Resilience thinking improves SEA: a discussion paper

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Ecosystem resilience is the capacity of an ecosystem to recover after disturbance. A resilient ecosystem can withstand shocks and rebuild itself when necessary. Resilience in social systems has the added capacity of humans to anticipate and plan for the future. Humans are part of the natural world. We depend on ecological systems for our survival and we continuously impact the ecosystems in which we live from the local to global scale.

Resilience scientists have coined the term social-ecological systems to emphasise the interdependence between humans and nature, a concept that can be usefully adopted to encourage more holistic and participatory approaches to planning, based on local as well as scientific knowledge. Systems with high adaptive capacity are able to re-configure themselves without significant declines in crucial functions. A consequence of a loss of resilience, and therefore of adaptive capacity, is loss of opportunity, constrained options, an inability of the system to do different things. The effect of this is for the social-ecological system to emerge from such a period along an undesirable trajectory.

Since Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA) deal with the prediction of possible consequences of proposed changes (in either policies, plans, programmes or projects), and the management of potential consequences, it is clear that resilience thinking can provide "substance" to the world of impact assessment .

This paper is a summary of various papers and webtexts available through the Resilience Alliance (http://www.resalliance.org). As such, it contains many pieces of copy-pasted text without the proper references. However, this paper is not intended as a scientific document, but rather as an attempt to start a discussion between two worlds.

The Resilience Alliance is a small global group of scientists and their associates that develops and tests models of change processes in social-ecological systems with a view to improving understanding of what makes such systems more or less resilient to unexpected events or unintended consequences.

We will start by introducing the basic concepts of resilience thinking, and than develop some ideas on the implications for SEA practice.

1. Resilience thinking

A number of concepts of resilience thinking are explained briefly below.

Social-ecological systems

Resilience scientists have coined the term social-ecological systems to emphasise the interdependence between humans and nature Social-ecological systems are integrated systems of ecosystems and human society with reciprocal feedback and interdependence. The concept emphasizes the 'humans-in-nature' perspective. Although social and ecological components are identifiable, they cannot easily be separated for either analytical or practical purposes. The term ecosystem services similarly highlights human dependence on and benefits from nature, and adds weight to the growing need to consider social and ecological systems as part of a bigger, complex dynamic.

Adaptive Capacity

Adaptive capacity in ecological systems is related to biological diversity, and the heterogeneity of landscape mosaics. In social systems, the existence of institutions and networks that learn and store knowledge and experience, create flexibility in problem solving and balance power among interest groups play an important role in adaptive capacity. In both ecological systems and social systems the importance of memory and self-organization in the systems is critical in their capacities to adapt

Systems with high adaptive capacity are able to re-configure themselves without significant declines in crucial functions both in relation to the ecosystem services on which human well-being depends and in relation to social relations and economic prosperity. This resilience avoids crossing a threshold into an alternate, undesirable and possibly irreversible new state.

A consequence of a loss of resilience, and therefore of adaptive capacity, is loss of opportunity, constrained options during periods of re-organisation and renewal, an inability of the system to do different things. And the effect of this is for the social-ecological system to emerge from such a period along an undesirable trajectory.

The adaptive cycle of behaviour in complex systems

The adaptive cycle is a metaphor used to describe four commonly occurring phases of change in complex systems. The four phases are: exploitation, conservation, creative destruction (or release), and renewal (also referred to as r, K, omega, alpha).

During the slow sequence from exploitation to conservation, there is slow incremental growth and accumulation of capital; connectedness and stability increase. Competitive processes reflect succession in ecological systems, leading to a few species becoming dominant, with diversity retained in residual pockets preserved in a patchy landscape. For a maturing social or economic system, human and social capital are slowly accumulated, and skills enhanced and refined .

During the relatively rapid phase following an external disturbance or shock, the complex system begins to reorganize itself (creative destruction or release), leading ultimately either to restoration of the same structure and function, or to a different type of system.

Adaptive cycles are nested in a hierarchy across time and space, creating a nested hierarchy with a stabilizing nature. In essence, larger and slower components of the hierarchy provide the memory of the past and of the distant to allow recovery of smaller and faster adaptive cycles. A nested hierarchy of adaptive cycles represents a panarchy.

Panarchy

A panarchy considers the interplay between change and persistence. The dynamics of a system at a particular scale of interest, i.e., the focal scale, cannot be understood without taking into account the dynamics and cross-scale influences of the processes from the scales above and below it.

Adaptive cycles at different scales are linked by ‘revolt’ and ‘remember’ interactions:

- Revolt: critical change at one level cascades upwards and precipitates change at a higher level.
- Remember: facilitates renewal at the lower level by drawing on the capital stored in the higher larger cycle.

Resilience

Ecological systems provide a range of services that benefit society and support human health and well-being. Resilience of ecological systems is thus an important factor in looking at social-ecological resilience. Ecosystem resilience is the capacity of an ecosystem to tolerate disturbance without collapsing into a qualitatively different state. Resilience in social systems has the added capacity of humans to anticipate and plan for the future. Resilience is a property of these linked social-ecological systems (SES) and has three defining characteristics:

- The amount of change the system can undergo and still retain the same controls on function and structure;
- The degree to which the system is capable of self-organization;
- The ability to build and increase the capacity for learning and adaptation.

The key to resilience in social-ecological systems is diversity. Biodiversity plays a crucial role by providing functional redundancy; populations and species that may seem to be irrelevant for the

system, but may become important and maintain the integrity of functional groups within the system when conditions change (e.g. climate change). Similarly, when the management of a resource is shared by a diverse group of stakeholders decision-making is better informed and more options exist for testing policies. Active adaptive management whereby management actions are designed as experiments encourages learning and novelty, thus increasing resilience in social-ecological systems.

The 'flip side' of resilience is vulnerability: in ecological systems, threatened species or biotopes may be particularly vulnerable to the risk of extinction; in social systems, poor people or people lacking the means to adapt to, or recover from shocks or setbacks would be most vulnerable.

The challenges of managing socio-ecological systems

Social-ecological systems have some key attributes that make them intractable to conventional management approaches:

- they have non-linear dynamics with thresholds;
- the are self-organising and exhibit emergent behaviour;
- the effectiveness of management interventions depends on where a system is in the adaptive cycle and the relationship between the system of interest and systems at scales above and below that level.

In other words, interactions between people and nature at different levels of scale can lead to changes in ecosystem components that are neither predictable nor controllable. Social-ecological systems are thus subject to complex problems for which there are no definitive or objective solutions; very often, the very application of a solution may in turn create problems. Although the outcomes of events in complex systems cannot always be predicted and complex systems cannot be controlled, they can be influenced and optimally managed.

Participation and deliberation leads to trust and shared understanding; polycentric and multilayered institutions allow for more adaptive responses at appropriate levels; accountable authorities that pursue just distribution of benefit to vulnerable groups enhance the adaptive capacity of society as a whole. Similarly, forms of social capital such as leadership, social networks and trust appear to be important aspects of adaptability and thus resilience.

Many of the problems encountered in managing natural resources arise because of a mismatch between the scale of management and the scale(s) of the ecological processes being managed. Mismatches between the scales of ecological processes and the institutions that are responsible for managing them can contribute to a decrease in social-ecological resilience. Solutions to scale mismatches usually require institutional changes at more than one hierarchical level.

2. What does Resilience thinking mean for SEA?

Strategic Environmental Assessment comprises impact assessment on policies, plans or programmes. SEA moves beyond project-specific boundaries and addresses larger system interactions at regional or sectoral scales. For the wide range of problems with a spatial dimension, the landscape is the arena where human perception and actions meets ecological processes and ecosystem services. Here, spatial systems analysis and landscape ecology can provide useful methodologies.

SEA seeks to be more proactive and integrative than project level EIA, and vision-driven or objectives-led in its approach, allowing improved long term planning for sustainability. Given the different levels at which SEA can be applied, and the necessary consistency between, e.g., policy, plans and programmes, SEA makes the connections between forward planning tools that ultimately translate into projects on the ground ('tiering').

The concept of social-ecological systems in which the social, biophysical and also institutional environments are interlinked, creating one entity, puts the integration discussion in impact assessment

in perspective. According to resilience thinking it is impossible to think of environmental assessment in the biophysical sense only, something which up to present still is the most common approach to environmental assessment.

The characteristics of SEA provide an ideal vehicle for applying resilience thinking in practice, helping to distil out the key issues related to sustainability of both human systems and the ecological systems on which they depend. However, the complexity of social-ecological systems presents a major challenge for impact assessment practitioners striving to make confident predictions and management recommendations.

The main implications of resilience thinking for SEA are likely to include the following:

1. It is necessary to acknowledge complexity and unpredictability; this is a novel way of addressing SEA that has been underpinned by the notion of prediction. Essentially, resilience thinking posits that the systems are complex, uncertain, and unpredictable. Hence, managing development to retain systems resilience requires ongoing attention to auditing, monitoring and adaptive management.

2. Resiliency thinking requires a longer-term view that requires audit, monitoring and adaptive management, framed within criteria and indicators for resilience and sustainability.

3. Assessment of biophysical, social-economic and institutional-governance aspects in SEA is essential.

4. Defining the boundaries of the SEA to incorporate key social-ecological system interdependencies.

5. Visioning as part of the SEA is crucial to prioritising the values attached to components of social-ecological systems.

6. Scoping of the issues to be addressed in SEA must identify the priority interdependencies and most vulnerable elements of both social and ecological systems.

7. Specialist studies undertaken as part of an SEA must be undertaken collaboratively, rather than in ‘silos’, to ensure that the interdependencies between social and ecological systems are addressed in an integrated way.

8. Tiering and panarchy, and the interactions and influences of adaptive cycles and planning tools at various levels and scales, need to be addressed.

9. Interdependencies and complex dynamics between human and natural systems must be fully recognized in the conceptual approach to SEA, incorporated in the key questions being asked of SEA and the issues addressed, the integration of specialist studies to ensure that links are identified and assessed, and formulation of recommendations during SEA.

10. Looking at past behaviour of, and historical patterns of social-ecological systems should inform SEA (e.g. trends and characteristics with regard to the ability of systems to adapt, learn, recover).

11. A focus on ‘resilience of what’ and ‘resilience to what’, distinguishing between what can and cannot be managed, should help to focus SEA on priority issues.

12. Particular attention to the ‘resilience of whom’ (i.e. prioritising the most vulnerable parties) would benefit SEA and help to improve social-economic equity and sustainable livelihoods.

13. Identifying critical and irreplaceable elements of the system being assessed, where knowledge about their resilience is minimal, and/ or where unprecedented shocks or external disturbances on the system are likely. In these instances, the utmost precaution should be applied in evaluating potential impacts and risks.

14. More emphasis on governance, institutions and the level of management with regard to society's ability, commitment and preparedness to manage systems for resilience.

15. Increased emphasis on adaptive co- management. Adaptive co-management is an emerging approach for governance of social-ecological systems. Key features of adaptive co-management include: a focus on learning-by-doing; synthesis of different knowledge systems; collaboration and power-sharing among community, regional and national levels; and management flexibility. These features can promote an evolving, place-specific governance approach in which strategies are sensitive to feedback and oriented towards system resilience and sustainability.