Response to Xiangzhou Xu (RC2)

We are grateful for the detailed reading of the paper and substantive comments of Reviewer 2 (Xiangzhou Xu). Below are the *original comments* followed by our response to them.

General comments

Landslide plays an important role in landscape evolution, delivers huge amounts of sediment to rivers and seriously affects the structure and function of ecosystems and society. This paper, which is entitled "The role of geomorphology, rainfall and soil moisture in the occurrence of landslides triggered by 2018 Typhoon Mangkhut in the Philippines", tries to examine the factors susceptible to landslides, consider the potential for early warning of the landslides. The topic looks very interesting and valuable. Nevertheless, a major revision is needed before the manuscript is accepted for publication in the journal NHESS.

Specific comments

Some problems are listed as follows:

1. *Title: I suggest you erase the words "triggered by 2018 Typhoon Mangkhut" in the title. I think the readers will be interested in a relatively universal law related to landslides instead of only a certain storm. Also you have to add an in-depth discussion corresponding to the title revision.*

We consider that due to the specificity of the study, referred to Typhoon Mangkhut, it is important to state this in the title. Although it is a site and event specific study, it provides key data and results that, together with further analysis, will help stating general laws about the triggering mechanisms of landslides in the Philippines. Throughout the paper we mention several times the importance of repeating similar analyses for other areas and meteorological events in order to generalise some conclusions.

2. *Abstract: This part has to be rewritten. The point, "a) it was one of the most intense rainfall 20 events in the year but not the highest", is a condition to induce the landslides instead of a result. In addition, have you resolved the problems presented in lines 99-104 (page 4), Section Introduction? Please let me know in the abstract with a concise description.*

We have rewritten the abstract following the suggestions of the reviewer.

"In 2018 Typhoon Mangkhut (locally known as Typhoon Ompong) triggered thousands of landslides in the Itogon region of the Philippines. A landslide inventory of Typhoon Mangkhut is compiled for the first time, comprising 1101 landslides over a 570 km2 area. The inventory is used to study the geomorphological characteristics and land cover more prone to landsliding as well as the hydrometeorological conditions that led to widespread failure. The results showed that landslides mostly occurred in slopes, covered by wooded grassland in clayey materials predominantly facing East-Southeast. Rainfall (GPM IMERG) associated with Typhoon Mangkhut is compared with 33 high intensity rainfall events that did not trigger regional landslide events in 2018. Results show that landslides occurred during high intensity rainfall, coinciding with the highest soil moisture values (clays saturation point), according to SMAP-L4 data. This indicates that, in addition to rainfall from the typhoon, soil moisture plays an important role in the triggering mechanism. Our results suggest that SMAP-L4 and GPM IMERG data show potential for landslide hazard assessment and early warning where ground-based data is scarce. However, other rainfall events the months leading up

to Typhoon Mangkhut that had similar or higher intensities and also occurred when soils were saturated did not trigger widespread landsliding, highlighting the need for further research into the conditions that trigger landslides in typhoons."

3. *Study area. Too many details have been given in Section 2. You may delete some descriptions which are not closely related to the topic of the paper, and the subtitles of the section, including subtitles 2.1-2.4.*

We appreciate the comment, however we think all the information included in Section 2 is relevant for the understanding of the different methods and results of the article. We have rewritten some sentences in this section, as per Reviewer 1 comments for clarification.

4. Methods.

(1) Line 110, page 4: What's the meaning of the unit "m.a.s.l"?

m.a.s.l. means "meters above sea level", we have clarified this.

(2) How to distinguish a landslide in the area with scarce plants?

We actually decided to do our mapping manually instead of using automatic tools, which normally rely on fewer parameters, such as vegetation change (NDVI). Changes in vegetation were really helpful in the area to identify landslides, but they were not the only ones. High resolution imagery was used to identify landslides also based on changes in sediment accumulation in the lower part of the slopes or along roads.

An example:

a)   b)

c)   d)

Figure 1: Pre Mangkhut (a and c) and post (b and d) images from Baguio airport runway landslide. Images a) and b) are an ortophoto, c) and d) are Google Earth images (note that North is at the bottom right of the picture).

(3) I do not think a rainfall with the intensity of 4 mm hr-1 is intensive rainfall. Line 374, page 12. You said "Our study suggests a threshold of 2600 mm of rainfall accumulated over the rainy season for landsliding to occur". However, in lines 226-227, "Our selection of high intensity rainfall events was. . . exceeding 4 mm hr-1". The intensity of 4 mm hr-1 is really too small. Maybe 4 mm min-1?

We appreciate that the explanation of the selection criteria for high intensity rainfalls was confusing. Therefore, we have improved this explanation in the revised manuscript:

"In order to select high intensity rainfall events we filtered rainfalls with intensity higher than 4 mm hr-1 in average for 3 consecutive hours, which would mean at least an accumulated rainfall of 12 mm in 3 hours. Although 12 mm may not seem a high amount of rainfall, the selection criteria was based on the fact that only 3% of the 30 minute rainfall records from GPM IMERG exceeded 4 mm hr-1 in 2018. The mean daily rainfall of 2018 was 9 mm day-1, and only 34 rainfall events fulfilled the condition of having an intensity of 4 mm hr-1 for 3 consecutive hours at the grid point near Barangay Ucab. "

We would like to include two Figures to visualize more graphically the selection criteria for rainfalls that we considered "high intensity". Note that Figure 2a refers to the daily rainfall and Figure 2b to the rainfall intensity. In both figures the threshold for high intensity rainfalls is indicated, but in Figure 2b it must be noted that it have to last for 3 consecutive hours.
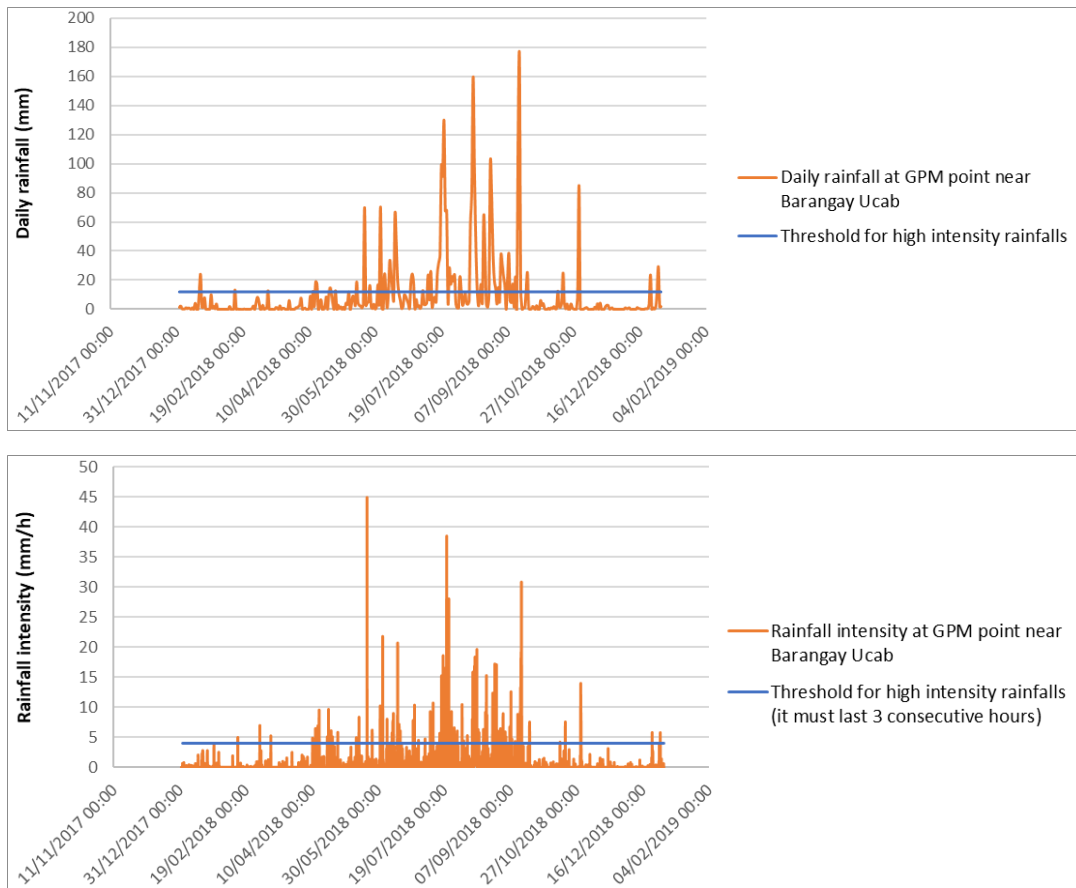
Figure 2: a) Daily rainfall and b) rainfall intensity along 2018 at the nearest GPM point of Barangay Ucab.

5. Discussion.

Section 5.1. What's the meaning of preconditioning, and have you discussed the preconditioning here?

We have actually changed the concept preconditioning for predisposing.

6. Figures and tables.

(1) Most of the figures are not clear. The sizes of the texts in some figures are too small. The figures should be clear as they are printed in black and white.

We have increased the font size and changed changed the markers in order to make it evident for b/w prints of Figure 9

We have increased the font size of Figure 8 and Figure 4

We think the colours and sizes of all the Figures are correct now.

(2) Figure 1. What are the differences between the "study area" and "Regions Study Area"?

In section 2.1 the text is referring to different Regions in the study area with different geomorphologic features. We have added the reference to the section in the Caption of Figure 1 of the revised manuscript

(3) Figures 2 and 8. The general titles of the figures are needed.

According to the guidelines of NHESS for figures and tables, the description of the figure must be added in the caption but not in a title. We consider that the captions are explicative enough to not need general titles in the figures.

(4) Figures 9 and 10. The scales of the vertical coordinates are anticipated.

We are not sure what the reviewer tries to point out here. It would be helpful to have some more information about what he means.

(5) The format of the table in the manuscript is not suitable to the requirements of the journal NHESS.

We have changed the format of both tables.

7. The English writing of this paper is readable. Nevertheless, still some minor language errors exist, e.g., the word "are" in line 153 of page 5 should be erased; in line 51 of page 2, the words ", however the. . ." may be replaced with the words "; however, the. . ."; the first letter of the word "Clay" in line 256 of page 9, may be in lower case.

We appreciate the comments:

- "are" has been erased
- "however the" a comma has been added
- "Clay" upper case has been substituted by a lower case