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Earthquake, GIS and multimedia. The 1883 Casamicciola earthquake

Fabrizio Bramerini([1]), **Sergio Castenetto**([1]), **Elena Cubellis**([2]), **Maria Giovanna Martini**([1]), **Marcella Rebuffat**([3]) **and Pierluigi Soddu**([1])

([1]) *Servizio Sismico Nazionale, Roma, Italy*

([2]) *Osservatorio Vesuviano, Napoli, Italy*

([3]) *Osservatorio Vesuviano, by Servizio Sismico, Roma, Italy*

Abstract

A series of multimedia monographs concerning the main seismic events that have affected the Italian territory are in the process of being produced for the Documental Integrated Multimedia Project (DIMP) started by the Italian National Seismic Survey (NSS). The purpose of the project is to reconstruct the historical record of earthquakes and promote an earthquake public education. Producing the monographs, developed in ARC INFO and working in UNIX, involved designing a special filing and management methodology to integrate heterogeneous information (images, papers, cartographies, etc.). This paper describes the possibilities of a GIS (Geographic Information System) in the filing and management of documental information. As an example we present the first monograph on the 1883 Casamicciola earthquake, on the island of Ischia (Campania, Italy). This earthquake is particularly interesting for the following reasons: 1) historical-cultural context (first destructive seismic event after the unification of Italy); 2) its features (volcanic earthquake); 3) the socio-economic consequences caused at such an important seaside resort.

Key words *earthquake – GIS, multimedia – documentation, education – Casamicciola (Italy)*

1. Introduction

In 1992, the National Seismic Survey of Italy started the «Documental Integrated Multimedia Project on the largest Italian earthquakes of the last century» (DIMP) (Soddu *et al.*, 1993; Castenetto *et al.*, 1992).

The goals of the project are:

– *to recover* the historical and technical-scientific records of the natural phenomenon: earthquake;

– *to improve* and spread an «earthquake education», reading and analyzing the consequences of this catastrophic natural event on the population and on the socio-economic order;

– *to educate* people primarily in the epicentral zones of the destructive earthquakes (Calsamiglia *et al.*, 1990).

The instruments to reach these goals are:

– *a multimedia centre on earthquakes*, by the Seismic Survey, with a consultation room open to users, an archive/library organized and assisted by advanced multimedial technologies (Giustiniani and Bonazzi, 1992; Ridolfi, 1992);

– the realization of *multimedia monographs* on the major events, selected not only for the intensity, but also for the socio-economic and cultural consequences they had (table I).

The project will be developed by researchers who have a geographical link with the epicentral areas or have studied and investigated the different aspects of the earthquake.

Table I. Selected earthquakes.

Locality	Date	Victims	Intensity (MCS)
Casamicciola	July 28, 1883	3100	X
Liguria	February 23, 1887	1200	IX
S. Eufemia	September 9, 1905	2600	X
Messina	December 28, 1908	100000	XI
Avezzano	January 13, 1915	33000	X
Vulture	July 23, 1930	8500	IX
Belice	January 15, 1968	600	IX
Friuli	May 5, 1976	4000	IX-X
Irpinia	November 23, 1980	12000	IX-X

2. Multimedia monographs

For each selected earthquake, we shall produce monographs available on different supports: books, videos and CD-ROM.

Each monograph will be the result of synthetically processed information stored in the multimedia documentation centre. In particular, we think about *books* as a tool useful for investigations and studies on the bibliography and iconography available. Through *videos* we shall obtain the transfer of an educative message, even for correct behavior, reading critically the earthquake chronicles.

CD-ROM will represent a fast consultation tool on the type and number of available materials, allowing, moreover, heterogeneous data to be processed and compared (Martini *et al.*, 1994).

In this paper we describe the characteristics of the informatic synthesis of the different typologic information.

2.1. *GIS and earthquake monographs*

In our informatized monographs the earthquakes have been analyzed following a new procedure. Besides a synthetic description of the event (localization, magnitude, casualties and damage to buildings) is also provided information that is heterogeneous for (fig. 1):

- type (alphanumeric, photos, satellite images, etc.);
- means (paper, magnetic, etc.);
- method (directly, bibliography, etc.).

An integrated management and processing of heterogeneous data can offer the preservation of scientific and cultural data that contribute to form the historical memory of the seismic event (fig. 2).

The project and the example illustrated in this paper, have been developed in ARC INFO, using software in AML (fig. 3).

This software works in UNIX on workstation HP 9000/750, in local network.

2.2. *Data retrieval, filing and data base structure*

We have collected, stored, checked, integrated and analyzed a different kind of data (all the data are spatially referenced): land (territory, seismology), socio-economic, documentation, law (legislative data) (fig. 4).

Territory – This sector contains the information to delineate the physical shape of the territory affected by the earthquake:

- general cartography;
- orography (with 2-D and 3-D models);
- hydrology;
- geology and tectonics.

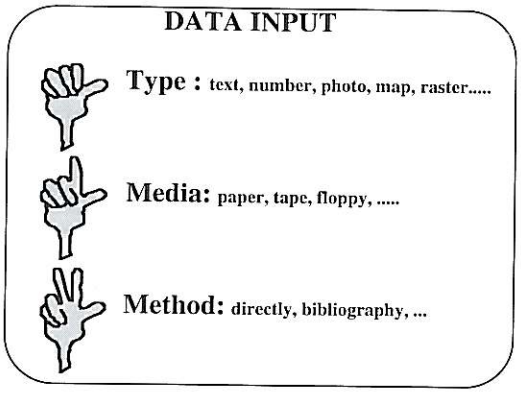

Fig. 1. The information is typologically heterogeneous.

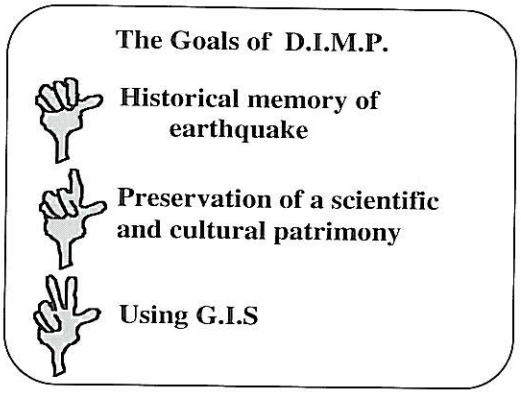

Fig. 2. The goals of Documental Integrated Multimedia Project (DIMP).

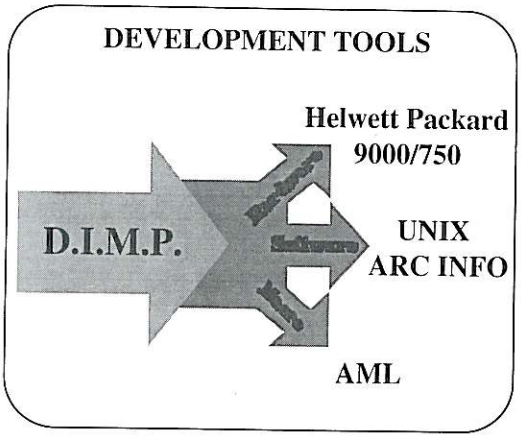

Fig. 3. Hardware and software used to design a special filing and management of information.

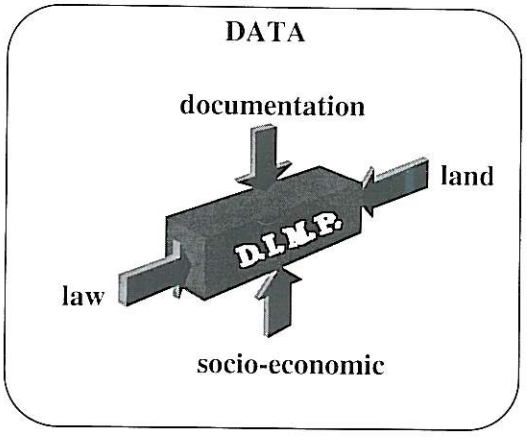

Fig. 4. The different filing of information.

Seismology – This sector contains (fig. 5):
- epicentres data base;
- seismograms;
- isoseismals;
- seismotectonic maps.

Socio-economic data – The socio-economic situation in the area where the earthquake occurred can be known through data from basic cartography:
- population density;
- historical and updated administrative boundaries;
- damage to people (dead, homeless, injured, etc.);
- rescue statistics.

Documentation – The documentation is divided into the following sectors:
- bibliography: references about texts on the event will be provided and for every item the references and an abstract will be filed;

Fig. 5. Example of historical cartography (Mercalli, 1884).

– phototeca: the phototeca will contain the files of photographs of damaged buildings, rescue operations and rebuilding. These images will have a reference with the position visualized on the basic cartography and a reference card;

– newspapers: such as a bibliographic data base, the newspaper articles concerning the event area will be filed in the form of images (fig. 6).

Legislative data – This sector contains the national laws, codes, the rescue directions, the rebuilding, the prevention and the backing amounts (fig. 7).

2.3. *Management system*

The data used are heterogeneous, so the management of the whole program is in ARC-PLOT and the software in AML. The best possible information is provided by a simple consultation system by means of windows and icons (fig. 8).

Users – The whole work has been designed for highly heterogeneous users and particularly:

– for the people in earthquake stricken municipalities, for historical memory recovery;

– for scientific sectors, as a basis for consultation and study;

– for schools, to spread information and to educate;

– for public administration, for knowledge and programming.

We can note the users are heterogeneous both in scientific preparation and culture, and their expectations from this type of data base are extremely different (scientific consultation, divulgative consultation, etc.). So, in this first step of the project, we have built a system of easy consultation: the explaining icons are suitable for our purpose (fig. 9).

3. The 1883 Casamicciola earthquake

Now we describe the first monograph being produced by the NSS. This monograph concerns the 1883 Casamicciola earthquake, on the island of Ischia.

3.1. *The earthquake*

The July 28, 1883 earthquake is characterized by the maximum seismic energy released on the island of Ischia (Campania, Italy) in history. This catastrophic event destroyed the upper part of the little town of Casamicciola, with collapses and heavy damage mainly at Lacco Ameno and Forio, but damage was recorded throughout the island. Few houses remained untouched, most collapsed partially or totally. Not only private buildings were destroyed, but also the hotel trade, country houses, churches. Chronicles and reports give us horrific numbers: 2313 dead (about 600 Italian tourists and 51 foreigners) and 762 injured. The rooms collapsed were 5587 on the whole, 3316 in Casamicciola and the others subdivided among Forio, Lacco Ameno, Serrara Fontana and Barano; the Ischia municipality was untouched.

There are many documents on this earthquake, spread in libraries, archives, municipalities, represented in particular by scientific papers of that time scientists, chronicles, letters, newspapers, iconography, etc. (Dantone, 1883; De Rossi, 1884; Giuochi, 1884; Johnston-Lavis, 1885; Mercalli, 1884; Palmieri and Oglialoro, 1884). The iconography, mainly photographs that began to be used, makes an important contribution for the reconstruction of the macroseismic field.

The Casamicciola earthquake is the first earthquake after the unification of Italy (1860), and for the first time the new government issued codes for antiseismic prevention. Several proposals for the rebuilding were realized in a short time and commissions were formed to investigate the territory and to make choices for a zonation into dangerous and not-dangerous areas (Florio, 1883; Lo Gatto, 1883). All this work was synthetized in: «Regolamento Edilizio per i Comuni dell'Isola di Ischia Danneggiati dal Terremoto del 28 Luglio 1883», issued by the Public Works Authority (Ministero dei Lavori Pubblici, 1884; Regio Decreto 20 agosto 1884).

Fig. 6. The front cover of the French review «Paris-Ischia», a magazine for the Casamicciola earthquake victims (1883).

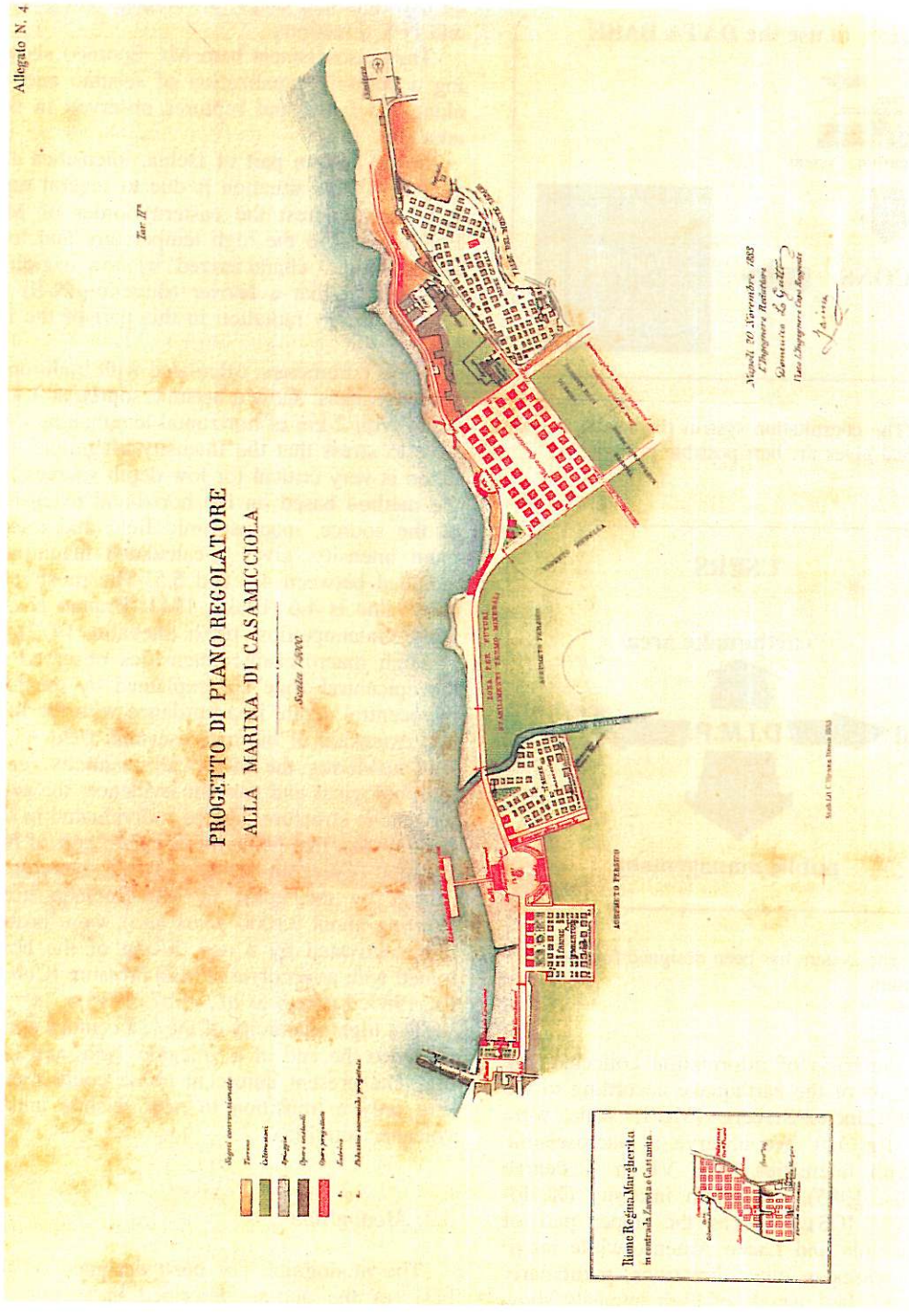

Fig. 7. Example of a proposal for the rebuilding of Casamicciola (Lo Gatto, 1883).

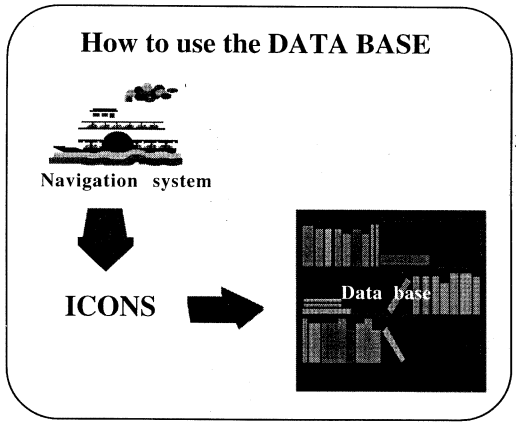

Fig. 8. The consultation system (by icons) is very simple and gives the best possible information.

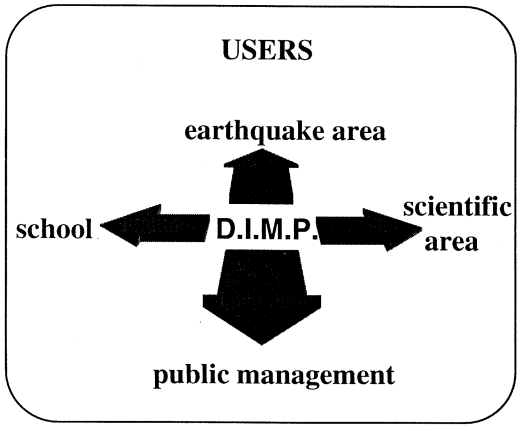

Fig. 9. The system has been designed for heterogeneous users.

On the basis of information collected, the isoseismals of the earthquake according to the Mercalli-Cancani-Sieberg (MCS) scale were traced (fig. 10). We observe a macroseismic field with intensities from VI to X degree (Cubellis, 1985). Maximum intensity (X, locally XI MCS) involves the upper part of Casamicciola and Lacco Ameno, while intensity decreases in other directions, particularly northward. Isoseismals of high intensity show an asymmetrical shape, developing along E-W and N-S directions.

These isoseismals hem Mt. Epomeo showing a possible canalization of seismic energy along the faults and ruptures observed in the area (fig. 11).

In the eastern part of Ischia, intensities are very low. This situation is due to several ruptures that interest the eastern border of Mt. Epomeo and to the high temperature and low depth bodies, characterized by low rigidity, that behave like a barrier (direction N-S) to seismic energy radiation in this part of the island.

Focal parameters, calculated with traditional source models, show a seismic source at 1 km depth with 2 km of horizontal lengthening. We have to stress that the Intensity-Magnitude relation is very critical for low depth sources, so the method based on the horizontal extension of the source, macroseismic field and maximum intensity, gives a calculated magnitude included between 4.2 and 5.5. The most reliable value is 4.6 (Blake, 1941; Branno *et al.*, 1984; Galanopoulos, 1962; Shebalin, 1972).

High macroseismic intensities observed in the epicentral zone are explained by the low hypocentral depth, in accordance with the limited extension of the macroseismic field.

Considering the historical seismicity, geomorphological and tectonic evidence, the seismogenetic structure may be individuated in the fault system that hems the northern part of Mt. Epomeo (Vezzoli, 1988). These structures, caused by the uplift of Mt. Epomeo horst (starting about 33000 years ago), were probably reactivated by a new lifting of the horst joined with a laccolyte at high pressure (Cubellis, 1985; Luongo *et al.*, 1987, 1995).

The high seismicity of the last century could evidence the end of a volcanic cycle and lifting. The present quiescent phase could represent only a transition to new seismic and/or volcanic activities.

3.2. *Monograph*

The monograph has been designed on the basis of the outline described in sections 2,

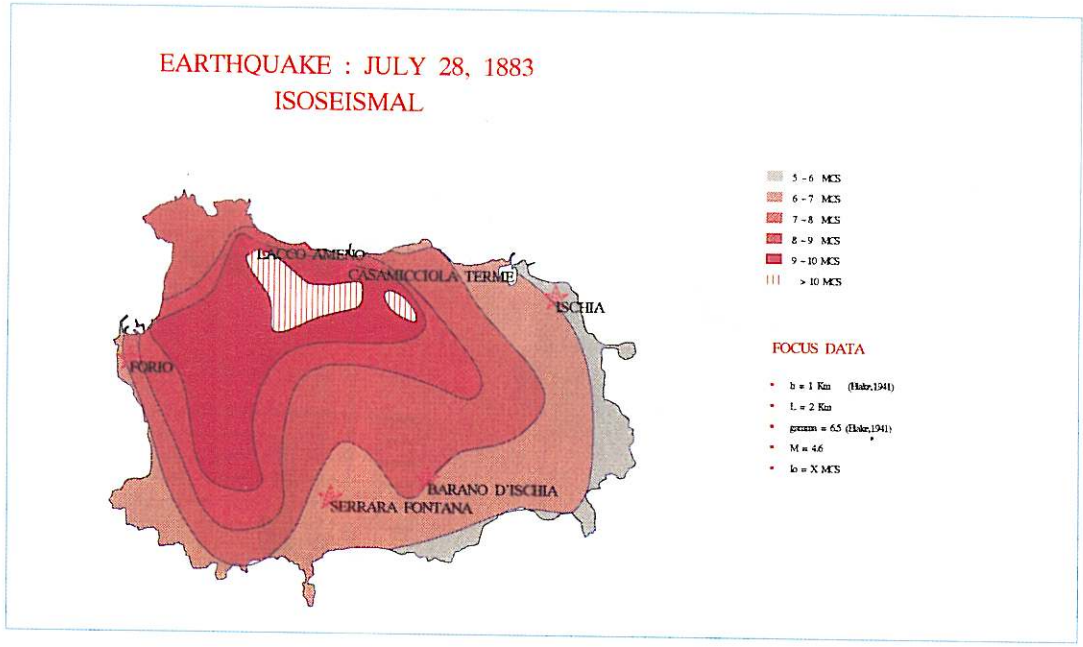

Fig. 10. July 28, 1883 earthquake. Isoseismal (Cubellis, 1985).

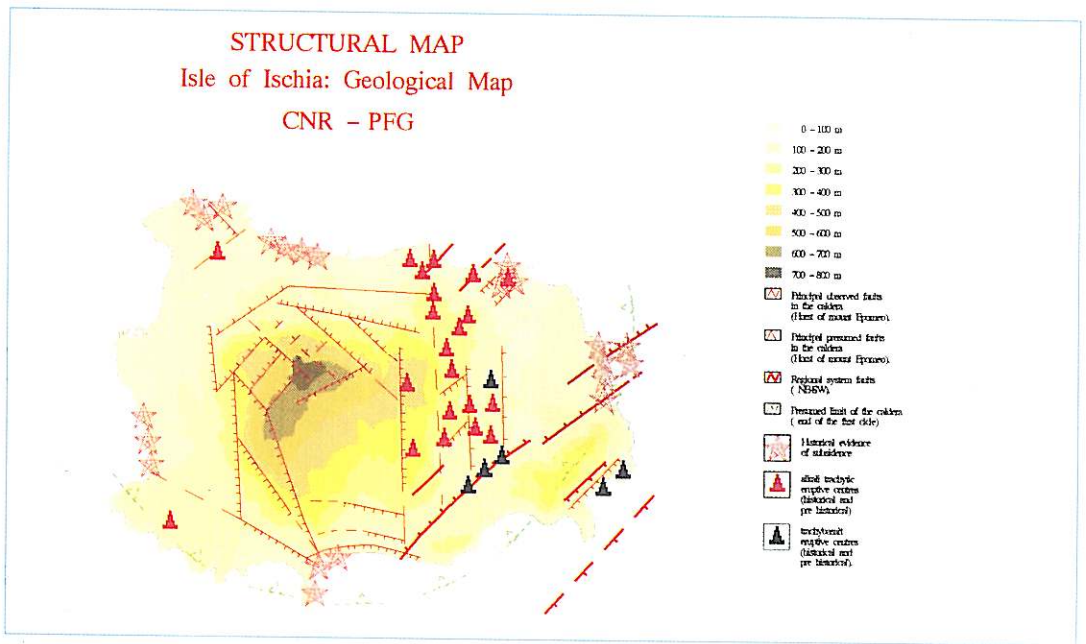

Fig. 11. Structural sketch of Ischia island (modified after Vezzoli, 1988).

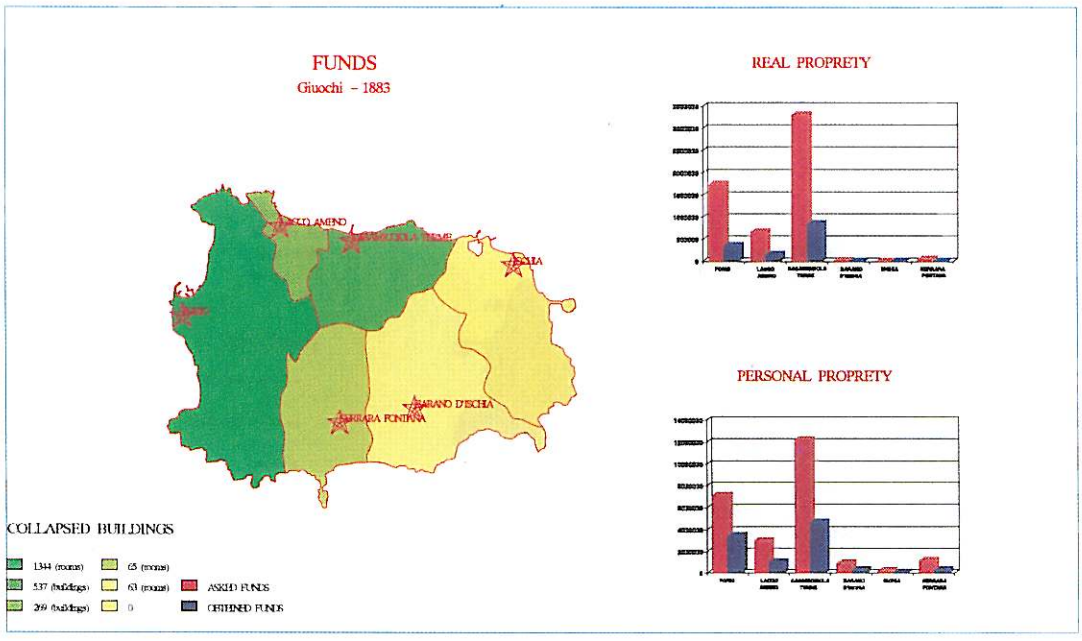

Fig. 12. Funds for the compensation of damages: real and personal property.

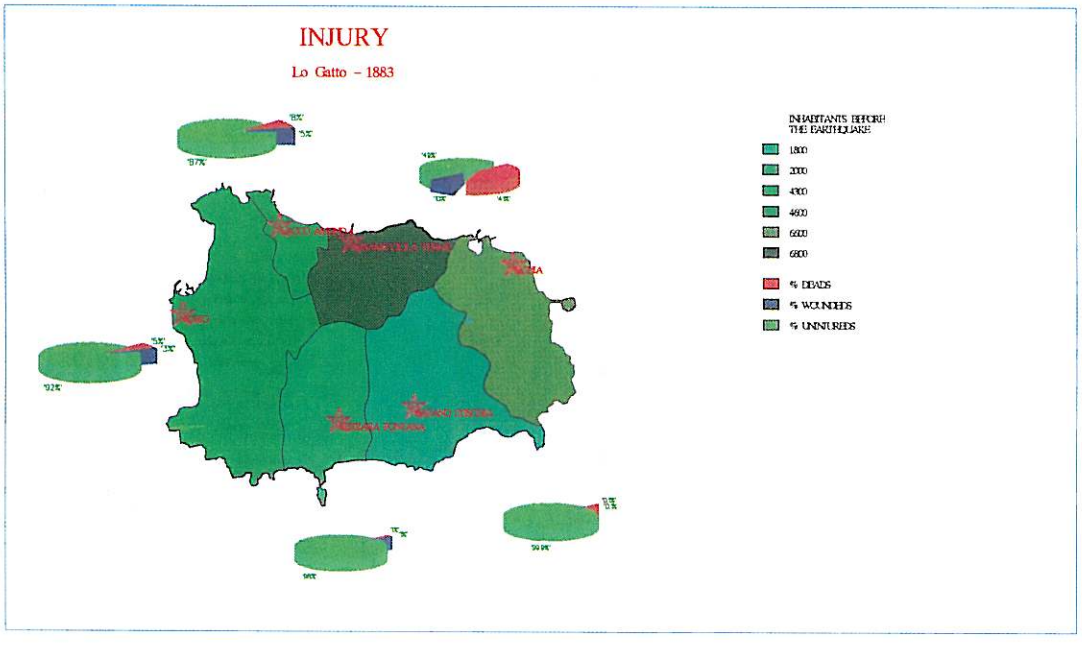

Fig. 13. Percentage of dead and injured people.

2.1, 2.2 and 2.3, with information on the following topics: land, documentation, socio-economics, seismology. The system makes it possible to investigate single items or to obtain elaborations and comparisons among heterogeneous information. For example it is possible to show on a map of the locality of Casamicciola the photographs taken after the earthquake, making a tour through the images of the town.

Other examples of the integration of the data made by ARC INFO, and the possible layouts, are:

– the damage (funds for the compensation of damages: real and personal property) with information on the number of collapsed buildings (fig. 12).

– the percentage of dead and injured people compared with the number of inhabitants before the earthquake (fig. 13).

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