**Flow and turbulence characteristics in partly-obstructed open channel with vegetation patch**

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**Abstract**

Vegetation has been heatedly-discussed due to its important roles in ecosystem restoration functions. In decades, the fluid mechanics has been explored in vegetated open channel flows. However, it should be noted that attentions are mainly focused in the quasi two-dimensional flow configurations, under which the boundary effects in the third dimension are usually ignored. For instance, the above-mentioned situations include the vertical flow structure under the submerged vegetation condition and the depth-averaged horizontal flow structure under the emergent vegetation condition. Uncertainties might be present when applying the derived flow knowledge in those quasi two-dimensional flow configurations into the vegetation-flow environments, particularly in the vegetation/flow boundary regions. In the study, attention was paid to the partly-obstructed open channel with a vegetation patch. Both submerged and emergent vegetation conditions were considered in experiments. The mean flow velocity and turbulence structure were investigated under different vegetation densities and flow conditions.

The investigations show that, in the vegetation region far away from the vegetation patch lateral boundary, the vertical profiles of longitudinal velocity (*U*) and Reynolds stress (*τxz*) perform as same as classic flows over vegetation canopy. Near the vegetation patch lateral boundary, the velocity and Reynolds stress profiles at the near-bed region, however, show abnormal characteristics, which are rarely addressed by existing literatures. To be more specific, the negative gradient is observed on the vertical profile of longitudinal velocity at the near-bed region, coinciding with negative Reynolds stress (*τxz*). The vegetation density and the flow rate were identified to have positive impacts on the particular phenomenon, which is believed to be resulted from the vertical behavior of generated horizontal coherent vortices confirmed by the peak in energy spectral density with low frequency. The analysis of momentum equation suggests that the low momentum from the vegetation region carried by the horizontal coherent vortices negatively contribute to the velocity profile. Of more significance is that the negative *τxz* suggests the suppression of the particle entrainment at bed, while the positive *τxy* tends to enhance the transverse transport of suspended loads in the sediment transport.

**Keywords: partly obstruction, logarithmic velocity profile, horizontal coherent vortices, momentum exchange**