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Modeling of reservoir flushing by means of existing hydrodynamic models

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Sediment flushing has been reported as one of the most efficient techniques for reservoir desiltation. This technique consists in opening the bottom outlets of a dam to induce an accelerated flow that mobilizes part of the sediments deposited in the reservoir. The efficacy of flushing depends much on conditions such as the hydraulic head in the reservoir, the discharge capacity of the outlets, the sediment characteristics, and the topography of the reservoir, among others. In this context, numerical models become an extraordinarily useful tool for reservoir operators, as the efficacy of flushing can be previously evaluated by means of numerical modeling. However, though there are several studies that have simulated flushing numerically, most of them are based on specific case studies whose conditions cannot be generalized. This study aims to analyze the capacity of three hydrodynamic models (HEC-RAS-1D, IBER-2D and FLOW-3D) to simulate flushing events. For that purpose, those conditions tested in laboratory for two experimental setups were implemented and simulated in these hydrodynamic models. The first experimental setup was based on a one-dimensional approach in which the width of the outlet coincided with the width of the reservoir. This experimental setup was carried out in a 12.5 m long and 0.30 m wide horizontal rectangular flume at Universidad Politécnica de Cartagena, Spain. Here, 10 pairs h_s – h_w were tested, where h_s and h_w stand for the initial sediment and water elevations, respectively. Sediments consisted of a uniform sand with d_{50} = 0.7 mm, bulk density ρ_b = 1650 kg/m^3, and grain density ρ_s = 2650 kg/m^3. In these experiments, the evolution of the water surface and bed surface, as well as the liquid and solid hydrographs, were characterized by means of videos recorded from a side of the flume. The second experimental setup consisted of 3 of the experiments documented in the PhD thesis by Lai (1994), which were conducted in a 50 m long, 2.4 m wide and 1.5 m high rectangular concrete flume at University of California at Berkeley. In this experimental setup, the reservoir was emptied through a 0.15 m wide and 0.25 m high sluice gate., which allows analyzing the influence of the width ratio between outlet and reservoir. Sediments consisted of walnut shell grit with d_{50} = 1.25 mm and ρ_s = 1390 kg/m^3. In these experiments, liquid and solid hydrographs were characterized by means of discrete measurements of the water surface and sediment concentration at the outlet. To assess the capacity of the hydrodynamic models to simulate flushing, the hydrographs obtained from laboratory experiments are compared to those obtained numerically. Preliminary results show that the model FLOW-3D obtained the best approach to the results obtained in laboratory. The results obtained with HEC-RAS also show a good approach to the experimental results, but with

comparatively high differences in magnitudes for the peaks of the liquid and solid hydrographs. The results obtained with IBER show the greatest differences with respect to the results obtained in laboratory.