Generation of automatic seismic risk scenarios in Catalonia (Spain)

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ABSTRACT

The emergency plans include various levels of intervention depending on the severity of the event in order to have ready the adequate amount of resources. The early warnings based on rapid detection provided by seismic networks activate the emergency plans, when needed.

A real time system based on a VSAT seismic network has been developed and is now operational. The system generates a SMS message informing of the location and magnitude of the earthquake event. The automatic generation of a seismic risk scenario based on vulnerability assessment methodologies, using GIS techniques is under development.

INTRODUCTION

A methodology for the evaluation of earthquake vulnerability and risk of dwelling buildings at a regional scale is being integrated to an automatic calculation process to generate damage scenarios. These scenarios can be used for the estimation of the possible effects, the preparation of the emergency management and also to give a first forecast, in conjunction with a new VSAT based real time seismological network, immediately after occurring an earthquake.

The main objective for simulating damage scenarios is to have, in case of earthquake, a quick evaluation of the possible intensities felt in each municipality of the region, the possible number of people that could have felt the earthquake with several intensities and the affected area for each intensity. If the earthquake has an intensity high enough to produce damages, the method gives an estimation of building damages to, human casualties and economic losses.

This damage scenarios simulation becomes an useful, simple and quick tool for civil protection for the preparation and activation of the emergency plans.

A Geographical Information System (GIS) is used to visualize the results together with different information layers.

VSAT SEISMIC NETWORK OF CATALONIA

In 1996 a new concept of seismic network was designed and planned in order to fulfill two main objectives:

i) to provide rapid information for Civil Defense services and society in general and

ii) to obtain systematically high quality data for the scientific community.

It is planned to create robust, high performance field infrastructures and install up to 20 stations equipped with three component broadband sensors and a high dynamic range. The stations are based on VSAT platforms sending continuous almost real time seismic data via satellite to the Hub at the processing center of the Institut Cartogràfic de Catalunya (ICC).

Data are continuously stored and processed with an automatic location system. After validation by seismologists information is disseminated via Internet.

A detailed description of the network can be found in Goula et al., (2001).

At present 8 fields stations are operative, with STS-2 and Guralp CMG-3T sensors together with the reception and processing center(See Figure 1).

Seven more stations (# 9 to 15 in Figure 1) have been financed and their sites are selected. They will be constructed and installed during 2006.

Five other stations are under the process of site selection and another one (# 20 in Figure 1) constituted by an OBS Broad Band (from Guralp Systems) has been installed successfully on the sea bottom near an oil platform. Data will be send via satellite VSAT to join the other data in the Reception Center of Data in ICC (Barcelona).

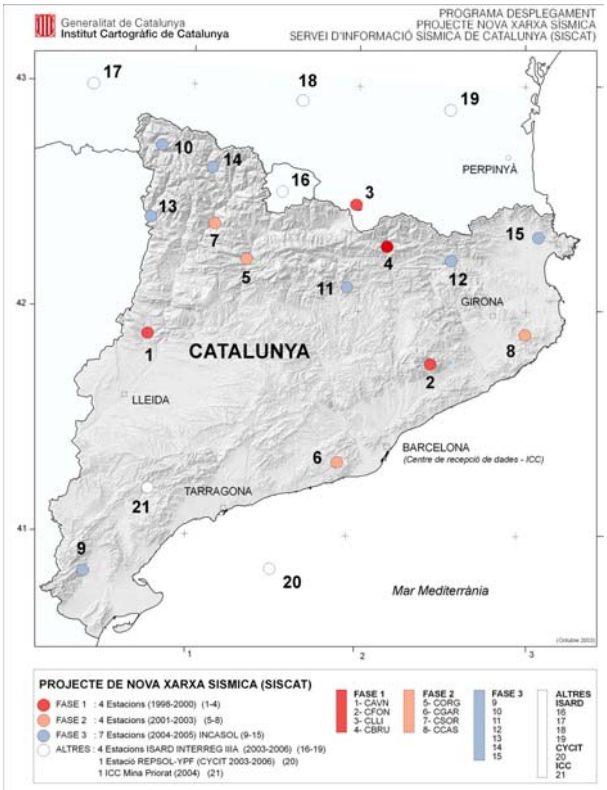

Fig. 1. Map of situation of BroadBand stations of the VSAT Network

A view of Bruguera Station in the Pyrenees (# 4 in Figure 1) with the seismometer vault, the instrumental house, the solar cells and the VSAT antenna is shown in Figure 2. All stations are provided with high performance electrical and environmental protections.

REAL TIME ALERT SYSTEM

At the central site, an acquisition computer stores the seismic data into ringbuffers with a capacity of 16 days of data using NAQS Server software. NAQS Server software is a primary software element for data acquisition and seismic data handling.

Fig. 2. View of VSAT- Bruguera Station

At present, seismic data and triggers are automatically processed by a Data Analysis Computer, which performs the automatic event detection, and determinates the hypocenter and the magnitude of the earthquake. A complete documentation of the event location is automatically generated.

This automatic process will be substituted by an Earthworms based system (USGS, 2005), now under development, in order to generate triggers, detect events, and determinate location and magnitudes of events quickly with great accuracy.

When an event occurs and it is located the alert system sends an SMS message to a distribution list. According with the configuration parameters the distribution list can be different depending of the event characteristics. Alert system reports when one message is delivered and when it is stored at the Message Service Center. The latent period of the alert message is between 2 and 3 minutes since the event detection.The information sent in the alert message are:

–Header
–Origin time (UTC)
–Magnitude (ML)
–Hypocenter location (lat, long, depth)
–Location error (RMS)
–Number of stations witch have detected it
–Nearest station which has detected it
–Distance between the epicenter and the nearest station (Km)
-Level of Emergency depending on the magnitude and location.

DAMAGE SCENARIO MAPPING

A methodology has been proposed to generate damage scenarios that give an estimation of the possible effects of a given earthquake for the preparation of emergencies. The method can also be used to give a first damage estimation, immediately after the occurrence of an earthquake.

Another application of the methodology is the zonation of the territory in order to establish the criteria for activation of different levels of the earthquake emergency plan according to the severity of the estimated consequences of the events.

The methodology consists of three steps:

1) Estimation of epicentral intensity.

Once the epicenter depth and magnitude of the earthquake has been determined Real Time Alert System, it is possible to estimate the epicentral intensity from a correlation between magnitudes and intensities felt by the population.

2) Intensity attributed to each municipality.

It is necessary to adopt a law of attenuation of the intensity versus the distance. The relationship used for Catalonia has been fitted to the intensity data points contained in the database of felt earthquakes.

3) Estimation of building damage, assessment of the human casualties and evaluation of economic losses.

In the case of intensities greater than V these computations are carried out following the methodology developed by Susagna et al. (2005) and Roca et al. (2005). The number of uninhabitable buildings, the number of homeless, and the damages to the people are also computed. Data on building occupancy (inhabitants / building) for each municipality and average surface of the houses are used. The economic losses produced by the damage to the buildings are estimated and, finally, are expressed in terms of the Gross National Product (GNP). The surface that could be covered by debris is also estimated.

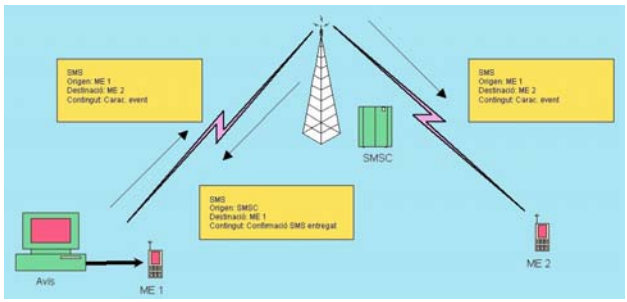

Fig. 3. Schematic representation of the real-time alert and SMS

A Geographical Information System (GIS) was used to develop an application - *ESCENARIS V1.00* (RSE, 2003) - to visualize the results together with different information layers. An example of a scenario map and list of municipalities is shown in Figure 4.

This procedure is now being implemented in connection with the real-time VSAT transmissions based seismic network of the ICC to provide the Civil Protection authority with fast and complete information to activate adequate levels of the Seismic Activation Plan**.**

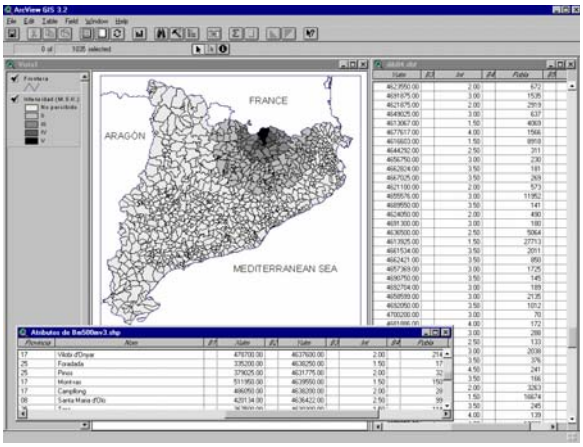

Fig. 4. Example of a scenario map with the list of municipalities for an earthquake of M=4.0 in the Pyrenees

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