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Interactive comment on "Theoretical Interpretation of the Exceptional Sediment Transport of Fine-grained Dispersal Systems Associated with Bedform Categories" *by* Tian Zhao et al.

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RESPONSE: The authors appreciate the careful review by Anonymous Referee 1. Below is our response.

REFEREE: The manuscript presents an analytical model to calculate the suspended load across fine-graded dispersal fluvial systems. Essentially the paper combines an existing empirical expression for the suspended transport rate (Eq. (1)) with further existing empirical expressions for the bed drag coefficient that take into account the different roughness of different sand beds (dune bed, ripple bed, moving flat bed). The keyword here is "empirical": there seems to be no first-principle-based model input

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Discussion paper

from the authors, which makes me question whether the paper is sufficiently novel to justify publication in ESD. From checking the journal scope, it seems that ESD focuses on the physical processes rather than engineering-like curve fitting. I therefore believe that the manuscript would be more appropriate for an engineering journal.

RESPONSE: In this manuscript, the authors would like to draw our colleagues' attention to the two different sediment transport modes bridged by a regime shift associated with the abrupt bedform category change. Part of our effort in this paper is to describe the common practice of sediment transport process, from the incipient motion of a sediment grain to the behavior of the coupled grain-bed-flow system. Each step in this process is represented by one or several formulae corresponding to general physical processes, rather than simply fitted by in situ data for regional use. Hence, we believe that, though simplified and preliminary, we have been applying basic physical principles to examine a specific interaction between the Earth surface and the hydrosphere.

REFEREE: In favor of the authors, one could possibly make the point that the manuscript reveals the physical mechanism behind the transition from low to large suspended load in fine-graded systems (roughness changes). However, at least for me, it has always been clear that this is the reason for this transition and I am quite sure that there have been other studies in the past making this connection (though, to be fair, I cannot point out any).

RESPONSE: We appreciate that the anonymous referee holds a similar view on the scientific problem of sediment transport regime shift. In the manuscript, we suggest that the flow mobility parameter Ψ can serve as a threshold for deciding the dominant bedform and the corresponding sediment transport mode, and higher water depth h can highlight the difference and the shift of principal bedform component and sediment transport behavior. Although these results seem empirical from the referee's view, our attempts can be the first to quantitatively examine the response of sediment transport behavior to bedform changes in the fine-grained dispersal system, and can thus assist future study in exploring the related physical mechanisms.

REFEREE: This being said, my only major criticism concerning the paper's validity is the apparent unawareness of the authors of the mechanisms that lead to the erosion of dunes when sediment becomes finer: It is quite well known that the wavelength of the smallest bedforms is controlled by the saturation length, which describes the response of the transport rate to small changes of the flow (e.g., see the review by Charru et al. 2013, doi: 10.1146/annurev-fluid-011212-140806). It is also quite well known that suspended load has a much larger saturation length than bedload (Wu et al., 2007, ISBN: 9780203938485; Claudin et al. 2011, doi: 10.1017/S0022112010005823).

RESPONSE: The authors are grateful to the referee for the opportunity to carefully examine the mechanisms of dune erosion with the suggested references above. Unfortunately, van Rijn (2007, doi:10.1061/(ASCE)0733-9429(2007)133:6(649)) did not include bedform wavelength or particle saturation length in his bed roughness predictor, which was constructed based on sediment grain size d, flow mobility parameter Ψ, and water depth h. Although this predictor and its initial form in roughness height (van Rijn, 1984, doi:10.1061/(ASCE)0733-9429(1984)110:10(1431)) have been widely utilized in sediment transport modeling, we believe it would be helpful to consider the relationship between particle saturation length and bed roughness in future studies of sediment transport modeling, based on our results.

REFEREE: Now, the finer the sediment the larger the proportion of suspended load load relative to bedload and thus the larger the saturation length. This implies that bedforms with short wavelength (i.e., dunes) are eroded, which leads to the mentioned decrease of roughness. In this context, it seems inconsistent to approximate the total transport rate as the transport rate of suspended load for all fine-graded systems (assumption 3 in line 76) because the presence of dunes in fine-graded systems consisting of larger particles (but still fine) is associated with bedload transport. One could possibly argue somehow around that, but I strongly feel that something is missing here.

RESPONSE: We are aware of the increasing portion of bedload in total sediment transport. However, van Rijn (2007)'s calculation suggests that the bedload transport rate is

smaller than the suspended load transport rate by at least an order of magnitude, when the bed sediment grain size d < 250 μm. Since this is from the same source where our roughness predictor comes from, we believe the transport rate of suspended load has already been a good estimate of the total sediment transport rate. It is also beneficial to include the bedload part, nevertheless, in this manuscript, the authors would like to highlight the role of suspended sediment transport in shaping dominant categories and sediment transport regimes.

REFEREE: Minor comments: - Supplementary material should be in PDF format (I cannot read the equations without commercial software). RESPONSE: The supplementary information has been converted to a PDF file.

REFEREE: lines: 14 and 63: add the word “empirical” before “bed roughness predictor” RESPONSE: Fixed.

REFEREE: 23: define phi RESPONSE: Fixed.

REFEREE: 48: define u and h RESPONSE: Fixed.

REFEREE: 51: “c is the total sediment concentration by mass” - the quantity c does not appear above line 51. RESPONSE: Fixed. We have also emphasized our usage of sediment concentration by mass in line 86.

REFEREE: 100: define “dune” and “megaripple” RESPONSE: Fixed. Please see line 103.

Please also note the supplement to this comment:
https://www.earth-surf-dynam-discuss.net/esurf-2018-64/esurf-2018-64-AC1-supplement.zip

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