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Improvements to the Rapid Geomorphic Assessment for Preliminary Evaluation of Channel Stability

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Relevant idioms





Outline

1. RGA Refresher
2. Expressions of Concern
3. Proposed (Interim) Improvements
4. Pilot Application in Ottawa





1. RGA Refresher





Introduction/Refresher



- Rapid Geomorphic Assessment (RGA) – Field-based method for preliminarily evaluating channel stability and sensitivity to disturbance in association with land development planning (MOE, 2003)

- Profound influence on management of natural channel systems in Ontario:
 1. Identification of **most sensitive reaches** prior to estimation of their **erosion thresholds** as an input to **stormwater management criteria**
 2. **Prioritization** of reaches for municipal **erosion risk mitigation** and **habitat restoration** initiatives
 3. **Monitoring** of changes in channel stability over time



RGA Summary

- Checklist
- 4 modes of adjustment
 - Aggradation, degradation, widening, planimetric form adjustment
- Geomorphic indicators
 - Present, absent or N/A
- Index scoring
 - Variable weights based on applicable indicators

FORM/ PROCESS (1)	GEOMORPHIC INDICATOR		PRESENT		FACTOR
	NO (2)	DESCRIPTION (3)	NO (4)	YES (5)	VALUE (6)
Evidence of Aggradation (AI)	1	Lobate bar			
	2	Coarse material in riffles embedded			
	3	Siltation in pools			
	4	Medial bars			
	5	Accretion on point bars			
	6	Poor longitudinal sorting of bed materials			
	7	Deposition in the overbank zone			
		SUM OF INDICES			
Evidence of Degradation (DI)	1	Exposed bridge footing(s)			
	2	Exposed sanitary/storm sewer/pipeline/etc.			
	3	Elevated stormsewer outfall(s)			
	4	Undermined gabion baskets/concrete aprons/etc.			
	5	Scour pools d/s of culverts/stormsewer outlets			
	6	Cut face on bar forms			
	7	Head cutting due to knick point migration			
	8	Terrace cut through older bar material			
	9	Suspended armor layer visible in bank			
	10	Channel worn into undisturbed overburden/bedrock			
	SUM OF INDICES				
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.			
	2	Occurrence of large organic debris			
	3	Exposed tree roots			
	4	Basal scour on inside meander bends			
	5	Basal scour on both sides of channel through riffle			
	6	Gabion baskets/concrete walls/etc. out flanked			
	7	Length of basal scour > 50% through subject reach			
	8	Exposed length of previously buried pipe/cable/etc.			
	9	Fracture lines along top of bank			
	10	Exposed building foundation			
	SUM OF INDICES				
Evidence of Planimetric Form Adjustment (PI)	1	Formation of cufe(s)			
	2	Single thread channel to multiple channel			
	3	Evolution of pool-riffle form to low bed relief form			
	4	Cutoff channel(s)			
	5	Formation of Island(s)			
	6	Thalweg alignment out of phase meander form			
	7	Bar forms poorly formed/reworked/removed			
	SUM OF INDICES				
STABILITY INDEX (SI) = (AI + DI + WI + PI) / m					





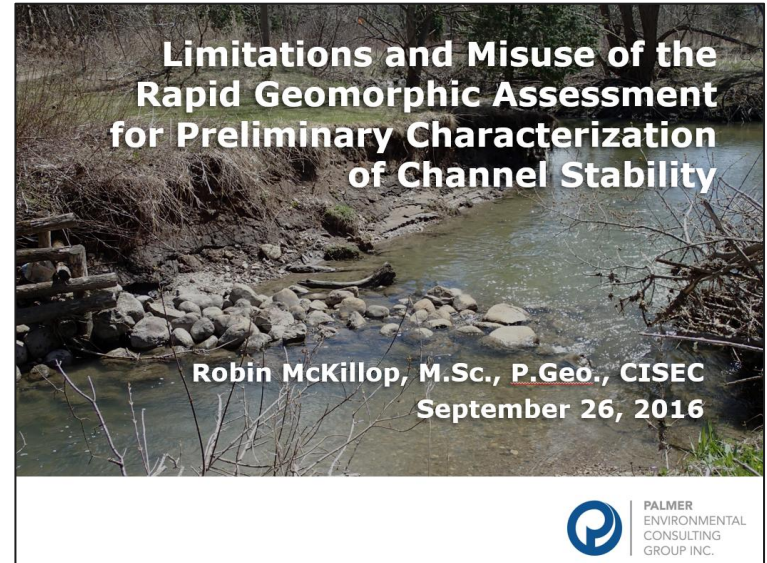
2. Expressions of Concern





McKillop (2016) – Natural Channels Systems Conference 2016

- Limitations
 - Unsound statistics
 - ~~Allowance for contradictory processes~~
 - Importance of calibration
- Misuse
 - Inappropriate watercourse application
 - Unclear representation of planimetric form adjustment
 - Over-assignment of indicators





Papangelakis et al. (2023a)

- Global review of river assessment procedures, including RGAs
- Key findings:
 - Lack of **historical context** and **legacy** conditions
 - Lack of **sediment** source and transport considerations, including longitudinal connectivity
 - Criticality of **training** for meaningful results
 - Importance of **reach selection** (prior presentation by Mike and Kelsey!)

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RESEARCH ARTICLE

Measuring geomorphology in river assessment procedures 1: A global overview of current practices

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Abstract
Despite geomorphic processes being increasingly recognized as a vital component of river management projects, evidence suggests that they may not be adequately captured in common river assessment procedures. We reviewed 91 river assessment procedures from around the world to evaluate their effectiveness in capturing geomorphic processes relevant for river management goals. Our objectives were to summarize which common geomorphic indicators are measured and how in different types of river assessments categorized based on their main focus: geomorphic, physical habitat, mixed geomorphic and habitat, and hydromorphology. Our analysis identified differences in the types of geomorphic indicators included and measurement methodologies between the types of assessment procedures. Some geomorphic processes, such as sediment transport, are nearly completely absent from all assessments, despite their importance for geomorphic processes. The variability among assessment procedures suggests that a single procedure is unlikely to capture all geomorphic components required to support every river management program. Here, we discuss how the strengths and limitations of different assessment types can be used to guide decisions around how to select assessments and geomorphic indicators to support management project goals. A companion paper expands the discussion of how to plan effective river assessment procedures to support unique management goals.

stream assessment, geomorphic indicators, river management

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Papangelakis et al. (2023a)

- “The near universal use of predesigned assessment procedures...runs the risk of both **missing important geomorphic processes** and simultaneously gathering additional **information that may not be useful** for a given management context.”
- “The **training** of the people carrying out the assessment is an important consideration because many aspects of the assessments rely on **visual, subjective inspections** of the **presence/absence** of certain features in the field (e.g., the rapid geomorphic assessment) or when interpreting desktop data....Therefore, **adequate training and consistency** among the personnel conducting assessments is **imperative** for producing **meaningful assessments** of geomorphic conditions.”

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KEYWORDS
river assessment, stream assessment, geomorphic indicators, river management

1 | INTRODUCTION

Globally, river assessments have been used to understand the condition of river systems, identify potential management or restoration paths, and monitor responses to interventions (Fryirs, 2015). The inherent spatial and temporal complexity of river systems, as well as differences in local, regional, and international policies, has led to a large number of assessment procedures that either focus on specific aspects of the river

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Discussions are open until six months from publication.

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Papangelakis et al. (2023b)

- Companion document to 2023a, which outlines an objectives-based framework for choosing and refining river assessment procedures
- “Given the ever-evolving scientific understanding of fluvial systems, **river assessment procedures must be flexible and continually updated.** Accordingly, tools like **predesigned data sheets** and **measurement protocols** that provide a template for consistent measurement should only be **used critically** and with **appropriate and ongoing adaptive modifications.**”
- “We cannot understate the **importance** of...[**post-assessment QA/QC**]...and the importance of **continually adjusting appropriate indicators** and standard best practices because a **“poor evaluation is almost always worse than no evaluation”** (Rutherford et al., 2004) in that it gives a false sense of accomplishment without meaningful insights.

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RESEARCH ARTICLE

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Measuring geomorphology in river assessment procedures 2: Recommendations for supporting river management goals

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Funding information
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Abstract
Fluvial geomorphology, which describes the form and processes of rivers, is increasingly being incorporated into river assessment procedures. However, the complexity of geomorphic processes makes a single universal and standardized assessment protocol a challenging and possibly impractical task. In this paper, we present a set of recommendations for choosing appropriate river assessment procedures and measuring geomorphic indicators to effectively capture important geomorphic processes required to support river management goals. We outline steps for building a river assessment procedure based on an adaptive approach rather than a one-size-fits-all approach, where the geomorphic indicators, spatial and temporal scale, and methodologies used are carefully chosen based on the goals of the management project; the assessment aims to support. Guidance for choosing the appropriate geomorphic indicators is based on their significance (usefulness in characterizing the system), ease of measurement, and temporal scale needs. We also present recommendations on measurement techniques for each indicator while highlighting recent technological and methodological advancements that help overcome resource challenges often faced in river assessment. Given the wealth of scientific and technological developments in the field of geomorphology, it is possible to improve how geomorphic form and function are measured and incorporated into river assessments that support watershed management goals.

KEYWORDS
river assessment, stream assessment, geomorphic indicators, adaptive management

1 | INTRODUCTION

The assessment of river environments is commonplace worldwide, performed during many phases of river management projects and for a wide range of goals including establishing baseline conditions to inform future management decisions and channel designs, evaluating the

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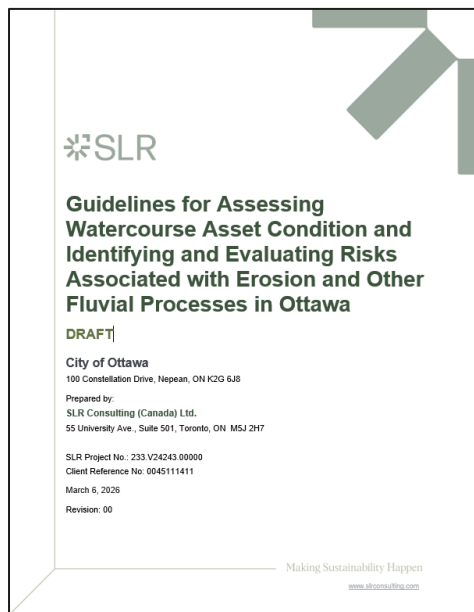
3. Proposed (Interim) Improvements





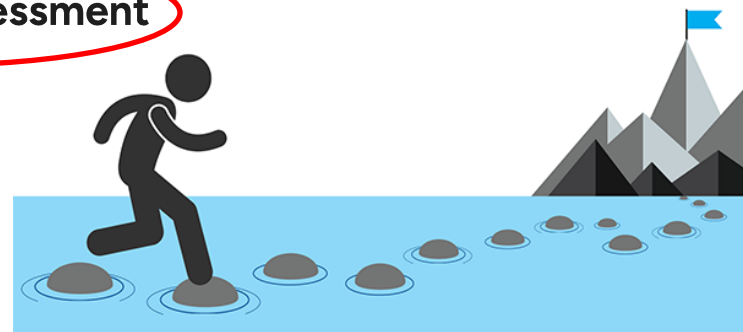
Opportunity through City of Ottawa project

- Development of new, standardized methodology for identifying and evaluating erosion-related risks along watercourses in Ottawa



Site-scale assessment

Reach-scale assessment





Modified RGA

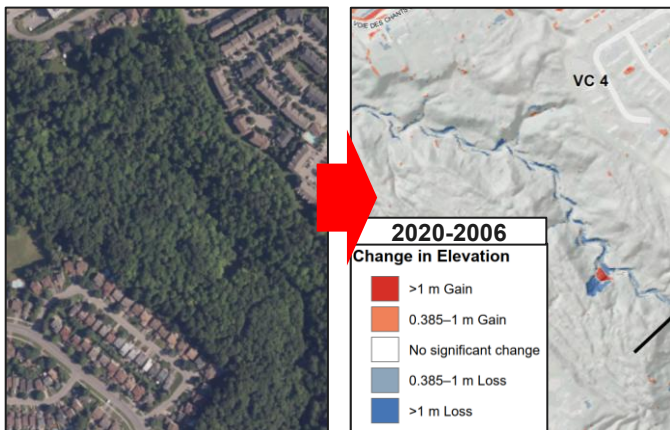
- Same general approach – categorized checklist with scored indicators
 - Modes of adjustment
 - Indicators
 - Index scoring & stability rating
- Targeted **desktop** interpretations
- **Temporal** considerations
- Illustrative procedural **schematics** and photographs!

Modes of Adjustment	Indicator	Strength of Indicator				Score
		0	1	2	3	
Evidence of Aggradation	Mid-channel Bars					
	Channel Infilling					
	Sum of Indices					/2
Evidence of Degradation	Abandoned (Suspended) Bed Material					
	Incision into Non-alluvial Substrate					
	Knickpoint(s)					
	Entrenchment					
	Bar Terracing					
Sum of Indices					/5	
Evidence of Widening	Paired bank erosion					
	Sum of Indices					/1
Evidence of Pattern Change	Change in channel threads					
	Change in sinuosity					
	Atypical, natural avulsion(s)					
	Thalweg out of phase with channel planform					
	Sum of Indices					/4
Reach Stability Score	Aggradation + Degradation + Widening + Pattern Change / m					
					Reach Stability Rating	Stable Stressed Unstable



Modified RGA

- What it doesn't (yet) include...
 - Historical/watershed context and legacy conditions
 - Sediment supply – surplus or starvation
 - Requirement for *direct* measurement – although encouraged!

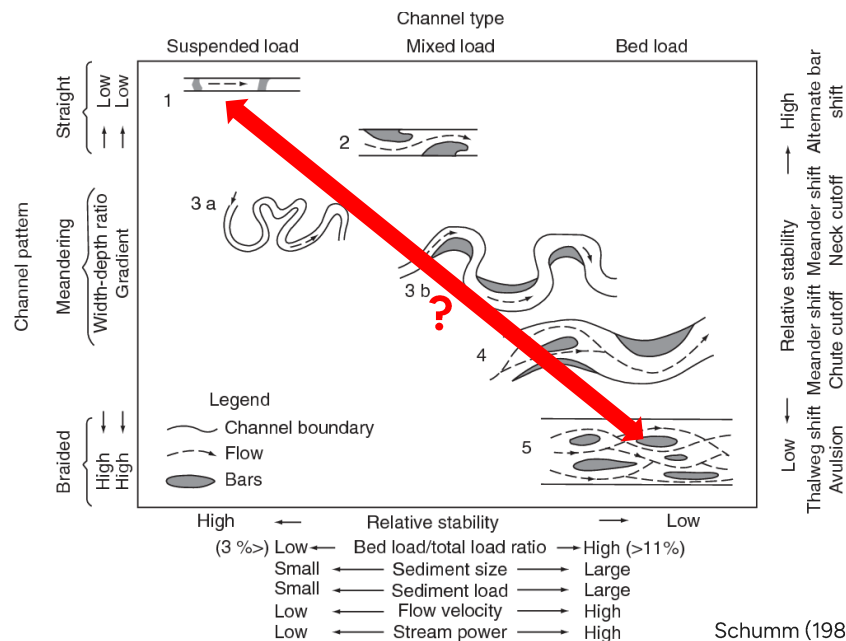


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	Sum of Indices					/4
Reach Stability Score	Aggradation + Degradation + Widening + Pattern Change / m					
					Reach Stability Rating	Stable Stressed Unstable



Modes of adjustment

- 3 of 4 remain the same: Aggradation, Degradation and Widening
- Reframing of 4th for methodological consistency: Planimetric Form Adjustment → **Channel Pattern Change**
- Dynamic equilibrium!...channel adjustment is not necessarily a form of morphological instability





Indicators

- Various modifications aimed at improving **morphological meaningfulness** and **consistency in evaluation**
 - Several similar indicators, but with 'tighter' definitions
- **Universal applicability** – All indicators at least broadly applicable to all reaches
 - Excludes interaction with anthropogenic features – for better (consistent applicability) or for worse (Thorne et al., 1996)
- **Strength of indicators**, based on guiding **determinants**, not just presence/absence





Determinants

- Strength of each indicator evaluated based on holistic consideration of one or more guiding **“determinants”**, each of which represents **continuum of strength**

- Temporal** considerations and implications



*“Recognizing adjustment processes in both space **and** time is essential...”
(Vermont ANR, 2009)*

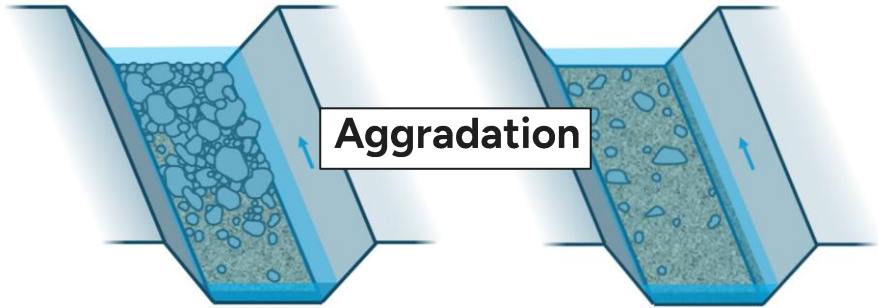
Evaluation of “Mid-Channel Bars” as an indicator of Aggradation

Determinant	Indicator Strength*				Notes
	Not present/ observed (0)	Weak (1)	Moderate (2)	Strong (3)	
Number of mid-channel bars	None observed	Rare bars	Occasional bars	Frequent bars	Consider comparison to other reaches
Size of mid-channel bars	None observed	Small bars (<50% channel width)	Mid-size bars (50-75% channel width)	Large bars (>75% channel width)	
Age of mid-channel bars	None observed	Narrow range in age of bars (e.g. single deposition event)	Middle range in age of bars (e.g. two deposition events)	Wide range in age of bars (e.g. three or more deposition events)	Consider similarities/differences in apparent timing of deposition, based on sediment freshness (e.g. organic cover, shrub establishment, staining)

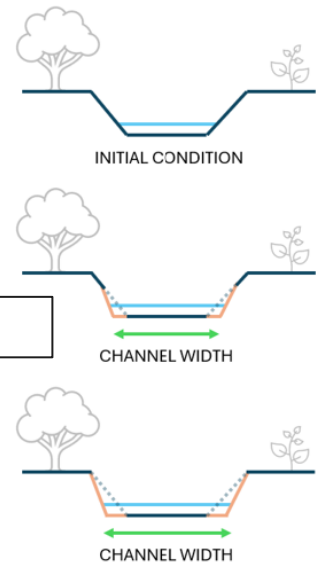


“Strong” indicator

Illustrative schematics and photos for improved consistency in evaluation



Widening

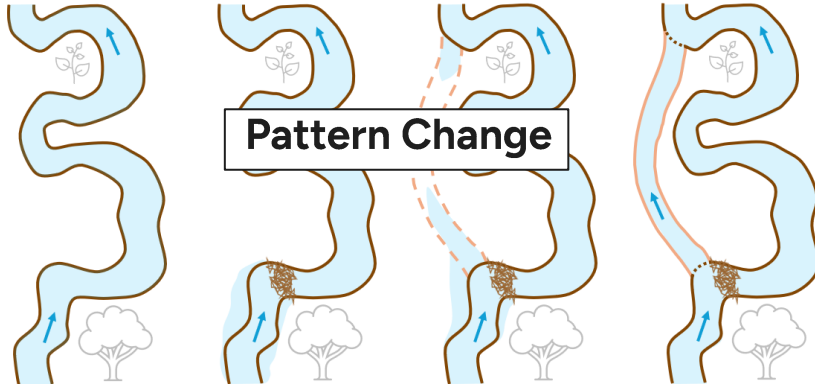


INITIAL CONDITION

BEAVER DAM CAUSES BACKWATERING

FLOW ROUTES OVER FLOODPLAIN

AVULSION CHANNEL FORMS



Degradation





4. Pilot Application in Ottawa



Bilberry Creek – Pilot Reach



Modes of Adjustment	Indicator ¹	Strength of Indicator ²				Score
		0	1	2	3	
Evidence of Aggradation	Mid-channel Bars	x				0
	Channel Infilling		x			1
	Sum of Indices					$(0+1)/2=0.5$
Evidence of Degradation	Abandoned (Suspended) Bed Material	x				0
	Incision into Non-alluvial Substrate				x	3
	Knickpoint(s)		x			1
	Entrenchment			x		2
	Bar Terracing		x			1
	Sum of Indices					$(0+3+1+2+1)/5=1.4$
Evidence of Widening	Paired bank erosion			x		2
	Sum of Indices					$2/1=2.0$
Evidence of Pattern Change	Change in channel threads		x			1
	Change in sinuosity		x			1
	Atypical, natural avulsion(s)			x		2
	Thalweg out of phase with channel planform		x			1
	Sum of Indices					$(1+1+2+1)/4=1.25$
Reach Stability Score	Aggradation + Degradation + Widening + Pattern Change/m					1.3
Reach Stability Rating					Stable Stressed Unstable	



Key Takeaways...and the Future

- RGA is a useful tool; however, legacy of use of current RGA does not justify continued use without improvements
 - Mismanagement of stormwater + misguided erosion mitigation/habitat restoration priorities + misleading monitoring results
- Proposed modifications to the RGA are just a step in the right direction – an *interim* improvement
 - More meaningful indicators + strength not just presence/absence of indicators + guiding determinants backed by illustrative schematics and photos
- Initial pilot application successful; additional testing planned before finalization and public release
- Always a need for Professional to undertake systematic QA/QC and help interpret results!





Questions?

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