Quantitative spatial analysis of rockfalls from road inventories: a combined statistical and physical susceptibility model.

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For NHESS

General comments:

The paper is a good and different approach to assessing rockfall susceptibility using the weights of evidence method and validating with an inventory of rockfall impacts rather than zones of initiation.

1-One concern is that it is not that well demonstrated that the posterior probability value is the rockfall susceptibility index that is revealed on the colour coded map. There is a fairly clear explanation as to how the authors produced the resulting map, but the map itself is very small, the units are not explained that clearly, the ranges between colours are not labeled on the legend, etc.

2-In addition, in order to validate their susceptibility model, the authors also used a logistic regression method to producing a susceptibility map and success rate curve (fig. 2), which they mention only in the discussion. This should be described at the onset when describing the main method(s) and highlighting the differences between both methods.

3- The idea of combining the probabilistic susceptibility map with the rockfall susceptibility map is good as slope angle is not used in the statistical model and it helps narrow down the susceptible areas within steep slopes. It is important to explain a bit more the approach of the physical susceptibility map because it is such an important feature in producing your final product. This is briefly touched upon. It is also important to mention that the physical susceptibility map is based on some calculations but also qualitatively assigned parameters. E.g., slope angle thresholds.

4- References cited in a paper should always be in chronological order.

5- When the authors mention someone's work with a reference, they should use the past tense consistently…sometimes it is in the present, sometimes in the past. They are referring to past studies therefore it should be in the past tense.

6- In terms of quality of the writing. There needs to be a revision by someone whose first language is English and who has a good command of English grammar. This is not to offend the authors, I think that the paper would benefit in the end.

7-Perhaps there should be a bit more discussion about the limitations of the baseline data. For example a bedrock geology map of 1:250,000 scale does not provide a lot of detail. So the authors should probably address issues that may improve the model in the discussion/conclusion. Some issues are addressed, but there is likely more to add in the discussion/conclusion.

Similarly in the Inventory section, the authors mention in the last sentence that major problems are expected analysing the DEM with a 25 m resolution and corresponding derivations of it in the statistical analyses, but it is not mentioned again in the discussion/conclusion. Were there obvious problems? If so, they should be mentioned.

In addition, there should be discussion on whether the authors think that this is a model that works. It seems that the success rate curves in Fig. 4a and prediction rate curves are good but not excellent as they are not extremely steep. Elaboration on the results and how the product could be improved would help.

In addition, for the non-statistician, perhaps the meaning of values of posterior probabilities vs prior probabilities should be explained. What do those values tell you? Eg., p. 103 last two sentences at one specific site.

8-There are some terms used throughout the text that should be corrected.

Rock slope instability, should be unstable rock slope. What you are describing, measuring, monitoring, creating susceptibility maps from, etc., is the slope itself, not the instability.

Registered impacts, should be recorded impacts. Registered is used for enrolment in a club, certification of some kind, e.g., registered nurse. Record as you write down, tabulate, compile, etc.

The term Quaternary geology, in this case, because the authors only use three units and two of them are bare rock and landslides and the real Quaternary units are slotted in Others category, it should be called surficial geology.

Also Quaternary is a proper noun

Use of term violated. It is too strong a term, should use the assumption was erroneous, incorrect, flawed, etc.

Usually "since" relates to time, should not be used instead of because.

Word: Data…always plural

9- Other than Figure 1, the other figures are much too small. Figure 2 should be taking up a whole page and be sideways. In Figure 3, we can barely see the lines and labels, which make it difficult to follow the reasoning in the paper. Figure 5 a b …much too small. Fig. 6 …better

Specific comments:

I have made specific comments directly on the text, but also here is a list for most of them:

p. 82 line 26 …yield slope angles that are too low

p. 83. The last sentence is not clear. See suggestions on marked copy.

p. 84. Line 4. Until now, …. In Norway were mainly…

p. 84. Lines 19 to 21. Last sentence is too strong. "However, their focus was strongly mathematical methodology, and not on the input data and geological model. In addition, a lack of detailed knowledge about the local geological conditions as well as the used inventory is obvious."

Suggestion: However, their focus was to use a more mathematical approach. It seems that more detailed information on the inventory and the geological conditions may have been missing….

P. 84 line 29. Last sentence. The results should provide

P. 85. Line 2. At last, should be Lastly,

P. 85 line 7. geological studies have shown

Line 10. This led to increasing the number of studies focusing on current unstable rock slopes in this country and related geology. (Böhme et al., 2011, etc…

Lines 14-16. The restriction to using a county instead of natural borders, the latter probably being more appropriate for modelling a natural process, was chosen due to the division of the Norwegian Directorate of Public Roads based on counties.

p. 86 lines 8-10. However, there is a tendency increasingly complicated mathematical models, that can be powerful

Line 17. Change compute to generate

Lines 18-20 Our focus is hereby not on the mathematical methodology and explains thus the application of a relatively simple mathematical model.

P. 88 Line 6 delete pure

Line 8. Change how strong to the strength of the

Line 9. Delete is after class

P. 89. Line 6 delete with

Line 16 change has been used to was used

p. 90 Line 1. A rockfall susceptibility map was produced previously for all of Norway, which divided potential source areas and propagation zones (Derron, 2010).

Line 6 outcrop not outcropping

Line 8 25mX25 m cell size or 25m2 cell size or 25 m resolution, not 25 m cell size

Small rock cliffs can thus

Line 9 replace just by only
Line 16 replace joining by combining
Line 26 delete a time period

p. 91 please see corrections directly on hard copy.
Line 2 delete the year
Line 4 registration routines...replace with recording methods. Also: in 2003 not from 2003
Line 5: replace this date with 2003
Events older than 2003 were used as training data and those that occurred after were used as validation data.

Line 7 replace applying for to "to using"
Line 9 data are strongly not is
Line 17 delete about this conflict.

Lines 19-20 This study investigates rockfalls only spatially. Thus, temporal inconsistencies are not considered important. However, strong spatial restrictions have been addressed ....
Line 21-23. The first imitation is that the records are limited to public roads. This has been resolved by restricting the study area for spatial analysis to a 1 km buffer around the road network called training area.
Line 27. The training area covers ...

p.92 line 12 replace with the help with using
lines 13-14 that have the most influence have been used for generating the final susceptibility map

line 19 replace transport with movement
line 21 replace including with , which include

p. 93 line 3 ...area based on field experience from which seven classes are defined:

line 22. 5.2 Surficial geology

p. 94 see corrections on hard copy

p. 95 What are the values of the seismic energies in Fig. 2l?
line 23 3x3 m cell?
Line 27 9x 9 m moving window

See hard copy for corrections

p. 96. The statement regarding the studentised contrasts and displaying cumulative classes (ascending or descending) for some parameters is not clear. Please reword. It needs to be clearly explained why you have done that and what they tell you in the end. In addition, why you chose to do it for some parameters, but did not need to do it for others.

p. 97 Line 8 Where is the value W+ -1.19 in the table? The value in Table 2 is -1.36 for sed. rocks

Line 20. The other units have all significant negative relations to the occurrence of rockfalls, except the uppermost allochthon.
Comment: The uppermost allochthon value is -0.36. Please explain how it doesn't have a significant negative relationship?

p.98 6.2 Surficial geology   See point 9 in General comments

Line 13 replace less with fewer
Line 14 Rockfalls occur preferentially within a distance of 1400 to 3800 m from a geological lineament… refer to a figure or a reference

Line 24 indicate not indicates

p. 100. Line 22 Rather, it may be that extreme events have a stronger influence on…

P. 101 line 13 replace violated with erroneous
 Line 18 replace it is noticeable with it appears

Data…plural

p. 103 lines 3-5 …good point to make

line 24 See point 2 in General comments

p. 105 In the formatting of the references, it looks like the last numbers refer to the page where the references are cited. Is this requested by the journal ?