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A simple guide to ecosystem services

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1. Key Points

- Ecosystem Services are the outputs of ecosystems from which people derive benefits. There are four service types: supporting (e.g. ecosystem processes such as soil formation); regulating (e.g. hazard regulation such as flood protection); provisioning (e.g. food and timber provision); and cultural (e.g. recreational, tourism).

- Many services occur in the same locations, so the extent of one is often directly linked to one or more other services.

- All these services have a value or worth, though this is not always solely economic and an economic value is not always easy to assign. It is important to understand the links between different services to be able to assess the trade-offs/co-benefits when implementing a policy, or to identify the impacts of climate change.

- The key challenges ahead are to understand on what spatial scale different ecosystem services act, on what time scale to evaluate different services, and whether there are limits and thresholds beyond which a particular ecosystem service ceases to be provided.

- Monitoring of the state and rate of change of ecosystem services will enable policy modification through better understanding the processes that link the different services. This will support both mitigation and adaptation decision-making.

2. Introduction

Whether people realise it or not, they receive many benefits from the natural world around them. These benefits from surrounding ecosystems (interaction of plants, animals and natural processes) are known as **ecosystem services**. By understanding the interdependence of ecosystem services and attempting to quantify their value, it is possible to understand the balance of positive and negative impacts of a certain policy or management practice. This is fundamental in the ecosystem service approach, which aims to reduce the risk of unforeseen consequences by helping policy makers to make informed decisions whilst considering the full range of potential impacts.

Ecosystem services are visible to the public in familiar areas such as crops and livestock in fields or pollination by insects. Many more services are less obvious such as soil formation, essential for crop production; water purification; for a healthy water supply; and protection from hazards such as flash floods through types of land use. All ecosystem services have a value to society – even those that are difficult to quantify.

An ecosystem is a dynamic complex of plant, animal and microorganism communities and their non-living physical and chemical environment interacting together. Therefore many of the services do not act independently and if there is a change in one, then there is likely to be a knock on effect on one or more other services. By understanding the interdependence of these services it is possible to predict their reaction to changes in their environment. Changes may occur through, for example, a variation in climate or a different land use brought about by policy changes.

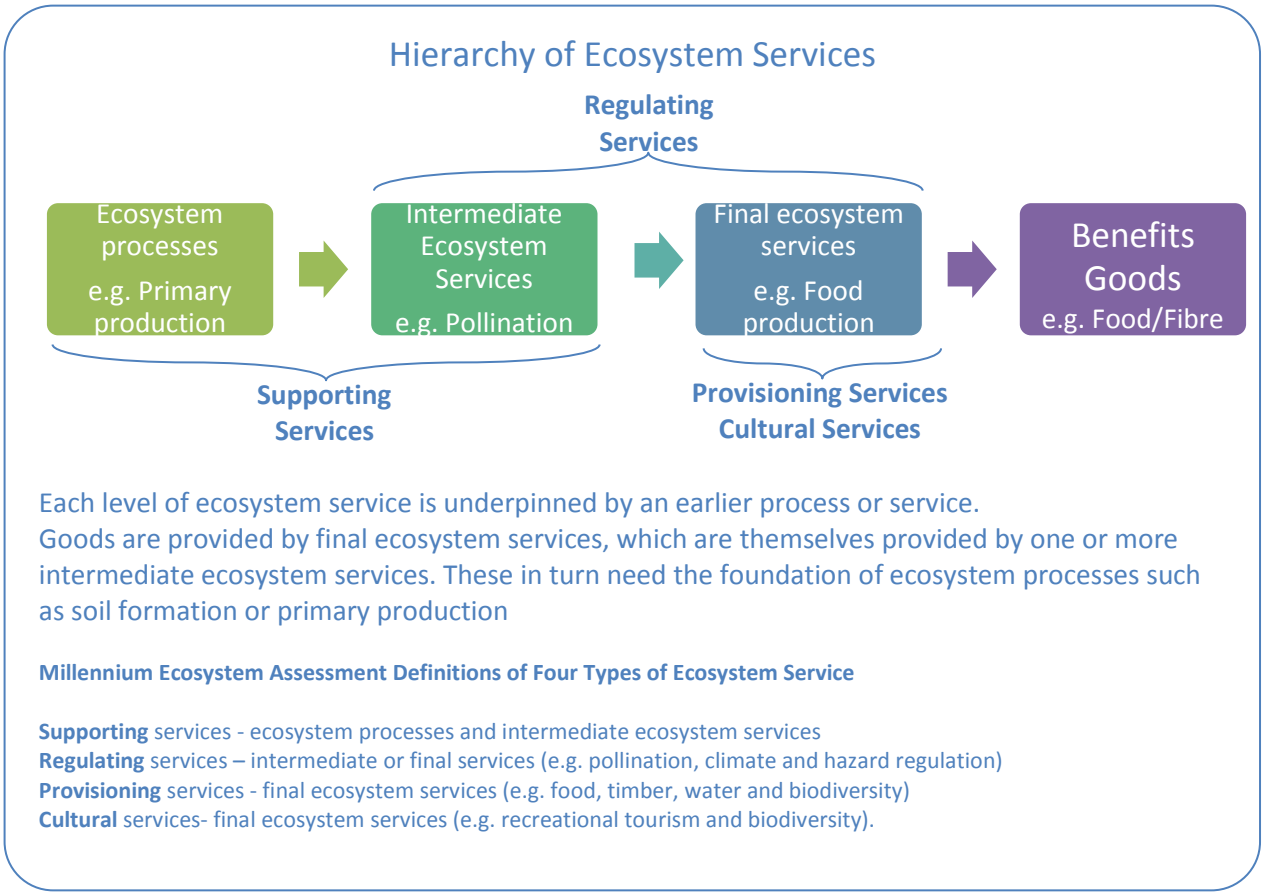
Valuing these services is both important and difficult due to the variety of service types. Some can be conventionally valued economically, such as crops and timber, whilst others such as nutrient cycling or soil formation that do not have a direct market are typically more difficult to value in a traditional way. One way to understand a service's value is to imagine the cost for humans to use technology to replace it. How to compare different approaches to valuation leads to much discussion and consultation with stakeholders and experts.

With knowledge of ecosystem service linkages and some agreement on values of services, it is possible to have a better understanding of the consequences of a policy (actual or potential). Policies can then be designed to protect or enhance particular suites of services that are identified as the most important. By monitoring the effects of a policy on the most valued ecosystem services the policy can be re-evaluated and modified. This systematic framework for decision making is called the ecosystem services approach.

3. Ecosystem Services at a Glance

Ecosystem: - A dynamic complex of plant, animal and microorganism communities and their non-living physical and chemical environment interacting as a functional unit.

Ecosystem Service: - The outputs of ecosystems from which people derive benefits.

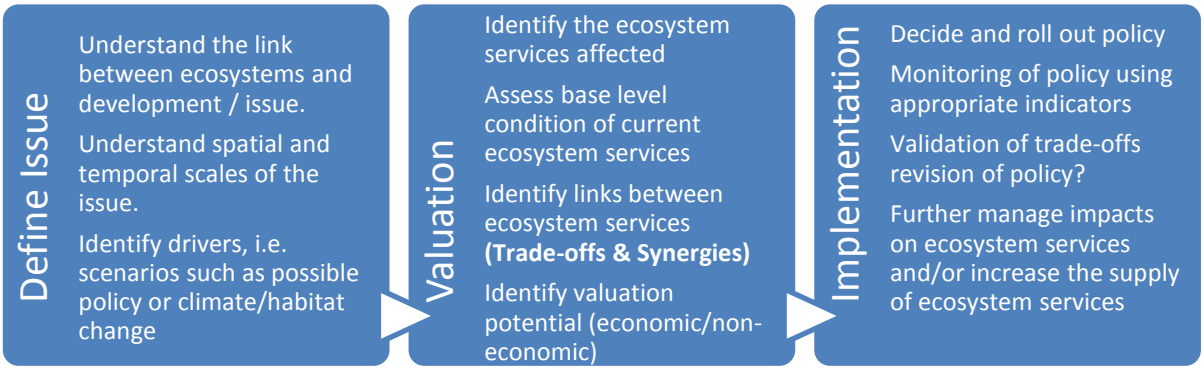


Each level of ecosystem service is underpinned by an earlier process or service.
Goods are provided by final ecosystem services, which are themselves provided by one or more intermediate ecosystem services. These in turn need the foundation of ecosystem processes such as soil formation or primary production

Millennium Ecosystem Assessment Definitions of Four Types of Ecosystem Service

Supporting services - ecosystem processes and intermediate ecosystem services
Regulating services – intermediate or final services (e.g. pollination, climate and hazard regulation)
Provisioning services - final ecosystem services (e.g. food, timber, water and biodiversity)
Cultural services- final ecosystem services (e.g. recreational tourism and biodiversity).

The **ecosystem services approach** is a framework for integrating ecosystem services into decision-making. It incorporates the linkage between the different ecosystem services, the respective values of each ecosystem service and impact assessment on these values by changing scenarios and policies. The ecosystem services approach therefore seeks to broaden the areas considered when making policy, to reduce unforeseen consequences. The framework follows a broad plan:



4. Defining the Issue

Understanding what is causing a change in ecosystem services and how that change is caused gives clues as to how and what changes in the ecosystem services may occur.

What's driving the ecosystem change?

Direct drivers: Physical changes that can be identified and monitored, e.g. habitat change, pollution, climate change, invasive species and overexploitation.

Indirect drivers: Alter the level or rate of change of one or more direct drivers, e.g. demographic, economic, socio-political, science and technologies and cultural.

Different drivers work on different spatial scales. Some act on a large national scale such as climate change. Others act on a more local scale, such as a change in land use brought about by specific policy changes.

Drivers act at different rates and understanding this helps us prioritise action: drivers that act most rapidly may require more immediate attention. It is necessary to identify the temporal scale of drivers and which ecosystem services are affected and how they are affected. For example climate change may occur at a slower rate to immediate habitat change brought about by a change in land use.

Which services are affected by the policy or scenario?

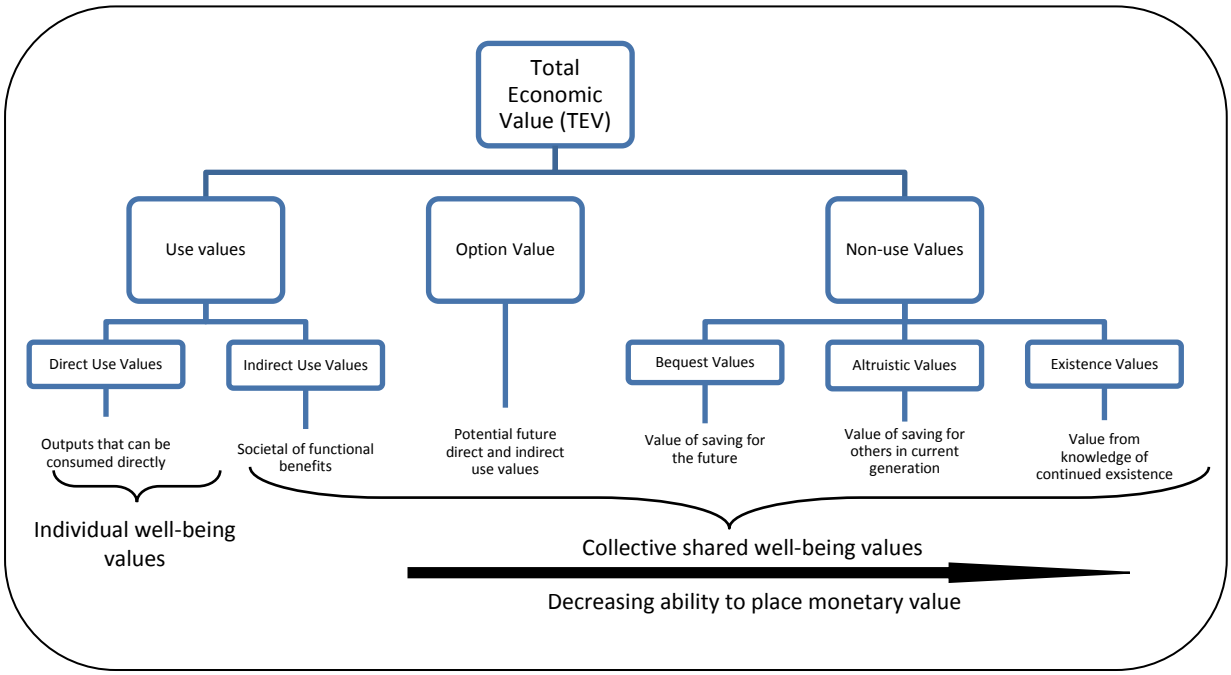
Changes in a policy or scenario will affect some ecosystem services more than others. Identifying which are the most sensitive to these changes enables those to be prioritised. This allows for more efficient strategies for quantifying and qualifying of ecosystem service valuations.

5. Valuation

Valuation of ecosystem services is a key need for future decision-making. Comparing the changes in different ecosystem services is necessary to understand the wider implications of any policy.

Due to the nature of many ecosystem services, they are often not fully 'captured' in commercial markets or adequately quantified in terms comparable with economic services and manufactured capital, and therefore can be given too little weight in policy decisions (Costanza *et al.* 1997). The total value of some services is infinite, meaning that without them human existence would not persist. It is therefore necessary to quantify the change in the service under different projected scenarios. Further complication may occur depending on the resilience and reversibility of any such change of a certain ecosystem service.

There are broadly two types of valuation possible, the more familiar **economic valuation** and **non-economic valuation** (e.g. Health & Social). Ecosystem services can be valued within a Total Economic Value (TEV) framework (UK NEA, Defra). The overall structure of the framework is described below (Reproduced form UK NEA). It demonstrates the spectrum of different values.



Direct use values are where individuals make planned or actual use of an ecosystem service (e.g. timber, food and recreation). This can be both through extracting resources (e.g. timber) and trading it on a formal market or through not extracting a resource (e.g. recreation), which is non-marketable. They are often provisioning and cultural services.

The **indirect use values** are those where individuals benefit from a resource through it supporting them rather than their direct use. Therefore they risk being overlooked until damaged or lost. The ecosystem services that are considered to have an indirect use value include nutrient cycling, waste decomposition, pollination and climate regulation (i.e. regulating services). Because they are utilised indirectly they are much more difficult to value. Any changes in quality or quantity can be difficult to

measure as they often occur over different spatial scales and therefore affect many different individuals**.**

Option values are resources that may have the option of being used in the future even though they are not available to current users. The future uses of these resources can either be direct or indirect. It can often be thought of as a form of insurance through maintaining current ecosystems so that they may reveal future uses and values that are either unforeseen values or not yet exploitable.

Even less easy to value monetarily are the **non-use values.** It is often difficult to put a price on values such as bequest, altruistic and existence values. The **bequest value** is where individuals attach value to the fact that the ecosystem resource will be passed on to future generations. Whereas valuing resources for the current generation is seen as the **altruistic value**. The **existence value** is the value placed on the continued existence of certain resources. For example, people may value a certain charismatic species' continued existence, despite the fact that they will never see it.

Trade-offs and Synergies

Trade-offs and synergies between ecosystem services occur because they are often dependent on each other. A trade-off occurs when a scenario or policy attempts to optimise one ecosystem service whilst suffering a reduction or loss in benefit of one or more other ecosystem services. These can be obvious trade-offs for space such as forestry and arable land, or through causality, such as a change in land use leading to a reduction in carbon storage or soil erosion reducing soil fertility. There will be other less obvious trade-offs that require a deeper understanding of the interconnectivity of the ecosystem services. Services may not trade-off in the same spatial areas. For example, in river catchments, changes at the top of a catchment may only manifest themselves further down.

It is easy to understand how a change in one ecosystem service can lead to a change in another service. However, in reality, an ecosystem service may be linked to many services making trade-offs more complex to understand. Thus it is very important to gain data on any mechanistic linkage or correlation between ecosystem services to make it easier to predict possible outcomes.

The likelihood of interdependence of many ecosystem services means that when looking at any one scenario it is necessary to consider the whole spectrum of ecosystem services.

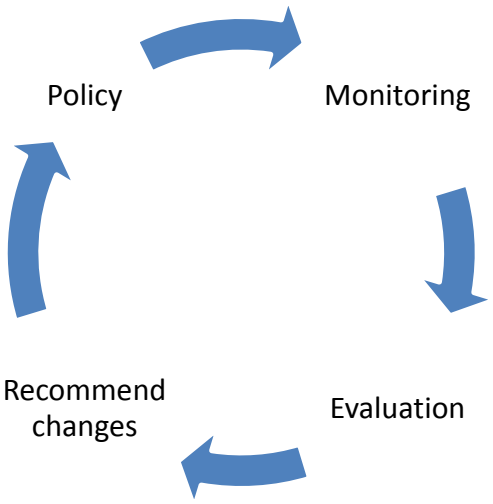
As well as trade-offs, synergies may occur. A management strategy for improving one ecosystem service might lead to improvement of another (e.g. forestation in the correct areas can lead to increased carbon storage, biodiversity as well as cultural wellbeing).

Implementation

By understanding the interdependency of ecosystem services and attempting to quantify their value, it is possible to understand the balance of positive and negative impacts of a certain policy or management practice.

Once a new policy is introduced it is useful to implement a monitoring system to validate any predictions made on the affects to ecosystems services. This will further inform any potential trade-offs and synergies. Monitoring can be done by focussing on key indicators; often certain species are indicative of certain well functioning processes. A good monitoring process aids future policy and

practice decisions. In this way, by adopting a learning approach, the course of a policy can be altered/improved in the light of new data.



6. Key Challenges

Spatial issues: The spatial scale selected for consideration may have a significant impact on the analysis of the effects of any given driver. The spatial scale upon which different ecosystem services act and upon which a driver may act must be considered. Especially as each ecosystem service often acts at a different scale. Forestry may only seem to act across the area that it covers in some ecosystem services such as carbon sequestration. However other services and benefits that forestry provides, such as biodiversity and water quality, may be realised on a wider scale and by a greater number of people.

Temporal Issues: Impacts on ecosystems may have effects that could extend beyond the time period of any policy appraisal. A change in an ecosystem service may take time to develop and this may affect valuations of services. This being so, any benefits and costs will not be immediate and will occur over a period of time. An evaluation should therefore use discount rates over the longer term.

Limits and thresholds: The state of an ecosystem determines the quality of the services it can provide. If the condition of an ecosystem deteriorates, its ability to provide that service will also reduce. The process of deterioration may be gradual or it may reach a threshold beyond which the service ceases to be provided. This may be an irreversible change, with the service ceasing to exist. Such an instance was seen in the Newfoundland cod fishery collapse in the early 1990s resulting from overexploitation of the resource. Cod stocks could not recover in a timely manner and lead to the collapse of the fishery, along with the loss of thousands of jobs. As valuation often attempts to look only at marginal change, the possible irreversibility certain ecosystem services must be considered when valuation occurs and policies are proposed.

7. References

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