

The Transformation Process as an Adaptive Cycle Illustrated by Recovery from Desertification in Shinyanga

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Abstract

The paper delineates a framework for social-ecological system assessment and transformation based on Holling's adaptive cycle. It considers assessments of disturbance beyond the biophysical system's capacity to recover. The transformation process for recovery is depicted as an adaptive cycle of using human and economic resources (exploitation phase), accumulating knowledge as well as social, cultural, and economic capital (accumulation phase), formulating new approaches to biophysical system management (disturbance phase), and developing new institutional arrangements (reorganization phase). The transformation process leads to the implementation of management interventions for the biophysical system. Interventions relate to the four phases of the biophysical system adaptive cycle: (1) reducing pressure on the resource (exploitation phase), (2) addressing legacy issues (accumulation phase), (3) increasing system resilience (disturbance phase), and (4) rehabilitating adverse effects (reorganisation phase).

In Shinyanga, Tanzania, before colonial occupation, there were intact Miombo and Acacia woodlands. Woodland clearance to eradicate tsetse flies and expand agriculture led to soil erosion and desertification. Centralized attempts at restoration by the colonial government, and subsequently the independent government, failed to be implemented. When a new centralized program was established in 1986, the program manager found he needed to work in partnership with local farmers and incorporate traditional knowledge and institutions to be effective. The traditional practice of ngitili enclosures (areas of standing vegetation that remain closed to livestock during the wet season to be used as fodder resources during the dry season) was integrated with modern agroforestry techniques. A nested system of village, regional, and national institutions was created, and international financial contributions were received. Restoration of woodlands was achieved, and other ecosystem services increased, such as wood supply, bringing economic benefits and improving biodiversity. Sustainability analysis identified disturbance threats to be managed for ongoing sustainability, such as population growth, elite capture of benefits, and rule compliance by neighboring villages.

Introduction

The paper sets out a framework for social-ecological assessment and transformation based on Holling's adaptive cycle (Holling and Gunderson, 2002). There are three main components:

- the assessment of disturbance beyond the capacity of a biophysical system to recover,
- the steps of the transformation process as phases of an adaptive cycle, and

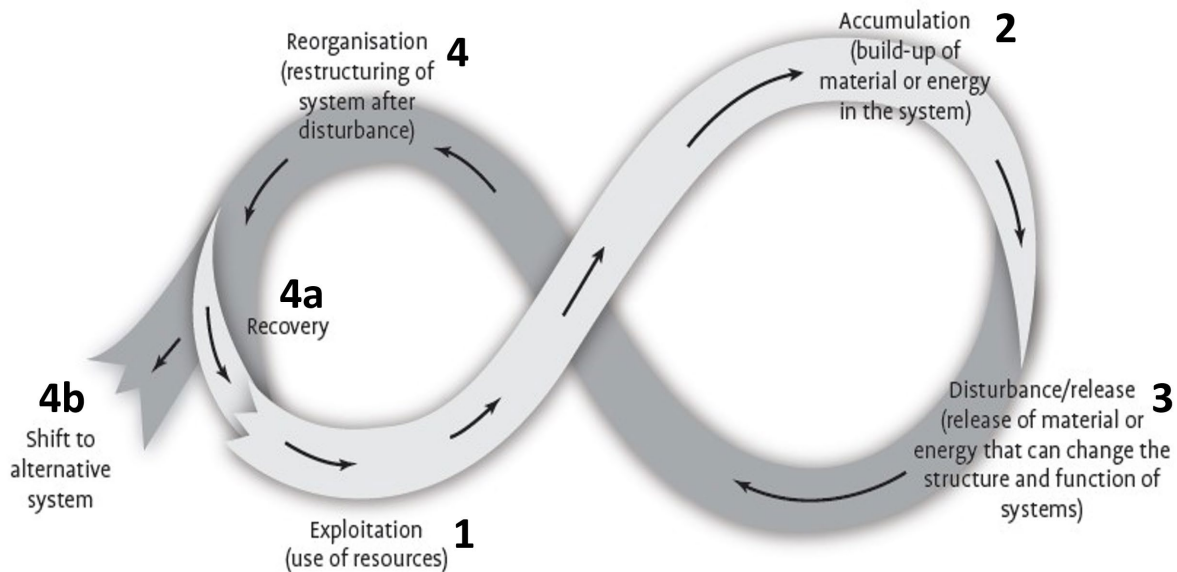
● the implementation of management interventions to the biophysical system. The framework is illustrated by a case study from Shinyanga, Tanzania. Woodland clearance for agricultural development and control of tsetse fly led to desertification. Attempts by the central government to restore the landscape failed. However, landscape transformation was achieved through a partnership between the government and local farmers, incorporating traditional knowledge and institutions.

Operational Basis for Sustainability

Panarchy theory provides an operational basis for sustainability using the adaptive cycle to describe how ecological or social systems can be sustained.

As shown in Figure 1, there are four phases of the adaptive cycle (Holling and Gunderson 2002, Jenkins 2016a):

- first, the exploitation phase, which is the use or harvesting of resources,
- second, the accumulation phase, which is the storage of material or energy in the system,
- third, the disturbance phase, where changes to the structure and function of the system can occur, and
- Fourth is the reorganization phase, which is the restructuring of the system after disturbance.



PHASES OF THE ADAPTIVE CYCLE	1 Exploitation – Use of resources
	2 Accumulation – Build-up of material or energy
	3 Disturbance – Release that change the system
	4 Reorganisation – Restructuring after disturbance
	4a Recovery
	4b Shift to an alternative system

Figure 1: Four Phases of the Adaptive Cycle (adapted from Holling and Gunderson 2002)

The adaptive cycle can be sustained if the resources continue to be available and the system can recover from disturbance. This is path 4a in Figure 1. Otherwise, the system may shift to an alternative, usually degraded system state. This is path 4b in Figure 1.

Types of Assessment and the Adaptive Cycle

Associated with each phase of the adaptive cycle, there are different types of assessment, as shown in Figure 2 (Jenkins, 2023). For the exploitation phase, there is the process of impact assessment, which is common for new developments. For the accumulation phase, there is cumulative assessment, which examines the incremental impact of actions when added to past, present, and reasonably foreseeable future actions. For the disturbance phase, there is resilience assessment, which analyses potential pathways for system failure and the thresholds of critical variables associated with system collapse. For the reorganization phase, there is recovery assessment, which is the process of developing management interventions to address environmental damage and degradation.

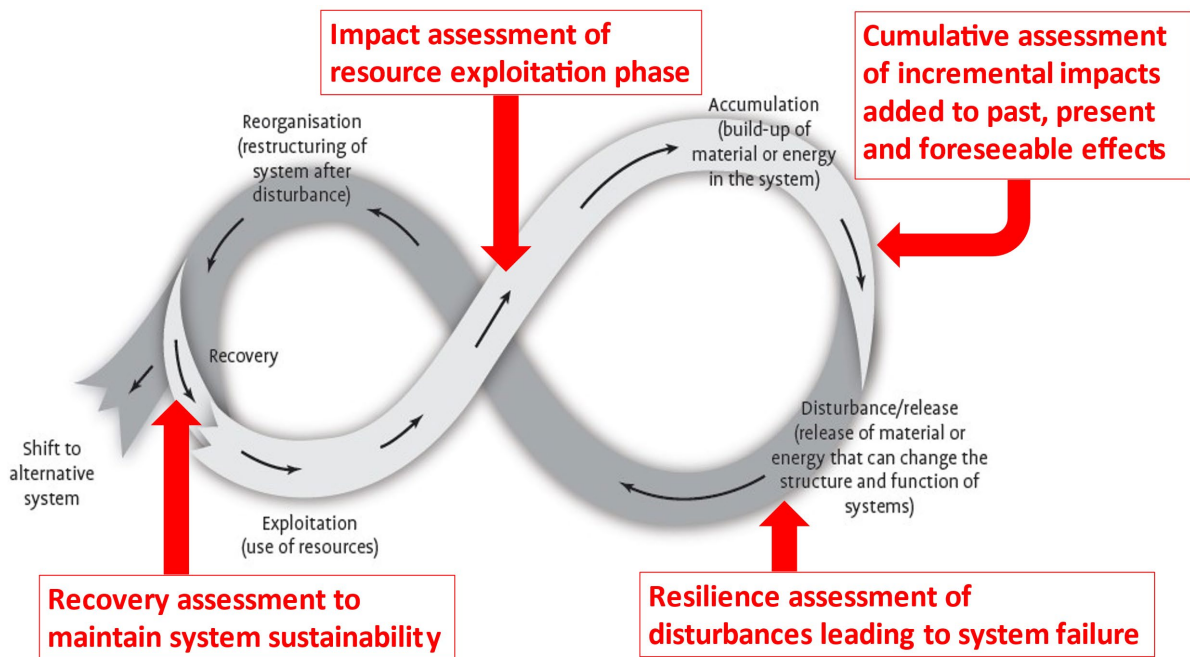
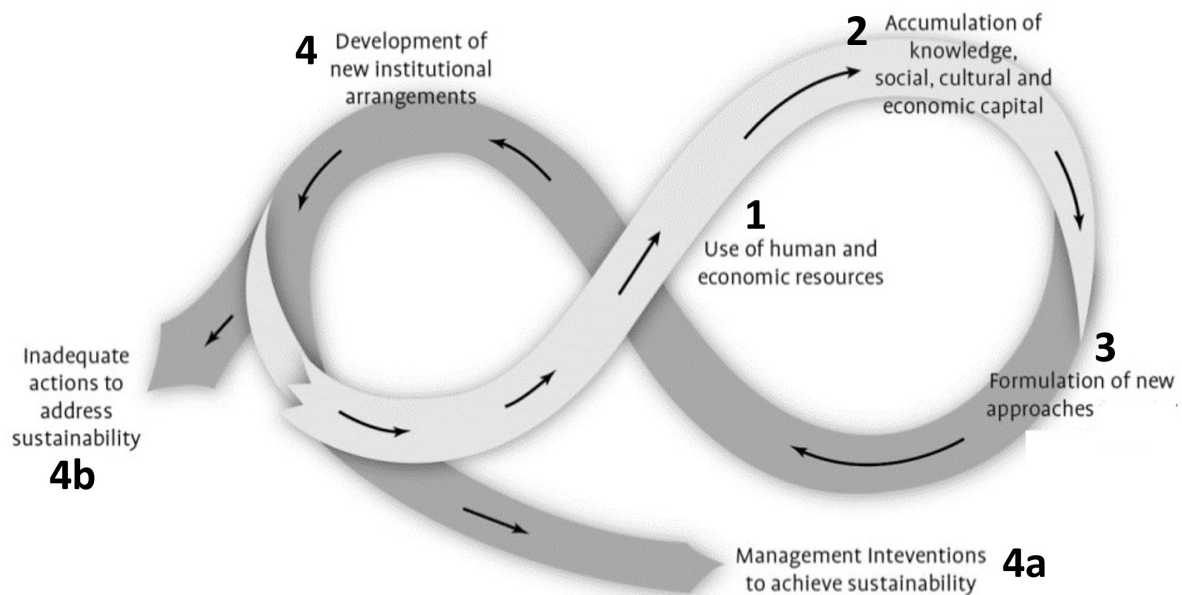


Figure 2: Types of Assessment and the Adaptive Cycle (Jenkins 2023)

Transformation Process as an Adaptive Cycle

The steps in the transformation process can be depicted as phases of an adaptive cycle, as shown in Figure 3 (Jenkins 2018). The exploitation phase is the use of human, technical, and economic resources to address a resource management issue. The accumulation phase is the accumulation of knowledge and social, cultural, and economic capital to develop integrated approaches to sustainability strategies. The disturbance phase is the formulation of new approaches to management that change existing practices. The reorganization phase is the development of new social systems to implement new approaches to management. New social systems can lead to adopting management interventions leading to a sustainability

strategy. However, failure to adopt appropriate interventions will lead to inadequate actions to achieve sustainability.



TRANSFORMATION PROCESS	1 Exploitation – Use of Resources
	2 Accumulation – Accumulation of Knowledge
	3 Disturbance – Formulation of New Approaches
	4 Reorganisation – New Institutions 4a – Management Interventions 4b – Inadequate Actions

Figure 3: Steps of the Transformation Process as Phases of an Adaptive Cycle (Jenkins 2018)

Interventions for each phase of the Adaptive Cycle

The output of the transformation process are management interventions to achieve sustainability of the biophysical system. Interventions can be developed for each phase of the adaptive cycle.

Adapted from Chapin’s approaches to fostering sustainability (Chapin et al. 2009), these are:

- reducing pressure on resources in the exploitation phase,
- addressing legacy issues of accumulated changes in the past in the accumulation phase,
- increasing the resilience of the system in the disturbance phase, and
- rehabilitating adverse effects on the system for the reorganization phase (Jenkins 2016a).

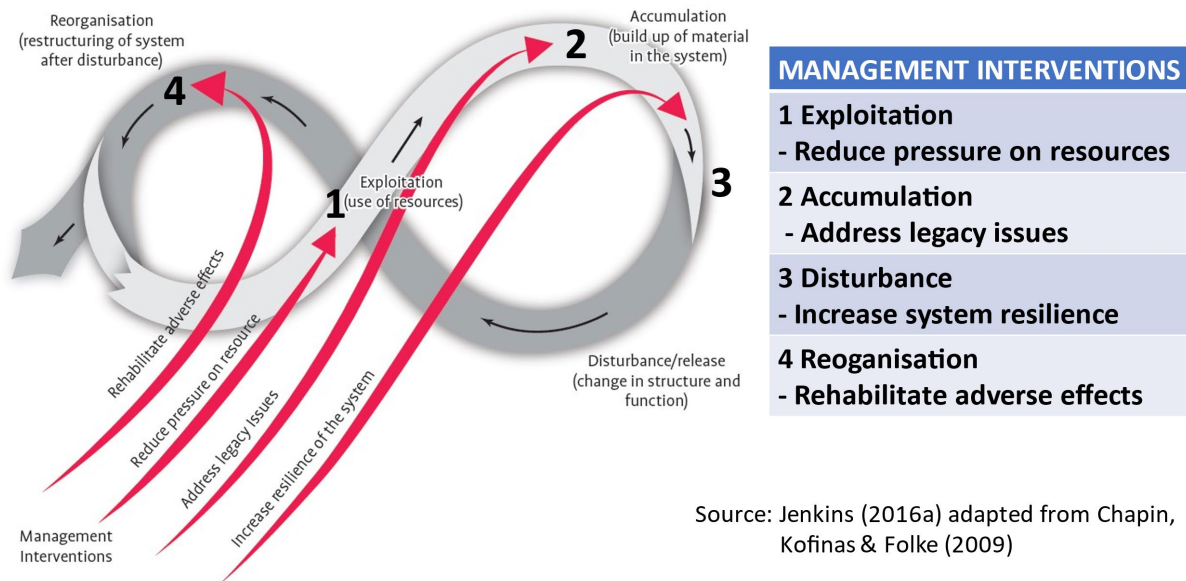


Figure 4: Management Interventions for each Phase of the Adaptive Cycle

Shinyanga Degradation

Shinyanga is a semi-arid region in the north of Tanzania. There is a pronounced dry season from May to November. The dominant native vegetation is Miombo and Acacia woodland. The Sukuma people, who are agro-pastoralists, are the majority of the population (Chazdon and Spiers 2021).

Large-scale deforestation and bush clearing have converted much of the land into an open savannah and agricultural landscape. Both the colonial government and, after independence in 1961, the Tanzanian government attempted restoration using top-down approaches. However, these efforts were not taken up by farmers and were unsuccessful (Barrow 2016).

Shinyanga Recovery

The failure of another top-down approach in the 1980s led the project leader to adopt a more participatory and community-based approach. A key innovation was to revive the traditional practice of *ngitili*. Ngitilis are areas of standing vegetation that remain closed to livestock from the beginning of the wet season and are opened for livestock at the peak of the dry season to provide fodder (Kamwenda 2002). This takes grazing pressure off the rest of the landscape. Modern agroforestry practices, including the planting of woodlots and fodder banks and the use of nitrogen-fixing trees to increase fertility and crop yields, were incorporated (Pye-Smith 2010).

Traditional institutions were used to manage the ngitilis. This was the responsibility of a community assembly or Dagashida. Compliance was also through a traditional approach using local patrols or Sungusungu (Duguma et al. 2013). A key success of the restoration of ngitili has been the cooperation of traditional and formal institutions (Barrow 2014). The village government establishes and institutes local bylaws that are compatible with traditional

rules. It also participates in conflict resolution when issues cannot be resolved at the community level. There was also institutional support at regional, national, and international levels (Kilahama 1994).

The outcome of the transformation was not only the recovery of vegetation and biodiversity but also increased productivity for farmers with increased fodder, fuel, and construction materials (Monela et al. 2005).

Shinyanga as Assessment and Transformation Process

The Shinyanga recovery from desertification can be shown in the framework for social-ecological assessment and transformation. Figure 5 shows the process steps through assessment, transformation, and implementation.

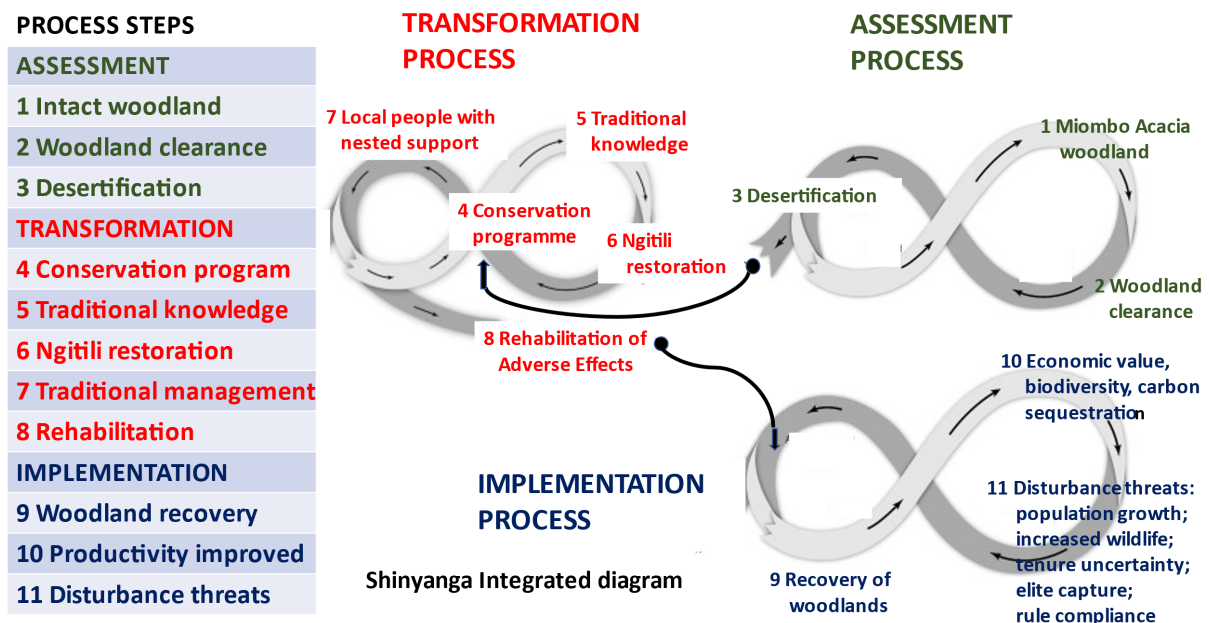


Figure 5: Shinyanga as Assessment and Transformation Process

The Assessment Process commences at the accumulation phase of intact woodland (Step 1), followed by the disturbance of woodland clearance (Step 2) and the reorganization phase of desertification (Step 3).

The Transformation Process begins with the allocation of resources to a conservation program – the exploitation phase (Step 4). There is then the revival of traditional knowledge – the accumulation phase (Step 5) – and the development of a new management approach of ngitilis with complementary modern agroforestry techniques – the disturbance phase of the transformation process (Step 6). New institutional arrangements are put in place with traditional management working with formal government institutions – the reorganization phase (Step 7).

This is followed by implementation of the management intervention (Step 8). This leads to recovery of the woodland (Step 9) and the accumulation of economic value, biodiversity, and carbon sequestration (Step 10).

The value of the framework is not only to provide a description of the process but also to provide an analytical tool. The final step shown is the assessment of sustainability threats to the new system (Step 11). This includes population growth, increased wildlife and crop destruction, tenure uncertainty, elite capture, and compliance with rules.

Concluding Comments

The paper has set out a social-ecological assessment and transformation framework with:

- assessments for each phase of the adaptive cycle
- the steps of the transformation process are described as phases of an adaptive cycle and
- management interventions for each phase of the adaptive cycle

The paper has also shown the application of this framework to the recovery from desertification in Shinyanga, both as a description of the transformation process and as an analytical tool for sustainable management.

Interpretation of other case studies in this social-ecological assessment and transformation framework are being compiled by the Social Ecological Resilience and Transformation (SERT) thematic group of IUCN. The compilation focuses on successful transformations and the effective use of elements of the framework.

The framework has been used as an analytical tool for sustainability assessments. Management approaches for addressing eutrophication in six New Zealand lakes were analyzed. The analysis showed that the management interventions were reducing nutrient loads in each catchment, but the interventions were insufficient to achieve sustainable water management (Jenkins 2016a).

Furthermore, the framework has also been used as a design tool for identifying actions that can be taken to achieve sustainability. This has been undertaken at the catchment scale, where failure pathways that threaten the values associated with each lake and the critical variables associated with those pathways were determined. Using the adaptive cycle phases, potential management interventions were identified for transformation strategies for each lake (Jenkins 2016b). The framework has also been at the regional scale with nested adaptive systems to devise a regional water management strategy for the Canterbury Region of New Zealand involving actions at four spatial scales and a restructuring of institutional arrangements to address water availability and water quality impairment sustainability issues (Jenkins 2018, and Jenkins (in press)).

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