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Natural Hazards and Earth System Sciences
Discussions
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Interactive comment on "An assessment of landslide distribution in the Faifa area, Saudi Arabia, using remote sensing and GIS techniques" *by* T. Alharbi et al.

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Reviewer #4 had seven comments. Comments 1, 4, and 6 were justified and were addressed in the revised text in accordance with suggestions made by Reviewer #4. Regarding the remaining comments, we respectfully disagree with statements he made and for a number of them, he misrepresented the information we included in our original text. In reviewing the manuscript, the manuscript was apparently not carefully examined.

Reviewer's Comment: 1) Replace the word hazard by susceptibility.

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Authors' Response: We did.

Reviewer's Comment: 2a) The planar sliding is considered a rock failure and is not a landslide phenomenon. We disagree. The planer failure can give rise to large-scale landslides that involve areas as large as mountainsides. Examples include: The KM Mountain landslide in the state of Washington in the State involved a mass movement of 1.2 to 1.5 million cubic meters was controlled by planer failure along bedding orientation within a sandstone sequence (Lowell, 1990). The 1965 Hope landslide in southern British Columbia in which 48 million cubic meters were displaced occurred along planer felsite dikes that were dipping sub-parallel to the slope (Mathews and McTaggert, 1969).

Continue Comment: 2b) Point out that in jointed rock units, the occurrence of failure depends on the friction angle of the discontinuities and not for the intact rock. That was pointed out in the original text. Refer to page 6700 lines 15 through 17. There we cite the conditions for failures along surfaces (e.g., fractures). One of these conditions is that the dip of the planar discontinuity must be greater than the angle of friction of the surface (40°). The reported angle (40°) is based on laboratory-based testing of shear strength of planar surfaces (mean: 39.6 for 29 measurements) within the study area and was similar to reported values for granites collected from shear zones elsewhere (Barton, 1973; Jaeger and Cook, 1976). Granites make up more than 80% of the outcrops in the study area.

Continue Comment: 2c) it is difficult and time consuming to evaluate friction angles on regional scale. Thus, authors should employ a representative value of friction angle of discontinuities instead of the intact rock.

Authors' Response: Again, we did not employ friction angles for intact rocks, we used a representative value of the friction angles for discontinuities. In the revised text we mentioned that the reported friction angle was based on laboratory testing of shear strength of planar surfaces within the study area, and was similar to reported values from granites collected from shear zones elsewhere.

Continue Comment: 2d) Mention that the adopted approach cannot replace the detailed work on the field.

Authors' Response: We clearly stated in the original manuscript that the adopted approach cannot replace the detailed work on the field. In page 6703 lines 11 to 15 in original text we stated: "A word of caution: the adopted approach should not be considered a substitute for traditional field-intensive methodologies and measurements, but should be only considered for inaccessible areas, where obtaining detailed field measurements is difficult and/or cost prohibitive."

Reviewer's Comment: 3) Authors state their model predicts $\sim$ 82% of future slope failures. To validate the model, separate a fraction of slope failures from the database either using temporal or spatial criteria and validate the results by comparing these subgroups.

Authors' Response: This is what we reported in the original manuscript. We refer the reviewer to page 6692 line 26 to page 6693 line 2. Using a random number generator, we extracted a subgroup of 500 debris flows from the predicted database and used this sample to validate our model results by comparisons to observed debris flows in the field and Google Earth images. In addition, the first reviewer requested comparisons between predicted and observed landslides for areas that are classified as being non-prone to landslide development. The success rate for the subset of samples (2380 samples) that were randomly selected was found to be 99.2%.

Reviewer's Comment: 4) Replace the term "risk map" by using the phrase "map showing points where slope failures could cause damages."

Authors' Response: We did.

Reviewer's Comment: 5) Delete section 2.2.2 as overland flow has nothing to do with slope failures and consequently should be deleted.

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Authors' Response: We respectfully disagree with this statement. There are certainly many instances where the displacement can start out being called "sheet wash" or some such, then evolve into a debris or earth flow as more material is set in motion downhill and the solid materials start moving largely on their own. It has been demonstrated that debris flows are usually triggered by overland flows (e.g., Blijenberg el al., 1996; Burton and Bathurst, 1998). Despite the genetic relationship between overland flows and debris flows, section 2.2.2 was omitted from the revised text for clarity purposes and to avoid confusing landslides with other types of mass movement.

Reviewer's Comment: 6) P.6697, line numbers 10-20. The paragraph should be placed in introduction.

Authors' Response: We did. In response to the referee's request, lines 10-20 were omitted from this section.

Reviewer's Comment: 7) The basic point in statistics is to ïňĄnd a model that describes a database and not just correlate two points that would be liked to be correlated. It is recommended to use another statistical analysis e.g. logistic regression analysis or a discriminant analysis in order to develop a model that is the appropriate one for describing the database of this study. Figures 5 and 8 should be replaced by the outcome of the suggested statistical analysis.

Authors' Response: We respectfully disagree. Our findings (82% success) for prediction of landslide in areas prone to mass movement and 99.2% success rates in areas non prone to mass movement is proof that we have a method that works well in the study area. The use of a limited number of factors (in our case NDVI, slope, flow accumulation) to identify areas susceptible for landslide development has been demonstrated in many other studies elsewhere (Wells, 1987; Wieczorek, 1987; Coe et al., 2008). The use of statistical models such as logistic regression analysis, neural networks, and Neuro-Fuzzy (Pradhan et al., 2010; Quan and Lee, 2012; Devkota et al., 2013) becomes increasingly important in areas where many more factors have to be considered in the identification of areas susceptible to landslide development.

The final revised version of manuscript will be submitted to the editorial office as soon as the remaining comments are received.

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Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 1, 6685, 2013.