Effect of vegetation on mass transport in compound channels

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A great variety of natural water streams and artificial channels can be classified as ‘compound channels’ since their cross-stream section can be assumed to be characterized by a main channel and shallow floodplains. The main agents of transport of momentum and mass between the main channel and the floodplains are found to be the quasi-two-dimensional (2D) macro-vortices (with vertical axes) generated at the transition region, where there is an intense generation of vorticity owing to the flow depth jump. This mechanism is further complicated by the presence of vegetation with different characteristics (species, shape, rigidity and spatial distribution) on the lateral floodplains. Understanding the mass transport pattern and evaluating hydraulic characteristics under different conditions are essential to the protection of the open compound channel ecosystem.

The present study focuses on the hydraulic characteristics and effect of mass transport in compound open channels with rigid vegetation and flexible vegetation on the floodplains. The effects of different plant types and plant densities on floodplain flow in open compound channels were simulated by a fixed slope flume. An experimental investigation based on particle image velocimetry (PIV) measurements of free-surface velocities forms the basis for an analysis of both the specific features of macro-vortices and of the related mean flow characteristics.

A numerical integration of sets of particle trajectories starting from the Eulerian velocity fields obtained from the particle-image velocimetry (PIV) technique are performed for each experiment. The resulting absolute and relative dispersion and diffusivity are discussed in detail to describe the mixing processes.

The presence of vegetation strongly impacts not only the Eulerian flow, but also to dispersion properties in compound channel. Further analyses are needed to clarify the possible generation of time-dependent Lagrangian coherent structures (LCSs), which are recognized to be material elements with a strong influence on the mass transport.