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Local magnitude scale in Slovenia

J. Bajc (1), Ž. Zaplotnik (2), M. Živčić (3), and M. Čarman (3)

(1) Faculty of Education, University of Ljubljana, Ljubljana, Slovenia (jurij.bajc@pef.uni-lj.si, +38615892233), (2) Faculty of Mathematics and Physics, University of Ljubljana, Ljubljana, Slovenia, (3) Environmental Agency of the Republic of Slovenia, Seismology and Geology Office, Ljubljana, Slovenia

The Seismology and Geology Office of the Environmental Agency of the Republic of Slovenia is recording and processing data about the earthquakes occurring in Slovenia and the surrounding areas. For the last 30 years the magnitudes M_{LV} of the earthquakes recorded by the Slovenian seismic stations were computed using the maximum ground velocity on the vertical component with the attenuation determined to fit the magnitudes recorded by Wood-Anderson seismograph in Trieste. In the last 15 years the digital seismic network of the Republic of Slovenia has grown from 6 to 28 permanent seismic stations and recorded large set of earthquakes, but attenuation relation for the local magnitude has not been re-evaluated yet. We use a large data set of earthquakes occurring in the area between $44.6°$ and $47.0°$ N and $12.0°$ and $17.0°$ E in the period from January 1997 to December 2010 to calibrate the local magnitude equations. An iterative least-square method is used to determine distance attenuation coefficients and station corrections for the Wood-Anderson magnitude (M_{WA}). The magnitude equation is obtained from the automatically determined amplitudes from simulated Wood-Anderson seismograms of more than 1800 earthquakes. The magnitude span of the data used is between $M = 0.6$ and $M = 5.2$, with all but few tens of events between $M = 1$ and $M = 3$ and the hypocentral distance span from 20 km to 280 km, with less than 0.4 % of the distances larger than 210 km. The relation obtained is

$$M_{\mathrm{WA}}^{j} = \log\left(A[\mathrm{mm}]\right) + 1.38\log\left(\frac{r[\mathrm{km}]}{100\ \mathrm{km}}\right) + 3.0 + C_j\ ,$$

where A is the maximum amplitude on the horizontal component of the synthetic Wood-Anderson seismogram, r is the hypocentral distance and index j refers to the station, so that C_j is the station correction. Station corrections C_j obtained for 30 stations are in the range from -0.26 to 0.30.

Currently, the M_{LV} of an event is determined as the mean of the M_{LV} magnitudes at individual stations, using a single magnitude equation with no station correction terms. The same set of recordings is used to determine the coefficients in the relation for M_{LV}. For the calibration of the M_{LV} magnitude equation the data of more than 3100 earthquakes is used.

Attenuation in the calibrated M_{LV} equation is somewhat higher than the one used presently by the Seismology and Geology Office. However, the M_{LV} values obtained using the present single equation and the new equation with station corrections do not differ significantly. The main gain of the introduction of the station corrections is the reduction of the M_{LV} uncertainty by about 35 %.

By comparing M_{LV} and M_{WA} as obtained in the first part of the study, we show that the linear function $M_{\mathrm{WA}} = 1.06M_{\mathrm{LV}} - 0.075$ describes well the relation between the two magnitudes. However, it has limited use, since the magnitude span of the data used is mostly between $M = 1$ and $M = 3$, with just a few tens of events with $M > 3$. Nevertheless, the difference between the two local magnitudes does not exceed 0.3 for most of the events with both magnitudes determined.