Environmental Security

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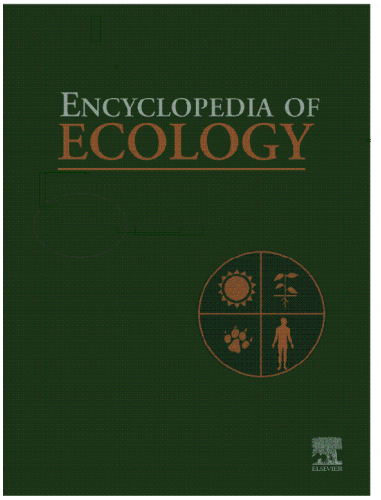

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Environmental Security

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Introducing Environmental Security

The relationship between environmental change, stress, and environmental degradation relative to the issue of security has garnered increased importance as new challenges have emerged since the end of the Cold War. The question of the relationship between environment and security is now a common interest among both the scientific and policy communities, especially as the traditional security concepts based on national sovereignty have been revisited following changes in the European political landscape at the end of the twentieth century.

The notion of environmental security has been historically linked to environmentally induced conflicts caused by environmental degradation in one or more of the following fields: overuse of renewable resources, pollution, or impoverishment of human-settled places. The notion has been developed mainly by international policy researchers and has focused on the role of the scarcity of renewable resources such as cropland, forests, water, and fish stocks. Attention has been devoted to the theoretical analysis of possible insecure pathways, beginning with scarcity and leading to outbreaks of violence. Thus, environmental security has been discussed as a concept of international security policy.

Environmental degradation has various impacts on the behavior of the involved actors and might play a role as reason, trigger, target, channel, and catalyst of conflicts. The decrease in quantity and quality of resources, rapid population growth, and unequal resource access are the basic drivers behind increasing environment-related security risks. Notably renewable resources like water and land are crucial factors in security issues, especially with respect to instability and migration between and within countries or regions. Scarcity of nonrenewable resources can contribute to instability in the international as well as in the national contexts.

The question then arises as to how such environmental stresses and the associated risks might evolve. While the debate on these issues is still ongoing, it is increasingly accepted that environmental threats are escalating contributors to insecurity and social conflicts among and within countries.

Results of the increasing human appropriation of regional landscapes can have a variety of ecological effects directly drawing on the notion of environmental security. Focusing on environmental security is the essential step to be developed in the study of interactions between humans and the environment in social–ecological systems (SESs) (see Socioecological Systems), which in the real geographic world are social–ecological landscapes (SELs) (see Fitness Landscapes), and it is critical in understanding how humans create and respond to environmental change.

Defining Environmental Security

A recent comprehensive overview of the environmental security field observes that

- the environment is the most transnational issue, and its security is an important dimension of peace, national security, and human rights;
- over the next 100 years, one-third of the current global land cover will be transformed; hence the world will be facing increasingly hard choices among consumption, ecosystem services, restoration, preservation, or degradation; and
- environmental security is central to the national security, comprising the dynamics and interconnections among humans and natural resources.

Based on these assumptions, there are many different approaches to define environmental security, most of them originating in international policy debates. Some of the respective definitions have been documented in **Table 1**.

Traditionally, there are two main definitions of security according to the two main points of view:

- *Environmental security*. The major challenge concerns the global environmental change, focusing on the interactions between ecosystems and mankind, the effects of global environmental change on environmental degradation, the effects of increasing social request for resources, ecosystem services, and environmental goods.
- *Human security*. This item addresses different security aspects like social or political security. In this context, values at risk are the survival of human beings and their quality of life.

The relevant objects of environmental security are complex, adaptive systems with two main components – the social, characterized by human intent, and the ecological, rising without intent; these have interacted historically, and society strongly determines the landscape ecological components of such systems.

To introduce environmental security with reference to SESs, it is useful to refer to the definition provided by Arnold Wolfers in 1962, stating "Environmental security, in an objective sense, measures the absence of threats to acquired values, in a subjective sense, the absence of fear that such values will be attacked."

Basically, it is necessary to consider that

- security of SELs must be assessed both objectively and subjectively, because security is meaningless unless there is somebody perceiving it;
- security is value laden, and what we consider values is related to our normative systems that nowadays recognize concepts like ecosystem functions and services, ecosystem integrity, and sustainability as fundamental values for the survival and well-being of mankind; and
- humans have been historically providing threats to those values from local to global scale, but there are also threats coming from natural hazards and disasters.

A Socioecological Perspective of Some Recent Threats to Environmental Security

In this article, the notion of environmental security is developed from a system ecology perspective, namely with reference to threats to social–ecological systems and ecosystems services. The overall conception of environmental security is based on some general principles of human environmental interactions:

- Human well-being has several key components: the basic material needs for a good life, freedom and choice, health, good social relations, and personal security.
- How well-being is expressed and experienced is context and situation dependent, reflecting local social and personal factors such as geography, ecology, age, gender, and culture. These concepts are complex and value laden.
- Ecosystems are essential for human survival and well-being through their provisioning, regulating, cultural, and supporting services. Evidence in recent decades of escalating human impacts on ecological systems worldwide raises concerns about the consequences of ecosystem changes for human well-being.
- Human well-being can be enhanced through sustainable human interaction with ecosystems on the base of appropriate instruments, institutions, organizations, and technologies. The creation of these items through participation and transparency may contribute to people's freedoms and choices and to increased economic, social, and environmental security.
- There are direct and indirect pathways between ecosystem change and human well-being, whether they are positive or negative. Indirect effects are characterized by more complex webs of causation, involving social, economic, and political threads.

The dynamic spatial configuration resulting from human appropriation of regional landscapes can have a variety of ecological effects at multiple scales. For example, a direct effect of urbanization is the alteration of local ecological processes through the modification of land cover: converting desert to residential land cover alters many environmental parameters, such as soil physical and chemical properties, water availability, vegetation, and associated animal and microbial communities. Additionally, urbanization alters the spatial configuration of land-cover patterns within a region. New land-cover types are juxtaposed within increasingly fragmented native land-cover types. Changes in the structure of the landscape can have ecological effects such as modifying nutrient transport and transformation and affecting species persistence and biodiversity.

In the recent historical development of social-ecological systems, there is an increasing superimposition of

Table 1 Some definitions of environmental security

AC/UNU Millennium Project	Environmental security is the relative public safety from environmental dangers caused by natural or human processes due to ignorance, accident, mismanagement or design and originating within or across national borders.
AC/UNU Millennium Project	Environmental security is the state of human–environment dynamics that includes restoration of the environment damaged by military actions, and amelioration of resource scarcities, environmental degradation, and biological threats that could lead to social disorder and conflict.
Barnett J (1997) 'Environmental Security: Now What?', seminar, Department of International Relations, Keele University, 4 Dec. 1997.	Environmental security is the proactive minimization of anthropogenic threats to the functional integrity of the biosphere and thus to its interdependent human component.
Belluck DA, Hull RN, Benjamin SL, Alcorn J, and Linkov I (2006) Environmental security, critical infrastructure and risk assessment: Definitions and current trends. In: Morel B and Linkov I (eds.) *Environmental Security and Environmental Management*, pp. 3–16. Dortrecht: Springer.	By ensuring environmental security we mean guarding against environmental degradation in order to preserve or protect human, material, and natural resources at scales ranging from global to local.
AC/UNU Millennium Project	The term environmental security refers to a range of concerns that can be organized into three general categories: 1. Concerns about the adverse impact of human activities on the environment. 2. Concerns about the direct and indirect effects of various forms of environmental change (especially scarcity and degradation) which may be natural or human-generated on national and regional security. 3. Concerns about the insecurity individuals and groups (from small communities to humankind) experience due to environmental change such as water scarcity, air pollution, global warming, and so on. Combining these we might conclude that the condition of environmental security is one in which social systems interact with ecological systems in sustainable ways, all individuals have fair and reasonable access to environmental goods, and mechanisms exist to address environmental crises and conflicts.
AC/UNU Millennium Project	Environmental security is the maintenance of the physical surroundings of society for its needs without diminishing the natural stock.
'Environmental security of Russia', issue 2, The Security Council of the Russian Federation, Moscow, 1996, p. 55	Environmental security is protectedness of natural environment and vital interests of citizens, society, the state from internal and external impacts, adverse processes and trends in development that threaten human health, biodiversity and sustainable functioning of ecosystems, and survival of humankind. Environmental security is an integral part of Russia's national security.
US Department of Defense (1996)	Environmental security is comprised of restoration, compliance, conservation, pollution prevention, environmental security technology, and international activities.
'On Principles of Environmental Security in the Commonwealth States', Dec. 4 1997	Environmental security is the state of protection of vital interests of the individual, society, natural environment from threats resulting from anthropogenic and natural impacts on the environment.
NATO Science Programme 1997	Scientific problems related to environmental security including the reclamation of contaminated military sites, regional environmental problems and natural and man-made disasters; affordable cleanup technologies are of particular interest.

technostructure, biostructure, and ecostructure called 'technosubstitution', which leads to an increase in thermodynamic flows and sinks. This has large consequences on ecological patterns and processes, and thus on ecosystem services and sustainability.

In short, the previous statements could be tentatively reformulated to define environmental security according to the following: environmental security, in an objective sense, aims to evaluate the level of threats to acquire and sustain ecosystem values in terms of ecosystem goods and services at multiple scales and, in a subjective sense, represents the level of fear that such values will be attacked and possibly lost.

In the above definition, environmental security has to do with risks or fragility (vulnerability) of losing ecosystem goods and services as well as the perception of those risks. Thus, fragility is deemed multilayered, multiscale, and complex, existing in both the objective physical and social realms, as well as in the subjective realm. Often it exists because of the choices we make. As well, it is often imposed upon people and communities because of our political or social-economic systems. The perception of security is quite fundamental at all levels of human organization, from the individual to the governments. As to environmental security in the subjective sense, the 'threats' are of an abstract nature, in the domains of feelings and cognition.

The level of fear that such values will be attacked and possibly lost much depends on the correct information and the consciousness of the role and significance played by ecosystem goods and services. In this respect, given that both objective and subjective measures provide reliable estimates of environmental security through, for example, efficient indicators and sampling designs, it is interesting to judge the concordance between 'objective' and 'subjective' evaluations.

As an example, the environmental security of the same location might be evaluated differently in objective and subjective terms (**Table 2**). In cases (a) and (d), there is concordance between objective and subjective evaluations; for case (a), both agree on positive (high) environmental security, whereas for case (d) both agree on negative (low) environmental security. In contrast, cases (b) and (c) are discordant; in the first case, there is no fear that values such as ecosystem goods and services will be attacked and possibly lost, while the objective evaluation says just the opposite. This is very dangerous but common in the real world because people are often unaware of the environmental degradation they cause. In contrast, in case (c), there is fear that ecosystem goods and services will be attacked and possibly lost (low environmental security) but there is no objective reason for such fear. For example, certain Mediterranean beaches are often naturally covered by seaweed leaves (*Posidonia oceanica*), which is an indicator of good coastal ecosystem quality. However, most tourists wrongly perceive beaches covered by leaves as 'dirty' and 'insecure', so leaves are removed becoming a waste.

Table 2 Possible combinations between 'objective' and 'subjective' evaluations

	Objective	
Subjective	++ (a)	+ − (b)
	− + (c)	− − (d)

Departing from the individual perspective, security can be derived through different livelihood strategies of which the environmental strategy is one. Although fragility, as the capacity to cope with external stress, is a concept that deals with problems and stress situations – the lack of security – in local people's lives, the focus on livelihood strategies and security can be seen as the opposite. Studying the factors that make people feel safe and secure gives us a deeper understanding of their day-to-day thinking when making decisions that affect their livelihood. It also puts focus on the strategies that work well and could be further developed and encouraged from a management and planning perspective.

Regarding the family perspective (the family level), security is related to the feelings of safety, assurance, and confidence in that the family will be able to secure a livelihood for itself in the future, and the precautions that the family members take to ensure this. The concept of security is thus closely connected to what is most important for local people – their everyday survival. This applies to each hierarchical level of social organization.

Climate change is likely to make many threats worse, especially heat waves, drought, and flood, and that occurs in a context where many global and social trends are also creating fragility. Where it is safe and ethical, the explicit inclusion in social–ecological studies of people living and working in a study area can promote scientific realism and reveal non-intuitive causal relationships. This integration may provide social benefits, including a better public perception of science and scientists. A holistic or 'integrated risk management' approach is needed, to reduce fragility and deal with risk effectively. Environmental security is such an integrated risk assessment and management approach.

Resilience

A social–ecological perspective of environmental security stresses adaptability and learning through thoughtful probing. Emphasis needs to be placed both on dealing with threats and hazards, and on human response to risk. Encouraging risk-adverse behavior or discouraging risk-prone behavior is more effective than simplistic schemes intended to reduce hazard. The reason for this is that people tend to engage in more risky behavior, if they perceive a more secure environment (risk homeostasis).

There can be large differences among countries, in terms of the causes of fragility and coping capacity. The root causes, where choices exist, arise from (1) how we perceive and respond to risk, (2) how we relate to the natural environment, and (3) our values.

Our present system of economic values is based upon a static view, and it is heavily influenced by wealth and power distributions of the status quo. In contrast, the evolutionary basis of our biological insight stresses adaptation and response to changing conditions.

The flip side of fragility, which is resilience, requires greater attention than is given at the moment for addressing environmental security issues. In its current form, resilience is the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same identity, function, structure, and feedbacks. Resilience and fragility are inversely related to each other. Because SESs are complex and exhibit chaotic behavior, to cope with environmental threats optimal solutions do not exist, as it is difficult to learn general lessons from several local cases, whereas we need to know trends at different scales. Both holistic solutions and cultural change are necessary to reduce risk and improve environmental security.

The current state of understanding how to measure and manage for resilience in SESs can be approached with a set of scenarios and simple models to guide in the identification and manipulation of the system's resilience on an ongoing basis and during times of crisis. This process emphasizes the chaos created by disasters (take the recent New Orleans flood as example), and the means by which people move to rational decision making, either through research or bargaining, depending upon what is known or unknown.

In this approach, the sustainability of any particular state depends on the properties of the stability domain corresponding to that state. Ecological sustainability is often described in terms of the resilience of the system, and that implies also the capacity to manage environmental security.

Environmental Security and Sustainability

The main area of interest of environmental security is the intersection of three different capitals: social, ecological, and economic. Many of our popular and scientific ideas are based upon a static view of the world and of the place of humans in it. Some views of sustainability have this static quality.

The welfare function provides a way of thinking about the sustainability of economic and environmental change. There is no generally accepted definition of sustainable development (and it is doubtful whether the concept has scientific validity).

Of all the environmental policy concepts to emerge in the last 20 years, none is more compelling than that of sustainability. The concept was put on the international policy agenda by the Brundtland Commission more than a decade ago, by formulating the classic definition of sustainable development, namely, development that "seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future." The introduction of these concepts has raised the important question as to whether humanity at the global scale is currently on a sustainable or unsustainable path.

An alternative approach is to consider the sustainability of an economy and its supporting environment in terms of its capacity to absorb stress and shock without fundamental change (resilience). For any economy, there are many possible states, each delivering different levels of welfare to society.

Ultimately, the major obstacles to sustainable development can be reduced to three basic categories: willingness, understanding, and capacity. The first and major obstacle has been described as a lack of political will to implement those changes that are glaringly necessary. Asymmetric power structures, vested interests, and conceptions by humankind which emphasize antagonism, competition, and individualism over cooperation and solidarity lie at the heart of this obstacle. Even in cases where political will is present, another obstacle is the lack of understanding of the behavior of complex systems.

This understanding is often failure to address the relevant linkages within and between systems and across scales. Compartmentalized perceptions of reality and a scientific tradition and training that are still largely reductionist impair the development of understanding. Inadequate institutions, lack of financial resources, unskilled human resources, weak infrastructure, plain poverty, and other limitations contribute to the third obstacle: insufficient capacity to perform the actions and changes needed, affecting notably (but not exclusively) the developing world.

Self-organization of ecological systems establishes the arena for evolutionary change. Self-organization of human institutional patterns establishes the arena for future sustainable opportunity. Selective pressures also come from aspects of the physical–chemical environment, such as geomorphology, hydrology, biogeochemistry, and climate. Evolution, in turn, shapes ecosystems because ecological systems are self-organized from evolved components. Those self-organized components include some suites of organisms that create physical structure and are reenforced by that structure. Others act as 'ecological engineers' altering the physical structure and especially the biogeochemistry of ecosystems.

As a consequence, the interplay of evolution, ecology, and the physical–chemical environment is a complicated dynamic arena, in which configuration and control change eternally. Humans facilitate self-organized

patterns more intensively and over much larger scale ranges than do other organisms.

Environmental Security and the DPSIR Model

Systems with high adaptive capacity are able to reconfigure themselves without significant declines in crucial functions in relation to primary productivity, hydrological cycles, social relations, and economic prosperity. A consequence of a loss of resilience, and therefore of adaptive capacity, is loss of opportunity, constrained options during periods of reorganization and renewal, and an inability of the system to do different things.

The effect of this is for the SES to emerge from such a period along an undesirable trajectory, lowering environmental security.

Are there elements that sustain adaptive capacity and management (see Adaptive Management and Integrative Assessments) of SESs in a world that is constantly changing? Addressing how people respond to periods of change, how society reorganizes following change, is the most neglected and the least understood aspect in conventional resource management and science.

Resilience is the key to enhancing adaptive capacity. It is possible to identify and expand on four critical factors that interact across temporal and spatial scales and that seem to be required for dealing with natural resource dynamics during periods of change and reorganization:

- learning to live with change and uncertainty;
- nurturing diversity for resilience;
- combining different types of knowledge for learning; and
- creating opportunity for self-organization toward social–ecological sustainability.

To assess determinants and constraints of environmental security, a conceptual model can be adopted like drivers, pressures, state, impacts, responses (DPSIR) model (**Figure 1**). The assessment of threats directly refers to risk assessment, that is, socioecological system fragility at multiple scales and levels of social organization. Within socioecological landscapes, the agents and factors determining and constraining environmental security can be represented in terms of driving forces, pressures, states, impacts, and responses, according to the DPSIR scheme adopted in the EU (**Figure 1**).

These items are arranged with respect to different steps of environmental agency. Within all these steps, effects can lead to modifications of environmental security. Land use provokes a change of landscape states (including states with increasing risks), and this modification effects modifications of ecosystem or landscape services (e.g., including reduced provisions of focal goods and regulations). As a consequence, several items of human well-being will be changed, leading to new societal demands, drivers, and motivations (including

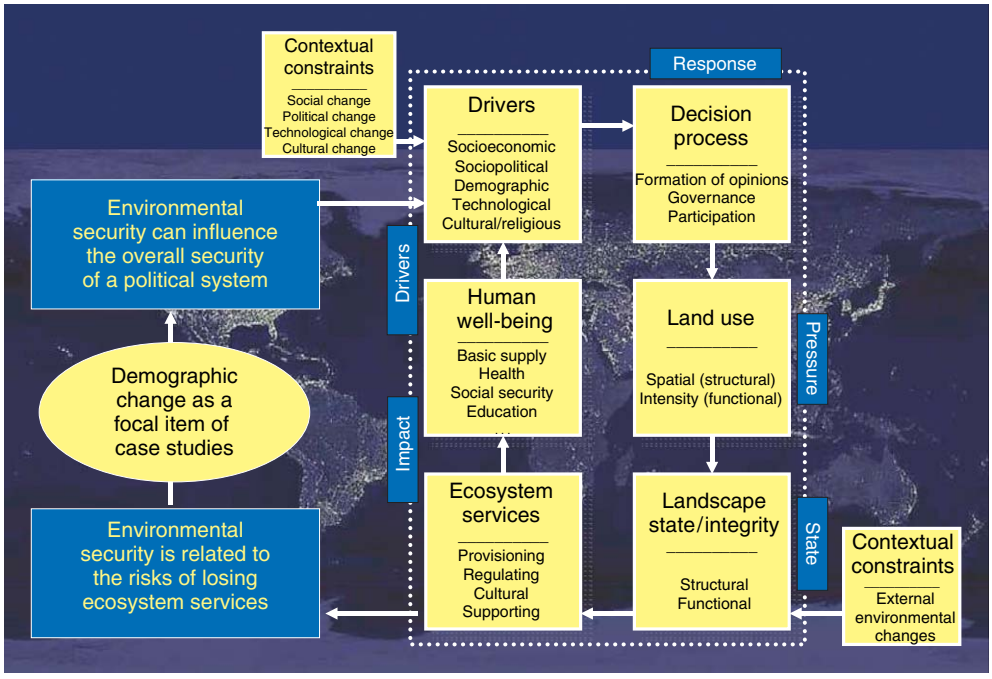

Figure 1 A conceptual DPSIR model of human–environmental systems, focusing on the risk of losing ecosystem goods and services (see Ecosystem Services), exemplified by the potential consequences of demographic change.

security-relevant developments in the society). These items influence the environmental decision processes in correlation with external constraints, and finally new opinions on how to cope with the environment will be realized in political decision processes.

The ecological key variable within this human–environmental cycle is ecosystem or landscape integrity. In some interpretations, integrity is strongly related to the idea of wilderness, other authors refer to a social value perspective, and in a third group of interpretations integrity represents a complex systems approach, which is mainly based upon variables of energy and matter budgets and structural features of whole ecosystems.

Taking into account the focal ideas of the security concept, it is possible to use an alternative formulation for the ecological components of sustainable development: 'meet the needs of future generations' in this context means 'keep available ecosystem services on a long-term, intergenerational and, on broad scale, intragenerational level'. From a synoptic viewpoint at the categories of ecosystem services, one fact becomes obvious: all ecosystem services are strongly dependent on the performance of the regulation functions. The correlated processes do not only influence production rates and supporting services, but in the long run they also determine the potentials of ecosystems to provide provisioning and cultural services.

If we take into account that the integral of the regulation services represents self-organized processes in ecosystems, it becomes clear that the respective benefits are strictly dependent on the degrees and the potentials of self-organization. To maintain these services, the ability for future self-organizing processes within the respective system has to be preserved. Applying this viewpoint, we can define ecological integrity as a 'political target for the preservation against nonspecific ecological risks that are general disturbances of the selforganizing capacity of ecological systems. Thus, the goal should be a support and preservation of those processes and structures which are essential prerequisites of the ecological ability for self-organization'. Such an adaptive management (see Adaptive Management and Integrative Assessments) strategy, which contains flexible reactions, attempting to improve the regulation capacities of ecosystems, could be a very effective means to foster environmental security.

See also: Adaptive Management and Integrative assessments; Ecosystem Services; Fitness Landscapes; Socioecological Systems.

Further Reading

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Environmental Space

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Introduction

The concept of 'environmental space' was first developed in the 1980s as an academic concept. It was mentioned as 'environmental utilization space' by Siebert in 1982 and Opschoor in 1987. According to Opschoor, "the 'environmental utilization space' reflects that at any given point in time, there are limits to the amount of environmental pressure that the Earth's ecosystems can handle without irreversible damage to these systems or to the life-support processes that they enable." The 'environmental utilization space' consists of both 'stocks' (renewable, semirenewable, and nonrenewable resources) and 'sinks' (capacity to absorb human impacts).