Morphodynamics of a steep gravel bed stream: inferences from a Froude-scaled experimental river

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Most of our understanding of reach-scale channel dynamics comes from field studies and experiments using physical models. The majority of the physical models have been set up using either stream tables where both the bed and banks are erodible or straight walled flumes with erodible beds, though there have been several studies of channel dynamics in flumes with sinusoidal walls that mimic a regular meandering pattern. Most of these experiments have been relatively short, running for only a few hours. We have conducted a series of experiments using a fixed-bank flume with a bank alignment based on Fishtrap Creek, a forested stream in British Columbia. This channel is typical of many moderately sized channels with forested floodplains, in that it has a highly irregular bank alignment and bank erosion is usually sporadic and localized. In fact, for these kinds of channels, the bank alignment is effectively fixed for all but the largest flood events. Our experiments were conducted to identify modes and mechanisms of channel response to changes in sediment supply and discharge over a model time span equivalent to several decades of prototype peak flows: this corresponds to model runs up to 100 hours in duration. The experimental channel has an average width of 0.30 m and a length of 6.0 m: the model grain size distribution and model peak flows were specified based on Froude scaling of the field prototype. During the experiments, we continuously monitored the rate and size distribution of sediment transport. We also sampled the bed surface texture and mapped the bed topography at one-hour intervals. The results shed new light on the time required to establish equilibrium, and the morphologic variations that are typical even under constant sediment supply and discharge. They also elucidate some important differences between the morphodynamics of channels with irregular channel banks and those with regular (and/or erodible) boundaries.

Experimental apparatus at the UBC Geography hydraulics facility