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Event scale variability of mixed alluvial-bedrock channel dynamics

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The relationship between flood events and fluvial behavior is critical for understanding how rivers may respond to the changing hydrologic forcing that may accompany climate change. In mixed bedrock-alluvial rivers, the response of the system to a flood event can be affected by a large number of factors, including coarse sediment availability in the channel, sediment supply from the hillslopes, bedrock-controlled changes in channel width and planform, and the shape of the hydrograph. We use the Daan River Gorge in western Taiwan as a case study to directly observe the effect of individual flood events on channel evolution. The 1200 m long and up to 20 m deep bedrock gorge formed in response to uplift of the riverbed during the 1999 Chi-Chi earthquake. The extremely rapid pace of change ensures that flood events have measurable and often dramatic effects on the channel. Taiwan is subject to both summer typhoons and a spring monsoon, resulting in numerous channel-altering floods with a range of magnitudes. Discharge is therefore highly variable, ranging from 5 to over 2000 m3/s, and changes in the channel are almost entirely driven by discrete flood events. Since early 2009 we have monitored changes in the gorge with repeated RTK GPS surveys, laser rangefinder measurements, and terrestrial LIDAR surveys. Six rainfall stations and five water level gauges provide hydrological data for the basin. We find a distinct relationship between flood magnitude and the magnitude of geomorphic change; however, we do not find a clear relationship between flood characteristics and the direction of change – whether the channel experienced aggradation or erosion in a particular flood. Upstream coarse sediment supply and the influence of abrupt changes in channel width on bedload flux through the gorge appear to have important influences on the channel response. The better understand these controls, we use the model sedFlow (Heimann et al., 2014) to explore the effects of interactions between sediment supply, channel width, and flood characteristics on aggradation and erosion of the channel bed.

Heimann, F. U. M., Rickenmann, D., Turowski, J. M., and Kirchner, J. W.: sedFlow – an efficient tool for simulating bedload transport, bed roughness, and longitudinal profile evolution in mountain streams, Earth Surf. Dynam. Discuss., 2, 733-772, doi:10.5194/esurfd-2-733-2014, 2014.