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

Sajid Ali

First, we would like to thank you for evaluation and highlighting the deficiencies in the manuscript. It is indeed valuable addition and help us to improve our manuscript. Please find below our response to Referee’s comments.

Comment: The method is already well known in literature and the paper does not seem to me to introduce any originality, it’s more like a technical report where a consolidated procedure is used to obtain a map.
The description of the input data is very wanting, in particular the main information related to landslides is practically non existent, something very strange if a landslide susceptibility map is to be prepared. This aspect somehow also invalidates the validation of the map.
Most of the decisions taken in the choice of the model and in its setup are not justified but just given. The literature analysis does not help at all. Some of the important details are not provided and only in few cases it is possible to deduce or extrapolate the needed information. An example is the study area: is it 2 km large? It’s just a ’rigid’ buffer along the highway or it is obtained using geomorphological analysis (slopes, catchments?). According a figure, it should be a ’strip’ some km large, but it’s my deduction, if true, why this choice?
I was expecting (or hoping) for a discussion to find reasons for the choices, analysis in deep of the consequences of the choices on the final results, but this part is missing. My personal opinion is that the paper does not reach the minimum standards of quality from too many points of view and it is to be rejected, perhaps deeply re-thought, and eventually resubmitted.

Response: We explained the choice of the model on Page2|20-33 and will explain it more. Furthermore, the addition of valuable suggestion/comments from all three Referees would improve the data presentation and quality of the paper. In addition, the inclusion of a case study in discussion part will make it a valuable addition to this special issue.

My considerations are, I hope, supported by my comments in detail shown below:

Abstract:
Comment: Abstract is a copy and paste of some parts of the paper
Response: We tried to give an overview of the publication.

Comment: p1 l14: not sure you need to go so much into geological details in the abstract, just say that geology facilitates the landslide occurrence.
Response: Ok! We will do it. However, this is exactly the point in your comments to explain the input data.

Comment: p1 l27: validation of the credibility?
Response: the soundness and reliability was demonstrated by accuracy assessment.

1 Introduction

Comment: p1 l31 - p2 l3: these first 5 lines should be moved to the area description paragraph
Response: Ok we will do it.

Comment: p2 l5: why potentially?
Response: It is “momentous”. Therefore, we will remove “potentially”.

Comment: p2 l7: no, landslides are not caused by conditioning factors, they might eventually facilitate the occurrence.
Response: Without facilitation or pre-conditioning of the rockmass, landslides would not occur. For example, Seismicity and rainfall easily trigger those slopes, which have already been pre-conditioned means highly fractured.

Comment: p2 l9: too generic, variation of geology? Geological structure?
Response: means both conditioning and triggering factors!

Comment: p2 l10: too generic... how facilitated?
Response: We will explain it more!

Comment: General comment: the literature analysis is sterile because it does not motivate/support any of the choices taken in the procedure setup.
Response: We will explain it more!

2. General situation of the study area

Comment: I actually cannot understand how is the shape of the study area, is it a buffer (what kind of buffer) along the KKT? How large, how is it defined?
Response: It is buffer of 5 km along the Highway.

3 Geology along the KKH

Comment: p3 l29: active landslide zones: what does that mean? and how can you get it from the distribution of existing landslides? I guess you mean that the susceptibility in the area is high...
Response: It is referring back to Fig. 1, where an inventory of landslides of three different periods (1982-82, 1996-2000, 2014-16) is shown. Because of multiple episodes of slope failure within these zones, we termed it as active landslide zones.

Comment: p4 l1: again I’m not sure that ’activity’ is here used correctly, I suggest to re-phrase to avoid confusion with activity of a landslide which is another thing.
Response: We will re-phrase it.

Comment: p4 l17: see my previous comment.
Response: Due to multiple episodes of slope failure in different periods (1982-82, 1996-2000, 2014-16), we termed it as active landslide zone.

4 Seismology

5 Causative factors and spatial distribution analysis

Comment: p5 l14: all those parameters are always present, you probably mean depending on the values, or classes...
Response: Yes, you are right! we will re-phrase it.

Comment: p5 l15: what do you mean here with accurate and precise?
Response: Accuracy is the closeness of the information on a susceptibility map with the real values whereas precision is the exactness of the description of data.

Comment: p5 l15: entirely dependent on the availability of data relating to controlling factors? Not sure this is in general true, and in particular here using this type of model.
Response: The resolution of DEM and satellite images and the scale of the geological maps have a direct impact on the quality of susceptibility map.

a Lithology

Comment: p5 l19: what do you mean with time?
Response: Mechanical behavior of some formations changes quickly even after very low rainfall and fails whereas some formations take a bit longer to reach at that failure stage. So time of slope failure also depends on lithology.

Comment: p5 l21: what do you mean with spatial analysis? Did you count landslides for each lithology, or it is a spatial density (landslide area / area)?
Response: It is spatial density analysis.

b distance from faults

c Geomorphological factors

Comment: p6 l5 - p6 l9: the result of the numerical distribution of the landslides inside the classes might depend (actually it will depend for sure) on how the classes were chosen that is not described.
Response: We will explain it more!

Comment: p6 l6 -p6 l9: what do you mean with reduced? According to fig. 6 they seem to have some discriminating capabilities, I think you should support more your conclusion (perhaps correct, but should not be deduced just by looking at fig. 6)
Response: We will explain it more!

d Hydrology

Comment: p6 l15: no doubts about the correlation and the work done by Ali et al., but her it should be better introduced and contextualized.
Response: We will explain it more!

e Land cover

Comment: This is more a description of the land cover of the area instead of a spatial analysis that is entrusted to the reader.
Response: We will also discuss spatial analysis.

6 Methodology

a Literature review

Comment: The description of the data here is really poor and unsatisfactory. In particular, the description on how the inventories are and they were prepared is completely missing. How many landslides, type, some statistical description... landslides are here the secondary variable, the one that is used to understand how and if the causing factors are (quantitatively) important or not. Furthermore, what is a precipitation map? Is this an annual precipitation map? How did you obtain it? How to make sure that it is not too much event dependent (the bias introduced in the model would be dramatic).
Response: We will explain more and include landslide inventory map with types of failures as advised by first Referee. It is annual precipitation map. We interpolated rainfall data of six weather stations to generate rainfall map. We used spatial analysis results and Analytical Hierarchy Process (AHP) involving expert opinion to rate all parameters. It has reduced the chances of possible bias.

b Field reconnaissance

Comment: p7 l11: for all landslides?
Response: Yes! We did for all landslides.

Comment: p7 l12 - p11 l13: what does that mean? Another inventory? Is this a buffer around the highway where the map was prepared?
Response: Landslides within area of 2km^2 around the highway were only considered during preparation of Inventory.

c Remote sensing

Comment: Same impression I had about 'Literature review'.
Response: We will explain more!

Comment: What is the level of pre-processing of the satellite images (are they orthorectified? Atmospheric corrected?), what did you do with QGIS. How did you train the classification, how many ROIs, what model did you use (SVM, ML...)? The map is not divided in 4 classes, probably you did look for 4 classes in the training phase... The confusion method of the map versus what?? The image previously classified? How, by who, so whi did not use it?
Response: These images were pre-processed on QGIS. We used Maximum Likelihood Classification on Arc GIS 10.3. Yes! We looked for four classes in the training phase. We will explain this part more.

d Analytical hierarchy process

Comment: I think you should refer the explanation to table 2. (and not only in the next paragraph). Not sure you can say x,y axes. I also suggest you to add some references to find easily what CR and CI are.
Response: We will add more references!

7 Results.

Comment: p8 l15 - p8 l16: how did you choose the classes?
Response: We converted nine (9) susceptibility levels into four equally with interval of two except High Susceptibility which contains susceptibility levels of 5, 6 and 7. We did so to distinguish the locations that are more hazardous.

Comment: p8 l17: these numbers depend on the previous classification that was not justified, so they say nothing.
Response: We will explain that!

Comment: p8 l20: what kind of criterion is an 'owed to lucidity'?
Response: By keeping in mind the scale of the map, the visibility of a single map of 840 km long highway was an issue. So make it clearer to readers, we divided into two parts.

a Accuracy assessment

Comment: General question: did you use all landslides in the inventory? A part of? I can't understand what is the classifying parameter.
Response: We randomly selected 72 landslides from the inventory to validate the map.

Comment: p9 l8: among many you pick up ROC and LDA without justification.
Response: We will explain it more!

8 Conclusions

Comment: p9 l23: a set?
Response: means two maps. Thank you very much for pointing it out! We will rephrase it, as it is a single map!