Author's Response:
A modeling methodology to study the tributary-junction alluvial fan connectivity during a debris flow event

December 2021

The authors thank reviewers' valuable comments. Changes have been made to the manuscript to include reviewers' suggestions ("CrucecitaMS_V2.pdf"). To easily identify the changes done, we also uploaded a manuscript with tracked changes ("CrucecitaMS_V2_marked.pdf"). When necessary, we provide here line numbers where we included the reviewers' suggestions. First, we indicate the line number of the non-marked manuscript and, secondly, the line number of the manuscript with tracked changes. Also, the authors' responses in this document are marked in blue.

Referee 1:

Debris flow or debris flood? Please address the terminology issue also in the light of this new paper Church, Michael; Jakob, Matthias (2020). What is a debris flood?. Water Resources Research, doi:10.1029/2020WR027144

We thank the reviewer's observation. We have included the debris flood classification to surges 3 and 4 (section 2.2; lines 143-146; lines 160-163 marked version).

The Crucecita Alta deposit is described in bulk with other fans in the paper (Cabré 2020a). Figure 6 of that paper shows the inferred sediment concentrations during the event but, since we are focusing on this test site now, I would advise you to provide a paragraph discussing how you estimated the sediment concentrations for each surge.

In our model, the sediment concentration is a function $C_V(t)$, where t is time, and it depends on the minimum and maximum plausible volumetric sediment concentrations. This article introduced a semi-automatic calibration algorithm (Decision Support System). This algorithm evaluates the effect of different sediment concentrations and constrains the cases that reproduce the event flooded area and deposited volume. Therefore, sediment concentrations were not estimated directly but instead calibrated with our novel algorithm. The resulting concentrations are presented in Table 1 together with the other calibrated parameters.

Moreover, in Cabré 2020a it is stated that the maximum thickness of the deposits is 100 cm while your simulations of the viscous debris flow show a larger thickness of deposits for Surge 1.

We analyze the effect of the SD parameter over the deposit thicknesses for the viscous debris flow surges and the problem noticed by the reviewer in section 4.1; lines 338-345; lines 363-372 marked version.

The model calibration of debris flows just on the basis of the impacted area instead of deposits can lead to errors. In case it is not possible, please insert two sentences in the text highlighting this potential problem.

We thank the reviewer's comment. We have explained more specifically how our DSS considers the affected area and deposited volume to find the appropriate rheological parameters (section 3.4; lines 294-305; lines 316-328 marked version).

if a channel is wide enough

We thank the reviewer's suggestions, we replaced it with: "if a channel is large enough" (line 10; line 11 marked version).

citation missing (?)

We apologize for the citation misspelling. It corresponds to Takahashi 2014 (book) (section 1; line 46; line 54 marked version).

Figure 1: it is not clear what do the black lines represent in part b. Can you show in a less stylized way where exactly the element at risk (roads and buildings) are located in fig b?

We thank the reviewer's suggestions. We modified Figure 1 part b as suggested.

to design mitigation works

We thank the reviewer's suggestions, the word "test" was replaced with "design" (section 4.3; line 402; line 429 marked version)

L389: the broad flow typology

We thank the reviewer's suggestions, we rephrased the line to "The same hydraulic works should be studied under the broad flow typology" (section 4.3; line 404; line 431).

L398: are deviated and forced to deposit

We thank the reviewer's suggestion, we rephrased the line to "are deviated and forced to deposit due to the previous deposits" (section 4.4; line 413; lines 440-441).

With surge 4 avulsion is present, inundating the southern portion of the fan

We thank the reviewer's suggestions, we rephrased the line to "With surge 4, avulsion is present, inundating the southern portion of the fan" (section 4.4; lines 413-414; lines 441-442).

Figure 8: please explain why the deposition pattern in surge 4 is so rectified, it seems a little bit unrealistic - did you experience problems with DTM interpolation? Can you show the contour lines of your model DTM topography?

We have added contour lines every 2 m in Figure 3. We did not experience any problems with DTM interpolation, but it should be noted that the model has a 5 *m per pixel* resolution. FLO-2D has a grid of square cells, but these cells are also connected diagonally. Thus, the flow has eight

possible flow directions. When the flow aligns with one of these directions, the solver tends to generate preferential flows following this alignment. As seen in Figure 8, these rectified patterns in surge 4 align in near 45°(south-west direction).

buffer?
Fryirs et al. (2007) named the lateral impediment of sediment conveyance as a buffer, and the longitudinal impediment of sediment conveyance was named as a barrier. Since surge 1 could not reach the river, it is possible to say that the alluvial fan completely buffers this viscous debris flow.

please revise this paragraph as the concepts expressed are clear but their formulation is not so
We thank the reviewer's suggestions. We rewrote the paragraph (section 5.1; lines 456-464; lines 485-499 marked version).

incide
We changed the word "incise" for "carve" in order to avoid confusion (section 6; line 501; line 542 marked version).

Referee 2:

1. Throughout, the authors use the term "telescopic-like" to describe the sediment deposits and landforms they are observing. While this term provides an approximate visual intuition, I think the authors could come up with something more precise to capture this.

We decided to keep the term "telescopic-like" due to their geometric and sedimentological significance (Colombo, 2005; Cabré et al., 2020).

2. Throughout, the authors italicize place names like Crucecita Alta, etc. If this is the journal's style, then so be it, but this is a strange convention that I don't care for.

We thank the reviewer's comment. We corrected this issue throughout the manuscript.

3. Several times, the authors refer to "low-frequency, high-magnitude" debris flow events, but no reference values are given. Does low-frequency mean once a decade or once a century? It would be better to be specific here, and talk about the time-scales and magnitudes in dimensional terms that the reader can put in context (example at line 84).

We thank the reviewer's comment. We added a paragraph about time-scales and magnitudes associated with the 25M event (section 2.2; lines 126-131; lines 143-148 marked version).

4. The location for this field location is not clear from the manuscript as written. The authors give the location only as "$\sim 29°S, 70°W$" which is very imprecise. I was eventually able to locate the fan in question by cross-referencing the figures in Cabré et al. 2020 (Progress in Physical Geography: Earth and Environment). The fan is located at: $(28.895569°S, 70.449925°W)$. The authors should give this more precise location so that folks can locate this field site and look at aerial imagery in Google Earth, etc.

We have added the specific location suggested by the reviewer to the Figure 1 caption. Also, we changed all our maps from UTM coordinates to lat-log coordinates so anyone can find the place

of the alluvial fan without knowing the UTM zone.

Figure Comments

We thank the reviewer's suggestions. These comments improved all figures in the manuscript.

1. "...in debris flow prone areas..." (no s)

We thank the reviewer's suggestion. We eliminated the s (section 1; line 38; line 39 marked version).

2. missing reference?

We apologize for the citation misspelling. It corresponds to Takahashi 2014 (book) (section 1; line 46; line 54 marked version).

3. "surrogated" is a strange word choice here. Consider "thus, it can be used as a surrogate."

We thank the reviewer's suggestion. We replaced it as suggested (section 1; line 54-55; line 62-63 marked version).

4. "Riverbank erosion has previously trimmed the alluvial fan toe to the event" is an awkward construction. Consider revising.

We thank the reviewer's suggestion. We rephrased the sentence (section 2; line 112; lines 128-129 marked version).

5. I do not see a supplement, but it would be good if this imagery were put into a supplementary information file for the reader to easily access. A screenshot would do.

We thank the reviewer's suggestion. We added a supplement file with screenshots of Google Earth satellite imagery of Crucecita Alta fan for 2013, 2016, and 2017. `https://doi.org/10.6084/m9.figshare.c.5739287.v1`

6. "it can surrogate the flow" -¿ "it can be a surrogate for the flow"

We thank the reviewer's suggestions. We changed this line to "it can be a surrogate for the flow rheology" (section 3.1; lines 183-184; lines 200-201 marked version).

8. put this link to the data somewhere else, like a supplement or data availability statement. Does it have a DOI? line 217

We added the topographic data to a supplement. the doi is `https://doi.org/10.6084/m9.figshare.c.5739287.v1`

Final remarks

We added a paragraph in the introduction to present the research question this work addresses explicitly. Additionally, we moved the previous paragraph to introduce the research question appropriately (section 1; lines 67-76; 78-87 marked version).

We reduced the conclusion section's length to communicate this study's main findings more effectively (section 6).