

Institutionelle Analyse von Sozio-ökologischen Systemen (SES) (IIRM)

Sozio-ökologisches System (SES)

- *... ein kohärentes System bestehend aus biophysikalischen und sozialen Faktoren, die auf Basis von Regelmäßigkeiten auf resiliente und nachhaltige Weise zusammenwirken. (Redman u.a. 2004)*
- Spezialfall eines komplexen adaptiven Systems
- Auch: Mensch-Umwelt-System

Analyse der Robustheit von SES

Probleme

- Steigender Einfluss des Menschen auf biophysikalische Prozesse
⇒ Umweltprobleme
- Bisher: Entscheidungsoptimierung durch Reduktion der Unsicherheit
- Unausweichliche Unsicherheit in der Dynamik von SES verhindert Kontrolle
- Besser: Was macht ein SES robust?
- **Ziel:** Analyse-Framework für Robustheit SES

Robustheit

- = Erhaltung der Systemleistung bei innerer oder äußerer Unsicherheit
Für SES: Erhaltung von manchen gewünschten Systemeigenschaften, speziell Überlebensfähigkeit des Menschen im System
- Robustes Design ist Kompromiss aus Leistung und Robustheit
- Probleme mit Begriffen, z.B. Definition von Leistung in SES
- Resilienz ist ähnlich, aber schwer anwendbar auf designte Systeme, dafür auf selbstorganisierte Komponenten
⇒ Untersuchung der desigten und selbstorganisierenden Komponenten

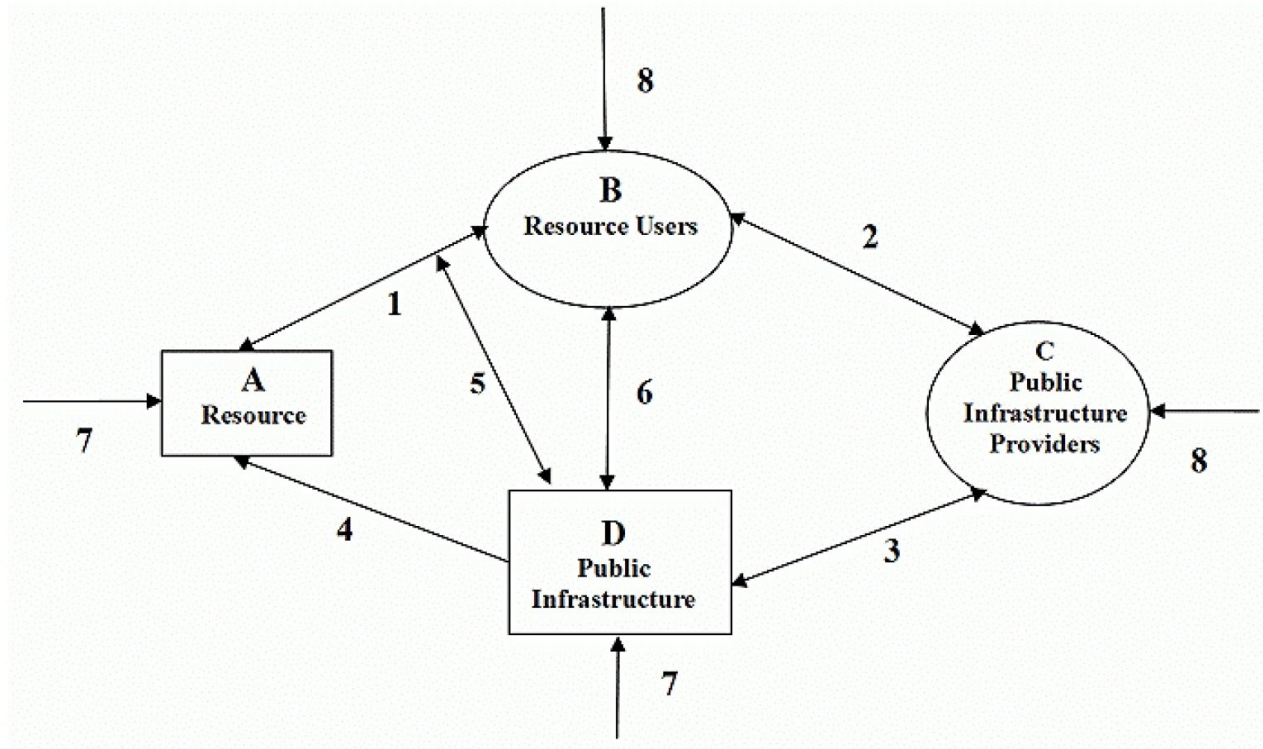
Entities

Table 1. Entities involved in social-ecological systems

Entities	Examples	Potential Problems
A. Resource	Water source Fishery	Uncertainty Complexity / Uncertainty
B. Resource Users	Farmers using irrigation Fishers harvesting from inshore fishery	Stealing water, getting a free ride on maintenance Overharvesting
C. Public infrastructure providers	Executive and council of local users' association Government bureau	Internal conflict or indecision about which policies to adopt Information loss
D. Public Infrastructure	Engineering works	Wear out over time
Institutional rules	Memory loss over time, deliberate cheating	
External Environment	Weather, economy, political system	Sudden changes as well as slow changes that are not noticed

Framework

Fig. 1. A conceptual model of a social-ecological system.



Links (1)

Table 2. Links involved in social-ecological systems

Link	Examples	Potential Problems
(1) Between resource and resource users	Availability of water at time of need/availability of fish	Too much or too little water / too many uneconomic fish—too many valued fish
(2) Between users and public infrastructure providers	Voting for providers Contributing resources Recommending policies Monitoring performance of providers	Indeterminacy / lack of participation Free riding Rent seeking Lack of information/free riding
(3) Between public infrastructure providers and public infrastructure	Building initial structure Regular maintenance Monitoring and enforcing rules	Overcapitalization or undercapitalization Shirking disrupting temporal and spatial patterns of resource use Cost / corruption

Links (2)

(4) Between public infrastructure and resource	Impact of infrastructure on the resource level	Ineffective
(5) Between public infrastructure and resource dynamics	Impact of infrastructure on the feedback structure of the resource–harvest dynamics	Ineffective, unintended consequences
(6) Between resource users and public infrastructure	Coproduction of infrastructure itself, maintenance of works, monitoring and sanctioning	No incentives / free riding
(7) External forces on resource and infrastructure	Severe weather, earthquake, landslide, new roads	Destroys resource and infrastructure
(8) External forces on social actors	Major changes in political system, migration, commodity prices, and regulation	Conflict, uncertainty, migration, greatly increased demand

Ausschnitt simples Beispiel (1)

- Gemeinschaftliche ökologische Ressource
- Kleine Gruppe mit recht homogenen Interessen, z.B. Bauerngemeinschaft
- Jedes Mitglied ist User und Provider
- Nur Arbeit und Waren als Tauschmedium
- Durch gemeinsame Arbeit fällt fehlende Kooperation direkt auf
- Gruppe trifft sich um Verteilung etc. zu entscheiden (Regeln)
- In stabiler Umgebung kaum Schwierigkeiten

Ausschnitt simples Beispiel (2)

- **Gefahr:** Auftreten neuer äußerer Einflüsse
 - ⇒ Z.B. Bau einer neuen Straße
- a) Neue Möglichkeiten bringen Leute zu anderen Berufen
 - ⇒ Population wird kleiner ⇒ Weniger Arbeiter zum Erhalt des Systems
- b) Mehr Leute zieht es in den Ort
 - ⇒ Mehr Nutzer ⇒ i) Ökologische Herausforderung für Provider/Regeln
 - ⇒ ii) Mehr Arbeiter ⇒ Besser Infrastruktur ⇒ Mehr “Leistung”
 - ⇒ allgemein: mögliche Spezialisierung führt zu größeren Veränderungen im System

Prinzipien (Simpel/Grundlegend)

1. *Clearly Defined Boundaries*

The boundaries of the resource system (e.g., irrigation system or fishery) and the individuals or households with rights to harvest resource units are clearly defined.

2. *Proportional Equivalence between Benefits and Costs*

Rules specifying the amount of resource products that a user is allocated are related to local conditions and to rules requiring labor, materials, and/or money inputs.

3. *Collective-Choice Arrangements*

Most individuals affected by harvesting and protection rules are included in the group who can modify these rules.

4. *Monitoring*

Monitors, who actively audit biophysical conditions and user behavior, are at least partially accountable to the users or are the users themselves.

5. *Graduated Sanctions*

Users who violate rules-in-use are likely to receive graduated sanctions (depending on the seriousness and context of the offense) from other users, from officials accountable to these users, or from both.

6. *Conflict-Resolution Mechanisms*

Users and their officials have rapid access to low-cost, local arenas to resolve conflict among users or between users and officials.

7. *Minimal Recognition of Rights to Organize*

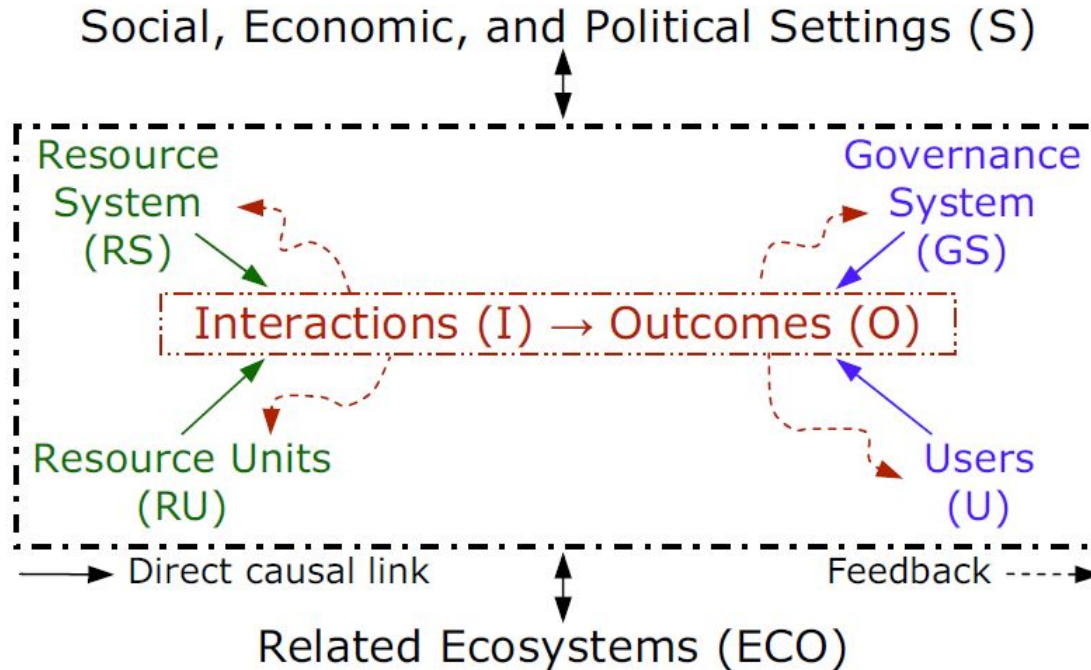
The rights of users to devise their own institutions are not challenged by external governmental authorities, and users have long-term tenure rights to the resource.

Zerlegende Analyse von SES

Probleme

- Nur simple, momentane Antworten auf komplexe Probleme durch Verwaltung
 - Ökologisches Fehlverhalten hat selten nur eine Ursache!
- Notwendigkeit der Annahme und des Verstehens der Komplexität
- Gekoppeltes Auftreten von SES erschwert Erfassung der Systemvariablen
- **Ziel:** Analyse-Framework für Probleme und Möglichkeiten gekoppelter SES

Framework-Überblick



Resource System

- a) Fischerei,
- b) ein See

Resource Unit

- Produkte des RS
- a) Fische,
- b) Wasser

Fig. 1. A multitier framework for analyzing an SES.

Variablen

Table 1. Second-tier variables in framework for analyzing an SES

Social, Economic, and Political Settings (S)	
S1- Economic development. S2- Demographic trends. S3- Political stability. S4- Government settlement policies. S5- Market incentives. S6- Media organization.	
Resource System (RS)	Governance System (GS)
RS1- Sector (e.g., water, forests, pasture, fish)	GS1- Government organizations
RS2- Clarity of system boundaries	GS2- Non-government organizations
RS3- Size of resource system	GS3- Network structure
RS4- Human-constructed facilities	GS4- Property-rights systems
RS5- Productivity of system	GS5- Operational rules
RS6- Equilibrium properties	GS6- Collective-choice rules
RS7- Predictability of system dynamics	GS7- Constitutional rules
RS8- Storage characteristics	GS8- Monitoring & sanctioning processes
RS9- Location	
Resource Units (RU)	Users (U)
RU1- Resource unit mobility	U1- Number of users
RU2- Growth or replacement rate	U2- Socioeconomic attributes of users
RU3- Interaction among resource units	U3- History of use
RU4- Economic value	U4- Location
RU5- Size	U5- Leadership/entrepreneurship
RU6- Distinctive markings	U6- Norms/social capital
RU7- Spatial & temporal distribution	U7- Knowledge of SES/mental models
	U8- Dependence on resource
	U9- Technology used
Interactions (I)	→ Outcomes (O)
I1- Harvesting levels of diverse users	O1- Social performance measures (e.g., efficiency, equity, accountability)
I2- Information sharing among users	O2- Ecological performance measures (e.g., overharvested, resilience, diversity)
I3- Deliberation processes	O3- Externalities to other SESs
I4- Conflicts among users	
I5- Investment activities	
I6- Lobbying activities	
Related Ecosystems (ECO)	
ECO1- Climate patterns. ECO2- Pollution patterns. ECO3- Flows into and out of focal SES.	

- Über 30 Variablen
 - Teilweise Zerlegbares System
 - Klassen und Unterklassen
 - Relativ separate Untersysteme
 - Größer als Summe seiner Teile
- ⇒ nicht immer alle relevant
- Kombinationen von Variablen
 - Tiefere Ebenen für jede

Analyse

- Einfluss der verschiedenen Variablen auf das Gesamtsystem
- Erkennen von Beziehungen zwischen Variablen
- Zerlegbarkeit des Systems in Ebenen und Variablen (Bedeutung!)
- **Frage:** Welche Kombinationen führen zu nachhaltiger und produktiver Nutzung und welche zu Zusammenbruch und hohen Kosten?

Beispiel - “Tragedy of the Commons”

- Hardins Gleichnis einer frei zugänglichen Weide
- Jeder Hirte hat direkten Profit durch jede zusätzliches Tier auf der Weide
- Probleme durch Überweidung treten erst später ein

⇒ Übersetzung in das Framework

Beispiel - “Tragedy of the Commons” (1)

Table 2. Second-tier variables used by Hardin (50) in “The Tragedy of the Commons”

Social, Economic, and Political Settings (S)		
S1-	S2-	S3- S4- S5- Market incentives S6-
Resource System (RS)		Governance System (GS)
RS1- Sector — pasture		GS1-
RS2-		GS2-
RS3- Finite size		GS3-
RS4-		GS4-
RS5- Renewable resource		GS5-
RS6-		GS6-
RS7-		GS7-
RS8-		GS8-
RS9-		
Resource Units (RU)	Users (U)	
RU1- Mobile animals on stationary grasses	U1- Large number of users	
RU2-	U2-	
RU3-	U3-	
RU4- Fattened cattle can be sold for cash	U4-	
RU5-	U5-	
RU6- Distinctive markings	U6-	
RU7-	U7- Maximization of short-term gains for self	
	U8-	
	U9-	
Interactions (I) → Outcomes (O)		
I1- Maximum harvesting levels by users	O1-	
I2-	O2- Destruction of ecological system	
I3-	O3-	
I4-		
I5-		
I6-		
Related Ecosystems (ECO)		
ECO1-	ECO2-	ECO3-

Beispiel - “Tragedy of the Commons” (2)

Table 2. Second-tier variables used by Hardin (50) in “The Tragedy of the Commons”

Social, Economic, and Political Settings (S)		
S1-	S2-	S3-
S4-	S5-	Market incentives
S6-		
Resource System (RS)		Governance System (GS)
RS1- Sector — pasture		GS1-
RS2-		GS2-
RS3- Finite size		GS3-
RS4-		GS4-
RS5- Renewable resource		GS5-
RS6-		GS6-
RS7-		GS7-
RS8-		GS8-
RS9-		
Resource Units (RU)		Users (U)
RU1- Mobile animals on stationary grasses		U1- Large number of users
RU2-		U2-
RU3-		U3-
RU4- Fattened cattle can be sold for cash		U4-
RU5-		U5-
RU6- Distinctive markings		U6-
RU7-		U7- Maximization of short-term gains for self
		U8-
		U9-
Interactions (I) → Outcomes (O)		
I1- Maximum harvesting levels by users		O1-
I2-		O2- Destruction of ecological system
I3-		O3-
I4-		
I5-		
I6-		
Related Ecosystems (ECO)		
ECO1-	ECO2-	ECO3-

- Profit im Fokus führt zu Überbewirtschaftung und letztlich zur Zerstörung
- Lösung: Persönliche Treffen der Beteiligten
⇒ Diskussion und Bildung von Normen (U6)
⇒ Soziales Kapital erhalten

Literatur

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