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## Comment on nhess-2022-60

Anonymous Referee #1

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Referee comment on "An updated area-source seismogenic model (MA4) for seismic hazard of Italy" by Francesco Visini et al., Nat. Hazards Earth Syst. Sci. Discuss., <https://doi.org/10.5194/nhess-2022-60-RC1>, 2022

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Updated area-source seismogenic model for seismic hazard of Italy

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The manuscript is well written and well within the scope of NHESS. It is an important contribution for probabilistic seismic hazard studies in Italy. It follows the state of the art in the field. It is written in a compact form, rather technical, and it sometimes lacks details or a more extended explanation. There are also some parts that are unclear, because of the writing that aims at being very (too much) concise. I advise minor revision because the procedure and results are sound, nonetheless I think that some significant work is required to improve the clarity of the text, clarity of the explanations and justifications provided and of some of the figures.

The manuscript describes one of the area-source models that has been used to derive the new seismic hazard model of Italy (MPS19). It follows the usual steps in the building of an area source model. Among these steps, the authors select 3 steps/decisions that bear uncertainties to populate the logic tree : determination of time windows of completeness, Mmax values, determination of seismic rates. The final hazard values are delivered, obtained by combining the source model logic tree with the ground-motion logic tree established in MPS19. Uncertainties on the hazard values are also provided, in the form of coefficient of variation estimates. Uncertainties related to the source model are compared with uncertainties due to the ground-motion prediction part.

Organization of the text: The introduction should be shortened and some of the material and explanations that are currently there should be transferred to a proper section: all the explanations on how ZS9 was established, using ZS4 as a starting point.

Page 1 in the last decades => decade

Page 2, ZS9 is called ZS4, and Z16 is called ZS9, there is a mix of names which need to be corrected (mix with MPS4 and MPS9?)

Page 2, "in ZS9 the choice of drawing area sources large enough to include all the seismicity above a certain magnitude threshold, a criterion used in [...]", this sentence is unclear

"the increase in the surface of area sources incorrectly reduced the hazard estimate in the central parts of the area" : this sentence is not that clear, why would the largest density of events be in the central parts ?

Page 3, Section, introduction, It would be nice to see maps that show how you have used the geophysical data to define the areas. This part is quickly treated without much detailed explanations or maps. It is a pity. It is important to understand how area sources are delineated, the process that leads to the polygons.

Page 3, section 2.1

"Earthquakes [...] that occurred in the Italian and neighboring areas"

"The parameters of the 43% of" => the parameters of 43% of

Section 3.1 The SZ16 seismotectonic zoning

'be consistent with the CPTI14 earthquake catalogue': what do you mean?

Section 3.2. This section is difficult to read and should be re-organized for the sake of clarity, e.g. by splitting the section in different paragraphs, beginning the description with the most common sources and then describing volcanic sources.

Why using only 1 or 2 depth values, instead of a pdf that would best represent the depth distribution per source zone?

Prevalent : what do you mean with this term? Is it the most appropriate?

"basing on" => based on

Section 3.4

A reference must be indicated for the Gutenberg-Richter model (for the exact equation used).

The equation would be more readable in equation format.

Section 3.4.1

Do you use exactly the same time windows as Stucchi et al. 2011 ? This is not clear if you apply the method, or use the same windows. I assume you use those from Stucchi et al. 2011, otherwise more information should be provided on how they have been assessed.

"Being the approach" ?

"to avoid the oversampling of some Mw intervals that contain values derived from the conversion of more than one discrete epicentral intensity value" => this sentence is not clear

This is unclear why in the historical method, a 0.23 bin is used; then in the statistical method, 0.46 is used. Strange that the historical method can handle a smaller bin.

More would need to be said so that the reader can appreciate the estimation of periods of completeness step.

Section 3.4.2

“for the definition of the maximum magnitude, we used the estimates provided by MPS19, described in Visini et al. 2021”: can something be said about these estimates ? how they have been evaluated ?

Woessner et al. 2015 does not provide the rational behind selecting 6.5 as a minimum for active crustal areas. It would be important to have one explanation for the choice of this value as threshold.

“the two values of  $M_{wmax}$  were also checked with the estimates of the maximum  $M_w$  of the composite seismogenic sources of DISS ...” : how checked ? What happened if one fault inside the source provided an  $M_{max}$  larger than the largest magnitude observed including uncertainty ?

Section 3.4.3 is not that clear.

Approach I should belong to one paragraph.

Approaches ii to v should be grouped in one paragraph.

ii) observed rates : for which magnitude ?

iii) what is the “threshold magnitude  $M_t$ ” of an area source?

iv) observed and forecasted number of earthquakes above a given magnitude ?

v) minimize the root-mean-square of observed rates => within which magnitude interval ?

Section 4

“3 ERFs developed adhoc” : please, what do you mean ?

“the annual rates of earthquake occurrences are given as a non-cumulative magnitude-

frequency distribution" => if this detail is provided, then you could provide the name of the distribution in openquake format, otherwise this detail is not necessary

"the cov is the weighted std divided by the weighted mean": why weighted ?

## Section 5, Discussions and Conclusions

Some sentences in the third paragraph are not clear, e.g. :

"because of the lack of available data that can even produce apparent differences in seismicity distribution at the local scale"

"seismic hazard results are different if the same quantity of seismicity is assigned to sources of different size"

I fully agree with the last sentence of section 5. We don't know if the future will reproduce observations in the past. We know that the catalogs available are still too short to be representative of what may occur. We should not discard models on the basis that they do not reproduce the past.

Figure 1

The new zoning should be put on top of the old one.

Figure 2

Legend for zoning ZS16 should be put in the graphic that displays the zoning.

Figure 3

There is no need to show the y-axis below 20km depth.

It is not clear where the 5% bar is ? how can it be at zero depth if it is the percentile 5% of the distribution?

Figure 4

Caption is very difficult to follow.

Full circle: do you mean plain circles?

Figure 6

To appraise the impact on the rates of a given method, it would be extremely important to superimpose models for a given source (group by source the 5 alternative results). Also, to understand the variability on the results due to the 5 different methods, it would be very important to show a source with poor data (few events).

There are too many log scales on these graphics (from  $1e-8$  up to 100). It produces a visual bias on the alignment of observed rates. There is no need to keep the axis below  $1e-5$  nor above 10, nor above magnitude 7.5.

The annual rates are cumulative or non-cumulative?

Figure 9. If indicating probabilities over 50 years (horizontal lines), it would be clearer to plot probability over 50 years versus acceleration.

Figure 10

Final uncertainties are rather small (considering the 16 to 84 percentiles), with respect to other PSHA studies.

To read the graphics, keeping the y-axis ticks on all graphics would help.

Figure 12

The figure is difficult to read, and it is then difficult to follow the corresponding text page 11. One solution would be to get rid of the individual realization, in order to see the three curves corresponding to the three GMMs. The observation made by the authors that "the uncertainty due to the GMMs is of similar order of magnitude as the uncertainty related to the ERF" is not obvious on this figure.

Figure 13

The cov is calculated from the distribution for a given acceleration level, and this is sound.

It would be more straightforward to plot the acceleration versus the cov, rather than a mean probability which has a loose meaning.

In any case, mean APO should appear in the y-axis label.

"Although the scatter in the results for the different sites and PGA levels": verb is missing?

Caption : Againt =>against