CONTROLLING FACTORS OF FLOW SEPARATION IN NATURAL, MEANDERING STREAMS

Flow separation is a physical phenomenon that is observed near the banks of many meandering rivers. In these flow separation zones, the flow is either recirculating or stagnant and can occur both at the boundary of the inner and the boundary of the outer bend of rivers. These flow separation zones influence the hydraulics, ecology and morphodynamics of rivers, for example, by decreasing the effective width of the rivers and reducing their conveyance capacity. However, the exact conditions under which flow separation occurs and the extent to which they influence the size of the flow separation zones remain unclear.

The geometric and flow characteristics controlling the onset and size of flow separation are tested in a case study at the Glanerbeek near Enschede, where the surface flow patterns are visualised using Large Scale Particle Image Velocimetry (LSPIV). Cross-sectional profiles are measured with Real-Time Kinematic positioning (RTK), at the entry, apex and exit of each of the 10 investigated bends.

During the study, there was a specific focus on the following, potential, controlling factors:

- Flow depth
- Radius of the bend
- Radius/width (R/B) ratio
- Impingement angle
- Increase in cross-sectional area

A correlation was found with all of these potential controlling factors. The field study was executed on a day with higher water level and a day with lower water level. On the day with the lower water level, the total area of inner bend flow separation was significantly larger than on the day with higher water level. The strongest correlation was the increase in cross-sectional area with the outer bend separation zones, which showed that an increase in cross-sectional area leads to a decrease in the size of the outer bend separation zones. This is contrary to literature and could be caused by the methods used in this study. The impingement angle also showed a negative correlation with the size of the outer bend separation zones, as did the radius of the river bend. The R/B ratio showed correlation with the inner bend separation zones, even though this correlation was stronger during the first measurement day. These correlating parameters could be controlling parameters for the onset of flow separation. However, no specific threshold values have been found that induce the onset of flow separation zones.

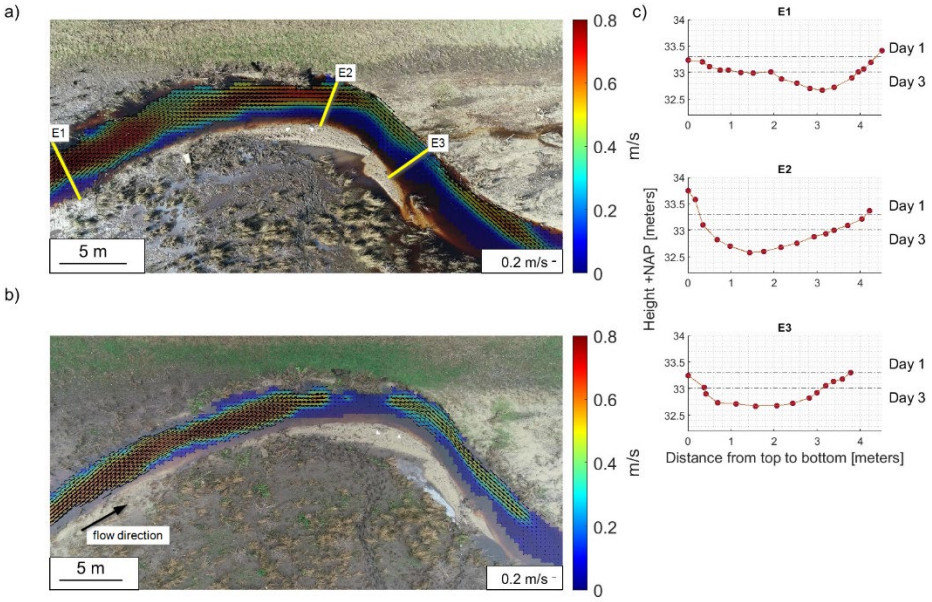

Figure 1: Surface flow patterns obtained by LSPIV on a) the day with higher water level (Day 1) and b) the day with lower water level (Day 3). c) Shows the cross-sectional profiles along the river bend including the water level on each day.

Irene Mulder

Graduation Date:
9 July 2024

Graduation committee:
University of Twente
Dr. ir. D.C.M. Augustijn
Dr. V. Kitsikoudis

UNIVERSITY OF TWENTE.