Paper is interesting and well-written, but my main issue is regarding the lack of novelty. Authors just applied old model of ANN to bedload prediction. We have many new models like tree-based, rule based,... deep learning and so on. Due to lack of novelty, I have to reject the paper. Sorry for the decision.

Response:
Thank you for your feedback.

The primary objective of this contribution is to apply an established machine learning tool, ANN, to the notoriously difficult problem of accurately estimating bedload transport rates across a range of fluvial environments. It is not the intent of this manuscript to apply the latest machine learning method. In this contribution we present an ANN trained model that is able to estimate bedload flux based on a combination of static and dynamic input parameters across a wider parameter space than any previous study (see expanded discussion on this in response to Reviewer 3). We demonstrate that this trained model outperforms existing, widely-used bedload transport models as well as previous, more limited, applications of ANN for bedload estimation. We show that this approach provides a versatile model for predicting bedload for a wide range of rivers without the need for model parameter calibration at any individual site. In the revised version of this manuscript we will edit the introduction to clarify the aim and scope of the paper.

We selected the Artificial neural Network (ANN) for this research because it is well-tested a powerful tool for modeling nonlinear problems with high dimensionality (Haykin, 2008). The proposed ANN is composed of multiple layers, which, by definition, is a deep learning approach. We acknowledge the reviewer's statement that there are many machine learning algorithms available. However, we disagree that the "newness" of any particular type of ML model or data analysis technique, in and of itself, defines the overall novelty of a contribution, but rather, the novelty lies in the application of the method to a new scientific question or challenge - here being the accurate prediction of bedload transport across a broad range of settings.

Each machine learning approach has its own strengths, limitations, and constraints. We opted to apply ANN for a number of reasons. ANN is an established tool. It has been shown to be versatile, with applications in geoscience including rainfall-runoff processes (Hsu et al., 1995; Han et al., 2021), turbidity currents (Naruse & Nakao, 2021), and prediction of riverbed porosity (Bui et al., 2019). Further, previous work focused on the application of machine learning techniques to predict bedload transport found that ANN outperformed alternative ML approaches - as described in the introduction of the submission. We aim to build on this existing work, with a focus on expanding the model parameter space through the use of the bedloadweb database, as model performance is only reliable under the range of conditions for which the model was trained. This is an important point as previous bedload databases used within ML and ANN models were primarily derived from a limited geographic region which can bias the training data (See Phillips & Jerolmack, 2019). An additional advantage of ANN is that it is well-established and as such can be easily implemented by other users. We will more clearly outline the broader applicability of ANN in geoscience, and with regard to the estimation of bedload transport rates, in the revised introduction of the paper.

It is worth pointing out that decision-tree models can be very sensitive to small variations in the training dataset (Geron, 2019), resulting in very different results due to these variations. Decision-tree approaches can also over-fit the data depending on the complexity of the classification trees. Rule-based machine learning is based on a number of if-then conditional statements and can sometimes require significant user knowledge, particularly for supervised learning routines (Nunez et al., 2006). Often, these types of approaches may use different models for prediction, based on how input data is classified by the tree structure or any identified set of relational rules.  While these approaches may be of potential interest for future work in this area or to answer different questions related to bedload transport, it is beyond the scope of this contribution.  Our aim is to instead use ANN to develop a singular model that can be broadly applied across the full parameter space of the training data, as this, in and of itself, represents an advance towards more accurate prediction of bedload transport.

In the revised version of the manuscript, we will more clearly articulate the reasoning for the selection of ANN compared to other ML methods.  We will also discuss the potential for other types of machine learning methods to highlight different characteristics of the data in the discussion of the paper. Further, we will discuss the strengths and limitations of the development and application of a universal model for the description of bedload transport presented in this contribution.


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