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Parameterization of the sediment transport in steep channels with boulders

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The presence of large relatively immobile boulders in steep mountain rivers is generally not taken into account in the development of equations to predict the bedload, leading to overestimates of the bedload rate by several times when applied to mountain rivers. Sediment transport in steep channels with boulders is herein investigated using 41 laboratory experiments carried out on a steep (longitudinal inclination of 6.7 to 13%), 8 m long (7 m usable) and 0.25 m wide, tilting flume. The experiments were made for varying flume slopes and boulder configurations (combination of boulder dimensionless distance and diameter), and for several sediment supply conditions. 35 experiments are made with boulders and six experiments without boulders. Boulders are herein defined as elements that although not transported by the flow, may move several times their diameter during experiments, mainly due to the scour holes formed around them. Water and poorly sorted sediments are constantly supplied at the flume inlet. Bedload at the channel downstream section, bulk flow velocities and morphological parameters are measured regularly during the experiments. The poorly sorted sediments (d50=9.3 mm, d65=11.9 mm, d30=7.1 mm, d84=16.6 mm, and d90=19.0 mm) are constantly fed into the system by a calibrated sediment feeder situated upstream, and recirculated during the experiments. The experiments show that the sediment transport capacity clearly decreases with the dimensionless boulder distance and is better estimated in terms of critical discharge for incipient motion of mobile sediments than in terms of critical bed shear stress. The channel longitudinal slope shows the strongest impact on the transport capacity, namely in what concerns the critical discharge for beginning of motion. In addition, it is also shown that the sediment transport decreases with boulder density. A sediment transport formula based on excess discharge relative to a critical value, which depends not only on the channel slope but also on the boulder spatial density, is proposed.

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