ID30_Jenkins_Outcome-Based Management for Sustainability, IAIA19 Brisbane

Abstract

EIA/SEA is based on effects-based management which involves assessing the adverse effects of proposed programs or projects and developing measures to avoid or mitigate those adverse effects. It places government in a regulatory role through assessment processes and compliance with conditions. However, EIA/SEA has not prevented environmental bottom lines from being exceeded and has led to further environmental degradation. The concept of sustainable development, particularly with the adoption of the UN Sustainable Development Goals requires a proactive role by government for programs and projects to achieve targeted outcomes. Rather than a reliance on proponent-led programs and projects and compliance with conditions, there is a need for outcome-based management. This involves sustainability strategies to meet multiple community outcomes, for programs and projects to be aligned with those strategies, and, for implementation to be audited against the achievement of outcomes. The paper sets out a systems approach for developing sustainability strategies through failure pathway analysis and management interventions to address the critical variables where resilience thresholds are threatened. Implementation requires projects to be aligned with the strategies, management systems demonstrating how compatibility can be achieved, and, management plans for specifying the measures to achieve the sustainability targets with independent auditing of plan adoption and outcome achievement.

Introduction

Environmental impact assessment (EIA) is “effects-based management”. Proposed projects are assessed for adverse effects and the intent of EIA is to avoid, remedy or mitigate significant adverse effects. The concept is to allow resource use and development activities while operating within environmental limits. The role of government is primarily one of a regulator in managing the assessment process, setting conditions of approval and monitoring compliance with those conditions.

However, when environmental limits of resource availability or the cumulative effects of development are reached, then effects-based assessment of further development can only lead to rejection of that development if environmental limits are applied or impacts beyond environmental limits if development is approved. While EIA has brought the consideration of environmental factors into development decisions, the evidence from state-of-environment monitoring is that environmental outcomes are being compromised.

To achieve sustainable development when environmental limits have been exceeded requires proactive interventions to address environmental degradation, i.e. sustainability strategies. Sustainability strategies are needed to address the cumulative impacts of multiple users to achieve a satisfactory environmental outcome, i.e. “outcome-based management”.

This requires analysis at the bioregional scale relevant to the cumulative impacts in advance of further development. It also requires the consideration of existing users who are likely to have current environmental approvals. This means it is not sufficient to rely on compliance with conditions and regulations, rather incentives are needed to foster change among existing users. It is not just the biophysical system associated with the environmental impacts that needs to be considered in developing a sustainability strategy but also the socio-economic system including resource users, affected people, the community and government institutions. Implementation of a sustainability strategy also needs a financial mechanism.

Systems Approach for Sustainable Outcomes

Nested adaptive systems analysis provides a framework for developing sustainability strategies (Jenkins, 2018). There are seven major elements of this framework: (1) the adaptive cycle which defines the system response to disturbance; (2) socio-ecological systems as linked socio-economic and biophysical systems; (3) the nesting of adaptive cycles to link systems operating at different spatial and time scales; (4) the definition of failure pathways that can lead to system collapse; (5) the identification of critical variables and their thresholds leading to collapse; (6) the management interventions to address failure pathways; and (7) the sustainability strategy as a combination of interventions to achieve sustainable outcomes.

The Adaptive Cycle

The adaptive cycle describes how an ecological or social system can be sustained in obtaining resources for its survival, and its ability to accommodate disturbance and recover (Gunderson and Holling 2002). There are four phases: (1) Exploitation – the use or harvesting of resources; (2) Accumulation – the storage of material or energy in the system; (3) Release – the disturbance of the system; (4) Reoganisation – restructuring of the system after disturbance (Fig. 1).

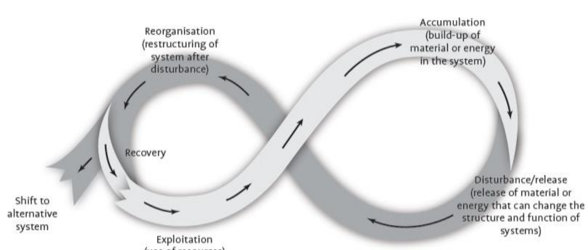

Fig. 1: The Adaptive Cycle
(adapted from Gunderson and Holling 2002)

The adaptive cycle can be sustained if the resources continue to be available and the system can recover from disturbance. Otherwise the system may shift to an alternative (degraded) system.

Socio-Ecological Systems

Socio-ecological systems are linked socio-economic and biophysical systems. This highlights four generic sustainability issues: (1) the capacity of a natural system to be sustained; (2) the impact of human activity on the natural system; (3) the contribution of natural systems to human activity; and (4) the capacity of the socio-economic system to be sustained (labelled 1 to 4 in Fig. 2). In this context, impact assessment of proposed developments is one component of issue 2 (the link from human activity to the natural environment). Ecosystem services are a positive expression of issue 3 (link from biophysical systems to socio-economic systems) while environmental disasters (like flooding and hurricanes) are a negative impact. Ecosystem management relates to Issue 1 (sustainable physical systems), while institutional analysis is an example of Issue 4 (sustainable socio-economic systems).

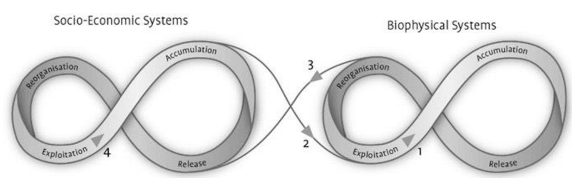

Fig. 2: Socio-ecological Systems (Jenkins 2016)

Nested Adaptive Systems

Sustainable management issues often involve multiple spatial and time scales that are linked, i.e. nested systems. Fig. 3 shows the example of relationship between nutrient contamination of a catchment and its linkages to algal blooms in a streambed.

The catchment adaptive cycle is (1) exploitation – nutrient intensive farms; (2) accumulation – the cumulative load of nutrient sources; (3) release – the discharge of nutrients into surface runoff and groundwater seepage; (4) recovery – nutrient attenuation. This is linked to the streambed adaptive cycle through the nutrient load to the stream with (5) exploitation - periphyton growth associated with nutrients, light and temperature; (6) accumulation – the build-up of periphyton cover on the streambed; (7) disturbance – the occurrence of algal blooms; and (8) recovery – from flushing flows or invertebrate grazing; or (9) ongoing algal blooms.

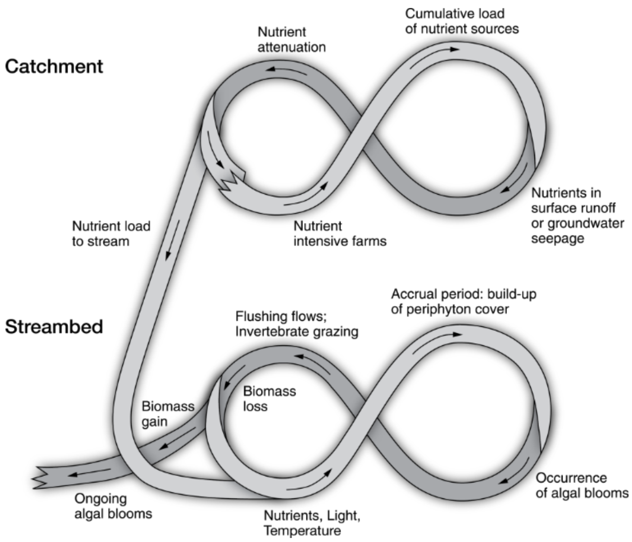

Fig. 3 Nested Adaptive Cycles for Algal Blooms in Rivers (Jenkins 2018)

Failure Pathways and Critical Variables

The nested adaptive cycles for algal blooms in rivers is an example of a failure pathway. This example was drawn from a sustainability analysis of water management in Canterbury (Jenkins 2018) where some rivers are experiencing an increasing frequency of algal blooms in catchments undergoing land use intensification. Bacterial contamination and sedimentation are two other forms of streambed degradation in Canterbury rivers. Analysis of the system is needed to find out what is driving the degradation. An analysis of six New Zealand lakes experiencing eutrophication indicated six different failure pathways (Jenkins 2016).

For the failure pathway it is necessary to identify the critical variable to be managed to achieve sustainable outcomes. Table 1 sets out the critical variables for algal blooms in Canterbury rivers. Examples are the nutrient loss rates associated with nutrient intensive farming, and the accrual period between flushing flows with respect to the build-up of periphyton in rivers.

Adaptive Cycle Phases	Critical Variables
Catchment exploitation Nutrient intensive farms	Nutrient loss rates
Catchment accumulation Cumulative load	Catchment contaminant load
Catchment Disturbance Contamination of surface runoff and groundwater	Nutrient concentration in runoff and seepage
Catchment Reorganisation Nutrient attenuation	Nutrient attenuation factors
Streambed exploitation River contamination	Nutrient, light and temperature levels
Streambed accumulation Build-up of periphyton	Accrual period between flushing flows
Streambed disturbance Potential for algal blooms	Periphyton cover Chlorophyll a level
Streambed reorganization Recovery from algal blooms	Flushing flows Invertebrate grazing

Table 1: Critical Variables for Algal Blooms in Rivers (Jenkins 2018)

Management Interventions

Management interventions in the biophysical system can be developed for each phase of the adaptive cycle. These have been adapted from the stewardship strategies of Chapin et al. (2009): (1) reducing the pressure on the resource in the exploitation phase; (2) addressing legacy issues of accumulated changes in the past in the accumulation phase; (3) increasing the resilience of the system in the disturbance/release phase; and (4) rehabilitating the adverse effects of the system for the reorganization phase (Fig. 4).

Management interventions for algal blooms in rivers are set out in Table 2. Note the suite of interventions involve actions by many parties, e.g. farm practices by farmers, catchment limits and environmental flows by the regional council, and, public health warnings by the Health Department. This requires new institutional arrangements to ensure coordination of the suite of interventions as part of the sustainability strategy.

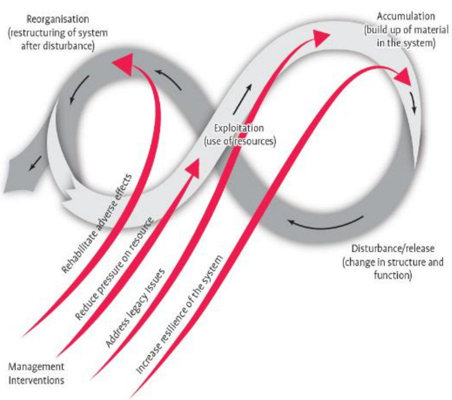

Fig. 4: Management Interventions for each Phase of the Adaptive Cycle (Jenkins 2016)

Adaptive Cycle Phases	Interventions
Catchment exploitation Nutrient intensive farms	Improved farm practices to reduce loss rates
Catchment accumulation Cumulative load	Catchment limit on contaminant load
Catchment Disturbance Contamination of surface runoff and groundwater	Riparian planting Woodchip bioreactors
Catchment Reorganisation Nutrient attenuation	Constructed wetlands
Streambed exploitation River contamination	Concentration limits for nutrients Streambed shading
Streambed accumulation Build-up of periphyton	Maintenance of flushing flows
Streambed disturbance Potential for algal blooms	Public health warnings
Streambed reorganization Recovery from algal blooms	Sediment removal to increase invertebrate habitat

Table 2: Interventions for Algal Blooms in rivers.

Institutional Arrangements for Interventions

An adaptive cycle can be described for the process of developing management interventions to achieve sustainability (Fig. 5). The four phases are: (1) the use of human and economic resources to address a sustainability issue (exploitation phase); (2) the accumulation of knowledge, social, cultural and economic capital to develop sustainability strategies (accumulation phase); (3) the formulation of new approaches that change existing practices (disturbance phase); and, (4) the development of new approaches to implement the new approaches (reorganization phase). This has the potential to lead to the adoption of management interventions to achieve sustainability. However, the failure to develop adequate actions will lead to ongoing degradation.

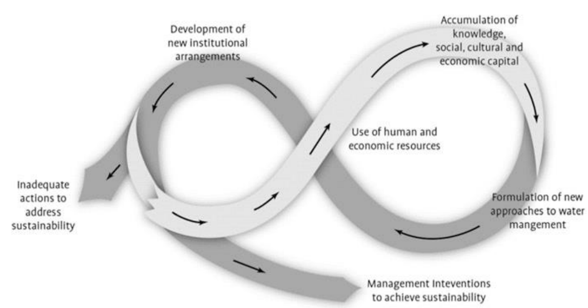

Fig. 5: Adaptive Cycle for Institutional Arrangements (Jenkins 2016)

Case study of the Pahau Catchment

One of the initial applications of sustainability strategies in Canterbury was in the Pahau Catchment, a tributary of the Hurunui River. An investigation of the cause of algal blooms in the Hurunui River identified that the Pahau Catchment was the greatest contributor of nutrients to the river. The outcome sought was the reduction of nutrient load.

A community/government partnership was formed to investigate issues, involve the community and implement improvements (Jenkins 2009). Actions agreed to by the community included controlling stock access to waterways and land use improvements by farmers, riparian plantings by landholders along river reaches, and, irrigation management improvements by the irrigation company. The regional council facilitated the process and provided extension advice. It also undertook water quality monitoring. The voluntary actions by the community led to a 60% drop in phosphorus load over 5 years (Fig. 6).

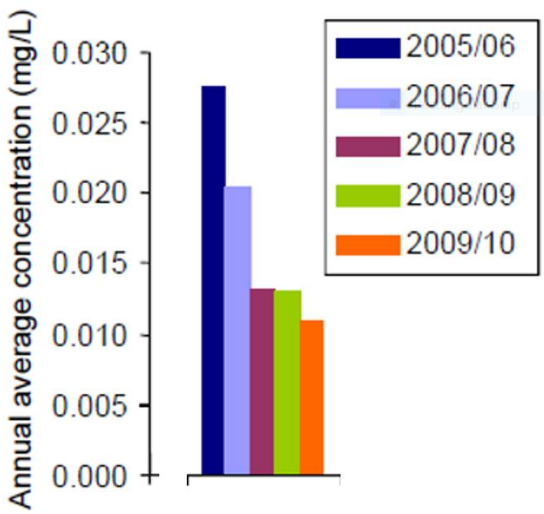

Fig. 6: Reduction in annual average phosphorus concentration in the Pahau River.

The success of this approach and other small-scale examples in Canterbury led to the development of a water management strategy being developed for the entire region based on nested adaptive systems with governance by self-managed communities (Canterbury Water 2009, Jenkins 2018).

Evolution or Revolution

The changes needed to develop sustainability strategies to address situations where environmental limits have been exceeded require a revolution in impact assessment rather than an evolution. Some of the key differences are: (1) a focus on outcomes rather than a focus on effects; (2) a framework based on systems analysis rather than impact assessment; (3) strategy-led development rather than proponent-led development; (4) consideration of all users not just proposed actions; (5) consideration of incentives not just regulation; (6) monitoring and management of aggregate and individual outcomes rather than monitoring compliance with conditions; (7) redesign of institutional arrangements rather than reliance on existing institutional arrangements; and, (8) need for a financial mechanism for implementation rather than relying on the proponents bearing the cost.

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