Geophysical Research Abstracts
Vol. 19, EGU2017-14204, 2017
EGU General Assembly 2017


# A Threshold-based, on-site earthquake early warning approach for Italy

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A real-time strategy for a P-wave based, on-site earthquake early warning system has been developed and tested using the database of Italian earthquakes. The key elements of the proposed methodology are: 1) the real-time, continuous measurement of three peak amplitude parameters (the initial peak of displacement, Pd, velocity, Pv, and acceleration, Pa) along the vertical component of the P-wave signal and 2) their empirical combination to predict the ensuing Peak Ground Velocity at the same site. The observed parameters are compared to prior established threshold values and then converted into a single, dimensionless variable. A local alert level is issued at the recording site as soon as the empirical combination overcomes a given threshold.
The three parameters are continuously measured along the recorded signals, starting from the P-wave arrival time, and progressively expanding the time window. A possible risk when using this approach is the inclusion of the S-waves in the analyzed P-wave signal portion, which may lead to an overestimation of the predicted ground shaking level. To minimize the S-wave contamination, an efficient algorithm for the automatic detection of the S-wave arrival time has been included. The algorithm is based on the real-time polarization analysis of the three-component seismogram and on the Singular Value Decomposition (SVD) (Rosenberger, 2010; Amoroso et al., 2012) and is able to distinguish variations in the polarization of the original signal, and to discriminate the dominant P-wave signal from the arrival of later S-wave phases.
The performance of the method has been evaluated by defining successful, missed and false alarms, and counting the relative percentage, after applying the approach to a testing catalog of Italian earthquake records. The database we used for the system testing and calibration consists of more than 200 Italian events in a magnitude range $3.5 < M < 6.5$, provided by the Italian Strong Motion Network (Rete Accelerometrica Nazionale, RAN). Here we show that the joint use of three peak amplitude parameters together with the polarization analysis algorithm, significantly improves the performance of the system, as compared to the use of a single parameter without the SVD filtering. The proposed methodology provides more reliable predictions of the expected ground shaking and is expected to be a more robust approach for a single-station, threshold-based earthquake early warning system.