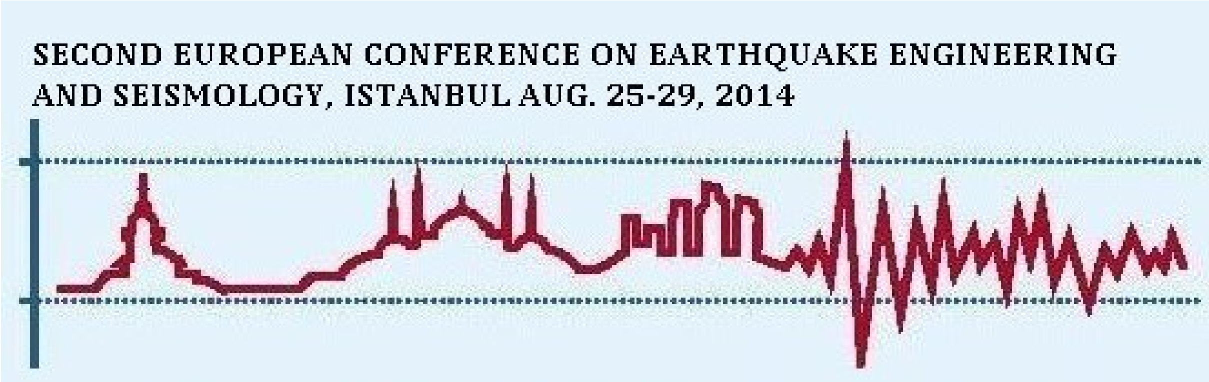

EMPIRICAL RELATIONSHIP M_L-M_D FOR THE VOLCANIC AREA OF MT. ETNA (ITALY)

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Studies on seismicity at Mt. Etna are of extreme importance for the high seismic and volcanic risk which characterizes the area. In this region, seismic events are mainly located at less than 5 km b.s.l. depth, producing arrivals with medium-to low-frequency content and/or complicated signatures at stations just a few kilometers distant from the epicentral area (Patanè and Giampiccolo, 2004); on the other hand, earthquakes which present high frequency content and sharp arrivals, similar to those of typical earthquakes of tectonic areas, are mainly located between 5 and 20 km.

Seismicity mainly occurs in the form of swarms, whereas foreshock-mainshock-aftershock sequences are rarely recorded, and seldom exceed magnitude 4.0 (Ferrucci and Patanè, 1993).

The calculation of the local magnitude M_L is more objective than that of M_D because the measurement of the signal amplitude is less ambiguous with respect to the decay of the earthquake coda, which may be masked by the presence of noise, volcanic tremor, or other shocks (Del Pezzo and Petrosino, 2001; D'Amico and Maiolino, 2005). Therefore, since relationships adopted to estimate M_D and M_L for Mt. Etna region do not produce the same results, it is mandatory to adopt an empirical conversion to produce a homogeneous catalogue. Moreover, different magnitude scales strongly influence the slope of the frequency-magnitude distribution. In particular, comparing the a- and b-value of the Gutenberg-Richter, different results are obtained.

The Standard Linear Regression (SLR) is the simplest and most commonly used regression procedure applied in literature to carry out M_D-M_L relationship (e.g. Gasperini and Ferrari, 2000; Gasperini, 2002; Bindi et al., 2005; Braunmiller et al., 2005). Its application without checking whether its basic requirements are satisfied may lead to wrong results (Castellaro et al., 2006).

As an alternative it is better to use General Orthogonal Regression (GOR) relation (Carrol and Ruppert, 1996), which assume a different uncertainty for each of the two variables (Lolli and Gasperini, 2012).

The application of GOR methods requires the estimate of the ratio η between the dependent and the independent variable variances, and when only the ratio variance is known, the GOR represents the simplest and mostly used approach.

A database of magnitude observations recorded at Mt. Etna during the period 2005 – 2012 is adopted for this study. The new M_L-M_D relationship obtained by applying the GOR is:

$$M_L = 1.237(\pm 0.009) \times M_D - 0.483(\pm 0.016) \quad (1)$$

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with a correlation coefficient R=0.90 and rms between observed and calculated M_L of 0.27. The superiority of the GOR relation over the SLR has been demonstrated on the basis of the best fitting between regression line and data distribution.

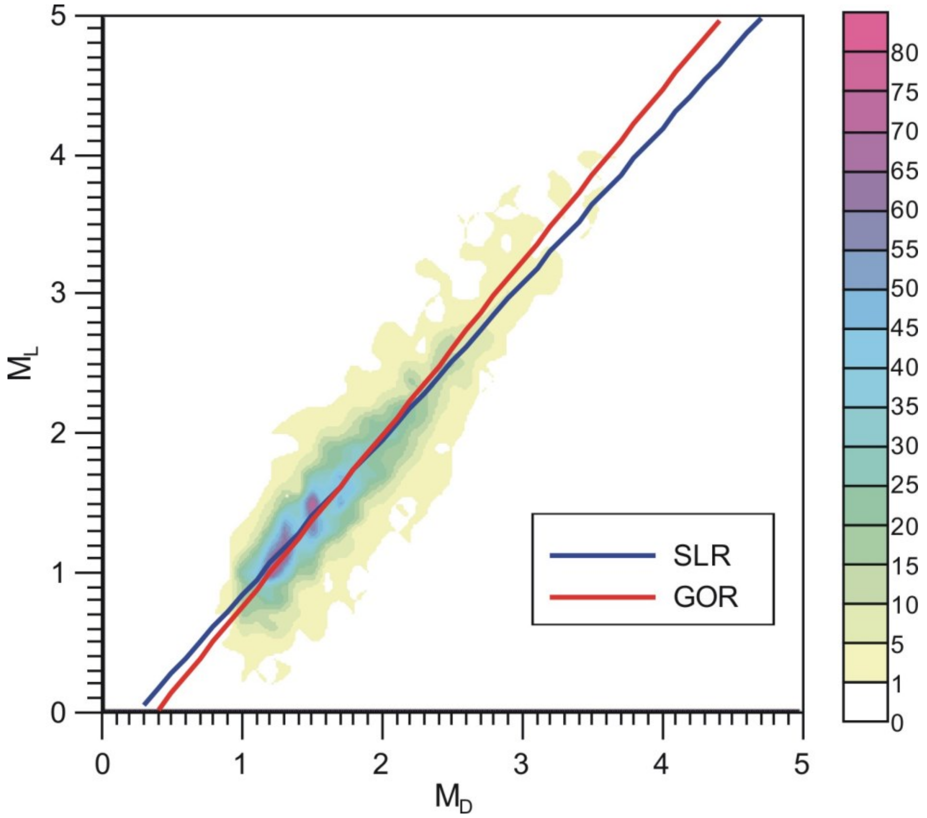

Figure 1. Plot of regression relationships for M_L and M_D obtained by using SLR (blue line) and GOR (red line). Colour scale bar indicates the number of earthquakes.

The M_L-M_D relationship obtained by GOR significantly reduces the previous bias between M_L and M_D estimated for earthquakes recorded at Mt. Etna and will be used for the purpose of catalogue homogenization. Conversely, the commonly used SLR may induce systematic errors in magnitude conversion, introducing apparent catalogue incompleteness, as well as a heavy bias in estimates of the slope of the frequency–magnitude distribution. All this can be avoided by using the GOR in magnitude conversions.

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