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# insight

An energy briefing paper

## An introduction to ecosystem services



## Executive Summary

Providing resources to support a growing world population, whilst protecting the environment on which we depend, is a major challenge in the 21st century. The ecosystem services approach is proposed as a key tool in meeting this challenge.

This briefing note provides a short introduction to the application of the ecosystem services approach in enabling the sustainable transformation to a low-carbon energy system.

This builds on research being undertaken by the UK Energy Research Centre (UKERC) Energy & Environment Theme, and provides key case studies from this research.

Energy Insights are occasional briefing papers on aspects of energy policy and research produced by UKERC.

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## What are Ecosystem Services?

Ecosystem services are commonly defined as "the outputs of ecosystems from which people derive benefits" (NEA 2011). They are generally categorised into four groups: provisioning services such as food and water; regulating services such as climate control and flood defence; cultural services such as recreation and aesthetic values; and supporting services such as pollination (Millennium Ecosystem Assessment, 2005).

To enable valuation, and to avoid double counting, ecosystem services are often further sub-divided. This is generally into three subsections (see Fig 1):

### 1. Ecosystem processes or intermediate ecosystem services

These are fundamental processes which occur in the natural environment. Supporting services fall into this category. Although these do not directly benefit human well-being they underpin the provision of all 'final ecosystem services' and 'benefits'. They are rarely the focus of management.

### 2. Final ecosystem services

These directly sustain or enhance human life. These final services are a human construct and are aspects of the natural environment which we perceive to be valuable or useful to us. As their influence on well-being is more tangible humans are more actively involved in their management.

### 3. Goods or benefits

These are of tangible and immediate value to human well-being. The realisation of an ecosystem benefit requires human intervention, for example time, finance or technology; these benefits would not exist without human intervention. Ecosystem Benefits are things that can be valued, either through monetary values or other measures of human well-being. Their continued provision is often the focus of management.

Figure 1 Diagram providing examples of marine and coastal ecosystem services, depicting how ecosystem processes link to final ecosystem services and their associated benefits (Adapted from the National Ecosystem Assessment, 2011)

## Why Ecosystem Services?

*Comprehensive assessment*
The Ecosystem Service Framework is particularly valuable in highlighting the more intangible ecosystem benefits e.g. waste processing capacity and cultural benefits. Due to their intangible nature, free availability, and often indirect use, these benefits routinely go unnoticed and consequently their importance is under-valued or unrecognised (Daily, 1997).

Utilising an ecosystem service framework ensures all potential impacts are recognised in the decision making process.

*Communication*
Ecosystem services are valuable in translating the complex ecosystem processes into terms which are readily understandable, facilitating communication both between scientific disciplines and with the wider community, including policy makers and non-expert groups.

*Sustainable provision of services*
The application of the ecosystem service framework for environmental management clarifies the linkages between fundamental ecosystem processes and human welfare, improving our understanding of how ecosystem benefits are provided and increasing the likelihood of ensuring exploitation is sustainable. It is essential to consider not only the benefits received from the environment, but also the processes underpinning the provision of these benefits.

*Transparent trade-offs*
Exploring changes in ecosystem service provision under different scenarios enables the equal consideration of environmental, economic and social issues when decisions about human activities are made. This clarifies the potential trade-offs between competing economic development options (Daily, 1997).

## Ecosystem Services and Renewable Energy

The derivation of renewable energy from the environment can be defined as an ecosystem service in its own right. However the utilisation of this ecosystem service will have impacts on other services, and even possibly on the long-term sustainable provision of renewable energy itself.

An ecosystem service assessment is essential to ensure that any negative social, economic or environmental impacts of renewable energy implementation are minimised, to avoid any nasty surprises in the future and to ensure that the exploitation of renewable energy is sustainable in its own right.

# Case studies

## Bioenergy

Non-food bioenergy crops can provide improved farmscale biodiversity compared to arable food crops (Rowe et al., 2011), but the impacts on wider ecosystem services vary depending on the crop type and the places where they are grown (Figure 2). For example, bioenergy planting may have a large impact on the amenity value of the landscape.

The ability to utilise these crops on marginal and poor quality agricultural land, where they do not compete with food crops, makes it likely that in the future they will form a greater part of a complex agricultural landscape. A better understanding in this area is required as there is increased pressure to securely produce large quantities of food from land. Land-based systems must be managed to deliver a range of ecosystem services in multi-purpose landscapes in which food, fuel and fodder crops exist alongside semi-natural habitats.

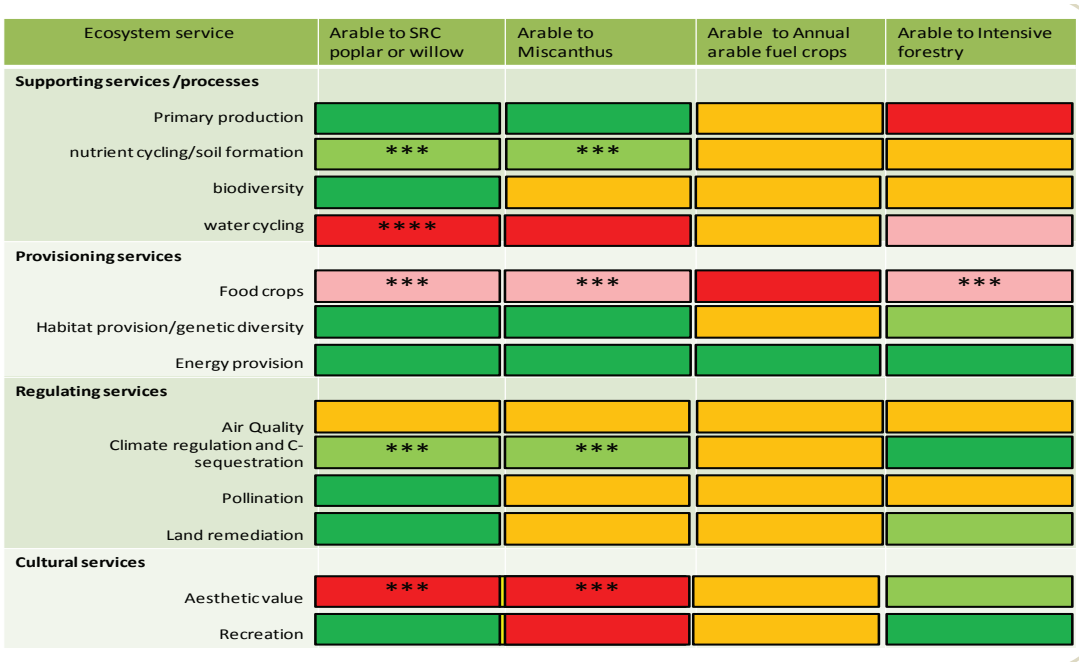
Developing appropriate frameworks to address these unknowns remains a challenge (see TABLE 1).

| | | | |
|---|---|---|---|
| Nitrogen leaching | ↑↑↑ | ↑↑ | ↔ |
| Visual Impacts | ↓ | ↓ | ↔ |
| Energy and Carbon Balance | ↑↑↑ | ↑↑↑ | ↑ |
| Hydrology (At catchment scale) | ↔ | ↔ | ↔ |
| **Biodiversity** | ↑↑ | ↑* | ↔ |
| Avian | ↑↑ | * | ↔ |
| Flora | ↑↑ | * | ↔ |
| Invertebrates | ↑↑* | * | ↔ |
| Mammal and Amphibians | * | * | ↔ |

- ↑ Positive impact,,↓ Negative Impact, ↔ No Change, * Limited data
- R. Rowe, et al (2009). Renewable & Sustainable Energy Rev. 13, 271-290

Figure 2 Ecosystem services and UK bioenergy

TABLE 1 – An assessment of the likely impacts of land use change from arable food crop (e.g. wheat) to SRC, Miscanthus, arable energy crops (e.g. oil seed rape) or intensive short rotation forestry (e.g. Eucalyptus), in the UK landscape. Redrawn from Harris et al., (2012)




## Marine renewable energy

The marine and coastal environment provides a host of complex and interrelated ecosystem services (Figure 1). There is concern that the implementation of offshore wind farms may have some negative impacts on the marine environment, and thus also on the associated ecosystem services. These impacts include noise, electromagnetic fields and visual and structural changes, potentially resulting in bird collisions, avoidance behaviour and changes in productivity.

However, they could also have some positive effects such as acting as artificial reefs. Exactly how these effects will impact the provision of ecosystem services will be extremely site specific, but those likely to be affected include carbon sequestration, food provision, and cultural services.

## Conventional energy

All forms of energy production will have some impact on ecosystem services through the land used to produce them (the "footprint") and the by-products that arise from production. Canadian tar sands provide an example of the potential trade-off between energy production and ecosystem services. Here, there is a direct impact on provisioning services (forestry), regulating services (carbon storage in the forests), and cultural services (fish and game and the spiritual value of the forests to the aboriginal population) due to the very large footprint of tar sands.

In addition, the influx of wastewater into rivers is likely to have impacts on cultural and regulating services downstream from the production areas, while the high energy input required to produce oil from the tar sands will have an impact on regulating services (carbon sequestration).

## References

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