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Interactive comment on "Fluvial response to changes in the magnitude and frequency of sediment supply in a 1D model" *by* Tobias Müller and Marwan Hassan

Anonymous Referee #1

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General comments

This paper focuses on the impacts of episodic sediment supply on river channels with particular attention to the role of the sediment size distribution, event frequency and magnitude. The study is performed using a one-dimensional morphodynamic model that accounts for transport, erosion and deposition of non-uniform sediment. The model is first validated against laboratory experiments and is then applied to study the evolution of the laboratory deposit under conditions that had not been previously investigated. Model results are analyzed to determine the impact that the event sequencing has on the evolution of a laboratory channel, and to characterize equilibrium conditions

with episodic sediment supply. The main results of this study are that 1) the order of the events has a limited impact on the long-term evolution of a channel bed, and 2) two different types of equilibrium can be defined depending on the frequency and magnitude of the sediment supply events. Equilibrium in the case of frequent low-magnitude events is similar to equilibrium obtained with constant flow rate and sediment supply. Equilibrium in the case of rare high-magnitude events is different than the equilibrium obtained with a constant sediment input rate.

These results give useful insight on how to model sediment supply to mountainous rivers. The pulse period and the fluvial evacuation time can be estimated from field observations. If their ratio is smaller than 1, the sediment supply can be modeled as a constant and specified input rate to the model reach as commonly done with morphodynamic models. Conversely, if the ratio between the pulse period and the fluvial evacuation time is larger than 1, the approximation of constant sediment supply should not hold and the sediment pulses should be specified as upstream model boundary condition. This information is not only relevant for morphodynamic modelers, it is also useful to researchers and professionals that are interested in the evolution of river reaches for geological, engineering and/or ecological studies. This notwithstanding, I find this manuscript difficult to read and I have the impression that some changes can significantly improve its clarity. I list my questions and comments below.

Detailed comments

1. The number and the order of the research questions on page 4 (lines 5-9) should probably change. The authors have three research questions, one at point (1) and two at point (2). The two research questions at point (2) should probably be listed as two separate questions. In other words, 'can the numerical model recreate the channel response that was observed in flume experiments of similar scope?' should be an independent question, let's say question 3. Before applying the model to answer questions 1 and 2, the authors compared the numerical results with laboratory data. Thus, they first answered question 3 and then they run the model to answer question 1

and 2. For clarity, question 3 should probably become question 1.

2. Page 6 line 1, I would reorganize this sentence saying that in the case of steady and uniform (normal) flow the bed slope is equal to the friction slope and then write equation (5).

3. Equation (9), I may have missed it but somewhere in the text the authors should say that the grain size distribution of the bed material is described in terms of 'n' characteristics grain sizes Di with 'i' denoting the generic grain size range, and that in the simulations presented in this manuscript 'n' is equal to . . .

4. Page 7 line 1, Why did the author choose a value of alpha equal to 0.45 when laboratory experiments with sand and pea gravel show that is varies between 0.2 and 0.3 (Toro Escobar et al., 1996; Viparelli et al., 2010)?

5. Page 7 line 2, Why did the authors implement a procedure to store and access the vertical stratigraphy and then do not use the numerical results to characterize the grain size distribution of the substrate (page 14, line 7)?

6. Page 7 line 10, How did the authors specify the downstream boundary condition of the flow equation in the case of subcritical flow?

7. Page 7 line 20-22, Was the laboratory flume a water recirculating and sediment feed flume? If it was, how did the authors accounted for the constant volume of water in the system in the calculations? (Parker and Wilcock, 2003; Parker, 2004 – Chapter 22)

8. Page 7 line 26, 84 should be a subscript.

9. Page 8 line 15 and throughout the manuscript, it seems that the geometric mean diameter and the other parameters describing the sediment size distribution refer to the bed surface (or active layer in this case). The authors should clarify when they refer to surface or substrate material. What about adding the subscript 's' to values representing the bed surface, the subscript 'sub' to values that are representative of the substrate, and the subscript 'l' for the load?

10. Pages 10 and 11, lines 16-17 and 1-20, this is a very long paragraph and it is very difficult to follow.

11. Page 11 line 24, Gfluv is this surface?

12. Page 12 line 2, What do the authors mean with 'transport rate at equilibrium might be reached before an equilibrium in slope'? If the time rate of change of bed elevation is computed with equation (8), when the bedload transport rate summed over all the grain sizes does not change in the streamwise direction (equilibrium), the bed elevation does not change in time and the slope does not change in time. I do not understand how mass can be conserved if the sediment transport is in equilibrium and the slope is not.

13. Page 12 line 16, why didn't the authors validate the model with the grain size distribution of the sediment used in the experimental run? This information should be given in the model validation section with the discussion on how they determine the values of the model parameters, i.e. reference Shields number of the Wilcock and Crowe relation and alpha.

14. It is not clear to me why the comparison between experimental and numerical results presented in Figure 3 is not done in the central 2 m long section of the flume. In other words, why did the authors average the numerical results over the entire flume length?

15. Page 13 line 4, maybe 'short' and 'small' are here more appropriate than 'shorter' and 'smaller' because they are not followed by a 'than'.

16. Page 14 line 19, is mlp = mean over the last pulse?

17. Page 15 lines 4-8, the authors write 'In simulations with a narrow GSD (sigma < 0.4), we observe a decrease in Smlp when the pulse period is long'. In Figure 6c there seems to be a decrease in Smlp when the ratio between the pulse period and the fluvial evacuation time is slightly larger than 1 in all the runs but two, i.e. sigma = 0.4 and 0.7.

As the ratio between the pulse period and the fluvial evacuation time increases, Smpl is larger the Sconst in the runs with sigma > 1. What am I missing? Any explanation for the behavior when the ratio is close to 1?

18. Page 18 line 30, two ‘which’ in one line. Consider rewriting.

19. Page 19 lines 8-10, the authors write ‘Yet, the flume might be too complex of a system to ever reach an equilibrium in the same way as the numerical model, and the response of slope in the flume experiments might be transient, meaning that the adjustment of the channel cannot directly be attributed solely to the most recent forcing event’. It seems that the authors are questioning the usefulness of the numerical simulations presented in this manuscript and the validity of their model verification. Consider rewriting in a more positive way.

20. Page 20 line 9, add ‘the’ between all and supplied.

References Parker, G. and Wilcock, P. R., 1993, Sediment Feed and Recirculating Flumes: Fundamental Differences, Journal of Hydraulic Engineering 119 (11), 1192-1204. Parker, G., 2004, 1D Sediment transport and morphodynamics with applications to rivers and turbidity currents, freely downloadable e-book at http://hydrolab.illinois.edu/people/parkerg/ morphodynamics_e-book.htm Toro-Escobar, C. M., Parker, G. and Paola, C., 1996, Transfer function for the deposition of poorly sorted gravel in response to streambed aggradation, Journal of Hydraulic Research 34 (1), 35-53. Viparelli, E., Haydel, R., Salvaro, M., Wilcock, P. R. and Parker, G., 2010, River morphodynamics with creation/consumption of grain size stratigraphy 1: laboratory experiments, Journal of Hydraulic Research 48 (6), 715-72

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