Response to Referee 1

We would like to thank the referee for the time and effort put into reviewing the manuscript. This response (R) carefully addresses all the comments (C). Where applicable, changes are proposed to the manuscript accordingly.

C: In this paper the Authors analyzed the possible contribution of using Open Street Map (OSM) data for enhancing the predictive performance and transferability in space of multi-variable flood damage models for the residential sector. To this purpose, they built a data-set by combining empirical observations from historical flood events in Germany and data derived from OSM, with the latter essentially related to building footprint geometry. Random forest regression models (RFM) were then learned on this data-set using regional sub-sets and were tested for predicting flood losses in other regions. The manuscript is overall well written and presented and the topic perfectly fits the scope of NHESS, following the path of similar papers published in the Journal in recent years.

R: We thank the reviewer for this basically positive evaluation.

C: However, in my opinion, the study suffers from a main methodological criticality, i.e. the representativity of the new additional parameters in correctly characterizing the building vulnerability to floods. Indeed, the nine selected parameters derived from OSM used for learning RFM were only related to the shape and extension of the building footprint area (with an obvious high correlation among them), neglecting instead other fundamental vulnerability variables, e.g. building material and type, presence of a basement, etc. As it is well known and understandable, footprint geometry has a highinfluence in determining flood losses; however, as shown in previous studies, the observed damage variability depends on many (hazard and) vulnerability factors, which should not be neglected for a comprehensive modelling of flood damages.

R: We agree with the reviewer that building vulnerability is determined by diverse influencing factors and acknowledge that understanding how building vulnerability can be correctly characterized implies valid and relevant research questions.
However, the generic research question of our study is on assessing how new promising data sources like volunteered geographic information and open data can help to tackle challenges in natural hazard research. Specifically, we focus on OpenStreetMap as a potential data source for flood vulnerability modeling in its current state. We focus on OpenStreetMap, since it is the most comprehensive open data containing building footprints data of good quality. With this in mind, we do not aim to characterize building vulnerability as comprehensively as possible, but rather to see what is possible in terms of building flood vulnerability modeling with the available OpenStreetMap data. This knowledge will support future studies on building flood vulnerability which may investigate additional building characteristics and also the appropriateness of other data sources.
To make this dedicated focus clearer we suggest to change the title into: ‘Are OpenStreetMap building data useful for flood vulnerability modelling?’. In addition we will make changes to the abstract, the introduction, discussion and conclusions as detailed in the following responses..

C: This becomes even more important when we consider the problem of the spatial transferability of empirical damage models. For instance, we may have two regions which have sim ilar characteristics in terms of footprint geometry, but very different construction types: in this case, an OSM-based multi-variable model would be totally unreliable. For this reason, the main question that the Authors asked

in the title "Are new open building data useful for flood vulnerability modelling?" is a bit pretentious, given that the answer is quite obvious if they limit their analysis on including only the nine additional variables listed in Table 2.

R: As said in the answer to the previous comment we will adjust the title to make the focus on research objective of this study clearer. The suggested title also fits better to our research hypothesis p3L26-27. In addition we will state research objective i) more precisely: 'understand which building geometry variables are useful to describe building vulnerability'. (p3L29)

C: For the same reason, also the results shown in Section 4 are expected; moreover, these indicated that the consideration of all the new footprint parameters does not actually greatly improve model performances (Table 4). Also the variable importance shown in Figure 5 is only partly informative: it basically says that water depth is more important than building shape and extension, but this is already known (and also shown in similar studies, e.g. Wagenaar et al. 2017, Amadio et al. 2019, both published in NHESS).

R: Figure 5 represents the outcomes of an intermediate step of our data analyses workflow. The purpose for the assessment of variable importance is to get a basic understanding of the suitability of individual predictors in a highly correlated data set. In this regard the assessment of variable importance adds to the correlation analyses, but (we agree with reviewer) it does not reveal fundamentally new findings. We suggest to remove this figure from the manuscript and refer to the to the results of the assessment of variable importance in the text P13.LXX

C: The Authors are right in saying that information on building attributes in the OSM database are scarce and not useful for the kind of analysis they performed in their study. However, they could have exploited other public databases existing in Germany (e.g. cadastral, city planning maps, etc.) for building a more complete data-set. Therefore, I would suggest to the Authors to consider this possibility and repeat the same analysis in order to have more interesting results for improving our knowledge on flood damage modelling.

R: We fully agree that this would be an interesting research but it is beyond the scope of this study. We mention this perspective in our conclusions P21L9-10.

Specific comments:

C: P1.L13-15 and L16-18: based on previous general comments, I find these sentences potentially dangerous.

R: We will add further details to the abstract to better frame these statements to the context of this study and emphasize requirements for spatial model transfer. We suggest to rephrase as follows:
This regional split-sample validation approach reveals that the predictive performance of models based on OpenStreetMap building geometry data is comparable to alternative multi-variable models, which use comprehensive and detailed information about preparedness, socio-economic status and other aspects of residential building vulnerability. Still, the transfer of these models to other regions should include a test of model performance using independent local flood loss data.

C: P1.L17: what do you mean with "consistent"?

R: We use the word consistent with the meaning that something is accordant or compatible, i.e. adhering to the same definitions. With respect to OSM data this implies that the model variables and underlying data are based on the same data model, have the same definition, format, unit, etc.

C: P3.L14-16 and L29-30: you said that one of the main aims of the paper is to understand which building variables are useful to characterize building vulnerability, but you actually investigated only footprint-related indicators, which only capture part of the overall building vulnerability.

R: As said in the above responses, the focus of this study is on the use of OpenStreetMap data in its current status for flood vulnerability modeling. To make this dedicated focus clearer we suggest to change the title into: 'Are OpenStreetMap building data useful for flood vulnerability modelling?', and will state research objective i) more precisely: 'understand which building geometry variables are useful to describe building vulnerability'. (p3L29)

C: P3.L32: typo "modelsi".

R: will be corrected

C: Figure 2. Acronyms shown in the figure are defined in the text of the paper, but it would be better to report them also in the figure caption.

R: We will adjust the figure caption to include the abbreviations:
'Fig. 2: Data pre-processing, model learning and model transfer workflow, with BMu (upper benchmark model), BMl (lower benchmark model), BMrm (Benchmark model with random match of interview locations with OSM building data), A (Random Forest model using 8 predictors), B (Random Forest model using 8 predictors), and model transfers d2E (learning with Dresden and predictions for Elbe), d2D (learning with Dresden and predictions for Danube), E2D (learning with Elbe and predictions for Danube), D2E (learning with Danube and predictions for Elbe)'

C: P10.L19: "this analyses" -> "these analyses".

R:will be corrected

C: P10.L31: missing parenthesis after "Table 2".

R: will be corrected

C: P12.L4: please rewrite this sentence.

R: we will rephrase the sentence "Further, an independent assessment of OSM based vulnerability model performance we consider two benchmark models.".
into:
"Further, for an independent assessment of OSM based vulnerability model performance we consider two benchmark models.".

C: P12.L8: remove comma after "reasoning is"

R: will be corrected

C: P12.L5-14: this part should be moved to the previous section.

R: We agree with the reviewer and will move this paragraph to the previous section (3.2 Predictive model learning)

C: P12.L18-19: please rewrite this sentence.

R:We suggest to rewrite this sentence as follows:
The CATI data are mainly located in the Elbe and Danube catchments in Germany, which are the regions mostly affected by inundations and flood impacts.

C: P13.L21-26: as discussed in general comments, this result is expected and only partly informative, because you neglected other important vulnerability variables.

R: As stated above this is beyond the scope of our study. We will add insights from other recent studies (e.g. Wagnenaar 2017, Vogel et al. 2018, Carisi et al. 2018, Amadio et al. 2019) about the usefulness of other potential predictors for building vulnerability to the discussion.

C: P14.L1-2: this is also expected and due to the selected variables.

R: The assessment of variable importance using Random Forests has been included to the data analyses workflow because, in addition to the correlation analysis, it accounts for variable interaction effects. We report this outcome for the sake of completeness and transparency. As stated in our above response we agree with reviewer that it does not reveal fundamentally new findings and suggest to remove this figure from the manuscript.

C: P14.L11: missing parenthesis after "Table 4".

R: will be corrected

C: P15.L15: you finally chose the models with 6 and 8 variables (as the bestperforming ones). This is fine, but, actually, the variability in the performance indicators is very small (this is also due to the used variables), and probably you could have opt for the simpler models.

R: We agree that the differences in performance between the models are not pronounced. The calculation of the variables from building footprints is done automatically and does not require additional effort for data retrieval and formatting. Therefore, we base our selection of candidate models on objective measures of model performance.

C: Figure A2 should be moved to the main text (and not in the Appendix) and discussed in more detail for the interpretation of the results.

R: We will follow the suggestion of the reviewer and include Figure A2 as a new Figure 9 to the manuscript. We will expand the discussion about regional differences visible for the regional sub-samples in the text.

C: P19.L6: I think this point deserves more discussion and analysis (see also my general comments). You just mention it.

R: As stated in the previous answer, we will expand the discussion about difference in regional sub-samples.

C: P20.L17-22: as in the abstract, these are potentially dangerous statements.

R: As stated above we will adjust the title to make the focus on research objective of this study clearer and refine our research objective i): 'understand which building geometry variables are useful to describe building vulnerability'. (p3L29).
At this point we will stress the idea of spatial measures as proxy variables more clearly.:
As not many variables of building characteristics are available from OSM data, the spatial measures calculated from building footprint serve as a sort of proxy variables for these unavailable details.

C: P21.L7-8: as in the abstract, these are potentially dangerous statements.

R: In line with the previous answer we will also rephrase this sentence to emphasize the idea of spatial measures as proxy variables for unavailable details about building vulnerability characteristics:
The geometric characteristics of building footprints serve as proxy variables for building resistance to flood impacts and are of use for flood loss estimation.

C: P12. L9-10: I agree and this is what I suggest you to do (you can use information from other public databases to be merged with data coming from OSM). Otherwise, at present, this study provides partial (and potentially misleading) insights for flood damage modelling.

R: Indeed this is another interesting research study. We think, that with the redefined title and more precise formulation of our research objectives this type of analyses is out of scope of this study.

References

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