Responses to Reviewer's Comments – Final iteration

RiverBedDynamics v1.0: A Landlab component for computing two-dimensional sediment transport and river bed evolution

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Reviewer #2

We sincerely thank Reviewer #2 for his continued engagement with our manuscript and for providing these additional comments that have helped refine our paper and enhance its quality. Your thoughtful feedback throughout the review process has been instrumental in improving the clarity, accessibility, and scientific rigor of our work. We are grateful for your attention to important details like the justification for our shear stress calculations and boundary conditions. Below, we address your specific comments in this final round of review.

Comments

Comment #1:

First, the authors have added some information justifying their choice of defining the bed shear stress using water depth rather than hydraulic radius as a default and in their specific examples. The additional information is appreciated, however, I think there is still some potential for confusion. Where the issue is first introduced (L374-384), the authors argue that when cell sizes are smaller than channel widths, most cells will not contain river banks, so resistance by the banks can be safely ignored (hence using water depth do define the shear stress). However, later, in the context of the example (L891-893), the authors instead justify using the water depth because the cell sizes are much larger than a channel width; then, most cells will include a channel, so most cells are adjacent to other channel cells, and again the banks should be neglected. So it seems that the authors recommend using water depth both when cells are much smaller than channels, and when they are much larger, and the hydraulic radius should only be used in the specific case where the cells are approximately the width of a channel? If so, I think it would make sense to collect the reasoning together and state it explicitly, somewhere around Eq. 5. Then this discussion can be briefly referred back to at the specific example. I think that would help best help readers make an informed choice for their own implementations.

Response:

We appreciate the reviewer's careful reading and helpful suggestion to clarify our reasoning for using water depth as the default for shear stress calculations. To address this comment, we have revised the explanation near Eq. 5 and the discussion in the watershed-scale example to ensure consistency and avoid potential confusion.

In the revised text, we explicitly state that the choice of using water depth rather than hydraulic radius depends on the spatial resolution relative to channel width. Specifically, we use water depth as the default for the following reasons:

1. When cell sizes are much smaller than channel widths, most cells represent the channel interior and do not contain river banks. In this case, the hydraulic radius effectively

becomes equivalent to water depth, making the additional complexity of hydraulic radius unnecessary.

2. When cell sizes are much larger than channel widths, a single cell contains both the channel and surrounding floodplain. In this case, most cell boundaries interface with other water-filled cells rather than channel banks, meaning that the hydraulic radius is less representative of actual flow conditions.
3. Our model simulates both channelized flow and overland flow using the same governing equations. Since hydraulic radius relies on the presence of defined banks, it is not applicable in overland flow conditions, further justifying the use of water depth as the default option.

We have consolidated this reasoning in the section around Eq. 5, as suggested, and provided a brief reference back to this explanation in the watershed-scale example. Additionally, we clarify that the hydraulic radius approach is most appropriate when the cell size closely matches the channel width, as this is the scenario where bank roughness significantly influences shear stress calculations.

These revisions ensure that our justification is clearly stated and consistently applied throughout the manuscript. Thank you again for your insightful comment, which helped improve the clarity and accessibility of our methodology.

Comment # 2:
Second, the authors now include extra explanation of their 'zero-gradient' boundary condition option for the domain outlet (L515-517). I now understand that the slope is set to match the slope at points immediately upstream, and so clearly does not result in no sediment flux out of the domain. However, in this context, the name 'zero-gradient' does not make much sense to me. I suppose the point is there no gradient in slope? But since slope is itself a gradient, I think this could cause confusion (as it did for me). If this is a standard term. I suppose it has to be retained. But if it is something the authors defined themselves, I suggest revising.

Response:
We appreciate the reviewer's careful consideration of our description of the zero-gradient boundary condition. We understand the concern that the name zero-gradient might be misleading since slope itself is a gradient, which could cause confusion.

To clarify, we have revised the text to explicitly state that the zero-gradient condition maintains the bed surface elevation slope of the immediately upstream reach. This ensures that sediment transport continues naturally without imposing artificial constraints at the outlet. We also explicitly note that the net sediment exchange at boundary cells is identical to that upstream of the outlet, reinforcing that sediment flux is maintained through the domain boundary.

We have retained the term zero-gradient because it aligns with its usage in our model implementation and is consistent with common numerical modeling practices. However, we have clarified its meaning within the text to ensure that readers can readily interpret it in the intended context.

We believe these revisions address the reviewer's concern while improving the clarity and accuracy of the manuscript. We appreciate the insightful feedback and the opportunity to refine our explanation.