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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Towards thresholds of disaster management performance under demographic change: exploring functional relationships using agent-based modelling" *by* G. Dressler et al.

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We appreciate the very helpful comments to our manuscript, please find our responses below:

1. The authors present two different geographic settings which should exhibit the same flood characteristics as the urban and the rural area are both lowland and downstream (Table 1). This approach makes sense in order to reduce the differences to road structures and spatial accessibility; to structures in space. However, the authors do not explicitly mention the ecological comparability in

terms of lead time of the settings (which is btw necessary to have a meaningful comparison for a given lead time in figure 7). Moreover, they leave the reader with the impression that the spatial settings are "very different in the geographic location" p.10,l.14. (Table 1 relates the "geographic setting" to flood characteristics). P.7, l.15 also implies that you investigate "towns along the upper and lower reaches of the rivers". Moreover, table 3 presents "possible implications [..] of [..] geographic settings" which are based on argumentation and not on simulation results. E.g. is a rural downstream region at more risk compared to an urban upstream region? My point is that the authors should make it more clear what can be derived from the two presented geographical settings and what is derived from an argumentative standpoint. This general remark applies for the respective passages throughout the whole manuscript.

Reply: This is a very good comment. Yes, we have only compared two geographical settings that are classified as downstream regions, and we have not tested upstream regions so far. Thus, implications drawn for rural, upstream regions are based solely on interpretation of the results, not on model analysis. We will state this more clearly in the results and discussion section. Of course, comparing with an upstream region would be a desirable next step. We could add common lead time intervals for both regions, e.g. as an overlay in Fig. 7, as step to enhance comparability.

2. While I find the iterative approach of scenario analysis convincing, I had problems to clearly relate the four subsections in the results part to them. E.g. figure 7 is used for the analysis of two scenarios. Would it not be a better approach to dissect your analysis into themed sections? Here, one could think about (1) social, (2) ecological and (3) spatial change. For (1): an analysis of #DMOs, capacity and knowledge for a given lead time and #disaster sites. For (2) you would add #disaster sites (which you did in figure 6) and lead time. And for (3) you present figure 7 differentiating the upper variables by the two geographical set-

tings. What I would suggest is a restructuring of the presentation of results. Table 2 is a good attempt for a themed presentation. However, why is the variation of lead time not part of the climate change process there? Is lead time not subject to climate change? Should there not be a correlation between flood intensity and lead time? Please discuss this relationship at least. Spatial heterogeneity is missing in the "Scenario overview" table as it only deals with processes. The latter is a good example for the fuzziness of the scenario description.

Reply: We agree that the current structure of the scenario analysis might be a bit hard to follow. We will try to restructure the results, following the suggestion of the reviewer, especially the two-step analysis of 1) analyzing DMO properties (# DMOs, DMO capacity, information access), while leaving the flood settings constant and 2) analyzing different flood settings (# disaster sites, sandbag demand) – this basically implies splitting Fig. 6 into two separate Figures. For these two analyses we would use coping time as measure for DMO performance. The combination of DMO properties and flood settings, differentiated by the two spatial settings, would then again be the final analysis but the differentiation between the different steps would be clearer.

We will then also rework the scenario overview in Table 2 accordingly to include the spatial differentiation as well.

Concerning the remark on lead time and flood intensity: Lead time is mostly determined by geographical and hydrological settings and river morphology, i.e. slope of the river, flow velocity, size of catchment area, etc. – climate change has only little effect on lead time.

Minor remarks:

3. Abstract, last sentence. Either mention the implications or delete. Don't refer to a section in the abstract.

Reply: We agree and think that it is fair to just leave out the sentence.

4. Introduction, p.1, l.24-30: Refer to relevant literature.

Reply: We agree, the same request was posed by Reviewer 1, we will add references here.

5. The intensity of events is reflected by the #disaster sites and the #sandbags needed. But how is the frequency of events reflected (p.6.l.23)? Is this part of the analysis or the argumentation?

Reply: In the current analysis, flood frequency is not directly reflected in the simulation. One simulation represents one flooding event that DMOs deal with, and the simulation ends after that event. We mention flood frequency in this section, as we theoretically motivate how we measure DMO performance, which in reality could of course be decreasing under a scenario with high flood frequencies, compared to a scenario where floods occur only seldom.

One could think of including flood frequency in the model by running a simulation with several disturbance events following each other, including a recovery period in between. However, this would require substantial extensions to the model, as recovery/rebuilding is not addressed in the model.

6. Section 2.2: Can you explain why there can be a "discrepancy between coping capacity and demand"? Is coping capacity (which you measure as coping time) not a function of demand (+resources). I could understand if there is a discrepancy between resources (#dmos) and demand (#sites + #sandbags needed) Maybe that would need reformulation.

Reply: We understand this discrepancy as the increasingly larger difference between demand (i.e. expected DMO performance) and actually realized coping capacity

(measures as coping time). The realized coping time is, of course, a function of resources (# DMOs, their properties) as well as demand (# disaster sites, # sandbags needed). Therefore, if resources decreases and demand increases, it is less likely that a expected coping time threshold is reached. We will reformulate the sentence.

7. P. 6, l. 17: the concept of resilience is suddenly appearing here. Please explain which definition of resilience you are referring to at this point. Hint: you are using an engineering resilience concept with resilience as return time (Maybe cite Rasch et al. 2016). Moreover, you use the concept of absorptive capacity (Maybe cite Bene et al. 2012).

Reply: We agree that we did not specify which concept of resilience we are referring to, and that we should already do so early on. To clarify our understanding, we need to distinguish two levels here: on the level of the performance of disaster management organisations (DMOs), we use coping time as performance measure. However, coping time should not be confused with return time, but rather as the scale whether damages to the community can be avoided (by ensuring protection) or not. This is rather a question of resistance than recovery with regard to the flood event itself. If we consider disaster management organisations as a social-ecological system itself that is subject to change (demographic, climatic), we can adopt a resilience perspective when we analyze under which conditions the capacity of DMOs to cope with flood events can still be ensured, and also which steps of adaptation or reorganization (e.g. technical improvements, better information access, etc.) might be necessary to maintain the functioning of DMOs. In this sense, we follow the definition of resilience as given by the IPCC (2014): "The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation". We will extend this section to include a clear definition of the used concepts.

IPCC (2014): Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1132 pp.

8. P.7,. l. 27-28: Change has an effect on population growth/shrinkage? Isn't population growth/shrinkage itself the demographic change which is different wrt to the level of urbanisation? Please rewrite.

Reply: Demographic change has several outcomes, one being population growth/shrinkage (but this also includes e.g. changes in the age structure, in-/outmigration trends, etc.). However, reasons for this also stem from other change processes, e.g. economic decline that caused a loss of jobs, etc. We will rewrite this sentence to make it more understandable.

9. P.11, l.28: Can you give some examples for such heuristics?

Reply: Although the current model results are only a first analysis, we could already show that the number of DMOs is the most important driver of disaster management performance – therefore securing the availability of members should be the top priority in order to ensure operational readiness. A second rule could stem from the interchangeability of information access and transportation capacity, i.e. that better information access can compensate for lower transportation capacity. Of course, more in-depth analysis would be needed to provide truly reliable heuristics.

10. P.12, l.9-10: The resilience concept is established in the context of disaster

management. Please specify why the ses resilience concept is especially useful here (or skip sentence).

Reply: We made the link to SES resilience here because of its focus on the capacity for adaptation and transformation, in contrast to the notion of only 'bouncing back'. We will make this link more prominent earlier on (see Comment 7) and skip this sentence here to avoid confusion.

11. P.12, l.21: why was Dawson (2011) not mentioned in the introduction?

Reply: Good point – we agree that Dawson should be mentioned in the introduction as well, as it shows the state of the art.

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