Earth Surface Dynamics Discussions

Earth Surf. Dynam. Discuss., referee comment RC4
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Comment on esurf-2022-23

Anonymous Referee #4

Referee comment on "Development of a machine learning model for river bedload" by Hossein Hosseiny et al., Earth Surf. Dynam. Discuss., https://doi.org/10.5194/esurf-2022-23-RC4, 2022

In this short and well-written manuscript, the authors present an ANN model for predicting bedload flux based on a published dataset. Machine learning is increasingly used for modeling and predicting natural dynamics, with known strengths and limitations. Bedload is perhaps one of the more challenging processes to model given its strong dependency on highly dynamic and local variables. A number of models have recently been published that attempt to predict bedload over large scales (continental and global; see below). This paper is therefore quite timely and adds to the broader communities' efforts to better predict fluvial dynamics. The following issues should be addressed before it is accepted for publication. These are not very major issues but will likely require additional analysis.

1. The observational dataset includes an unequal number of observations for each river - if the spatial variability is larger than the temporal variability this may lead to overfitting. The authors addressed that to a degree, but need to better discuss this issue. As it stands the model predicts temporal dynamics using observations from different rivers. ANN may be flexible enough to deal with this but, again, needs more discussion and maybe an additional analysis using some sort of average value for each site (regression may be more suitable in this case given the small sample size).

2. The removal of outliers is overall acceptable but can be very problematic when using a fluvial dataset as the 'extreme' values are often just the few large rivers in a dataset. The authors warn the reader to only use/interpret the results within the range of the variables but they should more carefully examine the outliers and try to include realistic observations and maximize the dataset (and thus model) representation of large rivers.

3. The metrics selected for representing the models' accuracy are reasonable but need some justification. Why MSE and not RMSE or PBIAS or R2?

4. The paper falls short in providing tools and guidelines for applying its outcomes. The paper's main outcome is to demonstrate the potential usefulness of ANN for modeling bedload flux. How can the reader use this knowledge moving forward? Will they have to develop their own ANN based on the dataset? How can it be used for other locations (as the authors suggested)? This is a common issue with ML modeling, but the authors can mitigate it with additional descriptions and tools (e.g. scripts).

5. The authors are encouraged to explore recently published papers such as:

Cohen, S., Syvitski, J., Ashely, T., Lammers, R., Fekete, B., & Li, H. Y. (2022). Spatial Trends and Drivers of Bedload and Suspended Sediment Fluxes in Global Rivers. *Water Resources Research*, e2021WR031583.

Gomez, B., & Soar, P. J. (2022). Bedload transport: beyond intractability. *Royal Society Open Science*, *9*(3), 211932.

Lammers, R. W., & Bledsoe, B. P. (2018). Parsimonious sediment transport equations based on Bagnold's stream power approach. *Earth Surface Processes and Landforms*, *43*(1), 242-258.

Li, H. Y., Tan, Z., Ma, H., Zhu, Z., Abeshu, G. W., Zhu, S., ... & Leung, L. R. (2022). A new large-scale suspended sediment model and its application over the United States. *Hydrology and Earth System Sciences*, *26*(3), 665-688.

Tan, Z., Leung, L. R., Li, H. Y., & Cohen, S. (2022). Representing global soil erosion and sediment flux in Earth System Models. *Journal of Advances in Modeling Earth Systems*, *14*(1).