POLICY BRIEF

Policy tools to manage synergies and trade-offs between ecosystem services

Context

Ecosystem services co-occur in bundles, with negative or positive associations, sometimes even synergistic. Management shifts usually make trade-offs between the supply of services to different users. Management decisions therefore require a good understanding of both the co-occurrences and interactions between different services and stakeholders' interest and needs.

Main findings

Ecosystem services are impacted both by climate change and responses to it. Consequently, these two aspects need to be explored together, not separately, to determine the most appropriate management approach.

Sustainable management options can be identified by combining participatory ecosystem services scenarios with optimisation tools which quantify trade-offs between services.

Key policy recommendations

- **Apply ecosystem service mapping and integrated assessments** to comprehensively evaluate the impact of policies and their implementation on multiple ecosystem services.
- **Use stakeholder assessments and participatory methods** to develop a clear understanding of winners and losers of a given ecosystem management decision by clearly identifying the beneficiaries of different ecosystem services.
- **Combine the use of participatory ecosystem service scenario building with optimisation tools** to identify the most sustainable and desirable policy responses and management options.

Context

Ecosystems provide many services, which often co-occur in bundles because they derive from the same ecological functions. Some services may be positively associated, or even synergistic, whilst others may be antagonistic. For example, increasing provisioning services, such as food or timber, often results in a decline in other services.

Consequently, managing ecosystems to optimise their ecosystem service provision involves context-specific trade-offs, and to do this whilst maintaining biodiversity requires a good understanding of service co-occurrences and interactions. It also requires understanding of the different drivers for stakeholders' interests and need for different ecosystem services (e.g. normative, regulative and cultural aspects).

Integrated ecosystem services assessments, supported by stakeholder analysis, can encourage synergies or avoid undesirable trade-offs between ecosystem services that may result in sectoral and policy incoherence.

Such assessments should include the following steps, as described by Cord and co-authors (2017):

- identify co-occurrences of ecosystem services
- identify ecosystem services which are positively or negatively associated
- identify drivers (environmental or social pressures) and policies that shape ecosystem service relationships
- support policy, planning and management decisions that balance the provision of the range of ecosystem services for stakeholders: often, the existence of trade-offs makes it impossible to optimise all services

Drivers of change can have mixed effects on multiple services at the same time. Policy drivers may have unintended effects if only one ecosystem service is focused on. Consequently, there is a need for more coherent policy approaches that seek to simultaneously address the use of and/or impacts on multiple ecosystem services.

This brief considers how the results of some BiodivERsA-funded projects are helping to build up the scientific evidence base showing how trade-offs and synergies between ecosystem services can be better understood and managed. It uses results from three BiodivERsA-funded research projects (VITAL, REGARDS, CONNECT) and one BiodivERsA/FACCE-JPI funded research project (TALE). In addition, it also uses information from the FP7 project TEEMBIO.

Key results

Understanding how drivers (environmental or social pressures) and policies shape relationships between services

Grassland ecosystems – and particularly permanent semi-natural grasslands - provide a range of ecosystem services from food provision (through forage and livestock) to carbon storage, habitat provision for many animal and plant species, and landscape quality. Climate change can lead to shifts in the balance of ecosystem services provided by grasslands. **Mountain grassland ecosystems** are particularly vulnerable to climate change. In general, while climate change mitigation is an important strategy for biodiversity conservation, bioenergy production remains a controversial mitigation action due to its potential negative impacts (habitat modification and land-use change), including in grassland areas.

Climate change and management change jointly alter the balance of ecosystem services

Meller and co-authors' (2015) findings indicate that the magnitude of range shifts by European birds due to climate change is greater than the impact of land conversion to woody bioenergy plantations within the EU. However, local conservation conflicts due to bioenergy production are likely to occur and could be addressed by adopting appropriate sustainability criteria for bioenergy.

Kohler and co-authors (2017) linked the functional dynamics of grassland vegetation to ecosystem service operating ranges – under normal conditions and under changed management, i.e. from mowing to summer grazing in response to more frequent summer droughts. They showed that the grasslands have the potential to maintain their biomass provision and forage quality under the management shift, whilst their carbon storage and soil fertility will decline. The predictions show that management shifts in response to climate change have differing impacts on ecosystem services, thus changing the trade-offs.

Lamarque and co-authors (2013) showed with participatory scenario building that farmers' adaptability to climate change on mountain grasslands was constrained by their limited opportunities to access more grassland or to mechanise mowing to save costs. Consequently, their responses to climate change are likely to result in conversion of mountain grasslands from mowing to grazing and an increase in areas fertilised with manure, as they try to maintain livestock production. Abandoning land or developing tourist income is only considered preferable by farmers if faced with drastic climate change.

Abandonment can lead to further changes in ecosystem service supply; according to Ingrisch and co-authors (2018) abandonment increases the resistance but decreases the recovery of grassland carbon dynamics to climate-induced drought. In other words, the carbon dynamics – measured as changes in gross primary productivity, ecosystem respiration, phytomass and its components, and leaf area index – were more strongly affected in the managed grassland but recovered faster than in the abandoned grassland.

Consequently, while management shifts as a response to climate change can have a desired effect on one ecosystem service, land managers and policy makers need to also consider the possible impacts on other services.

Stakeholders perceive ecosystem services differently

Farmers, policy makers and researchers perceive the relationship between soil fertility and above-ground biodiversity differently, for example when predicting the effect of fertiliser applications (Lamarque and co-authors 2011). Stakeholders' differing knowledge of biodiversity and soil fertility influences their perception of agricultural management effects on ecosystem services. While all are aware of the effect of agriculture on ecosystem services supply, their knowledge of relationships between ecosystem services differs.

To support decision making, stakeholders should be well informed of the ecosystem services concept, and use it carefully to facilitate understanding and agreements amongst themselves.

Combine scenarios and optimisation tools to identify trade-offs at landscape scale

Increasing afforestation or production of crops for biogas or biofuel is often associated with negative impacts on other ecosystem services such as soil erosion, poorer water quality and less water quantity at low flows. Lautenbach and co-authors (2013) combined different crop rotation changes with an optimisation algorithm to find bioenergy crop expansions with the fewest negative effects. Lautenbach and co-authors (2017) also identified priority afforestation areas in a tree-poor region that promote synergies and avoid trade-offs between carbon sequestration, benefits to threatened plant species and overall plant species richness.

Verhagen and co-authors (2018) demonstrate that, in addition to mitigating negative impacts of one ecosystem service use to others, landscape optimisation tools can be used to deliver multiple ecosystem services. Using landscape optimisation algorithms they identified a combination of on-farm measures (organic management and establishment of linear elements) and off-farm measures (taking land out of production) that can be used to simultaneously increase fruit yield, endangered species habitat and landscape aesthetics while minimizing losses in the most common land use in the area (dairy farming).

Policy recommendations

EU policies lack policy tools to integrate ecosystem services into land management decisions in a coherent way. Policies that focus on only one sector and ecosystem service often have unintended negative consequences for other ecosystem services. Integrated ecosystem services assessments can help avoid this by facilitating coherent land use policies and decisions that result in more multifunctional ecosystems.

Key recommendations are to:

- Apply explicit **ecosystem service mapping** and integrated assessments to comprehensively evaluate the impact of policies and their implementation. Such assessments should be used to avoid undesirable trade-offs and where feasible to support the synergistic delivery of multiple priority ecosystem services.
- Understand the whole picture of winners and losers of a given ecosystem management decision by **mapping the beneficiaries** of different ecosystem services, understanding different perceptions regarding the importance of different services and how their management decisions affect the services.
- Combine the use of **participatory ecosystem service scenario building** with **optimisation tools** to identify the most sustainable and desirable policy / management options, as stakeholders are not always aware of all the consequences of their choices.

Policies that affect ecosystem services require a better understanding of how a changing environment and management will alter the delivery of different ecosystem services.

Key recommendations are to:

- Further develop and apply **information tools and indicators** targetted to multiple, not individual, ecosystem services and their joint response to policy and/or management measures at local and regional scales.
- **Impacts of climate change** and the impacts of related policy responses (e.g. promoting bioenergy) need to be explored together, not separately, to determine the best policy or management approach.
- Integrating ecosystem services into decision-making requires a good understanding of how **land management affects ecosystem service supply** and trade-offs. Research findings that reveal the effect of land management changes on ecosystem services should be used to inform policy decisions.
- Use this knowledge to direct public policy and funding towards the optimal management of ecosystems for delivery of multiple ecosystem services, and avoid undesirable negative trade-offs.

The above recommendations capture the key 'best practice principles' that should apply across all policy sectors. The EU Strategic Environmental Assessments and Environmental Impact Assessments provide a starting point for their uptake in practice.

Links to sources

VITAL project website
REGARDS project website
CONNECT project website
TALE project website

Scientific publications used in this policy brief can be found in the Information Sheet of this briefing, downloadable from:

www.biodiversa.org/policybriefs

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About this policy brief

This Policy Brief is part of a series aiming to inform policy-makers on the key results of three BiodivERsA-funded projects (VITAL, REGARDS, CONNECT), and one BiodivERsA/FACCE JPI-funded project (TALE), and provide recommendations to policy-makers based on research results. One project funded by the European Commission (TEEMBIO) was also considered.

The series of BiodivERsA Policy Briefs can be found at www.biodiversa.org/policybriefs.

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The key research results presented here were validated by researchers from the VITAL, REGARDS, CONNECT, and TALE research projects. he policy recommendations made do not necessarily reflect the views of all BiodivERsA partners.

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