How Does a River Bifurcation System Respond to Peak Flows? A Case Study of the Upper Dutch Rhine Bifurcation Region

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Sediment transport capacity and supply of sediment to a river channel increase significantly during peak flow events. Here we study how a river bifurcation system (partitioning water and sediment over its downstream branches) responds to peak flow events. We focus on the Pannerdense Kop bifurcation in the Dutch Rhine River, an engineered system where planform and channel width are fixed. We analyze water discharge and bed level data measured over the last century. We observe rapid aggradation in one of the branches (Pannerden Channel) following the peak flow events of 1993 and 1995, and little to no bed level change in the other branch (Waal). Prior to the event, both branches eroded, and the upstream part of the Pannerden Channel had a greater erosion rate than the Waal. After the 1993 and 1995 peak flow events, the erosion in the upstream part of the Pannerden Channel slowed significantly, whereas the upstream part of the Waal branch continued to erode (though at a smaller pace than before the peak flow events). This differential erosion has resulted in a gradual increase of water discharge toward the Waal branch. Interestingly, the bifurcation system does not appear to respond equally to all peak flow events. We hypothesize that the bifurcation response to the 1993 and 1995 peak flows differs from previous peak flows because of the sequence of the two events. Between the 1993 and 1995 events, the system may not have had sufficient time to disperse the sediment deposited at the upstream end of the Pannerden channel. Another reason for the response to the 1993 and 1995 peak flows to differ from previous events may be that the channel bed surface within the region of interest has coarsened significantly. This study illustrates the importance of peak flows regarding bifurcation dynamics, and further research is focused on the interaction between bifurcation dynamics and the dynamics of the larger-scale system.