Dec. 09, 2018

Editor

Nat. Hazards Earth Syst. Sci.

Re: nhess-2018-241

Dear Editor,

With this letter, we are submitting the revised version of the captioned manuscript. All comments from the editor and reviewers have been well addressed. Details are given in the attached response to editor and reviewer's comments.

The co-authors really appreciate the invaluable comments and do believe that the manuscript has been greatly improved accordingly.

Thank you very much for reviewing.

Best wishes,

Jian Huang

Manuscript: nhess-2018-241

Title: Study on the combined threshold for gully-type debris flow early warning

Authors: Jian HUANG, T.W.J. van Asch, Changming WANG, Qiao LI

Revision - editor' response

General Points:

1. ***Paper is well written and it is as per the scope of the journal. Editorial panel has observed some minor corrections which hamper the high quality publication.***

   Answer: Thanks for the editor's comments. The problem has been revised in this revision.

Specific Points:

1. ***Fig. 2 (a) North arrow and Scale bar is missing.***

   Answer: The problem has been revised in this revision. Please refer to the Fig.3(a).

2. ***If possible, different elevation heights can be presented by DEM map.***

   Answer: The DEM map has been added in this revision. Please refer to the Fig.2(a).

3. ***Provide the slop map of the study area.***

   Answer: The map has been added in this revision. Please refer to the

Fig.2(b).

4. ***Fig. 3 Location of YL06 is missing.***

   Answer: The YL06 has been added in Fig.3 in the revision.

5. ***Line 177, rainfall intensity 73.5 mm/hr instead of 73.5 mm.***

   Answer: It has been revised in this revision.

6. ***Line 194 and line 210, pore pressure value for SY01 is differed.***

   Answer: It has been revised in this revision.

7. ***What will be effect of any hydraulic structure i.e. check dam at downstream on pore pressure, how it will be considered in existing method.***

   Answer: During this study, monitoring sensors of pore pressure were installed at the upstream to illustrate how the deposited material start to slip, and then become a debris flow. Check dam at downstream plays a great role to mitigate the influence of debris flow. In this manuscript, we focused on the combined method for forecasting the debris flow occurrence. The effect of check dam to the method, we can do more during the next stage of study.

Revision – peer reviewer' response

Summary of the paper:

Huang, et al., 2018 implement an early warning system for gully-type debris flows, especially for the northern part of Qingping town, Mianzhu city, Sichuan province, southwest China. The authors attributed the recent occurrence of such mass movements in this region to the fact that the area was hit by an earthquake and heavy rainfalls over a short period of time. That resulted in the gully – type debris flows mentioned before. As a consequence, the authors developed a three-step warning system choosing the critical pore pressure and rainfall factors as their key parameters. Their system/model, which should be pointed out, is quite an accomplishment considering they developed and applied a new model from scratch.

Answer: Thanks for the reviewer's comments.

Minor Comments:

1. ***Reading the paper it was sometimes hard to follow the thread since there were some structural in the paper under review by Huang, et al., 2018 in the methodology chapter. It not only contains methodological aspects but also the data analysis. That being said, the methodology chapter should end at line 144 and the data analysis should be put into a new chapter called e.g. "Results".***

Answer: Thanks for the reviewer's such a good suggestion. The structure of this manuscript has already been revised in this revision.

2. ***The discussion chapter (starting at line 270) limits the application of said model to one specific gully, but in the introduction they suggested that they developed a model that was applicable for more than just the one gully. Maybe a change in phrase should be considered, since it is a little misleading for the reader. Even more so as they give an outlook that a broader application must be done in future studies. The same could be said for the abstract which leads the reader to believe that they indeed developed a model that is applicable for mountainous areas in general which in other ways is very well written and summarizes the paper well.***

   Answer: The abstract and discussion of this manuscript has been revised in this revision to make it clearer for understanding and without misleading.

Comments on the Content:

1. ***Given that it is indeed a new model and that its application is limited to southwest China at the moment, the question arises why the authors have developed it in the first place.***

   Answer: Gully-type debris flows are common in Southwest China, especially after the Wenchuan earthquake. The Wenjia gully was not a debris flow gully before, but it caused great damage and economic

losses right now. Therefore, based on the consideration of research funds it has been selected as a typical case study area for the field monitoring and data collecting. Even though there are many limitations and work to deal with in a short time, we still have to begin this study as soon as possible.

2. ***There are several other models on slope stability as well as warning systems that should have been at least mentioned in the paper. The authors, moreover, do not give a reason why they have decided in favour of their specific model to calculate their parameters since there are several other models to calculate them and therefore Huang et al. should make their motivation clear. There is for example the SINMAP – Model (Deb & El-Kadi, 2009), a GIS -based model for example used in Hawaii in order to predict landslides or the even older TOPMODEL from 1979 (Beven & Kirkby, 1979) to account for the hydrology.***

   Answer: More referred literatures have been added in the introduction of the revised manuscript. The authors finally selected the model from Keefer et al. (1987), which is mainly determined by the field monitoring system, including the rain gauge and pore pressure monitoring sensors. The aim is to find the relationship between the rainfall and pore pressure, as well as the occurrence of debris flow events.

3. ***On the other hand, the authors (Huang, et al., 2018) made it clear why a warning system for the south west part of China was needed, since the model's first and foremost application should be to save lives in the region.***

   Answer: The earthquake trigged thousands of landslides and cracked mountains, which made these areas prone for debris flow development under rainstorm conditions, and its effect maybe for a long time. Based on these reasons, Wenjia gully has been selected as a case study area, and establish a field monitoring and early warning system to mitigate the losses from debris flow.

4. ***As for choosing the critical pore pressure, the authors do not justify their preference of this parameter over, for example, the Factor of Safety or the critical soil depth (MEMPS – Model, (Michel & Kobiyama, 2016)) to estimate the debris flows.***

   Answer: Based on the field monitoring system, critical pore pressure has been selected as a triggering factor for forecasting debris flow occurrence. The other parameters, we think that they might be useful for the geohazards early warning system, and we will study them in the near future.

5. ***The application and presentation of their findings benefit from the large amount of data which were collected through their measurements but it lacks a specific figure/map overlaid with their***

model. That would have made it easier for the reader to see where the different warning levels had occurred.

Answer: During this application, the tracing alert is in a real-time way. So, we focus on the combined thresholds, to check whether it's useful or not. For readers, it's better that more figures provided for a comprehensive understand where the different warning levels had occurred. But frankly speaking, when we came to the field for an investigation. It's very hard to make sure the accurate position where debris flow start. Therefore, the map of different warning levels we didn't put it into this manuscript. Fortunately, we got more field monitoring data and experiences on debris flow early warning for the next study.

Summary:

1. ***All in all, the paper describes quite a new approach for estimating the danger of debris flows but it does not give a motivation why this specific model has been chosen and not other methods already published. On the other side, the authors of the study clearly stated why a model is needed. This should make a good basis for future studies on gully – type debris flows even though the use of the chosen model is still limited to testing the area described. On a positive note, it can be said that, the paper is also suitable for people that are not familiar with the topic and besides the methodology***

chapter being not that structured and the discrepancies between abstract/discussion on the one hand and the introduction on the other it is indeed very well written.

Answer: Thanks for the reviewer's comments. The Wenjia gully was selected as a case study, and the model used in the area for its simple and useful consideration, as well as which has been determined by the field monitoring system. The nice suggestions about the literatures and structure changes have been modified in the revised manuscript, and more research work will be considered in the near future.

Revision - reviewer' response

Summary of the paper:

Huang et al. (2018) explored the combination thresholds (pore pressure and rainfall) for gully-type debris flow in Wenjia gully, China. A three-level early warning system is presented and applicable to the real-time debris flow warning. The topic is certainly of interest for the readership of Natural Hazards. However, the overall quality of the manuscript is poor in presentation. The main problem is the lack of a clear discussion of the contribution of this work.

Answer: Thanks. All the comments have been considered and revised in the revision.

Detailed Comments:

1. ***The Introduction section is not well organized, which makes readers confused about the real relevant background information and its relationship to your topics.***

   Answer: The introduction of this manuscript has been reorganized in the revision to make it clearer for the readers.

2. ***Table1: What is the time period of the accumulated precipitation? The conclusion that the number of debris flows decreases with time is hard to read from the table. Instead, a figure of trend line will be better.***

Answer: The definition of the accumulated precipitation has been added in the revision. Please refer to Lines: 150-152. The trend figure has been added as well, please refer to the figure 5 in the revision.

3. ***Some contents of Section 3.1 and Section 3.2 are unlikely to belong to Methodology, they are more like data sources and results, and should be re-organized..***

   Answer: The section 3.1 and 3.2 have been reorganized in the revision.

4. ***In Fig 7, it is not convincing that only one record exceeds the threshold, besides, is the location of the debris flow matched with SY01? It is necessary to specify the locations of debris flow events and monitoring sensors. How about other two debris flow events that have detailed records (you mentioned there are three debris flow events with detailed pore pressure monitoring data).***

   Answer: The one record of pore pressure presented in Fig.9 to show that the changes of pore pressure can be regarded as a factor for forecasting debris flow occurrence. And after this rainfall event, when we came to the field for investigation. It's very difficult to ensure the accurate location where the debris flow started. But at the location of SY01, we can make sure that the thickness of deposited material has been changed by the debris flow. The other two debris flow events are discussed below following the presented method. Field monitoring

data is difficult to obtain, and the debris flow events are not easy as well. Based on such condition, the presented method can be thought as a preliminary result for this research stage. When more data collected in the future, the combined threshold still can be developed and improved by the presented methodology.

5. ***In Fig 8, as only several rainfall events are used to validate the proposed results, the readers will seriously doubt these statistical-based conclusions.***

   Answer: After installing the monitoring sensors, more than five years have passed. There are only three debris flows which have been captured by the monitoring system. While more data collected in the future, we do believe that the presented method would be more seriously for the readers.

6. ***Line 229-236: 8 rectangular points with debris flow means the rainfall event with debris flow, should the magenta points also belong to this group? And the blue points also belong to the triangle group? It is confused. Why there is only 5 points? only 5 rainfall events have the pore pressure information? The analysis of Fig 8 is not clear enough to obtain the final conclusion (the rainfall threshold and pore pressure threshold need to be combined) and needs to be improved.***

   Answer: In fig. 10, the magenta points and blue points indeed

exceeded the rainfall threshold, but there was no debris flow occurrence. Therefore, it proved that the rainfall threshold might not be referred as the only index for predicting debris flow occurrence. The pore pressure in the deposited material plays an important index in slope stability. So, we combined them together to show a comprehensive analysis for debris flow early warning. The only 5 triangle points of rainfall amount are history events in the study area, which exceeded the rainfall threshold, but there is still no debris flow. All these information show that rainfall thresholds are not enough for the gull-type debris flow forecasting.

7. ***Line 263-266: it would be better to show the changes of rainfall and pore pressures for the two rainstorms in 2014 you mentioned, like the small circular magenta solid points in Fig 9.***

   Answer: Fig. 11 (Fig.9 before) shows how to use this presented method for gully-type debris flow early warning in a real-time way. Therefore, only one case has been analyzed in this figure, and the other two cases in 2014 has been listed in Table 1, and illustrated in the conclusion section by a discussion. For readers, we think it's better to be clear and simple to use the provided method in practice. While more valid data collected in the future, more deep analysis work will be done to complement this methodology for gully-type debris flow early earning.