

Interactive comment on “Construction of an Integrated Social Vulnerability Index in urban areas prone to flash flooding” by Estefania Aroca-Jimenez et al.

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Dear,

I am submitting a revised copy of our manuscript "Construction of an Integrated Social Vulnerability Index in urban areas prone to flash flooding" (doi:10.5194/nhess-2016-408) by Aroca-Jimenez et al. We are very grateful to the reviewer for the helpful comments on our manuscript. We have addressed all the comments made by the reviewer. To facilitate the review, we have modified the manuscript highlighting in yellow the changes carried out (please see Supplement document). We have taken advantage of this new opportunity to improve text, figures and tables as the reviewer has requested. In this regard, the concept of both vulnerability and all its components

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(i.e. sensitivity, exposure and resilience) have been clarified. As the reviewer recommended, we have created a new subsection under the section 2 (i.e. "2.2.2 Database generation"). Moreover, we have modified Figure 3 by adding the description of the variables in order to increase readers' friendliness as reviewer suggested. To facilitate understanding of the results, we have added a new column to Table 2, indicating the vulnerability component to which each vulnerability factor belongs. Conclusions have been amended to express clearer how the methodology proposed here constitutes an improvement on the state of the art and the extent to which the results may be included in flood risk management plans.

We thank you for the opportunity to resubmit our manuscript to the journal Natural Hazards and Earth System Sciences and hope that it is now suitable for publication. We look forward to hearing from you at your earliest convenience.

CITED REFERENCES: -Adger, W. N.: Vulnerability, *Global Environmental Change-Human and Policy Dimensions*, 16, 268-281, 10.1016/j.gloenvcha.2006.02.006, 2006. -Birkmann, J., Cardona, O. D., Carreno, M. L., Barbat, A. H., Pelling, M., Schneiderbauer, S., Kienberger, S., Keiler, M., Alexander, D., Zeil, P., and Welle, T.: Framing vulnerability, risk and societal responses: the MOVE framework, *Natural Hazards*, 67, 193-211, <http://dx.doi.org/10.1007/s11069-11013-10558-11065>, 10.1007/s11069-013-0558-5, 2013. -Cutter, S. L., Boruff, B. J., and Shirley, W. L.: Social vulnerability to environmental hazards, *Social Science Quarterly*, 84, 242-261, <http://dx.doi.org/210.1111/1540-6237.8402002>, 10.1111/1540-6237.8402002, 2003. -Frazier, T. G., Thompson, C. M., and Dezzani, R. J.: A framework for the development of the SERV model: A Spatially Explicit Resilience-Vulnerability model, *Applied Geography*, 51, 158-172, <http://dx.doi.org/10.1016/j.apgeog.2014.1004.1004>, 10.1016/j.apgeog.2014.04.004, 2014.

Please also note the supplement to this comment:

<http://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2016-408/nhess-2016-408->

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| Responses to the reviewer 1' comments | | | | |
|---------------------------------------|---|---------------------------------|---|---|
| No. | Comment | Location in the submitted paper | Location in the reviewed paper | Amendment |
| 1 | I would suggest the authors to clearly indicate what they define as vulnerability in the context of the existing frameworks as well as a clear definition of the terms exposure, sensitivity and resilience | Pages 1-3 (Introduction). | Page 2, Lines 15-17, and Page 3, Lines 2-3. | In agreement with the reviewer, we have included the theoretical concepts of vulnerability, sensitivity, exposure and resilience, in which the integrated social vulnerability index is based on. The key parameters or components of vulnerability are exposure, sensitivity and resilience (Adger, 2006; Birkmann et al., 2013). The social dimension of vulnerability (i.e. social vulnerability) has been traditionally estimated through the construction of an index, which is composed of several vulnerability factors (usually derived from a factor analysis or principal component analysis) (Cutter et al., 2003). Each vulnerability factor is in turn composed of several variables (variables considered as a means of explaining social vulnerability, such as age, gender, unemployment...). Traditional social vulnerability analysis usually shows the results for each vulnerability factor and for the total social vulnerability (i.e. the combination of the above vulnerability factors), but they do not analyze the results by component. In this regard, the main objective of an integrated social vulnerability analysis is to find out the involvement of each vulnerability component (i.e. sensitivity, exposure and resilience) to the total vulnerability (Frazier et al., 2014), which facilitates the incorporation of the analysis results into the flood risk management plans, particularly at regional scales. |
| 2 | It is not clear to me what the authors understand as vulnerability, integrated vulnerability and the components influencing vulnerability. | Pages 1-3 (Introduction). | Page 3, Lines 16-18. | We have clarified the concept of "integrated vulnerability analysis". This concept analyzes separately the different vulnerability components (i.e. exposure, sensitivity and resilience) and their involvement in total vulnerability, assessing, in addition, the interactions among them. |
| 3 | I would suggest the authors to make figure 2 more simple by reducing some information that is presented on the text. | Page 5. | | Figure 2 has not been summarized, as we have considered that its inclusion is essential in order to understand the methodology of the paper. The methodological procedures followed, especially the statistical analysis, are so complex and interrelated that they are very difficult to follow with a simple description in the text. Thus, Figure 2 in its current state allows: i) to display on a single graph the entire methodological process from data sources to final results; ii) to understand the sequence of statistical analysis in parallel to their reading; and iii) to understand the relationships among the different methodological steps and procedures. A simplification of the Figure 2 would result in readers feeling that there are unjustified breaks within the methodological procedure. Finally, Figure 2 enables to replicate our methodological procedure by other researchers and, therefore, to be contrasted. |

Fig. 1. Responses to the reviewer 1' comments_1

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| 4 | It is not entire clear to me, why the authors used a low probability scenario and not scenarios with medium or high probability | Page 5, Line 13. | | We have used the scenario of low or exceptional probability (500-year flood) because it is the flood hazard zone that is the most comprehensive representation of urban areas that could be affected by flash floods at regional scale, according to the European Flood Directive. |
| 5 | I would recommend the authors to create a new subchapter with the database generation. | Page 5, Line 5. | Page 6, Line 8. | Done. Thank you for the recommendation. |
| 6 | I would suggest them to describe a bit more the data used and to give some more information about the surveys done (i.e. telephone calls and/or personal research) | Page 6, Lines 6-11 | Page 6, Lines 12-14 | Done. Thank you for the suggestion. |
| 7 | I would recommend the authors to describe a bit more the idea behind the equation's modification from the original one presented by Frazier et al. (2014) | Page 9, Lines 8-9 and 11-12. | Page 9, Lines 8, 11 and 15-17. | We have clarified the modifications made in the equations presented by Frazier et al. (2014). So, we have replaced in the text the term "modified" by "adapted", since what we did was to adapt the equations to our terminology (i.e. changing the term "adaptive capacity" to "resilience"; Equation 1). In addition, we have used a different method to weight the vulnerability factors; Equation 2). A clarification in the text about the adaptation from Frazier et al. (2014) (lines 15-17) have been added. |
| 8 | I would suggest the authors to describe only their results to this part and to remove some parts describing methods on the methodology part as well as some parts discussing their results to the discussion part | Page 11, Lines 1-5 | Page 11, Line 1 | We have removed the text related methodology. |
| | | Page 12, Lines 5-6 | Page 13, Bottom of Figure 4 | We have moved the text to the bottom of Figure 4 since it was describing this picture. |
| | | Page 16, Lines 11-13 | | Done. As the reviewer recommends, we have eliminated certain parts of the text of the section 3.2 ("Social vulnerability patterns") because they were related to discussion of results. |
| 9 | I would suggest to add the description of the variables to increase reader's friendliness | Figure 3 | | Done. Thank you for the suggestion. |
| 10 | The conclusions presented are too general and do not reflect what exactly shown in this study. Conclusions based on the findings of the analysis presented would be more effective | Page 21, Lines 2-12 | Page 21, Lines 2-14 | We have reworded the conclusions trying to make them more specific. So, conclusions have been amended to express clearer how the methodology proposed here constitutes an improvement on the state of the art and the extent to which the results may be included in flood risk management plans. |

Fig. 2. Responses to the reviewer 1' comments_2