Improving Total Sediment Load Prediction using the GE Technique (Case Study: Malaysia)

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Abstract

Background/Objectives: Predicted total sediment load is usually used to identify the intensity of a sedimentation process. Currently, the existing available models to predict total load are mostly developed based on data collected from flumes, channels and rivers located in western countries. These models may not be valid to predict sediment transport of rivers in the Tropics due to significant differences in the hydrological and sediment characteristics conditions. A new model using genetic programming (GE) technique is used to improve the prediction of sediment load for rivers in tropical Malaysia. **Methods/StatisticalAnalysis:** The model predictions are compared with those obtained from five available sediment transport models, including Engelund & Hansen (1967), Graf (1971), Ariffin (2004), Chan et al. (2005) and Sinnakaudan et al. (2006). **Findings:** The performance of the model in relation to the test set shows less scattering around the line of equality, between the measured and predicted total sediment loads. Statistical analyses of 68 data sets give the coefficient of correlation, *r* and the discrepancy ratio of 0.82 and 0.53 respectively. **Application/Improvements:** Hence, the GE Technique used in the prediction of Total Sediment Load is found to give better accuracy compared to other methods.

Keywords: genetic programming technique, prediction, river, total sediment load

1. Introduction

The total load or total sediment load is defined as the combination of wash load and bed material load. Under conditions when wash load is not present, the term - bed material load and total load - are used interchangeably.

Currently, there are a few models that are used to estimate total sediment load, including Engelund & Hansen[1], Graf[2], Ackers & White[3], Yang & Molinas[4], Van Rijn[5], Karim[6] and Nagy et al.[7]. However, most of these models are developed based on flume data from western countries, such as, America and Western Europe and have not been widely used in other parts of the world[8]. Since the 1990's, some researchers have developed models based on Malaysian conditions[8,9,10]. However, these models failed to achieve consistent success in relation to the accuracy of predicting sediment loads and thus there is a need for a more accurate sediment model.

An Evolutionary Polynomial Regression (EPR) model[11] using genetic programming technique is developed based on a set of 340 recorded data of total sediment load. EPR is a data-driven hybrid regression technique developed by Giustolisi and Savic[12] that constructs symbolic models by integrating the best features of numerical regression[13] with genetic programming and symbolic regression[14].

2. Model Development

The first important step in developing the EPR model is to identify the potential model inputs and outputs. Based on previous studies[8], eight inputs are considered to be the most significant factors that influence sediment transport. These inputs include the hydraulic radius (R), the flow depth (y_o), the flow velocity (V), the ratio of flow depth to median diameter on bed material (y_o/d_{50}), the relative roughness on the bed (R/d_{50}), the stream width ratio (B/y_o), the ratio of shear velocity to average velocity (U^*/V), and the dimensionless unit stream power (VS_o/ω_s). The only output is the total sediment load (Tj).

The initial step in developing the EPR model is selecting the related parameters to evolve the model. This is carried out by a trial-and-error approach in which a number of EPR models are trained with the selected parameters until ultimately the optimum model is obtained.