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Experiments of Flow Field Influenced by Vegetation Distribution on Floodplain

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Abstract

The vegetation on floodplain can block river flow, raise flood level, and scour riverbed downstream the vegetation region. However, it can also protect the dike, reduce flood velocity, and increase the stability of channel. This experiment analyzed the relationship between vegetation distribution and flow field. We designed three vegetation arrangement pattern of unilateral vegetation, unilateral interval vegetation and no vegetation, respectively. The unilateral vegetation was defined as a 4.9 m length and 0.5 m width with vegetative area in one side of the experiment flume. The unilateral interval vegetation was defined as the same dimension of vegetative area but inserted 2 gaps with 1 m interval, and the vegetative area was separated into 3 blocks. The model of a single plant was assembled with stem and frond. The stem was a woody cylinder with 10 cm height and 2.2 cm in diameter. The other part was plastic frond with 10 cm in height. The flume was 20 m length, 1 m width and 0.7 m height with 2 kinds of bed slopes in 0.001 and 0.002, and 3 different discharges in 0.2 m3/s, 0.145 m3/s and 0.0855 m3/s. The velocity was measured by 2-D electromagnetic velocimeter (ACM2-R2). In addition, water depth was measured by Vernier calipers.

The velocity distribution showed that the current were divided into two parts. In the part of inside vegetation area, water level uplifted when flow entering the vegetation area, and it declined until the current leaving vegetation area. Compared with the current in the other half part of flume, the magnitudes of uplift were about 50% in both case of unilateral vegetation and unilateral interval vegetation. Downstream the vegetation area edge, the water level dropped immediately and violently. The water depth was shallower than that in the other half non-vegetation part, and the decline magnitude were 48% and 39% in cases of unilateral vegetation and unilateral interval vegetation, respectively. To explain this phenomenon, we measured and drew the velocity field. The result showed that in the case of unilateral vegetation, the velocity which inside the vegetation area decreased to 70%, and the velocity in another side which without vegetation increased to 190%, compared with the initial inflow velocity. In the case of unilateral interval vegetation, the water level profile was a ladder-like distribution, i.e. a higher water level and lower velocity in the vegetation blocks, and convers distribution inside the gaps. It led to gentle change in water level with 70% decrement and 170% increment inside and downstream the vegetation area. Consequently, the current division effect in case of unilateral interval vegetation was better than that of another case, and it was a beneficial method for the flood control.