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Marchesini et al. present a study that aims to identify areas in the Mediterranean region that are “non-susceptible” (minimally susceptible) to landslide activity. The authors use different methods that basically determine low percentiles of slope angles of observed landslides for different relative relief levels, and these percentiles are used as decision thresholds.

While the approach of identifying stable areas based on quantile regression is novel and interesting in this context, I have some concerns regarding the limitations of this approach and its disadvantages compared to more widely used landslide susceptibility modeling approaches that utilize presence and absence information. Additional major concerns are related to the need to use performance measures that adequately summarize the models’ ability to detect low-susceptibility areas (comments 11-13 below), the occurrence of a large percentage of fatal landslides in the identified “non-susceptible” areas (comments 16 and 19 below), and the limited substance of the Discussion (comment 18). The structure of the paper should also be improved substantially, and the Methods and Results would need to be rewritten considering suitable performance measures. Detailed comments are provided below.

Critique of “Method II”

The approach used in this study utilizes presence-only data of landslide occurrences without considering information from areas that have remained unaffected by landslides. In the case of the authors’ proposed “Method II”, for example, thresholds $t(r)$ are chosen in such a way that

$$P(S<t(r) \mid R=r \text{ and } L=1) = 0.05$$

for each relative relief value r (S: slope angle; R: relative relief; L: landslide presence(1) / absence(0)), using linear and exponential quantile regression models to model $t(r)$ parametrically. A grid cell with relative relief $R=r$ is considered “non-susceptible” if its slope angle $S=s$ is smaller than $t(r)$. By referring to these areas as “non-susceptible”, the authors suggest that

$$P(L=1 \mid R=r \text{ and } S<t(r))$$

is negligible, or at least that

$$P(L=1 \mid S<T)$$

is negligible, where $T = t(R)$.

Clearly, since the controlled quantity $P(S<t(r) \mid R=r \text{ and } L=1)$ depends only on landslide presence data (as it is conditional on $L=1$), this procedure does not explicitly or directly ensure that $P(L=1 \mid S<T)$ is negligible since the latter also depends on information from grid cells without landslide presence.

The formal relationship between these two quantities can be elaborated more formally using some probability calculus, and it would seem appropriate for the authors to elaborate on these theoretical relationships in this article instead of just applying a proposed methodology.

The solution to this issue would be to use, for example, logistic regression models or other models that utilize landslide presence and absence information to predict $\hat{p}(r,s) = P(L=1|R=r \text{ and } S=s)$, where “p^” is used to denote an estimator for the probability. In order to identify areas that are nearly unsusceptible to landslides, a probability threshold t can be used to construct a binary classifier. The threshold t has to be selected in such a way that a high negative predictive value NPV(t) = P(L=0|p^(r,s)<t) is achieved, e.g. NPV(t) = 0.99, which would require a very low probability threshold that can be determined empirically (see e.g. Goetz et al., 2011 in Geomorphology, and comment 11 below).

Additonal detailed comments

1. Contrary to the wording chosen by the authors ("non-susceptible"), the identified areas are clearly not completely unsusceptible to landslide activity as they contain (by construction of the classification procedure) 5% of the observed landslides. Reword: "low susceptibility"
2. P2814L19 – "Results proved" – use wording that reflects the empirical nature of the evidence
3. P2816L23 – If aerial photographs with scales ranging from 1:5,000 to 1:75,000 were used to inventory the landslides, there is probably an important difference in the quality of these inventories, in particular the smallest detectable landslide size. Additional explanation seems to be needed to support the idea that all inventories are "consistent" (P2817L32; omit the claim that the sample is "significant").
4. P2819 Eq. (3)-(5) – If I understand correctly this is a local planar approximation of topography. If this is correct, please say so, or provide other suitable verbal explanation of the procedure.
5. P2819L18-19 – This description of the algorithm is difficult to follow since it is rather imprecise. What exactly is the "10% cumulative frequency of both topographic slope and relief", i.e. the 10^{th} percentile of their bivariate distribution?
6. P2821L18 – "exponential model" would seem to be a more precise expression that should be used throughout the paper
7. P2821 and elsewhere – Results should be reported in a Results section, not in the section presenting the methods.
8. P2822, first two paragraphs of section 4 should be moved to the Methods section.
9. Figure 8 – According to the exponential model and using the authors' wording, location with a relative relief of 1000 m and a slope angle of 40 degrees or higher would still be considered "non-susceptible". The greater the relief within a 500 m radius, the steeper must be the slope to be considered susceptible to landslides, according to this study. It is difficult to see how this would be consistent with physical landslide processes as expressed by e.g. infinite slope stability models; e.g. the SHALSTAB model of Montgomery & Dietrich (1994, in Water Resources) predicts unconditionally unstable conditions when the slope angle exceeds the friction angle (typically smaller than 40 degrees), and conditionally unstable conditions at a smaller slope angle. These process models are typically only based on slope-scale variables (slope angle, upslope contributing area), and it is therefore surprising that the present empirical models consider relative relief within 500 m of horizontal distance as one of two predictors of landslide susceptibility.
10. P2823L14-25 should be moved to Methods section
11. P2823L16-18 Three comments of fundamental importance:
    a. This description of the index "I" is confusing due to partly unconventional terminology. E.g. if Nc is the "number of [observed?] landslide cells" and Lc is the "number of [observed?] landslide cells that overlaid [predicted?] non-susceptible cells", then the index I is false negative rate (FNR), or one minus the sensitivity. This is not the false

positive rate, as suggested by the authors, unless my interpretation of L16-18 is incorrect. I don't think the new and misleading term "matching index" should be introduced for this quantity since matching index sounds very much like the overall accuracy, which is a different measure of model performance.

   b. Furthermore, a good sensitivity can easily be achieved by setting a very low decision threshold, i.e. considering most of the study area as unstable. The use of the sensitivity for classifier comparison therefore only makes sense if its counterpart, the specificity, is held constant. The authors in fact seem to be holding the sensitivity constant at 95% in Models QLR and QNL as they perform quantile regression for the 5^{th} percentile of the data distribution of landslide locations.
   c. Finally, since the article claims that the identified areas are not susceptible to landslides, the authors should report the negative predictive value (NPV) as a measure of their ability to achieve this goal. The NPV is the proportion of the predicted non-susceptible area that was observed to be unaffected by landslides. As with the sensitivity, the NPV will vary with its counterpart, the positive predictive value (PPV). Perhaps the authors should consider specifying a desired NPV value in advance (e.g. 0.99 or 0.999), and to choose a decision threshold (or percentile, in the case of quantile regression) that is high (low) enough to achieve this NPV; PPV can then be used as a performance measure at the fixed NPV.

12. P2824L1-3 (and entire Results section): With a false negative rate of 6% in the QNL and QLR models, the identified area is not exactly "non-susceptible", but it perhaps has a low susceptibility (as expressed by the NPV, see previous comment). The index I does not provide sufficient evidence for a low susceptibility.
13. P2824L4-5 "too conservative", based on what, and in what sense? Can a model be "too conservative" if the goal is to identify "non-susceptible" areas? (See one of the previous comments regarding trade-off between NPV, PPV.)
14. P2824L14-23 and P2825L14-25 should be moved to the Methods section.
15. P2826L3-4 and L14-15: The presence of landslide susceptible terrain somewhere within a census region does not imply that its population is located in susceptible areas; it may be located in non-susceptible areas within the census region. Rephrase or omit; these statements don't seem to be important since the focus is on the prediction of non-susceptible areas. Same applies to L19 ("people living … in susceptible areas"), which may explain the lack of correlation in L20-21 and the referenced Fig. 5. Also rephrase P2830L12 and P2814L16 accordingly.
16. P2826L25-27: I.e. conversely 27% of the fatal landslide events occurred in the areas identified as by the authors as "non-susceptible"? Consequently, if I understand this correctly, the identified "non-susceptible" areas are in fact quite susceptible to landslide events.
17. P2827L2-8 and L12-18 should be moved to the Methods. I would expect the authors to provide a justification for the application of the proposed models beyond the calibration area.
18. P2828-9 The Discussion is rather limited and does not sufficiently discuss the present results in the context of the broader literature. E.g. advantages and disadvantages of the proposed methodology compared to other approaches for landslide susceptibility modeling, e.g. using classification methods (see Critique of Method II above) or process-based models (see comment 9.)

19. P2830L19-21: To the contrary, the authors should advise against the use of the present results for insurance or reinsurance purposes if the information provided on P2826L25 is correct, according to which 27% of the fatal landslide events occurred in the areas identified by the authors as “non-susceptible”.