Response to reviewers comments

on the manuscript no: nhess-2014-355

Landslide susceptibility analysis by means of event-based multi-temporal landslide inventories

revised for publication in

Natural Hazards and Earth System Sciences

by

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Here we list two main differences between our paper and Chang et al. (2014) paper as below:

1. **Methodology**
   The landslide susceptibility of Chang's paper mainly evaluated by comparison of observed rainfall data with the critical rainfall Q_{cr} obtained from a physical-based model. This kind of deterministic approach need many field soil parameters like saturated soil transmissivity, wet soil bulk density, effective angle of internal friction of soil and cohesion stress of soil. However in our paper, the landslide susceptibility is evaluated based on a statistical approach. We use the WOE method calculates the weight for each predisposing geo-environmental factor affecting the landslide based on the presence or absence of landslides. Thus it is quite different approach used in these two papers.

2. **Landslide inventory**
   Chang's paper developed two kind of model based on different combination of event-based landslide inventory, i.e. "catch-all" and "group" models. The catch-all model is establish by using information on all available typhoons and a group model by using information on a group of typhoons with similar accumulated rainfall. Basically, these two models are developed based on a combination of different typhoon landslide inventories as the past literatures. However in our paper, we developed the landslide susceptibility model only use one typhoon landslide inventory. We discuss the most suitable typhoon rainfall scale to establish an optimal model. This point is also the major contribution of our paper.

P1138, L11-L14: This means that landslide susceptibility zonation are useful only when similar events occur. If this is the case a detailed analysis of the typhoons events (direction, intensity, magnitude) is mandatory. Make comments and explain better
Our results indicate that the best model should be constructed by using landslide inventory close to the landslide occurrence threshold. According to the summary of distribution of landslides induced by the four typhoons for each susceptibility level (Table 5), except the extreme event of Typhoon Morakot which rainfall amount far exceeds the critical rainfall threshold required for landslides occurrence thus the weight of the landslide factors and landslide occurrence does not effectively distinguish areas that are susceptible to landslides. Over 80% of the actual landslide area of the other two typhoon events located in the areas of very high and high susceptibility levels. For Typhoon Mitag (small rainfall amount), 92.45% of landslides occurred within the predicted landslide area, while 83.15% of the Kalmaegi (median rainfall amount) landslides were within the predicted range. This indicates that the susceptibility model is not only useful when similar events occur.

P1138, L16: explain or predict?
explain

P1140, L6: What do you mean with relevant factors?
Relevant factors means the factors have higher explanatory power to landslide occurrence.

P1140, L11-L13: This is true only in some areas around the world and for some type of landslides.
Yes, it is an efficient way to map the landslides where the vegetation was stripped off due to landslide movement.

P1140, L13: Why multi-temporal?
We use the satellite images before and after a single typhoon to map the landslides induced by this single event.

P1140, L14-L15: What do you mean with scale of storm (magnitude)?
Rainfall scale means rainfall amount during typhoon period.

P1140, L17-L18: A very similar paper has been published in 2014 in Geomorphology 208, 137–148 by Chang et al. (Modeling the spatial occurrence of shallow landslides triggered by typhoons).
We explain two main differences of these two papers aforementioned.

P1141, L15: It' is relevant to group the rocks according to the age?
In the study area including two difference geologic province. The western foothills is composed of Oligocene to Pleistocene clastic sediments, the exposed rocks according to the different lithology and physical properties. Four stratigraphic units: sandstone-shale, meta-sandstone, conglomerate and gravel, and sand. The western Central Range belt is underlain by the pre-Tertiary metamorphic complex exposed, that stratigraphic unit is slate. Rock lithology is a well-known behavior and is of considerable interest in the weathering conditions and failure mechanism. Thus, rock failure conduction facing are highly susceptible to landslide.

P1142, L1: How did you map the landslides? visual interpretation or semi-automatic recognition?
We use NDVI value to identify bare land in images firstly. Bare land in flat areas such as river beds was ruled out automatically by using a filter that deletes areas with a slope gradient less than 10°. Bare land caused by agriculture or urban development was excluded manually, leaving the landslide-induced bare land.

P1142, L16-L18: this means that you have prepared a susceptibility model using both shallow and deep-seated failures. Is this true?
Yes, the cases where the vegetation was stripped off due to deep-seated slides were also included in the landslide inventory.

P1142, L19: From vector... this means the mapped landslides are in vector format?
YES

P1142, L20: Why you selected a 8 meter pixel and not 5 meter as the DEM?
Since the landslides were mapped from FORMOSAT-2 satellite images with 8m pixel resolution.

P1142, L23: How do you explain that very different cumulative rainfall (60 and 774) triggered similar amount of landslides (440 and 593 ha)?
This is probably because one another Typhoon Krosa (4-7 Oct 2007) affected the study area one month before Typhoon Mitag. Typhoon Krosa brought the average and maximum accumulated rainfall 585 mm and 918 mm, respectively. The critical rainfall threshold of landslide occurrence in Typhoon Mitag could be possibly became lower due to the high water content of soil effected by Typhoon Krosa.

P1143, L16-17: This figure is not useful
Fig. 3 is removed and replaced with the accumulated rainfall map of four typhoons in the revised manuscript.

P1144, L2: This can be due simply to the fact that most of the basin is on these two litologies. Have you grouped the geology too much?
The grouping of lithology is explained as above.

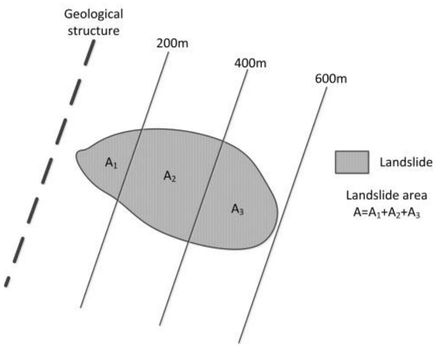
P1144, L9-10: Rainfall intensity and distribution should be more important than direction. In the paper "Modeling the spatial occurrence of shallow landslides triggered by typhoons" there is a figure with the rainfall distribution
This description has been modified in the revised manuscript. We also add the accumulated rainfall map of four typhoons as Fig. 3 in the revised manuscript.

P1145, L11-12: How relevenat is the difference between the different classes?
Landform analysis is a combination of the plan curvature and profile curvature. In Fig.4, we can see landform with concave or valley feature usually has higher landslide ratio.

P1145, L22-23: what is the meaning (type of vegetation) of these classes?
The value of NDVI ranged from −1 to 1; the higher the value of NDVI the denser of vegetation cover. Usually NDVI value smaller than 0 reflects the bareness area.

P1145, L26-27: Show them in figure 1
The geological structures like faults and folds considered in our paper are added in Fig. 1 in the revised manuscript.

P1146, L4-7: This is in contrast with what you describe in the beginning that "Geological structures such as faults, folds, and fractures usually play an important role in landslide formation". It seems that many failure are far from the linemants. Explain better.
The method to measure the distance to geological structure of landslide can be described by the following sketch. Take a landslide as example, the total landslide area is $A(=A_1+A_2+A_3)$, then area A_1 is classified into the distance class <200m, area A_2 is classified into the class 201-400m, area A_3 is classified into the class 401-600m, as well as for the other landslides. Thus the landslide ratio in each class only reflect the relation of area distribution and the distance to geological structure, not actually the initiation location of landslides.



P1146, L15-16: In the landslide susceptibility map (figure 6) area closer to the rivers are classified as stable. It seems a contradiction.
Distance to stream is measured from river bank, thus the stable area like river bed is excluded in affecting factors analysis, as well as the susceptibility evaluation.

P1147, L4: this is pixel?

Yes, it is pixel.

P1148, L25-27: If using four or five factors you have obtained a very good results, why in the final susceptibility map you have used 8 variables?
The purpose of this test is to find the factors has higher explanatory power for landslides. However, in order to reach the overall best performance, we still use eight factors to develop the susceptibility model.

P1150, L5: This result is very strange.
Rainfall amount like Typhoon Morakot (mean accumulated rainfall 2323 mm) is far exceeds the critical rainfall threshold for landslides occurrence. Many areas even with low geo-environmental susceptibility also appear landslides, thus the weight distribution among the landslide factors and landslide occurrence does not effectively distinguish areas that are susceptible to landslides. That's why a large scale landslide inventory is not suitable to develop susceptibility model.

P1150, L10-12: Can you explain why?
The description is little modified as "*Better prediction results can be obtained by using the landslide susceptibility model developed based on landslide inventories triggered by the rainfall amount close to the critical threshold for landslide to occur*"

P1151, L13: Not clear
The higher the weight contrast value, the closer relation of factor and landslide occurrence. In Fig.5, we can see the south-facing aspects (SW, S, SE) with higher weight contrast value in Typhoon Mitag, Sinlaku, and Morakot. However in Typhoon Kalmaegi, higher weight contrast values appear in north-facing aspects (NW, N, NE). It reflects the influence of rainfall spatial distribution in different aspect to landslide occurrence.

P1151, L17-19: This means that different susceptibility maps should be prepared for different typhoons events to be useful for planning purposes.
Actually, we don't need to prepare susceptibility model for different typhoon event. Mostly the landslides induced by typhoon events affect the study area are located in south-facing aspects (SW, S, SE). Based on our results, we only need to select the typhoon event with rainfall amount close to the critical threshold for landslide to occur and landslides located in south-facing aspects to prepare the susceptibility map. That would be more helpful for planning purposes.

P1152, L7-28: Too long, not useful
This paragraph is simplified and summarized in a new table (Table 6) in the revised manuscript.

P1153, L3: This chapter is more a summary than a conclusion. This needs to be rewritten.
We rewrite the conclusions in the revised manuscript.

P1153, L9-11: This should be explained better since you mention several times that susceptibility maps area useful only when similar events occur. If this is the case a detailed analysis of the typhons events (direction, intensity, magnitude) is mandatory.
As mentioned above, our results indicate that the best model should be developed by using landslide inventory close to the landslide occurrence threshold. According to the summary of distribution of landslides induced by the four typhoons for each susceptibility level (Table 5), except the extreme event of Typhoon Morakot, over 80% of the actual landslide area can be covered in the areas of very high and high susceptibility levels. For example, Typhoon Mitag (small rainfall amount) is 92.45% and Typhoon Kalmaegi (median rainfall amount) is 83.15%. Thus it is not only useful when similar events occur.

P1163, Table 3: You should prepare one table showing the results for the four typhoons.
During the test processes, we select the highest AUC value set in the level of same factor number combination to be the basis set to add an additional factor for the next test run. Thus the

combination of factors is varied in different typhoon events.

P1166, Table 4: Add a figure with the four maps and the four training and validation curves.
The training and validation curves of four typhoons are added in the manuscript (Fig. 5).

P1167, Table 5: Which map did you consider in this analysis? one map or four different maps?
Only one map developed by Typhoon Sinlaku was used in Table 5.

P1167, Table 5: Is this the map prepared with the landslide triggered by the Morakot event?
No, there is only one map developed by Typhoon Sinlaku.

P1168, Figure 1: 1) can you show in this map the features you have used to obtain the variable "distance from lineation"? It would be interesting to see how many they are and how they are distributed. 2) the word "stratum" can be deleted 3) add the rivers
Figure 1 is redrawn in the revised manuscript. We change the coordinate type, add geological structures and rivers.

P1169, Figure 2: 1) Add the major rivers 2) delete "study area"
Figure 2 is redrawn in the revised manuscript.

P1170, Figure 3: This figure is not useful.
Figure 3 is removed in the revised manuscript.

P1172, Figure 5: This figure is not clear
Figure 5 has been modified to make it more discernable.

P1173, Figure 6: In this map the classes are highly correlated and controlled by the elevation (ridge and valley) distribution. Is it realistic?
Through the grouped factors test of effect analysis, it indicated lithology, slope, elevation, and ground vegetation are the predominant factors affecting a large number of landslides in the study area. Figure 6 also exhibit this characteristic, ridge and valley reflect slope and water concentration, respectively. And part of the very high susceptibility area located in the south-west side of study area, which is close to the folds distribution in Figure 1.