

Dear Dr Fuchs et al,

It was my pleasure to review this manuscript, which is well-written, interesting, and covers an important topic. The manuscript describes the first known multi-hazard exposure assessment using building-level data, and offers sufficient detail to allow replicating in other geographies where such data exists.

Whereas the methodologies to assess changing exposure using building-level data are not fully novel, the new case study and multi-hazard perspective justifies the research and publication thereof.

Although I therefore feel that this paper should eventually be published, there are a number of shortcomings in the current version that need to be addressed before publication. The comments are a mix of major and minor issues, with some specific minor details at the end.

- Page 2421, L11-13: Looking at the 10-year average (grey line) in Figure 1, I can only see this decrease for the period 1975 – 2000 (instead of 1960-2000), and the trend jumps back up after 2000 to higher levels than ever seen before (as the authors briefly note later). I would suggest to be more nuanced about this temporary decline and any implications it would have for the effectiveness of disaster risk reduction measures.
- Page 2421, L26: what about spatial and temporal dynamics of vulnerability? I understand quantifying this is more difficult, but it should at least be mentioned. See e.g. Mechler and Bouwer (2014) and Jongman et al. (2015) for recent studies on the global scale and some references to more local studies.
- The introduction is not fully clear on the scope of the paper. Is it to produce an accurate understanding of building-level exposure in Austria; or rather the methodological advance of using building level data for national level exposure assessment; or both? If it is the first, the introduction should include a few more lines outlining the current knowledge regarding exposure in Austria, the methods applied in those study, and the precise gaps that the authors see. If it is the latter, the authors should more clearly indicate how the approach relates to earlier such analyses. In the current version of the Introduction, the authors say (Page 2422, L27): “Because of the limited data availability, comprehensive object-based and therefore spatially explicit analyses have thus not been extended beyond the regional level”. Only in the conclusions do the authors write that “The presented method together with the results may be used for similar assessments in other European countries, such as already available for the Netherlands (Jongman et al., 2014), and beyond, in order to get a more precise over view on exposure and possible losses.” Similar studies as indicated here should be discussed in the introduction, and used to put this new study in context, to better highlight the innovation.
- Page 2423, L18: “Hazard maps usually refer to an individual community, and depict the area affected by a design event with a return period of 1 in 150 years (Republik Österreich, 1976).” The reader may understand that the underlying hazard data has been published 4 decades ago – is this the case? The authors should fully extend on the nature, source and year of production of the hazard data, as well as on the resolution, geographical coverage and other details. A map showing the various hazard layers would be very helpful. The quality of the hazard mapping

should be incorporated throughout when interpreting the findings. How would the results change if other hazard data were used?

- Similarly to the previous point, the relationship between the individual perils should be discussed in more detail. Are they mutually exclusive (i.e. flash floods do not happen in avalanche prone areas?) Any other innovative insights we can learn from this multi-hazard perspective?
- Page 2424, L5: In what sense is this data 'unique in Europe'? Is it different from any other inundation model?
- Tables 1, 2, 3: it is not clear whether the data in these tables are the result of this research or based on existing data. The tables are included in the Results section, but their caption reads "[Exposure] according to the Federal States. Data source: Fuchs and Zischg (2013)". How much of this table contains new findings, and how much presents existing knowledge? Please clarify and improve caption.
- Page 2433, L8 onwards: the authors need to broaden the explanation of risk trends beyond exposure, here and throughout the paper. The losses in Figure 1 are of course resulting from the combination of hazard, exposure and vulnerability. The trend in exposed buildings will therefore never be the same as the trend in losses. How would changes in hazard (e.g. rainfall) over these years played a role and interacted with the increasing exposure? Any chance of adding some analytics (or suggesting how this can be done) in order to test the influence of exposure increase on losses?
- The discussion and conclusion sections offer room for improvement in several aspects:
 - o The discussion section needs to gain a significant chunk of discussion surrounding the limitations of the data and methods used in this study. Limitations will include for example the detail and quality of hazard data used in this study (which as said, needs more explanation in the Methods section too); the negligence of building type affecting the actual exposure (mainly high rise apartment buildings vs low rise houses); the building construction year data (e.g. what happens with buildings that are destructed and rebuild during the time of analysis?); etc.
 - o The conclusion section brings too many new facts, data and references. Many things never mentioned before in the paper (such as average annual fatalities because of the different hazards) are now mentioned here for the first time, which is in my view not the way a concluding section should be (which is, a conclusion of the findings based on facts in the results and discussion sections)
 - o I suggest the following to solve these issues (but feel free to solve them in another way):
 - Change 'Results' into 'Results and Discussion', where you integrate a selection of the results-related discussion points from the current 'Discussion' section
 - Add a new section 'Implications and limitations' (or similar), containing a selection of points from the current Discussion and Conclusions section

- Shorten the Conclusions section to contain only concluding remarks.
- Figure 3: I like these maps very much, from a visual perspective. However a few things are unclear in the current form:
 - What is the difference between left and right figures? I assume one is number of buildings and the other economic value? This needs to be clarified.
 - Just a suggestion: given that the differences between both indicators are so small (i.e. the difference between the left and right set of maps), for me it would be more interesting to see a set of figures showing the absolute number of buildings (or economic value) exposed to the hazards. E.g. have maps with the number of buildings exposed (absolute) on the left, and maps with the number of buildings exposed (deviation from the mean) on the right.
- Figure 4 needs better caption and information in the figure. Right now it is unclear what the different panels are.
 - E.g. what does panel e) indicate, and why does the exposure to flooding decrease here? Does this indicate that buildings are removed from the database, or got destructed?
 - Also, the base year needs to be mentioned. At this point it is not clear what the factor change refers to.
 - Why do the trends in panels c and e follow a step-wise pattern and the other figures a continuous flow? What exactly do they show differently, that would cause such different patterns? This is currently unclear to me, also after re-reading the text.

Minor comment: I suggest to change 'amount' of people/buildings/citizens/hotels to 'number on each occurrence (i.e. use amount for mass nouns and number for count nouns).

References

- Mechler, R., & Bouwer, L. M. (2014). Understanding trends and projections of disaster losses and climate change: is vulnerability the missing link? *Climatic Change*. <http://doi.org/10.1007/s10584-014-1141-0>
- Jongman, B., Winsemius, H.C., Aerts, J.C.J.H., Coughlan de Perez, E., van Aalst, M.K., Kron, W., Ward, P.J., 2015. Declining vulnerability to river floods and the global benefits of adaptation. *Proc. Natl. Acad. Sci.* 201414439. doi:10.1073/pnas.1414439112