

Interactive comment on “Landslide susceptibility mapping by using GIS along the China–Pakistan economic corridor (Karakoram Highway), Pakistan” by Sajid Ali et al.

Anonymous Referee #1

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The manuscript “Landslide Susceptibility Mapping By Using GIS Along The China Pakistan Economic Corridor (Karakoram Highway), Pakistan”, submitted by Sajid Ali and his co-workers for publication in the journal Natural Hazards Earth System Sciences, presents a GIS-based landslide susceptibility map of the Karakoram Highway, which connects China and Pakistan. This important highway is vulnerable to landslides, which may block the road and destroy the infrastructure. So the attempt to set up a landslide susceptibility map in this region is a valuable contribution to the hazard assessment around the Karakoram highway and may improve the maintenance and security along the road. But before publication in a scientific journal some major revisions seem to be needed, as originality and discussion of the data need to be specified and elaborated

C1

in more detail.

First of all, the structure of this manuscript seems clear but some parts are missing or not well-balanced. Almost eight out of ten article pages, i.e. 80% of the written text deal with introduction, situation and methodology. The most important parts of a scientific article, results and discussion, fit in only one article page. In fact, the discussion chapter is missing at all, although some statements are “hidden” in the chapter “accuracy statement” and in the conclusions. This structure needs to be changed, and most important, a well-balanced discussion of the results has to be elaborated. Please review your text passages thoroughly and sort primary information, results and discussion and clarify what the model outcomes mean scientifically.

In the following, I will comment on certain text passages and indicate questions. Introduction: I would appreciate more references on conditioning and triggering factors, and these can be used in the discussion again. Already in the first chapter, the insecurity of AHP is announced (p.2, line 29), and a combination with qualitative approaches and the use of GIS is considered a better option for regional studies.

General situation of the study area: How significant is the value of average annual precipitation in a Monsoon climate, also with abrupt changes to semi-arid / arid conditions? Are there more precise rainfall data available or can more datasets be taken into account in order to reduce the error source? Please clarify, how the precipitation data is used for the model.

Geology along the KKH: “Highly active landslide zones were identified from the distribution of existing landslides” – what about other zones which may have not been activated yet? Actually you do not know only based on the distribution of visible deposits how active a distinct zone is at the moment or at what certain frequency and what type of trigger is the main causing factor of the landslides. There might be lots of “old” deposits summing up to a higher total number of landslides in a rather “inactive” zone compared to a recently activated zone with less, but young landslides. Please

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clarify how you mapped and characterized the landslides in the field. An attribute table of the landslides would be very helpful and support the discussion.

Seismology: The earthquake events in the region seem to be well-documented. How do you include these data in your hazard assessment? Especially the recent strong ones (e.g. the referenced in Oct 2005 or Oct 2015) could be used in a detailed case study. I would strongly recommend to do a detailed case study for at least one strong landslide event including lithology, seismology, conditioning and triggering factors. This would ideally fit your GIS-based mapping results. If not, this would also need to be discussed in detail.

Geomorphologic factors: How did you divide slope steepness into classes? I wonder on what criteria you based the data processing.

Literature review: Do you need this subsection? p.7, line 8: six weather stations along the highway: where are they (what climate?) and how does the rainfall influence your model? Please discuss, although (or because??) you classify the susceptibility levels based on active faults, seismic zones and steep slopes.

Field reconnaissance: These data sets should be presented in more detail. A landslide inventory map with classification and indication of magnitude and/or frequency and a case study could improve this paper a lot. So far only the location (Fig. 1) and the number (72) of the mapped landslides are given. For instance, you could set up tables like the colleagues T. Stanley and D. Kirschbaum (2017) in their study on global landslide susceptibility mapping (Table 4 and Table 5).

Remote sensing: DEM-quality of 30x30 m² and its influence on the results needs to be discussed, as several recent studies have shown that the DEM quality is crucial for modelling outcome. The accuracy of the land cover map of 87% needs to be discussed – is it a good or bad value compared to other studies?

Weighted overlay method: crucial part of this study. You should disclose the criteria.

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In Table 2 the reader cannot follow your working procedure and how you chose the weighting factors.

Results: You need to explain the classification into four classes. What does a certain susceptibility level stand for? For this, table 3 could be developed in more detail (presence of active faults, seismic zones, steep slopes etc.).

Accuracy assessment: Please clarify, how the 72 landslide locations were used for validation. Only the location? What does the value of 72% tells us? Please discuss this outcome.

Chapter discussion is missing!

Conclusions: Primary information, for instance the classification of landslides into rock-fall, debris slide etc., must be provided earlier in the results (landslide map, attribute table as suggested above). Furthermore, some interpretation is mixed in here (stable/quite stable parts of the highway). This interpretation and discussion is very important for the paper. You should lay out a new chapter, as indicated above, including limitations of analysis and sources of error.

Table 4: Please indicate the absolute values of area and number of landslides because this improves the transparency of your data processing. Why/ based on what criteria did you reduce the number of 9 susceptibility levels to 4 in your final map? Please clarify.

Figure 1: Please indicate subfigures a), b) and c) and legend. Too many (bold) lines in mid-zoom map.

Figure 3: Scale in W-E direction is missing.

Figure 4b: Why don't you also focus on the earthquake zone in the south of highlighted section a)? Not only lithology but also seismic situation should be considered here!

Figure 5: Where is the highway? Please improve visibility.

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Figure 6: a) How would your model change, if you split the group of 31-45° again? Why do you show the group >65° and in subfigure d) the group 4000-4700m? Is the y-axis “landslide %” based on all 72 landslides? Please clarify. Please use these values in the suggested landslide map/attribute table (case study) and compare with other studies.

Figure 10/11: Captions of subfigures a), b) and c) are missing. One of these recent events might be suitable for a detailed case study.

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