Investigation of Performance of Sediment Transport Formulas in Natural Rivers Based on Measured Data in Kulfo River, Southern Ethiopia

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There is a wide range of objectives for sediment discharge predictions in natural movable-bed rivers, depending on physical phenomena, such as reservoir sedimentation, riverbed degradation, local scour or deposition around hydraulic structures, effects of sand and gravel mining on riverbed equilibrium. Individual situations are unique in their combination of physical phenomena. The large number of sediment transport formulas makes it extremely difficult to choose the appropriate one for a given river and situation. Besides the large number of available formulas, little is known about the performance of the existing predictors in reference to measured flow and sediment data in natural rivers. The use of field data is very important in making more realistic evaluations of sediment transport formulas.

In this study, selected bed-load transport formulas specifically developed for gravel-bed rivers and total load formulas are tested against the field data collected in the Kulfo River, near Arba Minch. Extensive flow and sediment data were collected from Kulfo River over the period 2002 to 2003. Subsurface bed material is characterized by sizes varying from very fine sand to small cobbles, while median particle sizes are typically in the medium gravel range. The large values of the geometric standard deviations of the bed material size distribution show that it is poorly sorted.

Total sediment discharge is determined from measuring bed load rate and suspended sediment concentrations in conjunction with water flow data. Instantaneous, as well as daily, monthly, and annual sediment discharge data are obtained. Sediment transport formulas are evaluated by using the deviations of calculated sediment discharges from measured data, which allows ranking of the formulas with respect to observed data. Here, a discrepancy ratio r, which is the ratio of predicted to measured discharges, is used. Another method used to evaluate the discharge formulas is to visually compare the sediment rating curves of calculated sediment discharge versus water discharge with measured curves.

As a result, among the tested total load predictors, formulas of Bagnold, Engelund and Hansen, and Yang were found to be in good agreement with measured sediment discharges. In addition the bed load transport formulas of Bagnold and Meyer-Peter and Mueller gave reasonable prediction of the bed load discharge and where selected for site-specific experiments. Although the selected formulas are tested for only one river, the results are judged to be indicative for natural rivers in similar hydraulic and sediment conditions with gravel-range bed materials