REAL-TIME REGIONAL ALERT SYSTEM BASED ON VSAT PLATFORMS 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 in Catalonia (Spain). 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 has already been developed and now is being implemented and tested.

INTRODUCTION

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.
These scenarios give a first forecast, in conjunction with a VSAT based real time seismological network, immediately after occurring an earthquake.
This presentation has been prepared for the EERWEM Meeting on June, 2006 in San Fernando (Spain). It constitutes a synthesis of different contributions presented at Lisbon (Goula et al., 2005) and San Francisco (Roca et al., 2006) for the anniversaries of the Lisbon, 1755 and the California, 1906 earthquakes. It presents the new developments for real time seismology and earthquake risk based on the VSAT regional seismic network of Catalonia (Spain).

VSAT SEISMIC NETWORK

In 1996 a new concept of seismic network was designed and planned in order to fulfil 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 the present time (May, 2006), 10 fields stations are operative, with STS-2 and Guralp CMG-3T sensors together with the reception and processing center (See Figure 1). One OBS station (#20) is also operative in front of the Tarragona Coast, not yet branched to the VSAT network (Frontera et al., 2006). Five more stations (# 11 to 15 in Figure 1) are under construction. One more station is planned in Andorra ((# 16) in Figure 1) and three more stations are under construction (# 17 to 19 in Figure 1), in the South of France (Interreg III a, ISARD Project). They will be equipped with Kinemetrics accelerometer episensors. All the stations will be operational at the end of 2006.

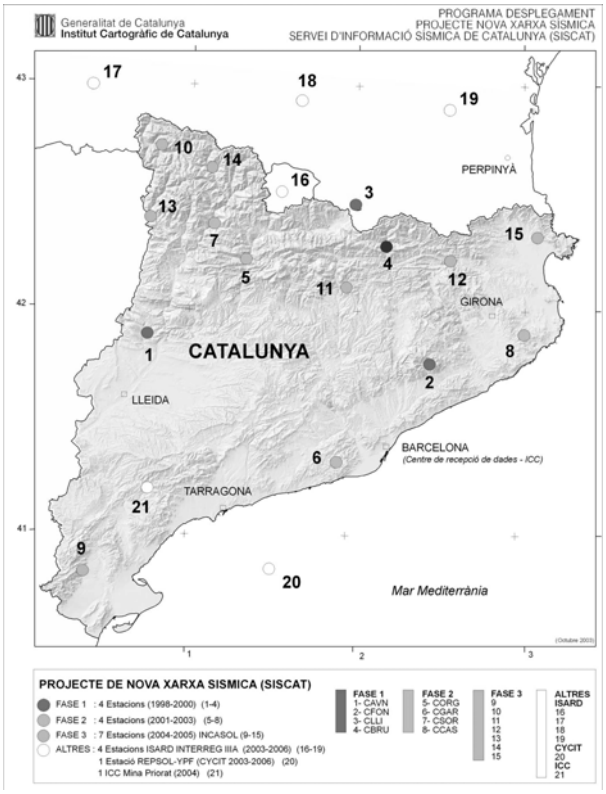

Fig. 1. Map of situation of BroadBand stations of the VSAT Network

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.
Data transmission from field stations to the central HUB placed at the ICC facilities in Barcelona is continuous and in quasi real-time, via the satellite HISPASAT- 1D and using VSAT (*Very Small Aperture Terminal*) platforms. A scheme of data transmission is joint in Figure 3 and a view of the reception antenna is shown in figure 4.

Fig. 2. View of VSAT- Bruguera Station

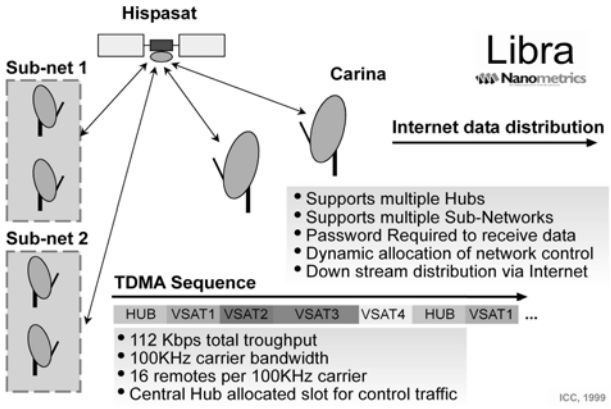

Fig. 3. Scheme of seismic data transmission

Fig. 4. View of the reception antenna installed in the ICC building

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.
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 Earthworm based system (USGS, 2005), developed by RSE S.A. (Romeu et al., 2006), in order to generate triggers, to detect events, and to 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 (Figure 5). 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 is:

–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.

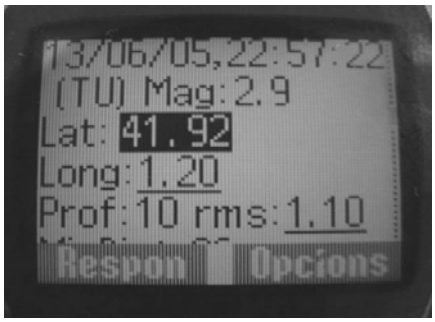

Fig. 5: View of the SMS message

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 by the 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. (2006) and Roca et al. (2006). 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.

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 6.

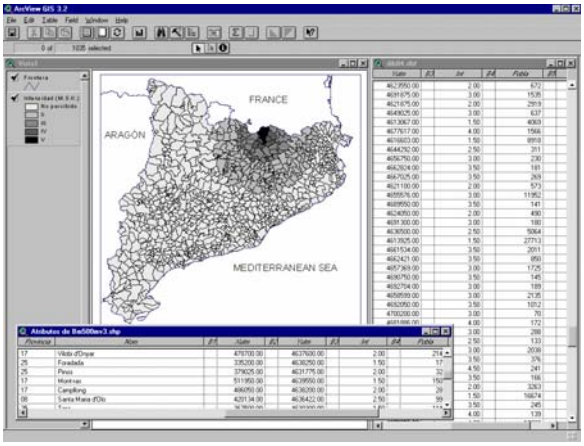

Fig. 6. Example of a scenario map with the list of municipalities for an earthquake of M=4.0 in the Pyrenees

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**.**

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