Adapting water governance in river basins to climate change: archetypical barriers

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River basin governance and adaptation

- Governing interdependence and collective action in river catchments for a static climate (e.g. Ostrom 1990, Saleth and Dinar 2008, Paavola 2010, Libecap 2011, Garrick et al. 2013)
  - Upstream-downstream externalities, variability in time, …
- Climate change affects collective action in river basins
  - Changing frequency and intensity of floods and droughts
  - Modifications of the hydrological cycle
  - …

➢ River basin adaptation research (e.g. Huntjens et al. 2012, Pahl-Wostl and Knieper 2014, Schlager and Heikkila 2011), but not much from a perspective on barriers to adaptation

➢ When do institutions (not) change in response to ongoing exogeneous trends?

Barriers to adaptation: state of the art

(Eisenack et al. 2014)

- Conceptualizations (Moser & Ekstrom 2010, Eisenack & Stecker 2012, Biesbroek et al. 2013)

  A 'barrier to adaptation' is (1) an impediment (2) to specified adaptations (3) for specified actors in their given context that (4) arise from a condition or set of conditions. A barrier can be (5) valued differently by different actors, and (6) can, in principle, be reduced or overcome.

- Many case-specific narratives (e.g. Burch 2010, Inderberg 2011, Jones & Boyd 2011, Krellenberg 2012, Vine 2012, Lehmann et al. 2013, …)
- Generic typologies (e.g. Adger 2009)
- Descriptive lists of *which* barriers emerged (e.g. Lorenzoni et al. 2007, Biesbroek et al. 2011)
- "Overcoming barriers": Ad hoc assumptions about how barriers come about

- Open issue
  - ➢ How to compare across cases in order to explain barriers?

Explaining barriers to adaptation

- Identifying repeated institutional patterns that bring about barriers
- Meta-study design with focus on river basins all over the world

Adaptation to climate change

- “Adaptation” refer to all actions the moderate harm or (exploit benefits) from climate change (typically on the local level)
- Stimuli from climate change affect diverse exposure units (within diverse contexts) in diverse ways, likely requiring different responses
- Ineffectiveness of climate protection requires adaptation to climate change

Methodology

Case study selection

1. Peer reviewed, English (1990-Juni 2015)
2. Topic (Keywords with synonyms)
   - Climate, adaptation, barriers
   - Rivers, inland waters
   - No other geographical restrictions
3. Content
   - Excluded if only: lakes, wetlands, irrigation systems
   - Based on primary data
   - Contains causal statements about barriers
   - Description of collective action issues

N=26

Semi-open coding of models

1. Identifying causal statements about barriers ("models", n=114)
2. Starting with first tier variables of SES framework (Oberlack 2014, based on Ostrom 2007)
3. Iterative refinement and development of a code system with higher tier variables
4. Inter-rater reliability checks

Formal concept analysis (FCA)

1. Objects: 114 models
2. Attributes: 141 codes
3. Compute re-occurring attributes to identify archetypes
4. Select those that occur at least 3 times and in at least 2 papers

More methodological detail…

Snapshot of 21 identified archetypes

Mech. 1: Coordination gaps (32 models)		
1.1	High transaction costs due to scattered responsibilities	I3-GS21
	… and heterogenous interests about water services	I3-GS21-A22
	… and limited horizontal coordination	I3-GS21-GS42
1.2	High transaction costs due to limited horizontal coordination	I3-GS42
	… with heterogenous interests and upstream-downstream externalities	I3-GS42-A22-RS12
1.3	High transaction costs due to limited vertical coordination	I3-GS41
	Insufficient reason due to …	I1-GS41
1.4	High transaction costs due to limited trust	I3-A25
	… and concurrent stimuli	I3-A25-RS5
1.5	Limited control of operator due to limited control in polycentric system	I4-GS31

Mech. 4: Uncertainties (21 models)		
4.1	Constrained capacity due to limited understanding of SES	I2-A12
	High transaction costs due to …	I3-A12
	Stalled social learning due to …	I5-A12
4.2	Constrained capacity due to limited understanding of climatic stimulus	I2-A13
	Insufficient reason due to …	I1-A13
	Co-occurrence of limited understanding of SES and of climatic stimulus	A12-A13

Mech. 2: Path dependencies (25 models)		
2.1	High transaction costs due to secure property rights with fixed allocations	I3-GS241a
2.2	Stalled social learning due to rules based on historical hydrology	I5-GS234b
	… and limited understanding of climatic stimulus	I5-GS234b-A13
	… and limited understanding of climatic stimulus and of SES	I5-GS234b-A13-A12
2.3	Stalled social learning due to slow procedures for institutional change	I5-GS91
2.4	Insufficient reason due to path dependency in agency	I1-A16
	High transaction costs due to …	I3-A16

Mech. 5: Competing priorities (20 models)		
5.1	Insufficient reason due to incompatible institutional incentives	I1-GS23
5.2	Insufficient reason due to concurrent stimuli	I1-RS5
5.3	Insufficient reason due to limited awareness of climate change	I1-A111
5.4	Insufficient reason due to perception of climate change as a future problem	I1-A15
5.5	Insufficient reason due to heterogenous interests about priority of adaptation	I1-A23

Mech. 3: Zero-sum games (24 models)		
3.1	High transaction costs due to heterogenous interests about water services	I3-A22
	Insufficient reason due to …	I1-A22
	… and high costs of adaptation	I1-A22-AO4
3.2	High transaction costs due to externalities of the adaptation option	I3-AO1
	… and top-down-decision-making	I3-AO1-GS44
	… and uncertain consequences of adaptation option	I3-AO1-AO2
	… and co-occurrence of heterogenous interests about water services	A22-AO1

Mech. 6: Tangible constraints (19 models)		
6.1	Constrained capacity due to financial constraints	I2-A31
	… in the presence of existing adaptation deficits	I2-A31-RS6
	… and poor coordination of data	I2-A31-GS421
	… and due to high transaction costs	I2-I3-A31
	… and limited understanding of SES	A31-A12
6.2	Constrained capacity due to limited information	I2-A41
6.3	Constrained capacity due to staff constraints	I2-A51

Zooming into archetypes…
[2.1]: secure water rights with fixed allocation

- Appears in 4% of models, 12% of papers
- Water rights guarantee extraction level for upstream users
- Climate change: Downstream users receive less during droughts
  - Downstream users need to challenge rights
  - Limited adaptation options downstream, little incentives upstream
- Difficult to change under the rule of law

Zooming into archetypes… [2.2]: hydrological standards

- Appears in 4% of models, 15% of papers
- River basin management frequently based on institutionalized runoff statistics of historic hydrology
- Climate change: statistics become systematically outdated
  - Adjustments of statistics taking projections into account?
  - Management procedures adequate for non-stationary statistics?
- Frequently co-occurring with [4.1], [4.2], relating to uncertainty
- Hydrological standards as institutions to legitimize decisions under uncertainty; institutional change not easy

Conclusions

- Case heterogeneity indeed overwhelming (in substance)
- Some archetypes reappear

  (although frequency is a limited metric here)
  - e.g. stationary hydrological standards
  - e.g. rigid water use rights
  - e.g. externalities created by adaptation options
- Typical limitations of a meta-study
- Use identified archetypes to guide
  - Selecting and conducting in-depth case studies
  - Designing focused comparative case studies
  - Designing large-N analyses to establish relevance and causality

Thank you for your attention!

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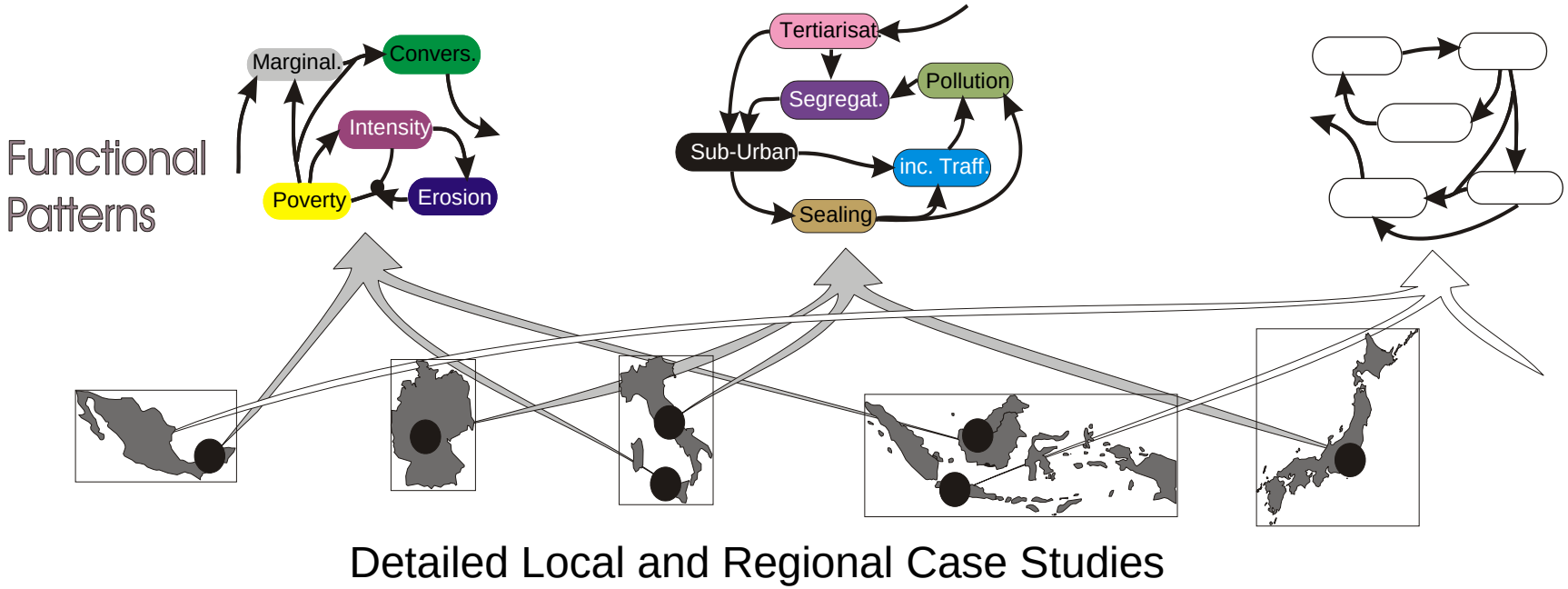
Archetypes…

Archetypes

Approach: identifying archetypical patterns



- **Decomposes barriers into sets of re-appearing patterns**
- **Patterns need not appear in the complete universe of cases**
- **There might be a whole suite of archetypes**
- **In some cases, multiple pattern can appear**

Motivation

- Some typical characteristics of case-based research
  - Small to medium number of cases
  - Large heterogeneity of cases' properties
  - No panacea for sustainable governance available
- Challenges
  - Not getting lost between trivial overgeneralization and ideographic trap
  - How can we move from descriptive to explanatory analysis?
  - How can we produce transferable knowledge for practice?

Overarching Issues

1. Aim for an intermediate degree of generality
2. Aim for an intermediate level of abstraction
3. Accept building blocks that only partially explain relations

Simple example: tools in a workshop

1. It contains multiple tools (as there is no tool that solves all problems)
2. Tools can be arranged in meaningful boxes or packages (simplifies order as they are needed for similar tasks)
3. Frequently, tools from multiple packages need to be used in combination

Archetype Analysis: setup

- Consider cases and their attributes
  - “Diagnostic attributes” characterize biophysical, technical and socioeconomic conditions of cases
  - “Design attributes” characterize institutional and technical arrangements that may be modified or created
  - “Outcome attributes” characterize present or expected future effects (possibly normative)

	Attributes (artifical example)									
case	diagnostic				design			outcome		
	a	b	c	…	d	e	…	f	g	…
1	✓				✓					
2		✓				✓				
3	✓	✓			✓	✓		✓		
4	✓		✓						✓	
…										

Archetype Analysis: definitions

An archetype is an implication with one of these forms

1. **Positive:** *For all cases of a specific subset [A]: if the diagnostic attributes [abc] and the design attributes [def] hold, then the outcome attributes [ghi] are expected*
2. **Normative:** *For all cases of a specific subset [A]: if the diagnostic attributes [abc] hold and the outcomes [ghi] are intended, then the design attributes [def] are recommended*
3. **Abductive:** *For all cases of a specific subset [A]: if the outcome attributes [ghi] are observed and the design attributes [def] hold, then the diagnostic attributes [abc] are inferred*

- Observe
  - Archetypes need not hold for the complete universe of cases
  - There might be a whole suite of archetypes
  - Multiple archetypes can apply to a single case

Archetype Analysis: stylized example

	Attributes								
Day	diagnostic				design			outcome	
	rainy	cold	windy	…	umbrella	pullover	…	comfortable	…
1	✓				✓			✓	
2		✓				✓		✓	
3	✓	✓			✓	✓		✓	
4	✓		✓						
…									

- Some (positive) archetypes in the example:
  - “If its raining and people use an umbrella, then they feel comfortable”
  - “If its cold, and people wear a pullover, then they feel comfortable”
- “rainy & umbrella” applies to 1, 3, but not to 4
- Both “rainy & umbrella” and “cold & pullover” apply to 3

Archetype Analysis: abstraction of cases

- Abstraction of cases: simple design recommendations may become invalid

	Attributes						
Day	diagnostic				design		
	rainy	cold	windy	…	umbrella	pullover	…
Plan for a weekend 1	✓				✓		
Plan for a weekend 2		✓				✓	
Plan for a weekend 3	✓	✓			✓	✓	
4	✓		✓				
…							

Archetype Analysis: abstraction of attributes

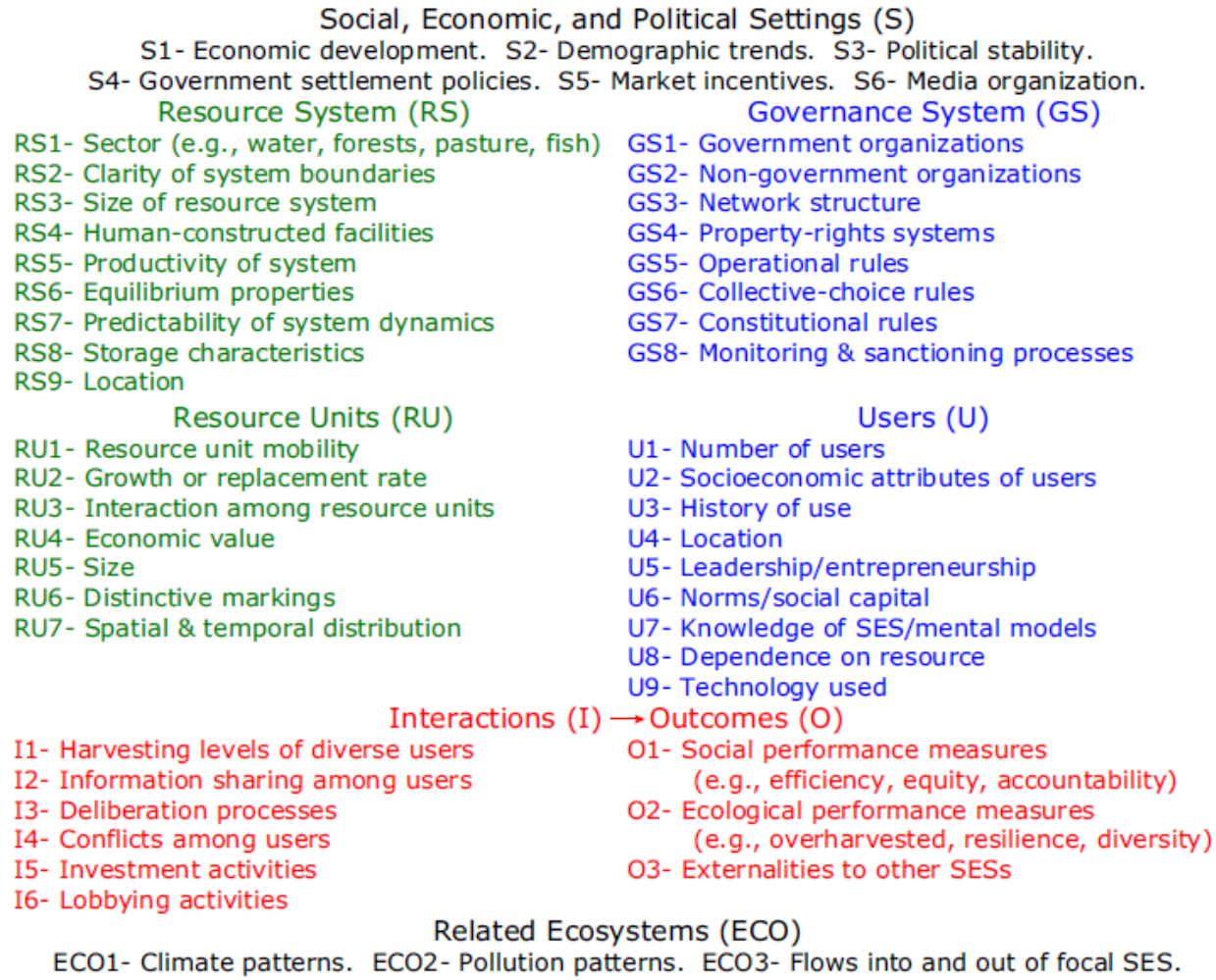
- Abstraction of attributes: may become less meaningful

	Attributes						
Day	diagnostic				design		
	rainy	cold	windy	…	umbrella	pullover	…
1	✓				✓		
2		✓				✓	
3	✓	✓			✓	✓	
4	✓		✓				
…					**“take package”**		

Coding

Starting point for coding

- **SES framework to characterize models**
- **"Models" are "statements that credibly claim scientifically and empirically justified results about the occurrence of a barrier"**
- **Variables that describe the model can be refined to higher tiers to capture relevant detail**



(Ostrom 2007)

Final coding system (second tier and some more detail)

Resource System

RS1- size and scale
- RS1.2 (upstream-downstream effects)

RS2- stimuli and exposure
RS3- current state of resource system
RS4- built infrastructure
RS5- concurrent stimuli
RS6- adaptation deficit

Adaptation Option

AO1- leads to externalities
AO2- with uncertain consequences
AO3- long lead times
AO4- high costs
AO5- reliance on technical measures

Governance System

GS1- participation
GS2- rights and responsibilities
- GS2.1 fragmented responsibilities
- GS2.3.4b rules based on historic hydrology
- GS2.3 institutional incentives / other
- GS2.4.1a secure property rights

GS3- institutionalized control
- GS3.1 limited control in polycentric system

GS4- social connectivity
- GS4.1 limited vertical coordination
- GS4.2 limited horizontal coordination
- GS4.21 poor coordination of data

GS5- conflict resolution mechanisms
GS6- social learning
GS7- accountability
GS8- scale of institutions
GS9- adaptiveness of institutions
GS10- formality of institutions

Actors

A1- individual knowledge, beliefs, preferences
- A1.11 low awareness
- A1.2 limited understanding auf SES
- A1.3 limited understanding of climate stimulus
- A1.5 low priority compared to other issues

A2- heterogeneous interests
- A2.2 about water services
- A2.3 about priority of adaptation
- A2.5 limited trust

A3- access to material resources
- A3.1 financial constraint

A4- access to information
- A4.1 limited information

A5- staff resources
- A5.1 limited staff capacity

Interactions

I1- insufficient reason
I2- constrained capacity
I3- high transaction costs
I4- control
I5- stalled social learning

FCA

Formal concept analysis (FCA)

- Qualitative knowledge representation and inference algorithms, developed in mathematics (Ganther & Wille, 1999)
- Input: Table of 'objects' and their attributes
- Here: objects=models; attributes=SES vars
- Computer-generated output
  - Output 1: 'concept lattice' (puts more general and more specific patterns into relation)
  - Output 2: implications, e.g. IF female AND child THEN girl
- One difference to QCA: algorithm only builds on valid attributes (not negated attributes), so less problems with missing data / case heterogeneity

	female	male	child	girl
Mia	X		X	X
Paul		X	X	
Clothilde	X			
Wilhelm		X