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Interactive comment on "Alluvial channel response to environmental perturbations: Fill-terrace formation and sediment-signal disruption" *by* Stefanie Tofelde et al.

Anonymous Referee #2

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General Comments: This well written paper describes a set of seven flume experiments in a sand box in order to mimic conditions and controls of fill-terrace formation. The main controls explored are changes in water Qw and sediment Qs discharge and changes in base level. The paper gives a nice and consistent description of current terrace formation theories, models and controls. It gives a clear description of the experiments and relates them in a transparent way to current model insights on fluvial dynamics. The derived conclusions are supported by the sand box experimental evidence but the translation to field evidence is not equally well considered and not always supported by evidence (there a quite some constraints related to the physical experiments). The main limitation of this investigation is that all results and relation-

ships found are only valid for a flume sand box system which cannot be linearly scaled up to real world system without some critical considerations and reflections. First of all is the sand box experiment dealing with a relatively short and steep fluvial system with Qw,in = Qw,out. The setup resembles, in a qualitative way, more an alluvial fan system than a large mature fluvial system, that are usually studied in the cited terrace studies. Secondly, is the 'fluvial system' studied a braided system only, while many studied and cited terrace systems are thought to be initiated when the fluvial system switched from a braided to (more) meandering state (and back). Finally has the used methodology the issue of reproducibility. If we would repeat the same experiments in the same sand box would we get the same terraces (properties) and results?. This is crucial to know because the laser scanning allows us to measure very small changes (with known uncertainties) but if there is significant other uncertainty ('noise') in the sand box data of a higher magnitude we might be over interpreting the data. As long as we do not know the 'noise' in the experiments we should be reluctant to draw too many conclusions from relative minor changes in elevation. I recommend to address these potential limitations in the discussion in a separate section. Having raised these concerns I do believe the experiments generate an interesting set of criteria and hypotheses that could and should be more rigorously tested on real world systems and be evaluated in numerical models. I will certainly test some of the proposed relationships on existing terrace field evidence and with numerical modelling. I therefore recommend to publish this publication after revisions.

Specific comments: The validity of the results and relationships observed are certainly more valid for fluvial fan type settings where also transport distances are relatively short and gradients are steep and we only observe braided behavior. In such real world systems we actually do observe ifferences in gradients between different fill type terraces. The large and longer fluvial systems are often characterized by almost parallel gradients of preserved terraces. Often terrace formation and preservation is linked to tributaries causing reach specific changes in Qs and Qw, something that has not been evaluated in the experiments. The link between landscape dynamics and Qs,in is another scaling challenge. Landscapes often display a delay between environmental changes and sediment flux responses. These response lags can be even an order magnitudes larger than the lag-times within the fluvial system itself. This is related to coupling and decoupling of hillslope dynamics to the fluvial system. The autogenic dynamics analysis requires more thought. We can only discard them if they do not occur after longer repeated runs under 'stable' conditions. It seems there is more autogenic dynamics related in the transient response of channel width an aspect in the model results that are not as detailed analyzed as the terrace profiles, surface slopes and signal propagation. I like the prediction that net deposition along the channel leads to the majority of the grains at the outlet being freshly delivered from hillslopes (assuming hillslope coupling). While during incision older material is reworked in the outlet material, potentially yielding older ages (with cosmogenics). In terms of the boundary conditions of the physical experiments I have the following remarks/questions: How realistic is a constant Qs,in input? In reality sediments are released as sediment waves into the fluvial system. How important are the initial conditions? (referring to initial channel and 'spin-up' phase). What is the effect of stopping the experiment for the laser scanning? Doesn't this 'disturb' the experiment. A comparison between two equal runs with and without stopping could answer this issue? If this has been investigated before, please cite the relevant literature on this. You give temporal lags in measured time. How would you scale this up to reality? (see fig 5) A difference between the Qw and Qs experiments compared to the base level change scenarios is the there is far less accommodation space in the upper part for terrace preservation (a narrow steep incision) compared to the downstream section and its response to base level change. Shouldn't this not be included in the impact analysis of perturbations? I fully agree with the statement that simulating long-profile evolution requires an improved understanding of the transient response of channel width. I presume that the Wickert and Schildgen, 2018 relationship between S, Qs ,in and Qw are also only valid for braided sand box systems under transport limited conditions? This also implies uniform 'bedrock' lithology. In reality (all cited real world examples) tectonic stability doesn't exist, nor do

uniform lithologies or transport limited conditions. I am not suggesting to exclude the comparison but be more sensitive of the differences. The view of terraces/floodplains as temporal storage space is a realistic one. The percentage of Qs,in is in temporary storage during experiment in total in time, in Fig 5 could be used to quantify this effect and the possible effect on cosmogenic age.

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