

Response to Referee 1 - Marcel Hürlimann

General comments The manuscript presents data from the debris-flows monitoring system in the Mosardo catchment, which seems to be the oldest in Europe (monitoring over 30 years!). The topic of the ms is perfectly fitting with the themes of the journal and the outcomes are relevant for researchers and practitioners. However, the ms needs some improvements before publications in NHESS. In the following, the major and minor critiques are listed.

We wish to thank Dr. Hürlimann for his constructive comments. Below we present our responses. Our responses includes the changes that we will implement in the manuscript if we will be invited to submit a revised version.

Major critiques:

I. A general, but important critique is that the explanations and descriptions are in some parts of the ms too short. This lack of complete information makes the understanding of some outcomes a bit complicate. I will describe the parts that need to be enlarged in the major and minor critiques.

The aim of this paper is to present a catalogue of debris-flow events recorded in an instrumented basin. For this reason, data analysis is focused on a few selected issues and is essentially intended to describe the basic features of the recorded debris flows (date of occurrence, triggering rainfall, and hydrographs shape). Following the suggestions of the reviewer, however, we have extended some parts of the manuscript.

II. The text of some sections is sometimes mixed up and the authors should follow the defined structure or adapt the structure and titles. First example: the contents of Sections 2 (Settings) and 3 (Data): L74-82 should be placed into Section 2, while L65-66 may be stated at the beginning of section 3. Another example is between section 4.1 (occurrence) and 4.2 (rainfall), where the rainfall is already analysed in section 4.1. In addition, I propose changing the title of 4.2 into "Rainfall threshold" (or similar).

We accepted the suggestion (no. 2 of Minor critiques) to change the title of Section 3 to include the monitoring system. We kept in this section the text at the lines 74-82, which describes the monitoring system. We moved the text at the lines 65-66 to the beginning of Section 3.

We modified the structure of Section 4 (Summary of recorded data). The first subsection presents the rainfall thresholds for debris-flow initiation, while the second and the third subsections deal with debris-flow occurrence (day, hour, etc.) and debris-flow hydrographs, respectively.

III. The relation between rainfall characteristics, sediment availability and debris-flow triggering may be better explored. Detailed data on the sediment availability are not available, but it may be approximated indirectly by number of days between two debris-flow events, volume of previous event etc. Finally, this information should be analyzed together with the rainfall characteristics. A similar approach was applied in our monitoring site in the Pyrenees (see Pastorello, R.; Hürlimann, M.; D'Agostino, V. (2018). Correlation

between the rainfall, sediment recharge and triggering of torrential flows in the Rebaixader catchment (Pyrenees, Spain). *Landslides*. 15(10),1921-1934).

The point raised by the reviewer is undoubtedly relevant. However, according to the aims of this paper, which is intended to present a debris-flow dataset, we would prefer not to explore it. The identification of proxies for sediment availability and their possible influence on rainfall thresholds for debris-flow triggering could become the objective of future studies: we mention this issue in the section on rainfall thresholds.

IV. The definition of rainfall thresholds is a complex task. The section regarding this topic is very short and more information is necessary of the method how the two thresholds were defined (which rain gauges, how the rainfall duration was determined, how the curves were finally defined etc.). In addition, non-triggering rainstorms must also be added in the plot and commented in the text (explain false positive, false negative etc.). In conclusion, I strongly recommend to improve this part of the ms and enlarge the text.

We have revised the subsection on rainfall thresholds (now subsection 4.1). We have provided details on the separation of rainstorms, the rain gauges used, and how rainfall duration was determined. We added a plot of rainfall intensity versus duration for non-triggering rainstorms.

V. Some Figures need to be improved since information is lacking (legend and more detailed figure captions: see comments below). On the other side, Fig3 and maybe Fig2 are not really substantial and do not refer to the main topics of the ms (debris flow occurrence, rainfall characteristics, hydrographs). I propose including some additional plots on these three topics and maybe delete Figure 3.

We removed the figure 3, as suggested by the reviewer. We would prefer to keep the figure 2 because it shows the cross-sectional geometry of the instrumented channel and its variations during the monitoring period. This is an information that relates to the debris-flow hydrographs presented in this paper.

We added two figures (non-triggering rainstorms in the rainfall intensity – duration plot), and hour of occurrence versus day of the year, as suggested by the reviewer.

Minor critiques:

1. Introduction may be enlarged including some additional information, experiences and open questions of debris-flow research and in particular of instrumental monitoring of debris flows.

We refer to a recent review paper (Hürlimann et al., 2019) for experiences and open questions in debris-flow monitoring. We have extended the introduction by stressing the problems of debris-flow data collection resulting from the low frequency of such events even in the most active catchments and the importance of making the datasets freely available.

2. The title of section 3 may be changed into “Monitoring system and data” (or similar).I propose adding technical details on the ultrasonic sensors and rain gauges used during the last 30 years and some experiences gathered.

We modified the title of Section 3 according to the suggestion of the reviewer.

Unfortunately we cannot provide technical details on ultrasonic sensors and rain gauges because these instruments were replaced several times and no track was kept of their technical specifications.

3. L83-84: the information on the number of surges would be helpful and should be added in Table 2.

Done. Thank you for this suggestion.

4. L103-118 and Fig.4: add legend in Fig.4. Explain, which rain gauge was used to draw the plot of the potential triggering rainstorms. If the plot includes multiples or all rain gauges, then you have to explain, what was the procedure to avoid duplications. In general, I recommend to better explain the text between L103-118 (especially the last part).

Legend in Fig. 4: done.

The plot of rainfall intensity versus duration does not include multiple rain gauges.

5. L119-122: Good arguments. You may propose some ideas to resolve this aspect. See point III in major critiques.

In this paper we comment the existing Moscardo dataset and we mention the absence of measurements of the variations in sediment availability as a limitation of data so far collected. We added a sentence in the conclusions stating that this issue could be solved if more systematic topographic surveys of the sediment source areas will be carried out in the future.

6. L127: you may create a plot of the time of triggering and add it as Fig. 5b

Done; thank you for the suggestion.

7. L132-140: This part should be at the beginning of Section 4.1. Afterwards, I would start with the rainfall analysis

We have substantially modified Section 4 (Summary of recorded data): now it starts with rainfall thresholds analysis.

8. L185-193 (Fig.8 and Table2): the analysis of the hydrographs is very interesting. I have two suggestions: i) could you provide the return period of three hydrographs? ii)Is it possible to also add the statistics of the surge volumes in Table 2?

i) The return period likely refers to the peak discharge. We would prefer not to perform this analysis because the small sample size makes such an estimation highly uncertain.

ii) We added in the text (section 3) a comment on debris-flow volumes, with a focus on the largest values. Basic statistics of debris-flow volume – as well as of flow velocity and peak discharge – can easily be derived from the data of Table 2.

Specific comments:

L60. Could you be more precise and replace “several”

Done: 32 check dams and bed sills.

L74-75: English is not very clear (to me).

We have rephrased the sentences at the lines 74-75.

L80 and Fig.2: please add “near the monitoring sites A and D” in the caption of Fig.2

Done.

L88 and Fig.1: please add the position of the video camera in Figure 1.

We added two sentences on video camera installation and video recordings.

Fig. 7. Add legend

Done.

168: please correct the citation format

Done.

L207 and Fig9: please add the cross-section labels D and E in the text and in the plot. This would clarify the actual names (up/downstream) in the plot.

Done.

Table 1: please also add the slope angle in degrees

Done.