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Peak-Duration magnitude for the Irpinia Seismic Network, Southern Italy

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The estimation of magnitude is a routine task in the seismological observatories and can be obtained through well-established automatic procedures. Several magnitude scales are available, based on amplitude measurements of different seismic phases, and/or on total signal duration. In particular, duration magnitude is adopted in many regional networks since it allows for a rapid determination of earthquake size, for a large number of events, through a fairly simple procedure. The main purposes of this work are two: to derive a duration magnitude relationship for the Irpinia Seismic Network (ISNet, http://isnet.na.infn.it) in Southern Italy and to develop an automatic procedure for discriminating among events occurring inside and outside the network.
To the former aim, we performed a multiple regression analysis to get a duration magnitude relationship of the form
$M = a*\log\tau + b*\log R + c$
where M is the local magnitude, τ is the signal duration, and R is the epi(hypo) -central distance. Signal duration is evaluated on the vertical component of velocimeter records as the time from the first P-arrival time to the time along the trace at which the wave amplitude has decreased to the noise level. The parameters a, b and c are determined through a linear regression analysis. For events inside the network (R < 100 km) the coefficient c turned out to be negligible, so we adopted a simpler relationship of the form $M = a'*\log\tau + b'$. Measuring the distances in kilometers and the durations in seconds, we obtained the following set of parameters: a =-3.83+/-0.12 , b =3.03+/-0.12, c =0.42+/-0.08, a' = -1.59+/-0.14, b' =2.06+/-0.08.
Moreover, for each station we determined a station correction coefficient, comparing theoretical and observed magnitude values, to improve the accuracy on magnitude estimation.
The ISNet data management system is set to automatically detect earthquakes having magnitude greater than 2. A current problem for the automatic detection system is the discrimination of seismic events occurring inside the network from those located outside. Given the dependency of signal duration (τ) and peak-amplitude (P) on source-to-receiver distance, the simultaneous measurement of these two parameters can be effective to identify events inside the seismic network. To this aim, we propose two methodologies, both based on the combined use of τ and P.
The former approach is based on the Peak-Duration Magnitude that is defined as
$Mi = a*\log\tau i + b*\log Pi + c*\log Ri + d$
where Mi, τi, and Pi represent the magnitude, the total signal duration, and the peak-amplitude for the i-th station, respectively, and Ri depends on both the i-th station and epicentral coordinates. Parameters a, b, c, and d are determined through a multivariate linear regression analysis. The previous equation can be then used to determine the epicentral coordinates given a set of (τi, Pi) measurements at the network stations.
A rough, but faster method is based on a the definition of a decision-table according to threshold values for τ and P. The basic idea is that (large) earthquakes far away from the network produce small amplitudes and long durations. We then derive two threshold values for τ and P for earthquakes occurring inside the network and having a maximum magnitude of 3. The τ threshold is derived from a relationship linking the duration and magnitude, such as $\log\tau = A + B*M$, while the P threshold is derived from a similar relationship relating the peak-amplitude and magnitude, such as $\log P = A' + B'*M$. The coefficients are determined through a best-fit procedure obtaining A=1.202+/-0.017, B=0.258+/-0.009, A'=2.28+/-0.12, and B'=0.72+/-0.06.
Some examples of application of both approaches will be shown.