Geophysical Research Abstracts
Vol. 19, EGU2017-13488-2, 2017
EGU General Assembly 2017

The role of the hyporheic flow on sediment transport processes : an experimental approach using particle image velocimetry

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The study of river dynamics usually considers a turbulent stream on an impervious bed. However, it is known that part of the total discharge takes place through the erodible bed, especially for mountain rivers. This hyporheic flow (or subsurface flow) is likely to play an active role in the stability of the erodible bed. The question then arises: How does the hyporheic flow affect bed stability and thereby bed load transport?

Monitoring hyporheic flow under natural conditions remains a key challenge. Laboratory experiments and new measurement techniques shed new light on this problem.

Using PIV-LIF method (Particle Image Velocimetry - Laser Induced Fluorescence) we investigate hyporheic flows through erodible beds.

The experiment is conducted in a 2-m-long and 6-cm-width flume with 2-mm-diameter glass beads and 4-mm-diameter natural pebbles under turbulent stream conditions.

In parallel, we develop a simple analytical model that accounts for the interaction between the surface and subsurface flows at the bed interface. As the Reynolds number of the hyporheic flow is fairly high (10 to 100), inertia cannot be neglected. This leads us to use the Darcy-Forchheimer law instead of Darcy's law to model hyporheic flows. We show that this model is consistent with the PIV-LIF experimental results.

Moreover, the PIV-LIF data show that hyporheic flows modify the velocity profile and turbulence.

Our measurements and empirical model emphasize the exchange processes in coarse-grained river for incipient sediment motion.