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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Flood Vulnerability Assessment of Urban Traditional Buildings in Kuala Lumpur, Malaysia" *by* Dina D'Ayala et al.

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We thank review 2 for the critical observations relating to the methodology of the paper and the request to expand on the impact and possible use of the study in the community. We believe the reviewer's query were most stimulating and hopefully the answers are equally satisfactory. The manuscript has been amended to reflect these observations and discussion

I have now read the paper titled: "Flood Vulnerability Assessment of Urban Traditional Buildings in Kuala Lumpur, Malaysia". The paper focuses on the vulnerability of buildings to flooding in Malaysia by developing a vulnerability index for each building based on a number of parameters and by actually taking a step beyond and calculate also the economic loss under different flood scenarios. The paper presents an interesting approach to vulnerability assessment however it demonstrates also a number of significant weaknesses. In more detail:

Title: The title indicates that the main focus of the paper is the vulnerability assessment of buildings, however, the paper goes beyond that: a hazard map for different scenarios is produced and the possible economic loss under different scenarios is assessed. The title should probably change in order to include all that. Moreover, according to the title the focus is on traditional buildings, whereas in the abstract the buildings are referred to as urban heritage buildings which indicates something else and elsewhere in the text as residential buildings (page 3, line 101). This should be also considered in rethinking the title of the paper.

Response: We thank the reviewer for the consideration of the relevance of the title to the content of the paper. It is true that we do not only assess vulnerability but we have tried to determine the risks posed to these buildings by 3 different hazards scenarios. The emphasis of the paper remains on the multi-scale vulnerability, which is novel, rather than on the risk, which is assessed in a more conventional way. For what concerns the buildings, these are indeed traditional, considered as a whole and in this particular setting, they represent an important heritage, within an area which is considered a protected area for minority population settlement, and the specific buildings are residential. So all the above terms apply. We have changed the title and some of the introduction to reflect the reviewer's observation. The new proposed title is: Flood Vulnerability and Risk Assessment of Urban Traditional Buildings in a Heritage District of Kuala Lumpur, Malaysia

Abstract: the abstract is rather long and gives too much detail (e.g. field surveys with Google street view) but also it does not refer to additional aspects that the paper covers such as the economic loss calculation.

The abstract has been updated to reflect the whole content of the paper and shorten

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it.

Introduction: in the introduction but also elsewhere in the text the authors refer to non-structural measures but they never connect them to the results of their study or their aims. Also in the introduction, they refer to floods but they do not explain what kind of floods they are looking at. Later on in the manuscript, the authors shed light on that matter but it would be better if this would be done earlier on.

By non-structural measure in this paper we mean adaptive measures at local levels, spatial planning (flood risk adapted land use), building regulation and improvement of building flood resistance (wet-proofing and dry-proofing), flood action plans at a local scale, rather than financial measures such as insurance. Currently there is no sufficient evidence to prove that insurance is an effective measure to mitigate flood risk in Malaysia, to our knowledge. This is why reference to insurance is not made. We have clarified this in the Introduction (lines 51 to 56). We have added a reference to the type of flood analysed in the Introduction. See line 109-112.

SMART: What is the relationship to the authors with the SMART project? Is SMART part of what they are doing or do they just use ready made results from this project? It is not very clear. More clarification is also needed in the description of the SMART defense scenario. What does this include? What kind of defense measures? Where?

SMART (Stormwater Management and Road Tunnel) project is a very well-known major structural flood control intervention, implemented in Kuala Lumpur in the first decade of the 21st century, a first worldwide. The relevant reference is included in the manuscript (Abdullah 2004). It is not within the scope of this manuscript to describe the SMART project in greater details than already included at lines 72 to 74, lines 178 to 181 and Table 1, which clearly explain the operations of the SMART infrastructure and its effect on flooding control in Kampung Baru area.

Figure 4: The authors estimate the time of peak at all ungauged locations within the study area. Why is this information relevant to the vulnerability assessment of build-

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ings?

Response: This has been explained in the text. Lines 237-239.

Vulnerability index: Why do attributes vary between 3 and 5? Please clarify.

Response: Qualitative parameters have 3 attributes, (e.g. Low, medium , high,) while quantitative parameters have 4 to 5 attributes to ensure capture of important quantities which represent thresholds in vulnerability. A sentence has been added to explain this.

Vulnerability parameters: How do parameters 1 to 6 relate to the expected intensity? I guess 8and this also has to be clarified) that in e.g. parameter 4. With the height of stilts between 0 and 0,5m(?) there is 55 VR. But if the height of the flood is 2m this specific building will be highly vulnerable.

Response: in most risk models, hazard and vulnerability are independent variables of the problem. The vulnerability is the propensity of the asset to be damaged given its own characteristics, independently of the magnitude of the hazard. So in this case the vulnerability indicators are independent of the specific intensity of a particular flood with a particular return period in this area, as they are applicable to any other urban context. Therefore in the case of the stilts, the mean value for 0.5 refers to typical values or most probable values of stilts in urban contexts, with direct reference to construction practice. Lower values of the stilt will increase the vulnerability and higher values correspond to lower vulnerability. A building with stilts will still be less vulnerable than a building without. The differential between the flood height and the stilts height is accounted in the damage function as explained in section 3.3. Similarly for other parameters. This explanations have also been extended in the manuscript text.

Weighting and classification: the authors do not refer to the weighting of the parameters or the classification of the final VRs. These are two important issues that should be considered when working with indices. A reference to the following paper which deals with these issues is considered in my opinion necessary: Papathoma-Köhle M., Schlögl, M., Fuchs, S. 2019. Vulnerability indicators for natural hazards: an innovative selection and weighting approach. Scientific reports.

It is stated in the manuscript (section 2.5) that all parameters are summed to the VI unweighted as there is not sufficient historical recorded evidence or insurance payment to provide statistical or even anecdotal correlation between specific vulnerability indicator to actual damage or losses so that a classification (ranking) or weighting of any of the parameters would have a statistical significance. For this reason, this strategy is not pursued as already explained also in Stephenson, D'Ayala 2014. Also in fluvial flooding indicators relevance is less polarized than in torrential flooding. A reference to the paper above is included in the text.

Flood depth-damage ration function: page 14, lines 375-376: does the window height play a role? The window sill height has a role, as it can be seen by the steep slope in the region of 0.5 to 1 m. of the damage-flood depth function.Building with a lower window sill have a higher vulnerability than buildings with higher window sill

Figure 6: The authors create a vulnerability curve based on the mean values of several damage functions in the literature. Why is it expected that the buildings in Malaysia correspond to an average value of the existing models? The depth damage ration functions used in the paper are from different countries (Japan, Ethiopia, and global generic functions). Clarifications are needed at this point. What are the points in the figure? The building used in the present study. Please clarify.

Response The curve in Figure 6 is not a vulnerability curve is a damage function. Historically researchers have been using heuristic damage functions derived from historic USA data and recently recast in FEMA MH documents. In recent years other damage functions from other part of the world are emerging, but these depend on available empirical field data. However in most cases such function are obtained as averaged value of insurance claims over grid cells, so the relevance to specific building type or urban conditions is rendered negligible by the averaging. Credible values of flood insurance claim for Malaysia to derive a robust damage function are not available currently. The reason for using several functions, some global, some local is to eliminate biases of any particular function, by averaging the expected damage ratio for the same flood depth. The high determination coefficient obtained and the relatively modest std for each average point, shows that the process is acceptable, given the lack of more accurate data. A sentence to explain this is added in the text. A statement has been added to clarify that the damage function has been validated against other damage functions derived on the basis of historical damage. Confidence boundary at 95The vulnerability for each individual building is taken care as a multiplier of the damage function in equation 5.

Figure 7 and 8: The authors present some descriptive statistics of the index. Why is this information relevant? How and by who can it be used?

The descriptive statistic is used to validate the empirical model both in terms of the choice of the parameters and the choice of the sample of buildings. For the parameters is seen that they are all differently distributed within the sample, hence they are uncorrelated, which then supports their necessity and sufficiency for inclusion in the vulnerability index model. The cumulative distribution of the VIi shows that the distribution obtained is well represented by a lognormal regression, which again provide confidence in the sample choice to represent the occurrence of different vulnerability level in the district. The descriptive statistics also justify the division of the sample in vulnerability classes (table 4). These are chosen to divide the total vulnerability rating in equal ranges, while identifying threshold values which are critical to the likely response of the building to flood. In terms of who should use this analysis: The vulnerability cumulative function can be used at the level of the single building owner, to determine the level of vulnerability of their property and identify features that can be improved to reduce such vulnerability. At the level of the district and with reference to the map as well as to the classes it can be seen that buildings belonging to the same class are clustered, meaning that there are local intervention at the scale of few compounds, (such as drainage, surfacing, slope) which can be address to reduce such vulnerability.

At the municipal level, if this exercise is repeated for different neighbours then a ranking of them in relation to the mean and dispersion of the VI function can provide support to decision making in terms of nonstructural flood mitigations at neighbor scale. Text has been added to explain this at lines 610-620.

Table 4: the classification of the vulnerability classes has to be justified.

The categories in the manuscript were derived from the actual range of the sample. To make our results more generic, we use the theoretical values, i.e. 110 to 1100 for 11 factors, to re-categorise the vulnerability classes. This makes our methodology and results more comparable with studies conducted in other areas. the manuscript has been modified to reflect this and the classes have been explained.

Interpretation of results: The results are described but not interpreted or used to demonstrate the importance of the approach for specific end-users. For example, (page 17, lines 432-433) "the buildings in the eastern part of the area have higher vulnerability“. Why is that (e.g. older part of town?) How can this information be used?

Response: we have included a new discussion and added three examples whch explain the meaning of the results for an individual building owner. At lines 527 to 544.

Page 18, lines 454-455: This needs to be discussed more. There are two issues here: 1. Why is the number of floors a parameter of flood vulnerability anyway? Is a building with more floors more or less vulnerable to flooding and why? It can offer vertical evacuation to residents but apart from that does the number of floors contribute to the reduction or not of the physical vulnerability? And 2. The high number of floors means high building value which reduces the degree of loss. Some discussion on this kind of drawbacks of the approach is also needed.

The text has been changed to better explain how the parameter number of storey is treated in this study. See line 309-313. see also answer to reviewer 1

Estimation of replacement cost due to different flood scenarios: In my opinion the scenarios should also be reflected in the VR 8see previous comment about vulnerability parameters.

As we already mentioned the vulnerability in this study, as in most other literature on the subject, is independent of the hazard scenario.

Type of hazard addressed (page 20, line 485): this information comes too late. The authors focus on flash floods and river floods and they combine "the total flood risk“. What is the difference between these two processes as far as their impact on the building is concerned? Why do the authors suddenly start talking about risk? Is this what they assess?

This comment is related to two earlier comment from this reviewer. We have addressed both the type of flooding and the computation of risk in the title and in the introduction. In the manuscript the risk, or worst case risk scenario for each building was considered on the same map. We agree that this might be confusing and it does not reflect the physical aspect of the phenomenon. For this reason the manuscript has been amended and the risk associated to each of the 3 scenarios produced is evaluated separately and compared to the others.

Discussion: Some vital information is missing. what were their assumptions and uncertainties? How can this study be improved and further developed in the future? How can the results (e.g. the vulnerability maps) be used by end-users? The manuscript has been revised accordingly The possible use by end users is addressed at lines 610 to 658 The assumptions and uncertainties are discussed extensively at lines 660-725

Conclusions: the conclusions should be stronger and show what the authors have really achieved with the specific study. Instead there are some repetitions (e.g. lines 564-576) without having a strong message at the end.

This has been extensively addressed in the conclusions. Line 660-725

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