A review of:
A modeling methodology to study the tributary-junction alluvial fan connectivity during a debris flow event

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Synopsis

Garcés et al. present a modeling study of an alluvial fan in southern Chile, which suffered a series of debris flows in 2015. The objective of the modeling is to use a reduced complexity approach that captures the broad patterns of sediment dispersal without having to explicitly model the complex physics of debris flows. In this way, different mitigation strategies (e.g. basins, spillways) can be tested without extreme computational expense. The authors co-opting models originally developed for water and debris-flows with simplified physics, and combined them in a hueristic way allows different parts of an event to be modeled as one of two types of debris flows. The authors make a distinction between *viscous* debris flows, where clasts are supported by the viscosity of the flow, and *inertial* flows, where clasts readily settle out of the flow. Based on field evidence, the authors split the hydrograph of the event into five surges, which is each modeled individually, with individually calibrated parameters.

The authors assert that this technique captures the broad trends of erosion and deposition during this rainfall event, and further that this approach can be used to evaluate debris flow mitigation structures in similar arid environments. In particular, they highlight that the modeling approach allows one to test a range of different parameter values and debris flow types at a tolerable computational cost.

Overall Comments

Overall I found this manuscript to be reasonably clear, well-structured, and sound in its methods. I am not a frequent reader of NHESS, but from checking a few recently-published articles, this manuscript appears to be a good fit for the mission of the journal. The modeling approach the authors outline requires substantial tuning, user input, local knowledge, and has a limited ability to etrapolate beyond the location being evaluated. As a result, quite a bit of data would be required to use this modeling approach for hazard mapping or analyzing a proposed mitigation approach. That said, the authors have done a good job of describing and clearly outlining when their model is applicable and when it is not, which I think is an especially strong aspect of this paper. I came away with a good sense of where and when an approach like theirs would be applicable, and what data I would need to collect in advance to use their methods.

I see no major obstacles to publication, and have enumerated a few minor comments below that I think would improve the manuscript's clarity.

Minor Comments

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.

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.

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).

4. The location for this field location is not clear from the manuscript as written. The authors give the location only as "∼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.

5. The authors discuss "sediment connectivity" at several points, but it is not *entirely* clear to me what they mean by this. Do they simply mean that sediment flows from the fan into the river? If so, it is important to talk about the time scale over which this is evaluated. In a mountainous catchment like this, the river will transport all of the sediment in the fan over geologic time (10s of thousands of years), so the fan is simply a temporary sediment storage place. However, if the authors are speaking only about short time-scales, then the connectivity is related to (a) how much sediment can bypass the fan and move directly into the river, plus (b) the amount of sediment the river can scavenge from the fan toe. I might recommend choosing a different term, because it sounds to me more like the authors are evaluating how much the sediment is "partitioned" between the topset of the fan versus how much spills into, and is carried away by the river.

Figure comments

1. FIGURE 1: I like this map a lot. It is well designed, but could the authors put latitude and longitude instead of UTM coordinates? This would help users locate the field site. Without knowing what UTM zone you are in, we cannot accurately locate this catchment. This idea goes for all of the maps.
2. FIGURE 2: These colors are not friendly to colorblind readers. I am not personally colorblind, but 5–8% of males are, and ∼1% of females are. The potential for miscommunication could be easily avoided with a different color choice. I recommend the authors try a multi-panel figure here in addition to changing the color categories.
3. FIGURE 3: The caption uses "longitude" when I think the authors mean that the channel is 550 long.
4. FIGURE 5: It would be helpful to label the columns and rows of this set of maps since this is a matrix of conditions. Specifically, it would be helpful to have "Surge 1" and "Surge 2" on the left-hand side of the left panels, while "Max Flow Depth", and "Final Flow Depth" were above the top row. This will make it easier for your reader, who has to check back and forth from the caption at the moment.
5. FIGURE 6: The same panel labeling comment applies here and to all of your other multi-panel map figures. It would make it so much better for the reader.
6. FIGURE 7: Again, these color lines are not colorblind-friendly. Some readers will not be able to tell the green and red lines apart.

Line comments

1. "...in debris flow prone areas..." (no **s**) — line 35
2. missing reference? — line 50
3. "surrogated" is a strange word choice here. Consider "thus, it can be used as a surrogate."
4. "Riverbank erosion has previously trimmed the alluvial fan toe to the event" is an awkward construction. Consider revising. — line 109

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 — line 117
6. "it can surrogate the flow" $\rightarrow$ "it can **be a** surrogate **for** the flow" — line 173
7. Is this a typo? It seems you refer to W_i^* being a function of the function before it is defined? — line 197
8. put this link to the data somewhere else, like a supplement or data availability statement. Does it have a DOI? — line 217
9. The authors say that low-frequency events are becoming more frequent. So are they still low-frequency? better to put an actual recurrence interval here. — line 461