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Vrancea earthquake early warning system upgrade

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The Romanian territory is exposed to high seismic risk associated to earthquakes occurring in Vrancea area. The historical earthquake catalogue (between 984 and 1900) shows 2-5 intermediate-depth events per century with magnitudes between 7.1 and 7.8. Located at about 140 km epicenter distance from Vrancea, Bucharest – the capital of Romania - experienced at least twice per century heavy damage due to these intermediate depth earthquakes. A study of the macroseismic maps of the major earthquakes that have occurred in Vrancea area in the last century (November 10, 1940, Mw=7.7, hypocenter depth h = 150 Km; March 4, 1977, Mw=7.4, h = 94 Km; August 30, 1986, Mw=7.1, h = 130 Km and May 30, 1990, Mw=6.9, h = 90 Km), reveals the fact that macroseismic intensity in Bucharest is just one unit less than the maxim reported one. The observed intensities (in MSK scale) were around IX $\frac{1}{2}$ for the 1940 event and above IX – IX $\frac{1}{2}$ for the 1977 earthquake. Considering the increased vulnerability of the city, an early warning system for strong Vrancea events is compulsory to reduce the seismic risk. We have to mention that shallow events originating from Vrancea zone have small magnitudes and have no impact on Bucharest.

A method to rapidly estimate magnitude in 4-5 seconds from detection of P wave in the epicenter was developed together with a real time software implementation. The ability to rapidly estimate the earthquake magnitude combined with powerful real-time software, as parts of an early warning system, allows us to send earthquake warning to Bucharest in real time, in about 5 seconds after detection in the epicenter. This allows 20 to 27 seconds warning time to automatically issue preventive actions at the warned facility.

Knowing that the only source of seismic hazard for Bucharest is Vrancea zone (by its intermediate depth events), the EWS specially designed for it doesn't provide the exact location of the events.

Several early warning system parts were upgraded in order to be used in conjunction with Earthworm Acquisition System: the algorithms to rapidly detect seismic events, the algorithm that eliminates false detections and alarms, the methods to estimate the earthquake magnitude and the way the warning is sent to the users. All of these parts have to work automatically, in real time, without interruption for a long period of time.

Several tests were carried out in order to test the real-time performance of the current system by using several software modules of Earthworm Acquisition System. These tests were carried out also by using the existing offline data recorded since 2004 at National Institute for Earth Physics, Bucharest, Romania.