Nat. Hazards Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/nhess-2019-311-RC2, 2020

Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Modelling landslide hazard under global change: the case of a Pyrenean valley" *by* Séverine Bernardie et al.

Anonymous Referee #2

Received and published: 8 April 2020

The manuscript show a study of the influence of climate change on slope stability in a valley of the Pyrenees. Authors describe a very inspiring exercise integrating different inputs and models to simulate the effects on slopes' propensity to failure of possible future land use and precipitation scenarios. To do this, they use up-to-date tools based on spatially distributed models and perform a complete procedure to achieve their objectives. The article is a model for how such work could be conducted in other areas and is a suitable contribution for the journal. I have only several corrections and suggestions that I proceed to expose.

1. There is a major problem with the terminology throughout the manuscript. Authors use the term "landslide hazard" but they did not estimated that in their study stricto sensu. Hazard implies spatio-temporal probability. Authors are really estimating the

change in the Factor of Safety (FoS) (i.e. Slope Stability) of the slopes according to different conditions. It is true that the results of their calculations are spatially distributed and they are providing temporal information. Nevertheless, their model outputs are not the expected number of landslides per year and per area. The nature of the data have its implications because, for example, the FoS do not serve to estimate risk. If authors want to be precise, they have to use in the text and in the title the term "slope stability" instead of "landslide hazard".

2. Many researchers have described how anthropic activities have high impact on the stability of slopes (cf. Glade, 2003; Remondo et al., 2005). Crozier (2010) state "Changes resulting from human activity are seen as a factor of equal, if not greater, importance than climate change in affecting the temporal and spatial occurrence of landslides". This is reasonable because slope modifications due to infrastructure construction or urbanization and significant land use changes produce great alteration on slope conditions. Please, discuss your results taking this paradigm in your mind. In the presented study area the human activities have a minimal disturbance to the environment, which may explain that the increase of precipitation due to climate change could have more impact than human action. This is not the situation in many countries, specially across the Global South. This idea must be stressed because, if not, other researchers can underestimate the human action over the physical medium.

3. Authors explain in the introduction section that there are two ways to simulate future scenarios of landslide activity: physical and statistical models. They use an approach based on physical modelling to investigate failure processes at regional scale. I suggest authors to justify the selection of a physical model and discuss about other approaches. To do so, I suggest them to consult several papers about comparisons between physical and statistical models (e.g. Cervi et al., 2010; Zizioli et al., 2013; Davis and Blesius, 2015; Ciurleo et al., 2017; Bartelleti et al., 2017; Galve et al., 2017; Oliveira et al., 2017).

4. In order to enrich the literature and discussion of the manuscript, I suggest authors

to read the following papers dealing with the effects of land use change on landslide susceptibility and hazard: Vanacker et al., 2003; Van Beek and Van Ash, 2004; Reichenbach et al., 2014; Galve et al., 2015; Persichillo et al, 2017.

5. I also suggest authors to discuss about the application of their model and the extrapolation of their results to other regions (data and model requirements).

6. It is needed a large map where all the cited toponyms are included.

7. I do not like how authors describe landslide typology and morphologies. For example, they use "landslides with rotational shear surfaces, landslides with translational shear surfaces". Why are they using this long descriptions if they can use widely accepted landslide classifications such as Cruden & Varnes (1996) or Hungr et al. (2014)? Regarding the landslide associated landforms they use "(i) the landslide-triggering zone (LTZ) and (ii) the landslide accumulation zone (LAZ)" to designate parts of the mapped landslides. However the term accepted by the international community for their "LTZ" and "LAZ" should be "Zone of depletion" and "Zone of accumulation" (Varnes, 1978). The use of appropriate and widely accepted terminology avoid the necessity of explaining the not so widely used terms, as authors have to do in the second paragraph of page 8.

8. Models seem to indicate that "Bare soils" are always stable. Please, explain that?

9. I would appreciate a table with the model validation results and a figure with the ROC and PRC curves. How can explain the high performance of the models? In my opinion, the prediction capability is very good for a physical model applied at regional scale.

—

OTHER COMMENTS

Table 2 "Defined using related literature based on field investigations". Local or global literature?

Figure 1. - Colour landslide according to their type. - Add coordinates. - Authors only mapped active landslides? - Caption: Change "layer" and "layers" by "deposits".

Figure 2. - Change "Mineral surfaces" by "Bare Rock" (as Corine Land Cover terminology)

Table 3 How was additional cohesion calculated?

Section 3 "Gave" is a term used for creeks or streams in the western Pyrenees. Please, change the term to the appropriate English word or define "Gave" in the text. Please, define what the "Soum de Grum" and the "Grand Barbat" are. Are they a place, an area, a district, a landform?

Page 4 Line 25. What is GIEC? Lines 29 and 31. Assign citations to ALICE and GARDENIA tools.

Page 6 Line 21. What are the RTM services?

Page 9 Line 10. Please, define "moraine colluviums"?

Page 14 Line 15. Add a citation to ALADIN-Climate model of Météo-France.

Page 16 Line 14. Please, explain the method applied to define the hazard classes.

Page 17 Reducing the first paragraph could make the reading more fluent.

Page 18 Lines 3-16 aprox. This is an explanation of the validation techniques and it may be displaced to the metholodology section. In this regard, how were no-landslide/stable points selected to produce ROC curves?

REFERENCES

Bartelletti, C., Galve, J.P., Barsanti, M., Giannecchini, R., Avanzi, G.D.A., Galanti, Y., Cevasco, A., Azañón, J.M. and Mateos, R.M., 2017, May. GIS-Based Deterministic and Statistical Modelling of Rainfall-Induced Landslides: A Comparative Study. In Workshop on World Landslide Forum (pp. 749-757). Springer, Cham.

Cervi, F., Berti, M., Borgatti, L., Ronchetti, F., Manenti, F. and Corsini, A., 2010. Comparing predictive capability of statistical and deterministic methods for landslide susceptibility mapping: a case study in the northern Apennines (Reggio Emilia Province, Italy). Landslides, 7(4), pp.433-444.

Ciurleo, M., Cascini, L. and Calvello, M., 2017. A comparison of statistical and deterministic methods for shallow landslide susceptibility zoning in clayey soils. Engineering Geology, 223, pp.71-81.

Crozier, M.J., 2010. Deciphering the effect of climate change on landslide activity: A review. Geomorphology, 124(3-4), pp.260-267.

Cruden, D.M. and Varnes, D.J., 1996. Landslides: investigation and mitigation. Chapter 3-Landslide types and processes. Transportation research board special report, (247).

Davis, J. and Blesius, L., 2015. A hybrid physical and maximum-entropy landslide susceptibility model. Entropy, 17(6), pp.4271-4292.

Galve, J.P., Bartelletti, C., Notti, D., Fernández-Chacón, F., Barsanti, M., Azañón, J.M., Pérez-Peña, V., Giannecchini, R., Avanzi, G.D.A., Galanti, Y. and Lamas, F.J., 2017, May. Deterministic and Probabilistic Slope Stability Models Forecast Performance at∼ 1: 5000-Scale. In Workshop on World Landslide Forum (pp. 741-748). Springer, Cham.

Galve, J.P., Cevasco, A., Brandolini, P. and Soldati, M., 2015. Assessment of shallow landslide risk mitigation measures based on land use planning through probabilistic modelling. Landslides, 12(1), pp.101-114.

Glade, T., 2003. Landslide occurrence as a response to land use change: a review of evidence from New Zealand. Catena, 51(3-4), pp.297-314.

Oliveira, S., Zêzere, J., Lajas, S. and Melo, R., 2017. Combination of statistical and physically based methods to assess shallow slide susceptibility at the basin scale.

Natural Hazards and Earth System Sciences, 17(7), pp.1091-1109.

Reichenbach, P., Mondini, A.C. and Rossi, M., 2014. The influence of land use change on landslide susceptibility zonation: the Briga catchment test site (Messina, Italy). Environmental management, 54(6), pp.1372-1384.

Remondo, J., Soto, J., González-Díez, A., de Terán, J.R.D. and Cendrero, A., 2005. Human impact on geomorphic processes and hazards in mountain areas in northern Spain. Geomorphology, 66(1-4), pp.69-84.

Van Beek, L.P.H. and Van Asch, T.W., 2004. Regional assessment of the effects of land-use change on landslide hazard by means of physically based modelling. Natural Hazards, 31(1), pp.289-304.

Vanacker, V., Vanderschaeghe, M., Govers, G., Willems, E., Poesen, J., Deckers, J. and De Bievre, B., 2003. Linking hydrological, infinite slope stability and land-use change models through GIS for assessing the impact of deforestation on slope stability in high Andean watersheds. Geomorphology, 52(3-4), pp.299-315.

Varnes, D.J. 1978. Slope Movement Types and Processes. In Special Report 176: LAndslides: Analysisand Control (R.L. Schuster and R.J. Krizek, eds.), TRB, National Research Council, Washington, D.C., pp. 11-33.

Zizioli, D., Meisina, C., Valentino, R. and Montrasio, L., 2013. Comparison between different approaches to modeling shallow landslide susceptibility: a case history in Oltrepo Pavese, Northern Italy. Natural Hazards and Earth System Sciences, 13(3), p.559.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2019-311, 2020.