Nat. Hazards Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/nhess-2020-37-AC1, 2020


Natural Hazards and Earth System Sciences
Open Access
Discussions



# *Interactive comment on* "Sensitivity and identifiability of rheological parameters in debris flow modeling" *by* Gerardo Zegers et al.

**Gerardo Zegers et al.**

gerardo.zegers@ucalgary.ca

Received and published: 18 April 2020

We thank the Reviewer for his time in commenting on our paper. We provide responses to each individual point below. For clarity, comments are given in italics, and our responses are given in plain blue text.

The authors investigate the sensitivity of debris flow simulation results to the model parameters used by the FLO-2D software. Two debris flows in northern Chile are employed as case studies. Some of the key findings of the study are that there is some redundancy of information, that there is a certain degree of equifinality, hampering the identification of "correct" model parameter sets, and there is a broad spectrum of levels of sensitivity among the different model parameters with regard to the various



Printer-friendly version

Discussion paper

reference parameters. This paper covers a highly relevant topic which is certainly within the scope of NHESS. It is generally well-written, concise, and appropriately illustrated. Reference to the relevant sources is given. Before publication, I recommend some optimization, mainly concerning the precision of some formulations and statements and comparison of the results with other studies. In summary, I recommend minor moderate revisions.

***General comment*** What would be interesting to see is a little bit more of discussion on how the findings of the study (e.g. the patterns shown in Fig. 4 and Fig. 5) relate to previous work. Do the results confirm earlier studies, or are there some contradictions? If yes, how could they be explained?.

We will address this recommendation by adding more discussion on how our results and findings relate to previous work. Such discussion will be framed around the following ideas:

D'Agostino and Tecca (2006) compared FLO-2D simulations performed with two sets of rheological parameters and three values of the laminar coefficient K (six simulations in total), concluding that K controls the flood area and that rheological parameters control maximum flow depth. On the other hand, our results indicate that the laminar coefficient K provides the fourth-fifth largest sensitivities in simulated flood areas. Such difference probably relies on their experimental design, since their conclusions are drawn from only six model simulations.

Chow et al. (2018) conducted simulations with FLO 2D using 26 different sets of rheological parameters obtained from 45 previous studies, combined with different values of volumetric sediment concentration (Cv), specific gravity (Gs), and surface detention (SD). They found that the most influential parameters - in order of importance - were Cv, SD, and $\beta 1$ (which characterizes fluid viscosity). These results are different from ours due to discrepancies in the sampling method, their use of fixed sets of rheological parameters and their parameter ranking definition, which does not consider separate effects on key simulated variables. Further, Chow et al. (2018) analyzed changes in Cv ignoring the effect of the total sediment volume, whereas we examine the effects of total volume and sediment concentration separately, obtaining that the total sediment volume is more important than the maximum sediment concentration. Finally, Chow et al. (2018) used fixed sets of parameters related to viscosity and shear stress, reporting thus an aggregate effect of a bigger variation of these parameters. In this study, we analyze parameter importance through local sensitivities across the entire parameter space, recognizing that the relative importance of parameters can change depending on the sub-region examined. This effect is shown in Fig. 1 through the cumulative frequency distribution of DELSA indices for Cvmax on the mean Velocity. For 60

***Specific comments***

*Section 3.1: some of the references are formatted in a strange way*

References will be formatted correctly, following the reviewer's suggestion.

L143: V is used here for volume, but before was is used for velocity - using VolT instead of VT would be more consistent. The same applies to VTest introduced in L149.

We will change the notation as suggested by the reviewer. we will use $Vol_T$ for the total volume and $Vol_{Test}$ for the estimated total volume of sediments.

L146: "or non-flow condition": please explain more clearly how this relates to SD.

We thank the reviewer for this observation. We agree that "or non-flow conditions" is confusing, so the text will be modified as follows: The detention coefficient SD is a model parameter that reproduces flow detention. The FLO-2D User's Manual and previous studies (D' Agostino and Tecca, 2006) suggest that $SD$ acts as the minimum flow depth possible to occur (i.e. flow stops if flow depth < $SD$). D'Agostino and Tecca (2006) noted that this coefficient has a strong influence on the results, and it can be used as a surrogate of the rheology.

L172ff: If Zegers (2017) has successfully simulated an event through calibrating the parameters with this same event, this is NOT a validation. It would only be a validation if the calibrated parameters are then applied to another event. Please clarify.

We agree with the reviewer's point in that the word "validation" is misused. We will re-word the paragraph as follows: "Such values are obtained from a reference simulation conducted by Zegers (2017), who successfully simulated the 2015 debris flow events at Acerillas and La Mesilla creeks using FLO-2D.

Fig. 1: Nice figure, but two remarks: (i) The lines in the overview pane leading to the detailed map of La Mesilla should pass behind the legend, and not in front of it. Further, it would look better if the lower line for La Mesilla would start at the southern end of the deposit. (ii) The threshold values in the legends are ambiguous: >0-1 m; >1-2 m etc. would be correct.

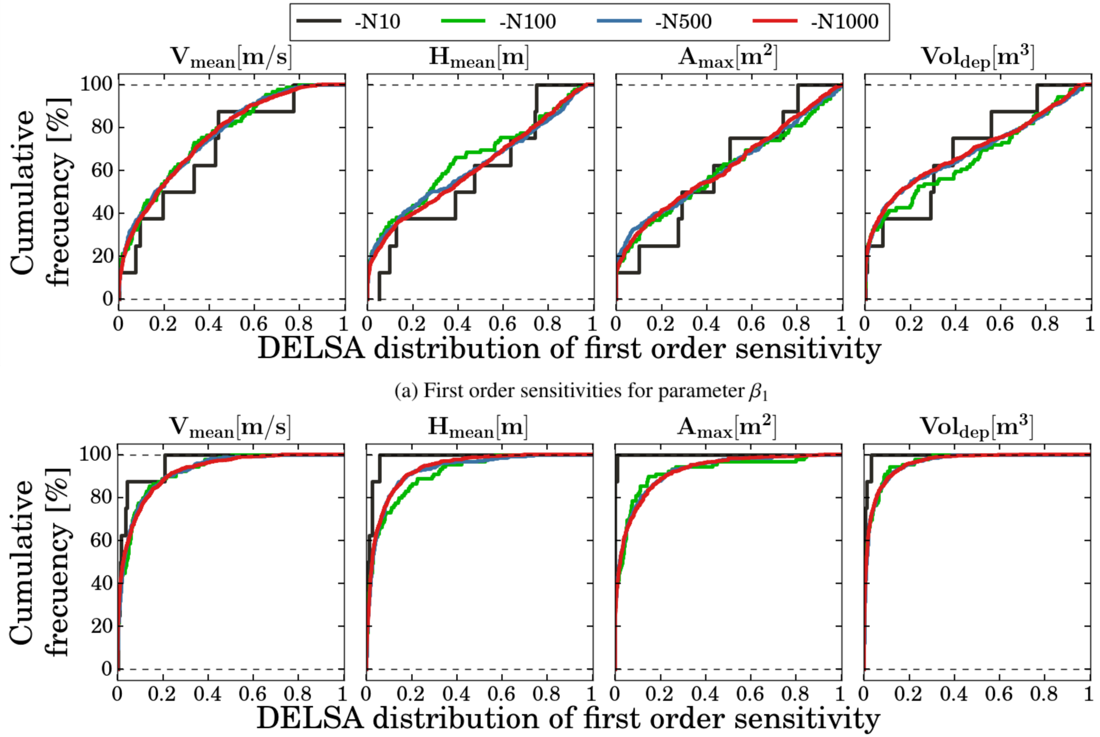
We thank the reviewer's suggestions. The new Figure will look like:

Fig. 3: Please revise caption (some issues of grammar).

The figure caption will be corrected as suggested by the reviewer.

---

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2020-37, 2020.




(a) First order sensitivities for parameter $\beta_1$

(b) First order sensitivities for parameter $Cv_{max}$

**Fig. 1.** Effect of the sample size Nk on the cumulative distribution function (CDF) of DELSA indices for parameters beta1 (top) , and Cv{max} (bottom) at the Acerillas creek.



Printer-friendly version

Discussion paper

Interactive comment

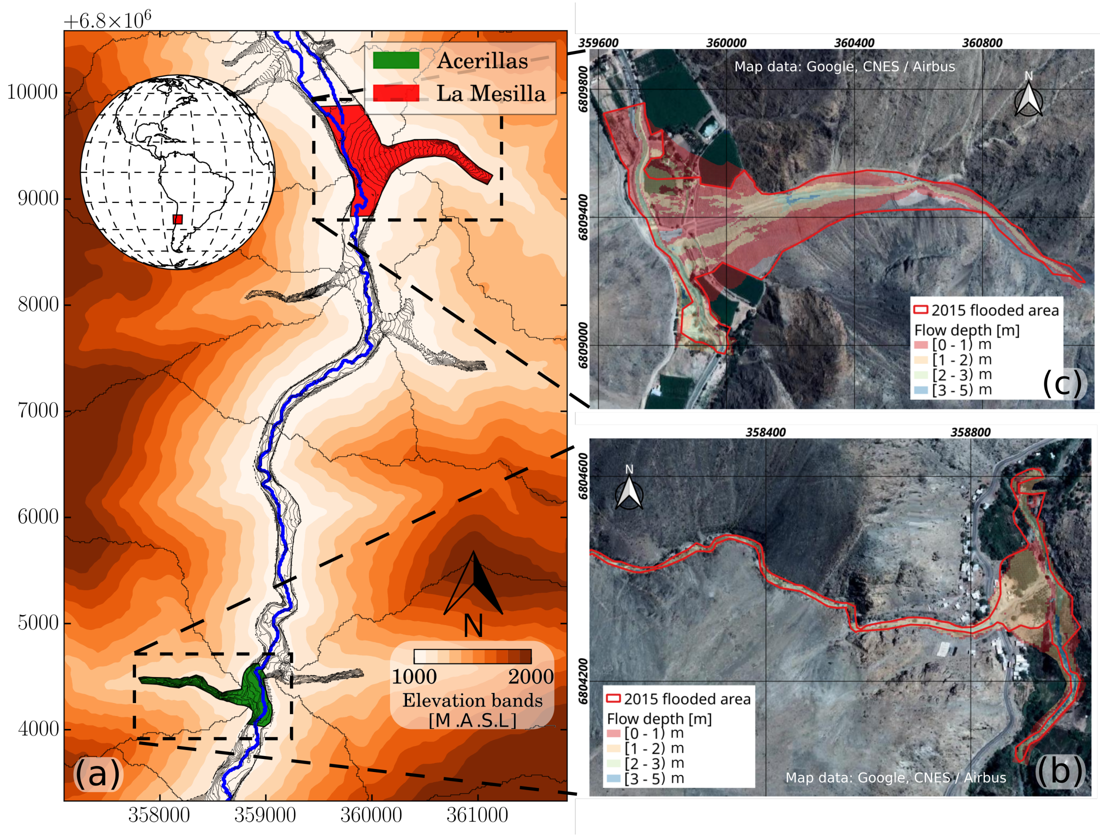



**Fig. 2.** (a) Location of the two case study creeks and reference models results. The maximum observed flood areas and modeled flow depth (reference models) are shown for (b) Acerillas creek, and (c) La Mesilla



Printer-friendly version

Discussion paper