Part I

Introduction

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Edited by Jetske A. Bouma and Pieter J. H. Van Beukering
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1 Ecosystem services: from concept to practice

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Learning objectives

- Describe and understand the concept of ecosystem services, its strengths and its weaknesses.
- Explain the implicit assumption that human well-being and healthy ecosystems go together and discuss possible tensions that may arise.
- Explain the main characteristics of ecosystems and ecosystem services and the implications for the measurement, valuation, and governance of ecosystem services.
- Discuss the main critiques on the concept of ecosystem services.
- Discuss the conditions for integrating ecosystem services into decision-making and policy.

1.1 Introduction

Ecosystem services are hot, and they have been hot for a while. In 1998, Costanza *et al*. published their famous article about the societal value produced by ecosystems through ecosystem service delivery, an article which at the time this introduction was written had been cited more than 10 000 times. In 2005, the Millennium Ecosystem Assessment (MEA) framed the need to protect biodiversity and the world's ecosystems in terms of ecosystem services (MEA, 2005). In 2009, "The economics of ecosystems and biodiversity" (TEEB) followed up by presenting an approach to help decision-makers recognize, demonstrate, and capture the values of ecosystem services and biodiversity. And by now, most (inter)national policies in the field of nature conservation refer to ecosystem services when explaining the need for nature conservation, biodiversity protection, and sustainable resource use.

Despite the popularity of the concept of ecosystem services, policy-makers and practitioners are struggling to implement the concept in practice. An important reason for this science–policy divide is the lack of an interdisciplinary framework that guides

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policy-makers through the definition and measurement of ecosystem services to their valuation and the translation of these values into effective policy instruments and governance arrangements (see also Daily *et al*., 2009). Even though several books have been published about ecosystem services, few books address the measurement, valuation, and governance of ecosystem services in an integrated way. Such an integrated approach is important, because without a full understanding of the underlying complexities of ecosystem service provisioning, the concept is easily misunderstood. Policy-makers need simple concepts to communicate the role and importance of ecosystems, but this should not imply that when translating the concept to practice the complexity of ecosystem services can simply be ignored. Hence, this textbook aims to explain what is required to translate the simple concept of ecosystem services to the practice of complex ecosystem-related decision-making and how ecosystem service delivery can be safeguarded for generations to come.

We start off this introductory chapter by defining the concept. Given the important role that the MEA (2005) has played in defining ecosystem services, we will use the MEA approach as our point of reference throughout the book. We continue to discuss the concept in relation to human well-being and we address potential conservation–development trade-offs. We define the characteristics of ecosystem services and discuss the implications of these characteristics for the measurement, valuation, and governance of ecosystem services and the underlying ecosystems on which they depend. We discuss critiques that the concept is too simplistic, and would imply a commodification of the ecosystem and commercialization of the resource base. We end the chapter with a short discussion of the different textbook chapters, and an explanation of the reasons for clustering the chapters under four broad themes.

1.2 The concept of ecosystem services

The MEA (2005) defines ecosystem services as “the benefits humans derive from ecosystems.” This is a very broad definition, but not without meaning as it underlines (1) the human uses of ecosystems and (2) the benefits that ecosystems provide. The MEA (2005, p. 40) classifies ecosystem services into four categories:

- Supporting services which are ecosystem services “that are necessary for the production of all other ecosystem services”;
- Provisioning services refer to “products obtained from ecosystems”;
- Regulating services are “benefits obtained from the regulation of ecosystem processes”;
- Cultural services which are “nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences.”

Figure 1.1 illustrates the way in which these different services provide benefits for human well-being. Note that the supporting ecosystem services provide benefits indirectly through the provisioning, regulating, and cultural ecosystem services. As Figure 1.1

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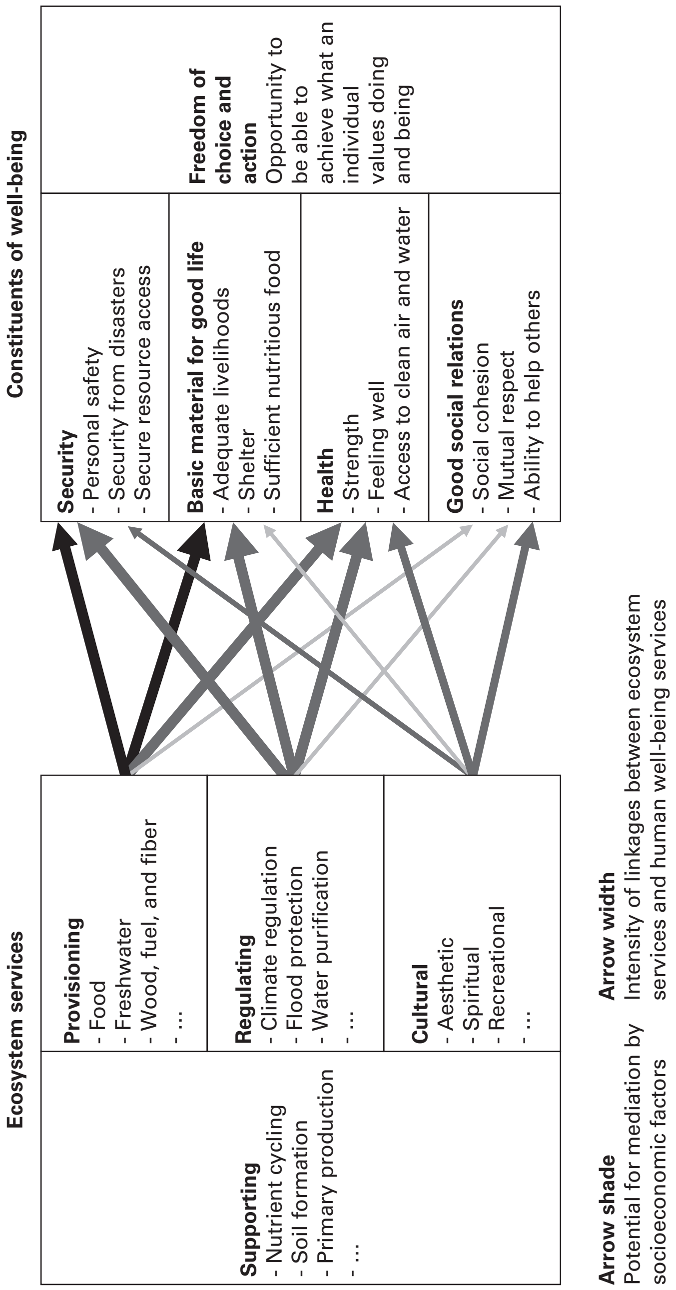

Figure 1.1 The concept of ecosystem services. *Source:* MEA (2005).

indicates, what underlies the provisioning of ecosystem services is a healthy and biodiverse ecosystem. It is important to note that the relationship between biodiversity and ecosystem services is complex and non-linear. Although biodiversity forms the basis for all ecosystem services, biodiverse ecosystems do not necessarily provide more ecosystem services than ecosystems that are less diverse (Naidoo *et al*., 2008). In Part I of this book the relation between biodiversity and ecosystem services will be further elaborated and explained.

What Figure 1.1 conceals, and what is illustrated clearly in Figure 1.2, are the trade-offs between different types of ecosystem services that often arise. For example, maximizing provisioning services such as food and timber production often comes at the cost of decreased generation of regulating and supporting services. In fact, the greatest threat to biodiversity, land conversion, is mainly driven by an increasing demand for provisioning services such as food, fuel, and fodder. Degraded ecosystems may continue to produce large amounts of provisioning services, yet the overall diversity of ecosystem services provided is less. This reduces the resilience of the ecosystem, and threatens the provisioning of ecosystem services in the long run. A good example of this trend is the drive towards monoculture food production. By increasing the productivity of food production, soil formation processes are diminished and disease regulation is reduced. This reduces the resilience of the agro-ecosystem, and would eventually also reduce food production, and may still, if disease regulation and nutrient inputs were not substituted by external inputs (fertilizer, pesticides). Figure 1.2 illustrates how different farming systems produce different types of ecosystem services, and how this compares to an undisturbed ecosystem, in which fewer provisioning services are produced.

1.3 Ecosystem services and human well-being

The MEA (2005) argues that, because ecosystem services benefit human well-being, improving the health of ecosystems will improve human well-being as well. Because this assumption is at the core of the concept of ecosystem services, it is important to fully understand the relationship between human well-being and ecosystem services. In a general sense, ecosystems provide humankind with well-being since without clean air, water, food, and other services humankind would not be able to survive. In addition, ecosystems brought economic prosperity: conversion of ecosystems to agricultural land increased food production, harvesting of fish, timber, biomass, and other natural resources generated income and both triggered development, thus contributing to human well-being in an important way. The flip side of this development has been that overuse of provisioning services, and the resulting overexploitation of ecosystems, has resulted in more than half of the world's ecosystems having been lost in the past century, the depletion of biodiversity having increased to an unprecedented rate (UN General Assembly, 2010). On balance it is safe to say that the exploitation of ecosystems has greatly benefited humankind and increased human well-being, but if humankind continues this way the costs of overexploitation are likely to exceed the benefits at some point.

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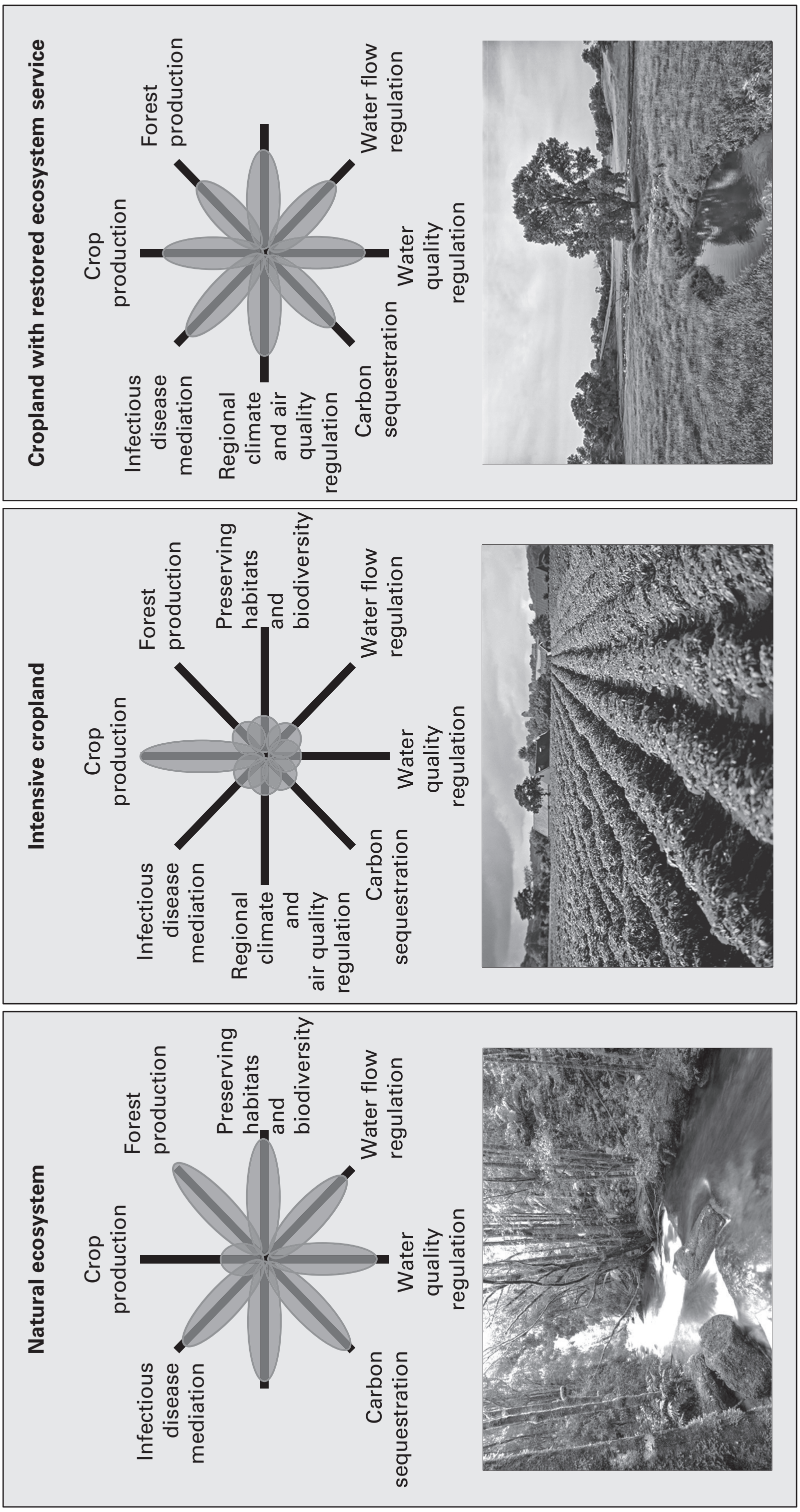

Figure 1.2 Hypothetical "flower" diagrams for comparing land use and ecosystem service trade-offs. *Source:* Foley *et al.* (2005, p. 573).

Rockström *et al*. (2009) argue that the planetary boundaries of biodiversity depletion have been reached already, especially when considering the expected impacts of climate change. All in all, there are still great uncertainties about the level up to which we can continue depleting biodiversity without adverse impacts on human well-being. However, it is clear that the risk of ecosystem collapse is real, and that it has increased, with potentially huge costs for humanity.

At the core of the discussion about the boundaries to ecosystem exploitation lies the debate about weak versus strong sustainability, e.g. the question whether the global ecosystem poses strict boundaries on human development or that these boundaries can be softened by technological development. Neumayer (2003) discusses the concepts of weak versus strong sustainability, defining weak sustainability as a reflection of the neoclassical, economic paradigm that it does not matter what capital stock future generations inherit, as long as the aggregate is similar to that of the current generations. Strong sustainability, on the other hand, assumes that natural capital is not substitutable, and that future generations should inherit a fixed amount of natural capital as loss of natural capital cannot be compensated. Those referring to planetary boundaries generally adhere to the principle of strong sustainability, whereas those referring to technological innovation generally suggest that weak sustainability is sufficient.

The key question is thus whether natural capital is substitutable. Fitter (2013) discusses the substitutability of ecosystem services by man-made capital, distinguishing between the substitutability of supporting services and the rest. He concludes that except for nutrient cycling none of the supporting services can currently be substituted by artificial processes but that for the final services certain replacements do exist. For example, wastewater treatment can replace natural water purification, biocides regulate diseases and pollination can also be done by hand. However, the costs of replacing ecosystem services by man-made capital are often substantial and replacing natural capital by man-made capital usually greatly increases energy use as well. With increasing population density, replacement of ecosystem services by man-made capital may be cost-effective, although the famous example of the New York water supply indicates that even in urban settings clean water from a nearby ecosystem is often more cost-effective than water purification by industry (Appleton, 2002). In most cases, the costs of having to replace ecosystem services by man-made capital are enormous, however, if the services are substitutable by man-made capital at all.

To what extent ecosystem services can and will be substituted by man-made capital is something which only the future can tell us. Without affordable alternatives for most ecosystem services it is important to realize, however, that at present ecosystem collapse would have enormous implications for humanity. This has been an important motivation behind the formulation of global targets for biodiversity protection and ecosystem conservation, and it certainly has been a major reason behind the framing of ecosystem services – to make people aware that their well-being ultimately depends on the health of ecosystems. Perhaps the question should not be to what extent improving the health of ecosystems improves human well-being. Instead we need to ask ourselves how the provisioning of ecosystem services can be safeguarded for generations to come.

Box 1.1 The nutrient cycle, food production, and the agro-ecosystem

The invention of fertilizer has been one of the key factors behind population growth and world development, as it has starkly increased agricultural productivity, and reduced hunger and mass starvation around the world (e.g. "the Green Revolution"). It has facilitated an intensification of agriculture, which also helped to protect the world's terrestrial ecosystems as less land needed to be converted to agricultural land. The manufacturing of fertilizer is very energy intensive, however, and each year around 120 million tons of nitrogen from the atmosphere is converted into fertilizer, more than the combined effects of all terrestrial processes on earth (Rockström *et al.*, 2009). Much of this nitrogen leaks from agricultural lands to aquatic and marine ecosystems, resulting in the eutrophication of lakes, rivers, and wetlands.

Box 1.1 illustrates the complex relationship between ecosystem services and human well-being. The example presented shows how substitution of nutrient recycling by fertilizer greatly enhanced human well-being, but also created some serious problems by changing the nitrogen cycle and discharging large amounts of nutrients in surface and groundwater, resulting in the eutrophication of lakes, rivers, wetlands, and coastal zones.

1.4 Natural capital, economic development, and livelihoods

Another dimension of the relationship between ecosystems and human well-being is that the availability of natural capital is highly skewed.

Hamilton (2006) calculated that for the ten richest countries in the world natural capital reflects only 1–2% of their capital stock, but that for the ten poorest countries the share of natural capital is 30–45%. Partly, this has to do with the relative value of the different assets, but it also reflects the relatively important role that natural capital still plays in the asset base of many developing countries around the world. Saying that these countries should conserve their stocks of natural capital to protect biodiversity and conserve the ecosystem has implications for their development, not because economic development necessarily implies conversion of natural capital stocks, but because natural capital forms a crucial part of their asset base. Although there are examples of countries that have both developed economically and maintained their natural capital stock (Costa Rica) examples are limited, and it is important to acknowledge that the opportunity costs of nature conservation can be high. Similarly, biodiversity is highest in the poorest regions of the world (Fisher and Cristopher, 2007). The correlation between poverty and biodiversity may seem surprising, but it is actually the lack of (economic) development that causes both biodiversity and poverty to be high. Under these conditions, protecting biodiversity may have implications for the poor. For example, Cernea and Schmidt-Soltau (2006) indicate that protected area establishment has increased poverty in parts of Africa as local communities were displaced. Integrated conservation–development approaches try to avoid adverse livelihood impacts when protecting nature by investing in alternative livelihoods like the marketing of non-timber forest products. Experiences with these type of approaches indicate, however, that it is difficult to protect the ecosystem and alleviate poverty at the same time. Although there are examples of projects that simultaneously protect the ecosystem and alleviate poverty, the majority of projects either alleviate poverty or protect diversity. Alternative approaches for improving conservation while avoiding adverse livelihood impacts are payments for ecosystem services and community co-management, which aim to create direct incentives for sustainable use. In the last part of this book we will further elaborate the different approaches, and address the distributional aspects of ecosystem service provisioning, nature conservation and local livelihood as well.

When an ecosystem is degraded, restoration of the ecosystem can jointly improve human well-being and increase ecosystem health more easily. Especially when local livelihoods depend on the services provided by the ecosystem, better management of the ecosystem can improve local livelihoods, and sometimes even alleviate poverty. This is because poor people tend to depend on ecosystem services most: poor people usually lack assets, such as land, and access to services, such as drinking water and electricity, which makes them dependent on collective resources, such as wastelands for grazing, the river for water, and the forest for fuel. If this resource base is degraded, the services delivered will be limited, and the people depending on these services will remain poor. For example, degraded soils are not very productive, polluted wetlands do not generate much fish, and drinking water from polluted rivers makes people sick. Restoring watersheds, wetlands, and wastelands increases productive capacity, with often important livelihood benefits. Box 1.2 illustrates the potential of ecosystem restoration, although it is also important to acknowledge that the costs of ecosystem restoration may be high.

Box 1.2 Degraded ecosystems and the potential for ecosystem restoration

Inspired by several successful examples around the world, ecosystem restoration has become a very popular subject for the academic community as well as decision-makers. Not only is ecosystem restoration considered beneficial for nature in general, it is also increasingly seen as a lucrative investment with genuine economic benefits. TEEB calculated the economic feasibility of ecosystem restoration projects for various ecosystems and concluded that even the least “lucrative” rehabilitation activities are economically justified (Table 1.1).

Probably the most well-known example of successful ecosystem restoration is China’s Loess Plateau, which John Liu famously documented in his documentary “Green gold” (which can be viewed on YouTube). The Loess rehabilitation project started in 1995 with a budget of US$500 million targeting an area of 3.5 million hectares, which is comparable to the size of Belgium. The benefits of this ecosystem restoration project are enormous: sediment flows into the Yellow River were reduced significantly, the frequency and intensity of droughts and floods diminished, local food supply grew, and many people were lifted out of poverty as a result of better ecosystem conditions (Ferwerda, 2012).