Earth Surf. Dynam. Discuss.,
https://doi.org/10.5194/esurf-2019-78-RC2, 2020

Earth Surface Dynamics Discussions

Interactive comment on "State of the Art Study of Influence of Bed Roughness and Alluvial Cover on Bedrock Channels and Comparisons of Existing Models with Laboratory Scale Experiments" *by* Jagriti Mishra and Takuya Inoue

Rebecca Hodge (Referee)

rebecca.hodge@durham.ac.uk

Received and published: 16 March 2020

This paper addresses the relationships between sediment supply and the formation of sediment cover in a bedrock river channel. The paper presents a new set of flume experiments that measure sediment cover formation over surfaces of different roughnesses. The flume results are then compared to predictions made using a range of models from the literature. Overall the paper is a useful addition to the research literature on this topic area, and I would recommend publication subject to some revisions as outlined below.

One general point is that the introduction and section on models could be more clearly structured. For example, the introduction covers a range of very relevant papers, but is mainly a summary of each of them, and they seem to be presented in a fairly arbitrary order. For example, Johnson et al (2010) and Finnegan et al (2007) are reported as having similar findings, but they are presented in different sections of the introduction. It would be useful to outline more clearly what some of the key debates have been, and show how the different papers have contributed to these debates. Further specific comments are below.

An interesting aspect of this paper is the calculation of roughness lengths by minimising the differences between the models and the experimental results. I would like to see further consideration of how these roughness lengths compare to the measured hydraulic roughness lengths. The need to alter roughness lengths for the models suggests that the models are not accurately reproducing all aspects of the processes in the channel. What are the models missing? It may also suggest that the way in which roughness lengths are calculated by Johnson's model is incorrect. Can you say any more about this, and maybe make recommendations for how the models could be improved and roughness lengths should be calculated? A recent paper by Ferguson et al (2019) addresses how to calculate roughness lengths in bedrock-alluvial channels with multiple roughness length scales, and might be of interest.

Throughout, it would be helpful to name the experimental runs in a way that describes the bed roughness, such as Gravel50, or Net4. When they are all called Run it is harder to remember which is which.

Comments by line:

1: No need to include state of the art in title. I would reword the title as the influence of bed roughness and sediment supply on alluvial cover in bedrock channels.

7: Abstract needs to be clear that this paper is focussing on bedrock channels.

11: Add more details about the experiments that you carried out.

18: Interesting idea that economic growth has increased the occurrence of bedrock channels; do you have any evidence for this?

22: Sediment cover can start to form when sediment supply is less than the transport capacity.

28: However, see also Cook et al. (2013) in which no erosion occurred when there was no sediment supply.

30: See also some of Turowski's work about the amount of cover determining the elevation of erosion, e.g. Turowski et al. (2008).

37: This relationship depends on the relative roughness of the bed and the sediment though.

86: Specify that it is the critical shear stress for sediment movement. Is this for grains in sediment patches, or on bedrock?

97: Is L is the macro-roughness height of just the bedrock?

107: By deposition, do you mean Pc?

109: New model, so start a new paragraph.

126: Not entirely clear which two models you are referring to. Start the section by briefly presenting the two models before getting into the details of each.

128: Can you only apply the Inoue model if you have measurements of both the alluvial and bedrock hydraulic roughness? What if you don't have them? If you had hydraulic roughness measurements then presumably you could substitute those into the Johnson model? Are there other differences between the models as well?

135: Might be useful to explain how Turowski and Hodge's model is a probability based model.

150: Explain more clearly what you mean by no-sandbar conditions. Are you getting no bars at all, or just not a certain type of bar? Later on you refer to alternate bars in Chatanantavet and Parker's experiments.

159: What is the net made from?

180: State that these measurements were performed for all 5 surfaces. It might also be useful to explain why you use 5 mm gravel here, but sand in the rest of the experiments.

187: What is the grain size of the sand? There is a lot of variation in the supply rates between the different experiments; how did you decide what range of supply rates to use for each bed?

188: How was equilibrium state defined?

193: How often was the alluvial cover calculated?

196: Add a column onto Table 1 to include the hydraulic roughness of each experiment.

230: In the Fig 3 caption, explain that the bedrock bed is white and sediment is dark.

242: How do you measure the average thickness of the alluvial layer? The methods mention measuring the topography of the bedrock bed, but not measuring the topography once sediment cover has been added.

243: I had to look up what this equals sign meant; I don't think that it's commonly used in Europe.

245: Still not clear where the thickness values have come from. Is the average thickness evaluated across the entire bed (so that it includes areas where the thickness is zero), or just the areas with sediment cover? I'm also not sure how to interpret Fig 6. If the average thickness includes areas with zero cover, then ηa/L could increase because the cover is growing spatially, but with the depth of all sediment cover remaining the same. The other extreme would be that the spatial extent of the cover doesn't change, but the depth of any existing cover increases. What is the relative contribution

of lateral vs. vertical growth of the sediment cover to the increasing average depth?

253: Is the relative roughness referred to here calculated from the hydraulic roughness length? It would be interesting to see how it varies as the bed transitions from bedrock to alluvial. The changes over time in Fig. 7 are interesting, but it's hard to compare the equilibrium conditions with different Pc values. I think that more could be done with these data, e.g. plotting ks/d against Pc for the different runs.

270: State that these grain sizes are different to those of the previous results.

281: In the legend it would be useful to label the equation 5 and 10 lines with the papers that they come from.

289: Be clear what you are minimising the RMSD between; I assume that it's the amount of sediment cover?

291: Is this parameter calibrated in the same way?

328 and 329: Again, specify what you are minimising the RMSD of.

345: What is τ*c referring to here? I'm confused because I would expect the bedrock critical shear stress to be less than the alluvial or combined critical shear stresses.

345: I don't follow the sentence starting 'As a result..'.

389: I think that this is the first explicit mention of the hydraulic roughness of the alluvial beds. See earlier comments about including more of these data.

References:

Cook, K.L., Turowski, J.M., Hovius, N., 2013. A demonstration of the importance of bedload transport for fluvial bedrock erosion and knickpoint propagation. Earth Surf. Process. Landforms 38, 683–695. https://doi.org/10.1002/esp.3313

Ferguson, R.I., Hardy, R.J., Hodge, R.A., 2019. Flow resistance and hydraulic geometry in bedrock rivers with multiple roughness length scales. Earth Surface Processes

and Landforms. https://doi.org/10.1002/esp.4673

Turowski, J.M., Hovius, N., Meng-Long, H., Lague, D., Men-Chiang, C., 2008. Distribution of erosion across bedrock channels. Earth Surface Processes and Landforms 33, 353–363. https://doi.org/10.1002/esp.1559

Interactive comment on Earth Surf. Dynam. Discuss., https://doi.org/10.5194/esurf-2019-78, 2020.