Answers to Prof. Jerolmack

February 27, 2017

This paper synthesizes 100+ years of research on laboratory river channel geome- try data to assess the success of threshold channel theory for explaining the relation between river discharge and width. It also seeks to better our understanding of why braided rivers are so common in the lab, and whether there is a phase space in which single-thread channels that transport sediment can exist WITHOUT the assistance of bank cohesion/vegetation. The main conclusions from this assessment of experiments are that: (1) threshold channel theory predicts very well the width of laboratory chan- nels with no or little sediment transport; (2) threshold channel theory predicts the scal- ing relation between width and discharge well for lab rivers with significant transport, but these rivers are offset from the threshold prediction; and (3) increasing sediment transport rate leads to river widening and a departure from the threshold prediction until a critical width - likely associated with bar formation - at which the river begins to braid. The first two points have already been demonstrated by some of these same researchers for field rivers; as they point out, it is quite nice that lab rivers behave identi- cally in this respect to field rivers. The third point is the most novel and also speculative finding of this paper, but it is backed up by a fascinating re-analysis of experimental data. In particular, the authors look at the width of channels just before the point of bar formation in some classic transient channel adjustment experiments from the 1960s, and show that there appears to be a well defined upper limit on channel width. The paper is clear, concise, and well written. The analysis is straightforward but fascinating. The findings about the upper limits of channel width stability raise more questions than they answer, but this also tells us precisely where to go with future experiments. Indeed, the authors usefully suggest some specific future experiments that could shed light on these questions.

I don't see any need for major revisions. However, these findings touch on other questions and I found myself wondering if and how their interpretation may agree or disagree with other studies. It might be useful for the authors to broaden out their discussion to include some of these.

Detailed answers to your comments and questions are given below. When two questions are related we have grouped them together and provided an overall answer.

First, the conditions for bar iniation and geometry are well known and theories and laboratory experiments are in pretty good agreement. Is the finding in this paper of channel width = 1.7 times threshold for braiding related the classically determined bar initiation ? Related, another classic Parker paper on the braiding/meandering transition proposes a stability crite- rion related to water discharge, width, depth and slope that has been validated with field data; this is related to the onset of bar formation. Does the authors' result here square with the Parker stability criterion ?

Parker (1976) studied the formation of bars and its consequences on channel geometry. He proposed that the limit between single-thread and multiple-thread channels occurs when the ratio (H/W) of a stream is equal to the ratio of its slope to the Froude number of the flow (S/Fr). Following your suggestion, we compared our limit-channels with this criterion and found that the limit-channels of Stebbings are on the verge of braiding according to Parker's prediction. Furthermore we also find that the threshold channels and the experimental channels of Ikeda et al (1988) and Ashmore (2013) accord with the threshold proposed by Parker. Thus our empirical finding, based on these experiments, is not in contradiction with Parker's analysis. We added a paragraph to explain this in detail in the text and a supplement in appendix with a new figure that shows the comparison.

More broadly, this paper steers clear of the question of how far rivers can get from threshold - it does not consider the Shields stress of rivers in the analysis, and considers width-discharge scaling (and depth and slope in the ap- pendix). Do the findings in this paper bear at all on the Shields stress of rivers?

The paper cited for field alluvial river data, Li et al. (2015), proposes a continuously varying Shields stress and indicates that there is no real attractor of (near-)threshold dynamics. On the other hand, we

(Phillips and Jerolmack, 2016) assessed coarse-grained rivers - including some of the same data - and found that when the dependence of critical Shields stress on channel slope is taken into account, there is strong evidence that channels organize to a Shields stress slightly in excess of critical. It is indeed fascinat- ing that the threshold channel theory predicts the proper scaling of channel geometry with discharge, even when the magnitude is incorrect (as shown by these authors in their previous 2015 paper from field data, and also in the appendix of this paper where we find that depth and especially slope are offset from the theoretical line). Do the authors have any comment on what we can say about the state of Shields stress of rivers? In other words, is the existence of a certain transport state (Shields stress or Rouse number) a cause or a consequence of channel organization? I know the data alone can't answer this question, but these authors already flirt with some of the deep paradoxes of channel geometry, and are in a better position than most to speculate on this too.

In a threshold river the channel shape adjusts so that the shields parameter is everywhere constant and equal to θ_t. When the shear stress is above threshold, theories have been proposed to explain the geometry of the section but the available experiments do not allow us to test these theories. Specifically, we lack experiments with shear stress measurements. They would be needed to provide a sound answer to your question. Of course we agree that this is an important questions and it is the subject of an ongoing experimental and theoretical work in our group.

Minor comments follow below.

p. 6, line 20: "lead" should be changed to "led". Done

Table 1: Could you provide parameters that would allow computation of hydraulic variables? e.g., Discharge, width, depth, slope?

p. 8, line 12: "anymore" should be "any more" line 15: the word "influence" is mispelled. Done

Figure 5 caption: "normed" should be "normalized". Done

p. 10, about the rarity of single channels in the lab and possibly very small phase space. Could the authors comment on whether there is something about field scale that makes this phase space "less fragile"? Or in the field is it cohesion/vegetation that forces this?

p. 10, line 9: authors point out that Ikeda is only experiment they know of that makes stable single-thread rivers in the lab. They should make clear that they mean without adding effects of cohesion/vegetation.

We changed the sentence.

p. 10: "...with a lower flat section were...". The "were" should be "where". Done