Review by Astrid Blom (Oct 2018) of the *revised manuscript*

"Morphodynamic model of Lower Yellow River: flux or entrainment form for sediment mass conservation?"

by Chenge An et al.

The authors asses the differences between modelling sediment conservation using a flux-based formulation and an entrainment-deposition type formulation. They apply the two forms of the sediment conservation equation to the Lower Yellow River and study the differences between the predicted results. The work is novel and of interest to the ESurf reader. The differences between figures 6 and 7 are quite large, which is an interesting finding. I am quite happy with how the authors have addressed my previous concerns. I have two remaining suggestions: (1) to stress a bit more strongly the *essential* difference between the flux form and the entrainment form of the conservation equation "*We define the flux form as based on the local capacity sediment transport rate, and the entrainment form as based on the local capacity entrainment rate*" and (2) explain the entrainment form of the conservation equation in more detail. I would suggest acceptance of the paper based on minor revision.

Suggestions:

(Please note: line numbers and equation numbers all refer to numbers in the tracked changes manuscript)

1. Based on the authors' response to my previous 2nd comment I now understand what the authors mean by a flux based approach and an entrainment based approach. The authors' response is:

> We have now specifically defined what we mean by the flux form and entrainment form. See Lines 23-24 of the manuscript with track changes. We define again here: "Here we identify the flux form as based on the local capacity sediment transport rate, and the entrainment form as based on the local capacity entrainment rate". Although we do not go into details in the paper, we note here that our system (the Yellow River) is suspension-dominated to the point where bedload is negligible. The phenomenon documented by Bell and Sutherland (1983) can be quantified using an entrainment-based *bedload* formulation such as Pelosi and Parker (2014). We note here that El kadi Abderrezzak and Pacquier (2009) list the form $dQ_s/dx = (Q_s^{cap} - Q_s)/L_{ad}$, where L_{ad} is the adaptation length. This is nothing more and nothing less than an entrainment form, but one for which the guts of the adaptation length L_{ad} remain undefined. In our system L_{ad} is specifically given as $q_w/(v_s r_0)$, where q_w is the water discharge per unit width and v_s is fall velocity.

   This response in the response letter helped me a lot, and I actually find it clearer than the explanation in the revised manuscript. I'd suggest incorporating the above lines in the manuscript text, also the part of Bell&Sutherland, Pelosi&Parker and El Kadi Abderrezzak.

   In trying to understand the essential difference between the flux form and the entrainment form, it was the following sentence by the authors that made the difference to me: "*Here we define the flux form as based on the local capacity sediment transport rate, and the entrainment form as* *based on the local capacity entrainment rate*." I'd stress that information at various points of the manuscript: abstract, conclusions and introduction. I indeed do find that sentence in the revised abstract, but I'd move it upward as it is quite an important remark that will help the reader understand the essential difference between the two forms.

2. Ln 54-55. The fact that one of the two (sediment transport rate or entrainment rate) is related to flow hydraulics is not the essence of the difference between the two forms, right? The essence rather is your phrase "*Here we define the flux form as based on the local capacity sediment transport rate, and the entrainment form as based on the local capacity entrainment rate*."

3. Ln 25-26, 44. I find the terms equilibrium and nonequilibrium still confusing. I now understand that your words "(non)equilibrium" relate to the "sediment transport rate". Yet if you'd decide to relate the words "(non)equilibrium" to the "entrainment rate", would you have to reverse the use of the 2 words?

4. Also see my previous Comment 26. I'd add the information on the numerical schemes for solving the equation of conservation of sediment mass (in the section on the flux form as well as in the section describing the entrainment form) to the manuscript. I may have overlooked though.

5. Ln 152-153. "*For all the governing equations in this paper, the flood time scale is implemented by introducing If into each time derivative*." I am not sure I understand the meaning of this information. I think it would be relevant to let the reader know explicitly which time coordinate, t or t_f, is indicated in the legends of your figures? For instance, see figure 8. Maybe also list this information in the captions?

6. Section 2.3. I think the reader will need some help in this section.
   - Why not start off with listing the general entrainment form of the conservation equation of sediment mass, where the right-hand term of Eq.8 is equal to D_s - E_s ?
   - then step by step explain what D_s is and how it is modelled?
   - then E_s ?
   - the information on slide 8 of Chapter 4 of Gary's E-book would definitely help here
   - I'd add references to the section
   - please also indicate it if an equation is newly introduced (and so no references exist)

7. Eq (9). I do not understand the background of this equation. Can you help me and the reader out here?

8. Ln 211. Please explain to the reader what is the physical meaning of the "sediment transport" being at equilibrium. I guess that under these conditions the upward sediment flux due to turbulent eddies is equal to the downward sediment flux related to gravity or the fall velocity. So under conditions in which the "sediment transport" is at equilibrium we are dealing with the Rouse profile?

9. Ln 674. Please note that the instabilities reported by Chavarrias et al (2018) do not have a numerical origin. They result from complex eigenvalues of the system of equations and do not result from the numerical solution procedure.

Specific or detailed comments:

10. Ln 49. alternate → alternative?

11. Ln 121. Reference to E&H consists of an unwanted ".", I think. Something like this is also found in L65.

12. Ln 183. Not sure you like how the symbol turns out here.

13. Ln 275. This text could use some more nuance.
    Indeed Blom et al (2016, GRL) apply the fractional form of E&H that was introduced by Van der Scheer et al (2002).
    Yet Blom et al (2017, JGR) propose a much more general power law load relation for mixed-size sediment (called "GR", but inspired on the form of E&H) that is capable of including hiding effects. It is listed in Eq 19 in Blom et al (2017 JGR).
    I think that the reason for it to not be applicable to the LYR is that it has not been calibrated to the LYR data and we do not know suitable values of the constants in the GR load relation. I do not think the reason for it to not be applicable to the LYR is that it does not include hiding effects.

14. Ln 281 and 305. Porosity value is listed twice.

References

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