ES06: Professional Geoscience 1: River Restoration in Canada, from Planning to Effectiveness Monitoring

Conveners: Marwan Hassan[1], Shawn Chartrand[2] and David Luzi[3]

Co-chairs: Marwan Hassan[1], Shawn Chartrand[2] and David Luzi[3]

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River restoration (RR) is in the middle of its fifth decade of practice. In this relatively short period, RR has grown into a global enterprise, involving all if not most of the world's largest engineering consultancy's, and an annual budget which has grown into the billions of dollars. Despite this somewhat rapid growth, RR practice continues to face many basic challenges, which limits the abilities of any one practitioner or team of practitioners to envision, develop, plan and implement effective RR projects, as measured in ecological and physical terms. For example, continuous simulation of 1-dimensional channel evolution from the basis of proposed RR designs are often difficult to interpret or understand due to a lack of adequate boundary condition information, such as rates of water and sediment supply. Climate change and the behavior of aquatic species in decline unfortunately complicates these challenges. Furthermore, coordinating and guiding RR efforts amongst many different project members and stakeholders toward a defensible design plan is a daunting task for even the most capable of managers. In many ways, RR is the contemporary litmus test of our collective abilities to successfully apply science and engineering to address the often conflicting issues of property and infrastructure protection, and ecological function. To promote a dialogue of learning, the RR community needs to convene and air successes and failures so that the approaches taken build upon our knowledge base, and push us further along the curve of meaningful restorative actions. This session invites presentations from all scales of RR with a clear focus on (1) approaches to planning for RR under fast-paced, and more traditional project timelines, (2) technical analysis pursued to support design development given the overall project objectives, or the regulatory criteria which define aspects of expected project effectiveness (e.g. fish passage performance), (3) contingency or adaptive planning in light of conditions that preclude explicit analysis (e.g. future climate and associated patterns of sediment erosion and deposition), and (4) particular successes, failures or difficulties that would help us achieve the goal of continual improvement of RR actions. One to two invited talks from leading practitioners and/or researchers will be sought.

Primary Affiliation: CGU Earth Surface Processes

NOTE: THIS DOCUMENT CONTAINS INFORMATION FOR ALL SESSION SUB-SECTIONS. PRESENTER ABSTRACTS ARE FOUND AT THE END OF THE DOCUMENT.

SCHEDULE MAY BE SUBJECT TO CHANGE.

ORAL SESSION ES06a

Chairs: M. Hassan, S. Chartrand, D. Luzi **Room: GEOG 229**

Tuesday, May 30th

TIME	AUTHORS	TITLE
09:00	D. Gaeuman*, R.L. Stewart and B.Schmandt	Gravel management downstream from dams: Geomorphic responses to gravel augmentations and dam-controlled floods
09:30	P. Padovan*, P. Villard, and J. Cockburn	Assessing Hydrogeomorphic Adjustment in Urban Hybrid Channel Restoration Projects: Highland Creek, Toronto, Ontario
09:45	S. Masse*, T. Buffan-Belanger, P. Bison and J. Ruiz	The "Freedom space for rivers" concept as a passive restoration approach for sustainable floodplain management
10:00	James Ogilvie*, Allan Bronsro, Lee Nikl and Mark Adams	Creek Rehabilitation Following a Tailings Dam Breach and Debris Flow: Mount Polley Mine, British Columbia
10:15	Shawn Chartrand*, Marcin Whitman, Brian Cluer, and Michael Burke -	San Clemente Dam Removal And Perspectives On Design Of Step-Pool Stream Channel Segments -

POSTER SESSION ES06

Chairs: M. Hassan, S. Chartrand, D. Luzi **Room: ESB Atrium**

Tuesday, May 30th

Poster No.	AUTHORS	TITLE
P02-ES06	Kimisha Ghunowa*, Bruce MacVicar, and Peter Ashmore	Spatial Decision Support Tool for Cumulative Stream Power Modeling

SUBMITTED ABSTRACTS

ES06-01 The "Freedom space for rivers" concept as a passive restoration approach for sustainable floodplain management

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Abstract
The Freedom space for rivers (FSR) concept promotes the delineation of a single space that integrates multiple fluvial dynamics such as floods, lateral migration, channel avulsions and riparian wetlands connectivity. In this space, fluvial processes are left free to operate and anthropic activities are restricted in order to limit risk for citizens and infrastructures, while providing a series of ecological services and socioeconomic benefits. In highly perturbed systems, the FSR concept appears to be a cost-effective and an appropriate river restoration approach while in undeveloped river reaches it ensures the continuity of fluvial process and restricts floodplain development. Many methodological and institutional challenges arise for the applicability of the FSR concept in river management. To investigate these challenges, working groups bringing together regional stakeholders were created in collaboration with local watershed organizations and municipal authorities in three contrasting river environments in Quebec. The collaborative research approach aimed to better understand challenges and opportunities faced by the communities to implement FSR management concepts. Stakeholders' engagement help to identify local concerns regarding FSR management, to collectively set up implementation strategies and to transfer knowledge gained on river dynamics and fluvial hazards. Farmers' reluctance to limit bank stabilization and to widen riparian buffers, a lack of political will, the absence of government incentives to support local FSR actions emerged as the main obstacles for the integration of FSR concepts in management practices. In the three studied territories however, regulatory protection of FSR is feasible in undeveloped or uncultivated land to prevent future development in high-risk areas and to ensure the quality of ecological services associated with floodplains. Raising stakeholders' awareness about natural hazards and hydrogeomorphological processes appears essential for incorporating new management practices that aim to give more space to rivers in order to reduce vulnerability and improve the resilience of communities. [299 words]

Presentation type: Oral Presentation

ES06-02 Spatial Decision Support Tool for Cumulative Stream Power Modeling

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Abstract
The change of land use from rural to urban tends to radically alter the implicated streams, typically infecting them with many symptoms of the "urban stream syndrome". The key driver of the syndrome is hydrologic change; the product of increased imperviousness and efficient conveyance and characterized by frequent larger flows, increases in peak flows, and seasonal shifts in flood occurrence. Streams are unable to maintain stability due to an imbalance between sediment transport processes and the flow energy, which inexorably leads to the symptoms of morphological alteration, ecological degradation and a reduced capacity to support ecosystem services. Many strategies have been tried to prevent damage in or rehabilitate these urban streams. However, significant uncertainty remains about their outcomes because current practices do not consider the marginal impact of additional land use changes within a watershed or the spatially cumulative impact of urbanization beyond the reach scale. The objective of the current paper is to describe a spatial decision support tool to predict changes in stream power under different scenarios of land use and cover change at the network scale. Change in stream power is modelled for its suitability as a predictor of changes in channel stability. The tool is written in Python and packaged as an ArcGIS toolbox for ease of use. The current framework integrates empirical relationships between discharge, drainage area and imperviousness to assess pre- and post- development impacts of urbanization along the stream networks. Continued development of the tool will allow increased use of field and site specific model results to refine the accuracy of predictions. Visual displays of the spatial and temporal sensitivity of streams to urbanization can assist in decision making processes. [277 words]

Presentation type: Oral Presentation

ES06-03 Regional Reference Curves for Small and Medium Streams in Southern Ontario

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Abstract
A critical first step in channel restoration is determining the appropriate bankfull cross-sectional area of the watercourse that is being restored. Ideally, this dimension is determined directly from channel measurements. However, bankfull indicators are often unreliable or absent in creeks that need restoration. To help solve this problem, a series of regional reference curves were developed for selected hydrophysiographic regions of southern Ontario. These regions, which have similar surficial geology and mean annual precipitation, were in Waterloo, Peel, York and Durham Regions. The curves relate bankfull cross-sectional area at riffles to watershed drainage area. Smaller creeks were used to develop the curves since many restoration projects tend to be in smaller watersheds with drainage areas under 100 km^2. Data were collected at riffles since these features hold grade and control stability throughout fluvial systems. Morphological data were collected from a total of 24 stable creeks in southern Ontario. The data revealed a strong positive correlation ($r^2 > 0.95$) between bankfull area and drainage area. The resulting curves are able to predict the bankfull cross-sectional area for impaired watercourses that lack reliable bankfull features, such as severely eroded alluvial systems, concrete-lined channels, or piped drainage. The curves can be used by stream designers, as well as regulators who are tasked with reviewing channel designs. This presentation will describe how study sites were selected, outline the approach used to collect and analyze field data, and provide examples of how the resulting curves may be applied to design and practice.

Presentation Type: Oral Presentation

ES06-04 Creek Rehabilitation Following a Tailings Dam Breach and Debris Flow: Mount Polley Mine, British Columbia

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Abstract
The breach of the tailings dam at the Mount Polley Mine and the resulting debris flow scoured the length of Hazeltine Creek (approximately 8 km) and the mouth of Edney Creek, leaving the remaining creek channel exposed and eroding, with turbid waters flowing into Quesnel Lake. The debris flow was estimated to have scoured approximately 0.6 – 1.7 M m3 of the glaciolacustrine and fluvial sediments underlying the previous alignment of Hazeltine Creek. The resulting incised channel was exposed to head cutting, gully erosion and sidewall slumping resulting in downstream movement of suspended particulate material to Quesnel Lake. A two-phased approach was used to rehabilitate the creek and re-establish its biological functions. The first phase was to design and construct an engineered, non-erodible channel foundation to stop channel erosion from occurring. Hydrology and geomorphology studies were completed, and the results from these were used in the field to support the construction. The channel morphology was developed to approximate pre-existing conditions, including a low-flow channel and two levels of floodplains. This initial channel stabilization work was completed over a period of five months using a combination of traditional channel design techniques and innovative implementation methods. A field-fit design and construction approach was used to minimize schedule and capital expenditure. The second phase, which is ongoing, was to re-establish habitat values within the creek. The overall objective for the rehabilitation of fish habitats was to restore the life history functions that could be realized in each reach. Design features also planned for the provision of in-stream cover while re-establishment of riparian vegetation was underway and restoration of habitat for wildlife associated with small streams and their riparian environments.

Presentation type: Oral Presentation

ES06-05 Gravel management downstream from dams: Geomorphic responses to gravel augmentations and dam-controlled floods

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Abstract
The geomorphic effect of introducing a gravel augmentation totaling 520 m^3 into a gravel-bed stream during a dam-controlled flood in May of 2015 was monitored with bedload transport measurements, an array of seismometers, and repeated topographic surveys. Half of the augmented gravel was injected into the flow with front-end loaders on the rising limb of the flood and the other half was injected on the first day of the peak. Virtually all of the gravel transported past the injection point was deposited within about 7 to 10 channel widths of the injection point. Most of the injected gravel deposited along the left bank of the river whereas the right half of the channel bed was dominated by scour. The downstream third of the depositional area consisted of a small dune field that developed prior to the second gravel injection and subsequently migrated about one channel width downstream. A second deposition front was observed upstream from the gravel injection point, where a delta-like wedge of bed material developed in the first hours of the flow release and changed little over the remainder of the release. These two depositional area represent small-scale bed-material storage reservoirs with the potential to accumulate and periodically release packets of bed material. Interactions with such storage reservoirs are hypothesized to cause large bed-material pulses to disperse by fragmenting into multiple smaller pulses. As a refinement to the conceptual model that views sediment pulse evolution in terms of dispersion and translation, the concept of pulse fragmentation has practical implications for gravel management. It implies that gravel augmentations can produce morphologic changes at locations that are separated from the augmentation point by arbitrarily long reaches, and it highlights the dependence of pulse propagation rates on the nature and distribution of the bed-material storage reservoirs in the channel system. [299 words]

Presentation type: Oral Presentation

ES06-06 Assessing Hydrogeomorphic Adjustment in Urban Hybrid Channel Restoration Projects: Highland Creek, Toronto, Ontario

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Abstract
Stream degradation in urban systems has increased the need for stream restoration and erosion control. Numerous stream restoration approaches exist, ranging from hard-amouring or engineered approaches, usually employed in areas with space constraints, to softer bioengineering and 'natural' channel design approaches where the required planform and potential migration can be accommodated. In many confined urban landscapes, limited area is available to accommodate the size of channel and related planform requirements for 'natural' approaches. Especially given that channel enlargement tends to accompany increases in imperviousness. Hybrid restoration techniques are often utilized in urban watersheds where 'natural' channel design approaches cannot be accommodated. These interventions are expensive and given their relatively recent introduction as part of urban river management their long-term 'success' is not well documented. Understanding possible post-implementation adjustments provides insight into urban river processes and the potential for this approach as a tool for urban river management. Historical photo analysis (1999-2015) and design element surveys were completed for hybrid restoration projects in Highland Creek; a heavily urbanized watershed in Toronto, Ontario, Canada. The most commonly observed adjustments included channel degradation, outflanking of grade control, and channel widening. The findings provide insight that will improve future restoration approaches. [197 words]

Presentation type: Oral Presentation