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Estimation of scour depth around bridge piers with artificial neural networks: the impact of training data

L. Brandimarte (1) and E. Toth (1)
(1) University of Bologna

Pier and abutment undermining due to scouring and riverbed erosion has been widely recognized as the main cause of bridge damage and failure. Bridge damages and failures have deep social and economic implications due to the costs of reconstruction, maintenance, and monitoring of existing structures, the disruptions of traffic circulation, and, in some extreme cases, the cost of human lives. The most commonly used equations for evaluating scour at bridge crossings are empirically based formula, derived from laboratory experiments, which tend to overestimate scour depth when using field data. Furthermore, scour depth estimates evaluated by applying different empirical formula range from few centimeters to kilometers, showing a lack of reliability due to the complexity of the scour process and the number of variables involved, both physical and non-physical. Thus, to overcome the limits of the empirical formula one could explore a different and innovative approach by applying Artificial Neural Networks (ANN) models to predict scour depth around bridge piers, taking advantage of their capability to flexibly reproduce the highly non-linear nature of the relationship between input and output variables, also when such relationship is not explicitly known a priori. This study aims at investigating this approach: a wide set of field data collected in the USA is used to implement different architectures of ANN for predicting the local scour depth as a function of different variables characterising the flow, the sediments and the pier. In particular, the work analyses the saliency of the input variables and the impact of the use of different training data sets on the performances of the model in validation. Then, the scour depths estimates predicted by the ANN models are compared to the estimates got by empirical formula conventionally used in the literature and in the current practice.