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Title: **Development and assessment of uni- and multi-variable flood loss models for Emilia-Romagna (Italy)**

Author(s): Carisi et al.

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**Iteration: Second review**

I really appreciate the efforts made by the authors in improving the paper that is now clearer and more robust. However, I think that some critical points need further clarification. I report these points below as major criticisms. I also add some minor comments that could improve the readability of the paper. I leave authors the choice to consider them or not. Finally, typos are highlighted.

P.S. I still do not agree on the use of the OMI values, as reconstruction costs can be easily derived from price lists. But, I accept this as a modelling choice.

### **Major criticisms**

1. It is still not clear to me how the MCM model has been transformed into a relative model. Why authors refer to Secchia values and not UK values for the calculation of the relative curve? I would adopt market values referring to UK in 2005 not Italian ones. This is an important point to understand/explain estimations supplied by the model. Likewise, knowing whether relative damage in literature models has been derived by means of the reconstruction value or of the market value can support results discussion.
2. I do not understand the motivation given by authors on the worse performance of SMV with respect to other models, in terms of absolute damage estimation (i.e. that this is due to the fact that the model is identified for relative damage). Indeed, if the difference between relative and absolute damage is only due to the building value (which is considered by the model as non "important" variable) why such a behaviour should occur? I would like to have a more detailed explanation.
3. I also do not agree on the motivation supplied by authors on why empirically derived model underestimate damage, i.e. "looking at the empirically derived models, for example, the most precise model in terms of RMSE (SMV model) underestimates loss to buildings. This result can be expected and explained with the fact that citizens tend to overestimate damage during declaration and, consequently, observed loss is higher than estimated ones". This is true if models were derived from "correct" (i.e. not overestimated) data but the calibration dataset was made up by real "overestimated" data (as stated by authors). Please, discuss.
4. Pg. 15 line 12-18; "The reason behind this fact must be attributed to the morphologic and socio-economic context where this models have been drown, that differs considerably from the Secchia ones, in addition to the different criteria adopted to develop them. In fact, an other factor that influences the performances of the literature models applied on the Secchia case study is the different scale on which these curves are calibrated and applied: some of them are developed to be applied at the micro-scale (e.g. MCM, FLEMOps), while other at the meso-scale (e.g. Rhine Atlas, JRC curves). However, also among the meso-scale curves there are some of them with better results in estimating damages in the Secchia area than others, but it is difficult to identify a-priori which curve is better for a certain context." → I do not agree. I think that a deeper investigation on models properties and assumptions (e.g. hazard and vulnerability features of the context where they have been derived, values used for translating absolute damage into relative damage, level of aggregation of original data) can guide the identification of most suitable models. This should be discussed in the paper.

5. As regard transferability, I think that some considerations must be added on the role of vulnerability. Figure 10 shows that in the municipality of Bomporto and Bastiglia, despite different water depths, similar damage occurred. This can be explained by different vulnerability of buildings owing to the two dataset, which can also be the origin/ cause of prediction errors.

#### **Specific minor comments (which can increase the readability and clarity of the paper)**

Pg. 3 line 23-27; “The analyses described in this paper contribute to the understanding of possibilities and limitations of flood damage modelling in Northern Italy. In particular, we address the problem of lacking consistent data and the consequent difficulty in the development of reliable damage models for local applications. Also, our study investigates the open problem of transferability of empirical damage models to different areas and socio-economic contexts. Finally, the analysis aims to provide further insight on accuracy and robustness of uni- and multi-variable models in estimating flood loss to buildings and contents” → These aspects do not represent the real research questions of the paper, neither they are recalled and discussed in the final sections. I would suggest authors to remove the sentence.

Pg. 3 line 35; “As anticipated,.....” → where?

Pg. 4 line 26-29; Which is the southern boundary?

Pg. 5 line 4; “Thanks to several eyewitness accounts, video footage and studies conducted by the scientific committee” → which scientific committee? No reference is made to it before in the paper

Pg. 5 line 14-17; “Accordingly, citizens and property owners were asked to fill forms about public properties damages (Form A), private properties, furniture and registered goods damages (Form B), economic and productive activities damages (Form C) and agriculture and agro-industrial sector damages (Form D). In the present analysis, damage assessment focuses exclusively on private properties (Form B)” → name of the forms can be omitted as they have no sense for non-Italian readers.

Pg. 7 line 24- 26; The sentence contains a repetition, it can be simplified as “the reconstruction of the flood event was performed by means of Telemac-2D, a fully-2D hydrodynamic model which solves the 2D shallow water Saint Venant equations using the finite-element method within a computational mesh of triangular elements”

Pg. 8 line 32-33; “This section briefly recalls well known and largely employed literature depth-damage models, as well as two empirical depth-damage models and one multi-variable loss model that we identified “ → the models for Secchia are not recalled but derived in the research, please correct

Pg. 9 line 3-4; “All uni- and multi-variable models illustrated here are applied for predicting loss to household contents resulted from the January 2014 Secchia flood event” → they are used also for buildings (i.e. structures and installations)

Pg. 11 line 4; “Usually, the buildings do not have an underground level. Therefore, for the impacted buildings a water depth equal to zero means no damages).” → This sentence repeats contents already discussed in the previous sentence and can be omitted.

Pg. 13 line 26-27; “.... is the possibility to understand the influence of the factors on the damage process for this specific context (different concept from the correlation one)” → The difference in concepts is not so obvious for RF non-expert readers. Please, explain better.

Pg. 18 line 15-18; “Small differences in the ranking of the models, compared to Tables 4 and 5, is due to the fact that the regression curve for content damages is derived starting from the structural damages to

buildings and due to the variability of these values it brings this uncertainty also when applied for estimating content damages starting from the results of other models" → I do not understand what authors mean here. Please, rephrase; the sentence is not clear

Pg. 18 line 27-29; "Even though some literature models have similar performance to locally identified empirical models, the best performing literature models cannot be identified a-priori, which hampers the practical utilization of literature models themselves for predictive purposes" → see comment 4

Pg. 19 line 35-5; "According to Elmer et al. (2010), Schröter et al. (2014) and Schröter et al. (2016), the use of a number of explanatory variables to sustain more complex models (i.e., multi-variable model) leads to additional knowledge of the event, especially if the interdependence of the parameters are considered. However, this may introduce additional uncertainties, especially if the additional parameters are not collected specifically aiming at this kind of analysis. As a matter of fact, Secchia's database was collected for other purposes and does not include hydraulic parameters" → this sentence is not linked with previous or following one. A logical gap is present. I suggest to remove it.

Pg. 19 line 15-17 "According to Amadio et al. (2016), Molinari et al. (2012), Molinari et al. (2014b), and Scorzini and Frank (2015), the most urgent need in Italy, as far as loss estimation is concerned, is to identify guidelines, valid for the whole country, to collect consistent and comparable data, even if they relate to different context" → a proposal for a standardised procedure for data collection is included in Ballio et al., The RISPOSTA procedure for the collection, storage and analysis of high quality, consistent and reliable damage data in the aftermath of floods, *Journal of Flood Risk Management*, 2015

Pg. 19 line 24-25 "this study demonstrates that models can be transferred to similar contexts with satisfying results" → similar context on the bases of what? Please add

Pg. 19 line 6-7 "Finally, our study also emphasizes that loss-data collection is a fundamental and delicate task, and data-collection protocols are urgently needed for harmonizing and standardizing the compilation of flood-loss data sets" → the concept has been already state previously. The sentence can be removed.

## **Figures and Tables**

Figure 3 - caption "Grey points in the background represent the observed relative loss (buildings only)" → the sentence is repeated

Figure 9 – Top panel is in Italian

Table A1 → it is not clear what values in the second column represent. Are they the mean bin value of observed damages? Please specify

## **Typos**

Pg. 7 line 12; "this difference...." → I guess there is a typo. "this" must be replaced with "the"

Pg. 9 line 26. "The FLEMOps model assesses relative flood damages to private households referring us to several factors" → "us" must be deleted

Pg. 12 line 11 → "Depends of" should be replaced with "Depends on"

## **Bibliography**

I did not check the bibliography for lack of time