EMSC Felt Report Correction Procedure

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Warning: The corrected intensities given in the data files are only preliminary, it is more correct to apply the calibration to averaged values.

Attention: Felt reports continue to be collected for many weeks following major earthquakes and so the datasets provided here may evolve over time.

The current recommended correction for image based testimonies is to

1. Reject felt reports with intensities 11 and 12 (since they are unreliable in practise)
2. Bin and average the reports using your chosen method
3. Apply the following correction to their intensities

$$I_{corrected} = \begin{cases} \overline{I_{image}} & if\ \overline{I_{image}} < 2.5 \\ 1.3\overline{I_{image}} - 0.75 & if\ \overline{I_{image}} \geq 2.5 \end{cases}$$

For individual values, this correction can also be applied although the average values of corrected values may be slightly larger at lower intensities due to the non-linearity of the correction at I=2.5. In general it is preferable to apply it to the averaged values since this is how it was defined.

History of the Calibration Correction

The image based felt reports used by the EMSC ask users to select an image that corresponds to the shaking that they experienced. There are 12 images that show increasing effects and damage that roughly correspond to the European Macroseismic Scale (EMS-98). However, analysis of the reports collected have found that the results underestimate the macroseismic intensity estimated by other methods and so an empirical correction was derived:

$$I_{corrected} = \begin{cases} I_{image} & if\ I_{image} < 3 \\ 1.3I_{image} - 0.75 & if\ I_{image} \geq 3 \end{cases}$$

This formula was derived in 2016 and an article was published in early 2017 in SRL [1] – "Thumbnail-Based Questionnaires for the Rapid and Efficient Collection of Macroseismic Data from Global Earthquakes". For the calibration, the article studied 17 earthquakes from around the world, that occurred between July 2014 and April 2016 and that ranged in magnitude from M4.2 to M8.3. About 17,000 felt reports had been collected for these 17 quakes and for each earthquake, a plot of the average macroseismic intensity vs distance from the epicentre was made for the EMSC reports. This was compared to a similar plot of USGS DYFI data. Importantly, testimonies with reports of 11 and 12 EMS intensity were rejected from the analysis since they were found to be unreliable reports in the majority of cases. In order to make the plots, bins with sizes proportional to the log distance were defined and average intensity calculated for each bin with more than one observation. The same procedure was applied to the USGS DYFI data, although this data had already been averaged using

10-km square bins (probably using a UTM based coordinate system). It was also considered in the article that the MMI scale used by USGS DYFI is equivalent to the EMS-98 scale. The empirical correction was then proposed in order to align the EMSC results to the USGS DYFI results. The results also correlated well with other independent macroseismic intensity estimates for 2 of the earthquakes. Importantly, this meant that the correction was defined using macroseismic averages.

In February 2023, a M7.8 struck central Turkey and Syria and a study was made of the data collected at the EMSC following this mainshock [2]. Analysis of the 46,240 reports collected within 72 hours of the earthquake again showed that reports of intensities 11 and 12 were unreliable in general (since their locations were not correlated with the fault line). The 6082 felt reports collected explicitly for the mainshock were binned using a 10-km grid (using a UTM based coordinate system) in order to have local averaged macroseismic intensities. These intensities were compared to values produced independently by Hancilar et al. (2023) and it was shown that the empirical correction dramatically improved correlation between the two intensity values (Figure 1). It also concluded that macroseismic intensities greater than 8 are only rarely observed in practise.

Felt Report Webservice

This webservice (https://www.seismicportal.eu/fdsn-wsevent.html) provides researchers with a method to download the felt reports collected by the EMSC for particular events. It applies the calibration correction individually to report values to encourage the researchers to use corrected values. However, until May 2023, it used the following correction:

$$I_{corrected} = \begin{cases} I_{image} & if\ I_{image} < 3 \\ 1.3I_{image} - 0.75 & if\ I_{image} \geq 3 \\ 10 & if\ I_{image} \geq\ 8.27 \end{cases}$$

It was felt that intensities greater than EMS-10 were unrealistic, since EMS 11 corresponds to most buildings being collapsed and EMS 12 corresponds to the destruction of all almost all structures in a neighbourhood. However, this additional clipping of values meant that averages of the corrected values were lower at the upper end of the scale compared to applying the correction as it had been derived (see Figure 1).

From June 2023, values were no longer be clipped to I=10. Also, reports of 11 and 12 will be included in the datasets for future events. This is for completeness, we still recommend that they be eliminated in practise.

Applying this version of the correction also meant that there was a small discontinuity at I=3 for mapped values. Changing the transition boundary to I=2.5, removed this small issue.

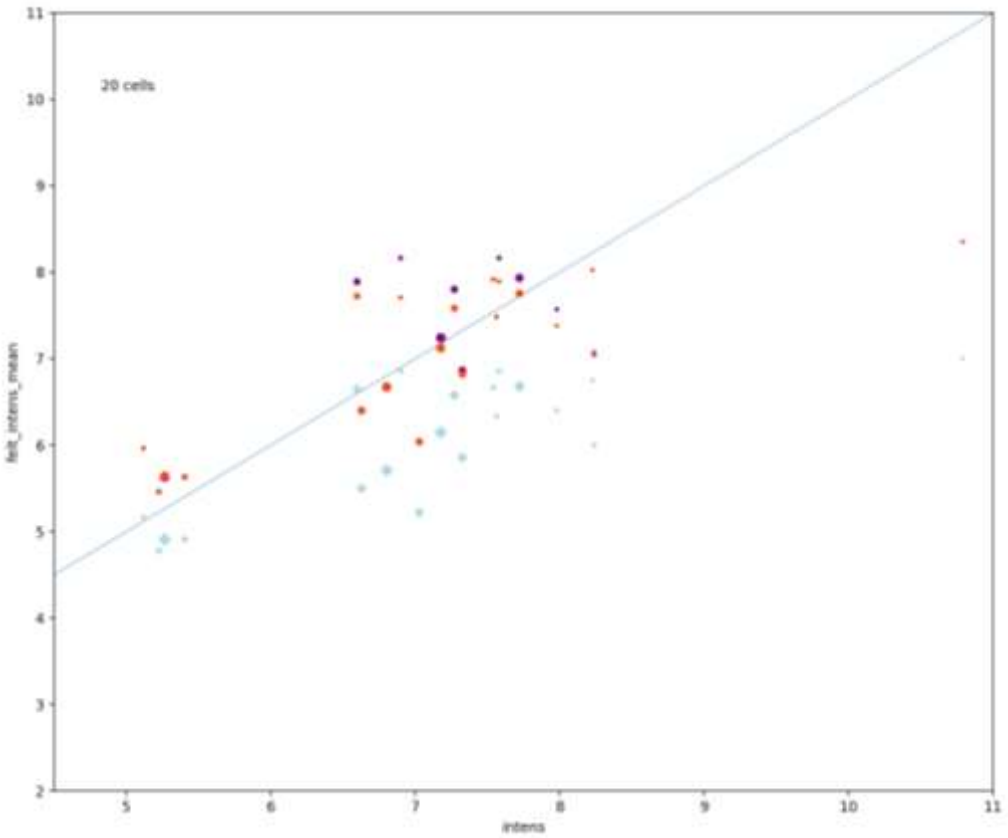

Figure 1: Effect of clipping intensities to the intensity 10. In this plot of averaged felt report intensities versus reported Macroseismic intensities, the dataset, for the M7.8 in Turkey in Feb 2024, has been divided into a grid of 10km of square bins and a result is reported if there were at least 4 reports in a particular bin. The uncorrected values (light blue diamonds) are far below the line of proportionality (light blue diagonal line) and corrected averages (purple circles) are more correlated with the independently reported macroseismic values (Pearson correlation = 0.76). The average of individually corrected intensities are also shown (red hexagons) and are also more correlated (0.8) but their values fall below the purple circles as we get above intensity 7 due to clamping the maximum individual intensities to 10.

References

[1] Rémy Bossu, Matthieu Landès, Fréderic Roussel, Robert Steed, Gilles Mazet-Roux, Stacey S. Matin and Susan Hough, “Thumbnail-Based Questionnaires for the Rapid and Efficient Collection of Macroseismic Data from Global Earthquakes”, Seismological Review Letters, 88 (**1**), Jan/Feb 2017.

[2] Rémy Bossu, Maren Bose, Robert Steed, David J. Wald “The Potential of Crowdsourced Data for the Rapid Impact Assessment of Large Earthquakes: The 2023 M 7.8 Kahramanmaras-Pazarcik, Türkiye, Earthquake”, Seismological Review Letters, 10.1785/0220230421, April 2024