

Interactive comment on “Modelling long-term, large-scale sediment storage using a simple sediment budget approach” by V. Naipal et al.

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Review overall

I think the manuscript describes well the rationale for the emerging priority of representing soil redistribution in Earth System Models. The authors have set out a clear model and its assumptions and then described some of the approximations necessary to parameterise the model. On that basis the model is used to make estimates of erosion and deposition during the last millenium. The results are compared to estimates made by Hoffman and colleagues. Usefully, the authors provide an assessment of uncertainty in their modelling. Overall, I think the manuscript will make a useful contribution to the literature and could be published with revision. I provide below comments which support my conclusion and which I hope can be useful to the authors in their revision.

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Comments and points for clarification

1) I think equation 10 is a description of net soil redistribution by water. The E provides gross water erosion and $1-f$ provides an adjustment based on the "remaining soil that has not been transferred to the floodplain directly". I think this approximation of net soil redistribution by water should be made clear as I think this emphasises the need for and significance of a net approach. I also think that (if I have understood the approach correctly) you should be able to validate your approximation against maps of net soil redistribution e.g., Australia. Note that 137Cs-derived maps for net soil redistribution across Australia include wind and water erosion and to validate only the water component the gross wind erosion would need to be removed (for which data is also available for Australia).

2) I think I understand why you needed to choose a grid resolution for your study. However, if the modelling is to be used in global ESM then it will need to be independent of grid resolution. I suspect that its application to other larger and flatter catchments would be represented by much of your model but perhaps not in the assumption that 5 arcmin is optimal for representing floodplain and hillslope. For example, Australia has some very large catchments which could mean that your chosen grid resolution may have no floodplain. I agree that a finer resolution would also not work in many regions but would work in other very steep, rugged terrain regions.

3) There is very little justification for the model parameter values in section 2.2 (page 8). You may be interested in considering for this manuscript and future work whether your approximation for f is consistent with the Multi-resolution Valley Bottom Flatness (MrVBF) data for Australia can be found on the link below.

<https://data.csiro.au/dap/landingpage?pid=csiro%3A5681>

The land cover type and metrics are readily available Australia and presumably for present slope so that might provide additional calibration / validation for your model. I'm not convinced about the use of average slope (as opposed to median) and which

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will be influenced by the resolution of the grid.

4) I think if scaling is to be an important part of the paper, as demonstrated by section 3.1 and abstract, then some background on Hoffman et al. (2013) needs to be included so that this topic in the manuscript is easier to comprehend.

5) I think it reasonable to qualify the extent to which this modelling can be used generally within ESMs to model soil redistribution by making explicit the contribution of soil redistribution by wind. In many global regions and drier more gusty phases in the past (and potentially the future), wind erosion may be considerably more important than water erosion. In other semi-arid regions the interplay between downslope erosion by water and removal by wind may cause a net soil redistribution to tend towards little change for some long period. In any case, I think it may be worthwhile for modellers interested in implementing your model that the wind erosion and dust emission component is important for soil redistribution. I accept that these processes may not be particularly relevant in the Rhine but note that they are in the sandy previous outwash plains of other parts of Germany and NW Europe.

6) I think the grammar and syntax of the manuscript need to be improved e.g., focus on consistent tenses. This might also be a good time to reduce the duplication of background material in the Introduction cf. start of Methods section. I think much of the technical justification might be moved from the Introduction to the start of the Methods section.

7) References need some attention e.g., Oost or Van Oost

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