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FEASIBILITY STUDY OF A NATION-WIDE EARLY WARNING SYSTEM: THE APPLICATION OF THE EEW SOFTWARE PRESTO ON THE ITALIAN STRONG MOTION NETWORK (RAN)

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The dramatic increase of vulnerability to earthquakes of metropolitan areas over the last decade and the very low probability level at which short-term earthquake forecasting is still feasible have led to consider Earthquake Early Warning Systems (EEWS) as the most effective, pragmatic and viable means for seismic risk reduction in cities. Over the last few decades, the theoretical and methodological advances in real-time data analysis have been accompanied by a rapid improvement in telemetry and computer technology. Hence, nowadays, a number of EEWS are being developed or already exist worldwide (e.g., Japan, Taiwan, Mexico, Italy, Turkey, California, etc.; Allen et al. 2009; Allen and Kanamori 2003; Kanamori 2005) which are able to rapidly perform seismological analysis of the ground motion during a strong earthquake.

Among the EEWS operating worldwide, the leading experience of the operational early warning system implemented by the Japan Meteorological Agency highlights the effectiveness of a combined onsite and network-based approach to rapidly broadcast the rapid warning after a potential damaging earthquake. At the nation-wide scale, the Japanese system makes use of real-time data streamed by the extremely dense accelerograph array (about 1000 seismic instruments) deployed across Japan.

With more than 750 accelerometric stations installed over all the active seismic zones, target cities and strategic infrastructures, Italy has the potential for a nation-wide early warning system, although the communication network and data sharing must be still expanded and improved. A significant number of these stations, about 500, are nodes of the RAN (Italian Accelerometric Network) managed by the Italian national emergency management department (Dipartimento della Protezione Civile, DPC), whose data are used for emergency response services (Gorini et al. 2009). The aim of our work, which is carried out in the framework of the REAKT-Strategies and tools for Real Time Earthquake RisK ReducTion FP7 European Project, was to explore the feasibility of a nation-wide earthquake early warning system in Italy exploiting the RAN and the software system PRESTo. It is worth noting that this feasibility study took into account only the geometrical characteristics of the RAN, under the assumption that the hardware and the management software of the national accelerometric network allow for a real-time streaming of seismic data towards the DPC centre.

The work is organized as follow. First, we summarize the main characteristics of the RAN and the main concepts of PRESTo. Then, the potential of the EEWS at the national scale is evaluated by playbacks of real-data from a few tens of the largest earthquakes occurred during the last ten years in Italy recorded by the RAN, which are made freely available by the ITalian ACcelerometric Archive, ITACA 2.0 (http://itaca.mi.ingv.it; Luzi et al., 2008; Pacor et al., 2011).

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In the following part of the work, a novel approach for the assessment of the RAN performance as EEWS at national scale is proposed. The method aims at extending the feasibility analysis also to regions that did not experience earthquakes in the last ten years, as well as to consider the effective seismic hazard over the whole Italian territory. For this reasons, a statistical approach has been implemented considering a nation-wide grid of synthetic sources, the same grid that is used to derive the seismic hazard map in Italy (http://esse1-gis.mi.ingv.it/s1_en.php). Moreover, on the basis of the RAN and synthetic sources grid geometries, the performance for the whole Italy in terms of time of the fist alert availability, blind zone dimension, and lead-time is evaluated and presented (Figure 1). Furthermore, the convenience for Italy of having an EEWS at a national scale is assessed, similarly to what was done for deriving the seismic hazard map in Italy that is used in the Italian seismic code (CS.LL.PP., 2008), taking into consideration for each node the magnitude values corresponding to the 10% and 50% probability of occurrence in 50 years. On the basis of these scenarios, for each synthetic source we assessed the extension of the damage area and its relation to the expected blind zone. Whenever for a given scenario the damage area is larger than the blind zone it means that the EEWS is convenient, and we refer to this high efficiency area as the 'Safer' zone. Finally, by considering a virtual testing period of 50 years, each grid's node is considered as a seismic source capable of generating a sequence of earthquakes with magnitude varying according the seismo-genic zones properties to which it belongs. In this way, for each node of the grid and considering the present-day RAN configuration, an analysis of PRESTo performance is carried out. In conclusion, the RAN-PRESTo system is extensively tested in terms of its capacity to determine the location, magnitude and generated ground shaking for a huge number of earthquakes that might occur in Italy in the next 50 years, according to the Gutemberg-Richter law.

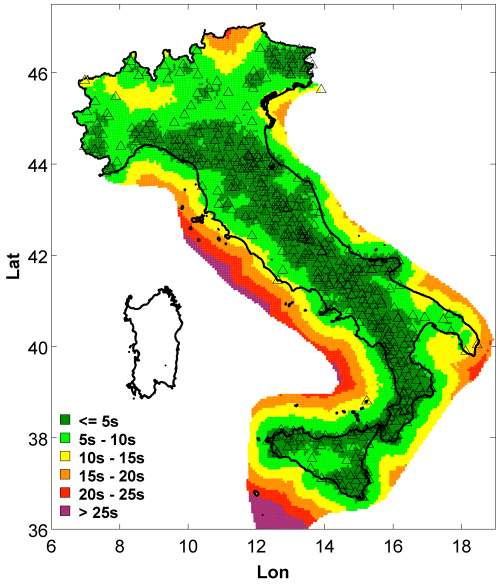

Figure 1. Time of the first alert availability when three RAN stations are potentially triggered.