

Nat. Hazards Earth Syst. Sci. Discuss., referee comment RC1  
<https://doi.org/10.5194/nhess-2022-64-RC1>, 2022  
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## Comment on nhess-2022-64

Adam Emmer (Referee)

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Referee comment on "Rare flood scenarios for a rapidly growing high-mountain city: Pokhara, Nepal" by Melanie Fischer et al., Nat. Hazards Earth Syst. Sci. Discuss., <https://doi.org/10.5194/nhess-2022-64-RC1>, 2022

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### General comments:

This study deals with the identification of exposed elements (buildings, roads) to (virtual) outburst flood scenarios in the city of Pokhara, Nepal. The authors exploited OpenStreetMap and manual mapping of built-up areas from remote sensing images and overlaid these layers with spatial extents of outburst flood scenarios simulated in HEC-RAS software. The authors repeatedly mention that the city is threatened by an outburst floods, but (nowadays) there are no lakes which could burst located upstream in the Sabche cirque. Therefore, the reader may wonder what could be the source of such flooding? I see a good argumentation with the 2012 flood, but it was also not an outburst flood according to the description provided by the authors (rather a highly mobile ice-rock avalanche which transformed into the hyper-concentrated flow; perhaps somewhat similar to the 2021 Chamoli disaster; [10.1126/science.abh4455](https://doi.org/10.1126/science.abh4455)). Overall, the flood scenarios used are not well-justified and would benefit from better linkages to the past floods and potential future flood sources. For instance, why using 1,000 to 10,000 m<sup>3</sup>/s (1,000 m<sup>3</sup>/s step) and not e.g. 1,000 to 5,000 m<sup>3</sup>/s (500 m<sup>3</sup>/s step) if the 2012 flood corresponds to 3,700 m<sup>3</sup>/s in Kharapani. And it was likely less in Pokhara I guess – to put your flood scenarios in the context, could you also use HEC-RAS to estimate the 2012 peak in the city? If it was the largest recent flood, it could provide good guiding value for comparison and scenarios justification. Future flood scenarios should be better connected to potential sources of these floods in my opinion. Possible flood sources are very briefly touched in only one paragraph of discussion section 5.2, but I'm convinced it deserves more attention. My suggestion to the authors is to elaborate bit more on the potential source(s) of their otherwise virtual flood scenarios (sub-glacial outburst (?), glacial surge-induced damming of the valley (?), outbursts of possibly landslide-dammed lakes (?), transformed ice-rock avalanche (?)). Could (some of) these processes lead to the impoundment / generation of enough water for 10,000 m<sup>3</sup>/s in the 30 km far city? The latter seems the most likely to me (also in the light of the 2012 event), but than it is not an 'outburst'. And so I suggest to re-consider and check the use of the word 'outburst' in this context as it could be terminologically misleading (similarly, the use of the word 'risk'). Considering the actual content of the manuscript, my suggestion for possibly revised title would be '(Extreme) flood scenarios and exposed areas in a rapidly growing ... ', or similar.

Specific comments:

Fig. 1: please consider displaying topography (basic contour lines or cross-profiles at selected locations) in this figure

L99-100: please provide more details on your field mapping of sediment traces; how was it integrated with the overall workflow (Fig. 2)?

L107-108: I wonder what is the justification for using the steady flow HEC-RAS mode while it also offers unsteady flow mode which may be more suitable for this type of events characterised by limited though suddenly released total flood volume and substantial attenuation?

L126-127: this is not clear – did you use your field cross-profiles to enhance (manipulate) ALOS DEM? Or how these two are integrated in the study? Please provide more details on your methodology

L138-146: please consider summarizing these LC classes in table rather than in the text

L156-158: this is confusing; why don't you name the hazard classes according to the peak discharge?

L164-165: it would be good to map sediment extent also before the 2012 event, so you could display the change of sediment extent associated with the 2012 flood in your Fig. 3

L171-172: simulated peak discharge in Kharapani is 3,700 m<sup>3</sup>/s, but on L41 you mentioned peak discharge 8,400 m<sup>3</sup>/s; please comment on this discrepancy

Fig. 6: please show the complete SE bank in this figure (so the flood extents do not terminate in the air)

Fig. 7: the inset map seems to display something different to the main map (or some LULC classes are not shown for some reason (?))

Table 1: it is a little mystery why there is a fluctuation (not gradual increase) in exposed areas for some of the LULC classes (for instance developed-medium: 153,446 m<sup>2</sup> for HC1; 30,214 m<sup>2</sup> for HC5; 50,432 m<sup>2</sup> for HC6; 18,408 m<sup>2</sup> for HC8 and 49,981 for HC10); in other words – why is the impact area of certain LULC not always the highest for the largest peak discharge scenario? Or does it show a difference to the previous peak discharge scenario (hazard class)? Please clarify.

Fig. 8: this is confusing and hard to read and I'm not sure this is the correct graph type to be used; what is the link between this graph and Table 1? What is the actual meaning of the area on y axis (part (a))? For instance, when I sum up the areas for exposed grassland and all scenarios (Table 1), the total area is something about 2,4 km<sup>2</sup>; here the total area of exposed grassland approx. 17 km<sup>2</sup> which is confusing; the largest peak discharge scenario is shown at the bottom (I would expect starting with the 1,000 m<sup>3</sup>/s, so it can be deduced how much area is exposed for individual scenarios);

Table 2: please unify the naming of your hazard classes with the rest of the manuscript

Figs. 10 and 11: what are those strange geometric linear clusters of buildings exposed to hazard class 1-3? What about that cluster located far (and disconnected) from the river?

L282: ok, here you mention that you manipulated the DEM – please provide more details in the methods section

L289-290: ok, here is the possible answer to geometric clusters, but would that really be captured by HEC-RAS in this way (can it capture subsurface drainage in this mode)?

L337: the recommendations outlined here are very general (probably applicable anywhere) and not really providing a solution for the maintenance failure issue with the previous EW system; moreover, they are in detail elaborated by Thapa et al. (2022); I suggest revision or removal

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To sum up, I think this study might be of interest for the readers of NHSS, but I also believe it would benefit from some (rather major) revisions.