Geophysical Research Abstracts
Vol. 17, EGU2015-5465, 2015
EGU General Assembly 2015

Diffusion of bed load particles subject to different flow conditions

Martina Cecchetto (1), Luca Cotterle (2), Matteo Tregnaghi (2), Simon Tait (1), and Andrea Marion (2)

(1) Pennine Water Group, Department of Civil and Structural Engineering, University of Sheffield, S1 3JD, UK (m.cecchetto@sheffield.ac.uk), (2) Fluid Mechanics and Environmental Hydraulics, Department of Industrial Engineering, University of Padua, Via Marzolo 9, 35131, Padova, Italy

An in-depth understanding of sediment motion in rivers has acquired increasing importance lately in order to plan restoration activities that provide ecological benefit. River beds constitute the interfacial environment where several species live and mass exchange of sediments/nutrients/pollutants can take place. Moving grains interacting with the bed deposit and can locally change the bed surface topography they can also act as carriers for contaminants associated with the grains. Study the motion of grains on the bed, in particular the extent and variability of their travel distance with regards to the flow conditions can provide information on the transport of grain associated contaminants. The results of a series of experimental tests, in which increasing levels of boundary shear stress were applied over a bed deposit of natural river gravel, are reported. Image databases consisted of a series of bed images acquired at a frequency of 45 Hz were collected. Analysis of the images has provided time and position data to plot the trajectories of more than 200 moving grains for each test. This data enables the derivation of the statistics of the un-truncated probability distribution of the detected particles' step length, which is consider as the distance moved by a particle from the moment it is entrained to the instant it stops on the bed. In recent studies the movement of bed load material has been indicated as diffusive, but little is known about the spatial and temporal scales of this diffusion. The analysis of the longitudinal and transverse trajectories for the tracked particles has here revealed three regimes of diffusion: a ballistic diffusion which takes place at the very beginning of particles motion, an anomalous intermediate regime, and a normal subdiffusion which occurs for larger times. Characteristic time scales separate these three diffusive regimes. Results show that in experiments with higher shear stresses the time scale separating the ballistic from the intermediate regime decreases, whereas an opposite trend is observed for the boundary between the intermediate and the final subdiffusion regime. This suggests that flow intensity influences the particle traveling time depending on the diffusive regime. An equivalent pattern emerges for the transversal diffusion, even if it is characterized by much smaller time scales. The simultaneous measurement of the 3D near bed flow field via a PIV system has allowed the grain velocity to be linked to the spatial averaged fluid velocity. Understanding the type of advective and diffusive process along with its mechanics can potentially allow for derivation of bed-load transport rate equations, able to replicate this behaviour, without the need of experimental measurements.