



Resilience and Sustainable Development

**A REPORT FOR THE SWEDISH
ENVIRONMENTAL ADVISORY COUNCIL**

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What is resilience? Why is it important?

Ecosystem resilience describes the capacity of an ecosystem to cope with disturbances, such as storms, fire and pollution, without shifting into a qualitatively different state. A resilient ecosystem has the capacity to withstand shocks and surprises and, if damaged, to rebuild itself. In a resilient ecosystem, the process of rebuilding after disturbance promotes renewal and innovation. Without resilience, ecosystems become vulnerable to the effects of disturbance that previously could be absorbed. Clear lakes can suddenly turn into murky, oxygen-depleted pools, grasslands into shrub-deserts, and coral reefs into algae-covered rubble. The new state may not only be biologically and economically impoverished, but also irreversible.

Social resilience is the ability of human communities to withstand and recover from stresses, such as environmental change or social, economic or political upheaval.

Human and ecological systems are dynamic, interacting and interdependent. Resilience in such combined social-ecological systems concerns:

- how much shock the coupled human and natural system can absorb and still remain within a desirable state
- the degree to which the system is capable of self-organization
- the degree to which the system can build capacity for learning and adaptation

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Ecosystems are the basis for social and economic development

Examples from around the world demonstrate the dynamic interplay of resilience, diversity and human development.

In the Baltic Sea region, natural and restored wetlands retain 10–20 per cent of nitrogen emissions from human activities, curbing negative environmental effects such as eutrophication in the Baltic Sea. In China, the remaining forests in the upper Yangtze river catchment area have been estimated to be ten times as valuable left standing as they are cut for timber, because they help control flooding.

In some cases, ecosystem services can be valued based on the cost of providing the same service without nature's help. In 1996, New York City decided to invest almost \$1.5 billion to protect and restore a watershed in the Catskill Mountains that provides freshwater to the city. The capital cost of building a filtration plant would have been about 5-6 times higher, not including annual operational costs of about \$300 million.

When the supply of ecosystem goods and services is diminished, human societies suffer from effects such as soil erosion, floods and crop failure. These effects can have grave implications for human health, wealth, livelihood, food security, social cohesion, and even democracy. Therefore, actively promoting ecosystem resilience is critical to ensuring future human welfare.

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Gradual loss of resilience can lead to unexpected collapse

There is increasing evidence that ecosystems seldom respond to gradual change in a gradual way. Lakes often appear to be unaffected by increased nutrient concentrations until a critical threshold is passed and the water shifts abruptly from clear to turbid. Submerged plants suddenly disappear and animal and plant diversity is reduced – an undesired state from both a biological and economic point of view. Substantially lower nutrient levels than those at which the collapse of the vegetation occurred are required to restore the system. The economic and social intervention involved in a restoration is complex and expensive, and sometimes even impossible.

Studies of rangelands, forests, and oceans also show that **human-induced loss of resilience can make an ecosystem vulnerable to random events like storms or fire that the system could earlier cope with.** An ecosystem with low resilience can often seem to be unaffected and continue to generate resources and ecosystem services until a disturbance causes it to exceed a critical threshold. Even a minor disturbance can cause a shift to a less desirable state that is difficult, expensive, or even impossible to reverse.

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Building resilience is necessary in view of global change

Managing for resilience enhances the likelihood of sustaining development in changing environments for which the future is unpredictable and surprise is likely. When massive transformation is inevitable, resilient systems contain the components needed for renewal and reorganization.

Recent research indicates that we will have to increase the resilience of our social-ecological systems considerably if we are to cope with future climate change and other components of global change. According to new findings, “catastrophes” caused by for example storms, fire and flooding have become more common. This is a result of a combination of human-altered disturbance patterns in nature, and reduced social and ecological resilience. Coral reefs, mangrove forests and other coastal wetlands protect human settlements from coastal storms. Forests and wetlands work as “sponges” that absorb floodwaters. Unfortunately, we have eroded resilience in many natural systems to the extent that their ability to protect us from disturbance has diminished. In addition, the resilience of many social systems to natural catastrophes has been reduced as human population growth has forced people to settle and organize economic activities in vulnerable areas.

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Diversity in social and ecological systems is the key to resilience

Biodiversity plays a crucial role in ecosystem resilience by spreading risks, providing “insurance”, and making it possible for ecosystems to reorganise after disturbance. Ecosystems seem to be particularly resilient if there are many species performing the same essential function (such as photosynthesis or decomposition) and if species within such “functional groups” respond in different ways to disturbances. Then, species can replace or compensate for each other in times of disturbance. When humans reduce biodiversity or favour monocultures, ecosystems tend to become vulnerable.

In a coral reef, several species graze on algae. Due to overfishing in the Caribbean, one of the species, a sea urchin, became a dominant grazer throughout the region. However, a disease hit the sea urchins and they were decreased drastically. This resulted in a shift from a coral to an algae-dominated state resulting in reduced biodiversity and a decreased capacity to support human society.

A diversified decision-making structure is critical to building resilience in social-ecological systems. This implies that ecosystem management is shared by subunits of various sizes and scales, from national governments to local villages. It allows for testing of rules and policies over the short, medium and long term as well as at local, national and international levels. It enables social institutions to better match ecological processes.

Resilience and sustainable development: policy recommendations

Resilience in social-ecological systems is the key to sustainable development. To sustain development in a world in transformation, policy must enhance resilience and sustain social-ecological systems in the face of surprise, unpredictability and complexity. Further, policy needs to strengthen the perception of humanity and nature as interdependent and interacting. In particular, this requires:

- An active, adaptive management approach acknowledging uncertainty and expecting surprise, that treats policies as hypotheses and management as experiments from which managers can learn.
- Management that supports or creates diversity for enhancing resilience in both social and ecological systems.
- Policy that stimulates flexible and open institutions that allow for learning.
- Policy that provides incentives for participation by stakeholders and incorporates their ecological knowledge into institutional structures in a multi-level governance system.
- Policy that develops indicators of gradual change and early-warning signals for loss of ecosystem resilience and imminent shifts to less desirable ecological states.
- Policy that encourages ecosystem-friendly technology and economic incentives to enhance resilience and adaptive capacity.

Human well-being and development depend on ecosystem goods such as food, timber and medicines, and services such as water and air purification, carbon storage, pollination, soil formation, and the provision of aesthetic and cultural benefits. The challenge is to sustain the resilience of ecosystems – their capacity to cope with disturbances and maintain an adequate supply of goods and services. This is especially important in the face of global environmental change which may cause more frequent and intense disturbances.

The Environmental Advisory Council of the Swedish Government has invited researchers from the international scientific network Resilience Alliance (www.resalliance.org) to draw up a synthesis report ***Resilience and sustainable development***. This brochure, is presenting some of the report's main findings and is produced in collaboration with Albaeco (www.albaeco.com), an organization working with science communication.

The report and the brochure are available at www.mvb.gov.se or can be ordered from:

The Swedish Environmental Advisory Council
SE - 103 33 Stockholm, Sweden
tel. +46 8 405 2183, fax +46 8 204331



REGERINGSKANSLIET

Ministry of the Environment