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Discussions

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

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 green the changes carried out. Changes made after receiving the comments from the other reviewer are still highlighted in yellow. We have taken advantage of this new opportunity to improve text and figures as the reviewer has requested. In this regard, the inclusion of exposure in the Integrated Social Vulnerability Index has been

clarified, adding a new reference for this purpose. As the reviewer recommended, we have simplified the Figure 2 in order to improve its understanding. Moreover, we have explained better the concept of 'optimum number of clusters' at the results section, extending the information with regard to the BIC and the CAIC statistics. We have also modified the text of the section 4.3 ('Policy implications'), giving some practical examples of specific mitigation measures that can be suggested for each cluster of urban areas. Finally, 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, as both reviewers have recommended. 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.

Please also note the supplement to this comment:
http://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2016-408/nhess-2016-408-AC2-supplement.pdf

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Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., doi:10.5194/nhess-2016-408, 2017.

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Discussion paper

Responses to the reviewer 2' comments				
No.	Comment	Location in the submitted paper	Location in the reviewed paper	Amendment
1	Abstract, line 16: 'it has not yet provided'. Please rephrase this a bit, the sentence is unclear.	Line 16	Lines 16-18.	We have rephrased the sentence. As the reviewer pointed out, the sentence was badly phrased.
2	Some additional explanation is required on the inclusion of exposure in the social vulnerability index. In the traditional risk framework, exposure and vulnerability are two different components of the framework. As many researchers from the risk field read this journal, it should be specifically emphasized that including exposure is common practice in the social vulnerability field, even though this may contradict to the definition of risk and vulnerability which is more commonly used in the disaster risk community. This is important for the interpretation of the results.	Pages 1-3 (Introduction)	Page 3, lines 7-9.	We have explained that the inclusion of exposure in the social vulnerability analysis is a common practice, as the reviewer recommended. We have also included a new reference in order to strength this idea.
3	I have a few questions and a suggestion regarding Figure 2: - why is there an arrow going from Flash flood low probability municipalities to socioeconomic variables? Because the flash flood box is blue, it now seems like a hazard variable is added to the socioeconomic variables. This is, however, not the case (and should not be the case either). - why are sensitivity and exposure 'clustered' and is resilience not in this cluster?	Figure 2	Figure 2	Overall, we have simplified the Figure 2 in order to make it clearer and easier to understand. Moreover, we have done a terminological change from 'municipalities' to 'urban areas', since municipalities is usually used to refer to administrative boundaries or local administration (i.e. the council). Thus, we have used the term 'urban areas' when we talk about the areas prone to flash flooding and 'municipalities' when we refer to the town halls. - We wanted to show with this arrow that socio-economic variables had only been gathered to those urban areas that met the defined requirements, which were then named as 'Flash flood low probability municipalities'. In order to facilitate the understanding of this part of the Figure 2, we have modified the color of this box from a blue plain to a gradient blue-beige color, indicating that the 'Flash flood low probability municipalities' box is the beginning of the second part of the figure (beige boxes). - All vulnerability components (exposure, sensitivity and resilience) were taken into account in the Latent Class Cluster Analysis (LCCA), using as input data the factor scores of the urban areas of interest. The minus sign which is placed on the arrow that goes from the box 'Factor scores' to 'Resilience' box

Fig. 1.

				indicates the sign of the component when the Integrated Social Vulnerability Index (ISVI) was calculated, and not that Resilience was not considered in the LCCA. Traditionally, factors that express sensitivity or exposure are considered as positive values in the ISVI (see the plus sign that is placed on the arrow that go from the box 'Factor scores' to 'Sensitivity' and 'Exposure' boxes); while factors that state resilience are considered as negative values, as has been done here.
	- Perhaps add a third colour that specifies the (final) results. This would make it more clear why some arrows exist in the framework (for instance the arrow from factor scores to clusters of municipalities.			- Done. Thank you for the recommendation.
4	Section 2.2.2: I do not fully understand the use of the Euclidian distance method. If I do understand it correctly, the sum of the differences between variable values is considered to be the distance? So distance is not spatial? I think it would be good to explain this a bit more clearly, as some parts of the paper are spatial (the clusters of municipalities for instance). This causes (at least for me) some confusion.	Section 2.2.2	Section 2.2.3. Page 8, Line 9.	- We have changed the term 'distance' by 'similarity' in the text in order to clarify that we were not talking about spatial distance. From a statistical point of view, distance measures are a type of similarity measure, so it is correct to use the term 'similarity'. We have used the Euclidean distance to evaluate how similar to each other the variables were, as is explained by Euclidean distance definition (page 8, lines 9-10). The greater the distance among variables are, the more similar the variables among them are. Hierarchical Segmentation Analysis (HSA) groups variables according to their similarity rather than the distance, that is why LCCA was implemented for.
5	Captions of Figure 4 and Figure 5could be a bit longer. Figure + figure caption should be self-explanatory.	Figures 4 and 5	Figures 4 and 5	We decided to shorten captions of Figure 4 and 5 in order to have a more balanced length of the text of the section 3.1.
6	Figure 3 is perhaps not required, as it shows roughly the same as table 2? Perhaps move to appendix, as table 2 shows everything we would like to know (the variable clusters and the factor names)	Figure 3	Figure 3	Figure 3 and Table 2 do not show the same information. Figure 3 corresponds to the Hierarchical Segmentation Analysis (HSA) output, while Table 2 corresponds to the Factor Analysis output, which includes factor loadings that are necessary to construct the ISVI. HSA helps to overcome the Principal Components Analysis sample size limitations, so we think that including the Dendrogram into the results section of this paper is an interesting development.
7	Section 3.2: I am a bit puzzle with the notion of 'optimum number of clusters'. What does an optimum amount of clusters mean? Ok the statistics say so, but as a practitioner, what would	Page 15, line 3	Page 15, lines 2-3	We have extended the information about the BIC and the CAIC criteria in the text.

Fig. 2.

	it matter if you would have four clusters? How would this change the interpretation of the results?			BIC and CAIC are statistics that enable to establish a number of clusters, which can be used in flood management. We used the BIC and the CAIC criteria in order to select the more parsimonious number of clusters (i.e. the number of clusters that provides as much information as possible taking into account the number of parameters to estimate). The more information is explained by the model, the greater the number of estimated statistics will be. The above is shown in Table 3 (Page 15). The minimum values of the BIC and the CAIC statistics are reached with a model of 3 clusters, and their values increase again in the estimations that consider four and five clusters. This means that the number of parameters to estimate by the model (see Table 3, 'Number of parameters' column) are too high in comparison to the obtained increase of explained information ('Log-likelihood(LL)' column). From a practical point of view, the above means that an increase in the number of clusters from 3 to 4 or 5 would split a fairly homogeneous cluster of urban areas into several subgroups which would not be very different from each other. Therefore, a greater level of disaggregation would not help to improve the implementation of different flood risk mitigation measures for each cluster of urban areas.
8	Section 4.1: I would suggest to move parts of this to the method section. Most parts of this section are regarding the interpretation of the results. It is better to make this clear before the results section, instead of afterwards. A discussion after the results, weakens, in my opinion, the results.	Section 4.1, Page 18, Lines 22-23	Section 4.1	We have moved some parts of the text from section 4.1 to methodology section.
9	Section 4.3: I suppose the clustering of municipalities is interesting from a policy making perspective. It would be good to link the clustering to this section. How can it improve policy making if we can identify similar municipalities?			We have extended the text of this section including practical examples of specific mitigation measures to each cluster of urban areas.
10	Please make the conclusions a bit more specific for this paper. What can we really learn from this paper, especially from a policy making perspective. What does this paper add, besides being the first study on flash floods? A few lines on the conclusions for the study region (specific patterns identified) would be interesting as well.	Section 5	Section 5	We rewrote the conclusions after reviewer 1 recommendation. Conclusions were 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. 3.