Regime Shifts in Ecosystem Services

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Introduction

What is a regime shift?

A regime shift is a large, abrupt, persistent change in the structure and function of a system. We focus on regime shifts that lead to large, persistent changes in the bundle or suite of ecosystem services produced by a social-ecological system.

Why are regime shifts important?

- Often have large impacts on human wellbeing
- Often occur unexpectedly
- May be difficult, costly or impossible to reverse

What are examples of regime shifts?

Clear water lake

Turbid lake

Coloured corals

Bleached corals

How do regime shifts work?

Complex systems contain many components linked by feedback loops. As the system evolves, one or more feedbacks tends to become dominant, so that the system becomes structured and functions in a particular way – forming a particular regime. Dominant feedbacks tend to be self-reinforcing, creating conditions that enhance their persistence, and making regimes "sticky" once they form.

A regime shift occurs when a switch in the dominant feedbacks occurs, and is often associated with rapid non-linear change as the system reorganizes into a different structure and function. Such a switch can occur when a large shock (eg hurricane) overwhelms the dominant system feedbacks. More commonly, a gradual change (eg habitat loss) slowly erodes the strength of the dominant feedbacks until a threshold is reached at which a different set of feedbacks suddenly becomes dominant and the system rapidly becomes reorganized into a new regime. The slow erosion of feedbacks usually goes unnoticed until the actual regime shift occurs – hence it is often a surprise.

The Regime Shifts Database

Purpose

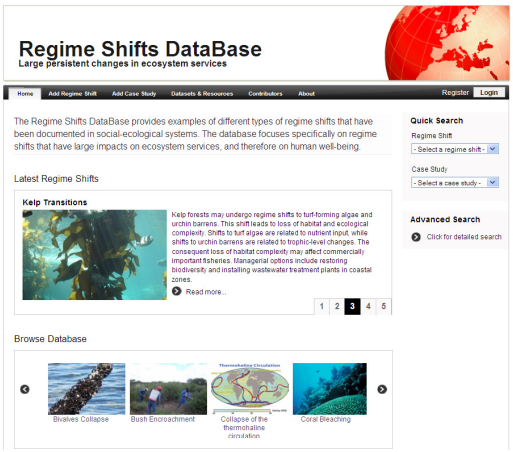
•To provide a high quality synthesis of different types of regime shifts documented in social-ecological systems, including their impacts on ecosystem services, drivers of the shift, and key feedbacks that maintain each regime.
•Develop consistent ways to identify and analyze regime shifts in social-ecological systems.

Uses

As input to: – Resilience and ecosystem assessments in particular areas – Research projects on regime shifts – Information for practitioners and ecosystem managers – Teaching resource – Information for students

Each entry describes

- The different regimes that can exist in the system
- Ecosystem services provided by each regime, and which societal groups benefit from these services
- Feedback mechanisms that maintain each regime
- Drivers of shift, including shocks, slow internal system changes, external direct drivers, external indirect drivers
- Management options to maintain a desirable regime or to transform to/restore a desirable regime
- Ecosystem type and land use under which the regime shift typically occurs
- Typical spatial & temporal scale at which regime shift occurs
- Evidence in support of the shift, inlcuding observations, models, experiments, paleo-data
- Confidence about the existence of the regime shift and the underlying feedback mechanisms
- Links to other regime shifts
- Diagrams or photographs illustrating the different regimes



Some examples

Regime 1	Regime 2	Ecosystem type	Key feedbacks	Key drivers	Ecosystem service impacts	Evidence	Confidence
Coral-dominated reef	Algae-dominated reef	Marine & coastal	Herbivory feedback	Fishing, disease	Fisheries, natural hazard protection, tourism, aesthetics	Models, observations, experiments	Well established
High bivalve mollusc abundance	Low bivalve mollusc abundance	Marine & coastal, freshwater lakes & rivers	Filtration – water clarity	Overharvesting of molluscs	Freshwater, fisheries, water purification, aesthetics	Models, observations, experiments	Well established
Old river channel position	New river channel position	Freshwater lakes & rivers	River sediment – gradient- current	Floods, erosion	Freshwater, crops, fisheries, water regulation, soil erosion regulation, natural hazard regulation, aesthetics	Models, observations	Well established
Clear lake	Turbid lake	Freshwater lakes & rivers	Dissolved oxygen – algae feedback	Fertilizer runoff	Freshwater, fisheries, water purification, pest & disease regulation, recreation, aesthetics	Models, observations, experiments	Well established
Non-saline topsoil	Saline topsoil	Drylands	Water table & dissolved salts	Clearing of deep-rooted vegetation	Food crops, water purification, regulation of soil erosion	Models, observation, experiments	Well established
Open grassy savanna	Closed wooded savanna	Savannas, drylands, grasslands	Fire, herbivory	Overgrazing, excusion of fire and browsers	Livestock production, woodfuel, climate regulation	Models, observation, experiments	Contested
Forest	Savanna	Forests, savannas	Albedo-moisture feedback, fire	Deforestation, forest degradation	Biodiversity, freshwater, food crops, livestock, timber, woodfuel, climate & water regulation	Models, observations	Contested
Arctic with summer ice	Arctic without summer ice	Polar, Marine & coastal	Ice-albedo mechanism	Greenhouse gas emissions	Wild animal and plant foods, climate regulation, water regulation	Models, observations	Contested
Strong thermohaline circulation	No thermohaline circulation	Marine & coastal	Salinity feedback	Freshwater influx due to climate warming	Fisheries, food crops, livestock, climate regulation	Models, paleo-observation	Contested

Research Projects

Global change drivers of regime shifts

Juan Carlos Rocha, PhD student

The aim of this project is to investigate the main global change drivers of regime shifts, and the impacts of regime shifts on global change drivers. I used a network analysis approach based on causal loop diagrams. Preliminary results show that agricultural processes, global warming, biodiversity loss, demographic and economic drivers are the main causes of regime shifts.

Building resilience to climate-driven regime shifts

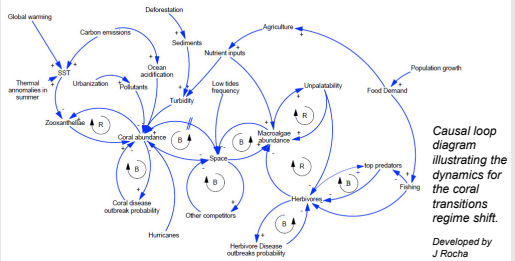
Rolands Sadauskis, MSc student

This project investigates options for building resilience to climate change driven regime shifts. "Leverage points" for building resilience are identified from causal loop diagrams and an analysis of feedback mechanisms at different scales. The project also analyzes how IPCC adaptation and mitigation strategies are likely to influence the resilience of climate-driven regime shifts.

Poverty traps as regime shifts

Johnny Musumbu, MSc student

This project analyzes social-ecological poverty traps related to livestock herding and soil nutrient depletion in sub-Saharan Africa as regime shifts. A set of interventions or leverage points were identified to change the dynamics of the systems and shift them towards more desirable regimes.



Causal loop diagram illustrating the dynamics for the coral transitions regime shift.

Developed by J Rocha

Regime shifts in agro-ecosystems: Impacts on ecosystem services

Christine Hammond, MSc student

This project characterizes the ecosystem service impacts of regime shifts in agro-ecosystems. Methods for qualitatively assessing the changes in ecosystem services associated with regime shifts, as well as the different stakeholders/users that benefit or lose under the different regimes, have been developed. Results will be illustrated and discussed in terms of management trade-offs.

Conversion to agriculture as a regime shift

Daniel Ospina, MSc student

This project analyzes the conversion from forest-dominated to agriculture-dominated landscapes as regime shifts. The project brings together 1) insights about the social-ecological feedback mechanisms underlying this conversion based on the forest transitions literature, and 2) an empirical detection of regime shifts by looking for evidence of multi-modality in global land-cover datasets.

Please contribute or suggest examples!

www.regimeshifts.org

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