An order of magnitude increase in stream power and sediment transport potential due to urbanization of the Highland Creek watershed, Toronto, Ontario

Roger T.J. Phillips[1, 3],
John S. McDonald[2],
Peter E. Ashmore[3]
[1]*Aquafor Beech Limited, Mississauga, Ontario, Canada*
[2]*Matrix Solutions Inc., Mississauga, Ontario, Canada*
[3]*Department of Geography, Western University, London, Ontario, Canada*

The basic idea that urban land use changes can dramatically alter the hydrological and geomorphological response of a watershed to climate conditions is well established. However, assessing the absolute changes in annual sediment transport flux, or the mass of sediment moved each year, is far more challenging. For hydromodified urban channels, post-development sediment transport is not simply a response to increases in discharge magnitude and frequency—or flashiness—but changes to sediment sources and channel morphology also influence the hydraulic–sediment transport relationship. Highland Creek in Toronto, Ontario provides an effective case study to detail the historical changes in channel morphology, stream power, and sediment transport. To assess watershed-scale sediment transport potential, an established methodology of specific stream power mapping is applied for both pre-development and post-development conditions. To calculate specific stream power ($\omega = \gamma Q s w^{-1}$) continuously through the drainage network, pre- and post-development estimates of slope, discharge, and channel width were compiled from multiple data sources. Modern channel slopes were generalized based on a 1 metre resolution DEM, and historic slopes were adjusted based on changes in sinuosity and spatial correlations in channel location between the two time periods. Modern discharges were extracted from a distributed HSPF hydrological model calibrated to the Water Survey of Canada stream gauge on the main branch of Highland Creek, while the historic discharges were interpolated based on empirical discharge-drainage area relationships from rural catchments in the region. Channel width estimates were estimated from channel maps digitized from historic aerial photography for both the pre- and post-development periods. Despite dramatic increases in channel width after urban development of the watershed, specific stream power estimates show an order of magnitude increase in sediment transport over many reaches. For alluvial (or non-engineered) reaches on the main branch, established sediment transport models from scientific literature produce similar results. This analysis indicates that the median sediment size on the main branch is likely mobilized on average about once a month, or in the range of about a dozen times per year, under hydromodified flows.

Biography

As a teacher, researcher, and geoscience consultant, Roger is an enthusiastic advocate for environmental geoscience and professional geomorphology. He has worked at Aquafor Beech since 2005, he teaches courses at the University of Toronto, and he is an active member of the Association of Professional Geoscientists of Ontario (APGO) working on a number of committees including the Registration and Geomorphology committees.