A NEAR REAL TIME ONSHORE/OFFSHORE SEISMIC AND TSUNAMI NETWORK IN THE SOUTHWESTERN HELLENIC ARC

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Abstract

In Summer 2008, we deployed an onshore/offshore permanent seismological network at the southwestern Hellenic arc for real time data transmission. The network consists of one marine station with buoy located offshore Zakynthos and three land stations at Killini, Pirgos and Keri - Zakynthos, connected through mobile telephony with a base station in Athens. One satellite station was placed on the island of Strofades. The buoy and satellite stations are equipped with broadband 3C CME4011 seismic sensors of 30 s to 50 Hz. The marine station is equipped with a pressure sensor for tsunami observations, while the satellite station also operates a Synotech triaxial Accelerometer, Model 356A01 of 2 s to 100 Hz. The operation of this "amphibious" seismic network in western Greece contributes to the accurate recording of the seismicity of the Arc and helps in delineating local active faults. A more reliable assessment of the seismic hazard is thus achieved.

Keywords: amphibious seismic network, permanent offshore seismic station.

1. Introduction

Greece is a country with very high seismic activity and most of the seismogenic faults are located in the offshore areas, outside the National Seismograph Network. It is therefore essential to develop and deploy marine seismological stations and integrate them with the National Network.

Seismological networks in Greece are landlocked and bias the definition of the foci parameters, particularly for events located offshore, outside the array. This can be improved by establishing seismological stations in the marine area that transmit data in nearly real time. Thus, the foci locations can be significantly improved. Delineating active faults offshore becomes more accurate and passive tomography can reveal reliable velocity models. As a consequence, seismic hazard assessment is significantly improved.

In the following we present the technical solution we have developed within the EC SEAHELLARC project, and is currently in operation offshore Zakynthos, in the southwestern Hellenic Arc (Fig. 1). The necessity to develop a new innovative system for real time seismic observations offshore is derived from the fact that worldwide there are hardly any permanent marine seismological stations in operation, and the few exceptions are very costly and complicated systems (Favali *et al.*, 2002; NERIES FP6 EC Project; D'Anna *et al.*, 2008).

2. The Onshore/Offshore Network

2.1 THE MARINE SEISMOLOGICAL STATION

The marine seismological station consists of two parts: The seismic sensors and data digitizer are placed on the sea floor, while the data processing and transmission unit, as well as the energy supply elements, batteries and solar panels are placed in a buoy, at the sea surface.

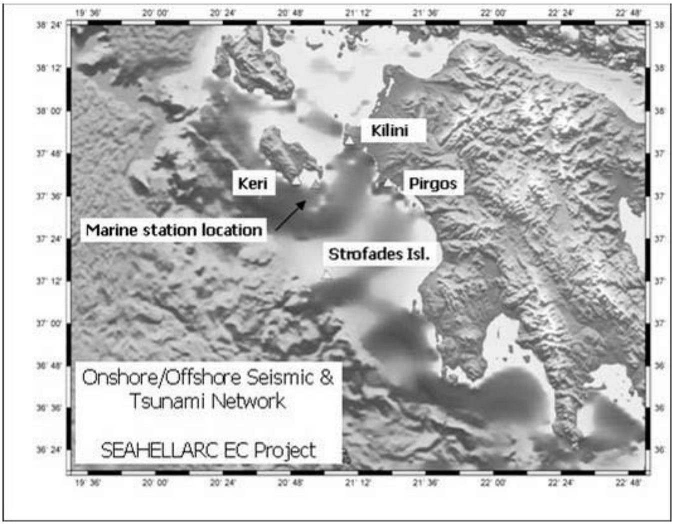

Fig. 1: *The Near Real Time Onshore/Offshore Seismic and Tsunami Network in the southwestern Hellenic arc. Stations are marked by triangles.*

In Figure 2 we present schematically the marine station and its components. The buoy is anchored at the sea floor by a wire rope and heavy anchor. The seismic sensors at the sea bottom are a 3C broadband system, CME Model 4011 30 s to 50 Hz. A GPS receiver provides continuous timing for the processing unit (SEDIS V CPU). The sensors are placed in a glass sphere and are gimbal mounted. The connection between the bottom and surface units is achieved by cable that transfers the digitized data to the processor in the buoy and supplies with power the electronic elements on the sea floor. Energy is provided by two car batteries that are recharged by 4 solar panels of 40 W each. The processed data are transmitted to a base station by mobile telephony (GPRS connection) where they are recorded and stored for further processing.

In addition to the seismic sensors a pressure sensor, model Esterline type 300DS is placed at the sea bottom and connected to the glass sphere. With this sensor, variations of pressure in the water column are observed and also transmitted by the surface unit to the base station (Fig. 3).

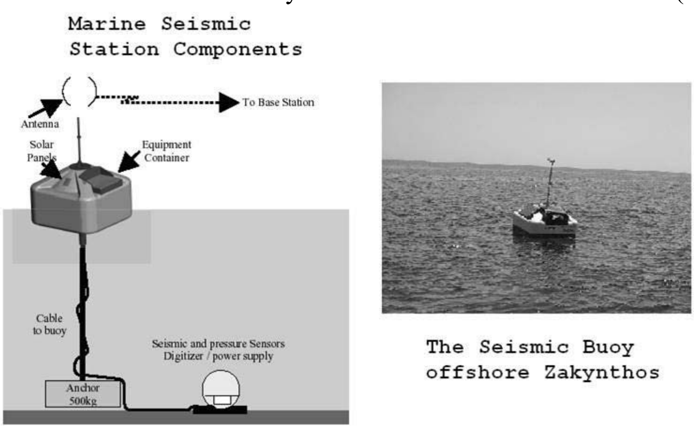

Fig. 2: *Schematic presentation of the offshore seismic station (left) and the seismic buoy deployed offshore Zakynthos (right).*

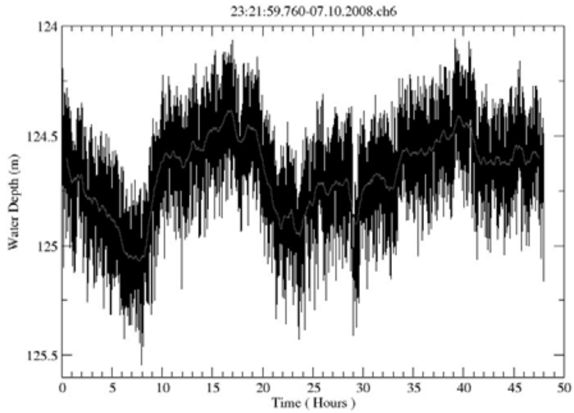

Fig. 3: *Variation of pressure in the water column for 48 hour period and average value of pressure, calculated using 1 hour step, as recorded from the seismic buoy deployed offshore Zakynthos.*

2.2 THE SATELLITE STATION ON STROFADES ISLAND

Since the remote island of Strofades in the Ionian Sea is out of reach for mobile telephony, we equipped the seismic station with satellite link provided by HELLASSAT to a base station in Athens. Data are transmitted permanently, in near real time. The station is equipped with a 3C broadband seismic sensor CME Model 4011 30 s to 50 Hz. A 3C Synotech triaxial accelerometer, model 356A01 of 2 s to 100 Hz, was also installed. The system is powered by 8 solar panels of 80 W each (Fig. 4).

Fig. 4: *The satellite station on the island of Strofades.*

2.3 THE MOBILE TELEPHONY - GPRS - LAND STATIONS

Three land stations EQUIPPED WITH MOBILE TELEPHONY (GPRS link)) were installed at Keri – Zakynthos, and Killini and Pirgos – western Peloponnese. All three stations are equipped with the same type modems for mobile telephony communication as the one used for the Buoy connection. At the moment the 3C seismic sensors are SM6 geophones of 4.5 Hz natural frequency. They will be replaced by broadband 3C sensors at a later stage of the project. Power is provided by rechargeable batteries and 2 solar panels of 80 W each.

Examples of the continuously recorded seismic data from the Pirgos station and the Strofades broadband station are shown in Figures 5 and 6, respectively. Records from all seismic stations from the ML 4.4 event of 26 August 2008, 09:46 (36.13N - 21.87E) are presented in Figure 7.

4. Conclusions

The continuous operation of the SEAHELLARC array since July 2008 has proved its capacity and ability to monitor local and distant seismicity at a permanent basis. Data recorded offshore and onshore by broadband and geophone sensors are continuously monitored by a base station, in Athens. The data, originally recorded in SEDIS format, are re-formatted to SU and Mini Seed and can be processed by standard seismological software packages. It is our intention to integrate the SEAHELLARC stations with those of the National Seismograph Network of Greece and further provide the seismic information to the European Mediterranean Seismological Network, in Strasbourg.

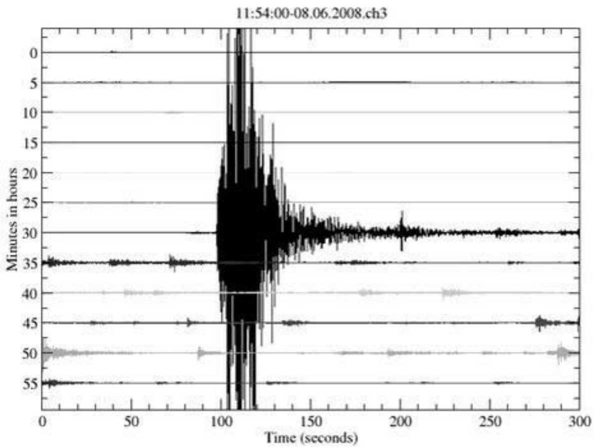

Fig. 5: *1hour of recorded data at Pirgos station: Event of 8/6/2008, vertical component. Each trace presents 5 min of data.*

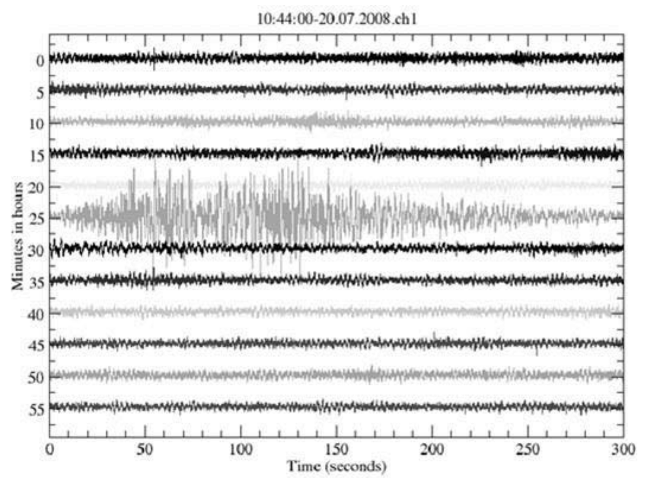

Fig. 6: *1hour of recorded data at the Strofades satellite station, broadband sensor: Event of 27/7/2008.*

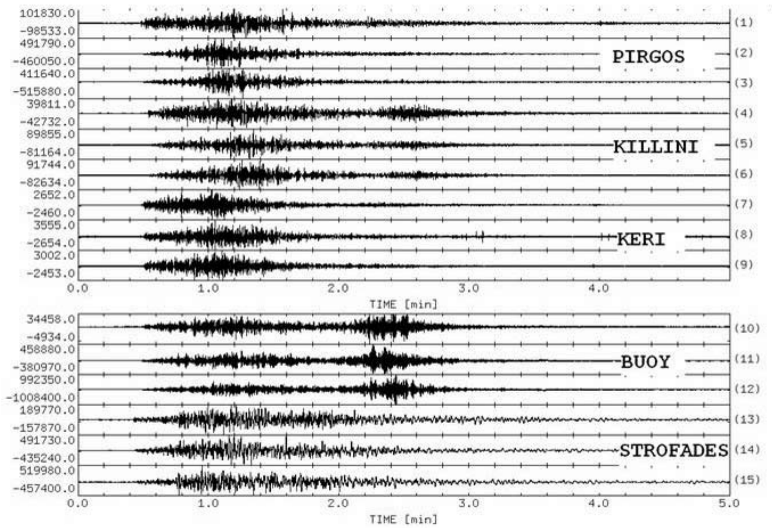

Fig. 7: *Event of 26/8/2008, ML 4.4, 09:46, 36.13N – 21.87E, recorded by all 5 stations of the amphibious seismic array in the southwestern Hellenic arc.*

5. Acknowledgements

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