

River classification and Management: An approach to Reading the Landscape

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Reading the Landscape: Integrating the theory and practice of geomorphology to develop place-based understandings of river systems. *Progress in Physical Geography* (2013), 37(5) 601–621

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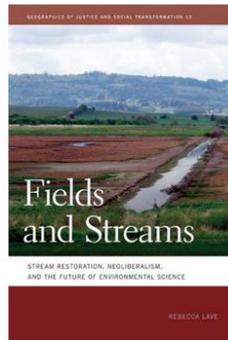
Some provocations to begin ...

- Given differing approaches to scientific enquiry, whose frameworks should be used to interpret landscapes?
- Should geomorphologists value quantitative applications over and above anything else, or is there space for a different kind of 'rigour' in landscape analysis?
- Are we learning about landscapes in the right way? Concerns for mastery learning based upon thinking and questioning rather than rote-learning applications (importance of critical thinking)

River classification: Theory, practice, politics

Marc Tadaki, Carola Cullum, Gary Brierley

- An emerging river classification industry?
- A key site of interdisciplinary practice and management applications
- Use of emerging technologies
- Emerging forms of governance are supported by – and made possible through - certain forms of biophysical knowledge



Rebecca Lave 2012

Theory - why classify rivers?

Classifications do 4 things (Melles et al. 2012):

1. Description and organization of knowledge (inductive generalization)
 - Extrapolate from particular to the general
2. 'Economy of memory', consistent spatial context for measurement and reference
 - Economy of monitoring
 - Economy of action
3. Easy to understand and use
4. Hypothesis testing

Theory - what can we classify?

- Physical, chemical and biological forms – diversity, area, boundaries (spatial)
- Flow and flux rhythms– shocks, continuity, equilibrium, etc (temporal)
- Ecological processes
- Habitat availability and viability
- Both are spatio-temporal, function oriented

NB – all are political!

What is being mapped?

- Cannot 'carve nature at its joints'
- The 'joints' are observer-dependent
- Want to understand and predict/foresight behaviour, therefore need to identify 'process domains'
- Need to specify entities to be mapped a priori, informing choice of scale and attributes
 - Under a complexity paradigm, we recognize that different attributes may have variable importance in different locations, since the same processes have different controls and drivers in different contexts
 - Interplay between theory and observation...

Theory meets practice

Consideration	Some alternatives
Classification aim	Typing - classify by (essential/explanatory) characteristics, e.g. braided river. Use similarity to explain/predict behaviour of others E/valuation - classify by achievement of a defined objective, e.g. ecological health status
Evidence	Field (survey) vs remote (GIS, DEMs, photos)
Resources	Data availability, disciplinary and methodological expertise, research questions and interest, funding, communities of practice
Institutional context	Styles of outputs, policy preferences, discursive vehicles

Emerging understandings under a complexity paradigm

- Complexity of landscape systems -multiple causalities, feedbacks, lags, thresholds, non-linearity, emergent properties
- Caution in the use of equilibrium principles
- Inherent uncertainty, often producing surprising and/or unpredictable outcomes (alternative states)
- 'Naughty worlds' (Kennedy, 1979)
- 'Perfect landscapes' (Phillips, 2007)
- New approaches to description and analysis are required ... geomorphic pluralism

Reductionism	Complexity paradigm
Static/at equilibrium	Range of variability
Will respond to 'disturbances' in predictable ways	Trajectory of change
Linear/predictable relationships	Non linear relationships ... emergence, contingency
Can engineer system if have sufficient knowledge	Irreducible uncertainty/unpredictability Surprises are expected

Reductionism	Complexity paradigm
Local differences in space/time are 'outliers', 'noise', 'complication'	Local differences may matter (a lot) History matters, context matters, neighbours matter...
Class members equivalent and interchangeable	Each location potentially unique
All members equally representative of the class	... so class members not interchangeable
Can extrapolate from sample/reference sites	...extrapolation can be dangerous!

Conventional and emerging approaches to river and landscape classification

- Standardized approaches to landscape classification sacrifice heterogeneity in order to generalize, treating landscape units as homogenous entities wherein all members of the same class are considered to be equivalent and interchangeable
- In these framings, all class members are treated as equally eligible candidates for sampling or monitoring sites, and knowledge and experience gained at these sites is assumed to apply equally well at all other sites in the same class
- But ... if management of biodiversity or geodiversity is an underlying goal, local 'noise' or 'complications' may represent the very attributes that we seek to protect (Fryirs and Brierley, 2009)
- Effective analysis of 'perfect' landscapes cannot be meaningfully formalized through prescriptive applications of 'checklist', 'tick-box' sets of rule-based procedures

Closed vs open-ended classifications

Prescriptive classes, designed to be universally applicable ... manages rivers as a series of 'norms'	Adaptable - can be place-specific and purpose driven, can be refined and developed as new knowledge and data become available
Closed (forces all situations into existing classes)	Open-ended (allows identification of new types)
Strict set of measurement tasks to describe landscape form	Divergent set of measurement tasks, framed around process-based considerations for differing archetypes. Recognizes that different measures are pertinent for different types of landscape.
Top-down, imposed scientific (technical) application	Adaptive management focus, with commitment to ongoing maintenance and learning

Practices of classification

How is river classification *done*?

Four examples:

- Systematic conservation planning (everywhere)
- River Habitat Survey (UK + EU)
- Natural Channel Design (US)
- River Styles Framework (Aus)

Systematic Conservation Planning (biodiversity/conservation value)

- Data – field surveys, monitoring, GIS, modelling (indicators, environmental surrogates)
- Reduce to key relationships
- Develop functions to optimise for particular attributes (eg biodiversity, fish habitat viability)

‘Our methods did not consider connectivity or ecosystem functions provided by wetlands to other freshwater hydro-systems. Indeed, this artificial separation will have demoted some wetlands whose values stem in part from their contribution to an integrated network of freshwater protected areas’ (Ausseil et al. 2011)

- Aim to allocate conservation efforts – spatial optimisation
- OPTIMAL KINDS

River Habitat Survey (UK + EU)

- Data – proformas, filled out by paid surveyors
- National scale standardized on-the-ground survey
- Inductive approach
- Network of systematic measurements (but issues with consistency/accountability of observers)
- Perform national-level statistical analysis (regression obsession), using large n to add value to truth claims.
- **What are we choosing to measure, and how do we account for place?**
- INDUCTIVE KINDS

Natural Channel Design (Rosgen, US)

- Data – proforma, prescriptive application of handbook – classify rivers as A1, B3 etc
- Infers process from form
- Construct (engineering) interventions based on river class
- Surveyors are users (and ‘experts’)
- Strong uptake and institutionalization in U.S.
- **Issues with field classification, and static nature of classes, geographical context lost**
- PRESCRIPTIVE KINDS

River Styles Framework (Brierley and Fryirs, Australia)

- Data – open (theoretically informed) and systematic qualitative field description, remote sensing, photos, sedimentology, and others
- Uses form to infer process (river behaviour and change)
- Non-prescriptive – provides tools for understanding multiple possible action pathways, open hypothesis testing
- **Enables interpretation of geomorphic units *within reach and catchment context***
- PEDAGOGICAL KINDS

Contrasting approaches to river classification from engineering and geomorphic perspectives

Engineering (Rosgen)	Geography/Geomorphology (River Styles)
Hard (fixed) classification framework applied to designate river types	Soft classification framework based upon archetypes; flexible, adaptive, open-ended (enables identification of new types)
Universal	Place-specific
Framed in relation to mechanistic applications of deterministic (positivist) cause and effect science, building upon theoretical insights derived from experimental procedures performed under controlled conditions and empirical field-based relationships	Informed by real world understandings of river diversity and variability framed in relation to theoretically-derived principles. Recognizes that landscapes are emergent, non-linear, uncertain phenomena that are not amenable to reductionist explanations. Explicit recognition of the value-laden nature of scientific enquiry.
Strict set of measurement tasks to describe river morphology	Divergent set of measurement tasks, framed around process-based considerations for differing archetypes. Recognizes that different measures are pertinent for different types of river.

Contrasting approaches to river classification from engineering and geomorphic perspectives

Engineering (Rosgen)	Geography/Geomorphology (River Styles)
Emphasizes systematic appraisal of morphologic attributes related to environmental controls (slope, discharge, entrenchment, etc)	Framed in relation to morphodynamics (process-form) attributes of assemblages of geomorphic units at the reach scale. Propensity to overlap is acknowledged. Reach boundaries may adjust.
Reference condition (stability focus)	Range of acceptable states – recognizes evolutionary adjustments and prospects for threshold-induced change in some settings
Reach-based; rigid boundaries	Catchment-scale; contextual; flexible boundaries
Concern for stability under assumed conditions of flow/sediment continuity	Recognition of natural range of variability framed in relation to capacity for adjustment, and differing evolutionary trajectories reflecting the contingent and emergent nature of any given catchment

Contrasting approaches to river classification from engineering and geomorphic perspectives

Engineering (Rosgen)	Geography/Geomorphology (River Styles)
Technical application, with a construction focus (soft-engineering whenever possible)	Framed in broader socio-cultural and institutional context working alongside managers and practitioners, considering the range of options from hard to soft engineering to the do nothing (leave it alone) option
Top-down, imposed scientific (technical) application, with limited regard for long-term monitoring	Adaptive management focus, with commitment to ongoing maintenance and learning

Conclusion: From natural to political kinds

Not merely describing, but embedding value-politics into our toolkits and enacting them into circulation

Not just 'how good is my river classification', but 'how is it constitutive and productive of social, institutional and political kinds?'

Landscape and river classification under a complexity paradigm: The use of archetypes to assess where, when and how local differences matter

Carola Cullum, Kevin Rogers and Gary Brierley

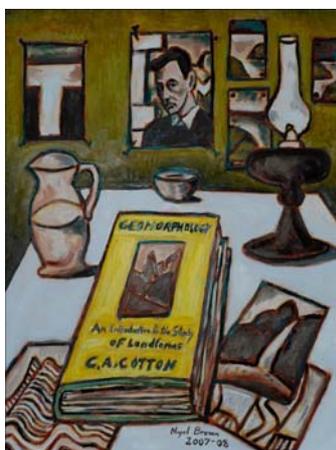
- Fuzzy representations are more 'realistic' than crisp classifications
- Local 'mental models', linking form and process
- Embrace variability and local differences (which complexity theory teaches us can be very important)
 - Range of variability around the archetype (seasonal differences, flood, transition zones, etc)
 - Spatially explicit local heterogeneity
 - Classifications contain information about heterogeneity
 - Use to refine classification
 - Assess boundaries
- Can extrapolate with care, mediating between the general and the particular

A small digression: Geomorphology and landscape art in New Zealand

Grandfather of geomorphology in New Zealand was Charles Cotton

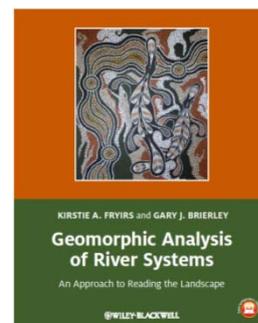
Representation of his work by Colin McCahon

One of his student's was Nigel Brown ...



Reading the Landscape

- Fryirs, K. and Brierley, G.J. 2013. *Geomorphic Analysis of River Systems. An Approach to Reading the Landscape*. Blackwell, Oxford, UK.
- A scaffolded, open-ended set of questions that can be used to identify landforms, assess their morphodynamics and interpret their interactions, evolution and likely future trajectories



Read these landscapes



Premises of 'Reading the Landscape'

- Meaningful characterization and description underpin effective interpretation and explanation, providing baseline information with which to foresight likely future states
- Use of detective-style investigations to differentiate among factors that affect landscape character, behaviour and evolution
- Our approach to 'Reading the Landscape' is a vehicle, rather than a guidebook, with which to operationalize geomorphological interpretations and understandings of landscapes

What is 'Reading the Landscape'?

- A basis for scientifically informed management efforts that respect and work with the inherent diversity and dynamics of any given river system
- A scaffolded framework of field-based interpretations that explicitly recognizes the contingent nature of biophysical interactions within any given landscape
- A bottom-up, constructivist approach that can be used to:
 - identify landforms
 - assess their morphodynamics, and
 - interpret the interaction and evolution of these features at reach and catchment scales
- A framework of questions, not a framework of answers: An open-ended and generic set of questions that inform process-form interpretations of river landscapes

Expert and local knowledges

- Instinctive and intuitive understandings (training and experience) of 'experts' – an 'innate morphologic eye' for form and pattern (Sauer, 1956)
- Need to frame scientific understandings alongside local knowledges to appropriately inform management practices

Four steps of 'Reading the Landscape'

Step 1: Identify individual landforms (geomorphic units) and interpret the process-form relationships that determine their process regime

Step 2: Analyse and interpret the assemblage of landforms at the reach scale and how they adjust over time

Step 3: Explain controls on the package and assemblage of landforms at the reach scale and how they adjust over time

Step 4: Integrate understandings of geomorphic relationships at the catchment scale

Implications

- Landscapes are not merely observed but are 'invented' (cf. Kennedy, 2006)
- Everything is contextual ... each catchment has its own geography and history
- Recognizing that there are multiple interpretations of landscapes, how can we best use available approaches and understandings to reliably inform management applications?
- Providing a formal statement of procedures with which to 'read a landscape' makes the approach transparent and therefore open to debate, thereby facilitating critical and robust analysis and transfer of knowledge
- Prospect to 'make the world differently' ...

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