OPERAs Ecosystem Science for Policy & Practice

How do you take into account trade-offs between ecosystem services in land management and decision making?

Summary

Navigating trade-offs is an essential part of decision-making.

It is particularly important in natural resource management in ecosystems where decisions that are made today may have implications for other systems and future generations. To operationalise the concept of ecosystem services (ES) and to manage natural capital wisely, decision makers need to have a full understanding of the trade-offs associated with their decisions, particularly regarding the provisioning of ecosystem services. If the increase of one ecosystem service happens directly or indirectly at the cost of another, maximising the provision of that service might lead to sub-optimal results. To support decisions, explicit information about trade-offs between ecosystem services is required. The OPERAs project made a number of contributions to improve our understanding of ecosystem services trade-offs and developed and tested methods that can assist in effectively navigating them.

Key messages

- Land use decisions inevitably come with trade-offs
- Awareness and understanding of how land use and ecosystem services synergise or trade-off can help land managers to find solutions that minimize trade-offs
- Certain groups of ecosystem services are more likely to lead to trade-offs rather than synergies; other groups of ecosystem services can be synergistic if well managed
- Trade-offs can occur over space, over time, or among stakeholders
- Whether management options and the trade-offs they incur are acceptable depends strongly on the values and preferences that stakeholders hold
- Multifunctional landscapes are not always win-win – some trade-offs cannot be avoided
- A wide range of tools are available to help decision-makers to navigate trade-offs effectively

Knowledge

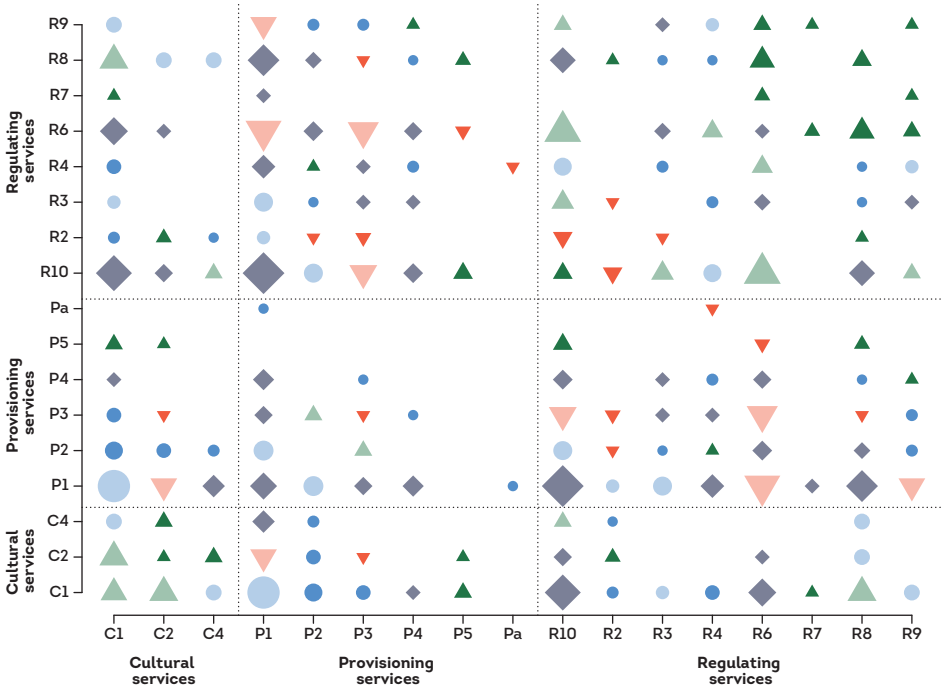
OPERAs researchers conducted a literature review on the subject of ES trade-offs.

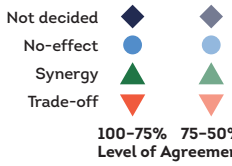
They found different relationships between different categories of ES. Regulating and cultural ES were more likely to have a synergistic relationship, while trade-offs were more common between regulating and provisioning services. Cultural and provisioning services had a 'no effect' relationship.

In order to optimise ecosystem service provision, objectives need to be set. Setting such objectives is often not straightforward, as the relationships between how much of a service is provided, and the value it has for society are often non-linear (e.g. minimum levels needed before a benefit is provided), location-dependent (pollination near crops, air purification near urban areas) and context-dependent.

OPERAs studies demonstrated that there are often improvements possible compared to the current level of ecosystem service provision, and future Business as Usual scenarios. Tools such as pareto-optimization can assist in identifying the best possible land management options, for a given set of objectives and accounting for trade-offs. And tools like Zonation can identify which areas are of most (or least) importance in meeting a region's ecosystem service objectives, thereby providing guidance to spatial planning to minimize impacts of land use change.

Result from analysis of 67 case studies with 476 pairs of ecosystem services, showing the empirical pattern of relationships between them. *The size of the symbol indicates the number of studies. The color intensity represents the level of agreement.* **C:** *Cultural services,* **P:** *Provisioning services,* **R:** *Regulating services.*





C: Cultural services,
P: Provisioning services,
R: Regulating services.

C1: Physical and experiential interactions,
C2: Intellectual and representative interactions,
C4: Other cultural outputs,

P1: Nutrition biomass,
P2: Nutrition water (i.e. drinking purpose),
P3: Materials biomass (e.g. for production and agricultural uses),
P4: Material water (i.e. non-drinking purpose),
P5: Biomass-based energy sources,
Pa: Renewable abiotic energy source

R10: Atmospheric composition and climate regulation,
R2: Mediation by ecosystems,
R3: Mass flows,
R4: Liquid flows,
R6: Life cycle maintenance, habitat and gene pool protection,
R7: Pest and disease control,
R8: Soil formation and composition,
R9: Water conditions.

(Lee & Lautenbach (2016)

Instruments

Environmental management will often require choices to be made between different land use options, and may se decision support tools in order to weigh up the trade-offs involved.

OPERAs developed a number of decision-support tools through their research in varied landscapes. Some of these tools deal with trade-offs explicitly by working with preferences e.g. CBA, MCA, MCDA, mDSS, while others do so implicitly by quantifying the impacts of different decisions and comparing them against each other e.g. TESSA, ToSIA, WeLCA.

Policy-making can often involve trade-offs when choosing which activities to encourage or favour and where to allocate funding. The Environmental Harmful Subsidy (EHS) tools were developed to help policy makers identify the impacts of policies, and navigate the potential trade-offs associated with them.

Practice

Many of the OPERAs exemplars were looking at multi-functional landscapes where there is the potential to explore the many facets of trade-offs and synergies in ecosystem services.

Research in the French Alps and in Costa Rica looked at whether services align spatially, i.e. form a 'bundle' (synergy), or not (trade-off). Spatial relationships are typically related to the land cover or land management that services are associated with. For example, in Costa Rica biodiversity hotspots were found to have the highest co-benefits for other services, while carbon hotspots have the lowest.

Temporal synergies and trade-offs describe how ecosystem services respond to factors such as changes in policy decisions, hydrological regimes, or climate. This was explored in the French Alps using scenarios to look at the impacts on ecosystem services.

Supply and demand trade-offs, studied in Barcelona, the Swiss Alps and the Lower Danube, refer to the societal demand for ecosystem services and whether this is met through the capacity of the ecosystem to provide services.

Trade-offs among beneficiaries looks at the degree to which the ecosystem services objectives of different groups of stakeholders are affected by changing boundary conditions or planning decisions. This was the focus of work in Peru where they found that the ecosystem service approach could contribute to territorial management by creating networks and strengthening relationships between actors.

The French Alps Exemplar

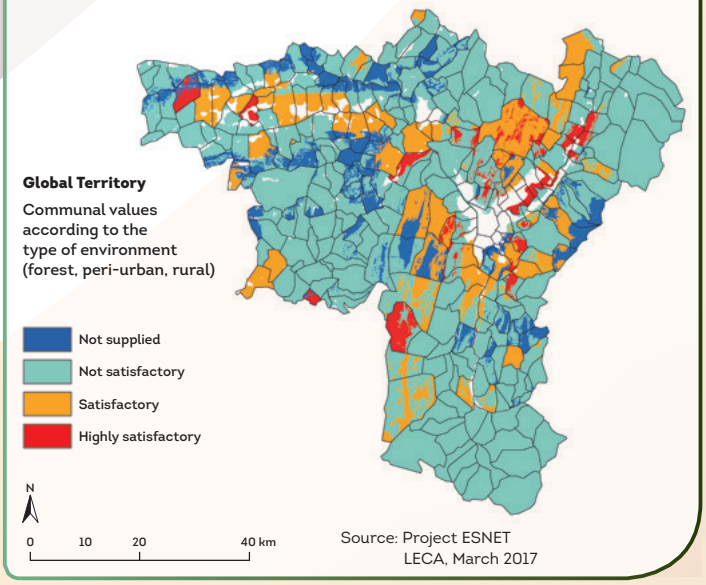
In the French Alps exemplar, trade-offs were studied in a number of different ways.

- Biophysical or spatial trade-offs,
- Temporal trade-offs – the effect of future scenarios on bundles of ecosystem services,
- Value-use trade-offs – using scenarios that reflect different values e.g. pro environment or pro-business and assessing the success of scenarios depending on values used.

It was useful for stakeholders to see how conservation objectives trade-off with other dimensions of sustainability. They found that, although current management strategies consider themselves to be pro-environment, they actually reflect a business as usual scenario. The work on values showed that, although multi-functionality is an ideal, there are certain endogenous trade-offs that cannot be avoided.

For example, a group of stakeholders, prepresenting different economic sectors, were asked to develop a 'multifunctionality rule' that would determine the supply of 12 ecosystem services in the Grenoble region. The predominant blue colours on the map show that under this rule ecosystem services are overall not considered to be delivered at satisfactory levels.

Assessment of ES bundles following 'ideal' multifunctionality rule



Source: Project ESNET LECA, March 2017

BackES

BackES is a tool for exploring possible solutions to current and future problems based on socio-economic, political and environmental information, criteria and goals. It can be used to determine potential land use strategies that will lead to a desirable combination of ecosystem benefits. Unlike forecasting methods, which often predict a range of future plausible scenarios based on current information, the starting point when using a backcasting approach is an ideal future scenario. From here, one works backwards to determine how that can be achieved. Follow up strategies and pathways leading to that desired future are then defined.

The Future

The OPERAs project researched trade-offs and synergies in ecosystem services in a variety of socio-ecological systems, covering the many aspects of the issue.

An essential part of managing trade-offs is to identify the relevant ecosystem services, measure them and identify preferences and targets, this process encourages a complete understanding of the benefits provided by the system.

The knowledge and instruments developed through this process will help environmental managers and policy-makers to identify and navigate the trade-offs that arise in environmental management.

> "A merit of the ecosystem service approach is that it makes visible some things that are usually invisible [to decision makers]"
>
> **Grenoble stakeholder**

> "Taking ecosystem services into land planning should become the rule!"
>
> **Grenoble stakeholder**

> "Scientific arguments have a definite weight in land planning decisions."
>
> **Grenoble stakeholder**

> "The fact that not the best scenario is not the same everywhere highlights the need to play on complementarities at regional scale."
>
> **Grenoble stakeholder**

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This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement number 308393.