

Interactive comment on “Uncertainty analysis of the estimation of stony debris flow rainfall threshold: the application to the Backward Dynamical Approach” by Marta Martinengo et al.

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Received and published: 4 December 2020

We would like to thank the anonymous referee #1 for the useful comments that will be used to improve the manuscript.

Summary

The study describes the uncertainty analysis of the estimation of rainfall threshold to initiate debris flow using the Backward Dynamical Approach. In general, the topic is novel and interesting to readers; whereas, quality of the manuscript is not up to the

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standards of an international journal. A major revision is needed to adjust the writing structure and clear the issues of the manuscript.

Major issues

1. The title used “stony” debris flow; it is better to explain why the study emphasize on the type of debris flow solely.

We agree. In our work, we only consider stony debris flow because of the hypothesis on which the BDA is based on. The BDA approach is applicable only if the presence of silt and/or clay in the mixture is negligible, namely if silt and/or clay have no effects on the overall rheological properties of the mixture. We will explain this aspect in the Introduction of the revised manuscript.

2. The Discussion content is combined with the Conclusion and poor discussed. Authors should make well discussions of your study and adjust your sections. It is suggested to adjust your writing structure in the form of Results and Discussion, then Conclusion. The Conclusion contents need to be rewritten.

We will adjust the paper structure in the revised manuscript dividing discussion and conclusions and improving their contents as suggested. In particular, in the Discussion we will analyse and interpret the results of our study more in detail. We will better stress what are the main effects of the uncertainty of the input parameters on the rainfall conditions estimate (i.e. intensity I and duration D) and what are the event characteristics that emphasize the variability of this estimate. We will also better highlight the impacts of the input parameters uncertainty on the threshold estimate and the differences between the mean values of both the (I , D) couples and the threshold, obtained performing the Monte Carlo simulations, and the outcomes of the standard calibration (i.e. the reference values) and what these differences imply. The Conclusion will be rewritten focusing on the resulting robustness of the BDA method. We will also stress in which cases it is necessary

to put care in the estimate of the input parameters, why it is advisable to apply the BDA to other study areas (namely to test this approach with different data), how it is possible to implement the developed uncertainty analysis to other parameters-dependent thresholds (e.g. the threshold proposed by Zhang et al., 2020) and finally, why it is important to perform a suitable validation analysis (not addressed in this manuscript) to assess the threshold forecast capability.

3. Authors should read the instructions of the journal to following its style. There are many parts in the manuscript is not coincided with the journal.

We thank the referee for the indications. We will adjust the structure in the revised version of the manuscript following better the journal guideline.

4. In P2, there are many method contents here; it is better to combine with the following Method section. The final paragraph in this page is not required and can be deleted.

We agree. We will reduce the description of the BDA and the proposed method for the uncertainty analysis in the Introduction. We will leave only a synthetic scheme of both because we consider it useful to guide the reader through the manuscript.

5. In the manuscript, the uncertainty of rainfall threshold is estimated; but, can the authors tell us how the results improve our precision of rainfall threshold for issuing debris flow warning?

Perhaps we were not clear enough in explaining the purpose of this paper. The uncertainty analysis and the validation differ in terms of purpose. The uncertainty analysis aims to inspect the robustness of a method, namely checking if the uncertainty of the inputs leads to high variability in the outputs. Instead, the validation purpose is to check the effectiveness of a method and the reliability of its outputs. This work proposes an operative methodology to analyse the robustness of the BDA method used for calibrating a threshold. Hence the results

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of this study cannot say anything about the reliability in forecasting debris flows. The goal of the BDA was to provide a physical-based approach to calibrate the rainfall threshold. However, the assessment of a possible improvement brought about by this new approach, with respect to other literature methods, must be carried out through a suitable validation analysis. We are currently developing a proper approach to validate the BDA-based threshold that will be the object of a forthcoming manuscript. In any case, we believe that it makes sense to validate only a threshold that revealed to be robust. Therefore, in carrying out our research, we first faced the robustness matter (this paper) and then we will deal with the validation topic (forthcoming paper). We will better clarify the aim of this work in the Introduction of the revised manuscript.

Minor issues

1. The term debris-flow and debris flow are mixed used in the context.
We thank the referee for the comment. Actually, we made some mistakes in the use of the two terms. In the revised manuscript, “debris-flow” and “debris flow” will be employed as an adjective and as a noun respectively.
2. Figure 2 is not required and can be deleted
As suggested by the anonymous referee #2, in the revised version of the manuscript we will insert a section devoted to the study area and data. We think that Figure 2 should acquire more meaning in this new section.
3. In P4, what are t_1 and t_2 should be explained here briefly.
We agree. We will insert a brief explanation of the computation of t_1 and t_2 in the revised version of the manuscript.
4. The texts (a), (b) etc. and legend are better to move on the corner of the figures

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4, 9, and 10 to spare the space.

We will follow the suggestion.

Opinion

In general, the manuscript is interesting to readers of the journal. Whereas, the writing structure of the manuscript needs to be adjusted and the scientific quality needs to be improved. I prefer not to accept the manuscript at present form without a major revision.

Bibliography

*Zhang, S. J., Xu, C. X., Wei, F. Q., Hu, K. H., Xu, H., Zhao, L. Q., and Zhang, G. P.: A physics-based model to derive rainfall intensity-duration threshold for debris flow. *Geomorphology*, 351, 106930, 2020.*

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