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The validity of simplified shear-stress incision models in meandering river systems: a case study along the Hsiukuluan River, eastern Taiwan

J.B.H. Shyu and K.-Y. Du
National Taiwan University, Department of Geosciences, Taiwan (jbhs@ntu.edu.tw)

River systems are directly affected by exogenetic processes. Several previous studies have shown that shear-stress incision models may be good tools to estimate the incision processes of bedrock channels, and the characteristics of river channel morphology can reflect the influence of neotectonic activities. However, since many parameters of the shear-stress incision models are difficult to quantify precisely in the field, many of such models are simplified based on some simple assumptions. Although it has been shown that such simplified models yield satisfactory results in some river systems, they may not be applicable to all types of river systems. For this purpose, we selected a highly meandering segment of a major river in eastern Taiwan, the lower reach of the Hsiukuluan River, to investigate if simplified shear-stress incision models remain valid in such an incised meandering river system.
The simplified shear-stress incision model suggests that the incision rate is directly related to the shear stress at the channel bottom, and along this segment of the Hsiukuluan River, the shear stress can be simplified to be just a function of the channel width and the channel slope, both of which can be measured in the field. Thus we calculated a trend of the incision rates based on the channel width and slope data we measured along the river. This trend is then compared with the incision rates obtained directly from the ages of bedrock river terraces along the Hsiukuluan River. The result shows that these two datasets have opposite trends. Therefore, we suggest that this simplified shear-stress incision model may not be applied to such an incised meandering river system. Several factors may contribute to the invalidity of the incision model. One of the most likely factors is that, in a highly meandering river system, the channel shape is likely far from uniform, and thus many of the hydrologic parameters cannot be simplified.