Temporal change of incision rate in relation to river terraces: model experiment

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It is a common method to estimate incision rate using river terrace to know uplift rate, under assumption of long-term steady-state in equilibrium between uplift and incision (e.g., Burbank et al. 1996; Pazzaglia & Brandon 2001). It seems that river terraces provide a straightforward way to quantify the incision rate, by calculating the height of a terrace (from the nearby modern river bed) divided by the age of the terrace. However, previous studies show that the incision rate calculated from a younger terrace results in a larger value, which is called "Sadler effect" and holds over the order of 10^7 years (Finnegan et al., 2014). Sadler effect suggests that incision rate estimated from a terrace is apparent speed. In this research, we aim to explore the factors that induce the Sadler effect by conducting model experiments that allow observation of temporal change of landforms.
A sand mixed with s kaolinite (volume ratio is 10.5 to 1) was employed as a model material for bedrocks. We settled the material in the experimental flume to form a 1 degree-dip flat slope as an initial landform. Rainfall was simulated by fine mist supplied from sprinklers. In this study, we realized uplift by tilting the flume. Landform was measured at interval of 20 minutes, by photogrammetry. After the preliminary stage for landform development, we set the uplift rate at 0.5 degree/ h.
We analyzed eight terraces (T1 –T8) along the identical channel. Identifying the time of formation of each terrace and measuring the temporal change of the terrace height from the nearby river beds, we calculate the incision rate in the same manner used in field researches. The incision rate calculated as such was higher if the terrace was younger, so the Sadler effect appeared also in the experiment. It was also confirmed that the Sadler effect of the identical terrace decreases as the elapsed time after terrace formation increases.
We also measured the "actual vertical erosion rate" from the difference of the altitudes of river beds at different time. The results showed fluctuation of river bed elevation, suggesting that Sadler effect can be attributed to temporal deviation from the long-term average, as mentioned by Gallen et al. (2015). If we can know the property of the deviation, it may be possible to estimate long-term-average incision rate only from young terraces.

Keywords: terrace, incision rate

Temporal change of averaged incision rate estimated from identical terraces