Berlin Workshop in Institutional Analysis of Social-Ecological Systems

IRI THESys
Transformations of Human-Environment Systems

Introducing the Socio-Ecological Systems Database (SESMAD): A tool for systematic SES case analysis and theory testing

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WINS Seminar, 5.11.2014

HUMBOLDT-UNIVERSITÄT ZU BERLIN

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Outline

1. Symptoms of a methodological problem
   - The challenge tackling SES complexity
   - The *too many variables*, *too many case studies* critique
   - The need to make theories dialogue with each other

2. SESMAD Part I: A relational database for single and comparative case analysis
   - Example 1: Governance of pollution in the Rhine
   - Example 2: 5 case case comparison

3. SESMAD Part II: A repository of environmental science theories

4. Closing remarks

2. Symptoms of a methodological problem

Multicausality, non linearities and equifinality

At any time a large number of factors may influence the outcome of a particular event, each one to a greater or lesser extent. At another time, the strength of those same causative factors on the same event may be very different

(Wilson 2001)

What is problematical about complex systems in this regard are their pervasive nonlinear causal relationships

(Holling, 1987)

Multiple conjuntural causation

(Ragin 1987)

CPR theory: 35 vars. and still…

TABLE 1 Synthesis of facilitating conditions identified by Wade (1994)—RW, Ostrom (1990)—EO, and Baland & Platteau (1996)—B&P

1) Resource system characteristics
   i) Small size (RW)
   ii) Well-defined boundaries (RW, EO)

How can research be conducted in a cumulative and rigorous fashion if this many variables need to be identified in every study?

(Agrawal 2003)

3) Institutional arrangements
   i) Rules are simple and easy to understand (B&P)
   ii) Locally devised access and management rules (RW, EO, B&P)
   iii) Ease in enforcement of rules (RW, EO, B&P)
   iv) Graduated sanctions (RW, EO)
   v) Availability of low-cost adjudication (EO)
   vi) Accountability of monitors and other officials to users (EO, B&P)

(1 and 3) Relationship between resource system and institutional arrangements
   i) Match restrictions on harvests to regeneration of resources (RW, EO)

4) External environment
   i) Technology: low-cost exclusion technology (RW)
   ii) State:
      a) Central governments should not undermine local authority (RW, EO)
      b) Supportive external sanctioning institutions (B&P)
      c) Appropriate levels of external aid to compensate local users for conservation activities (B&P)
      d) Nested levels of appropriation, provision, enforcement, governance (EO)

Agrawal (2001, 2003)

CPR theory: 35 vars. and still…

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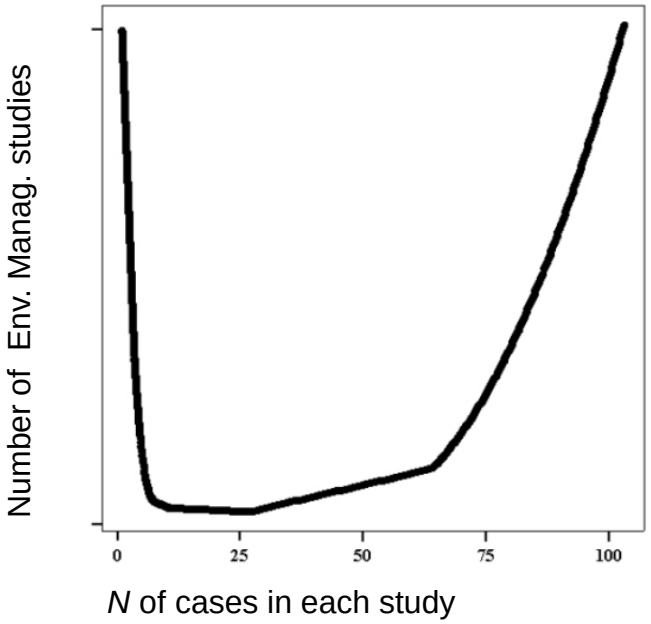
Need of frameworks that help organize variables and their relationships

Too many single case studies?

Ragin (2000)



Need of common measurement protocols that enable comparability across cases

Theoretical knowledge is scattered

- …across a wide range of fields, each with different theories (Turner II and Robbins 2008; VanWey, Ostrom and Meretsky 2005)
  - Evaluation of theories with regard to evidence becomes complicated
  - Empirical work becomes less efficient
  - Theoretical consolidation is hampered

Need of platforms that put theories in dialogue with each other and with evidence

SESMAD goals

Need of frameworks that help organize ***variables and their relationships***

Need of common ***measurement protocols*** *that enable comparability across cases*

Need of platforms that ***put theories in dialogue*** *with each other and with evidence*

2. SESMAD Part I:

A relational database for single and comparative case analysis

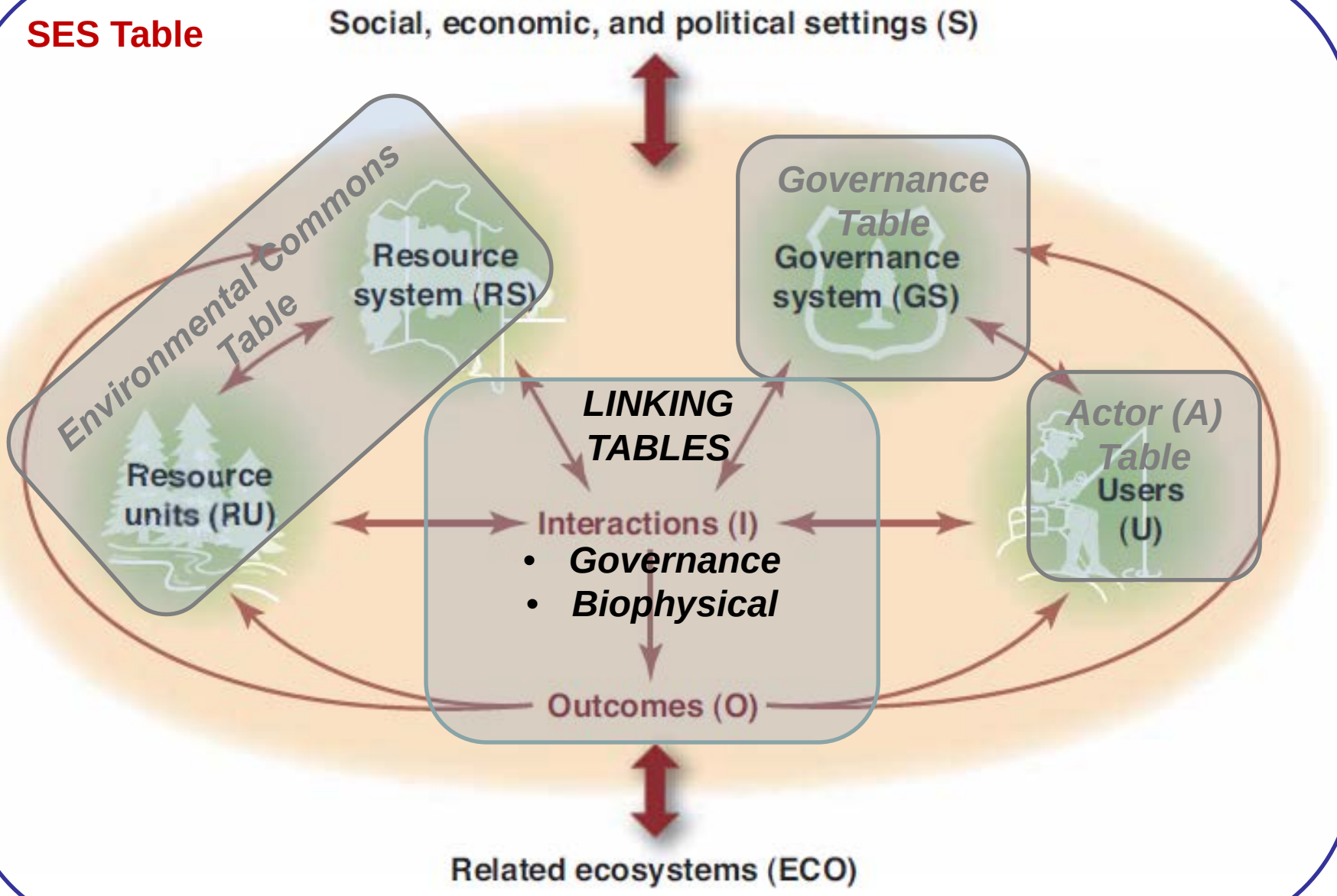
A collaborative project

Michael Cox	Dartmouth College, USA
Mike Schoon	Arizona State University, USA
Natalie Ban	University of Victoria, Canada
Chanda Meek	University of Alaska Fairbanks, USA
Forrest Fleischman	Dartmouth College, USA
Gustavo Garcia-Lopez	Puerto Rico Government
Brent Loken	Simon Fraser University, Canada
Frank van Laerhoven	Utrecht University, Netherlands
Graham Epstein	Indiana University, USA
Irene Perez Ibarra	Arizona State University, USA
Louisa Evans	James Cook University, Australia
Mateja Nenadovic	Duke University, USA
Andreas Thiel	Humboldt University, Germany
Sergio Villamayor	Humboldt University, Germany

SESMAD means

- A framework for consistent modelling of SES cases
  - SES Case: at least one environmental commons, governance system and actor group
  - Interactions: biophysical and *governance*
- A relational database

SES Table


Social, economic, and political settings (S)
Environmental Commons Table
Resource system (RS)
Resource units (RU)
Governance Table
Governance system (GS)
LINKING TABLES
Actor (A) Table
Users (U)
Interactions (I)
• Governance
• Biophysical
Outcomes (O)
Related ecosystems (ECO)

SESMAD means

- A framework for consistent modelling of SES cases
  - SES Case: at least one environmental commons, governance system and actor group
  - Interactions: biophysical and *governance*
  - Temporal frame (snapshot)

- A relational database
  - More than 150 general variables + project specific variables
  - Coding book

A tour around SESMAD

Variables

https://sesmad.dartmouth.edu/

Examples: *Can CPR theory scale up?*

International Journal of the Commons

HOME ABOUT LOGIN SEARCH CURRENT ARCHIVES FUTURE

Home > Vol 8, No 2 (2014)

International Journal of the Commons

Vol 8, No 2 (2014)

Special feature: Introducing SESMAD: The Social-Ecological Systems Meta-Analysis Database (Guest editor: M. Cox)

Special feature: Spatialities of the Commons (Guest editor: T. Moss)

Table of Contents

Introducing SESMAD: The Social-Ecological Systems Meta-Analysis Database (Guest editor: M. Cox)

Understanding large social-ecological systems: introducing the SESMAD project *Michael Cox*	abstract html pdf	265-276
Into the deep blue sea: Commons theory and international governance of Atlantic Bluefin Tuna *Graham Epstein, Mateja Nenadovic, André Boustany*	abstract html pdf	277-303
Evaluating the utility of common-pool resource theory for understanding forest governance and outcomes in Indonesia between 1965 and 2012 *Forrest D Fleischman, Brent Loken, Gustavo A. Garcia-Lopez, Sergio Villamayor-Tomas*	abstract html pdf	304-336
Governing the invisible commons: Ozone regulation and the Montreal Protocol *Graham Epstein, Irene Pérez, Michael Schoon, Chanda L Meek*	abstract html pdf	337-360
From Sandoz to Salmon: Conceptualizing resource and institutional dynamics in the Rhine watershed through the SES framework *Sergio Villamayor-Tomas, Forrest D. Fleischman, Irene Perez Ibarra, Andreas Thiel, Frank van Laerhoven*	abstract html pdf	361-395
Keeping the 'Great' in the Great Barrier Reef: large-scale governance of the Great Barrier Reef Marine Park *Louisa S. Evans, Natalie C. Ban, Michael Schoon, Mateja Nenadovic*	abstract html pdf	396-427
Governing large-scale social-ecological systems: Lessons from five cases *Forrest D Fleischman, Natalie C. Ban, Louisa S. Evans, Graham Epstein, Gustavo Garcia-Lopez, Sergio Villamayor-Tomas*	abstract html pdf	428-456

Example

- **Pollution in the Rhine** (Villamayor-Tomas et al. 2014)

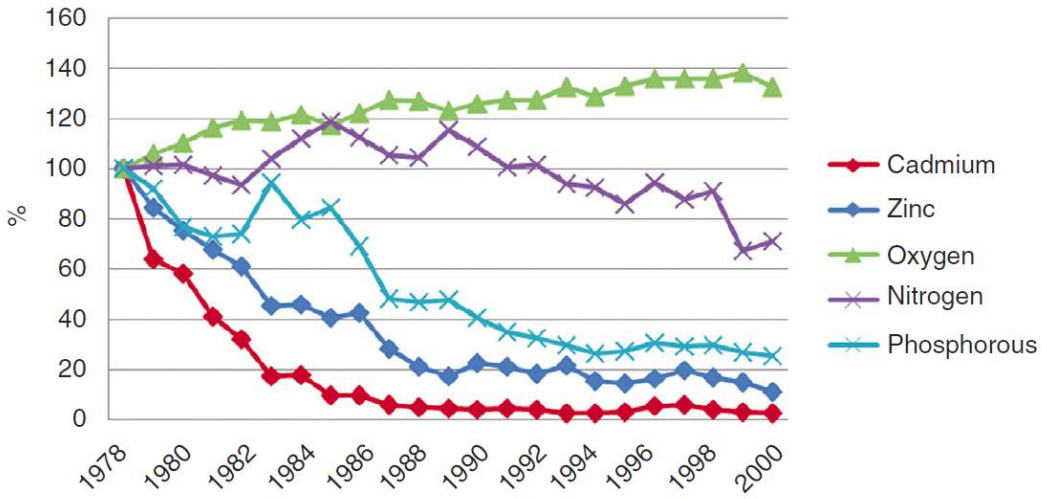
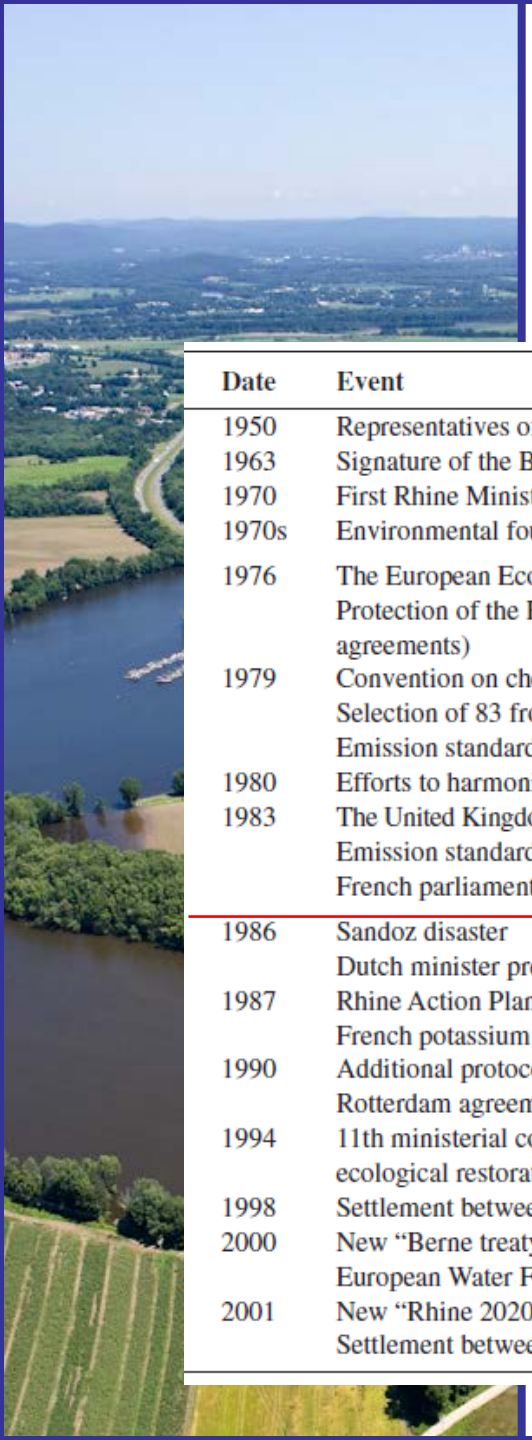


Figure 3: Changes in concentration levels of selected substances pre- and post-1986 (base year=1978).



Timeline

- Pollution in the Rhine

Date	Event
1950	Representatives of the Netherlands bring concern about pollution by Chlorides to the Salmon Commission.
1963	Signature of the Berne Convention and development of integrated monitoring system under new ICPR Secretariat.
1970	First Rhine Ministers Conference: negotiations to cope collectively with chlorides emissions from French potassium mines.
1970s	Environmental foundation *Reinwater* and a number of Dutch market gardeners sue French potassium mines.
1976	The European Economic Community (EC) joins the ICPR European Dangerous Substances Directive (76/464/EEC) Convention on the Protection of the Rhine against Pollution by Chlorides and Convention for the Protection of the Rhine against Chemical Pollution (Bonn agreements)
1979	Convention on chemicals enters into force Selection of 83 from 15,000 dangerous substances for further investigation Emission standards are proposed for mercury
1980	Efforts to harmonize existing national reduction programs for grey substances
1983	The United Kingdom stops blocking adoption of regulations for specific emission standards; Germany still concerned about competitiveness issues Emission standards are proposed for cadmium French parliament approves the Convention on Chlorides after agreement on mechanism to reduce salt emissions
1986	Sandoz disaster Dutch minister presents McKinsey report
1987	Rhine Action Plan (RAP) approved, first mentioning the target to reintroduce salmon into the Rhine. French potassium mines compensate Dutch market gardeners
1990	Additional protocol to the Convention on chlorides is adopted Rotterdam agreements: between city of Rotterdam and upstream chemical firms in upstream countries, under private law
1994	11th ministerial conference: Ecological Master Plan (adoption of Salmon 2000 program reinforcing the symbolism of the salmon for ecological restoration)
1998	Settlement between Reinwater and Dutch gardeners and the French government (potassium mines)
2000	New "Berne treaty" European Water Framework Directive
2001	New "Rhine 2020" Action Plan Settlement between State of France and province of North-Holland and Amsterdam (potassium mines).

Model

- Pollution in the Rhine

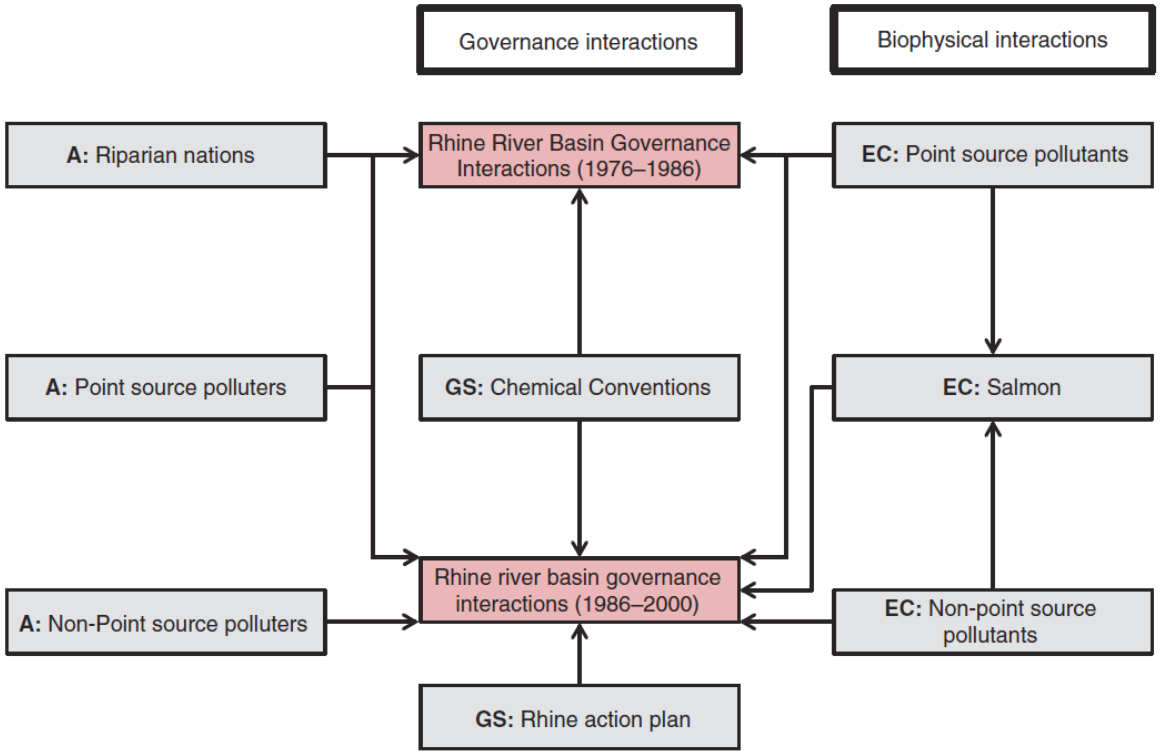


Figure 2: Structure of the Rhine SES during the two snapshots coded. The figure highlights the interaction between components.

Variable Analysis

- Pollution in the Rhine

Theoretical Variable (SESMAD component)	**Snapshot 1 (1976-1986)** *Little improvement in pollution abatement*	**Snapshot 2 (1986-2000)** *Notable improvement in pollution abatement*
Social variables		
Clarity of social boundaries	Yes (riparian nations and big industrial firms)	
	No	
Heterogeneity	High (riparian nations)	Low (riparian nations)
	Moderate (big industrial firms and farming sector)	
Proportionality	No (riparian nations)	Yes (riparian nations)
	Yes (big industrial firms)	

… and ecological triggers, and interest groups

Other Cases

- Blue Fin Tuna and ICATT (Epstein et al. 2014)

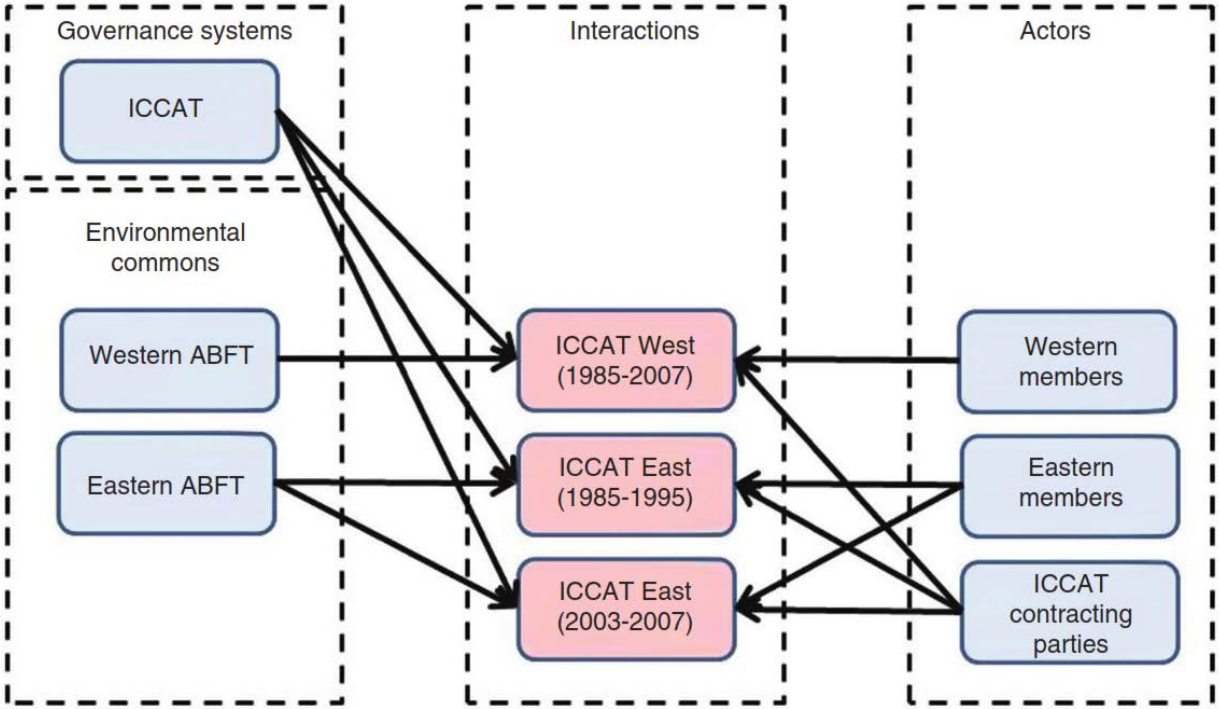
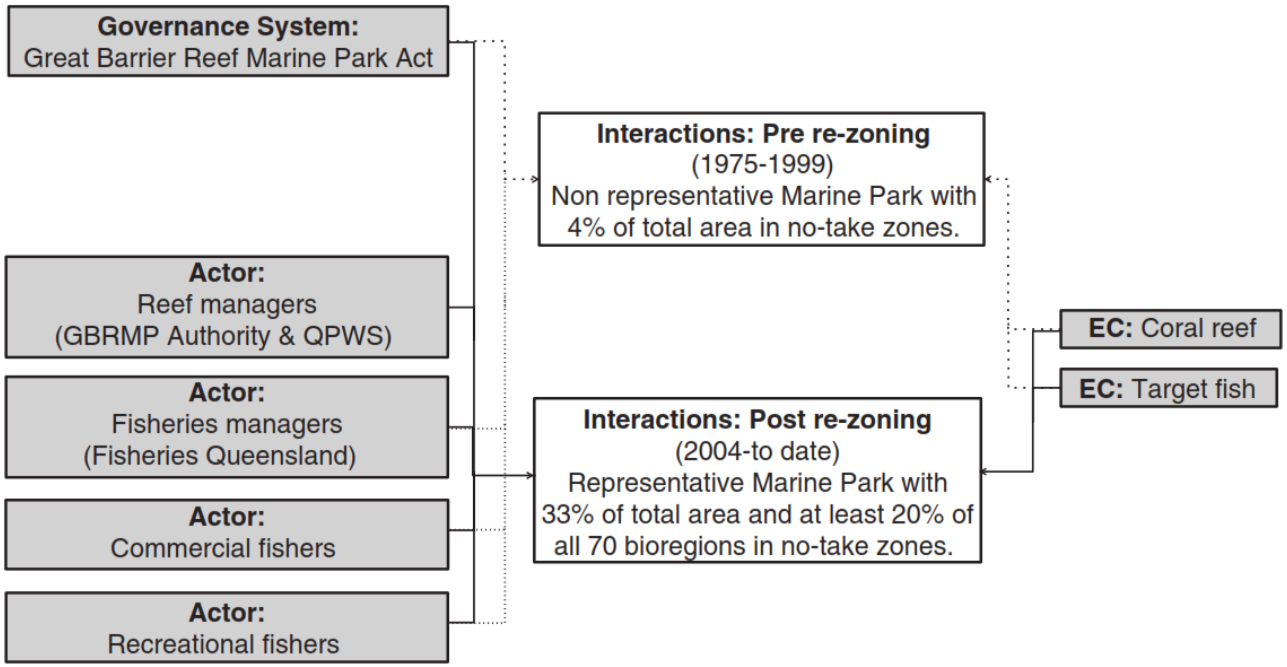
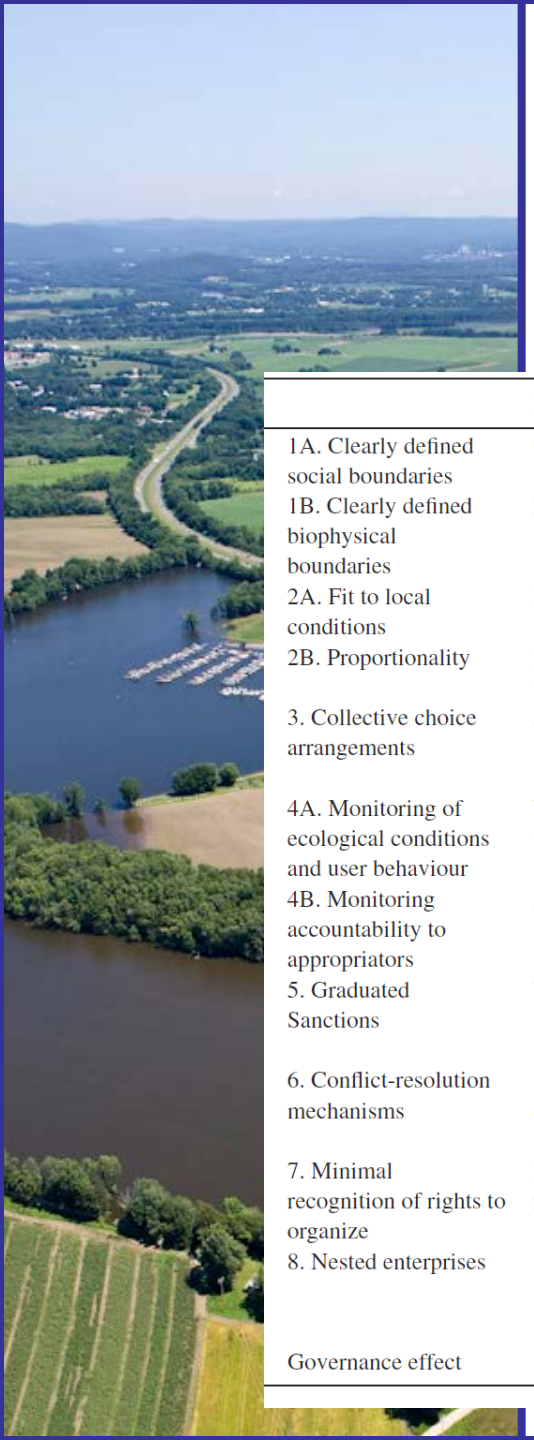


Figure 1: Schematic representation of the ICCAT case.

Other cases

- Great Barrier Reef (Evans et al. 2014)





Case comparison

- Indonesian forests-decentralization, Rhine-ICPR, Tuna-ICATT, GBR-MPA, Ozone-Montreal (Fleischman et al. 2014)

	Indonesian Forests	Rhine River	Great Barrier Reef	Montreal Protocol	ICCAT
1A. Clearly defined social boundaries	Contested	Present	Present	Present	Present
1B. Clearly defined biophysical boundaries	Present	Present	Present	Present	Unclear for migratory species
2A. Fit to local conditions	Inconclusive	Present	Present	Present	Absent as 'local conditions' not understood
2B. Proportionality	Disproportionate benefits to central government	Present	Inconclusive	Present	Present but no clear effect on governance outcome
3. Collective choice arrangements	Absent, then increasing after 1998	Absent but no clear effect on governance outcome	Absent but no clear effect on governance outcome	Present	Absent as governments represent users
4A. Monitoring of ecological conditions and user behaviour	Weak ecological and user monitoring	Present	Present	Present	Weak ecological and user monitoring
4B. Monitoring accountability to appropriators	Absent, then increasing after 1998	Substituted by other interest groups	Absent but no clear effect on governance outcome	Substituted by international agencies	Limited presence and knowledge contested
5. Graduated Sanctions	Weak or Absent	Present for point, Absent for non-point source polluters	Present	Absent as existing mechanism is not applied	Weak or Absent
6. Conflict-resolution mechanisms	Substituted by improved democratic system	Substituted by higher level negotiations and consensus	Present. Enhanced by legitimate judicial system	Substituted by higher level negotiations and consensus	Absent as high level negotiations highly contested
7. Minimal recognition of rights to organize	Rights improving but remain weak	Present	Absent but no clear effect on governance outcome	Absent but substituted by involvement of major user in initial rule-making	Absent but substituted by lobbying
8. Nested enterprises	Absent, then increasing after 1998	Present	Minimal considering the size of the system but no clear effect on governance outcome	Present but no clear effect on governance outcome	Present but no clear effect on governance outcome
Governance effect	Continued Decline	Partial Improvement	Partial Improvement	Partial improvement	Continued Decline

2. SESMAD Part II:

A repository of environmental science theories

A collaborative project

Michael Cox	Dartmouth College, USA
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Louisa Evans	University of Exeter, UK
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Sergio Villamayor	Humboldt University, Germany

Theories, and variable roles

- **Theory:** A statement that describes (1) a relationship between an outcome and a set of independent variables, the values of which are argued to be *sufficient* for predicting the outcome, and (2) a mechanism by which this relationship occurs.

- **Variable roles**

Type	Subtype	Description
Independent	Underlying	An independent variable that affects an outcome by affecting another, more proximate cause. Also referred to as a distal cause.
	Proximate	An independent variable that directly affects an outcome without the help of an intermediary variable.
	Moderating	An independent variable that affects an outcome by affecting the relationship between another independent variable and this outcome. This creates what is commonly referred to as an "interaction effect."
Outcome	Intermediate	An outcome that is affected by the independent variables in a theory, that in turn affects the final outcome (e.g. collective action of a commons user group)
	Final	The final outcome in a theory (e.g. the condition of an environmental commons as it is affected by levels of the intermediate outcome such as collective action)

Theory relationships

Relationship	Conditions and notes
Nested	1) Theory A contains all of the variables that theory B contains, with either the same values or the opposite set of values. 2) These variables do not need to have precisely the same roles in the larger theory as they do in the nested one (e.g. a proximate cause may become an intermediate outcome depending on its place in the larger theory).
Related	1A) Theory A and B have the same value for the same independent variable and predict the same value for the same final outcome, 1B) OR theory A and theory B have opposite values for the same independent variable and thus predict opposite values for the same final outcome, 2) AND the two theories do not share the common independent variable via a shared theory that is nested within each.
Contradictory	1) Theory A and B have the same value for the same independent variable but predict a different value for the same final outcome. 2) Because of the principle of equifinality, theories that have different values for the same independent variable and the same value for the same final outcome are not considered to be contradictory.

A tour around SESMAD

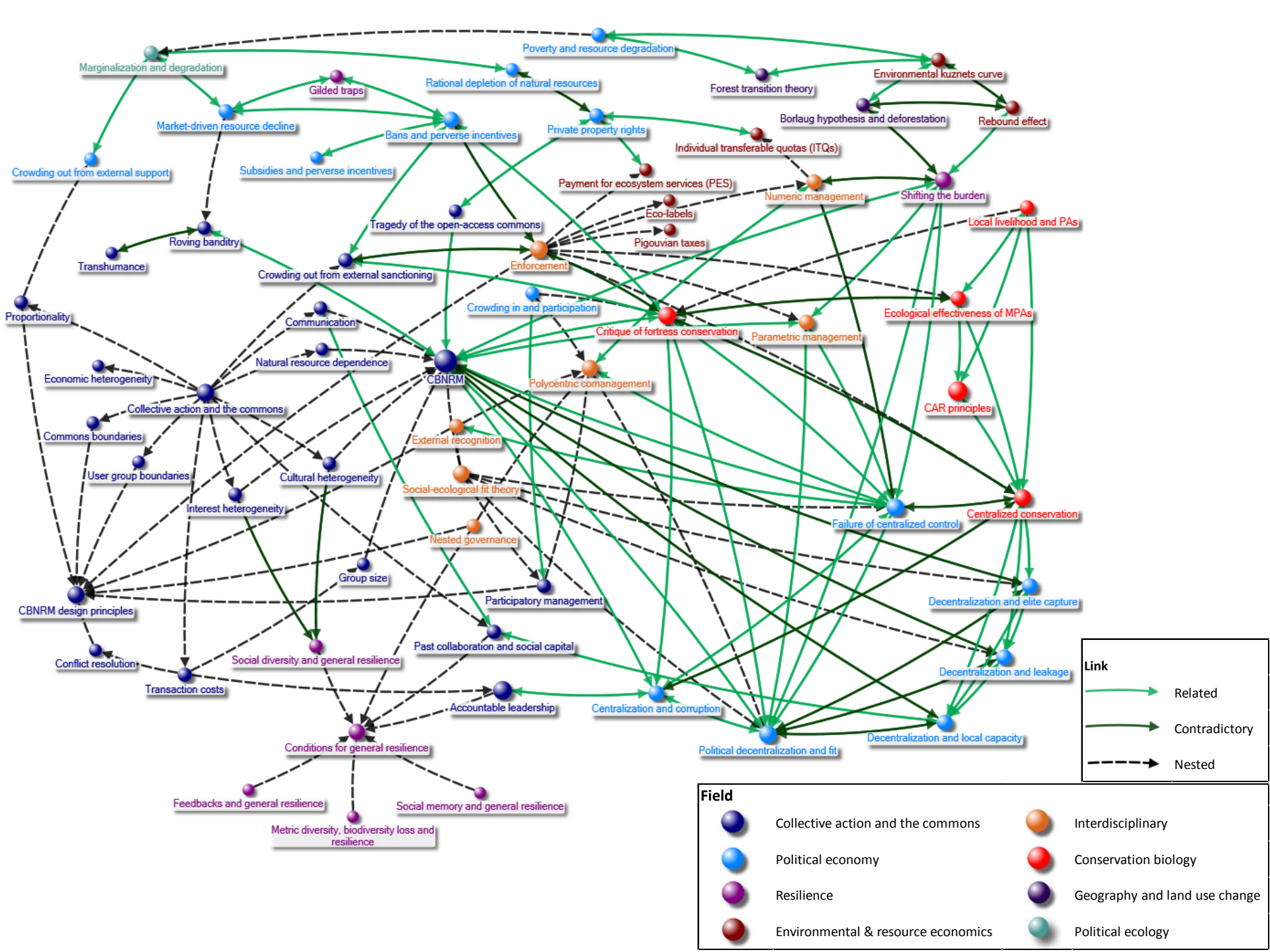
Theories

https://sesmad.dartmouth.edu/

Sample of coded theories

- Cox et al., 2015, *working paper*

Theory name	Field	Variables	Theories	Steps	List	Moderators
Accountable Leadership	Commons	6	3	4	1	2
CBNRM Design Principles	Commons	14	17	3	11	0
Commons Boundaries and Collective Action	Commons	3	11	3	1	0
Critique of Fortress Conservation	Con. Biology	14	11	4	5	0
Ecological Effectiveness of MPAs	Con. Biology	10	5	3	7	1
Local Livelihood and Protected Areas	Con. Biology	4	4	2	3	0
Individual Transferable Quotas (ITQs)	Env. Economics	6	2	2	4	1
Payment for Ecosystem Services (PES)	Env. Economics	7	2	2	1	5
Rebound Effect	Env. Economics	2	3	3	1	0
Borlaug Hypothesis and Deforestation	Geography	3	3	3	2	0
Forest Transition Theory	Geography	2	2	2	1	0
Enforcement	Interdisciplinary	7	11	3	2	1
Polycentric Co-management	Interdisciplinary	12	7	4	7	0
Social-Ecological Fit Theory	Interdisciplinary	2	1	2	1	0
Marginalization and Degradation	Political ecology	7	4	4	3	0
Crowding in and Participation	Political economy	3	3	3	1	0
Crowding out from External Support	Political economy	3	2	3	1	0
Poverty and Resource Degradation	Political economy	2	3	2	1	0
Feedbacks and General Resilience	Resilience	5	1	4	2	0
Metric Diversity, Biodiversity Loss and Resilience	Resilience	4	1	4	1	0
Social Memory and General Resilience	Resilience	5	3	4	2	0


Poverty and resource degradation
Marginalization and degradation
Gilded traps
Rational depletion of natural resources
Forest transition theory
Environmental kuznets curve
Market-driven resource decline
Bans and perverse incentives
Private property rights
Borlaug hypothesis and deforestation
Rebound effect
Crowding out from external support
Subsidies and perverse incentives
Individual transferable quotas (ITQs)
Payment for ecosystem services (PES)
Numeric management
Shifting the burden
Eco-labels
Tragedy of the open-access commons
Local livelihood and PAs
Roving banditry
Pigouvian taxes
Transhumance
Enforcement
Crowding out from external sanctioning
Proportionality
Crowding in and participation
Ecological effectiveness of MPAs
Communication
Critique of fortress conservation
Parametric management
Natural resource dependence
Economic heterogeneity
CBNRM
Polycentric comanagement
Collective action and the commons
CAR principles
Commons boundaries
External recognition
User group boundaries
Cultural heterogeneity
Social-ecological fit theory
Interest heterogeneity
Failure of centralized control
Centralized conservation
Nested governance
Group size
CBNRM design principles
Participatory management
Decentralization and elite capture
Past collaboration and social capital
Conflict resolution
Social diversity and general resilience
Decentralization and leakage
Transaction costs
Accountable leadership
Centralization and corruption
Decentralization and local capacity
Political decentralization and fit
Conditions for general resilience
Feedbacks and general resilience
Social memory and general resilience
Metric diversity, biodiversity loss and resilience
Link
Related
Contradictory
Nested
Field
Collective action and the commons
Interdisciplinary
Political economy
Conservation biology
Resilience
Geography and land use change
Environmental & resource economics
Political ecology

4. Closing remarks

An ongoing process

1. New projects embedded in SESMAD (Large MPAs, fisheries in Fiji, water scarcity in transboundary rivers)

2. Comparative studies ahead

3. Systematic theory testing, and building

Thank you

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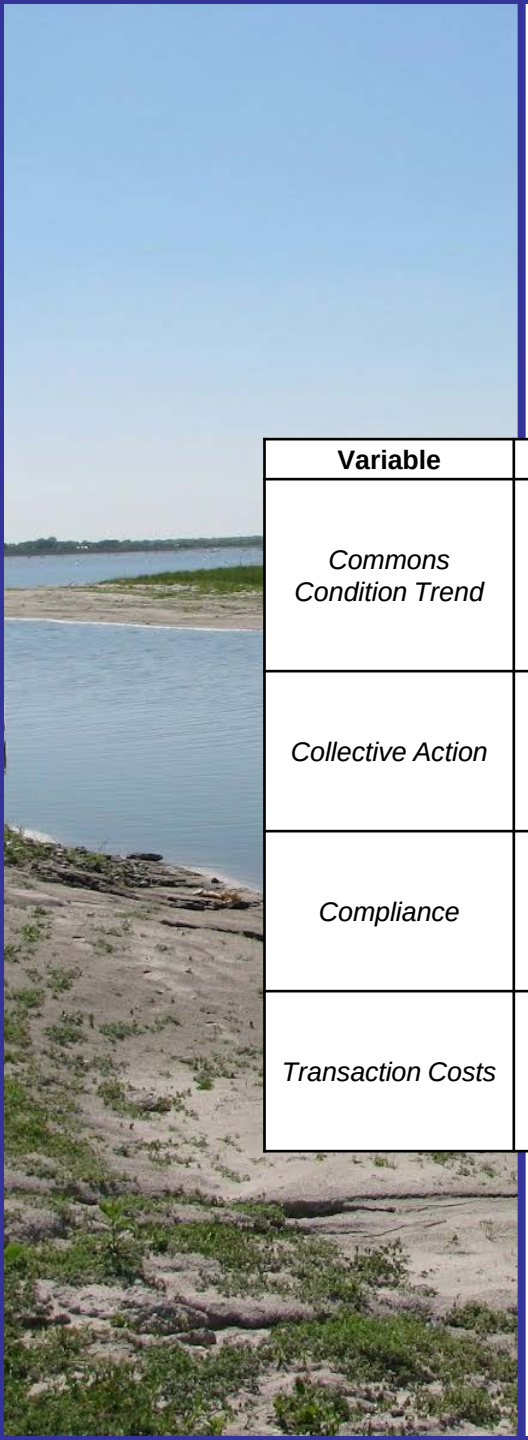


Sample of variable analysis

- Cox et al., 2015, *working paper*

Variable	Component type	Type	Theories	Question	Range
Commons Condition Trend	Environmental commons	Ordinal	59	Based on your answers to the Beginning Condition and End Condition variables, would you say that the condition of this commons has improved, remained the same, or worsened during this snapshot?	1 Worsened; 2 Remained the Same; 3 Improved
Collective Action	Actor group	Ordinal	16	What is the current level of collective action within the members of this actor group with respect to the use or management of this commons?	1 Low; 2 Medium; 3 High
Compliance	Actor group	Ordinal	15	Do members of this actor group follow the rules of this governance system with respect to the emission or appropriation of this commons?	1 No; 2 Somewhat; 3 Yes
Transaction Costs	Governance system	Ordinal	15	How high (or low) are the transaction costs of monitoring and enforcing the rules that this governance system involves in managing this commons?	1 Low; 2 Medium; 3 High

A diagnostic approach

- Identifying the conditions under which certain relationships hold
  - Identify configurations of explanatory variables that lead to outcomes (Heikkila 2004, Lam and Ostrom 2010, Basurto 2015)
  - Understanding the role of “context variables” (Bardhan 2000, Agrawal 2002)
  - Identify types of cases (Hinkel et al. 2014)
  - Identifying interactions between variables (Velded 2000, Poteete and Ostrom 2004)

CPR theory: interaction patterns?

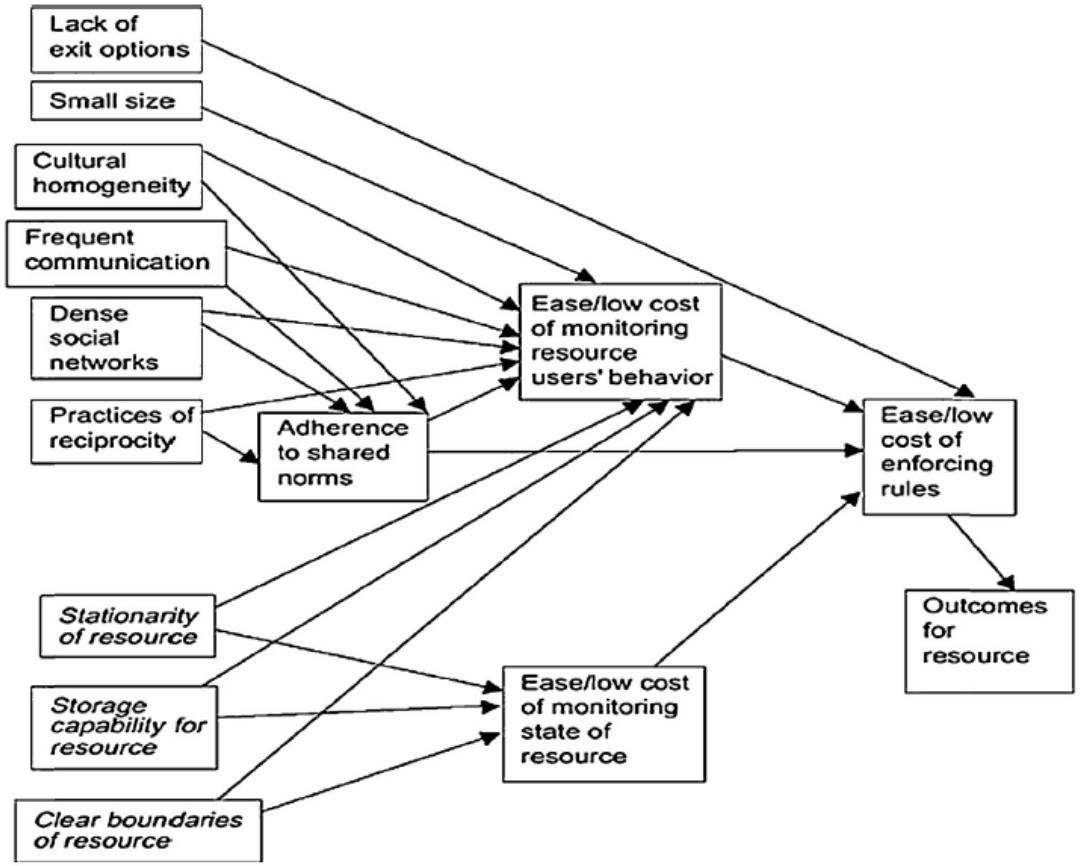
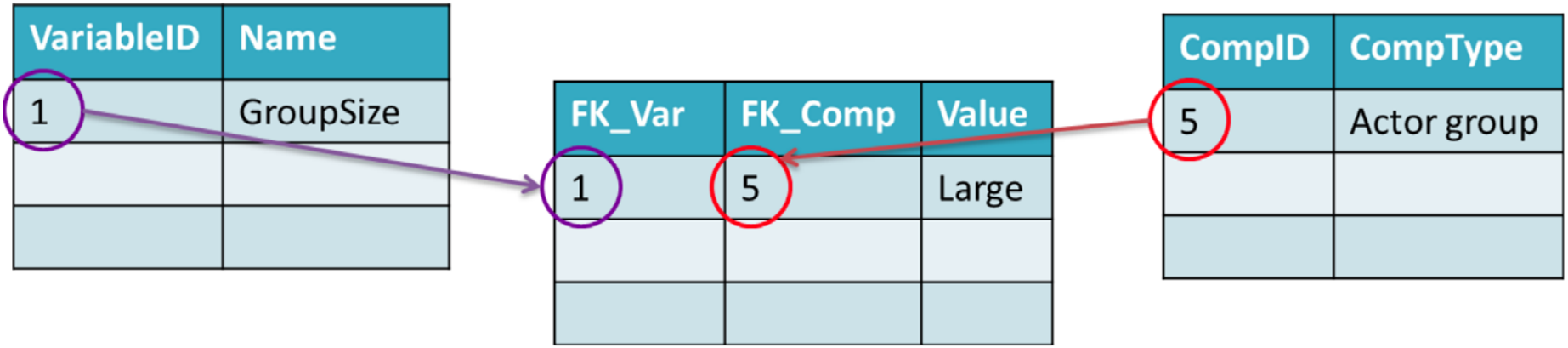


Fig. 1 – Postulated effects of variables on the outcomes of the commons.
Source: NRC (2002).

Araral (2014)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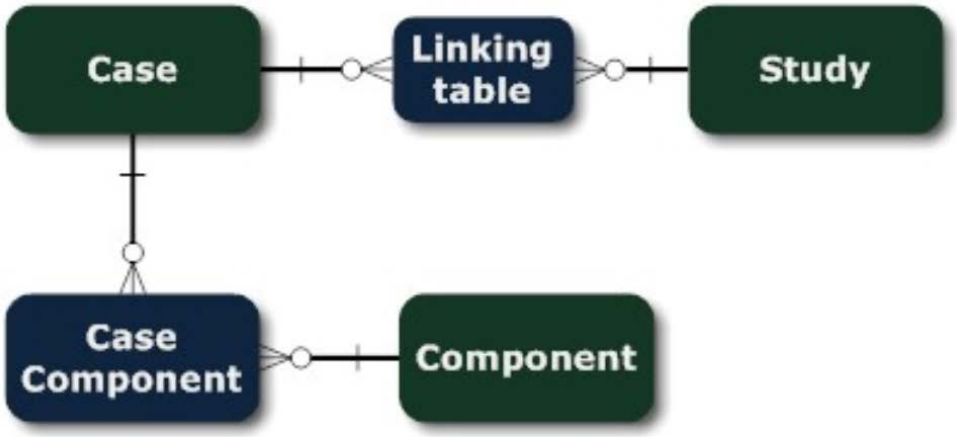
Actor group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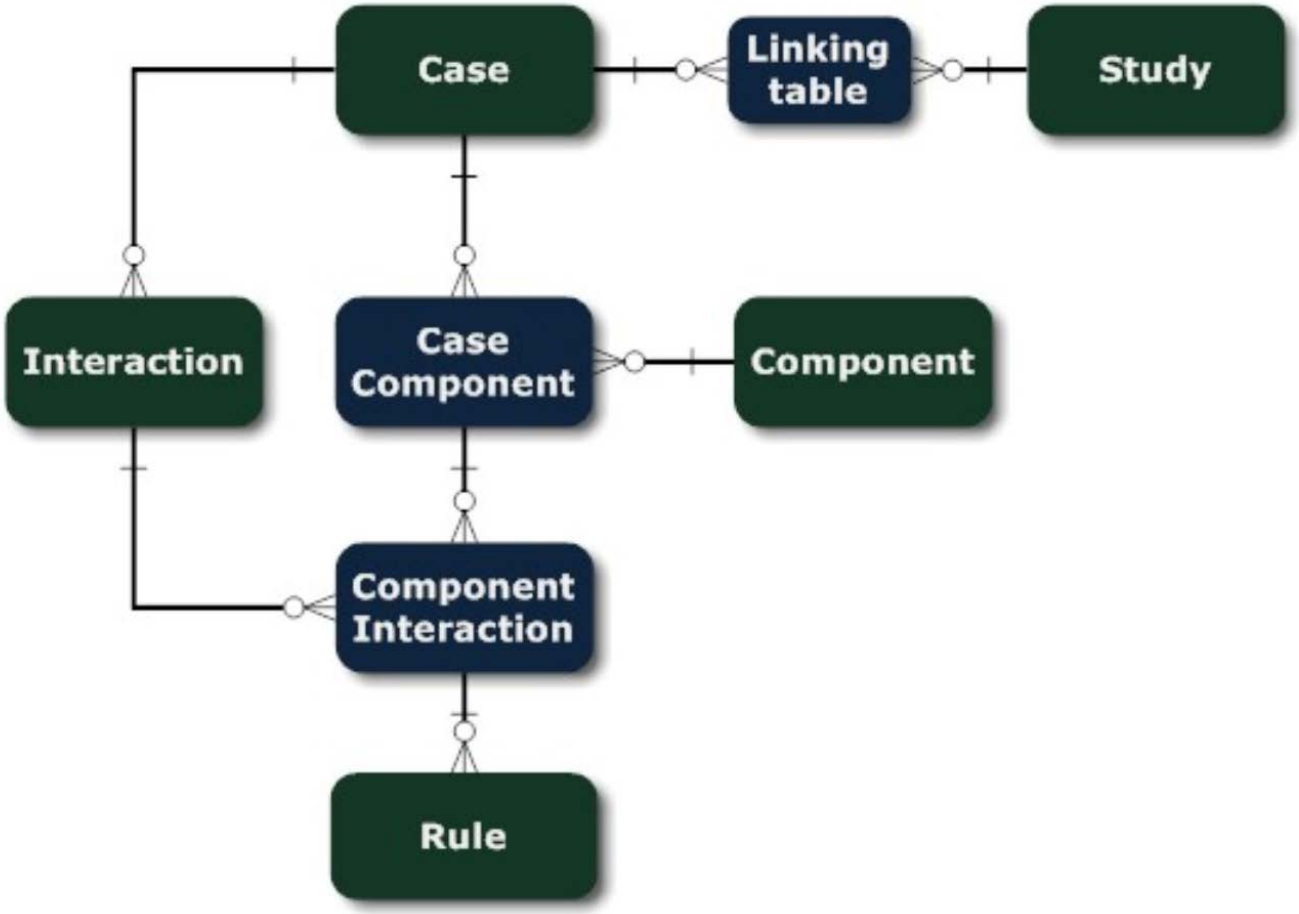
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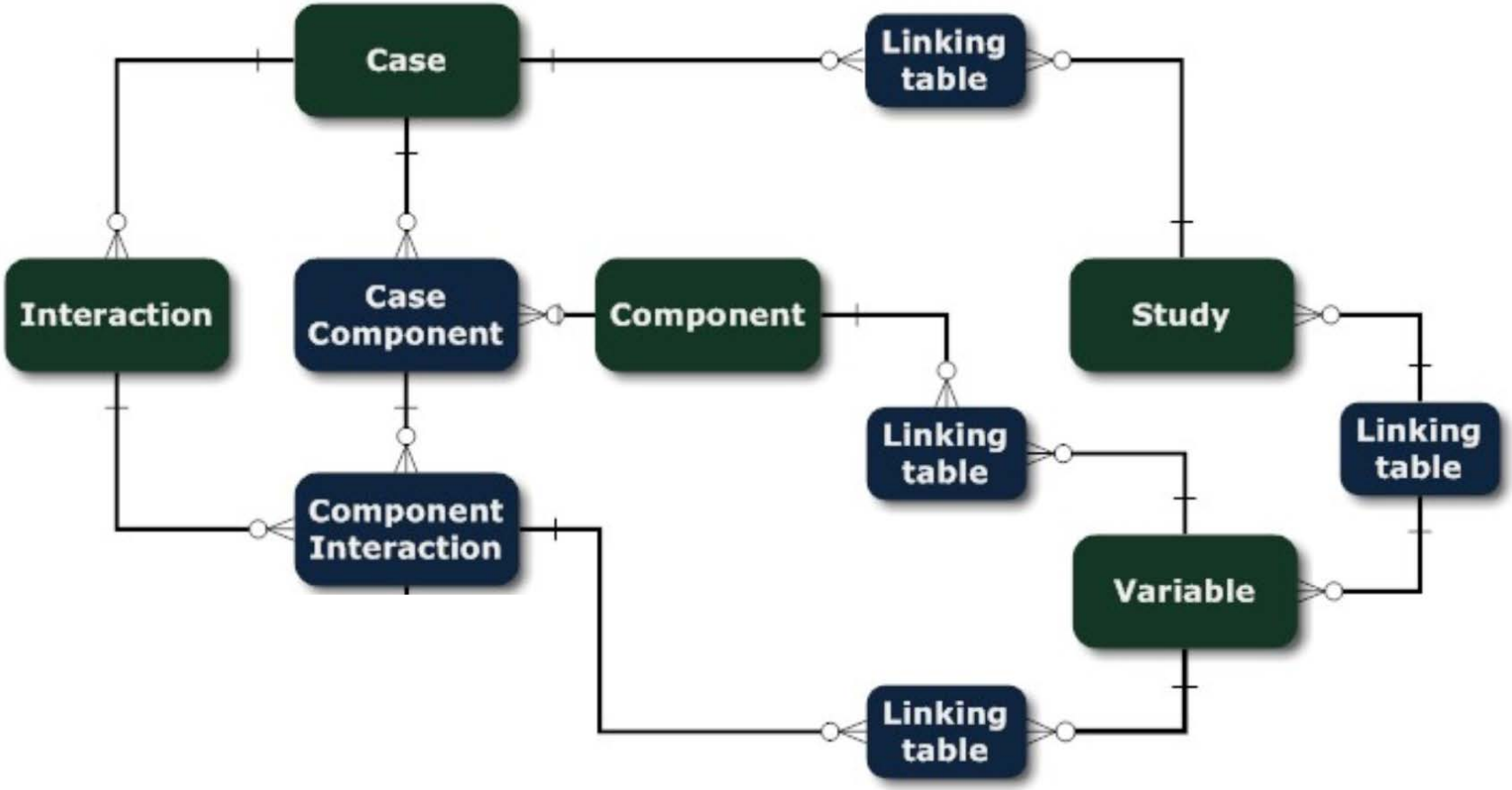
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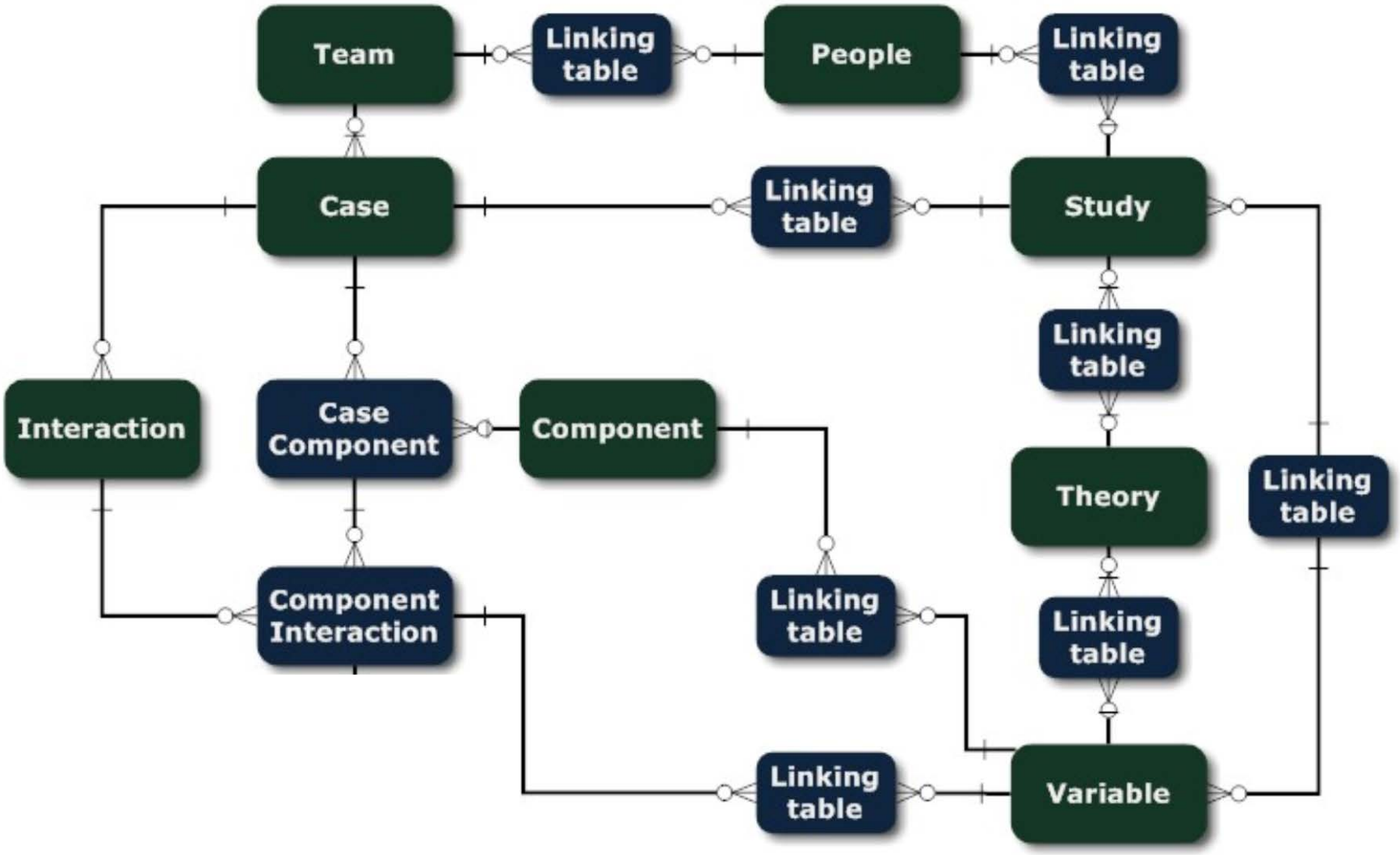
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Interaction
Case Component
Component
Theory
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Component Interaction
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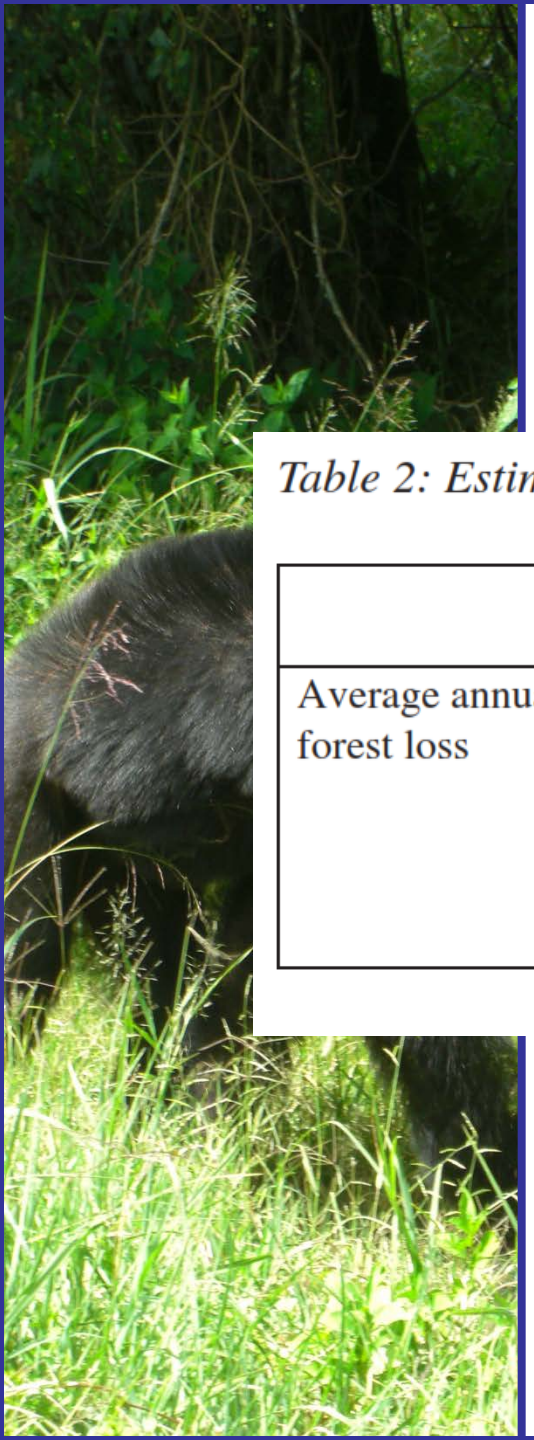
Variable

1 ↓	**COMPONENT TYPE Variables**	Governance System	Environmental Commons	Actor group
2 ↓	**COMPONENT SUB-TYPE Variables**	Formal Informal	Natural resource sys Natural resource unit Pollutant	None Local user group(s) Local government(s) Government agency Quasi-gov. agency Secretariat NGO(s) Corporation(s) Nation(s) Research community
3 ↓	**COMPONENT SECTOR Variables**	Water, marine, forest, pollution…		
4 ↓	**COMPONENT ROLE**		“Governs/Is governed” “inhabits/is habitat” “pollutes/is polluted” “Predates/is predated” …	Commons User Governance organization
5	**Variables**	…	…	…



Case Study 1

- **Indonesian Forests** (Fleischmann et al. 2014)

Table 2: Estimates of deforestation rates in Indonesia from 1990–2012.

	1990–2000 (95% CI)	2000–2005 (95% CI)	2005–2012	Source
Average annual forest loss	1.78 MHa (1.40–2.16)	0.71 MHa (0.54–0.88)	1.6 MHa	Hansen et al. 2013 Hansen et al. 2009
	1.914 MHa	0.310 MHa	0.685 MHa	FAO (2010, 2013)

Timeline

- Indonesian Forests

	Date	Event
Snapshot 1:	1965	Sukarno sidelined by Suharto & placed under house arrest
"New Order"	1967	Basic Forestry law asserts central govt. control over all forests. Logging permits granted by local govt. to small-scale enterprises.
regime	1970–1971	Central government revokes local logging permits. Large-scale concessions begin to be granted to political allies of regime.
1965–1997	Early 1980s	• Transmigration program: Javanese moved to outlying islands. • Erosion of customary ("adat") law • Ban on log exports forces concession holders to invest in plywood and pulp processing, which are subsidized
	Late 1980s	Development of Industrial Timber Plantations
	Mid 1990s	• "forestry crisis" – high levels of deforestation, overcapacity in wood processing sector, decline in timber concessions • Rise of coal mining & palm oil industries
	1997	Asian monetary crisis hits Indonesia
	1997–1998	Massive forest fires due to El Nino droughts & extensive logging.
Snapshot 2: Early	1998	• Fall of Suharto's government, democratic elections
democratic era		• Villagers demand local control over resources
1998-present		• Log export ban removed
	1999	Laws grant greater autonomy and revenue control to districts, districts permitted to grant small forest concessions New forestry law passes, reaffirming central government control over forests.
	2000	Constitution amended to recognize customary law
	2002	District government authority to grant concessions suspended
	2004	New laws reverse trend towards regional autonomy
	2006	National Land Reform Program begins
	2009	President commits to reducing CO_2 emissions by 26% by 2020
	2010	Norway and Indonesia sign REDD+ partnership aimed at reducing emissions from deforestation and forest degradation
	2011 and 2013	2 year ban implemented (2011) and extended (2013) on new logging & forest conversion concessions
	2013	Indonesia's Constitutional Court invalidates the Indonesian government's claim to millions of hectares of forest land

Model

- Indonesian Forests

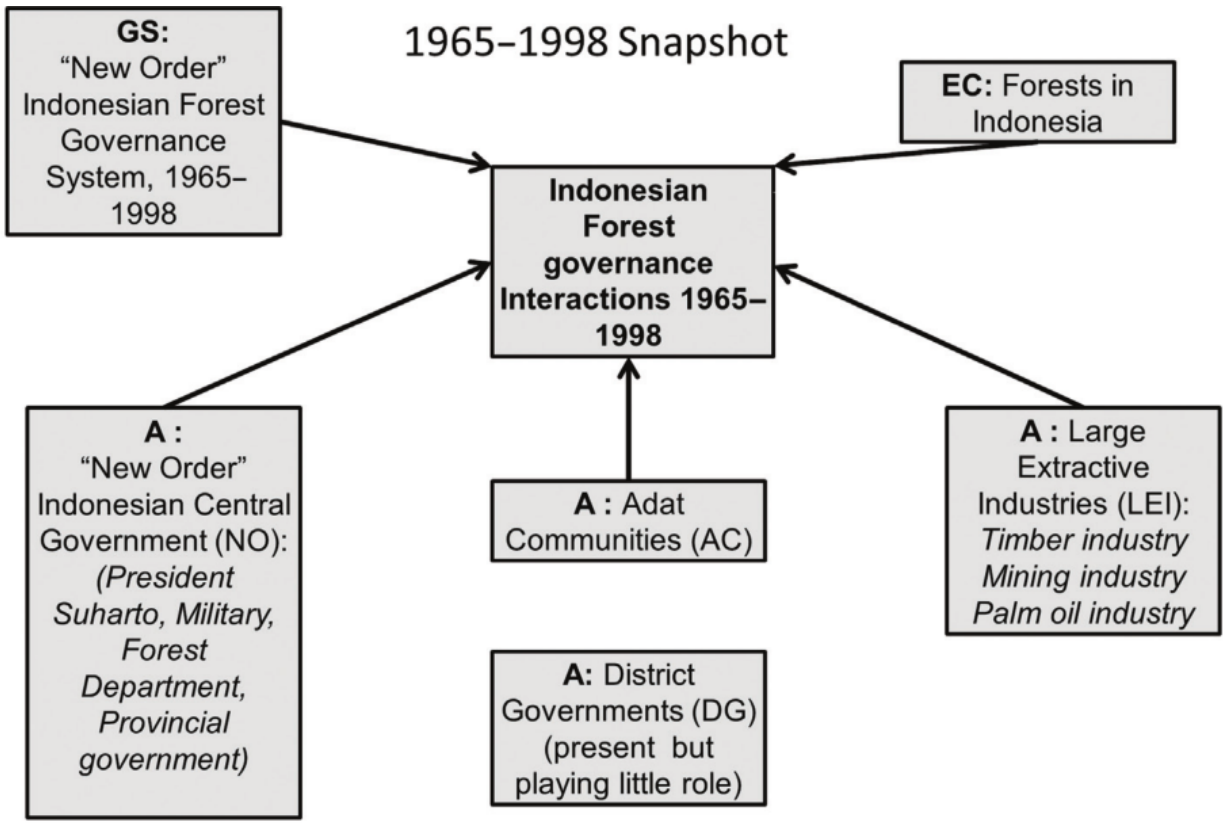


Figure 1: The structure of Indonesian forest governance during the "New Order" period, 1965–1998.

Model

- Indonesian Forests

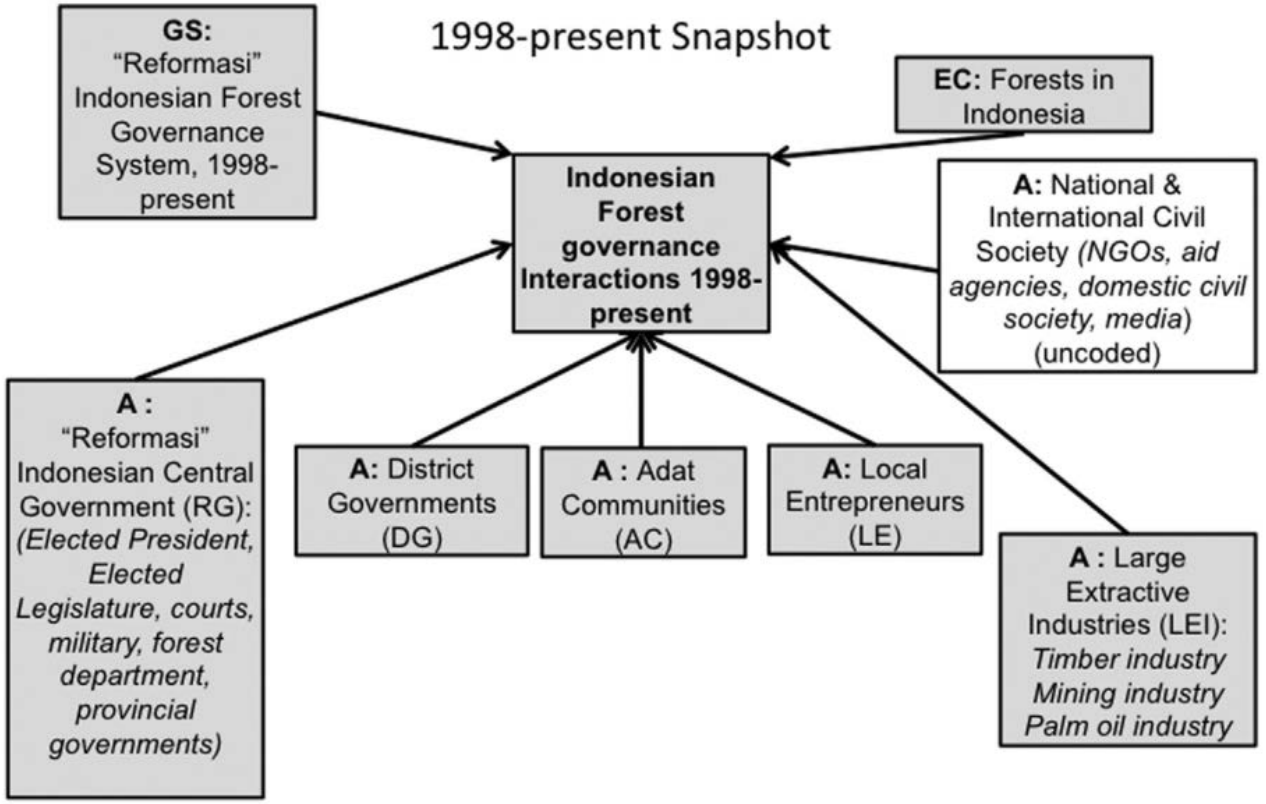
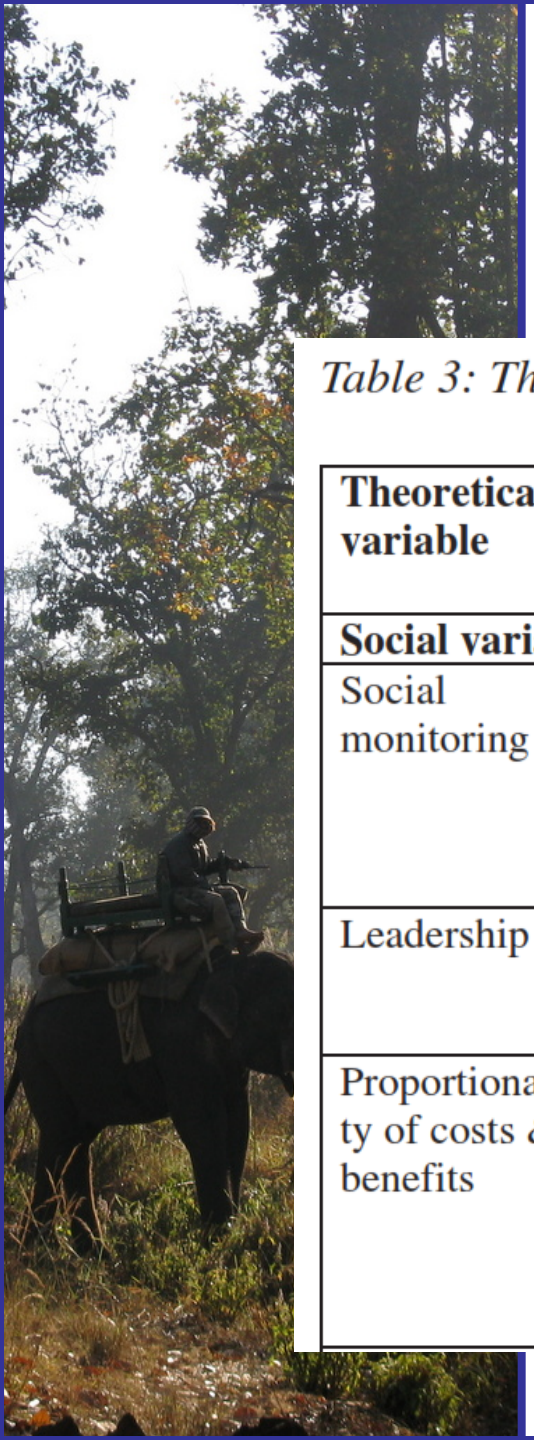


Figure 2: The structure of Indonesian forest governance during the "Reformasi" period, 1998-present.



Variable analysis

- Indonesian Forests

Table 3: Theoretically important variables used in this case.

Theoretical variable	Suharto "New Order" period 1965–1998	Democratization & "Reformasi" Period 1998–present
Social variables		
Social monitoring	Central govt. does little monitoring. Some adat communities also monitored their own behavior and that of timber concessionaires.	Govts. do some monitoring, as do local communities, civil society groups, and international agencies. Satellite technology makes monitoring cheaper.
Leadership	Dictator is strong, not accountable, and extraction oriented.	Leadership diffused between multiple levels of elected govt. & civil society.
Proportionality of costs & benefits	Timber revenue & taxes flow to central government & associated timber companies. Many costs passed on to future generations or local communities.	Benefits continue to flow to large companies & central actors. District govts. & adat communities bear costs, but tax revenue from forestry goes only to central govt.

Too many variables?

Scholars of commons have discovered far more variables that potentially affect resource management than is possible to analyze carefully

… and there are still missing variables

(Agrawal 2003, pp. 2)