MEASURING AND MONITORING
ECOSYSTEM SERVICES
AT THE SITE SCALE

Introducing a practical toolkit

Overview

Ecosystem services underpin our very existence. Despite this, they are consistently undervalued in economic analyses and decision-making. As a result, many services are in decline, along with the biodiversity that supports them. Measuring and monitoring ecosystem services can lead to better environmental planning, enhancing sustainability and human well-being.

This booklet introduces a new 'toolkit' for measuring ecosystem services at the site-scale which is accessible to non-experts and delivers scientifically robust results. It explains some key concepts including the need to consider a 'plausible alternative state' to measure differences resulting from changes in land management and use, and the importance of identifying beneficiaries.

An introduction to ecosystem services and this booklet

Ecosystem services are the benefits that people receive from nature—for example, the production of food, the provision of clean water, and the regulation of climate, as well as opportunities for cultural, spiritual and recreational experiences.

In recent history there has been a big decline in biodiversity as a result of human activities, and species are becoming extinct much faster than at any time in the past. Ecosystem services have also changed markedly, and many are in a reduced or degraded state.

Recognising that these changes affect us, there is a growing interest in ecosystem services, from academics and conservationists to policy-makers, economists and finance ministries. This has led to a rapid expansion of the literature seeking to define, measure and value ecosystem services.

- For example, the Millennium Ecosystem Assessment (2001–2005), involving more than 1,360 experts worldwide, provided a state-of-the-art scientific appraisal of the condition of and trends in the world's ecosystems and the services they provide.
- More recently, The Economics of Ecosystems and Biodiversity (TEEB), a major international study, drew attention to the global economic benefits of biodiversity, and highlighted the growing costs of biodiversity loss and ecosystem degradation.

In 2010, the world's governments adopted a new strategic plan (2011–2020) for addressing biodiversity loss, through the Convention on Biological Diversity (CBD) with 20 targets, including a number that relate to ecosystem services (see examples in box).

In 2012, the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), a new global mechanism to support Governments and Multilateral Environmental Agreements like the CBD, will be established, with the aim of bringing information together on biodiversity and ecosystem services to inform decision-making.

CBD Strategic Plan for Biodiversity 2011–2020
Strategic Goal D: Enhance the benefits to all from biodiversity and ecosystem services

Target 14
By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.

Target 15
By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15% of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.

Clean water is an essential ecosystem service
© Sergey Skrebnev/Dreamstime.com

There are many reasons to measure and monitor ecosystem services (see box). Until now this approach has been relatively little used because it appears that ecosystem services are technically difficult and expensive to measure. This booklet introduces a new 'toolkit' which is designed to provide practical guidance for measuring ecosystem services at the site scale and effectively communicating the results.

Measuring and monitoring ecosystem services can:

- **lead to better planning** decisions to support both biodiversity conservation and ecosystem service delivery
- identify and inform management strategies to **enhance economic sustainability and human well-being**
- **provide information on additional benefits** from traditional approaches to biodiversity conservation
- identify those affected by land use management decisions, and so help **spread the costs and benefits** more fairly among stakeholders
- provide information to **raise awareness and build public and government support** for evidence-based policy and management decisions.

What can the toolkit do?

- ✔ Help users with limited capacity (technical knowledge, time) and resources (money, 'man' power) to measure ecosystem services
- ✔ Provide simple gross assessments of ecosystem services at sites, and a way of assessing how these would change if the sites were altered
- ✔ Provide scientifically robust information on ecosystem services—*a first step* which can guide practitioners on whether more detailed studies would be useful
- ✔ Indicate who will be the 'winners' and who will be the 'losers' as a result of any change in land use and ecosystem service delivery
- ✘ Assess *all* ecosystem services
- ✘ Provide full economic valuations (although some monetary values can be calculated)
- ✘ Provide ecosystem service assessments suitable for Payment for Ecosystem Service (PES) schemes and REDD projects
- ✔ **Help decision-makers appreciate the true value of nature, and the consequences of destruction and degradation of natural habitats.**

Birdwatching is an increasingly popular form of recreation © BirdLife International

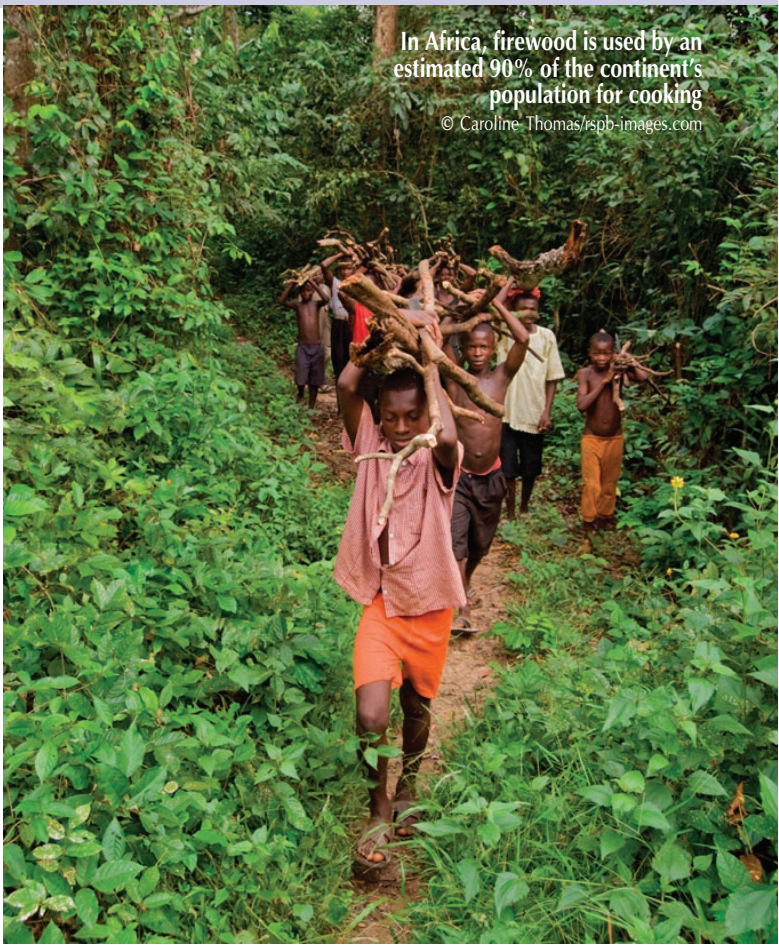
A word of warning: In most situations, not all ecosystem services can be maximised at once. Hence, there will be 'trade-offs' between them. In some situations, ecosystem service delivery may conflict with biodiversity conservation objectives. For example, conversion or degradation of a site might enhance one especially valuable service (e.g. biofuel production) or provide an immediate one-off benefit (e.g. timber extraction) while causing population declines or local extinctions of species reliant on the site. In such circumstances, it may be better to focus on long-term sustainability or not to use ecosystem service arguments for conservation, and to emphasise the intrinsic importance of biodiversity instead.

Ecosystem services are the benefits that people receive from nature

Ecosystem services are the aspects of ecosystems that, actively or passively, produce human well-being. They include the formation of soils, the provision of clean water, the production of crops, the regulation of climate and opportunities for recreation.

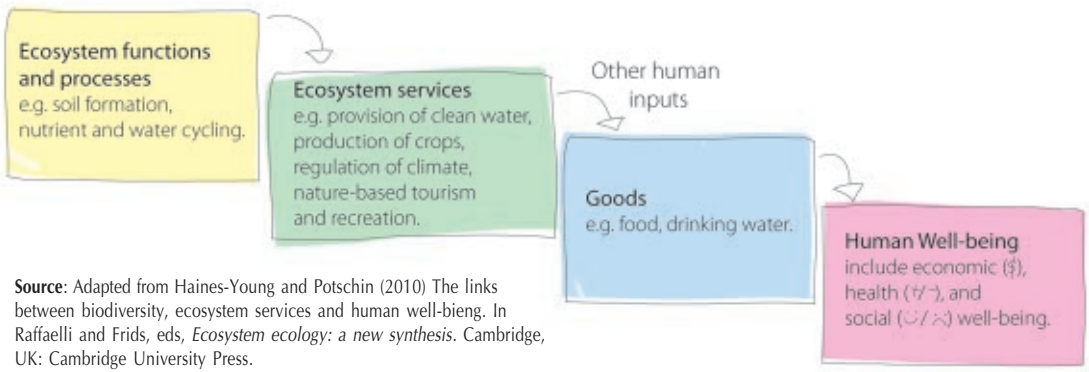
What are ecosystem services?

The rich variety of life on Earth—'biodiversity'—is important for human survival and well-being in many ways, from pollinating crops to providing wild-harvested fish and timber. These benefits that people derive from nature are referred to as 'ecosystem services'. They can be divided into processes (e.g. soil formation) which underpin services (e.g. crop production), which in turn provide goods (e.g. food), often in conjunction with other inputs (e.g. labour). Ecosystem services can be valued in monetary (market and non-market) and non-monetary terms to demonstrate their contribution to economic, health and social well-being (see figure).



In Africa, firewood is used by an estimated 90% of the continent's population for cooking

Conceptual framework of ecosystem services



Source: Adapted from Haines-Young and Potschin (2010) The links between biodiversity, ecosystem services and human well-bieng. In Raffaelli and Frids, eds, *Ecosystem ecology: a new synthesis*. Cambridge, UK: Cambridge University Press.

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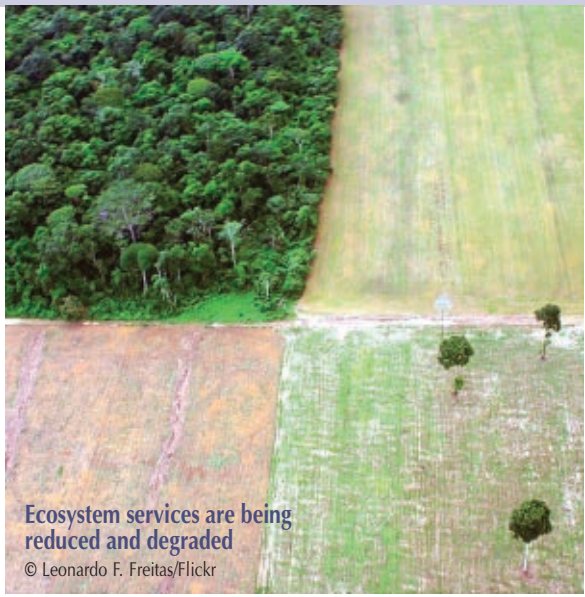
Ecosystem services can strengthen arguments for conservation

Biodiversity loss and ecosystem damage is occurring at an unprecedented rate and is having a negative impact on human livelihoods. Information on ecosystem services can help to communicate the value of nature to decision-makers in the hope of reversing this trend.

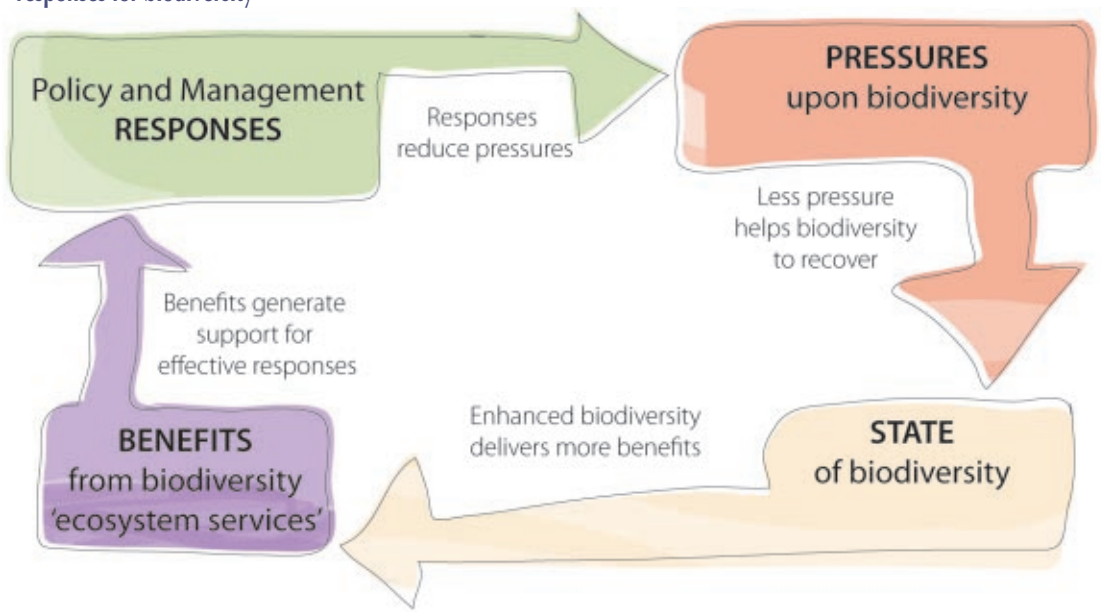
Why measure ecosystem services?

Conservationists have long been advocates for the protection of biodiversity, often through the effective management of key sites. These are commonly identified based on their importance for certain species, emphasising their degree of threat and/or irreplaceability (uniqueness). However, some decision-makers do not listen to these arguments, which emphasise the intrinsic importance of biodiversity and associated ethical reasons for its conservation. Hence, the case for conservation can be informed if the relationship between biodiversity and ecosystem services (see figure), and the importance and value of ecosystem services provided by sites important for biodiversity, are better understood.



Ecosystem services are being reduced and degraded

The relationship between ecosystem services ('benefits from biodiversity') and the state of, pressures upon and responses for biodiversity



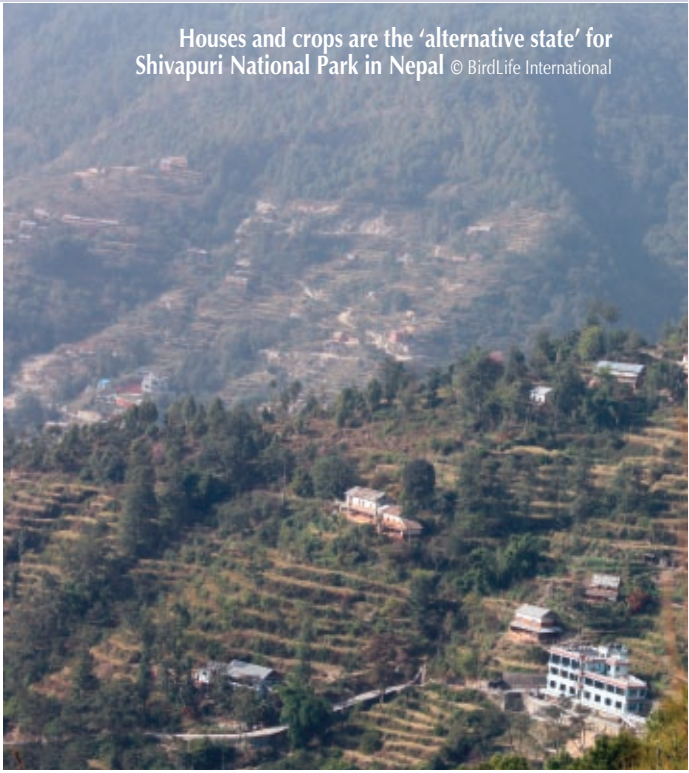
Source: Adapted from Sparks *et al.* (2011) Linked indicator sets for addressing biodiversity loss. *Oryx* 45 (3): 411–419.

Biodiversity and ecosystem services will change depending on the decisions we take

In some cases, conservation action can benefit both biodiversity and the delivery of ecosystem services. In others, there may be 'trade-offs' between biodiversity and ecosystem services. Simple assessments of the gross value of ecosystem services are not as useful as assessments of the difference resulting from changes in land-use.

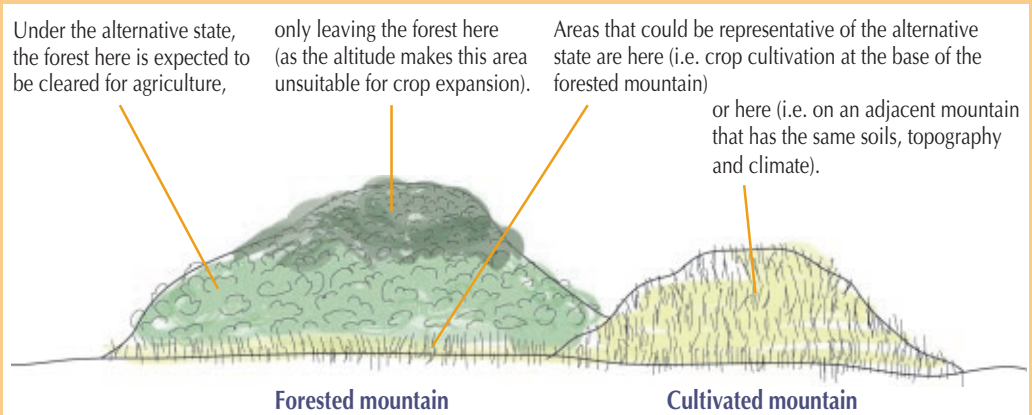
The need to consider a plausible alternative state

To make effective decisions, it is important to know the difference between the amount of the ecosystem service(s) provided by a site in its current state compared to a plausible alternative one (see box), where the habitat is converted (e.g. to agriculture), or in which resources are unsustainably exploited (e.g. through overfishing). Decision-makers need to consider whether conservation delivers greater benefits than conversion to other land-uses. If this is the case, then information on ecosystem services can be used to support the conservation of a site (e.g. when under threat from conversion or development) or the restoration of a site (e.g. rehabilitating logged forest or polluted or drained wetlands).



Houses and crops are the 'alternative state' for Shivapuri National Park in Nepal © BirdLife International

Definition of an alternative state: A plausible and often simplified description of how the future may develop, based on the best available current information and a coherent and internally consistent set of assumptions about key driving forces (e.g., availability of appropriate technology, market prices) and relationships. Alternative states are neither predictions nor projections and sometimes may be based on a 'narrative storyline'.



Ecosystem services only exist if there are people who can benefit from them

An ecosystem service only exists if someone somewhere is benefiting from it. Beneficiaries may occur far away, the benefits may be delayed in time, and the distribution of benefits may not be equitable. It is essential to understand who the beneficiaries are so that the full impact of changes in ecosystem services can be assessed.

The importance of identifying beneficiaries

Changes in the delivery of ecosystem services will have different impacts on different users (beneficiaries) depending on who they are, where they live and when they use the services (see figure). These impacts are often overlooked but are one of the most important aspects of any assessment of ecosystem services. Analyses should consider the equitable delivery of services, and which users stand to gain or lose from a particular land management decision. In some cases, those who bear any costs of ensuring the delivery of ecosystem services (often land owners or land managers) may need to be compensated by the users who will benefit most (often referred to as 'Payment for Ecosystem Services'), to enable a sustainable and ethically fair outcome.

The spatial relationships between ecosystem services and human beneficiaries

Ecosystem services and beneficiaries occur at the same location, e.g., cultivated crops for farmers.

Ecosystem services are provided in all directions towards beneficiaries close by, e.g., food from the lake to surrounding villagers.

Ecosystem services are received by beneficiaries in a particular direction, e.g., mangrove forests protect landward villagers from a typhoon.

Ecosystem services flow towards beneficiaries which are a long distance away, e.g., fresh drinking water from an upland catchment to people downstream.

Source: Adapted from Fisher *et al.* (2009) Defining and classifying ecosystem services for decision making. *Ecological Economics* 68: 643–653.

Local fishing communities benefit from the ecosystem services provided by nearby wetlands

Ecosystem services can be measured using simple but scientific methods

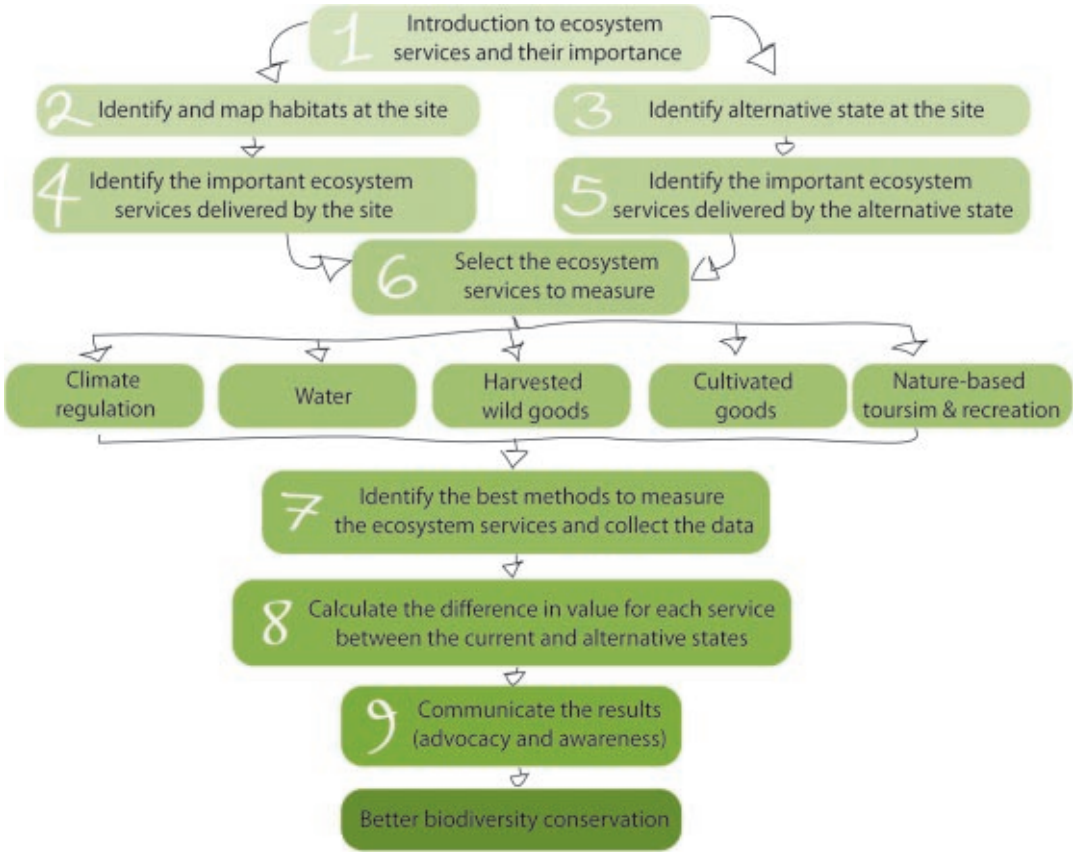
A new 'toolkit' has been developed to provide practical guidance on how to measure and monitor some ecosystem services at the site scale. The toolkit helps the user to identify which services to assess, what methods to use, and how to communicate the results for better biodiversity conservation.

Structure of the toolkit

The toolkit is designed as a decision key. It leads the user through a series of steps or questions, so that the user learns along the way (see figure below). For selected ecosystem services, values (biophysical and / or economic) are determined for the current and alternative states, and compared, alongside who would gain and who would lose should land-use change take place (see example in the figure opposite).

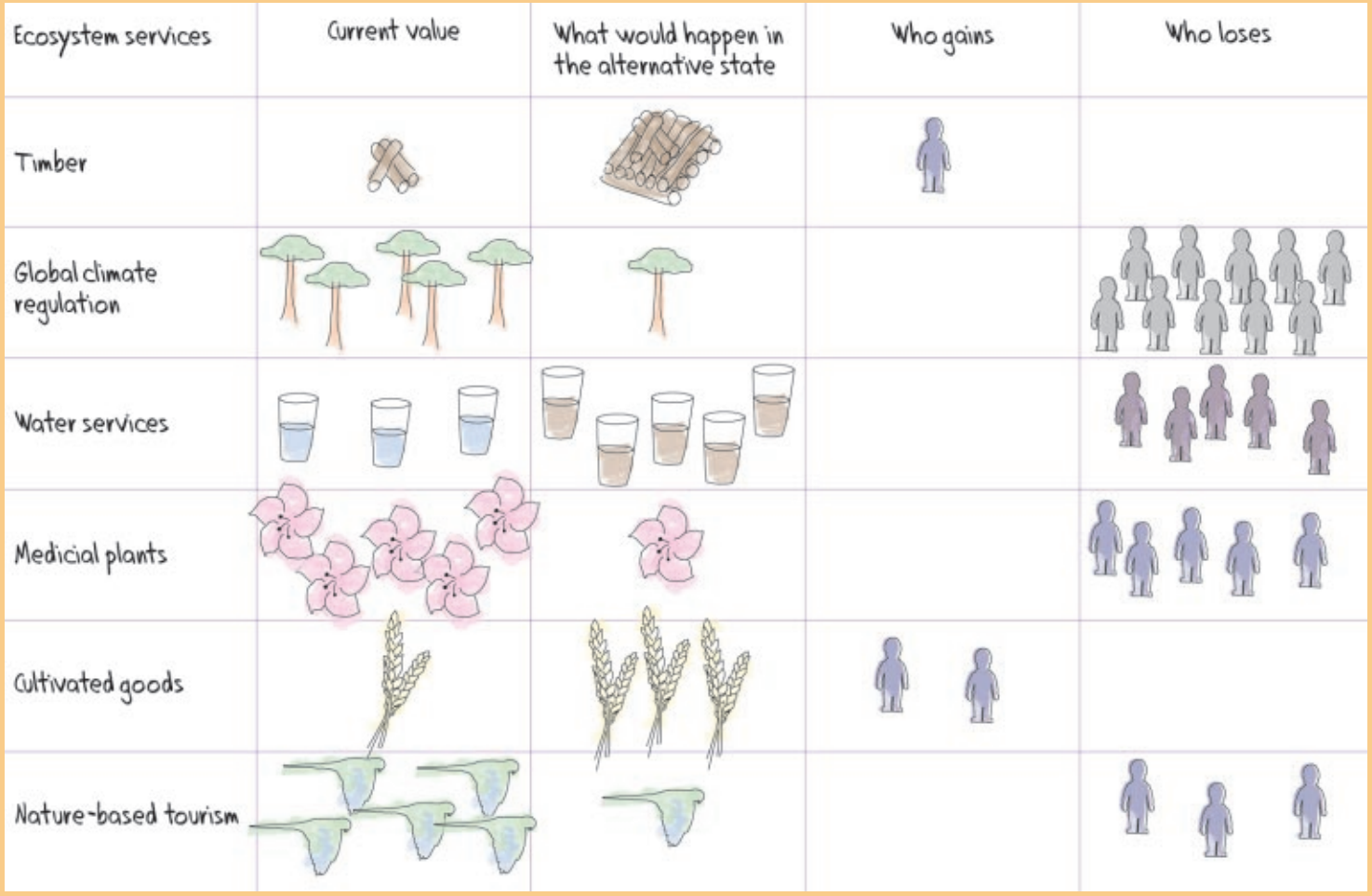
Above ground carbon stocks can be estimated using simple, but scientific methods
© BirdLife International

Steps in the use of the toolkit



Assessing ecosystem services at a site

In this hypothetical example, there are pressures to cut down a natural forest from the lower slopes of a mountain to increase food production. Is this a good option?



Comparing services
A simple assessment of the ecosystem services comparing the current with the proposed alternative state reveals that the conversion will provide valuable timber, but that the site will diminish significantly as a carbon store. The site will provide more water (because the trees will no longer trap the water) but the sedimentation load is likely to increase. The opportunities for freely harvesting wild goods (e.g. medicinal plants) will be replaced by cultivated goods (e.g. rice) which will be traded in markets. With much of the forest gone, the wild species diversity will diminish along with much of the nature-based tourism.

Comparing beneficiaries
Some people will benefit from these land-use changes—for example, the land-owner who has the rights to the timber and those who can develop and farm the land. However, some people will lose out, including the global community from the release of carbon in the atmosphere, the downstream communities from the reduced quality of the water and increased seasonal flows with the risk of flooding, and the local communities from the loss of access to a range of wild goods critical to their daily lives and opportunities to earn income from tourism.

The result
In this example, information on ecosystem services and the beneficiaries, and how these might change, provides important insights that should be considered in land-use planning. Conversion might appear as an attractive short-term option, but a more thorough review of costs and benefits over the longer-term might support continuing conservation of the forest.

Key: = local, = national, = global

Some technical information

The toolkit covers five classes of ecosystem services so far (see more details in the box below). There are plans to expand the toolkit to cover additional services in due course (notably coastal protection), but the initial focus is on these five classes because they are potentially important at most sites and feasible to measure with limited technical knowledge, time and resources.

In all cases users are encouraged to make use of information from reliable previous studies at the site. Users are also encouraged to undertake fieldwork involving simple measurements, stakeholder meetings and household surveys or individual questionnaires, as these provide up-to-date ground-truthing and improve the accuracy of the data, as well as important local contextual information for conveying the results. However, where this is not possible, a range of methods that can be applied remotely are suggested that use, for example, standard data tables and computerised geographical information, or transfer values from other similar sites.

Climate regulation services
Above-ground and below-ground carbon stocks are estimated using one of three methods: (1) reference to IPCC standard tables; (2) 'transfer' of values from similar sites; (3) simple field surveys to quantify the volume of living vegetation in different habitats. Loss of carbon through disturbances is estimated using standardised methods. Carbon dioxide, methane and nitrous oxide emissions are estimated using IPCC methods for appropriate habitat types. Data are extrapolated based on values per hectare.

Water services
Water provision can be calculated using data from water companies in many places and can be estimated from questionnaire surveys in others. However, in many situations water services for the alternative state are difficult to measure and so two online tools ('Costing Nature', 'WaterWorld') are recommended. These provide information on changes in water provision, seasonality, peak flows and sedimentation.

Harvested wild goods
The most important harvested wild goods are identified through a stakeholder workshop. For each of these, surveys of random selected households are undertaken to quantify the annual amount harvested, the unit value and related costs (including opportunity costs). The selected goods are then matched to land cover types and extrapolated according to average per hectare values.

Cultivated goods
The key cultivated goods are identified through a stakeholder meeting with informed individuals. For each of these goods, random household surveys are undertaken to quantify the annual amount cultivated, the unit value and related costs (including opportunity costs). Average values per hectare are applied to the area under cultivation.

Nature-based tourism and recreation
Data on the number of visitors to a site can be gathered through: (1) published reports on visits to sites e.g. protected areas; (2) a census of visitors over a random selection of days, extrapolated to an annual estimate. Economic contribution from tourism at the site is deduced from interviews with visitors—to estimate average expenditure (travel, food, other goods, entrance fees) per visit. The proportion of that value coming from nature-based tourism is estimated through simple questions about the alternative state.

Who is developing the toolkit?

The toolkit has been developed, thus far, through two projects: A Cambridge Conservation Initiative (CCI) project entitled 'Measuring and monitoring ecosystem services at the site scale: building practical tools for real-world conservation' and a BirdLife International / Darwin Initiative project entitled 'Understanding, assessing and monitoring ecosystem services for better biodiversity conservation'.

The work has been coordinated by researchers and conservation biologists from: Anglia Ruskin University, BirdLife International, Cambridge University, Royal Society for the Protection of Birds, and UNEP-World Conservation Monitoring Centre, with input and guidance generously provided by over 50 other scientists.

The methods and approaches presented in the toolkit have been tested at four sites to-date (2011), including Shivapuri–Nagarjun National Park (Nepal), Phulchoki Mountain Forest (Nepal), Montserrat Centre Hills (Montserrat) and Wicken Fen (UK), with implementation and support from Bird Conservation Nepal, the Department of Environment in Montserrat and the National Trust in the UK. In 2012, there are plans for further testing at a number of additional sites and publication of the methods and results through the peer-reviewed scientific literature, as well as the development of a 'toolkit' user-manual.

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CambridgeConservationInitiative

The **Cambridge Conservation Initiative (CCI)** is a pioneering collaboration between the University of Cambridge and nine leading internationally-focused conservation organisations and networks based in the Cambridge area. CCI seeks to transform the global understanding and conservation of biodiversity and the natural capital it represents to secure a sustainable future for all life on Earth. CCI partners together combine and integrate research, policy, practice and learning to create, deliver and promote innovative solutions for the conservation of biodiversity and to strengthen conservation capacity and leadership.

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BirdLife INTERNATIONAL

BirdLife International is a partnership of people for birds and the environment. As a worldwide community, we are the leading authority on the status of birds and their habitats. Over 10 million people support the BirdLife Partnership of national non-governmental conservation organisations and local networks such as the Royal Society for the Protection of Birds (BirdLife in the UK) and Bird Conservation Nepal (BirdLife in Nepal). Partners, operating in more than 100 territories, work together on shared priorities, programmes, and policies, learning from each other to achieve real conservation results. The BirdLife Partnership promotes sustainable living as a means of conserving birds and all other forms of biodiversity.

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What can the toolkit do?

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- ✔ **Help decision-makers appreciate the true value of nature, and the consequences of destruction and degradation of natural habitats.**

The toolkit for measuring ecosystem services presented in this booklet has been developed and tested by the following organisations

UNEP WCMC

UNIVERSITY OF CAMBRIDGE

BirdLife INTERNATIONAL

RSPB

Anglia Ruskin University

National Trust

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