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Adjustment processes of river longitudinal profile: laboratory experiment

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It is generally recognized that longitudinal profiles of graded rivers take exponential curve shapes. Even in an uplift area, a river attains a stable state, i.e., dynamic equilibrium between uplift and fluvial erosion. The change or adjustment of a river profile, however, is not still understood well, especially for a bedrock river. We have conducted physical model experiments in which an initial slope of the mixture of sand and silt was set up and rivers developed by incision of the slope. A weir with a slit at the center was placed at the downstream end to prevent the base-level change due to uncontrolled sedimentation inside of the observed area. Constant rainfall was realized by very fine mist supplied from ten nozzles installed above the flume. The rate of tilting, the axis of which was sited at the shoreline (landward uplift), can be controlled. The parameters of the present study are the gradient of an initial flat slope and the uplift rate. Two types of experiment were conducted, Ex. (i): experiments to test the dependence on initial slope gradient with no uplift; Ex. (ii) to examine the effect of tilting uplift. Results are as follows: Ex. (i) showed that the trunk stream eroded the river bed through two stages. The first stage ended when the valley head erosion ceased. The second deepening started because of the development of tributaries and resultant increase of stream discharge. At the same time, knickpoints generated, which were caused by strong erosion near a junction owing to the difference of bed gradients between a trunk stream and its tributary. Ex. (ii) showed that rivers were more influenced by tilting than erosion at first, but erosion gradually increased to balance with uplift (dynamic equilibrium). The experiment in which the tilting rete was changed during the run also showed dynamic equilibrium topographies for each tilting rate, but a profile with a part of convex shape occurred during the transition. The present study suggests that knickpoints occurs during the process to toward a graded state, equilibrium state for both static and dynamic equilibrium states.

Keywords: river longitudinal profile, laboratory experiment, tilting uplift, graded river