Earth **Surface**
Dynamics
Discussions

Open Access

ESurfD

Interactive
comment

Interactive comment on "Laboratory rivers: Lacey's law, threshold theory and channel stability" *by* François Métivier et al.

D. Jerolmack (Referee)

sediment@sas.upenn.edu

Received and published: 29 September 2016

Reviewer: Douglas Jerolmack

This paper synthesizes 100+ years of research on laboratory river channel geometry 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 channels with no or little sediment transport; (2) threshold channel theory predicts the scaling 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 identically 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. 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 criterion 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? 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 appendix). 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 fascinating 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.

Minor comments follow below. p. 6, line 20: "lead" should be changed to "led".

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.

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

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 foreces 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.

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