the 347 landslide phenomena documented in the CSIE2 (relative to 94 earthquakes which occurred between the eighteenth and twentieth centuries, Figure 7.1) about 70 will be re–examined and integrated. As the research contract was started only at the beginning of May 2000, until now were drawn out the descriptive syntheses of the landslide effects of Central and Central–Northern Italy (Table 7.2 and Figure 7.1), and the historical sources that document them. The analysis and a more precise geo–referentiation of the information is in course. The descriptive syntheses contained in the *Catalogue* are being re–analysed, based on the original sources, integrating them, if this is the case, with new historical data or scientific bibliography, orienting the results specifically to the sector of the hydro-geological risks.

Particular attention was paid to landslide phenomena which occurred in the same areas in occasion of different seismic events, thus permitting the realisation of summarising, specific mappings, syntheses aimed at highlighting the characteristics of these recurrences. Eleven events, highlighted in bold in Table 7.2, are particularly interesting for specific documentary or geological situations and therefore specific in–depth studies are in course.

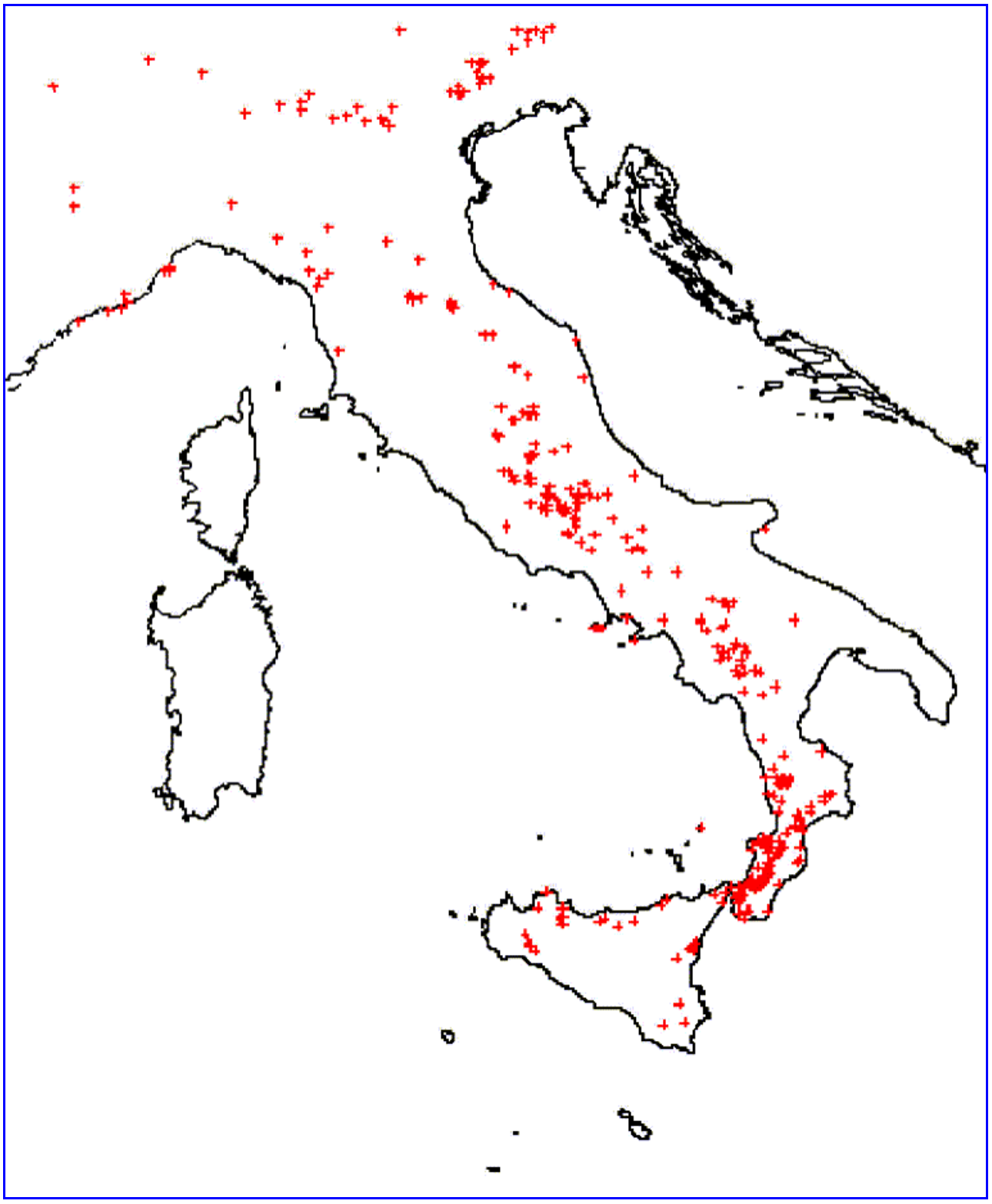

Figure 7.1 – 347 landslides associated to 94 earthquakes from 13th century to 1974. Data from the Catalogue of strongest earthquakes in Italy from 461 b.C. to 1990.

Table 7.2 – Earthquakes which induced landslide effects in Central and Central–Northern Italy. We have reported: the date of the main shock or the time interval during which the most destructive shocks occurred, the maximum verified intensity, the epicentre zone and the number of sites which underwent landslide effects caused by single shocks.

Date of the earthquake/s	I max	Epicentre zone	Sites
1231 06 01	VIII	Cassino	1
1349 09 09	X	Southern Lazio-Molise	2
1456 12 05	XI	Central–Southern Italia	2
1505 01 03	VII	Bologna	1
1545 06 09	VII-VIII	Valle del Taro	1
1584 09 10	**IX**	**Tuscan–Emilian Apennines**	**3**
1654 07 23	X	Sorano-Marsica	1
1688 06 05	XI	Sannio	1
1690 12 23	VIII-IX	Anconetano	1
1703 01 14 - 1703 02 02	**XI**	**Apennines of the Umbrian-Reatino area/Aquilano**	**5**
1751 07 27	X	Umbrian Apennines	1
1781 06 03	X	Marchigian Apennines	2
1786 12 25	VIII	Area of Rimini	1
1805 07 26	X	Molise	2
1815 09 03	VIII	Valnerina	1
1831 05 26	**VIII-IX**	**Western Liguria**	**2**
1832 0313	VII-VIII	Reggiano	1
1837 04 11	**X**	**Apuan Alps**	**1**
1838 02 14	**VIII**	**Valnerina**	**3**
1846 08 14	X	Northern Tuscany	2
1859 08 22	**IX**	**Valnerina**	**1**
1873 03 12	IX	Southern Marche	1
1873 07 12	VII-VIII	Meta mountains	2
1874 10 07	VII-VIII	Tuscan–Emilian Apennines	1
1875 03 17	VIII	Southern–Eastern Romagna	1
1878 09 15	VIII	Clitunno Valley	1
1881 09 10	VIII-IX	Southern Abruzzi	1
1882 06 06	VIII	Matese Mountains	2
1887 02 23	**X**	**Western Liguria**	**6**
1915 01 13	**XI**	**Marsica**	**39**
1916 05 17 - 1916 08 16	VIII	Northern Adriatic	1
1917 05 12	**VII-VIII**	**Ternano**	**2**
1919 06 29	**X**	**Mugello**	**4**
1920 09 07	**X**	**Garfagnana**	**3**
1927 12 26	VIII	Colli Albani	1
1945 06 29	VII-VIII	Staffora Valley	1
1961 10 31	VIII	Velino Valley	3
1974 12 02	VII-VIII	Valnerina	2

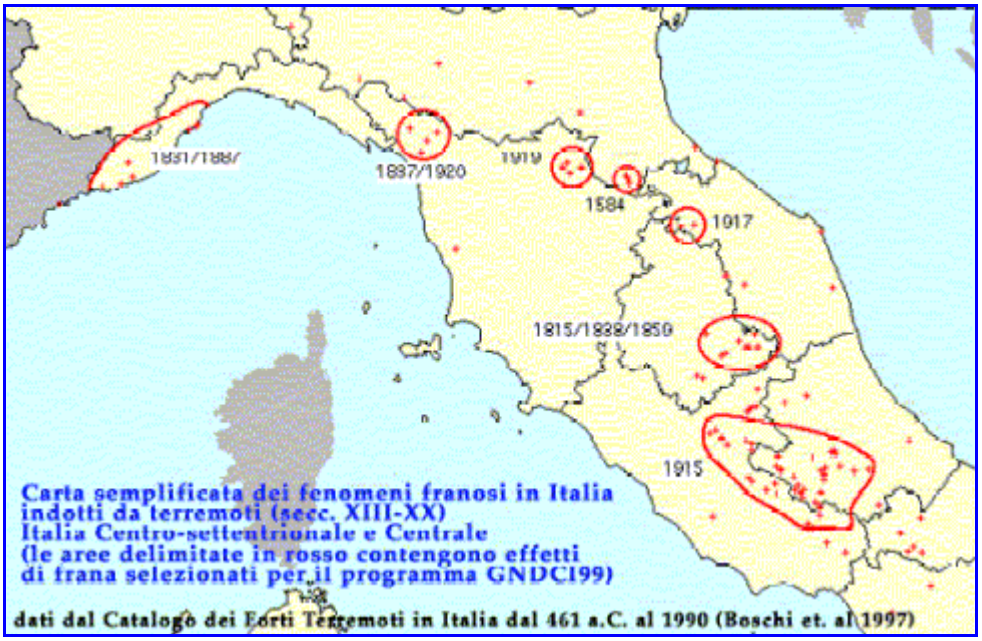

Figure 7.2 – Simplified map of the landslide phenomena in Italy induced by earthquakes (thirteenth–twentieth centuries) – Central and Central–Northern Italy. The areas marked off in red contain landslide effects selected for GNDCI 1999 programme. The dates of the earthquakes which landslide effects are particularly interesting for their documentary or geological aspects were highlighted.

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8 Acquisition of historical information on landslides in the Campania Region

8.1 INTRODUCTION

The activity carried out by team 2.53 was focused on the systematic analysis of landslide phenomena in the 2oth century in the Campania Region. The first phase of the analysis consisted in finding and reviewing possible new sources of information that could contain useful information for the period considered and the area under investigation. The most important information sources considered include:

a) Archives including of a variety of heterogeneous technical and administration documents from:
   - municipality, parish and private archives, that included regional and local historical descriptions and accounts;
   - the Genio Civile archive, that includes technical studies, reports, projects and construction plans;
b) bibliographical sources, including studies, papers, contemporary or post-event monographic reports;
c) newspaper sources, including accounts of reporters sent to investigate the event.

La ricerca delle fonti archivistiche è stata orientata alla conoscenza del contesto storico-amministrativo del periodo che va dalla fine del 1800 ad oggi, in modo da individuare gli organi preposti alla gestione territoriale ed alle risorse economiche. In questo senso è iniziata la ricerca presso gli Archivi di Stato di Napoli, Salerno, Avellino e Caserta, con l'individuazione dei fondi relativi alle amministrazioni pubbliche. Tra i fondi potenzialmente più interessanti sono stati individuati quelli del Ministero degli Interni, del Ministero dei Lavori Pubblici, della Prefettura di Gabinetto, del Tribunale delle Acque-Corte d'Appello, dei Ponti e Strade, e degli Annali Civili del Regno delle due Sicilie. Si è dato inoltre avvio alla consultazione delle fonti archivistiche ecclesiastiche presso due comuni della provincia di Napoli, Sorrento e Castellammare di Stabia, dove sono state condotte ricerche negli Archivi Parrocchiali, nella Biblioteca e nell'Archivio Diocesano. I primi risultati mostrano esiti positivi soprattutto per il periodo 1860-1950, per il quale sono stati riscontrati casi di dissesto idrogeologico, frane, voragini ed alluvioni.

Parallelamente alle indagini sulle fonti archivistiche è stata avviata la ricerca sulle fonti bibliografiche presso la Biblioteca Nazionale e presso la Biblioteca Universitaria di Napoli, analizzando i Cataloghi Generali. Sono stati esaminati i lavori più recenti, le bibliografie a carattere regionale e locale, e le relazioni a carattere scientifico. Utili nella fase di progettazione della ricerca sono stati i testi di Vincenzo Catenacci (1992) su "Il dissesto geologico e geoambientale in Italia dal dopoguerra al 1990", ed il testo di Roberto Almagià (1908) sugli "Studi sistematici sulla distribuzione delle frane nella penisola italiana: l'Appennino Centrale e Meridionale".

In questa fase sono state reperite molte informazioni su fenomeni franosi avvenuti in passato, per i quali si è proceduto all'individuazione ed all'analisi delle fonti primarie citate in letteratura. Presso le stesse biblioteche sono state consultate anche le testate giornalistiche di una ventina tra quotidiani e settimanali a tiratura nazionale e locale, tra queste Il Mattino, Il Mattino Illustrato, il Roma ed il

Pungolo. Anche in questo caso sono state reperite numerose informazioni sui fenomeni gravitativi ed alluvioni non riportate dal catalogo AVI. Un esempio dei primi risultati è nella Tabella 8.1.

Infine, è in corso di completamento la ricostruzione della franosità indotta dal sisma Irpino del 23 luglio 1930, per il quale è stata avviata una ricerca sistematica delle fonti documentarie e tecnico-amministrative, conservate presso gli Archivi di Stato e il Genio Civile di Avellino e Benevento. I primi risultati mostrano una concentrazione dei fenomeni gravitativi nell'area dell'VIII grado MCS. Tra questi, alcuni fenomeni assunsero dimensioni tali da indurre provvedimenti legislativi di trasferimento totale o parziale di centri abitati.

8.2 CONTRIBUTION TO THE DEFINITION OF A DIGITAL BIBLIOGRAPHIC FORM FOR THE ACQUISITION OF NEW INFORMATION FOR THE AVI DATABASE

For an efficient acquisition and storage of the information on historical landslide and flood events, a new computerised form was devised and tested. The form was designed to collect and store data collected from a large variety of sources, including archives, bibliographical sources and newspapers. Care was taken in the accurate transcription of the original text.

The form is composed of nine sections. The first section (Archive location) provides information describing where the archive or the source of information is located, including the complete address of the archive or the library. In the next three sections the information sources are classified according to there main types: libraries, newspapers, or archives. For each different source, the information needed to locate precisely the document is provided. The fifth section (Object) contains a brief description of the phenomena, the location and the date of the event. In the next section (Events), the most important events reported in the text are listed, with information on damage, and in particular on deaths, missing people and injured. In the last section all the sites reported in the text are listed with their original geographic names.

The form also contains a specific field for an accurate and complete transcription of the text that describes the exact type and characteristics of the event, the date of the event, the site (or sites) affected and all other possible information useful for better understanding the phenomena and for a correct mapping of all affected sites. Lastly, the form contains information on how a copy of the original document was acquired (photocopy, transcription, microfilm, photography), the date of the event, the name of the person that compiled the form and of the reviser, if any.

Table 8.1 – Examples of sites affected by landslides and floods in the Campania Region from 1851 to 1940.

Rif. n°	Date	Town	Prov.	Site	Landslide type	Flood	Other	Knowledge			Source	Copy	Notes
								Good	Suff.	Insuff.			
99	2/12/1851	Piedimonte	CE	various	X	X				X	G. del Regno	X	
1	09/04/1892	Napoli	NA	Piedigrotta	C				X		Il Mattino	X	
2	20/06/1892	Napoli	NA	Posillipo	C			X			Il Mattino	X	
3	19/07/1892	Napoli	NA	Fontanelle	C			X			Il Mattino	X	deaths
4	2508/1892	Pozzuoli	NA	Ant. Grotta	C			X			Il Mattino	X	
5	18/09/1892	Napoli	NA	Ponti Rossi	C			X			Il Mattino	X	deaths
41	22/03/1899	Meta	NA	Strada marina	C					X	Il Mattino	X	deaths
42	16/12/1899	Caposele	AV	abitato	X	X			X		Il Mattino	X	
58	09/04/1900	Napoli	NA	cave Fontanelle	X				X		Il Mattino	X	
48	16/03/1904	V.Equense	NA	P.Orlando	C					X	Il Mattino		
54	19/05/1906	Ercolano	NA	Resina	X	X			X		Il Mattino		
15	16/06/1910	Calitri	AV		X		earthquake			X	Il Mattino	X	
7	25/10/1910	Vietri	SA		C					X	Il Mattino	X	
12	03/12/1910	Quaglietta	SA	Caposele	Col?			X			Il Mattino	X	
16	05/01/1912	Borea	BN	Contrada Bucciano	C			X			Il Mattino	X	deaths
17	17/01/1930	S.V.Torio	SA	Via Ann.ta	X			X			Il Mattino	X	deaths
18	15/02/1930	Napoli	NA	Posillipo	C				X		Il Mattino	X	deaths
92	30/07/1930	S.G.la Molara	BN	S.Ianni-Perazzetta	X		earthquake	X			Roma	X	
98	31/07/1930	S.G.la Molara	BN		X			X			G. del Regno	X	
93	01/08/1930	S.G.la Molara	BN	variuos	X		earthquake	X		X	Roma	X	
94	02/08/1930	Baronia			X					X	Roma	X	
95	03/08/1930	S.G.la Molara	BN	S. Ianni-Perazzetta	X						Roma	X	
96	07/08/1930	Guardia dei L.	BN		?						Roma	X	
97	20/08/1930	Ariano I.	AV	voragine 1180						X	Roma	X	
21	05/09/1940	Pozzuoli	NA	Campana	X					X	Il Mattino	X	deaths
22	02/11/1940	Pimonte	NA	Gragnano-Agerola	X					X	Il Mattino	X	

Rif. n° is the bibliographical reference number; The *Date* represents the date of the newspaper from which the information was collected; *Town*, *Province* and *Site* provide geographical information; *Landslide type* is the type of mass-movement, when this information is available or can be inferred from the source; *Flood* and *Other* indicate other possible phenomena, including flood and earthquake. The *knowledge* levels indicate that the description of the phenomena is *good*, *sufficient* or *insufficient* for mapping the event; *Source* is the original source of information; *Copy* indicates the availability of a photocopy of the original document besides the transcription; in the *Notes* field deaths were reported.

9 Publications

Carrara A., Guzzetti F., Cardinali M., Reichenbach P. Antonini G., Galli M., Ardizzone F., Fossati D., Laffi R., Mazzoccola D., Sciesa E., Crosta G., Frattini P. (2000) – Geographic information technology to assess landslide hazard in regional environmental planning. August 2000, Munich, Germany.

Esposito E., Porfido S., Iaccarino G., Tranfaglia G., (2000) - Terremoti e centri storici dell'Irpinia: gli effetti del terremoto del 1930. Convegno Internazionale GeoBen2000, Moncalieri, Torino, Italy.

Guzzetti F. (2000) – Landslide fatalities and evaluation of landslide risk in Italy. Engineering Geology. In press.

Guzzetti F., Cipolla F., Pagliacci S., Sebastiani C., Tonelli G. (2000) – Il sistema informativo delle aree colpite da calamità geologiche od idrauliche: Applicazioni nel campo della protezione territoriale. IDRA 2000. XXVII Convegno di Idraulica e Costruzioni Idrauliche, Genoa, Italy, 12-15 September 2000.

Guzzetti F., Tonelli G. (2000) – Distribuire informazioni e conoscenze sul dissesto idrogeologico in Italia - I nuovi prodotti realizzati dal CNR-GNDCI nell'ambito del progetto AVI. DPCinforma, Anno V, N. 22, 13-17.