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Experiments on channel head bifurcation

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Channelization is an important aspect of geomorphological processes which attributes to the configuration of a landscape mainly in fluvial dominated areas. Besides, Channelization comprises of different phases: starting from the inception phase transforming to extension then finally to deletion. Therefore, profound understanding of these processes is fundamental to the study of the channel drainage networks evolution. Specifically, identifying the controlling factors and their threshold conditions for the onset of channel head bifurcation is very important in the field of landscape evolution study, particularly on channel networks. Hence, in this study we focused on the process of channel head bifurcation, which is the dissection of channel head into two or more channel branches.

We premeditated our experimental setup in a way that able to evaluate the validation of the theoretical finding that has been done by Mizushima, et al 2007, and to study the details of channel head bifurcation processes and their controlling factors. The theoretical study hypothesized that if the flow concentration is maximized at the top of the channel head, the channel migrates upstream without bifurcating. On contrary, if the flow depth at top edge of the channel head disperses, the channel head splits into two or more channels. They studied this problem using linear stability analysis and finally able to conclude that the channel head becomes unstable when the Froude critical depth divided by the bottom friction coefficient becomes sufficiently small compared with the width of the channel head.

Accordingly, we considered the findings of the theoretical study as our reference input for the experimental setup. A wide flat plain bed ending with a sudden fall at the downstream end was used to simulate a flat plain receiving shallow overland flow from a catchment. A small channel is introduced at the center of the downstream end, always made before the commencement of every experiment. we monitored the development of the channel as the experiment runs. When the experiment starts, the overland flow from upstream end flows as a very shallow water and heading towards downstream end, mainly to the channel head, because by keeping the flat plain horizontal we realized the flow on the flat plain as subcritical flow in the Froude sense so the upstream flow is influenced by the channel. The development of the channel was continuously monitored by recording successive photos from upstream top part of the flat plain, observation by our naked eye was made as well.

In this study we presented the relationships between the controlling factors such as flow depth and surface roughness with respect to the channel head width, for threshold conditions for the commencement of channel head bifurcation. In addition, we observed that channel head bifurcates when the channel head is enlarged in width into the level where the flow depth is sufficiently reduced to the level the flow is reorganized into two or more flow concentrations, and the bifurcation is realized when each small reorganized flows still persists eroding capacity to make the channel migrating upstream. Finally, we noticed that the experimental results are consistence with the basic considerations and results of the theoretical study.

Keywords: channelization, bifurcation, channel head, channel networks