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Experimental study on longitudinal mixing in open channel flow with various vegetation patterns

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In natural streams, vegetation considerably has an influence on the flow characteristics in a variety of ways. For example, vegetation distorts flow structure in both lateral and vertical directions and changes the magnitude of turbulence and shear flow. Due to these effects, diluted contaminants in river transport and disperse differently. Accordingly, many previous researchers have investigated the impact of vegetation on the mixing process. Most of them have estimated the dispersion coefficient since this is the crucial parameter to quantify the degree of dispersion of contaminants numerically. They mainly studied in diverse characteristics of vegetation, such as density or submergence, etc., and identified the change in hydraulic parameters involving the dispersion coefficient.

In this work, considering the vegetation distributed in various forms in the natural river, we studied the effect of vegetation patterns on the longitudinal mixing coefficient. Six types of spatial patterns considered in this study are represented numerically by introducing the standardized Morisita index. Laboratory experiments with artificial emergent vegetation were performed in multiple vegetation patterns, and the longitudinal dispersion coefficient was estimated from the measured concentration curves by applying the routing technique. And we analyzed the cause of change in dispersion coefficient by calculating not only the dispersion coefficient but also the magnitude of mean velocity, shear flow, turbulence, etc.

According to the experimental results, the mean velocity in the vegetated channel is almost the same regardless of the type of pattern but is always lower than that in the non-vegetated channel. The longitudinal dispersion coefficient gets larger as the arrangement changes from uniform to 2D clumped pattern. The cause of change in coefficient is closely related to the spatial velocity gradients in both lateral and vertical directions since the spatial heterogeneity of velocity increases the magnitude of shear flow.