Earth Surface Dynamics Discussions

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Comment on esurf-2021-97

Anonymous Referee #2

Referee comment on "Regularity of transportation for cohesive bank-collapsed materials" by Guosheng Duan and Haifei Liu, Earth Surf. Dynam. Discuss., https://doi.org/10.5194/esurf-2021-97-RC2, 2022

The transport of cohesive sediments and riverbank collapse processes are not well understood, though they are of vital importance for most (if not all) natural rivers. This study aims to improve our understanding of riverbank erosion using an experimental flume. The authors run experiments with different types of cohesive materials to examine sediment transport styles. They use sediment transport formulations to determine the amounts of sediment that were transported in bedload and suspended load based on grain size and flow velocity.

I found the paper to be very well-written and easy to read. While the ideas presented are at first intriguing—running large flume experiments to understand the role of materials in modulating riverbank erosion and their subsequent transport down channel—I have very significant concerns with the design and execution of this study. The biggest problems are 1) experimental design and reporting of results 2) use of obscure old sediment transport formulations and references that essentially ignore over half a century of extensive work. These problems make the paper currently unfit for publication.

Experimental Design and Results

The experiments are designed such that two different natural materials are placed on either side of a flume. Figures 1 and 3 show the experimental setup, which from the description and images looks generally acceptable to me. However, the figures and text mention various measurements that were taken that are not reported anywhere in the paper. For example, pore pressure gauge measurements, flow velocity measurements, and sediment concentration measurements at the outlet. Though the authors mention these, I find it bizarre that the *only* actual results from these experiments- which I know took a lot of hard work to conduct- are calculations of the weight and cross sectional area of collapsed sediment as shown in figure 6. In reality, the experiments as presented give no information about sediment flux, bedload vs. suspended sediment transport, or the role of different bank materials. The decision to use two different bank materials in a single

experimental run is strange- on one hand, I can guess that the authors were hoping to compare the role of materials properties in consistent flow conditions, which is understandable. But without the ability to measure independently any of the subsequent sediment transport- for example by measuring sediment flux at the outlet- the difference between the two materials used in each experiment cannot be determined. If any of the measurement results exist and were not included in this paper, I highly recommend that the authors massively overhaul their presentation of the experiments. At present, they don't really serve any purpose in the manuscript except to illustrate the sediment transport calculations that follow.

Sediment transport formulations and background literature

Because the authors were not able to experimentally measure the percentage of sediment that travels as bedload and suspended load, they use the grain size distribution from the experimental sediments to calculate expected values for sediment transport. Again, this illustrates the trivial nature of the experiments as presented- the authors could have chosen theoretical grain size distributions at random without running any experiments and obtained the same results. As it stands, this study is more of an exercise in doing sediment transport calculations than gaining any understanding in riverbank collapse. For example figures 7 and 8, while well presented, are just demonstrations of the already well-known dynamics of the equations used- they are not novel results because they do not compare with any measurements of bedload or suspended sediment flux from the experiments.

To make these calculations, the authors choose to use very old, obscure sediment transport formulations that ignore a very large body of work in fluvial geomorphology and engineering. For example, Eqn. 1 is used to calculate the size of sediment that would be transported under certain flow velocities. It is a bizarre formulation that includes the ratio of the diameter of a water molecule to sediment grain diameters (an approach I have never seen before and seems extremely suspicious). Decades of work has provided the background needed for predicting incipient particle motions in fluids, where the most canonical formulation is the shields criterion This concept can be found in many textbooks and hundreds of studies on sediment transport. An updated (but still over 30 years old!) formulation for the onset of sediment motion can be found in Wiberg and Smith, 1987. To be clear, there is certainly much room for improvement for shields stress formulations for sediment transport, and I would have *no* problem with the use of alternative formulations if they are adequately defended in the text. But to completely disregard the concept of shields stress entirely in a paper about incipient sediment motions causes me to worry that the authors are entirely unfamiliar with the entire field of sediment transport. The authors go on to use a Bagnold-like formulation that predicts the efficiency of the flow in moving sediment through bedload and suspended load. Again, though the general idea is ok, they use the original, very old Bagnold formulation from the 60's that has since been modified and updated extensively (for an example see Martin and Church, 2000).

Suggestions for the authors

Reading the literature: It is possible that the authors have limited access to scientific studies, many of which are behind a paywall- if this is the case, then that is no fault of the authors. However, the classic sediment transport formulations that should be used in this study (or at least be mentioned, before the authors explain why they choose to use uncommon formulations), can be found in any modern geomorphology textbook even without the need for accessing dozens of scientific papers (e.g., Anderson and Anderson 2010). I would encourage the authors to dig into one of these textbooks to understand the current state of science in the study of sediment transport thresholds for motion. In the end, it's possible that using a shields stress formulation may not change their calculations very much at all- but would help link their future work to the broader study of sediment transport, making it both more scientifically defensible and useful to the community.

Scientific study design: I think a more carefully designed set of experiments similar to what was described in the paper could result in an interesting study. The most interesting aspect of the paper to me is the idea of better understanding how different bank materials modulate bank collapse and sediment transport in rivers. Experiments could be run using only one bank material at a time. Carefully controlling the flow and conducting repeat experiments- say, 3-5 for each type of bank material- will ensure that results are robust. By using one material, the sediment flux at the outlet can be measured and reported for each different material, giving information about sediment transport styles and rates. Measurements within the flume could give more information about bedload vs suspended sediment fluxes that can be compared with theoretical formulations (like an updated Bagnold transport formulation). This would make the study much more robust, and would illustrate the utility of combining experiments and theoretical analysis.

References

Anderson, R. S., & Anderson, S. P. (2010). *Geomorphology: the mechanics and chemistry of landscapes*. Cambridge University Press.

Wiberg, P. L., & Smith, J. D. (1987). Calculations of the critical shear stress for motion of uniform and heterogeneous sediments. *Water resources research*, *23*(8), 1471-1480.

Martin, Y., & Church, M. (2000). Reâ□□examination of Bagnold's empirical bedload formulae. *Earth Surface Processes and Landforms: The Journal of the British Geomorphological Research Group*, *25*(9), 1011-1024.