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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

Jens Turowski (Editor)

turowski@gfz-potsdam.de

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Dear authors,

We have now received two reviews of your paper. Both reviewers agree that it will be a useful contribution to the literature. However, both reviewers see potential for improvements, in particular in the structure of the paper, the description of scope and objectives, the way that the various models are introduced and compared in the introduction, and the placement in the wider context. The reviewers provide comprehensive

and constructive suggestions and I do not think I need to comment on them. I have provided some comments from my own reading below. These largely align with the reviewers' assessments, but in addition, I recommend to conduct a comprehensive literature research (major point 3). You state that you want to provide a state-of-the-art review of the cover effect (line 10). The paper is not delivering on this promise at the moment – important literature is missing, and the review of the literature that is included stays on a fairly superficial level (see also comments of reviewer #1). Please clearly define the scope of your review and the paper in general. The first option is that you do a general review of the cover effect. Second, you could limit the review to the process timescale. Third, you could limit the review to the models that you actually test against your data. In any case, please have a look at the literature in the list provided at the end of this comment. All of these papers deal explicitly with the cover effect – spanning experiments, field observations, conceptual and theory development, and investigations of cover effects on channel morphology and dynamics – and are currently not mentioned. You can then include whatever is relevant for the scope you decide on. Note that I put down the papers from memory, without conducting a comprehensive search. There may be other papers I have overlooked.

I am looking forward to reading your revised paper,

Jens Turowski Handling Associate Editor

Major points

1) Objectives and physical rationale of the various models: the various cover models treat different aspects of cover distribution and dynamics, they use different approaches with respect to their assumptions and modelled details, and only partially overlap in their objectives. For example, the Johnson 2014 model is mainly concerned with the feedback between cover and roughness, while the Turowski and Hodge paper is concerned with the description of the distribution of sediment on the bed, and the transformation between a point of view considering masses and one considering

fluxes. As a result, Turowski and Hodge did not treat roughness feedbacks at all, while Johnson used a generic flux-based approach. Can the models then be meaningfully compared? Likewise, the Aubert et al. 2015 model includes hydraulic details that the reach-scale approaches of most of the other models do not treat explicitly. It seems important to me that the authors clearly work out the different focus of the various models, including the relevant assumptions and approaches. This means that a brief description of the physical and conceptual rationale of the models should be included in the paper. I agree with reviewer #1 that the key differences in model predictions should be worked out before comparing them to data. This gives the necessary background information to decide what kind of data are necessary to test the models.

2) Scales of observations, and field vs. lab work: The cover effect has been studied on a variety of spatial and temporal scales. Within the overview in the introduction, these scales are mixed and the conclusions drawn from the observations are not put in the correct context. For example, the authors cite the study of Cowie et al., 2008 (catchment scale, geological time scale, use of proxies for relevant variables) together with the study of Mishra et al., 2018 (scaled down lab experiments, channel scale, single meander bend), drawing a singular conclusion from two very different approaches. I think there is a need to make the reader aware of these differences.

3) Missing literature: For a comprehensive, state-of-the-art review that the authors intended to deliver (line 9 in the abstract), too much literature has been overlooked. Scanning through the reference list, more than a dozen missing publications immediately sprang to my mind (see below; the list is not comprehensive and the authors should conduct an additional research). The literature on the cover effect is not so extensive that it cannot be cited completely within a paper intended to review the field, so I suggest that the authors conduct a comprehensive literature research. As an alternative, they could limit their review to a process perspective (short time scales, small spatial scales), or even experiments, and omit work dealing with long-term channel dynamics, and morphodynamic adjustment. Establishing a clear description of the scope

and focus of the article would help to delineate the literature that needs to be included.

4) Methods: the descriptions of the methods and of the experimental set up are often incomplete. Please rewrite, bearing in mind that a reader should have all necessary information to reproduce your work.

Comments by line

9 The stated aims in lines 79-82 say something different. Note that the abstract is not part of the article, but a summary of it. As a consequence, it should be possible to read abstract and article independently.

26 It does not make sense to mention Cowie et al. and Mishra et al. in the same breath as is done here; they worked at fundamentally different scales.

27 Cowie et al. did not show this, they used plotted incision rates against the ratio of incised and total drainage area!

30 See also Wohl and Ikeda 1997.

32 There are plenty of other field studies working at a similar scale that are omitted here.

38 The linear model was actually first proposed by Sklar and Dietrich 1998 (cited elsewhere).

40 It would be good to explain the rationale behind the function: it is the most simple connection between the end points of no cover at no supply and full cover at supply equal or exceeding the transport capacity.

45 These papers give a more differentiated view then reported here.

57 It would be good to explain the rationale here. The exponential equation was actually derived for a mass ratio using a probabilistic argument, and equation (2) was obtained by assuming that the mass ratio is equal to the ratio of supply to capacity. The latter

assumption was demonstrated to be incorrect by the analysis of Turowski and Hodge 2017.

77 The Turowski and Hodge model is a generalized version of the arguments presented by Turowski et al. 2007 and Turowski 2009.

79-82 Here, you need to lay out the objectives and aims of the paper. Note that the statements here do not agree with the statements made in the abstract (line 9).

137 This is only one out of a family of equations that they derive. Three analytical examples, using different assumptions for their P-function, are given in their eqs. 30-32 (the one presented here is eq. 30). Other options (for example, parameterizing the P-function using the cumulative beta distribution) cannot be expressed in a closed form, but may also be interesting to test. Obviously, the authors can make a sub-selection of the family of models proposed by Turowski and Hodge, but they should justify their choice.

140 Not quite accurate, this depends on the circumstances.

141 The channel adjustment is not relevant for the present paper.

239 Lague, 2010, also used gravel layer thickness in a slightly different formulation.

Additional literature on the cover effect is listed below. I have not included literature where cover-dependent erosion models were implemented in landscape evolution models. You are welcome to contact me if you have trouble locating any of the articles:

Beer, A. R., Kirchner, J. W., and Turowski, J. M.: Graffiti for science – erosion painting reveals spatially variable erosivity of sediment-laden flows, Earth Surf. Dynam., 4, 885–894, https://doi.org/10.5194/esurf-4-885-2016, 2016.

Beer, A. R., Turowski, J. M., and Kirchner, J. W.: Spatial patterns of erosion in a bedrock gorge, J. Geophys. Res.-Earth, 122, 191–214, https://doi.org/10.1002/2016JF003850, 2017.

Dreano J, Valance A, Lague D, Cassar C.: Experimental study on transient and steady-state dynamics of bedforms in supply limited configuration, Earth Surf. Process. Landforms, 35, 1730-1743, https://doi.org/10.1002/esp.2085, 2010.

Fernández R, Parker G, Stark CP.: Experiments on patterns of alluvial cover and bedrock erosion in a meandering channel. Earth Surface Dynamics 7, 949-968, https://doi.org/10.5194/esurf-7-949-2019

Friedl F.: Laboratory Experiments on Sediment Replenishment in Gravel-Bed Rivers, Chapter 7, Master thesis, ETH Zurich, https://ethz.ch/content/dam/ethz/special-interest/baug/vaw/vaw-dam/documents/das-institut/mitteilungen/2010-2019/245.pdf, 2018.

Hancock GS, Anderson RS.: Numerical modeling of fluvial strath-terrace formation in response to oscillating climate, Geological Society of America Bulletin, 114, 1131-1142, https://doi.org/10.1130/0016-7606(2002)114<1131:NMOFST>2.0.CO;2, 2002.

Hobley, D. E. J., Sinclair, H. D., Mudd, S. M., and Cowie, P. A.: Field calibration of sediment flux dependent river incision, J. Geophys. Res., 116, F04017, https://doi.org/10.1029/2010JF001935, 2011.

Howard AD. 1998. Long profile development of bedrock channels: interaction of weathering, mass wasting, bed erosion, and sediment transport. In Rivers Over Rock: Fluvial Processes in Bedrock Channels, Tinkler KJ, Wohl EE (eds), Geophysical Monograph Series 107. American Geophysical Union: Washington, DC; 297–319.

Lague, D.: Reduction of long-term bedrock incision efficiency by short-term alluvial cover intermittency, J. Geophys. Res.-Earth, 115, F02011, https://doi.org/10.1029/2008JF001210, 2010.

Meshkova LV, Carling P. 2012. The geomorphological characteristics of the Mekong River in northern Cambodia: a mixed bedrock-alluvial multi-channel network. Geomorphology 147–148: 2–17. https://doi.org/10.1016/j.geomorph.2011.06.041

Moore RC.: Origin of inclosed meanders on streams of the Colorado Plateau, Journal of Geology 34, 29-57, https://www.jstor.org/stable/30063667, 1926.

Nelson, P. A. and Seminara, G.: Modeling the evolution of bedrock channel shape with erosion from saltating bed load, Geophys. Res. Lett., 38, L17406, https://doi.org/10.1029/2011GL048628, 2011.

Shepherd, R. G.: Incised river meanders: Evolution in simulated bedrock, Science, 178, 409–411, https://doi.org/10.1126/science.178.4059.409, 1972.

Shepherd, R. G., Schumm, S. A.: Experimental study of river incision, Geol. Soc. Am.Bull., 85, 257-268, 1974.

Sklar, L. S. and Dietrich, W. E.: Sediment and rock strength controls on river incision into bedrock, Geology 29, 1087–1090, https://doi.org/10.1130/0091-7613(2001)029<1087:SARSCO>2.0.CO;2, 2001.

Turowski, J. M.: Alluvial cover controlling the width, slope and sinuosity of bedrock channels, Earth Surf. Dynam., 6, 29–48, https://doi.org/10.5194/esurf-6-29-2018, 2018.

Turowski, J. M. and Bloem, J.-P.: The influence of sediment thickness on energy delivery to the bed by bedload impacts, Geodin. Acta, 28, 199–208, https://doi.org/10.1080/09853111.2015.1047195, 2016.

Turowski, J. M. and Rickenmann, D.: Tools and cover effects in bedload transport observations in the Pitzbach, Austria, Earth Surf. Proc. Land., 34, 26–37, https://doi.org/10.1002/esp.1686, 2009.

Turowski, J. M., Hovius, N., Hsieh, M.-L., Lague, D., and Chen, M.-C.: Distribution of erosion across bedrock channels, Earth Surf. Proc. Land., 33, 353–363, https://doi.org/10.1002/esp.1559, 2008.

Turowski, J. M., Hovius, N., Wilson, A., and Horng, M.-J.: Hydraulic geometry,

river sediment and the definition of bedrock channels, Geomorphology, 99, 26–38, https://doi.org/10.1016/j.geomorph.2007.10.001, 2008.

Turowski, J. M., Badoux, A., Leuzinger, J., and Hegglin, R.: Large floods, alluvial overprint, and bedrock erosion, Earth Surf. Proc. Land., 38, 947–958, https://doi.org/10.1002/esp.3341, 2013.

Whitbread, K., Jansen, J., Bishop, P., and Attal, M.: Substrate, sediment, and slope controls on bedrock channel geometry in postglacial streams, J. Geophys. Res., 120, 779–798, https://doi.org/10.1002/2014JF003295, 2015.

Wohl E, and Ikeda H.: Experimental simulation of channel incision into a cohesive substrate at varying gradients, Geology, 25, 295-298, https://doi.org/10.1130/0091-7613(1997)025<0295:ESOCII>2.3.CO;2, 1997.

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