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Earth Surface Dynamics Discussions

Interactive comment on "Stabilising Large Grains in Aggrading Steep Channels" *by* William H. Booker and Brett C. Eaton

Anonymous Referee #2

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Booker and Eaton presents a set of laboratory flume experiments aimed at determining the role of the full sediment grain size distribution, rather than the more commonly-used median grain size, in capturing the behavior of aggrading alluvial channels. Through this targeted series of experiments, the authors find that the equilibrium slope of the aggrading channels that they produce is dependent on the grain size distribution of supplied sediment, the rate at which it is supplied, and the discharge available to transport the supplied sediment. Overall, I found this to be a nice set of experiments and a compelling result highlighting the role of bed structure in determining the dynamics of aggrading alluvial channels. While I think these results would be of interest to the community, below I have outlined a few points that I think should be clarified prior to publication.

âĂć Reorganization of introduction - I think the introduction reads fairly well, but that further motivation could be provided by discussing the predictions of Lane's balance at the beginning of the article. One could use the idea that Lane's balance would predict the same slope for a give D50, regardless of the rest of the GSD as a null hypothesis, then reference the known importance of large grains in degrading systems and the lack of complementary work on aggrading systems in order to more directly motivate this work. I think this reorganization could help to streamline the logical progression of the manuscript.

âĂć Methods clarification - While I generally follow the experimental set-up, I think some more detail can be provided regarding a few points.

(1) How where the discharges determined? Are they specified to span the range of partial transport to full bed mobilization? It would also be useful to provide the calculated/estimated shear (or Shields) stresses related to each of these discharges of both flows. I'm aware that this may require some assumptions in relation to the sidewall correction, but given that most of the literature on this topic is presented in terms of Shields stress, it would be useful to also provide this estimate, especially for the discussion of relative transport capacity. (2) It took me until halfway through the results to recognize that the multiple measures of slope presented were from different time steps following the onset of sediment transport out of the flume. How long were the experiments run after this point and how were the experiments determined to be over? Was an equilibrium slope/transport rate reached or were adjustments still occurring when the experiment ended? If equilibrium was reached, how was it determined? (3) For the slope-derivation, I think more information should be provided regarding the randomForests model, how it works, and the degree of user-specification it requires. How many images are input in order to determine the slope? How are the sub-classes determined? Are there uncertainties associated with these slope measurements based on the method or number of sample images input? A citation here providing the relevant background information could also help. The authors later report the mean slope

and standard deviation for each experiment, but it is unclear if this is from multiple time slices (if so, how many?), multiple locations in the flume, or related to some uncertainty in the slope estimation. Organization-wise, I don't necessarily think this needs its own section in the methods. Alternatively, I might suggest splitting the methods section into (1) Experimental set-up, (2) Measurements, and (3) Slope derivation. ' (4) I find GS1 and GS2 not to be very informative variable names. I would suggest changing them to GSnarrow and GSbroad or something more information so it is easier for the reader to keep track of throughout the paper. Even H and L are a bit confusing to keep track of, but less so.

âĂć Organization of the results section - I found this section to be a bit muddy, with parts of the motivation, methods, and discussion being mixed in. While I am okay with some intermingling of these sections, in this cas, I found it to make this particular section a bit difficult to follow. Below I've made some suggestions to streamline this section. (1) Move Lane's balance discussion to introduction. See above. (2) Move sediment transport efficiency calculation to methods. I would suggest adding this following the slope derivation. If Lane's balance has already been presented in the introduction, it would naturally follow to calculate the sediment transport efficiency. Introduction of this calculation in the methods would allow the authors to more cleanly step through the results. Again, some information of the number of samples used to make these calculations would be helpful (table 5). (3) This is a style thing, but I would suggest avoiding things like "Panel A of Figure 3 shows.." and instead simply say "There is a significant difference between equilibrium slopes as a function of the supplied grain size distribution (Figure 3A)." I think this would help with readability. (4) Much of the information in the tables is not fully presented in the paper. I would recommend more explicitly discussing these results in the main text. Lots of the results are presented in a fairly vague way (e.g. - ". . .both systems retaining a higher proportion of sediment" even though the authors have quantified these effects more directly. I would suggest rephrasing to provide these values directly in the text (e.g. – ". . . in response to a doubling of sediment supply, both systems retained a higher proportion of sediment,

XX% for the narrow GSD and XX% for the broad GSD." This in-text quantification would also help to clarify the main differences between the experiments.

âĂć Argument for large grains – While I find the argument that the transition between partial transport and full mobilization of the GSD drives the observed differences in slopes observed in the experiments reasonable, I am not entirely convinced that the data presented really show this. I agree given the results that D50 is a poor metric for predicting behavior in aggradation systems, but I think more could be done to support the argument of the importance of large grains.

Do the authors have any observations from the experiments to be show this? For example, was the sediment exiting the flume sieved to determine the GSD of the transported sediment compared to the supplied sediment? Can the photos/videos of the bed be used to determine if there is significant sorting that arises during the experiments that may support this idea? I imagine that the videos could be used to track the mobility (or immobility) of the largest grains (or the bed surface as a whole) in the flume to better evaluate this idea.

The portion of the discussion where shear stress calculations are made is quite confusing. It is unclear what inputs are being used and what information is being drawn from the calculation. Specifically, this sentence is quite unclear "Equation 4 produces a shear stress 44.4% greater for entrainment of the D84 than the entrainment of the median in GSD1 than in GSD2." I assume the authors are solving for tau_ri with reference to the D84 of both GSDs, but the reference stress value and the actual calculated values should be made explicit to better support this point. Additionally here, a comparison to the estimated shear (shields) stresses applied in the experiments (see previous comment) would help to bolster this point.

âĂć Discussion of bar formation and effects – Currently, I think this point of the discussion appears as an afterthought. While I agree that this might not be the main result of the paper, the authors describe the differences in bar presence and morphology be-

tween GS1 and GS2 experiments in order to support their conclusions regarding the role of large grains. If this is a main point to bolster the argument related to the importance of large grains, mapping of these bar formations and quantifying their differences between runs should be included in the methods/results sections of the manuscript. This discussion would be better supported with photos or measurements in the text to more clearly illustrate the argument made.

Figure comments: General – Yellow is difficult to see, consider changing.

Figure 1 – Provide flume dimensions Figure 2 – on plot report D50, D84, and sigma as part of the legend (eliminates the need for Table 1) Figure 3 – Could combine with Figure 1? I'm not sure this particular image adds very much. Also revise run name fro G2Q100H (as this is not how the experiments are referenced in the main text). Figure 4 – Higher contrast between sediment and water would make this easier to differentiate. Here different run times are referenced which appear nowhere in the text. Figure 5 – H and L could be expanded to "high supply" and "low supply" . Consider rephrasing terms "normal" and "not normal". Provide sample sizes for each box plot and include labels for mean and standard deviation. Would eliminate need for additional tables. Figure 6 – Add "Calculated sediment transport efficiency" to y-axis label. Provide sample sizes for each box plot and include labels for mean and standard deviation. Would eliminate need for additional tables.

Table Comments: Table 1 – See Figure 1 comment. Table 2 – See Figure 4 comment. Table 3 – A bit confusing, I would maybe separate the GSDs as done in other tables. Table 4 – This isn't discussed much in the text. I'm also a bit worried about averaging over different timescales here and also whether or not the average is the best metric if the experiment is still moving towards equilibrium when sediment begins to exit the flume. It would be useful to see how the sediment transport rates vary as a function of time since the experiment begins. See general comments regarding time to equilibrium. Table 5 – See Figure 5 comment. Table 6 - See Table 3 comment. Table 7 – Not sure this adds very much, as this comparison with Lisle is not a main part of the

discussion.

Line comments (Apologies for some differences in style that arise here): General: The term here-in is used a number of times, I'd suggest removing all appearances of it Abstract: P1 1 - consider revising to "sedimentary deposits" P1 2 - remove "shape" Introduction: P1 14 - remove "the"; consider rewording to remove "new stimuli" P1 16 – remove "procilivity for adjustment" P1 21 – replace "that results from" with "due to" P2 3 – Remove sentence starting with "accordingly" P2 13 – Consider revising "The superposition of change upon a pre-existing mass"; a bit awkward P2 14 – Consider changing "Four pairs of experiments" to "Two sets of four experimental runs" Methods: P2 23 – consider changing to "each experiment" P2 25 – relative used twice in this sentence, consider rephrasing P2 25-30 – consider adding numbers to the list. That said, I'm not sure the list adds much here. P3 4 – Add comma after "at the beginning of the experiment" P3 8 – Change "to be output from" to "to exit" P3 8-10 – Consider rephrasing, is a bit unclear P4 3 –A randomForests is not, as I'm aware, a standard way to extract this data, so some citations here providing details of the model/method would be useful. Results: P5 1-10: I think this entire section can be made more clear and that providing the measured values in the text will help make the results read more directly. P6 10 – I don't think the authors have enough data to argue for a threshold change in behavior here. This transition could very well be a continuum that the authors may just be unable to capture given the data they've collected. I would be cautious using threshold here. P7 4-5: Saying the "two systems behave more similarly" is quite vague. Again, I think actually including the measured values in the text here would better demonstrate the differences between the experiments. P8 5 – Remove "a number of key observations can be made regarding the distribution of transport efficiencies". Rephrase next sentence to "The distribution of calculated transport efficiencies for. . .". Again, values here would help. Another option for rephrasing would be "The mean transport efficiency for GSD1 is XX% lower than for GSD2. . ." Discussion: P9 9-10 – Consider changing "poorly sorted" and "narrowly graded" to "broadly" and "narrowly" graded to make comparison more straightforward. P9 Equation 3 – small d remains

undefined in the text. P10 Equation 4 – Ds50 remains underfined, consider rewriting all references to median grain size with the same convention (even if they differ in original references) P10 25-30 – I have a very hard time following this section. Please consider rewriting to make calculation more explicit. P11 9-10 – Reconsider using poorly and well-sorted here and instead use broad and narrow GSD Conclusion: P12 23-34 – Consider replacing GSD1 and GSD2 with “narrow” and “broad” GSDs P12 4 – Revise to remove “as you increase”; Missing period.

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