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Hydrology and Earth System Sciences
Discussions



# *Interactive comment on* "Impacts of Changing Hydrology on Ravine Growth: Experimental Results" *by* Stephanie S. Day et al.

**Anonymous Referee #2**

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This paper deals with the important problem of gully or ravine growth. The paper has its merits as it presents a considerable amount of experimental data (20 experiments in total) using two different substrates and different hydrology settings. Some interesting problems such as width – discharge relation and modeling sediment transport are tackled. However, in its present form it needs still a bit of work. The results, presentation of the results and analysis is quite confusing. I believe the results are very interesting, but they need to be "fleshed out" considerably before this paper can be published.

Main comments

-The introduction gives a very good overview of the problem and state of the art. -The article claims to be studying ravines or permanent gullies. Yet this experiment is clearly tailored at measuring what happens during a newly forming incision, that erodes from



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scratch. I believe the results would be different if erosion would be analysed in an existing channel (or existing permanent gully). These might well respond to changes in discharge. -The choice and description of materials is crucial and should be better explained. “Mud” is not an objective description as far as I know. The 96 micrometer substrate classifies as sand following objective classification systems (0.05 – 2 mm) and the finer one as silt. What are the indications for cohesion and that the finer substrate really acts as detachment limited? What is the critical shear stress of these materials? Other properties such as angle of repose will also greatly influence wall stability and could be useful to include. -The experimental setup strikes me as odd to investigate ravine erosion/concentrated flow erosion. Why was a flat bed used? This way the flow does not concentrate until the outlet? From the only picture that is included of the experiments (Figure 1) it seems like you have multiple gully/ravine heads in the mud substrate. What is the effect of this on your results? -The presence of several knickpoints in the mud case seems to indicate the presence of plunge pools. These could potentially be very important yet I am missing an explanation on this. See for example results by Govers et al. Earth Science Reviews 2007. -The presentation of experimental results is quite confusing. The authors use a mix of “water delivery rate”, flow rate and discharge (figure 3), sediment volume removed versus mass (it should be easy to convert the first into solid discharge rates using the bulk density of the sediment) etc. Also a mixture of units is used (m3 in the text versus cm3 in figure 3) -It is not surprising to me that no good relation can be found with discharge. Previous studies, mentioned in the introduction, clearly indicate that gullies grow fast in early stages and then reach a more stable state. Figure 4 and 5 clearly shows this as sediment flux peaks in the beginning and then declines. -The text includes a lot of statements that are not backed up by data. For example, p.6 lines 11-12: “channels in the sand erode due to head cut propagation as well as lateral channel migration”. No picture or DEM is included however comparing the results and evolution in both substrates so there is no way to check this. The only available figure 6 is difficult to compare and raises further questions. I recommend to align this graphs

in the same direction (flow direction for example, with the outlet facing up). In the mud, two gully heads have formed. This confirms my point made earlier about the experimental setup. How was this handled in the data analysis? As flow splits, how was this modeled? Is the measured channel width the sum of both channels? could this explain why you see no increase in width with increase of discharge for the mud case. See papers by Torri et al. on using channel junctions of rills to model width downstream (10.1016/j.geomorph.2005.11.010). Another example are the statements about slope that are made in the text, yet no discussion is given on the slope results presented in table 2. -In paragraph 3.2 the authors are mixing results and materials and methods or model description. I believe these equations should go in materials and methods. -p8 line 5 “our sediments were easily eroded” Isn’t this contradictory to claiming the mud case is detachment limited? -What is the use of describing your experimental conditions in a table if you then cite flow rates etc. in every figure (example fig5)? -p.9 lines 1-4. This is an interesting conclusion. I think it merits some expansion, which comes after line 25. I think this would be clearer if the two paragraphs that are in between were moved. This width-discharge relation is used commonly in gully erosion models but lacks differentiation according to material type as far as I know. Did you measure top width or bottom width? I could not deduct this from the materials and methods. In many field studies bottom width was measured.

Minor comments

-Why not use the more common term gully erosion in stead of ravine erosion? (2844 terms in WoS versus 212 results) - if SI units are not deemed illustrative, please use at least standard abbreviations throughout the text for example p5line 1: ml/s figure 2 time (min) not (m) -table 1. Why call this flow? Flow rate or discharge. -The quality of the figures is not very high and looks like they have been done using a standard spreadsheet. Please improve using a more professional graphing programme (R, sigmaplot, grapher, whatever,. . .). -p.6 lines 1-2 and assuming that you have Dunnean runoff generation as you have in your experiments. With Hortonian overland flow generation, the

whole situation changes. -p.5 line 28. Explain meaning of the threshold line. -p7 line 2 Nachtergaele -figure 7. Please indicate the exact values used for b. 0.4 or 0.39 (text??). What is the value in case a.

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