Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2020-509-RC3, 2021

Hydrology and Earth System Sciences Discussions
Open Access

HESSD

Interactive comment

Interactive comment on "A Modular, Non-Newtonian, Model, Library Framework (DebrisLib) for Post-Wildfire Flood Risk Management" *by* Ian E. Floyd et al.

Anonymous Referee #3

Received and published: 22 February 2021

Review of "A Modular, Non-Newtonian, Model, Library Framework (DebrisLib) for Post-Wildfire Flood Risk Management" by Ian E. Floyd, Alejandro Sanchez, Stanford Gibson, and Gaurav Savant

This manuscript describes the theory and numerical modeling of DebrsiLib, a suite of algorithms intended to provide a framework for the modeling of non-Newtonian flows, such as mudflow, hyperconcentrated flow, and debris flow, with specific reference to post-fire debris flows. These algorithms are based upon the shallow water equations approach in HEC-RAS and AdH, with the "twist" being that of including modules that can handle the non-Newtonian properties of geophysical flows. To date, there is a gap in our collective ability to model runoff-generated debris flows, hyperconcentrated flows, and mudflows, such as those that are common within and downstream of recently burned areas. This manuscript attempts to address this gap, and therefore represents an advancement of our scientific understanding and modeling of these hazardous events.

However, this manuscript is beset with issues that require significant revision. Primarily, the authors present the manuscript in the introduction and conclusions as work that can be used to address post-fire flood and debris-flow risk. However, the manuscript does not deal directly with the complexity of flows that emanate from recently burned areas, nor does it even begin to discuss how these algorithms can be used to characterize and reduce risk. Therefore, this manuscript overstates its applicability to post-fire flood risk. Therefore, substantial revision and repackaging of the manuscript is required. Suggestions for revision are described in the general and line-by-line-comments below. I recommend acceptance pending moderate to major revision.

General Comments:

1) The title of the manuscript indicates a model that can be used to address flood and debris flow risk management in and below recently burned watersheds. Outside of a few sentences in the introduction, discussion, and conclusions, this manuscript does not have any specific framework for application in recently burned areas (see comments below on initiation mechanisms and flow variability), nor does it discuss how it can be used in a risk management framework. As such, the title does not represent the overarching theme of the manuscript and should be changed to reflect the emphasis on modeling based on flume experiments and comparisons to Newtonian flow models (e.g., HEC-RAS and AdH).

2) The library includes modules that can deal with multiple flow types (hyperconcentrated, mud, grain, and debris flow, after Figure 1, and lines 67 – 69 and 93 – 95. However, these types of flows can often occur in sequence within and below recently

burned areas. For example, the initial surge is often debris flow (e.g. Kean et al., 2011), followed by periods of hyperconcentrated flow and/or subsequent debris flow surges. The code apparently treats each of these flow types independently, and therefore is not an accurate representation of real-world flow conditions which have significant effects on the manner in which the flows erode/deposit and interact with natural and engineered channel features, all of which influence the runout and inundation extents, velocities, and flow depths the determine a locations degree of risk.

3) It's unclear how/if these models deal with in-channel erosion and deposition, if at all. The authors refer to "settling" (lines 105) but I do not see anywhere else in the manuscript this is addressed.

4) Data used for calibration and testing are based upon flume experiments, where a known mass of sediment and known volume of water are released en masse. This design is intended to mimic flow initiation from landslide processes. Post-fire debris flows are most commonly initiated by runoff and severe erosion, and therefore the input of water and sediment would be more closely approximated using a hydrograph based approach where discharge and sediment concentrations vary rather significantly over a longer period of time (as compared to a landslide trigger). How does the difference in release mechanism in the flume(s) affect the model performance and accuracy when applied to a different initiation process?

5) I would like to see an expanded discussion of the modeling results. As a reader I am left wanting to hear more about how the model results compare to the calibration and testing data beyond what is presented in Figure 3. More maps, graphs, text explaining the results and relative accuracy and real-world implications of model results are warranted.

6) The manuscript touts DebrisLIB, but this suite of algorithms is apparently not available but "planned released scheduled soon" (line 355). As such, the manuscript should be streamlined to avoid overemphasis on the library of algorithms and focus solely the

development of the individual models and testing against flume data. Do not over-promise the results and applicability at this point in time. Once these models are reviewed and published, it would be more appropriate to discuss real-world implications and applications in a separate "capstone-style" overview manuscript.

7) This is minor, but there are odd capitalizations throughout the manuscript that need to be fixed.

Line-by-line comments:

Title: Beyond the title and some lip service in the introduction and conclusions, this manuscript does not address risk management in and below recently burned areas. Therefore, the title and emphasis should be changed.

Manuscript L11: Algorithms are not non-Newtonian. Instead, "algorithms representing non-Newtonian flows." Also, "Non" should not be capitalized, here and throughout manuscript.

L28: should be "increase water runoff and erosion" or "increase runoff and sediment yield."

L63: recent fires in the southeastern US in 2016 and western Oregon in 2020 suggest the effects are not limited to arid and semi-arid environments.

L64: Decades to recover? Recover in coastal California, including Montecito, usually occurs in a period of a year or two. How are you defining "recovery?" Citations?

L92 – 97: It would be beneficial to the reader if the authors more formally defined the different types of flow beyond those in text and in Figure 1. Specifically, more discussion of the values represented in Figure 1 are warranted. Furthermore, it would be helpful if the authors discussed how a single flow "event" (e.g. January 9, 2018 in Montecito) may included multiple types of flows in sequence. Additionally, there is a weird mix of capitalizations in this section that should be fixed.

L118-119: Are you actually modeling erosion and deposition? Unclear to me. It's suggested that you modify sediment concentrations, but I do not see how entrainment and deposition are dealt with explicitly.

L160: "Shallow Water Equations" are capitalized here and not elsewhere. Be consistent.

L168 – 191: Equations are noted as #11 multiple times.

L254: "mildly nonlinear"?? It's either nonlinear or its not.

L287: should be "were used"

L296-297: Not really sure what is meant here by "regarding USACE modeling capabilities" and the flume experiments to be discussed in future papers.

L301 (and throughout): "Run out" is usually written as "runout" or "run-out." (I prefer the former over the latter)

L323: remove extra parenthesis

Figures: figure captions inadequately describe the figure. Any symbol/notation should be defined in figure caption.

Citations: There manuscript is lacking references to significant papers in post-fire debris flow and flooding research, further emphasizing the need to remove reference to post-fire debris flow and flood risk management from the title, introduction, and discussion/conclusions. No references for the D-Claw model developed by George and Iverson? The authors should at least present these papers and model by comparing and contrasting the differences between their approach and those of Iverson and George.

Here are the references:

George, D. L., & Iverson, R. M. (2014). A depth-averaged debris-flow model that includes the effects of evolving dilatancy. II. Numerical predictions and experimental tests. Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences, 470(2170), 20130820. doi:10.1098/rspa.2013.0820

Iverson Richard, M., & George David, L. (2014). A depth-averaged debris-flow model that includes the effects of evolving dilatancy. I. Physical basis. Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences, 470(2170), 20130819. doi:10.1098/rspa.2013.0819

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2020-509, 2020.