Geophysical Research Abstracts
Vol. 19, EGU2017-15180, 2017
EGU General Assembly 2017

Does fluid infiltration affect the motion of sediment grains? – A 3-D numerical modelling approach using SPH

Gerhard Bartzke (1), Benedict D. Rogers (2), Georgios Fourtakas (2), Athanasios Mokos (2), Ricardo B. Canelas (3), and Katrin Huhn (1)

(1) Universität Bremen, Marum, Bremen, Germany (gbartzke@marum.de), (2) The University of Manchester, (3) Instituto Superior Técnico, Universidade de Lisboa, CERIS

With experimental techniques it is difficult to measure flow characteristics, e.g. the velocity of pore water flow in sediments, at a sufficient resolution and in a non-intrusive way. As a result, the effect of fluid flow at the surface and in the interior of a sediment bed on particle motion is not yet fully understood. Numerical models may help to overcome these problems. In this study Smoothed Particle Hydrodynamics (SPH) was chosen since it is ideally suited to simulate flows in sediment beds, at a high temporal and spatial resolution. The solver chosen is DualSPHysics 4.0 (www.dual.sphysics.org), since this is validated for a range of flow conditions.

For the present investigation a 3D numerical flow channel was generated with a length of 15.0 cm, a width of 0.5 cm and a height of 4.0 cm. The entire domain was flooded with 8 million fluid particles, while 400 mobile sediment particles were deposited under applied gravity (grain diameter D50=10 mm) to generate randomly packed beds. Periodic boundaries were applied to the sidewalls to mimic an endless flow. To drive the flow, an acceleration perpendicular to the bed was applied to the fluid, reaching a target value of 0.3 cm/s, simulating 12 seconds of real time.

Comparison of the model results to the law of the wall showed that flow speeds decreased logarithmically from the top of the domain towards the surface of the beds, indicating a fully developed boundary layer. Analysis of the fluid surrounding the sediment particles revealed critical threshold velocities, subsequently resulting in the initiation of motion due to drag. Sediment flux measurements indicated that with increasing simulation time a larger quantity of sediment particles was transported at the direct vicinity of the bed, whereas the amount of transported particles along with flow speed values, within the pore spaces, decreased with depth. Moreover, sediment - sediment particle collisions at the sediment surface lead to the opening of new pore spaces.

As a result, higher quantities of fluid particles infiltrated through the larger interstices between the sediment particles, which successively increased the potential for the initiation of motion of sediment particles located in the deeper horizons. This effect has been underestimated in prior studies and highlights the importance of sediment - sediment particle collision and fluid infiltration as an important characteristic that can eventually help to better understand the development of the shear layer but also various sediment morphological features.