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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "An adaptive regional vulnerability assessment model: Review and concepts for data-scarce regions" *by* Mark Bawa Malgwi et al.

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The authors would like to thank Referee #2 for his/her insightful comments. Below, answers to the concerns raised are provided step-by-step.

"general comments"

The manuscript represents a good contribution to the understanding of natural hazards and their consequences. The presented conceptual framework aims to links vulnerability indicators with damage grades which highlights the value of damage grades in physical vulnerability assessments. A topic which is currently under-investigated. For

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the reader, it presents a comprehensive review on indicator-based approaches of physical vulnerability and flood damage models. However, I have some major concerns that should be clarified and fixed before the paper can be fully accepted for publication. First, the goals of the study are not always declared clearly. The link between the review part and the conceptual framework could be more streamlined. I suggest condensing the literature review and provide more details how to operationalize the framework including details about developed indicators.

Authors: Thank you for your comment. The manuscript will be streamlined to reduce the review and provide more details on the conceptual framework. Sections 1, 2, and 3 will be streamlined and reduced, and we will take up the highlighted issues in sections 4 and 5 and provided a more detailed discussion.

Secondly, I am a little bit confused by using the term vulnerability which is usually broader defined and includes social, ecological and economic vulnerability. In Section 2 you mentioned a focus on physical vulnerability to floods with a specific attention to buildings. The term building vulnerability is not properly defined in the paper, and it seems that this specific element of vulnerability is a main research area. Thus, the focus of the paper needs more streamlining (title, review and framework). I doubt that the developed framework is easily transferable to social or ecological vulnerability.

Authors: Thank you for your comment. The manuscript will be streamlined to better adapt the term physical (building) vulnerability in the title and review part. The suggested title now is “A generic physical vulnerability model for floods: Review and concepts for data-scarce regions”. The term vulnerability was not defined in the earlier sections (section 2, 3) because the reviewed studies used different definitions of vulnerability. However, the UNISDR (2009) definition was given in line 30. For our framework, we adopted a specific definition for vulnerability as stated in section 5.1. Nevertheless, we will streamline a revised version of the manuscript so that it becomes more accessible.

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Thirdly, section 5 needs more attention to explain the operationalization from concept to application. The operationalization of the framework is very conceptual, and in some aspects, it is very vague. It misses the connection to empirical indicators that builds the indices (BII, BRI, etc.) and thus shows that it can actually be applied to empirical case studies. Moreover, there are important aspects in the operationalization of damage grades that need more attention: e.g. judgement biases in the grading process, standardized training of experts and context-specific definitions of the grades etc.

Authors: The proposed indices (BII, BRI) are aggregations of the selected and weighted indicators. As shown in Figure 3 (Phase 3), the BRI and BII form the basis for the synthetic curve used for predicting damage grades. The developed damage grades are meant to offer simplistic comparisons and not precise predictions. Since it is an expert-based approach, judgment biases cannot be completely eliminated. However, in order for the proposed method to capture the actual damage range, we propose the use of the three damage states (most probable, lower probable and higher probable damage). Furthermore, as described in section 5.2.2, based on a recommendation by Grünthal et al. (1998) and Maiwald and Schwarz (2015), the definition of damage grades is not only based on damage pattern but on proportion. This ensures that damage grades are representative of the actual distribution of damage patterns in the region. We will make these recommendations clearer in the manuscript. We will also highlight that damage grades are regionally adaptive. That is, they are based on commonly-observed features within a region, hence, context-specific.

Fourthly, the three phases in Section 5.2. could be better embedded in the overall picture of the paper. For example, Table 4 presents a damage grade scheme which is unclear whether the conceptual framework applies the same grading scheme or not. In Section 5.1 and Section 3.1, recommendations for best-practice are mentioned by Blong (2003b). I do not see these recommendations picked up in the framework.

Authors: Thank you for the comment. We will adapt sections 2 and 3 to reflect the methods used in section 5.2. The suggested change will have the same format for

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both indicators (section 2) and damage grades (section 3), and present a background, application, and challenges for data-scarce regions. Further, we plan to extend discussions on identified challenges in section 4 and a proposed idea for the new framework in section 5. Table 4 serves to present an example of damage grades developed for Germany by Maiwald and Schwarz (2007). The conceptual framework recommends that damage grades are developed in a regional context. Frequently observed damage patterns within the region are to be used for developing the damage grades. In Section 5.2.2 we outlined that the main aim of this step is to identify commonly-observed damage patterns within a region and categorize them into classes. The damage grades developed by Maiwald and Schwarz (2007) which our study was based upon were developed using the recommendations by Grünthal (1993). Consequently, techniques described in section 5.2.2 systematically integrate the recommendations. We will clarify this in a revised version of the manuscript.

Fifthly, the structure needs attention and the arguments are sometimes not placed in the right sections. In Section 2 you have too many (sub)subsection, followed by many lists with detailed arguments. Section 4 discusses the need for linking indicator and damage grades but is not clear whether it is linked to the own contributing or written as a conclusion of the literature review. In Section 5, the author's contribution should be in the center. Explanations and smaller reviews should be avoided here. I see Section 5.1. a bit like a repetition of what is explained in section 2, 3 and 4.

Authors: Thank you for the comment. Sub(sections) and details in section 2 will be reduced. Section 4 is not a direct conclusion of the reviews presented in sections 2 and 3. Rather, section 4, draws from challenges highlighted in the individual methods and illustrates the added value for combining them in data-scarce regions. This illustration was carried out by using three observed damage cases from Nigeria during the 2017 flood. For section 5, we will reduce the information to better focus the content on our contribution. Section 5.1 was not a repetition but background information which includes definitions we adopt for our study (e.g., vulnerability, exposure, susceptibil-

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ity, local protection). This information was necessary before introducing section 5.2 “Operationalizing the framework”. The information was not provided in sections 2 and 3 (since they are reviews from different studies) or in section 4 (since it focuses on the linkage of vulnerability indicators and damage grades). We will make necessary adjustments during revision, see also comments to referee #1.

Sixthly, the main contribution of the conceptual framework, which I think is the applicability in data-scare regions is not sufficiently discussed in section 2 and 3. It should be more on the point. Also, the term ‘adaptability’ of physical vulnerability assessments to other regions could be better picked up in the review. Are all physical vulnerability assessments adaptive regional models? Which are regional adaptive? Why? I also suggest providing more information about the specific requirements and capacity for applying them across different regions. Your tables should reflect this by focusing on these aspects.

Authors: Thank you for your comment. We will streamline the contents of sections 2 and 3 to better address applications of each method for data-scarce regions. The suggested modification includes introducing challenges (for data-scarce regions) in both sections 2.3 and 3.3. These will serve as a background for research gaps that will be taken up and addressed in the framework. Another suggested change is to focus the review in section 2 on the deductive and normative method since they are more suitable for data-scarce areas. Based on recommendations from referee #1, we will change the term ‘adaptable’ to ‘generic’ in the title. This was to avoid confusion with the adaption component of the Disaster Risk Reduction (DRR) literature. Nonetheless, we will address the need for making the indicators and damage grades context-based.

“specific comments”

Paper is too long and own contribution is relatively short.

Authors: Thank you for your comment. We will make substantial effort to streamline sections 1-5 and reduce the content of the manuscript. We will also better highlight our

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contribution in the revised manuscript.

Title: “adaptive” and “regional” are not well addressed in the paper.

Authors: Based on a recommendation from Referee #1, we will replace the term ‘adaptive’ with the word ‘generic’ in order to avoid confusion with the adaptation component frequently used in the DRR literature. We will better address adaptability to the regional situation a revised version of the manuscript.

Abstract: When reading the abstract the conceptual framework is in the center, however, this is not reflected by the paper which focuses more on the literature review.

Authors: The abstract will be reformulated to balance both the review and conceptual framework. The suggested new abstract is “The use of different physical vulnerability assessment methods have evolved over the years from the traditional single-parameter stage-damage curves to multi-parameter approaches like the multivariate and vulnerability indicator methods. However, despite wide applications of these methods in assessing future flood risk, a gap remains in their application to data-scarce regions. Assessing physical vulnerability against future risks is even more critical for data-scarce regions, which are mostly are mostly areas with limited capacity to cope with disasters. To address this gap, we propose an expert based framework to link vulnerability indicators (integrating major damage drivers) with damage grades (integrating frequently observed damage patterns). To do this, we review current studies on physical vulnerability to floods indicators and flood damage models to gain insights on best practices. Thereafter, we propose a new conceptual framework to address selected gaps in literature. The conceptual framework is operationalized using three phases (i) developing the vulnerability index, (ii) identifying regional damage grades, and (iii) linking developed index classes with damage patterns utilizing the synthetic what-if analysis. The new framework constitutes a basic first step for enhancing damage prediction to support risk reduction in data-scarce regions. The framework is adaptable to different data-scarce environments and can integrate future changes in damage drivers and

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damage grades".

Introduction: too long and broad

Authors: Thank you for your comment. We will streamline and reduce the details provided in the introduction.

Line 81: Unclear how social loss is defined. I do not agree that building damages are the only or one of the most important factors for social loss. In particular, if you consider that not all affected people own a building.

Authors: Thank you for your comment. We will provide a definition of social loss and better address this concern.

Line 83: There is a critical difference between social and physical vulnerability assessment. You need to make clearer.

Authors: Thank you for your comment. In a revised version, we will better address this concern and more strongly focus on physical vulnerability.

Line 143: more references.

Authors: Thank you for your comment. Changes will be made accordingly.

Line 149: the term 'holistic' needs a proper definition.

Authors: Thank you for the comment. We will include the term 'comprehensive' to denote an assessment that considers all possible influencing parameters.

Line 256: difference between indicator and index is not defined.

Authors: Thank you for your comment. Suggested modification in the sentence reads "Generally, the aim of indicators is to simplify a concept through the use of an index (Heink and Kowarik, 2010; Hinkel, 2011). A vulnerability index is obtained by selecting, weighting and aggregating vulnerability indicators."

Line 264: it is not objectivity what you mean it is comprehensiveness. Objectivity is

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needed for every selected indicator.

Authors: Thank you for your comment. Changes will be made accordingly.

Line 222ff. Indicator weighting: statistical weighting based on data can explain the consistency and inference of indicators but cannot be used for an appropriate weighting of importance or measurability of the indicators. This should be mentioned at the beginning.

Authors: Comment is not very clear. We will add an explanation of the indicator weighting in a revised version of the manuscript.

Line 571: unclear if this is part of the framework or part of literature review.

Authors: Section 4 focuses mainly on the added value for linking vulnerability indicators and damage grades for data-scarce regions. It is not meant to be part of the review or the new conceptual framework, rather, it is the authors' contribution to illustrate the added value of combining two physical vulnerability assessment methods. This was demonstrated by using a hypothetically developed vulnerability index for two regions in combination with three building damage data from Nigeria. This section uses practical examples to bridge the gap between identified challenges/gaps presented in the reviews (in sections 2 and 3) and conceptual framework (section 5).

Line 701: Do you applied field surveys or remote sensing? When discussion about different option should be mentioned in the review section.

Authors: Carrying out a field survey to determine building typology and characteristics will be the most preferred option for such data collection because experts can have a first-hand impression of the local situation and can identify, in detail, construction features or qualities, which will determine how building representatives are selected. However, due to time and financial constraints, carrying out a field survey is not always feasible. Hence, the use of remote sensing is encouraged as an option, especially in a meso-(or macro-) scale study region,. Consequently, the authors recommended the

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study by Blanco-Vogt and Schanze (2014) which focus on extracting building representatives for meso-(or macro-) scale assessment.

Conclusion: Be more precise about the key messages both from the review and from the conceptual framework. An outlook of how the framework will be applied is also helpful for presenting the relevance. Please elaborate on the link between the relevance for risk reduction methods in developing countries and the data scarcity and barriers in collecting data in most of the developing countries?

Authors: Thank you for your comment. We will elaborate on the relevance of this linkage and current challenges in data-scarce regions (see also suggestions of referee #1).

“technical corrections”

Line 249: this sentence needs a reference

Authors: Thank you for your comment. Changes will be made accordingly.

Line 322: acronyms are not defined in table figure caption.

Authors: Thank you for your comment. Changes will be made accordingly

Line 329f. Sentence is unclear also the example does not seem to make sense.

Authors: Thank you for your comment. The example will be rephrased to better capture the intended purpose. The suggested change is: “For example, if we assume the same hazard level impacting a reinforced concrete and clay building, it is most likely that the clay building will incur higher damage than the reinforced concrete building. Therefore, experts my score a reinforced concrete building as less vulnerable than the clay building. However, in order to assign a value that qualifies the extent to which the reinforced concrete building is less vulnerable than the clay building (e.g., moderate, high, very high, etc.), expert knowledge will be required. This is because such assessment will require not only damage data but other factors such as common quality of construction

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types and material".

Line 443: reference missing

Authors: Thank you for your comment. Changes will be made accordingly.

Linen 415f:

Authors: Unclear comment.

Line 650, 661 and 680: fourth level of headline should be avoided.

Authors: Thank you for your comment. Changes will be made accordingly.

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