

Reply for review comments

Reviewer 1 (Prof. Carlo Gregoretti)

We sincerely thank you for the efforts you have made to improve our submission to *Natural Hazards and Earth System Sciences*. We have responded to all review comments and have made appropriate modifications to our manuscript related to these comments as detailed in the following paragraphs. The blue-highlighted sentences are the review comments; sentences in black represent our responses to these review comments.

Overview

The authors improved their work but there are some parts to be refined:

- 1) The subsection 4.3 is not understandable. The first sentence is not clear: what does it mean “We estimated the volume of storage from periodical photography and terrains ...”. For the following part, I suggest the authors to write that 36 cross section lines were considered along the reach and volume of storage was computed for each of the 35 areas between the cross-section line. Moreover, at the beginning of the second sentence did the authors confuse storage for channel?

We revised the first and second sentences in the section to improve understanding by readers. We computed “cross-sectional area” of the storage at cross-sectional lines, and did not computed areas between the sections. We have checked the sentence with a native English speaker again (pg. 11, lines 13-17).

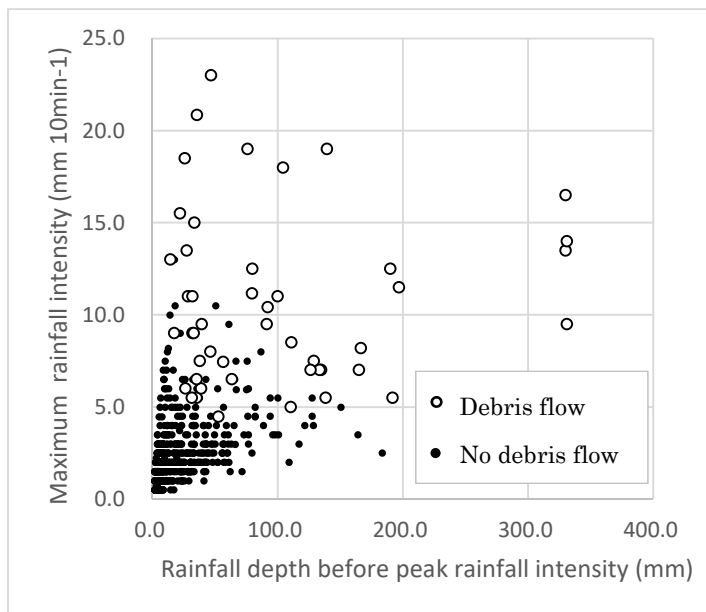
- 2) About debris flow monitoring (5.1), the reviewer does not understand the different separation time of rainfall durations for the two thresholds, 10 h, when the rainfalls are classified in two groups based on rainfall duration smaller or larger than 5h. Moreover, legend of Figure 5 should be corrected: no debris flow instead of debirs flow. The unknown points of Figure 5 need some specification or explanation in the caption or in the text: do they correspond to fully saturated debris flows or both to partly and fully unsaturated debris flows? About the weak positive dependence of partly saturated debris flow on the storage volume, a reason could be the dependence from another factor: the precipitated depth before debris flow occurrence (see point 4).

As shown in Figure 5, there are few debris flow events with rainfall duration of about 5 h, indicating that most of rainfall events can be grouped into two groups: long-lasting rainfall events caused by typhoons and stationary fronts (rainfall duration >5 h), and short-duration convective rainfall events characterized by high intensity (rainfall duration <5 h). Rainfall threshold lines in the Figure 5 express initiation condition of the debris flow, and was not used to classification of rainfall events.

As pointed out by the reviewer, we have corrected the misspelling “debirs flow” (Figure 5, legend).

We have added explanation on the unknown points in the figure caption. Because we failed to capture debris flow images during these “unknown” events, we do not have any information on the flow type. As pointed out by the reviewer, precipitation depth could be another factor affecting debris flow occurrence. However, we could not find clear relationship between rainfall depth and occurrence of debris flows (see next figure

showing comparison between rainfall depth and rainfall-intensity). Effect of long-time rainfall factors, including rainfall depth before debris flow occurrence, on the occurrence of debris flow is smaller than that of short-time rainfall intensity.



3) About subsection 5.3, where are the points F and G on Figure 2?

Although we have renamed points in the last revision, we forgot to revise point name in the Figure 2. We have revised the Figure 2.

4) About section 6.1, the sentence at the lines 16-19 of page 21 is not very clear: could you rewrite? Moreover, the writer agrees with the authors that the storage volume can influence the debris flow type. About the two debris flows occurred at Cancia in summer of year 2015 (Gregoretti et al., 2016), the former was partly saturated in the first minute while the latter was fully saturated. The reason is that the upstream storage volume in the second case was negligible because washed out by the first event occurred 12 days before. Authors, if willing, could insert this fact in this subsection. Considering Figure 7, another factor controlling the debris flow type could be the rainfall precipitated before the debris flow occurrence in the case of long duration rainfalls (typhoons). In this case the storage volume could be partly or entirely saturated by the rainfall previous debris flow and the degree of saturation could influence the proportional amount of partly saturated debris flow. Authors could explore this possibility after analyzing the rainfall data.

We have rewritten the sentence at the lines 15-18 in pg. 21. The sentence is now “Similarly, debris flow initiation zones in many other torrents are greater than 22.2° (e.g., VanDine 1985; McCoy et al., 2012). Although the α_2 may be different among torrents affected by soil parameters such as the internal angle of friction, the conditions for the occurrence of partly saturated flow may possibly be satisfied in such debris flow initiation zones.” We also introduced implication in Gregoretti et al., 2016 to support our discussion (pg. 21, lines 20-21).

We agree that the precipitation before debris flow events is the potential factor affecting the flow type. At the

same time, effect of the precipitation before the debris flow event would be vary affected by the volume of the storage. Large space would be needed to complete discussion on such initial water condition in the storage. We would like to analyze the impact of previous rainfall events on the debris flow type in future papers.

5) In section 7, authors should add some specification to support the sentence “In addition, our study elucidated that the slope geomorphic units is the key factor in the estimation of predominant type of the sediment transport...”

Based on the suggestion by the reviewer, we have added “talus slopes and channel deposits” in the sentence (pg. 24, line 13).

The following are the detailed comments and specifications.

1. Page 5 – line 9: ratio instead of ration?

We have replaced “ration” to “ratio” (pg. 5, line 9).

2. Page 22- line 27: what is it the length ratio of the channel sections? (see also Figure 11)

We have replaced “length ratio” to “proportional amount” (pg. 22, lines 26-28). We also replaced “length ratio” to “proportional amount” in y-axis and figure caption of Figure 11. Calculation method of the proportional amount is explained in pg. 20, line 11 –pg. 21 line 9.

3. Page 23– line 20: please insert could before exist.

We have inserted “could” as suggested by the reviewer (pg. 23, line 19).

4. Page 24 - line 27: is instead of are after Paolo Tarolli.

We have replaced “are” by “is” (pg. 24, line 24).