

General reply to the first reviewer (3-C381-2015)

“Landslide susceptibility mapping in Mawat area, Kurdistan Region, NE Iraq: a comparison of different statistical models”

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We want to thank the first reviewer for his considerate contribution and comments, which we believe have improved the quality of the manuscript. We have implemented the suggestions and tried to modify the paper in order to answer all critics (the revisions are highlighted in yellow and gray colors).

REMARKS

- In the entire paper, the authors use the term LSI landslide susceptibility index to refer to a probabilistic susceptibility. Landslide susceptibility is more appropriate to avoid confusion with susceptibility index-based estimation approaches.

We thank the first reviewer for the suggestion; we used “landslide susceptibility” or “LS” instead of “landslide susceptibility index” or “LSI” to refer to probabilistic susceptibility (e.g. line #6, 36, 39, 42...etc.).

- The landslide terminology is not always correct (e.g. triggering area in place of depletion zone, etc.).

We thank the first reviewer for this comment; we put “depletion zone” instead of “triggering zone” (e.g. lines #30-31, line #301). Although some papers such as “Thiery et al., Landslide susceptibility assessment by bivariate methods at large scales: Application to a complex mountainous environment, Geomorphology 92 (2007) 38–59.” used the term of “triggering zone” as well.

- Some of the paper speculation on the susceptibility comparison are based on small differences in the susceptibility model performances: this can be critical in particular if not considering the possible uncertainty associated to the different susceptibility model. Basically the authors need to prove that the differences obtained using the different models are not within the modelling uncertainties.

We thank the first reviewer for the suggestion; we tested the uncertainty associated to the susceptibility models. Two type of uncertainty were tested (1) Landslide susceptibility model error (Figure 10) and (2) Sensitivity analysis (Figure 11). Moreover, the method and outcome of these two uncertainty types were stated in lines # 340-353 and 487-504, respectively.

- Moreover, the paper has two additional critical problems: (i) the authors make wrong use of ROC term, indeed they use this term to refer to success rate curves, (ii) the authors make wrong use of the term of validation to define model skill prediction performance measures.

We thank the first reviewer for this information; we used the correct name, which are “Success Rate Curve (SRC)” instead of “ROC” (e.g. line #12, 321, 323...etc.) and “prediction skill” instead of “validation” for the whole manuscript (e.g. line # 318, 319, 325...etc.).

- The tables in the appendix can be probably put in the text, in any case these need to be correctly numbered.

We agree with the first reviewer, we modified that (Table 2).

- English grammar need a check, in particular the verb tenses are not correct in all the cases, probably the use of past tense in place of the present for describing what was done in the analysis is more appropriate.

We agree with the first reviewer, we improved the English form (highlighted in magenta color).

COMMENTS AND SUGGESTION

- **Page 2 Line 26** The term erosion here is not appropriate, use the correct terminology (e.g. use depletion zone).

We thank the first reviewer for this comment; we put “depletion zone” instead of “triggering zone” (e.g. lines #30-31, line #301).

- **Page 2 Line 31** Here and in the rest of the paper the authors use “landslide susceptibility index (LSI)” in place of the more appropriate “landslide susceptibility”. In fact using the term index is misleading, since the authors in most cases intend to refer to probabilistic susceptibility values. I suggest to use here and in the rest of the paper the term “landslide susceptibility”

We thank the first reviewer for the suggestion; we used “landslide susceptibility” or “LS” instead of “landslide susceptibility index” or “LSI” to refer to probabilistic susceptibility (e.g. line #6, 36, 39, 42...etc.).

- **Page 2 Line 34** Substitute “potential regions of landsliding” with “landslide prone areas”
We implemented that (lines #38-39).

- **Page 2 Line 37** These are not “different mapping techniques” but “susceptibility estimation techniques”

Exactly, we modified that (line #41).

- **Page 3 Line 63** “GIS techniques” is too general, please be more descriptive”

We explained the GIS techniques, which used (lines #69-70).

- **Page 3 Line 63** Substitute “between four types of LSI mapping” with “the four landslide susceptibility models”

We implemented that (line #70).

- **Page 3 Line 64** Something seems missing here. Please check the phrase.

We modified the phrase (line #71).

- **Page 3 Line 66** Substitute “included” with “was organize following four main steps”
We put “is organize following four main steps” instead of “included” (line #73).
- **Page 3 Line 67** Please rephrase “without any consideration of time the occurrences”
We modified the phrase (line #74).
- **Page 4 Line 105** Substitute “The study area has frequent landsliding because of environmental and/or human–induced reasons” with “Landslides in the area are frequent and they are mainly due to natural and anthropogenic triggers.”
We implemented that (line #112).
- **Page 4 Line 108** Substitute “of” with “controlling the distribution of”
We implemented that (line #115).
- **Page 4 Line 111** Something is missing here. Please rephrase.
We modified that (lines #125-129).
- **Page 4 Line 113** The term “high certainty” is too general; please express these in a quantitative way.
We agree with the first reviewer, we expressed about the identification of the landslides in a quantitative way (line # 130).
- **Page 4 Line 116** How can you obtain a total landslide area of 3127 km², having 351 and a maximum landslide area of 0.32 km²? Please check.
We thank the first reviewer for this comment, we found that there is a “point” is missing within the total landslide area number; the number should be “3.127” (line #11 and 133).
- **Page 5 Line 143** Substitute “prepared” with “were prepared”
Implemented (line #156)
- **Page 5 Line 146** Substitute “The input parameters have two forms: discrete and continuous. The discrete form (group A) includes lithology, land cover and slope aspect, while the rest (group B) are continuous forms. We prepared the input parameters in two ways based on the applied model.” With “The input parameters can be discrete and continuous: lithology, land cover and slope aspect (group A) are discrete, while the rest (group B) are continuous.”. Here probably the distinction between categorical and numerical is more appropriate.
We modified the phrase (lines #160-161), also, we distinguished between categorical, and numerical (lines #166-168).
- **Page 5 Line 150** Substitute “to test” with “to exploit”
We implemented that (line #163).
- **Page 5 Line 152** Substitute “to test” with “to exploit”
We implemented that (lines #165-166).

- **Page 5 Line 153** From here to the end of the section: not clear, please be more descriptive.
We clarified the phrase and described the binarization more (lines #170-172).
- **Page 6 Line 158** Substitute “We used the following eight factors as geomorphological predictive factors of landsliding” with “In the susceptibility estimation we used the following eight geomorphological variables”.
We modified the phrase (line #174).
- **Page 6 Line 159** “which is an important factor causing the landslides” please be more descriptive.
We clarified that (lines #175-176).
- **Page 6 Line 163** the definition of aspect is not complete and the following sentence need to be rephrased.
We removed the slope aspect definition because the second reviewer asked that.
- **Page 6 Line 166** The definition of slope curvature is not clear
We removed the slope curvature definition because the second reviewer asked that.
- **Page 6 Line 174** Substitute “mapped the landslide susceptibility map” with “realized a susceptibility zonation”.
We did that (line #190).
- **Page 6 Line 181** TPI and HI are inverted in Equation (1) and (2)
We thank the first reviewer for this comment; we modified that (Equation #1 and 2).
- **Page 6 Line 182** this is not true, TPI was used for instance by (A) Li, Y., Chen, G., Tang, C., Zhou, G., & Zheng, L. (2012). Rainfall and earthquake-induced landslide susceptibility assessment using GIS and Artificial Neural Network. *Natural Hazards and Earth System Science*, 12(8), 2719-2729. (B) Mohammady, M., Pourghasemi, H. R., & Pradhan, B. (2012). Landslide susceptibility mapping at Golestan Province, Iran: a comparison between frequency ratio, Dempster-Shafer, and weights-of-evidence models. *Journal of Asian Earth Sciences*, 61, 221-236. (C) Ozdemir, A., & Altural, T. (2013). A comparative study of frequency ratio, weights of evidence and logistic regression methods for landslide susceptibility mapping: Sultan Mountains, SW Turkey. *Journal of Asian Earth Sciences*, 64, 180-197.
We thank the first reviewer for this information, we modified that by removing “for the first time” from the sentence, and we put two citations suggested by the second reviewer (lines #198).
- **Page 7 Line 208** Before “The precipitation” add “Form the daily data series we estimated the year precipitation.” Which type of precipitation map?
We modified the sentence to be “We averaged annual precipitation from the daily time series data.” (line #226).

- **Page 7 Line 209** here you probably use IDW to “interpolate the precipitation data”
Exactly, and we clarified that (lines #226-228).
- **Page 8 Line 251** the definition of A is missing
We thank the first reviewer for this comment; and we gave the definition of A (line #254).
- **Page 10 Line 290** Make the sentence more clear and use the correct terminology: e.g. depletion zone scarp.
We clarified the sentence and we corrected the term to be “depletion zone” (lines #300-301).
- **Page 10 Line 300** In place of “landslide-present pixels” use “pixel with landslides” or “unstable pixels” and in place of “landslide-absent pixels” use “pixel without landslides” or “stable pixels”.
We used “pixel with landslides” and “pixel without landslides” instead of “landslide-present pixels” and “landslide-absent pixels”, respectively (line #307, 310, 312, 313 and lines #312-313).
- **Page 10 Line 307** The reference for R is missing.
We thank the first reviewer for this comment; we added the reference of R (line #316).
- **Page 10 Line 309** Here you are not doing a model validation but you are measuring the prediction skill of the model. Validation requires the application of the model in areas different from those the model were trained.
We thank the first reviewer for this comment; we modified the term to be “prediction skill” (line #319).
- **Page 10 Line 312** Here you are indicating ROC curve (Fawcett, 2006), but what you are using is a success rate curve (e.g. see Chung and Fabbri, 2003)
We agree with the first reviewer we modified it to be “success rate curve” (line #321) and we cited of “Chung and Fabbri, 2003” (line #325).
- **Page 13 Line 387** The sentence is not clear.
We already removed the sentence from the manuscript.
- **Page 13 Line 389** “The ranges of the prediction factors are good indicator to their effect”. This is not straightforward, be more descriptive.
We modified the sentence (lines #417-422).
- **Page 13 Line 403** Substitute “withheld of” with “excluded from”.
We substitute “withheld of” to “excluded from” (line #435)
- **Page 13 Line 407** Substitute “of” with “controlling the”
We implemented that (line #439).

- **Page 13 Line 408** Remove “This means that” because this is implicit in the definition of odd ratio.
We removed it.
- **Page 13 Line 415** Substitute “distribution of the LSI of” with “susceptibility zonations obtained using ”
We did that (line #448).
- **Page 13 Line 417** Substitute “that their spatial distributions are similar” with “a similar spatial distribution”.
We did that (line #449).
- **Page 14 Line 420** The sentence is not clear, please rephrase.
We thank the first reviewer for this comment; we clarified the sentence (line #452).
- **Page 14 Line 422** Substitute “with each other” with “with other susceptibility models”
We did that (lines #454-455).
- **Page 14 Line 426** Substitute “from GIS to a statistical software program” with “from GIS standard formats to the format required by the statistical software”
We did that (line #459).
- **Page 14 Line 428** Substitute “forme.” with “form.”
We implemented that (line #461).
- **Page 14 Line 436** In the paper the term “ROC curves” are wrongly used to refer to success rate curves.
We agree with the first reviewer; we used the correct term, which is “Success Rate Curve (SRC)” in the whole manuscript (e.g. line #12, 321, 323...etc.)
- **Page 14 Line 438** Here and after substitute the terms “yield” with other terms.
We implemented that (lines #470 and 471).
- **Page 14 Line 445** Again here the term validation is probably used to refer to the evaluation of the model skill performances. Please also refer to the comment on section 3.5.
As we said before, we substitute “validation” with “prediction skill” for the whole manuscript (e.g. line # 318, 319, 325...etc.).
- **Page 14 Line 458** Substitute “that tested” with “tested”
We implemented that (line #511).
- **Page 14 Line 474** This conclusion is a bit weak, remember that curvature can be calculated also considering different and greater kernel sizes.
We agree with the first reviewer, we removed this conclusion and modified this paragraph (lines #525-528).

- **Page 15 Line 480** Substitute “as the factor of” with “as significant factor to explain”. Moreover in the rest of the sentence be more descriptive.
We Substituted “as the factor of” with “as a significant factor to explain”, and modified the sentence (line #533).
- **Page 16 Line 497** See previous comment on the topographical position index.
We thank the first reviewer for this information, we modified that by removing “for the first time” from the sentence (line #553).
- **Page 16 Line 500** See previous comment on curvature.
We removed this sentence from conclusions.
- **Page 16 Line 504** Substitute “to one other” with “one to each other”.
We modified the sentence and we used “of each other” (line # 557).
- **Page 16 Line 509** See previous comments on validation.
We used “prediction skill” term instead of “validation” (line #562).

FIGURE

- **Fig 1** Use “return period” in place of “of the Imbricated Zone” in the legend
The geological term of “Imbricated Zone” is used by many publications such as (1) Jassim, S. Z. and Goff, J. C.: Geology of Iraq, Dolin, Brno, Czech Republic, 2006; (2) Fouad, S.F., 2010a. Tectonic Map of Iraq, scale 1:1,000,000, third ed. GEOSURV, Baghdad, Iraq; and (3) Sissakian, V. K.: Geological evolution of the Iraqi Mesopotamia Foredeep, inner platform and near surroundings of the Arabian Plate, Journal of Asian Earth Sciences, 2012. Therefore, we prefer to use “Imbricated Zone” term as the abovementioned authors stated.
- **Fig 3** Pictures do not allow to verify the real landslide type. Try to use different or more descriptive pictures. The graphical scale here are not useful, please try to use these to indicate some of the landslide characteristics (e.g. width, length, etc).
We thank the first reviewer for this comment; we used the pictures, which are more descriptive. Moreover, we added the width and the length of the landslides instead of picture scale.
- **Fig 4** Use another color scale in maps in Figure F to highlight better or the curvature variation in the study area.
We did that (Figure 4 F).
- **Fig 6** Is the figure A portraying TWI? It seems just a shaded relief of the study area. Please check.
We thank the first reviewer for this comment; The TWI map was missing and we plotted again (Figure 6A).
- **Fig 7** What are the “prediction factors estimation ranges”?

We meant, “the ranges of the prediction factor estimation weights”, and we stated that in the figure 7 caption.

- **Fig 9** A is not a ROC curve plot but a success rate curve plot
We agree with the first reviewer; we used “SRC plot” term instead of “ROC curve” (Figure 9A).

FIGURE CAPTIONS

- **Fig 1** Use “the Imbricated Zone” in place of “of the Imbricated Zone”.
We implemented that.
- **Fig 3** Please use a standard term for the classification of “slumps” (e.g. Cruden & Varnes classification).
We thank the first reviewer for this comment; we used the standard terms of (Cruden & Varnes classification).
- **Fig 8** What “based on different combinations models” means here?
We removed this sentence from the caption of figure 8.
- **Fig 9** Move “Bar graph showing” after “(B)”. The plot in A is not a ROC curve plot but a success rate curve plot.
We agree with the first reviewer; we moved “Bar graph showing” to be after “(B)” and we put “SRC plot” instead of “ROC curve” (Figure 9).

TABLES APPENDIX A

- Number both table and modify their references in the text.
We did that (Table 1 and 2)