

The evolution of gravel-bed morphology due to changing hydrologic regimes: A case study of an urban watercourse in Southern Ontario, Canada

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A field investigation has been undertaken to characterize the event-based morphodynamics of a gravel-bed watercourse in Toronto, Ontario, Canada, where significant amounts of land-use change have impacted the hydrological regime. The study reach exhibits a unique bed morphology, common to other urban streams in the area, which has been hypothesized to be an emerging trend in urban gravel-bed channels that have riffle-pool morphologies within northeastern North America.

Bedload was measured using in-situ Helley-Smith sampling methods, combined with RFID tagged tracer particles which were measured on an inter-event basis. The Helley-Smith samplers captured the sediment which is frequently mobilized (sand to fine gravel), while the tracer particles assessed the contribution of coarse particle mobility. Thus, the mobility of the entire bed surface was sampled. The transport relationships were combined with temporal hydrometric stream gauge records to investigate how changes in hydrology, common to urbanization, have impacted the temporal distribution of bedload transport textures, and the corresponding effective discharges.

Fractional transport analysis of bedload samples and tracer particles indicates that frequent events are capable of mobilizing sand and fine gravel to an equally mobile condition. Conversely, particles larger than this remain in a state of partial mobility for these events. The coarsest fraction is infrequently mobile on an event-basis and, when mobilized, typically stays on the same morphological unit for that given flood, a pulsing like characteristic. Additionally, the path lengths of the particles are shorter than those commonly reported in literature, further supporting this pulsing characteristic. This pulsing is thought to result from the frequent but short duration discharge events common to urban watercourses.

It is hypothesized that the frequent partial mobility of sand and fine gravel, and the pulsing characteristic of the coarsest particles, is a controlling factor in the unique morphology observed in these urban gravel-bed watercourses. The temporal trends in bedload texture and effective discharge provides insight into the use of “design discharges” for stream rehabilitation projects in watercourses undergoing land-use change. The results have implications on the evolution of aquatic habitat in urban channels as well as potential target morphologies and sediment mobility regimes for river rehabilitation designs.