Laboratory experiment of river terraces formation under tilting uplift

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Formation of river terraces is not simple in response to external forcing. Previous experimental studies showed that multiple terraces can be formed even by a single sudden sea level or a continuous change. It is so far difficult to precisely reconstruct a history of landform development from remaining topographic features along time axis. In this research, we conduct model experiments that allow observation of time development. It was aimed to investigate the timing of terrace formation, temporal change of longitudinal profile of channels and terraces, flow path position, and terrace heights and lengths, in response to temporally-constant tilting-uplift where the uplift rate linearly increases landward.
In the experiment, we simulated bedrock by the mixure of sand and kaolinite at a volume ratio of 10.5 : 1, which was installed into a tank to make an initial flat slope of 1 degree. Sprinklers supply misty rain to develop the topography. During the first 40 minutes, rain was supplied without no uplift in order to promote the development of the terrain for preparation. Later, the following procedures were repeated during the run: both uplift and rain were realized for 20 minutes, and then the run was paused temporally for photographing of topography to make 1 mm-mesh DEM by photogrammetry using more than 200 photos.
Many terraces were formed in the experiment, and we selected a series of eight terraces along a single flow path to analyze. Temporal change of longitudinal profile of the river and terraces showed that the terraces become steep after formation with time due to the tilting uplift, which resulted in a topography where higher terraces dip more steeply relative to the channel profile, as pointed out by a previous theoretical model. A formed terrace could be not only shorter due to lateral erosion, but also longer owing to downcutting of floodplan at downstream side, which means, in some time-scale, a terrace does not necessarily show an isochronal face. The terraces tended to form when both lateral and downward erosion were large.
It is still difficult to predict when and where a new terrace emerges. The terrace formation relates with not only the uplift but also the lateral and downward movement of channel, but it is not clear so far how discrete topographies (i.e., terraces) are made by continuous forcing, which has been called complex response. In this experiment, we confirmed fluctuation of vertical and lateral incision rates through the quantitative measurement, which resulted in oscillation of river bed elevation and presumably triggered the development of discreet landforms. This fluctuation is thought to be an autogeneous phenomenon that does not require meander cutting. While some previous studies pointed out that river bed elevation can fluctuate because of change in sediment production rate due to glacial-intergracial cycles, the present experiment suggests that the river bed elevation can fluctuate even in a low latitude area free from glacier, without strong external forces.

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