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Earth Surface Dynamics Discussions

Interactive comment on "Short communication: Field data imply that the sorting (D_{96}/D_{50} ratios) of gravel bars in coarse-grained streams influences the probability of sediment transport" *by* Fritz Schlunegger et al.

Anonymous Referee #3

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This manuscript addresses the question of whether bed sorting reflects transport rates of the bed material using a compilation of grain size measurements from (mostly?) gauged stream reaches and Monte Carlo simulations of flow competence. The dataset is useful and warrants eventual publication. However, the analysis does a poor job of testing the hypothesis, given what we know about thresholds for motion in gravel-bedded rivers. Moreover, the framing of the argument and the interpretation needs some improvement to help the reader understand the purpose and findings of the study.

Below, I list a number of concerns related to the analysis presented in this manuscript,

followed by suggestions to improve the presentation. Finally, I list some comments by line number, some of which echo or substantiate my main concerns/suggestions.

Concerns with analysis: Transport probabilities are estimated via a Monte Carlo approach, where "mean annual" shear stress is compared against the threshold stress for motion (i.e., is tau>tau_c?) for 10,0000 simulations for each site. Some of the variability between simulations results from measured standard deviations in mean annual discharge. However, any real transport variability that results from variability in water discharge is contaminated by synthetic variability in the other parameters (width, slope, critical shear stress, and grain size). The standard deviation of these parameters (except for tau_c) is set to 20% for all sites, without any justification.

The authors should justify their use of a mean-annual discharge. Why not use bankfull or channel-forming discharges, which typically occur every 1.5 or 2 years? Or, if the goal is actually to quantify the fraction of time that the threshold shear stress is exceeded, wouldn't it make the most sense to just estimate a threshold discharge for each site and count the number of flow measurements that exceed that discharge?

To estimate bed shear stress from discharge measurements, the study relies on a Manning's-n flow resistance calculation, in which Manning's n does not depend on any roughness length scale (e.g., D50 or D84). While this approach has been shown to compare favorably to measured flow velocities in some cases (Jarrett, 1984; Ferguson, 2007), it strikes me as an odd choice for this study, which is focused on the relationship between bed sediment size and transport conditions. Would including sediment size in flow resistance calculations affect the results?

Finally, I'm concerned that the analysis underestimates variability in the critical Shields stress and ignores the covariability between critical and bankfull Shields stresses. The critical Shields stress for bed motion varies by more than an order of magnitude between sites (e.g., Phillips and Jerolmack, 2019). Moreover, that study (Phillips and Jerolmack, 2019) makes a compelling case that the best predictor of critical Shields

stress is the bankfull Shields stress. This suggests that the inferred differences in excess shear stress between sites may not even exist. This is impossible to test without measurements of bedload transport (which I assume is outside the scope of this study), but this potential issue with the approach should be acknowledged.

Suggestions to improve clarity: Causality needs to be consistent throughout the paper. The title of the paper states that sorting influences transport (this causality is repeated in the conclusions, lines 174 to 177). However, the mechanistic argument stated in the intro (lines 28 to 32) is that lower bed mobility leads to enhanced armoring (winnowing of fines), which is expressed as differences in bed sorting. In reality there is likely a feedback between the two and causality in both directions, but the paper, in its title, intro, and conclusion, should at least be internally consistent.

The mobility of bars (which are bedforms) is used as the main motivation of the paper in the introduction and is mentioned several times in the short abstract, but this paper does nothing to discuss the mobility of bedforms. Please revise these sections to match the actual subject matter of the paper, which seems to be the extent to which the transport of bed material sorts that bed material.

Line comments

21 – 23. I don't think this reference suggests that the mobility of bars affects channel form.

39. It's unclear to me what mean-annual discharge is and why it's used. Is it the average discharge for the entire record? Or the mean of the maximum annual discharge? I assume that it's the mean of the entire record, in which case there is nothing "annual" about this measure.

45 – 46. So you avoided braided channels, but the intro suggests comparing braided and single-threaded channels is the main motivation of the study.

66 – 68. It doesn't "account" for slope dependency by bracketing a certain range of

values, and Lamb et al. (2008) show that the slope dependency extends to the lowest-sloping gravel bed rivers.

88. There is no roughness length scale in this roughness calculation.

106-108. How can you be sure that you're measuring the b-axis in a 2-D image? If assuming that the short axis is vertical, this should be stated.

109-110. By only counting the large particles once, you systematically underestimate the areal coverage by coarse particles. The correct solution to this is to choose a grid with a spacing that's larger than the largest grain.

119 – 124. Is there any justification for the 20% uncertainty?

126 – 127. Critical Shields stress at a site varies much more than this (see Turowski et al., 2011 for example).

130-132. Maybe I missed it, but are these streams also gauged? Are the data similar in quality and duration to the Swiss data? It seems worthwhile to state this since the results are so different between the two study areas (e.g., Fig. 3).

143. Is Qmed the mean or median? This is confusing.

156. It seems very difficult to say that the relationships in Figure 3 are linear.

157. I'm missing the justification for why the switch to D96 when D84 was stated to be the grain size of interest (line 69).

159. Bedload is not measured; D96/D50 is for the bed sediment.

References

Ferguson, R. (2007). Flow resistance equations for gravelâĂŘand boulderâĂŘbed streams. Water resources research, 43(5).

Phillips, C. B., & Jerolmack, D. J. (2019). Bankfull transport capacity and the threshold of motion in coarseâĂŘgrained rivers. Water Resources Research.

Turowski, J. M., Badoux, A., & Rickenmann, D. (2011). Start and end of bedload transport in gravelâĂŘbed streams. Geophysical Research Letters, 38(4).

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