

Response to Anonymous Referee #3

- *I won't repeat the points that Remy Bossu and Valerio de Rubeis stressed very nicely in their reviews, but will stress out just a few things that I consider crucially important: DYFI is the USGS online questionnaire; it is very famous and very popular. But, it's not the basis of the majority of European national online questionnaires. The tradition of collecting macroseismic data in organised way is old and rich in European countries. Almost each of them has developed its own national questionnaire, based on the scale that was used locally, as well as including details that were of importance.*

Thanks to indicate this error. We rewrote the introduction and section 4.2 mentioning the information above. More information can be found in our reply to R. Bossu.

- *It is definitely not written in EMS guidebook that one should decrease the intensities from the observers in third and fourth floors by one intensity value.*

This is a correct comment. –I intensity decrease for 3&4 floors is not 'literally' advised in the EMS-98 guideline. But allows us to explain why we do this rescaling (this has also been rephrased as such in the paper):

EMS98 says : *"One special case is the situation where the only reports are from tall buildings, because the shaking was so weak that it was only perceptible on the upper floors of such structures. This sort of datum is typical of intensity 2. »* This is insufficient information given by the EMS98 scale. If you are near an epicentre with intensity e.g. III, IV or V and you only receive a few online answers from people living in a high-rise building, then this value II is obviously false. Only a sufficient amount of data (see also further our reply to your main concern) can bring a reliable intensity assessment, which is obviously not the case with internet data.

EMS98 also advises (P.29) : *"It is well-known that people in upper storeys are likely to observe stronger earthquake vibration than those in lower storeys.... Various practices, such as reducing the assigned intensity by one degree for every so many floors, have been suggested, but never found general favour."*

Here again, the EMS provides insufficient guidelines. We know that changing the intensity is not a perfect approach because each building has its own frequency, different floor height, etc... but we do think that adjusting intensities for higher floor responses is better than doing nothing. The experience of the BCSF with internet data proves that this adjustment is important (in particular for big cities) and that this needs to be integrated in order not overestimate the intensity value in comparison with classic method of estimation.

The recommended practice by EMS98 is to discount all reports from observers higher than the fifth floor when assigning intensity. So reducing the assigned intensity by –I intensity only for floors 3 and 4 is not strictly prohibited by EMS98 scale.

This is another point that the EMS98 needs to take into account in the future and which was also addressed by Sbarra et al. 2012.

- *To exclude EMSC questionnaires because the intensities were not in accordance to the average values of other institutes is definitely not scientifically correct.*

OK, we added the EMSC questionnaires to our analysis which slightly increased the number of responses used in this paper (see tables 1 and 2 and Fig. 7A, see comment De Rubeis). The mean IAR of the Goch earthquake (fig. 7A) shows that the intensities derived from thumbnails and questionnaires are slightly different. Intensity analysis by using thumbnails tends to give higher intensities in the epicentral area than the questionnaires. We don't know why. Perhaps people tend to choose a higher intensity if they know they are close to the epicentre... Finding an appropriate answer to this question is unfortunately beyond the scope of the paper. Apart from the NRW-GD, all institutes show rather similar IAR's. See comments in the reply to V. De Rubeis.

- *But my main problem is the following: evaluating the intensity for some locality means to collect all the data about earthquake effects in that town or village and evaluate them together in order to obtain the intensity value for the said locality. It is not correct to assign individual intensity values to each observation and then recalculate the intensity following some rule. This is the only way to be sure that the intensity value is correct, and to obtain reliable seismic history of the settlement. Here, however, no one seems to care much about the earthquake effects described in questionnaires; lot of effort is put into fiddling with the already calculated intensities instead. What is the use of this? I can give it a benefit of being handy for showing the rough outline of the intensity field soon after the earthquake. But this cannot be a tool to really study a transfrontier earthquake. There is much more behind each coloured circle on the map than just playing with the grid size.*

We understand your concern and agree that evaluating earthquake effect percentages is the recommended method to assign intensities. However, let us explain why we choose a more simple and hence more rough methodology. The merged institutional intensity data of the Goch and Ramsgate that we have in our possession did not allow applying the recommended procedure: EMSC, NRW-GD and KNMI only gave us a list with individual intensities and coordinates, without the answers to the specific questions. The grid cell intensity from the BGS was taken from their website. EMSC also provided clustered data. From the USGS, BSCF and ROB-BNS detailed answers are available. This means that we have a part of the answers and hence simply cannot do better with the provided data than merging individual intensities. We prefer to perform a rough intensity analysis on the whole macroseismic field rather than applying a statistically-correct analysis on a subset of the data.

The current situation with individual testimonies collected online is also different than that with communal testimonies gathered from classical inquiries. Online macroseismology provides an alternative way to obtain a preliminary intensity value with only few testimonies. Certainly, online data does not replace, nor is invented to replace/improve the classical method but we must continue working in this direction to obtain new methodologies that can be applied in quasi real time based on few data. If we would strictly respect the EMS98 guideline, then we can stop with online macroseismology by individual internet enquiries because the data collected in cities or in squares are often not sufficient and representative due to their low content, not in the UK, not on the continent. Boatwright and Phillips (SRL, 2017) recently provided a new methodology to recalibrate intensities taking into account population density and response reaction. This might resolve the population issue in the future but it is not the same as carefully evaluated communal reports. Even if the recommended procedure would be followed, in numerous cases, the number of individual data collected in cells is often insufficient to realize a representative statistical processing of the intensity. To make a statistical analysis of earthquake effects with only few testimonies in a square is perhaps not better than the thumbnail averaging.

Our grid cell analysis is indeed a preliminary result but it proposes a new solution to obtain a rapid severity of shaking and which can potentially be used in quasi real time. That's it, not more. We performed this study to evaluate a methodology, it's pros and cons to create dense macroseismic maps by merging data. And in fact **the results are not so bad**: e.g. for Goch, the same site effects are confirmed as with other earthquakes (e.g. Roermond 1992) that were analysed in the same region with the classic communal methodology. After this paper, we agree it will be necessary to make a survey to obtain a more consolidate result conform to EMS98 procedure.

To conclude, you are right that we cannot assign EMS98 values by grouping intensities in cells. We changed this statement in the paper as it is not certain that a strong and certified EMS98 intensity value can be determined. The used intensities correspond to "individual severity of shaking" which is determined by following as much as possible the EMS98 guideline. Communal and field inquiries using the classical procedure are still needed complementary to individual internet data.

We added the following text to the paper to clarify our statement and methodology:

"Intensity degree definitions recommend to evaluate the percentage of people observing an earthquake effect, of which each effect is associated with an intensity value. Grouping the intensity values of a large number of responses in ZIP code areas leads to a robust intensity assessment. Unfortunately, the European macroseismic fragmentation complicates applying this procedure. The transfrontier Goch and Ramsgate macroseismic data that were provided to us by the (inter)national agencies only contained 'individual' intensities and not the detailed answers to the questions. Hence, the recommended procedure could not be followed. Moreover, in numerous cases, the number of individual data collected in cells is often insufficient to realize a representative statistical processing of the intensity. For all these reasons we decided to calculate the mean intensity of all (geocoded if possible) individual intensities within a cell. This grid cell intensity is an approximation of the intensity field and provides no certified EMS-98 value but it provides a solution to obtain a rapid severity of shaking after merging data."