Stockholm Resilience Centre

Brief

May 2018

Regime shifts: The challenge of sudden, long-lasting changes in social-ecological systems

PHOTO: F. MIKULCAK

Brief abstract/summary

Regime shifts are large, persistent changes in social-ecological systems. They persist over time, because of internal feedback processes that reinforce the new state of the system. Regime shifts have been shown to affect a range of systems for example coral reefs, freshwater lakes or savannah rangelands, and the people that interact with them. Common to all of them is that they often occur rapidly, are difficult to anticipate, and may be costly or even impossible to reverse.

Key messages

- Regime shifts are sudden, long-lasting changes in the way a social ecological system works that can have substantial impact on ecosystem services and human well-being.
- Preventing undesired regime shifts requires knowledge of the types of pressures that lead to different regime shifts, and tools to identify and detect early warnings.

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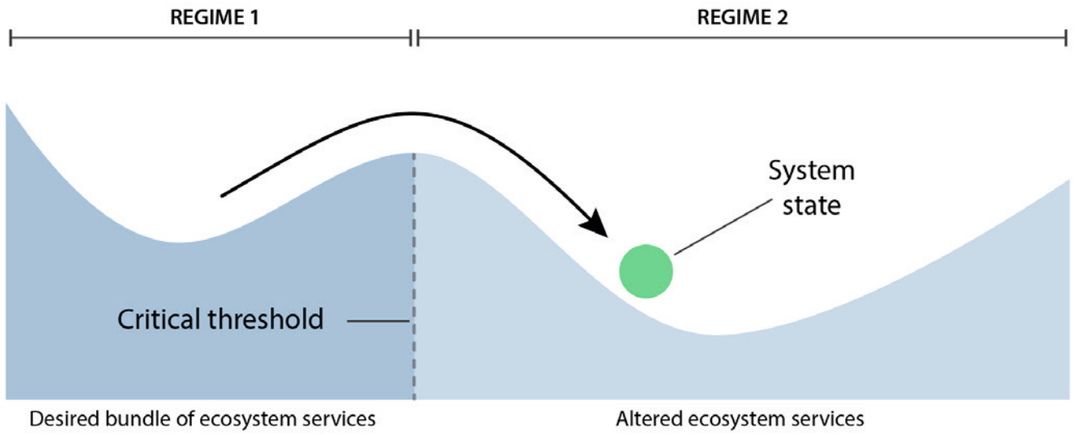
A programme funded by the
Swedish International Development Cooperation Agency (Sida)

BRIEF 2018



A system crossing a critical threshold (tipping point) and entering a new regime is often illustrated as a ball rolling out of one 'basin' into another. Although the ball can move around within the basin as long as the same feedback dynamics dominate it tends to stay within a single regime unless it passes a critical threshold. Illustration: J. Lokrantz/Azote Images

Regime shifts result from complexity

Social-ecological systems are characterised by many interacting processes, sometimes mutually affecting each other in 'feedback loops'. Feedback loops influence how a system evolves over time and responds to outside pressures or changes. 'Stabilising feedback loops' tend to maintain a system in the same basic state by counteracting changes, while 'reinforcing loops' can accelerate change leading to sudden dramatic changes in how a system looks and behaves. In a simple example of a fishery, a stabilising feedback occurs when a decline in fish stocks and catches causes fishers to switch to other livelihoods and fish less, allowing fish stocks to recover. In contrast, a reinforcing feedback would exist if fishers respond to declines by fishing more intensively, creating a vicious cycle, which reinforces the decline of the stocks.

In any complex social-ecological system, some combination of feedbacks will become dominant over time, leading the system to settle into a particular structure and behaviour, or 'regime'. Slow pressures on ecosystems, such as ongoing pollution, or a sudden shocks can disrupt dominant feedbacks so that a different set of feedbacks become dominant, leading to a sudden and dramatic change how the system looks and behaves. This is a regime shift[1]. For example, a freshwater lake may absorb a certain amount of pollution without apparently being affected, but when a tipping point in the level of pollution is passed it may suddenly shift from a clear-water state that supports fisheries to an algae-dominated state with insufficient oxygen for fish life[2].

When a system is close to a tipping point, even a small perturbation that usually would not have any dramatic impact can tip the system into a new regime[3]. Examples of perturbations include climatic fluctuations, large storms, fires, invasive species, or a disease outbreak. Slow and gradual changes, such as a lake slowly becoming more loaded with phosphorous pollution, can push a social-ecological system towards a tipping point without any obvious sign of change. Then small perturbations can cause the clear lake to flip to an algae-dominated regime[2].

1 Biggs, R., et al. 2012. Toward principles for enhancing the resilience of ecosystem services', Annual review of environment and resources 37,421–448.
2 Carpenter, S.R., O. Kinne, and W. Wieser (2003) 'Regime shifts in lake ecosystems: pattern and variation' (Vol. 15). *Oldendorf/Luhe: International Ecology Institute.*
3 Scheffer, M. 2009. Critical Transitions in *Nature and Society.* Princeton University Press, New Jersey

Agricultural landscapes incorporating trees provide a range of ecosystem services to Niger's arid region farmers. Intensification of agriculture, tree felling and human population increases in many regions have precipitated a regime shift in many areas to a desert landscape with the loss of ecosystem services from patches of trees and shrubs. Photo: F. Mikulcak

Case study: A social-ecological regime shift: Maradi Agro-ecosystem

The arid landscape of Niger's Maradi Region is historically characterized by sparse rural populations cultivating small fields amidst surrounding bush. Fallow areas, with regenerating trees and shrubs, and natural woodland helped to maintain soil productivity while providing a range of non-agricultural ecosystem services such as water conservation, natural timber and other forest products.

However, since the 1930's land clearing and tree-felling became common practices as the colonial administration implemented policies that incentivised farmers to intensify agriculture, switch to export crops such as cotton, and to clear native trees and shrubs. Loss of trees and shrubs exposed soils to erosion further decreasing soil fertility and tipping the system into a reinforcing feedback loop accelerated the shift towards a desert ecosystem. The shift impacted the biodiversity of the area and impacted provisioning services such as fuelwood and food for local communities. This directly affected human wellbeing, with increased poverty, hunger and malnutrition.

Why do regime shifts matter for development?

Regime shifts have both social and ecological consequences and causes, at a range of scales from changes in the ecology of a single lake to fundamental changes to global climate[4]. Regime shifts change the supply and range of ecosystem services, or benefits, that people obtain from ecosystems. These include services or 'goods' such as timber or fish, climate regulation and recreational and aesthetic benefits, which impacts human economies, security and health[5]. Managing systems in the face of regime shifts involves avoiding undesirable shifts, reversing them when possible or encouraging shifts that are considered more desirable. Setting boundary levels on the safe side of tipping points, and monitoring change can help detect if a system may be approaching a regime shift. It is also critical that potential tipping points are periodically reassessed, as they can change over time.

4 Lenton, T.M., H. Held, E. Kriegler, J.W. Hall, W. Lucht, S. Rahmstorf, and H.J. Schellnhuber (2008) 'Tipping elements in the Earth's climate system' *Proceedings of the national Academy of Sciences*, 105 (6), 1786-1793.

5 Rocha, J. C., G.D. Peterson, and R. Biggs. 2015. 'Regime Shifts in the Anthropocene: Drivers, Risks, and Resilience', PLoS ONE, 10, e0134639.

Further reading

Tipping into the future

A history of tipping points from an ecological perspective and how they inform resilience thinking in global development
Rethink article, 11 January 2018

The Regime Shifts Database
(www.regimeshifts.org)
provides a synthesis of different types of regime shifts documented in social-ecological systems, including their key drivers, impacts on human well-being and possible management and governance interventions.

GRAID insight briefs

This brief is part of a series which introduce key insights from social-ecological resilience research, and how they relate to challenges of development in the Anthropocene.

Human actions increasingly dominate the biosphere, the thin living surface of the earth on which people depend. The complex feedbacks between social and ecological processes and interconnections and between different places can lead to surprising sudden changes, as well as inertia in undesirable states. Awareness of the Anthropocene challenge and the complex behaviours of social-ecological systems highlights the need to embrace uncertainty, explore how stewardship can be supported at different scales, and for transformational change for a sustainable and just development.

For the full text of all briefs in this series visit www.graid.earth

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