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Comment on nhess-2021-336

Anonymous Referee #2

Referee comment on "Characteristics and causes of natural and human-induced landslides in a tropical mountainous region: the rift flank west of Lake Kivu (Democratic Republic of the Congo)" by Jean-Claude Maki Mateso et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2021-336-RC2, 2021

Dear Authors, I have read and carefully evaluatied your manuscript “Natural and human-induced landslides in a tropical mountainous region: the Rift flank west of Lake Kivu (DR Congo)”. I am pleased to report that I found it a relevant, scientifically sound, and well drafted contribution to the journal. It surely deserves publication. However, I have some comments and I recommend to address them to further improve the paper.

Best regards.

---GENERAL COMMENTS---

My main concern is about the structure of the paper. Although it is excellently written, I found it too long and with many repetitions. These shortcomings can maybe be fixed with a reorganization of the paper structure. To be more precise, I found that some concepts are repeated at least twice. The first time in the material and methods section: there, they are outlined with a mid-level of detail, and many questions arise to the reader. Then, the results section repeats everything and add some more details answering most of the answers from the readers. This happens e.g. for landslide, forest, and parts of the analysis. Sometimes, things are repeated once more in the discussion. I think this structure does not help the reader and is not effective. You could try to either reorganize the structure (e.g. moving some preliminary results in the methods section) or shortening the information and comments in the material section to the minimum. In any case, please avoid repetitions and be concise and straight to the point.

The state of the art review could be improved. Basically, the core of your study is a landslide susceptibility mapping (LSM) activity. Therefore, it would be advisable to include a paragraph about LSM. My advice is not to provide a detailed literature review, but you could focus on works that: (i) pertain to the same/nearby areas or areas with similar characteristics; use the same susceptibility model; try deciphering the important role played by LULC dynamics or urbanization. In the literature, the last point is usually accounted for simply by using land cover maps and/or road network as input variables, but you may briefly acknowledge works that tried alternate approaches or specifically addressed this topic, such as:

Luti, T., Segoni, S., Catani, F., Munafò, M., & Casagli, N. (2020). Integration of remotely sensed soil sealing data in landslide susceptibility mapping. *Remote Sensing*, *12*(9), 1486.

Chen, L., Guo, Z., Yin, K., Shrestha, D. P., & Jin, S. (2019). The influence of land use and land cover change on landslide susceptibility: a case study in Zhushan Town, Xuan'en County (Hubei, China). *Natural hazards and earth system sciences*, *19*(10), 2207-2228.

Shu, H., Hürlimann, M., Molowny-Horas, R., González, M., Pinyol, J., Abancó, C., & Ma, J. (2019). Relation between land cover and landslide susceptibility in Val d'Aran, Pyrenees (Spain): Historical aspects, present situation and forward prediction. *Science of the total environment*, *693*, 133557.

Reichenbach, P., Mondini, A. C., & Rossi, M. (2014). The influence of land use change on landslide susceptibility zonation: the Briga catchment test site (Messina, Italy). *Environmental management*, *54*(6), 1372-1384.

To perform the LSM and to assess the variable importance you use logistic regression (LR) and frequency ratio (FR). These methods have a long tradition, but maybe they are a little outdated, as more effective and complex methods are continuously proposed (e.g. in the field of machine learning or deep learning). Don’t you think this is a weakness of your work? I suggest defending the research strategy of using LR and FR on the introduction.

To my understanding, the shape of the area-frequency curves is quite logical. It is normal to have a rollover: it can be interpreted that below that area, the inventory progressively becomes incomplete because smaller landslides are harder to identify (and map), for several reasons. So, I wouldn’t spend so many energies to defend the presence of the rollover in your curves: it is a typical feature, useful to identify the size of the landslides that your model could probably miss.

If I understood correctly, you assess the importance of a variable by running the susceptibility model with only that single variable. I am not very convinced about this approach. The possible interplay among variables is lost. Moreover, a single-variable

susceptibility assessment seems of little use. At present, one of the reasons why more sophisticated LSM methods are used is that they also have internal modules that assess the variable importance.

---SPECIFIC REMARKS---

L27 which dynamics? Please, be more specific.

L35 which susceptibility models?

L56-59. It depends also how the human intervention was designed and executed. There is a big difference if you just cut a slope and build a house (or a road), or if the cut is accompanied by some additional works (drainages, concrete walls, …). This should also be highlighted elsewhere in the manuscript when you write about this issue.

Section 1.1 Besides describing the lithology, a short overview of the geological setting could be a nice addendum to this section.

Fig. 1 For the cities, I suggest using a color that better stands out from the colors used for elevation. E.g. black. And you could also add it in the legend. I initially confused cities outside the study area with parts of the study area.

L155-160: From what dates are the images? (This is explained later, but at this point of the manuscript, it is a spontaneous question: see my first general comment).

L174-178. Usually, a landslide is also considered shallow when the ratio depth/width or depth/length is small. I guess this is also your case?

L225. This is not clear to me.

Table 1. the meaning of "reference" in the second column is explained only later. This is confusing.

Table 1. The forest dynamics information is very interesting. In my opinion, it deserves also a figure. Unfortunately, the figure comes only after some pages. This is another example of specific issues comprehended in my first general comment.

Figure 2. The forest cover color hides the information about elevation. Didn't you already display the elevation in Fig 1? Here, you could just use hillshade and forest cover.

377 "these sources"

Table 4. It seems to me that the bedrock lithology has little influence in determining if a landslide will be shallow or deep seated. Maybe because the lithologies produce similar soils and the actual depth of soils (driven by morphology) is the real control?

478. I like that recent landslides are reasonably well predicted by a model trained with the old ones. This is like a multitemporal validation. It could be worth mentioning it.

493-In an earlier part of the manuscript you mentioned that elevation can be considered a proxy for meteo-climatic characteristics. Why you discard this interpretation here?

593 - Actually, the explanation may be that with this approach you artificially create incompleteness in your inventory. (this interpretation is in accordance with my general comment about frequency-area curves).

604 the influence of vegetation on slope stability is somehow a relevant part of the phenomena you are investigating, but this is never mentioned explicitly. Why didn't you openly prepare this issue in advance and you don't mention it explicitly? Forest loss means (I think) reduced root cohesion and reduced evapotranspiration. I would mention it clearly. You could also make reference to some works such as

Masi, E. B., Segoni, S., & Tofani, V. (2021). Root Reinforcement in Slope Stability Models: A Review. *Geosciences*, *11*(5), 212.

Schwarz, M., Preti, F., Giadrossich, F., Lehmann, P., & Or, D. (2010). Quantifying the role of vegetation in slope stability: A case study in Tuscany (Italy). *Ecological Engineering*, *36*(3), 285-291.

Arnone, E., Caracciolo, D., Noto, L. V., Preti, F., & Bras, R. L. (2016). Modeling the hydrological and mechanical effect of roots on shallow landslides. *Water Resources Research*, *52*(11), 8590-8612.

Glade, T. (2003). Landslide occurrence as a response to land use change: a review of evidence from New Zealand. *Catena*, *51*(3-4), 297-314.

608-612. I think there is (also) another explanation: the slope value you are using is an averaged value, while the built environment may be characterized by a locally steeper value. As instance, in a slope cut you could have a small 90° slope, which may not be well captured by the DTM. Even outside artificial environment, a similar situation may be present.

670-675. The stylistic writing of this part is so different from the rest of the paper. Here the sentences are very short and telegraphic. I suggest to better link them.