



Ecosystem Science for Policy & Practice



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Executive Summary

Exemplars within OPERAs

In the twelve OPERAs Exemplars policy meets practice. Here the potential for the operational use of the ecosystem services and natural capital (ES/NC) concepts are investigated across a variety of settings. OPERAs Exemplars are selected to represent a range of socio-ecological systems across scales. These are the testing grounds where project partners collaborate closely with stakeholders, where instruments are developed and applied, and for empirical research on both method and theoretical development. Therefore, Exemplars serve as venues for collaboration between the six Work Packages in OPERAs. This Exemplar Study Design Descriptions (Deliverable 2.1) offers an early reflection across all the Exemplars on their collective status in this Executive Summary, followed by the Exemplar-specific study designs.

The Study Designs all follow a commonly developed logic and format created in order to facilitate collaboration and synthesis between Exemplars. Each study design was developed by the individual Exemplar leaders and their collaborative teams listed on the cover pages. The study designs lay out the scope of both the academic and practical work that will be conducted in the Exemplars. Academically, the designs specify the research questions and the methods that will be used to address them. Practically, the designs specify the stakeholder needs that guide the development and implementation of tools and instruments in each Exemplar, which are being further developed and refined as initial research is now getting underway.

The Study Designs begin with a “Dream Abstract” highlighting the key goals and approaches of the Exemplar, then describe the rationale behind the study, how each Exemplar was selected, the research questions and goals that will be addressed through the Exemplar, and how stakeholder needs in relation to ecosystem service management will be addressed through OPERAs instruments. Please note that there is a description of OPERAs instruments in Appendix 1.

Selection and Organization of Exemplars

The Exemplars were selected during the initial development of the OPERAs project to apply a relevant range of criteria, including policy relevance, trade-offs, and thresholds, and be able to test tools and instrument in real-life settings. Furthermore, Exemplars were selected based on their diverse contributions to a set of criteria including: geographic scale and location within Europe, ecosystems and land use types, governance, stakeholders, and economic sectors. They were thus selected to cover a large variety of settings and to complement each other, but not necessarily for comparative analysis between them, although individual research activities, tools, and instruments within OPERAs are applied across more than one Exemplar. A brief overview of the Exemplars within OPERAs is given Table A.

To facilitate communication and management among the 12 Exemplars, they have been grouped into three thematic clusters, each with a point person from the Work Package 2 leadership team:

- **Regional Identity:** Dublin, French Alps, Swiss Alps, Montado, and Wine (managed by Kim Nicholas, University of Lund)
- **Aquatic Systems on the Edge:** Barcelona, Balearic, Lower Danube, and Scotland (managed by Meriwether Wilson, University of Edinburgh)
- **Large-Scale Dynamics:** Global, Europe, and Mediterranean Exemplars (managed by Ariane Walz, University of Potsdam)

Highlights of Exemplar Features and Objectives

Cluster on Regional Identity

The five regional Exemplars are place-based case studies located in iconic natural and cultural landscapes of Europe, including: the mountain ecosystems of both the Swiss and French Alps, the Montado cultural landscape in Portugal, an emerging Wine region in Southern England, and the urban-rural fringe of Dublin. In each Exemplar, decision-makers are experiencing management struggles in sustainably delivering ecosystem services under a variety of biophysical, economic, and social pressures. One cross-cutting theme in this cluster is the importance of valuing ecosystem service provision. This becomes increasingly difficult in going from provisioning to regulation and maintenance to cultural services. Several of these Exemplars aim to quantify ecosystem services provided under various management scenarios to identify stakeholder priorities. Other regional identity Exemplars aim to find ways to communicate and evaluate the cultural value provided by traditional landscapes and livelihoods using varying tools and methods. These range from Q-methodology applying quantitative analysis to statistically cluster qualitative perceptions in the Wine Exemplar, to developing and applying socio-cultural valuation methods (in the French Alps, Montado, and Dublin Exemplars). Visioning exercises using storylines (scenario development in the Wine and French Alps Exemplars) and backcasting (Swiss Alps) are used to provide concrete ways for stakeholders to examine, clarify, and act on their values to enhance the ecosystem services they value most. Visualization is an important means to help facilitate stakeholder understanding of ecosystem service tradeoffs, using such tools as “Our Ecosystem.”

Cluster on Aquatic Systems on the Edge

Europe contains some of the most diverse coastal, island and riparian corridor systems in the world, spanning numerous countries and regions. Five representative socio-ecological systems (SES) of distinct ecosystems and settings were selected for the OPERAs project, allowing for in-depth testing of tools and instruments, but also providing comparative insights that can be relevant for other SES contexts globally.

The *Barcelona Urban Dunes Exemplar* is collaborating with the municipal government to experiment with facilitated regeneration of dune grasses in the heavily utilized touristic beaches around Barcelona to achieve long-term dune stability and coastal services. The *Balearic Islands Blue Carbon Exemplar* examines the carbon storage capacity of seagrass, which is both poorly understood and at risk as these ecosystems are threatened by urbanization. The *Lower Danube Exemplar* focuses on research to demonstrate linkages between the river ecosystem management and community livelihood benefits. Here, the focus is on socio-cultural valuation, agriculture, and no-net-loss opportunities related to river basin infrastructure requirements. Finally, the *Scottish Multi-Scalar Exemplar* is comprehensive and diverse in its approach, as it is executed through four distinct but inter-related paths, including: a) ESCOM – fostering an ‘ecosystem services community’ seeking synergies, knowledge exchange and efficiencies across government, NGO, industry and academic partners throughout Scotland; b) a National Assessment of ecosystem service provision and policy capacities; c) a regional assessment focusing on the peri-urban fringe of Edinburgh and stakeholder valuation, and d) a regional assessment looking at managed re-alignment opportunities in the Inner Forth estuarine landscape.

Collectively these systems share many characteristics and pressures, as well as critical distinctions. All of these Exemplars contain keystone habitats that function as ecosystem engineers and have high biodiversity (e.g., seagrass, marsh and dune systems). All of these systems have witnessed intense urbanization over time from human settlement, agriculture, fisheries and tourism. While these pressures have collectively and cumulatively fragmented these coastal and riparian habitats, they offer different trajectories of restoration, re-creation and conservation to revitalize ecological corridors and functions. The same threats, when viewed through an ecosystem services lens, also offer opportunities to enhance shoreline protection, carbon storage, fisheries, reed management and tourism in potentially sustainable ways, as well as scientific insights. Yet, these opportunities can only be realized through analysing tradeoffs across the diverse ecosystem services and respective societal gains and losses, as well as policies that supporting or hinder ecosystem service provision and related governance dynamics.

Cluster on Large-Scale Dynamics

The large-scale Exemplars are largely directed towards high-level policy making relevant to the EU and linkages beyond. Here, the European Exemplar focuses on recent and forthcoming EU ‘land-based’ policy developments, such as the No Net Loss initiative, the Green Infrastructure approach, the Common Agricultural Policy 2014-2020, and their interactions. The Global Exemplar addresses international policy frameworks, namely the UNFCCC (United Nations Framework Convention on Climate Change) and the CBD (Convention on Biological Diversity) and potential synergies between the two; and the Mediterranean Exemplar incorporate agricultural ecosystem service provisioning and tradeoffs. All three large-scale Exemplars aim mainly to inform decision-makers, therefore two types of approaches are predominant: (1) information tools (e.g., models) to reach a

better understanding and quantify the effects of different policies on ecosystem service provision, and (2) channels to communicate this information. The European Exemplar mainly facilitates communication through workshops with relevant European-level stakeholders, while the Global Exemplar aims to develop online applications suitable for decision-makers, as well as direct communication at Conference of the Parties (CoP) side events.

Some key points from the Large-Scale Exemplars:

- Synergies and trade-offs between ecosystem services are key to all large-scale Exemplars. In addition, all large-scale exemplars address trade-offs over time and over space – which has been identified as a knowledge gap in ecosystem services research (Milestone 2.3). This is an advantage of working predominantly with simulation models. However, they can only indirectly or partially include trade-offs and synergies between beneficiaries, with the important exception of the regional case study in Peru within the Global Exemplar.
- The Global and European Exemplars encompass other regional-scale OPERAs Exemplars, and therefore have a synergetic function across the regional-scale Exemplars, similar to the Scottish Exemplar discussed below. They set the agenda for global pressures and linkages with European policies addressed in some regional exemplars, which creates and defines a common platform to study comparative issues across several exemplars.
- Identifying and/or engaging stakeholders is relatively difficult for the large-scale exemplars, because of difficulties identifying relevant stakeholders (Global Exemplar and Mediterranean Exemplar) or engaging policymakers (European Exemplar). In the case of the Global Exemplar, the main problem is the institutional gap between the two political communities. In the case of the Mediterranean Exemplar, the stakeholder community is widely dispersed across countries, continents, and institutions. In the case of the European Exemplar, identification is relatively easy as the Exemplar builds on work for DG Environment, but engaging policy makers is a challenge due to the current overload of science-policy-practice events. For this reason, the Exemplar focuses on the policy interactions, and the links to the regional scales.
- Communication of ecosystem services towards stakeholders will be realized through several channels. First, workshops bring relevant persons together and allow discussing synergies in person. Then, web-based visualization tools allow stakeholders to access and compare specific information on ecosystem service trade-offs in a suitable format (e.g., the online application “Our Ecosystem”). To prepare for the online application and start the dialogue, stakeholders will be interviewed about their requirements for accessible information on ecosystem services trade-offs and the planned visualization tool.
- Models – as information tools – play a key role in the large-scale Exemplars. They allow for quantitative assessment of ecosystem services and natural capital, but can be relatively difficult to communicate to stakeholders due to underlying assumptions and the simplification of the investigated system. While modelling enhancement towards agro-ecosystems will be an important activity focus in the Mediterranean Exemplar, exchange between land use and

ecosystem model and deduction of Ecosystem Services are a key issue in the Global Exemplar.

- Conceptual tools include policy analysis for the European Exemplar, accounting for the variety of policies and initiatives and their potential synergies, while the Global Exemplar uses scenario analysis to isolate singular and combined effects of key policy directives.

Conclusion

In summary, the OPERAs Exemplars cover a wide variety of settings. We consider the collection of Exemplars as “proofs of concept” for the operational potential of the ES/NC concept in individual contexts. A common BluePrint reporting protocol (WP2 Task1) will ensure that the progress in all Exemplars is systematically reported, and we can learn from the operationalization efforts in the individual Exemplars, even though the Exemplars are each pursuing individual research designs based on their unique questions and stakeholder relationships.

Two of the most salient features of OPERAs Exemplars are, first, their strong orientation towards engaging with and learning from non-academic stakeholders. Some of the Exemplars build on long-established collaborative activities with regional partners, and through constant dialogue over the years, stakeholder needs have been clarified long in advance. Others are still in the process of identifying and building relationships with the most relevant stakeholders. Second, OPERAs Exemplars use a wide variety of tools and methods. The Exemplar study designs that follow demonstrate that WP3 (Knowledge) and WP4 (Instruments) are heavily involved in the practical work within the Exemplars. As initially intended, the Exemplars serve as testing ground for instruments and tools from WP4, and they are the places empirical research is conducted for WP3.

The OPERAs Exemplars will continue to develop, both within Exemplars and in collaborative activities including regular conference calls and synergistic activities in project meetings. The study designs that follow are meant to facilitate and guide the interactive, adaptive learning approach that characterizes OPERAs.

Exemplar Name	Brief description
Swiss Alps	The primary goal of this Exemplar is to examine and develop management and policy options that support policymakers and ecosystem managers to make choices required for enhancing sustainable and societally acceptable development of the region. Going beyond existing research, a backcasting approach will be applied in which resilient ecological, socio-economic, and political development trajectories are modeled based on a future envisioned demand for ecosystem services. Ideally, our research activities using backcasting, surveys, participatory workshops, and innovative visualization and modeling techniques will support a planning and decision-making process that (i) is transparent, intuitive and backed by society, (ii) integrates and coordinates different sectoral policies as well as the broader public and experts, and (iii) develops flexible spatially explicit regional solutions to push new adaption strategies for maintaining a sustainable level of ecosystem services.
French Alps	In this project, we explore the interactions among ecological and societal processes, at multiple spatial and temporal scales, that underpin trade-offs and synergies among ecosystem services in the French Alps. We use stakeholder-led scenarios incorporating regional visions for future urban development and natural resource management the Alps, and apply models connecting biodiversity and ecosystem services, to evaluate ecological costs and benefits associated with alternative land-use pathways. We expect this process to facilitate the ongoing dialogue on sustainable development pathways, including needs for ecological compensation.
Montado Cultural Landscape	By bringing the ES/NC concept into practice, the productive, ecologic, and cultural aspects of the unique agro-forestry Montado ecosystem will be combined to promote an improved management that reconciles biological resources use with conservation interests. Key outcomes of this research are the establishment of criteria to evaluate and rank socio-ecological and cultural values at the local level and the selection of indicators that can be used at broader scales. By involving the key stakeholders in the process we thus envision to pro-actively contribute to agriculture and conservation policies in the frame of the EU CAP and the Convention of Biological Diversity.
Wine	Here we collaborate with producers in the rapidly expanding wine region of Southern England address stakeholder needs to increase wine yields and quality, to identify, measure, and enhance vineyard ecosystem services, and to enhance long-term strategic planning capacity through using scenarios and forecasting tools.
Dublin: Urban-Rural	An analysis of the landscape of socio-cultural values of Ecosystem Services (ES) may provide a means to inform better outcomes in spatial planning decision-making. Key research outputs are the development of a set of social and cultural

Fringe	value indicators and the development of a methodology for the assessment of socio-cultural values at the forward plan or project level. The work will consider how the process of assessing the social and cultural value of ES can be used within planning consultation to inform decision makers of the <i>landscape of values</i> that may exist (or change over time) in a given location.
Barcelona	The basic aim of this exemplar is to show that it is possible to get a healthy (but intensely managed) dune ecosystem on Mediterranean urban beaches with improved efficiency of the management structures and with new ways to share the cost and repayment of the coastal defence and dune regeneration works. Through analysis of coastal defence and regeneration projects and dune reconstruction experiments, it is expected to improve methodologies on control of invasive species, dune rejuvenation and use of social media strategies for trade-off management between the intense use of the beach and the conservation needs of the dune ecosystems.
Balearic Islands	This exemplar will provide estimates of the magnitude of ecosystem services provided by seagrass meadows in the Balearic Islands, a socio-economic assessment of these ES in the region, and an assessment of the trade-off of economic cost of <i>Posidonia oceanica</i> protection vs. value of carbon sink/emissions in seagrass meadows, including co-benefits of protection. The results of this exemplar will contribute to develop Blue Carbon strategies for mitigation of CO ₂ emissions through conservation of coastal marine ecosystems.
Lower Danube	The goal of the Lower Danube exemplar is to research and demonstrate the link between Danube ecosystems and a range of environmental benefits for communities in the area as well as in the Danube river basin, given the application of appropriate set of instruments to safeguard or improve them. The exemplar unfolds on several levels: local - to assess the value of wetlands for local communities and economies; regional-national - to test a decision-making support tool for the protection and management of Lower Danube ecosystems; river basin (international) - to test the applicability of the no net loss concept for finding and incorporating the real cost (loss) of nature in the cost and benefit analysis of river infrastructural projects on the Lower Danube.
Scottish Multi-scalar	Establish an Ecosystem Services Community (ESCom), which will help align research and build an operational and engaged science–policy–practice interface. ESCom will help identify user needs, and increase the relevance and impact ecosystem science for policy and practice. Within this context, we will implement a multi-scalar exemplar, supporting reporting and assessment for the national context, strategic planning regionally, and sustainable management at local scales, including (a) Edinburgh’s peri-urban setting, and (b) the Inner Forth coastal area.
Pan-European	This exemplar studies the synergies and trade-offs that individual land use policy initiatives may have on the supply of ES/NC in Europe, and explores what

Regulatory Directives	synergies and trade-offs may occur through policy interactions. We employ a number of approaches to assess how these land based policy initiatives can maximize synergies and minimize trade-offs, including: 1) modeling land use change for a range of policy scenarios; 2) quantification of ES/NC levels and changes therein through indicators and metrics; and 3) case study analyses (with links to other OPERAs exemplars).
Mediterranean	The core of the work consists of building a functional system to support the assessment of sustainable use of agroecosystems under changing conditions. We will define, in consultation with stakeholders, the nature and purpose of the valuation components. For the Mediterranean, the following are of interest: i) mapping and accounting for changes in natural capital and ecosystem services; ii) demonstrating and communicating the importance of ecosystems and their services; and iii) strategic planning, exploring future scenarios and robust climate adaptation options.
Global	Climate change and the loss of habitats and biodiversity are fundamental threats to the functioning of socio-ecological systems worldwide. Despite a strong potential to synergetic policy implementation, the development of global mechanisms to mitigate and slow down both processes is taking place almost in parallel with little interaction between the two communities. Pointing at potential synergies between these two arenas, to avoid jeopardizing either of the two goals or the interests of local communities through global mitigation mechanisms, we use a multi-scale ES/NC based scenarios analysis and develop an online visualization tools to individually test the multi-dimensional impacts of policies at global as well as at local scale.

Table A. Overview of the twelve OPERAs Exemplars described in this Deliverable.

REGIONAL IDENTITY EXEMPLAR CLUSTER

Swiss Alps Exemplar

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Dream Abstract

Mountain ecosystems are fragile and provide a range of crucial services to society. The provision of ecosystem services is strongly influenced by human actions and climate change. Existing research, however, does not bridge the spatially explicit supply of and demand for ecosystem services, often neglects cultural services, and provides only sparse knowledge on how to enhance long-term sustainable development of desired services. The primary goal of this Exemplar is to examine and develop management and policy options that support policymakers and ecosystem managers to make choices required for enhancing sustainable and societally acceptable development of the region. Going beyond existing research, a backcasting approach will be applied in which resilient ecological, socio-economic, and political development trajectories are modeled based on a future envisioned demand for ecosystem services. In order to integrate and match the spatially explicit supply of and demand for ecosystem services, transdisciplinary surveys and participatory workshops will be combined with innovative visualization techniques and an integrative modeling framework. Ideally, our research activities will support a planning and decision-making process that (i) is transparent, intuitive and backed by society, (ii) integrates and coordinates different sectoral policies as well as the broader public and experts, and (iii) develops flexible spatially explicit regional solutions to push new adaptation strategies for maintaining a sustainable level of ecosystem services. The study will reveal whether backcasting is a suitable, efficient and desirable approach for reframing planning processes to support long-term provision of mountain ecosystem services.

Study Rationale

The Exemplar study region is located in central Valais, a continental inner-Alpine mountain area and the driest region of the Swiss Alps. Changes in precipitation patterns and other disturbances induced by climate shifts are projected to have a huge impact on vegetation ([Rigling *et al.*, 2013](#)). Furthermore, changes in political and socio-economic boundary conditions affect decision-making and drive rapid land-use change in the fragile mountain region. In fact, about 15% of the agricultural area of the region has been abandoned in the period between 1981 and 2005, while settlement expanded by over 30% ([SFSO, 2009](#)). If observed climatic and land-use change trends continue, they will significantly affect the sustainability of ecological services of the region with important socio-economic implications.

Mountain and subalpine forests and grasslands provide a variety of private and public goods and services. Agricultural and forestry activities are still mainly oriented towards biomass production, however, environmental considerations are of increasing importance in forest- and agri-environmental policies and management ([Huber *et al.*, 2013a](#)). Reframing natural resource use, the concept of ecosystem services imposes itself as a common platform for (i) communicating the various values of ecosystems to stakeholders, for (ii) informing decision-making processes on alternative management and policy strategies reconciling ecosystems' capacity to provide and societal demand for various services and thus, for (iii) facing the systemic nature of the challenges ahead (e.g., [Farley, 2008](#); [Daily *et al.*, 2009](#)).

Many studies have investigated the underlying causal chain of global climate and socio-economic changes on ecosystem functions and related services ([Daily et al., 2009](#); [Nelson and Daily, 2010](#)). However, these studies often neglected joint consideration of the supply of and demand for ecosystem services ([Seppelt et al., 2011](#)) and disregarded cultural services ([Schaich et al., 2010](#)). In contrast to existing approaches that predict changes in land-use and the related provision of ecosystem services under different climate and socio-economic scenarios, we will start the project with eliciting stakeholders' future demand for regionally relevant ecosystem services, such as protection from natural hazards, identification with the cultural landscape, landscape aesthetics or maintenance of valuable habitats. Considering the current ecological, economic, and political framework conditions, sustainable pathways are inferred that will ensure a long-term provision of the desired ecosystem services. Actual policy programs often struggle with the formulation and implementation of effective long-term strategies for myriad reasons, e.g., long-term oriented strategies (i) contain high uncertainties, complicating the design and timing of policy interventions, (ii) exceed the typical election cycles and budgetary planning horizons of public institutions and thus, (iii) are politically and economically often costly with highly uncertain benefits, which accrue — if the strategy is successful — in the future with no or only limited immediate benefits for the initiator of such a strategy.

Therefore, securing the long-term provision of mountain ecosystem services requires effective communication and information tools so that decision-makers can (i) better understand how their actions might change these services in the longer-term, (ii) consider trade-offs among policy options and (iii) choose those actions that sustain the appropriate mix of services ([Ash, 2010](#)). In order to support such operationalization efforts we will combine dynamic ecosystem services modeling and participatory trade-off assessments. Following a back casting approach we aim at developing local and regional strategies for a resilient management of the mountain ecosystem. A spatially dynamic Alpine-Land-Use-Allocation-Model (ALUAM) (e.g. [Briner, 2012](#); [Briner et al., 2012](#)) allows for identifying mechanisms that trigger land-use changes and the provision of ecosystem services over time and will be fed with results from a survey among the broader public on future tolerable levels of ecosystem services. Modeled ecological and economic thresholds of the system and sustainable management pathways will then be discussed in workshops with decision-makers using innovative visualization tools. An initial study on practical needs for ecosystem services communication will guarantee that we can provide sound, clear and effective information to stakeholders for negotiating trade-offs associated with the desired future and related policy options.

Exemplar Selection and Description

Mountains are the undervalued ecological backbone of Europe and provide essential ecosystem services both to people living in the mountains and to people living outside mountains (e.g. [TEEB, 2010](#)). At the same time, mountain ecosystems are especially sensitive to rapid global development. The main pressures result from changes in land-use practices, infrastructure development, unsustainable tourism, fragmentation of habitats and climate change (e.g., [Schroter et al., 2005](#)). The Exemplar study region around Visp is a continental inner-Alpine mountain area affected not only by changes in precipitation patterns, but also by many of the drivers of mountain land-use change mentioned above. While traditional farming systems are in decline, touristic

activities and settlement development are continuously increasing. Thus, the Exemplar is a typical example of a European mountain ecosystem in which the provision of ecosystem services is strongly influenced by climate change and human activities framed by socio-economic developments as well as the political system with its institutions, policies and administrative structures. The Exemplar's outcomes will contribute to an improved understanding of the interlinked ecological and socio-economic dynamics in European agro-forest mountain ecosystems characterized by high touristic activities and settlement expansion, and a mismatch between a high demand for cultural ecosystem services including a traditional landscape on the one side and a decreasing number of farmers cultivating these lands and, thus, maintaining these services on the other side. Results will furthermore help identify principles of land-use change and management and important ecosystem properties which guide resilient land-use development for providing desired ecosystem services in mountain ecosystems.

The Exemplar study area (Figure 1) includes the booming urban and industrial center of the Visp municipality, the touristic destinations in the Saas Valley (Saas Fee, Stalden), and the remote Baltschieder Valley, in total 12 municipalities. The area is 348 km in area with around 15,000 inhabitants. Unproductive land accounts for 62% of the total area, while 20% of the area is covered by forest, and about 16% of the land is used by agriculture. Currently, 98% of the agricultural area is grassland, with farmers' activities focus mainly on milk and meat production. Small-scale farmers are dominant in the region; farmers cultivate on average less than 10ha of agricultural land and house around seven livestock units. Only 7% of the farms cultivate more than 0.5ha of crops, predominantly winter wheat and corn ([FOAG, 2008](#)). A still mainly production-oriented and nationally steered agricultural policy has strong political support ([Hirschi et al., 2013](#)). Forest management has shifted its focus from traditional resource use to the maintenance of healthy forests preventing settlement areas from rock falls and avalanches ([Rigling et al., 2012](#)). Agricultural land-use and forestry thus provide important ecosystem services such as agricultural products, recreation for residents and tourists, identification with a traditional cultural landscape, habitats for plants and wildlife, and protection against natural hazards. However, agricultural, forest and infrastructure policies to date are still highly functionally differentiated and institutionalized in traditional sectoral policies with relatively little coordination between them ([Hirschi, 2009](#)). Modeling of land-use and ecosystem services within the exemplar will be conducted on the plot level, with an approximate resolution of 100m x 100m. Participatory assessments will include stakeholders of all relevant sectoral policy groups (e.g. agriculture, forestry, tourism, regional planning, energy) as well as the broader population.

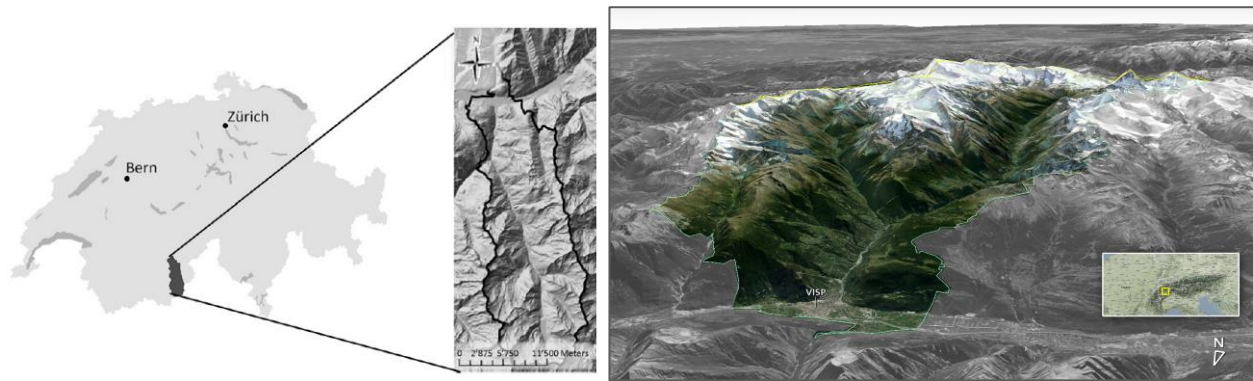


Figure 1. The case study region: Visp in the Southwest of the Swiss Alps.

Research Questions

The research goals and questions stated below will be approached by a three-step backcasting approach (Figure 2). The first step consists of elaborating a vision of tolerable future ecosystem services states in the case study region through a survey among the broad population. In a second step, this societal vision will be linked to the present ecological, socio-economic and political conditions within the integrative model framework ALUAM for inferring thresholds over time that would result in irreversible losses of ecosystem services with regard to the desired future. Finally, different management and policy options derived from these thresholds will be discussed and evaluated with key stakeholders and decision-makers. For supporting the inter- and transdisciplinary communication processes we will provide visualizations that disentangle the complexity of backcasting results and translate ecosystem services trade-off information into comprehensible and intuitive representation forms. Within this Exemplar, we will thus specifically address the following questions (Figure 2):

- RQ1: Which temporal socio-economic and ecological thresholds result in irreversible losses of ecosystem services with regard to a desired future?
- RQ2: Which economic, social and political transition pathways lead towards the long-term provision of mountain ecosystem services including cultural ecosystem services?
- RQ3: How can the supply of and demand for the provision of mountain ecosystem services be balanced?
- RQ4: What policy options do policymakers and ecosystem managers have to enhance sustainable development in mountain regions within the range of a set of tolerable future states?
- RQ5: How can inter- and transdisciplinary knowledge and 3D visualisation techniques be integrated in order to define shared future states of mountain regions as starting point for backcasting land management strategies?

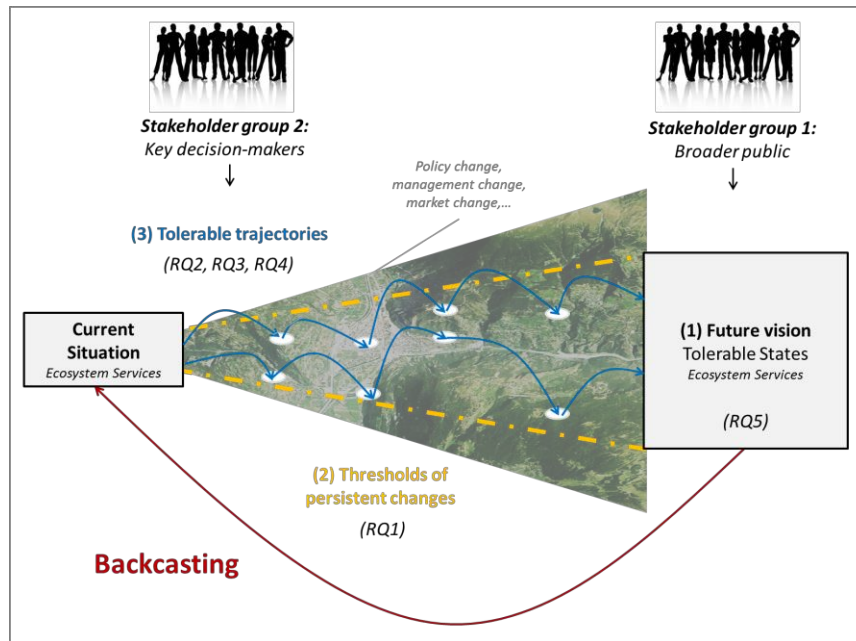


Figure 2. Three-step backcasting approach to answer our research questions (RQ).

Exemplar Goals

In this Exemplar, we will develop future visions supported by the broader public as an anchor for (i) evaluating current policy and management actions, for (ii) inferring system properties that serve as lower boundaries for future ecosystem services provision and for (iii) providing management and policy options that support policymakers and ecosystem managers to make choices required for enhancing sustainable development. Instead of confronting stakeholders with already modeled future scenarios as in many traditional approaches, stakeholders are involved in the planning process from the very beginning. In fact, backcasting, i.e., starting with the desired goal, is a quite intuitive way of planning and could facilitate stakeholders' understanding and acceptance for subsequent scientific analyses and related political implications. We can furthermore meet and include stakeholders' needs and concerns regarding the provision of ecosystem services and the development of their perceived landscape in an unbiased way. Applying transdisciplinary approaches and rigorous visualization techniques for eliciting demand for ecosystem services and combining them with the integrative ALUAM modeling framework, we explicitly take into account both supply of and demand for ecosystem services, as well as feedback effects between society and nature.

Results from the backcasting exercise should help fostering stakeholders' consciousness for a resilient ecosystem and build capacity and consensus among stakeholders to enable them to better cope with expected changes. Furthermore, our findings should illustrate flexible policy and management options that buffer the ecosystem towards changes and show capacities and limitations of the landscape in terms of ecosystem services provision. Thus, policymakers should

be offered information for discussing and negotiating concrete long-term measures balancing conflicting interests and improving or maintaining ecosystem services in the case study region. In our models, we will especially test options for more regional ecosystem-services related management systems and policy schemes and focus on spatial solutions that take into account local ecosystem properties as well as region-specific demands for, attitudes towards, and concerns regarding the future provision of ecosystem services. In Visp, as in other regions, recently enacted federal laws on spatial planning demand for substantial changes in state-of-the art planning policies and confront decision-makers with new challenges in meeting the demands of different sectoral interests. Our research thus focuses on unraveling interlinkages of land-use relevant policy sectors and identifying potentials of coordinated policy options to secure future ecosystem services provision.

Linking Stakeholders, Instruments, and Ecosystem Services

Stakeholder description

The Exemplar can build upon an existing stakeholder network established in a previous research project (e.g. Brand et al., 2013; Briner et al., 2013). Two target groups are crucial in the transdisciplinary approach (Figure 2): 1) A regional expert group with stakeholders representing the most important administrative sectors, e.g., agriculture, forestry, energy, tourism and regional planning, will advise the project from a study region perspective. They review and reflect results, coordinate the stakeholder involvement and give crucial input to the prioritization of management and policy measures within the Exemplar. An initial workshop with this group has been organized in April 2013 in order to inform the experts on ongoing and planned research activities as well as to discuss upper and lower boundaries of future potential ecosystem services levels. 2) The broader public, i.e., residents of the case study area, will help shape a societally accepted vision of the future landscape via a series of choice experiments. An initial choice experiment to elicit preferences of residents for future levels of different ecosystem services has been conducted in October 2013. The transdisciplinary process consists of experiments and workshops as summarized in Table 1.

In a next step, an online version of the initial choice experiment will be launched to enhance sample size and improve our picture of the publics' future vision of the case study region as well as to test the effect of a new medium on stakeholders' future preferences regarding ecosystem services trade-offs. After having backcasted the tolerable future using the integrative modelling framework ALUAM, the expert group will be invited to a second workshop in which backcasting results and management and policy options that could foster sustainable pathways to an acceptable future societal vision are discussed and prioritized. Feeding the online choice experiment with this information, a final survey will be conducted among the public to test how useful backcasting is as a planning approach and whether stakeholder can digest this kind of

Stakeholder Need	Instrument to address need	Ecosystem Service(s) Addressed*	Anticipated Outcome
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spatio-temporal information. Furthermore, a workshop to test people's group decision-making will be conducted among an interested group of residents.

Date	Action	Target Group	Aim
April 2013	Workshop 1	Expert group	Informing experts, eliciting needs and concerns, framing of future conditions for choice experiments
October 2013	Choice Experiment 1 (paper-based)	Broader public	Societally accepted vision of future ecosystem services level
April 2014	Choice Experiment 2 (online survey)	Broader public	Test for influence of medium on future vision, reference for backcasting, choice experiments
December 2014	Workshop 2	Expert group	Informing experts, discussing backcasting results
February 2015	Choice Experiment 3 (online, backcasting)	Broader public	Influence and added value of backcasting information on/for decision-making
August 2015	Workshop 3	Broader public	Group decision-making

Table 1. Planned experiments and workshops and related target groups in the Swiss Alps Exemplar.

Identification of stakeholder needs

Presenting and discussing outcomes of past research activities ([Huber et al., 2013b](#)) in the first workshop helped us to address and frame experts' concerns, attitudes, beliefs and needs regarding ecosystem services in the region. Though critical towards scientific results, the experts were very interested in understanding the dynamics and capacities of the landscape and in learning more on socio-economic and ecological thresholds that result in irreversible losses of ecosystem services in the longer term. They clearly emphasized the need to prioritize locally and regionally provided ecosystem services, especially cultural services, and to consider local demand and values in the assessment. In light of the growing pressure on agricultural land, the experts claimed for locally adapted and spatially explicit solutions and long-term policies that reconcile traditional agricultural practices and multiple stakeholder interests (Table 2).

In order to provide decision-makers with sound and understandable information for developing and discussing such long-term oriented policy strategies, we started in parallel a demand analysis for gathering practices' requirements for ecosystem services information, representation and visualization options. An online survey has been published in many social media communities and networks (Twitter, ResearchGate, LinkedIn, Facebook) and distributed among the ecosystem services community and other projects (e.g., Ecosystem Services Partnership, Marine Ecosystem Services, Scales Project). Results from this survey will feed into our planned workshops and choice experiments and can help framing graphical representation of ecosystem services among decision-support and information tools throughout the whole OPERAs project.

Local contribution to planning process and consideration of local demands for ecosystem services	Choice experiments (Adrienne Grêt-Regamey, Sibyl Brunner; ETHZ)	Biotic materials, mass flow regulation, habitat protection, cultural heritage and landscape aesthetics values	Active engagement of residents in planning processes, broader acceptance of decisions
Prioritization of regionally provided (especially cultural) ecosystem services and social values	Social valuation of ecosystem services, augmented reality method (Katja Schmidt, UP; Tom Klein, ETHZ)	Multiple	Overview of socio-cultural values for ecosystem services, sensitization of stakeholders for regionally important cultural ecosystem services
Understanding ecological and socio-economic thresholds that result in irreversible losses of ecosystem services in the longer term	Backcasting modeling experiments with ALUAM (Sibyl Brunner, ETHZ)	Multiple	Enhancing stakeholders' understanding of ecosystem services dynamics, spatio-temporal trade-offs and thresholds of the landscape as a sound basis for decision-making
Measuring and assessing the governance structures for long-term oriented ecosystem services provision	Policy network analysis (Christian Hirschi, ETHZ)	Climate sensitive ecosystem services with focus on agricultural, forest and water sector	Identification of governance modes, i.e. favored sets of ideas, approaches and instruments used to steer ecosystem functions and maintain/enhance ecosystem services
Locally adapted and spatially explicit planning options	Combination of ALUAM and policy network analysis (see above)	Multiple	Supporting decision-making processes potentially resulting in more integrative policy strategies and adapted land-use practices and thus enhanced provision of multiple ecosystem services
Having access to different well-edited representations types regarding ecosystem services (trade-offs)	Ecosystem services visualizations	Heritage values, landscape aesthetics values	Sound decision-making processes and enhanced understanding and acceptance of scientific findings

Table 2. Exemplar plan to address stakeholder needs and improve ecosystem services through instruments.

Collaborations within OPERAs

Work Package 2 – Practice

We will especially collaborate with the French Alps Exemplar by (i) distributing a demand survey (see below) for ecosystem services representation and visualization types among stakeholders in both Exemplars, (ii) implementing trait-based models for assessing ecosystem services that have been developed for the French study site into our modeling approach and by (iii) setting up the backcasting framework in both case study regions. Such a comparative approach helps us identifying common principles of land-use change and management practices as well as important ecosystem properties which guide resilient land-use development for providing desired ecosystem services among European mountain ecosystems in a more general way.

Further collaborations are planned with the Scottish Exemplar. Social valuation techniques and visualizations of ecosystem services will be applied in both Exemplars following the same questionnaire, and results will be compared and discussed in light of the different settings.

Work Package 3 – Knowledge

Governance structures and policy network analysis (Christian Hirschi, ETHZ): The long-term management of ecosystems and their services requires close coordination of the actions of various stakeholders with myriad interests, which often run counter to the overall societal interest to preserve ecosystems and their services. Adequate governance structures are required to enable such actor and interest coordination to support a long-term oriented ecosystem management. The focus on governance structures implies the recognition that many more actors and structures are at play and they interact in myriad ways. There is no universally accepted definition of governance but there is wide agreement that governance today goes beyond regulation, public management and traditional hierarchical state activity ([Rhodes, 1997](#)). In addition to these traditional forms of political steering, governance emphasizes the use of novel instruments (such as voluntary and market-based approaches) and cooperative structures between state and non-state actors from various sectors of society ([Evans, 2012](#)). We will analyze the current governance structures in the Exemplar study region using a policy network approach and assess which structural conditions enable best a long-term oriented management of ecosystems and their services ([Bodin and Prell, 2011](#); [Robins et al., 2011](#); [McAllister et al., 2013](#)). Results of the analysis will feed the ALUAM model framework and guarantee that political and management solutions inferred by the backcasting approach not only result in desired future ecological states but are also economically efficient and politically feasible.

Social valuation of ecosystem services (Katja Schmitd and Ariane Walz, UP; Tom Klein, ETHZ): We will compare stakeholders' socio-cultural values towards ecosystem services in Switzerland and Scotland by employing the questionnaire used within the regional assessment of the Edinburgh peri-urban region in the Swiss case study region. In line with the backcasting approach, the questionnaire will be adapted to local issues after consulting local stakeholders. The evaluation method will use Augmented Reality techniques that allow overlaying realistic perspectives with

ecosystem services information modeled under different scenarios by 3D landscape visualizations. Such an approach supports a location-based surveying and enhanced evaluation of ecosystem services (especially cultural services, like aesthetics, cultural heritage and sense of place) and identifies spatial ecosystem services hotspots.

Work Package 4 – Instruments

ALUAM (Sibyl Brunner, ETHZ): The ALUAM modeling framework used within this Exemplar combines an activity-based spatially explicit land allocation model, a forest-landscape model, a crop yield model and indices for the provision of different ecosystem services and has previously been applied for exploring feedback mechanisms between socio-economic and ecological components of mountain ecosystems and their impact on ecosystem services (e.g. Briner et al., 2012; Briner et al., 2013; Huber et al., 2013a). Within OPERAs we will apply the model in a novel backcasting set up for exploring ecological and socio-economic boundary conditions and inferring related management and policy strategies that will allow meeting the future demand for relevant ecosystem services as defined by stakeholders.

Collaborative Web-Platform (Tom Klein, ETHZ): Results from a demand analysis regarding how stakeholder best digest and make use of information regarding ecosystem services will be used to generate various representation forms, e.g., GIS-based 3D landscape visualizations, and to visualize and communicate especially the often neglected cultural ecosystem services. Combining visualization approaches with modeling parameters, we will conduct a workshop in which we generate a real-time virtual environment through a visual interface incorporating both spatial and temporal dimensions. Users will be able to explore future landscapes and make spatio-temporal trade-offs related to desired futures.

Work Packages 5 & 6 – Resource Hub & Dissemination

An important contribution to the Resource Hub will consist of a summary of different visualization options regarding an optimal and desirable representation of ecosystem services for communication processes and decision-making tested within different tools and among different exemplars. Furthermore, our experience will show whether backcasting is an intuitive, effective and desirable approach for reframing planning and decision-making processes. With regard to the governance and policy dimension of the Exemplar, the study will result in a typology of governance modes for the long-term management of ecosystem functions and services, which will be tested on the Exemplar and which provides the basis for comparisons between Exemplars.

References

- Ash, N., Blanco, H., Brown, C., Garcia, K., Henrichs, T., Lucas, N., Raudsepp-Hearne, C., Simpson, D., Scholes, R., Tomich, T., Vira, B., Zurek, M., 2010. Ecosystems and human well-being: a manual for assessment practitioners. Island Press, Washington, DC, USA.
- Bodin, Ö., Prell, C. (Eds.), 2011. Social Networks and Natural Resource Management: Uncovering the Social Fabric of Environmental Governance. Cambridge University Press, Cambridge.
- Brand, F.S., Seidl, R., Le, Q.B., Brändle, J.M., Scholz, R.W., 2013. Constructing Consistent Multiscale Scenarios by Transdisciplinary Processes: the Case of Mountain Regions Facing Global Change. *Ecology and Society* 18.
- Briner, S., 2012. Provision of ecosystem goods and services by agriculture and forestry in mountainous regions of Switzerland. Department of Agriculture. ETH Zurich, Zürich, p. 131.
- Briner, S., Elkin, C., Huber, R., 2012. Assessing the impacts of economic and climate changes on land-use in mountain regions: A spatial dynamic modeling approach. *Agric Ecosyst Environ* 149, 14-14.
- Briner, S., Huber, R., Bebi, P., Elkin, C., Schmatz, D.R., Grêt-Regamey, A., 2013. Trade-Offs between Ecosystem Services in a Mountain Region. *Ecology and Society* 18.
- Daily, G.C., Polasky, S., Goldstein, J., Kareiva, P.M., Mooney, H.A., Pejchar, L., Ricketts, T.H., Salzman, J., Shallenberger, R., 2009. Ecosystem services in decision making: time to deliver. *Frontiers in Ecology and the Environment* 7, 21-28.
- Evans, J.P., 2012. Environmental Governance. Routledge, London.
- Farley, J., 2008. The role of prices in conserving critical natural capital. *Conserv Biol* 22, 1399-1408.
- FOAG, 2008. Swiss Agricultural Census Data 2000-2006. In: Agriculture, F.O.f. (Ed.), Bern, Switzerland.
- Hirschi, C., 2009. Mountland Study Regions: Socio-economic and political context. Working Paper, Mountland Research Task 3 "Policy Developments and Innovative Policy Solutions".
- Hirschi, C., Widmer, A., Briner, S., Huber, R., 2013. Combining Policy Network and Model-Based Scenario Analyses: An Assessment of Future Ecosystem Goods and Services in Swiss Mountain Regions. *Ecology and Society* 18.
- Huber, R., Briner, S., Peringer, A., Lauber, S., Seidl, R., Widmer, A., Gillet, F., Buttler, A., Le, Q.B., Hirschi, C., 2013a. Modeling Social-Ecological Feedback Effects in the Implementation of Payments for Environmental Services in Pasture-Woodlands. *Ecology and Society* 18.
- Huber, R., Rigling, A., Bebi, P., Brand, F.S., Briner, S., Buttler, A., Elkin, C., Gillet, F., Grêt-Regamey, A., Hirschi, C., Lischke, H., Scholz, R.W., Seidl, R., Spiegelberger, T., Walz, A., Zimmermann, W., Bugmann, H., 2013b. Sustainable Land Use in Mountain Regions Under Global Change: Synthesis Across Scales and Disciplines. *Ecology and Society* 18.
- McAllister, R.R.J., McCrea, R., Lubell, M.N., 2013. Policy networks, stakeholder interactions and climate adaptation in the region of South East Queensland, Australia. *Regional Environmental Change* online first.

- Nelson, E.J., Daily, G.C., 2010. Modelling ecosystem services in terrestrial systems. *F1000 biology reports* 2, 53.
- Rhodes, R.A.W., 1997. *Understanding Governance: Policy Networks, Governance, Reflexivity, and Accountability*. Open University Press, Buckingham.
- Rigling, A., Bigler, C., Eilmann, B., Feldmeyer-Christe, E., Gimmi, U., Ginzler, C., Graf, U., Mayer, P., Vacchiano, G., Weber, P., Wohlgemuth, T., Zweifel, R., Dobbertin, M., 2013. Driving factors of a vegetation shift from Scots pine to pubescent oak in dry Alpine forests. *Global Change Biology* 19, 229-240.
- Rigling, A., Elkin, C., Dobbertin, M., Eilmann, B., Giuggiola, A., Wohlgemuth, T., Bugmann, H., 2012. Wald und Klimawandel in der inneralpinen Trockenregion Visp. *Schweizerische Zeitschrift für Forstwesen* 163, 481-492.
- Robins, G., Bates, L., Pattison, P., 2011. Network Governance and Environmental Management: Conflict and Cooperation. *Public Administration* 89, 1293-1313.
- Schaich, H., Bieling, C., Plieninger, T., 2010. Linking Ecosystem Services with Cultural Landscape Research. *GAIA - Ecological Perspectives for Science and Society* 19, 269-277.
- Schröter, D., Cramer, W., Leemans, R., Prentice, I.C., Araújo, M.B., Arnell, N.W., Bondeau, A., Bugmann, H., Carter, T.R., Gracia, C.A., de la Vega-Leinert, A.C., Erhard, M., Ewert, F., Glendining, M., House, J.I., Kankaanpää, S., Klein, R.J.T., Lavorel, S., Lindner, M., Metzger, M.J., Meyer, J., Mitchell, T.D., Reginster, I., Rounsevell, M., Sabaté, S., Sitch, S., Smith, B., Smith, J., Smith, P., Sykes, M.T., Thonicke, K., Thuiller, W., Tuck, G., Zaehle, S., Zierl, B., 2005. Ecosystem Service Supply and Vulnerability to Global Change in Europe. *Science* 310, 1333-1337.
- Seppelt, R., Dormann, C.F., Eppink, F.V., Lautenbach, S., Schmidt, S., 2011. A quantitative review of ecosystem service studies: approaches, shortcomings and the road ahead. *Journal of Applied Ecology* 48, 630-636.
- SFSO, S.F.S.O., 2009. *Arealstatistik der Schweiz*. In: *Topography*, S.F.O.o. (Ed.), Bern, Switzerland.
- TEEB, 2010. *Mainstreaming the economics of nature - A synthesis of the approach, conclusions and recommendations of TEEB*.

French Alps Exemplar

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Dream Abstract

Ecosystem services (ES) lie at the core of the interactions among humans and ecosystems. In this project, we explore the interactions among ecological and societal processes, at multiple spatial and temporal scales, that underpin trade-offs and synergies among ecosystem services in the French Alps. Besides the Grenoble urban region, we focus on three sub-systems: (1) the intensively farmed valley upstream of the city (Grésivaudan), (2) a mixed landscape of forests and grasslands in the Vercors range south of the city (Quatre Montagnes), and (3) a traditional livestock rearing area at high altitude (Lautaret). We use a prospective approach based on scenarios incorporating regional visions for the Alps, current urban planning exercises by public authorities, and a downscaling of European land-use and climate change projections. These scenarios, downscaled with the participation of local and regional stakeholders, propose spatially-explicit representations of future urban development, agriculture, forestry, water and aquatic systems management and nature conservation. Our assessment of these scenarios applies ecosystem service models that capture our detailed understanding of how biodiversity and different ecosystem services are interconnected. Stakeholders identify critical local issues regarding trade-offs among ecosystem services and biodiversity that need to be communicated to the public and considered for more sustainable management and policies. Increased consideration of these trade-offs could lead to legal changes, environmental measures or payments for ecosystem services, and would be incorporated into offsetting schemes. Stakeholders will then contribute to the evaluation of scenario projections by considering territory-wide ecological costs and benefits associated with alternative land-use pathways. We expect this process to facilitate the ongoing dialogue on sustainable development pathways, including needs for ecological compensation.

Study Rationale

The French Alps, and especially the Grenoble region, are undergoing an exemplary debate on future regional development that reconciles a dynamic economy and the preservation of exceptional natural assets that also contribute to its wealth, its attractiveness and the well-being of its residents.

Recent ecosystem service assessments have emphasized the need for ecosystem management and policy decisions to focus on multiple ecosystem services, and especially on their potential coincidence or trade-offs with biodiversity hot spots. The incorporation of fundamental understanding of mechanisms underlying ecosystem service and biodiversity trade-offs is a research priority. From the land management and regional development planning perspectives, such an understanding is expected to support policy and decision making by providing information on the consequences for biodiversity and ecosystem services of alternative pathways that are potentially based on other key criteria such as energy or economic development. In particular, the evaluation of urban development scenarios needs to incorporate among its multiple criteria the consequences, and even potential opportunities, for ecosystem service provision and biodiversity. Given a strong focus on multi-functionality, a wide range of ecosystem services are considered, including multiple ecosystem services from timber provision, global climate regulation, buffering of mass flow, to tourism and recreation, hunting and cultural values for forests; or the conciliation of cultivated crops, recreation, regulation of water flows, water quality and conservation of biodiversity of cultural value in peri-urbanised valley bottoms.

To meet this challenge, the Ecosystem Services Network Futures for the Grenoble Region (ESNET) models scenario-based changes in ecosystem services using models built around ecosystem services networks that combine multiple drivers and underlying ecological properties and processes at various temporal and spatial scales. The direct involvement of stakeholders from multiple sectors in scenario building and in the assessment of their outcomes ensures relevance to the local debate, and is expected to contribute novel, often implicit or neglected elements to this debate.

Exemplar Selection and Description

The French Alps exemplar is a regional case study that addresses issues relevant to European mountain regions regarding the interface between a dynamic economy, associated urban and infrastructure development, and natural assets with high values including biodiversity and the provision of multiple regulation and cultural services. As such, it exemplifies a nexus for inter-sectorial interface among policies and for multi-scale governance. While an exemplary case for multi-functional agriculture and forestry, this region is challenged to integrate nature conservation objectives and policies (e.g., Birds and Habitat Directives; EU Biodiversity Strategy to 2020, including its restoration objectives), with its economic development, and with objectives such as the development of renewable energy (climate policy) and insuring the quantity and quality of water bodies (Water Framework Directive). The Exemplar involves a broad range of stakeholders including decision makers, managers, producers and NGOs representing the main relevant sectors: agriculture, forestry, nature conservation, urban development, tourism and water.

The Central French Alps territory extends around the city of Grenoble and three main mountain chains: Belledonne, Vercors and Chartreuse (Figure 1). The study site presents areas with great landscape, physical, and natural diversity due to the geology, climate, orientation and elevation. These mountain chains offer great natural and semi-natural landscapes and benefit from many conservation policies (like Parcs Naturels Régionaux, Réserves Naturelles etc.). In the valley, the flat topography generates urban sprawl around the city of Grenoble and in the Grésivaudan valley, like in the plateau of Chambaran in the north-west of the study site. The 4450 km² of study site are covered by 56% of forests, 39% of agricultural surfaces and 5% of urban areas (Corine Land Cover 2010). During the 2003-2009 period, the urban areas gained around 33 km², or 14%, principally at the expense of agricultural areas. The changes observed depend on the landscape context, thus we will focus on two case study sub-systems: the intensively farmed valley upstream of the Grenoble city (Grésivaudan) and a mixed landscape of forests and grasslands in a mountain range south of the Grenoble city (Quatre Montagnes) (Figure 3).

The Grésivaudan case study has undergone extensive urban and suburban development, with its associated infrastructure and increasing demand for recreation and other amenities. Key issues already raised by regional and local stakeholders include: compatibility of food production with urban expansion and biodiversity conservation objectives (and in particular ecological networks), and the roles played by agricultural land in flood prevention (e.g., as flood expansion zones) and in limiting rock-fall and avalanche danger in the slopes above the valley.

The Quatre Montagnes case study, in the Vercors range, is a mosaic of forests, managed for timber production and/or other amenities including biodiversity and grasslands, used and managed in the context of livestock systems that heavily depend on EU subsidies. Rising peri-urban populations and tourism have increased demand for a variety of amenities (recreation, scenery, etc.) while simultaneously putting pressure on existing agricultural and forest management strategies. Key issues already raised by regional and local stakeholders include: compatibility of alternative grassland management strategies with biodiversity goals related to plant, bird and insect habitat but also to wide-ranging mammals (e.g., wolves); compatibility between goals of agro-environmental schemes (especially for grasslands) and peri-urban expansion; and compatibility of wood production with conservation of forest biodiversity (e.g., emblematic species like Tengmalm's owl).

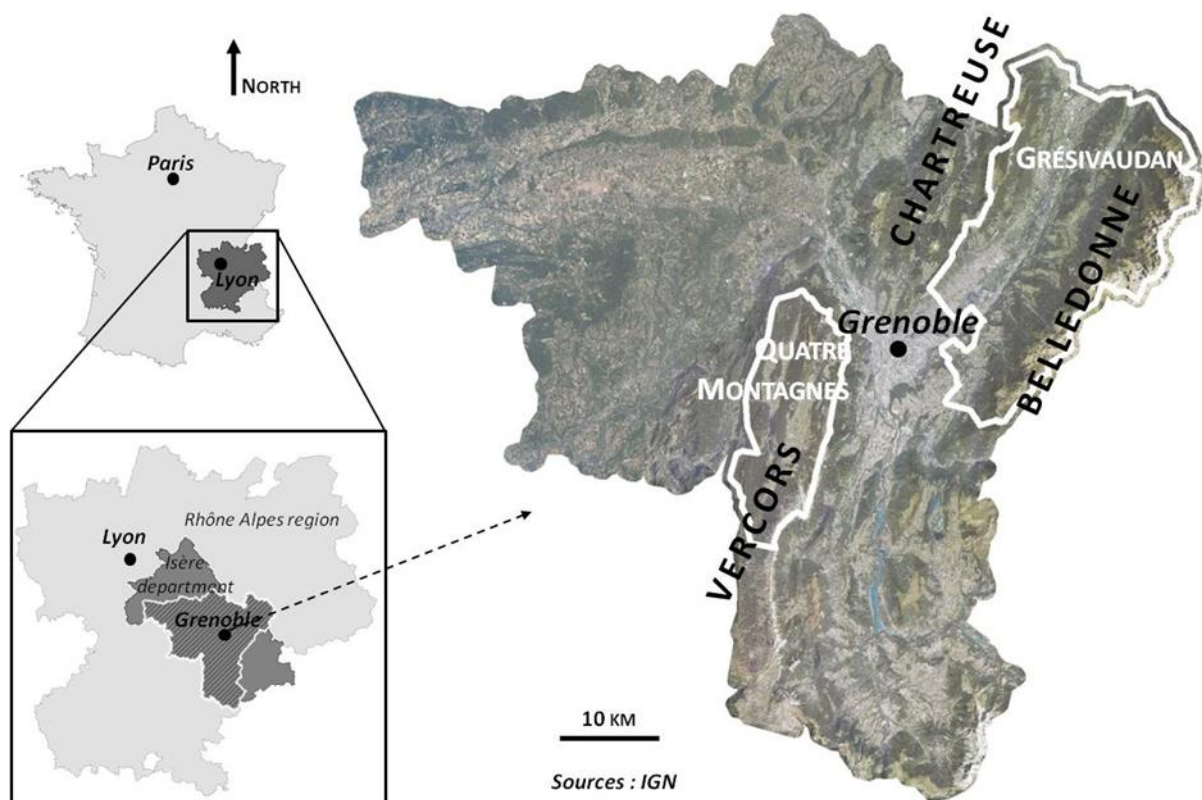


Figure 3. Study site location.

Research Questions

1. What are the networks of interacting ecosystem services in the Grenoble Region? What are the key ecological control mechanisms of ecosystem functioning?
2. What are plausible land use change scenarios given expected climate change and alternative options for urban and peri-urban development? What are their consequences for ecosystem services of crop, livestock and forest production, conservation of biodiversity of cultural value, regulation of natural hazards (mass flow and floods) and recreation?
3. What are the expected consequences of these scenarios in terms of reconciling biodiversity conservation with the capacity of ecosystems to provide a range of ecosystem services identified as priorities by decision makers and land managers?

Exemplar Goals

ESNET aims at assessing alternative futures of ecosystem services networks, defined as sets of interacting ecosystem services for the urban area of Grenoble, under combined scenarios of urban development, climate change, and non-urban land-uses. We hypothesize that ecosystem services are interconnected through their underlying ecological mechanisms and operate as networks from the local to the regional scales. These networks are underpinned by fundamental ecological processes as well as by human dynamics. For instance, biomass, primary productivity, and biogeochemical cycling are entry points to many ecosystem services, and therefore lead to intimate links among their dynamics. From the human perspective, management decisions have simultaneous impacts on multiple services, especially when multifunctionality is an objective, or conversely when production of one service is targeted at the expense of another. ESNET will primarily address the ecological dynamics determining ecosystem services trade-offs and synergies, while incorporating human dynamics in terms of land-use futures and ecosystem services preferences by local stakeholders and policy makers.

Linking Stakeholders, Instruments, and Ecosystem Services

Stakeholder description

Participants to the continuous stakeholder process have been selected based on researchers' knowledge of the territory, project partners' (ESNET project) previous contacts and suggestions by key informants, for individuals within main structures involved in territorial management for five socio-economic sectors: forestry, water management, agriculture, tourism and recreation, nature conservation, urban development and land use planning. Within each of these sectors, main stakeholders have been identified from governance structures, local authorities, NGOs, and regional natural parks. The initial workshop initiated a snowballing process, by which individual participants have opened access to their own networks and facilitated the incorporation of

additional partnering structures or individuals. The current network of committed individuals comprises about 30 participants representing a wide range of structures across sectors and our study scales and sites, as detailed in Table 3.

	No. of structures involved			
	Local		Local and regional	Regional
	Grésivaudan	Quatre Montagnes		
Agriculture	1	1	3	2
Biodiversity	1	1	3	4
Forestry	1	1	5	2
Tourism and recreation	1	1	3	2
Urban development and land use planning	1	1	3	4
Water management	1	1	4	2
Others	1		1	1

Table 3. Distribution of participating stakeholder groups, classified by socio-economic sector and scale.

The participation process is organized as a series of five workshops with a committed group of stakeholders (considered as a steering committee for the project), to integrate their participation throughout the project. The first workshop, held in September 2013 and followed by two more working group meetings and individual interviews, aimed to engage participants with the ecosystem service concept, to identify perceived key issues for regional development and land planning, and elicit perceived links between these and specific ecosystem services, thereby building a first overview of perceived ecosystem service networks. This process also identified specific needs of different stakeholders with respect to ecosystem service research on the study area. The second workshop (March 2014) will aim at downscaling regional scenarios, and specifically formulating them as visions about ecosystem service demand and expected land use changes. The third workshop will present ecosystem service models and identify useful indicators that should be informed by models in order to address stakeholder needs (Table 4). The fourth workshop will assess model projections of ecosystem service indicators under the scenarios, while the fifth and final workshop will use this information and results from MCDA to discuss possible futures and land planning implications.

Identification of stakeholder needs

Socio-economic sector(s)	Stakeholder need	Ecosystem services	Instruments	Anticipated outcomes
Mainly forestry but relevant to all with a role in management of natural areas	Establishing links between ES and ecosystem management activities in order to encourage actions fostering ES	P1 cultivated crops P4 wild animals and their outputs P7 surface water for drinking P8 ground water for drinking P14 plant-based resources R2 filtration... by plants... R3 filtration... by ecosystems R6 mass stabilization... R7 buffering and attenuation of mass flows R8 hydrological cycle... R9 flood protection R12 pollination... C7 aesthetic + protection against natural risks	MCDA - ALUAM	Consideration of ES and the underlying ecosystem processes chain in management plans
Mainly forestry,	Communicating to the	P1 cultivated crops	Mapping Information tool -	Use of ES concepts in

agriculture, water management and tourism	public about the value of ecosystem management interventions (e.g., forest management, hunting)	P4 wild animals and their outputs P7 surface water for drinking P8 ground water for drinking Cultural : C4 educational C5 heritage, cultural C7 aesthetic	Our Ecosystem	regulatory and planning documents
Tourism and forestry (sectors with direct relationships to the public)	Communicating and informing on (positive) impacts of a good ecosystem management on ES provision	Cultural : C6 entertainment C7 aesthetic + accessibility of forest	Mapping Information tool - Our ecosystem MCDA - ALUAM	Limiting use conflicts between tourists, users including local population, and foresters
Mainly forestry	Raising public and political (funders) awareness about management activities (role, impact etc.) in order to get funding for actions supporting good ecological condition or multi-functionality of forests	Focus on regulating ES necessary to sustain provisioning ES Examples : R6 mass stabilization and control of erosion rates R20 global climate regulation by reduction of greenhouse gas concentrations	Collaborative Web-Platform: User interfaces and visualizations	Understanding of forest multi-functionality by decision-makers and support of supply of non-marketable ES adequate budgets through environmental measures. Recognition of the forest production sector as provider of 'common good'
Forestry, agriculture, water	Mapping of ES for quick	Examples :	Mapping Information tool -	Incorporation of ES into

management, tourism and recreation, urban development and land use planning	and easy presentation of information to decision-makers	P1 cultivated crops P14 plant-based resources R6 mass stabilization and control of erosion rates R12 pollination and seed dispersal C6 entertainment	Our Ecosystem	decision-making, such as land planning and management plans
Urban development and land planning	Linking quantification of ES and economic valuation, without monetarisation, to emphasize the interest of the ES approach	Examples : P1 cultivated crops P14 plant-based resources R6 mass stabilization and control of erosion rates R12 pollination and seed dispersal	Offsetting / No Net Loss Possible use of financing instruments	Integration of offsetting of ES into land use planning and urban development Provide information for Payments for Ecosystem Services
Water management, forestry, agriculture	Understanding of ecosystem responses to climate change	P1 cultivated crops P7 surface water for drinking purposes P8 ground water for drinking purposes P14 plant-based resources R7 buffering and attenuation of mass flows R8 hydrological cycle and water flow maintenance	MCDA	Incorporation of uncertainties linked to climate change into regulations for resource management and exploitation

		C6 entertainment		
Agriculture and forestry	Demonstration of the interest of incorporating green infrastructure into farming systems	P1 cultivated crops R6 mass stabilization and control of erosion rates R13 maintaining nursery populations and habitats C7 aesthetic	MCDA	Support to agroforestry and conservation agriculture through the evolution of land use legislation
Water management, agriculture, urban development and land planning	Improving the understanding of the role of wetlands for overall ecosystem functioning	R3 filtration / sequestration / storage / accumulation by ecosystems R7 buffering and attenuation of mass flows R8 hydrological cycle and water flow maintenance R13 maintaining nursery populations and habitats R18 chemical condition of freshwaters C3 scientific	Offsetting / No Net Loss	Development of PES and/or offsets
Forestry, agriculture, water management, tourism and recreation, urban development and land use planning	Incorporation of ecosystem services into strategies for preserving nature against artificialisation and uses	P1 cultivated crops P8 ground water for drinking R3 filtration / sequestration / storage / accumulation by ecosystems R7 buffering and attenuation of mass flows R9 flood protection	Collaborative Web-Platform: User interfaces and visualizations	Reorganisation of governance structures ; increased inter-sectoral integration

		C6 entertainment C7 aesthetic		
Forestry, agriculture, water management, tourism and recreation, urban development and land use planning	Developing ecological connectivity	R5 mediation of smell / noise / visual impacts R8 hydrological cycle and water flow maintenance R13 maintaining nursery populations and habitats C10 existence	Mapping information tools – Our Ecosystem	Strengthened blue and green ecological infrastructure in planning strategies and implementation documents

Table 4. Exemplar Plan to Address Stakeholder Needs and Improve Ecosystem Services Through Instruments.

Collaborations within OPERAs

Work Package 2 – Practice

Collaboration with Dublin, Montado and possibly Scotland.

Work Package 3 – Knowledge

The French Alps exemplar is directly used for Work Package 2 work on the following topics:

- Networks of ecosystem services: developing concepts and methods for the analysis of ecological mechanisms, including biodiversity effects that underpin trade-offs and bundles of ecosystem services.
- Trait-based models of ecosystem services, including by interfacing with remote sensing products.
- Methods for ES trade-off analyses: a methodological framework is developed to provide an interdisciplinary methodological approach combining a diverse spectrum of quantitative methods that may be selected for (1) detecting ES associations, (2) identifying ES bundles and (3) isolating their drivers, depending on the management and policy context of a given ES study.
- Social valuation of ES:
 - Valuation of ES networks by stakeholders
 - Cultural services: evaluation by stakeholders of connections between their uses and preferences for tourism and recreation, and ecosystem and landscape properties.

Work Package 4 – Instruments

Instruments selected for the French Alps Exemplar:

- Information Tools: Our Ecosystem (Ecometrica); 3D visualization (ETH)
- Decision-support Tools: scenarios developed in collaboration with stakeholder, MCDA (with EFI and with local collaborators)
- Management instruments: compensation and offsets (Biotope)

Work Packages 5 & 6 – Resource Hub & Dissemination

Collaborations are being developed to link stakeholders with the Resource Hub and outreach.

Montado Cultural Landscape Exemplar

Margarida Santos-Reis, Centre for Environmental Biology (CBA)

Rui Rebelo, Centre for Environmental Biology (CBA)

Cristina Máguas, Centre for Environmental Biology (CBA)

Faculdade de Ciências da Universidade de Lisboa

Dream Abstract

The Montado is a unique agro-forestry ecosystem with high ecological and socio-economic relevance. Its large extent and man's shaping activities through millennia have resulted in a complex productive system with a high conservation value, being part of the Mediterranean basin biodiversity hotspot.

In socio-economic terms it stands as a multi-use system (e.g., cork and charcoal production, livestock husbandry, hunting, mushroom picking, eco-tourism) that occupies mostly 'marginal' areas with limited agricultural and industrial potential. It functions as a key employment provider (Portugal offers half the world's output of commercial cork and is a major producer of non-timber forest products), and represents a rural sustainable way of living, still heavily relying on traditional management knowledge (cultural heritage).

This cultural landscape is subject to pressures and drivers of change including rural abandonment, tree mortality, depreciation of cork market value, replacement by production forests, overgrazing, air pollution and climate change. By bringing the ES/NC concept into practice, the productive, ecologic, and cultural aspects of the system will be combined to promote an improved management that reconciles biological resources use with conservation interests.

Profiting from existing databases assembled in the frame of research and monitoring activities at the Montado Long-Term Socio-Ecological Research (LTSER) platform, combined with new research, analyses will comprise: (i) literature review on Montado values including cultural heritage, (ii) overview of data linked to ES with identification of knowledge gaps, (iii) involvement of stakeholders to assess their needs and perceptions, and (iv) testing OPERA tools and instruments.

From 2014 onwards, the new 'greener' Common Agriculture Policy (CAP) aims to significantly increase the percentage of ecological focus areas, thereby increasing biodiversity levels and the provision of biodiversity-based Ecosystem Services. Key outcomes of this research are the establishment of criteria to evaluate and rank socio-ecological and cultural values at the local level and the selection of indicators that can be used at broader scales. By involving the key stakeholders in the process we thus envision to pro-actively contribute to agriculture and conservation policies in the frame of the EU CAP and the Convention of Biological Diversity.

Study Rationale

Demonstration of the benefits and viability of agro-forestry systems is a major research topic in Europe and the adoption of such farming systems has been promoted. Attention is paid to impacts on the natural environment and to the balanced and efficient use of on-farm and external inputs and resources, such as soil, water, energy and nutrients, with the aim of improving the production of high quality products and the delivery of ecosystem services.

The large extent, structural complexity and pedo-climatic/land use variability of the dominant agro-forestry system in the Western Mediterranean region (*Montado*), translated into high biodiversity levels and diverse ES (including cultural). The multiple pressures currently faced by this socio-ecological system (e.g., rural abandonment, tree mortality, depreciation of cork market value, replacement by production forests, overgrazing by both game and livestock, air pollution, and climate change) set the stage for considering its analysis as an added-value for testing the application of ES/NC tools and instruments meeting the needs and requirements of practitioners at the local and regional levels.

Some of the key ecosystem services provided by the *Montado* system include: Provisioning (nutrition, materials and energy), Regulation and Maintenance (maintenance of physical, chemical, biological conditions), and Cultural (physical and intellectual interactions, spiritual, symbolic and other interactions).

By bringing the ES/NC concept into practice, the productive, ecological, as well as cultural aspects of this socio-ecological system will be combined to promote an improved management that reconciles the use of biological resources with conservation goals.

Exemplar Selection and Description

The LTER *Montado* Site, a node of the Portuguese Long-Term Ecological Research network (LTER Portugal), is located in the Alentejo province (southwestern Iberia) and represents a unique agro-silvo-pastoral ecosystem (named *Montado*, or *Dehesa* in Spain) found only in the Mediterranean basin. These savannah-like landscapes, dominated by cork (*Quercus suber*) or holm (*Q. rotundifolia*) oaks, with understory vegetation ranging from shrubs to grasslands, were shaped over millennia of traditional land use practices, and have high socio-economic and conservation value (Figure 4). These multi-use forests combine, in a single space, forest harvesting, livestock husbandry, pastures and/or crops, with other uses (e.g., hunting). Recently, awareness has been increasing regarding their benefits as other ecosystem services providers (e.g., biodiversity), but these non-productive functions are not equally perceived and valued by users, as they tend to be conflicting with productive ones. Long-term subsistence of such ecosystems depends therefore on active management and use by humans and its future is threatened by multiple causes (e.g., agriculture intensification, increasing fire frequencies, technological development, etc.).



Figure 4. Cork oak Montado system
(Companhia das Lezírias, ©JP Ferreira).

Capitalising on the interdisciplinary expertise and research investments of seven institutions in the *Montado* ecosystem, the LTER Montado was established in 2009 to allow the establishment of long-term research and monitoring (R&M) stations of the ecosystem structure and functions, as well as its response to environmental, social and economic drivers.

Due to the variability found in *Montado* landscape, resulting from different climate-soil interactions, main tree species and land-use patterns, LTER Montado was established as a macro-site with six core R&M stations distributed in the Alentejo province (Figure 5). Jointly, these stations provide a socio-economic platform by representing different pedo-climatic situations, land-use regimes and desertification scenarios, therefore involving different pressures (Table 5). In the frame of OPERAs, for local-focused instruments we will concentrate on the ‘Companhia das Lezírias’ R&M station, while for other approaches (e.g., governance issues) all the LTER Montado region will be considered.

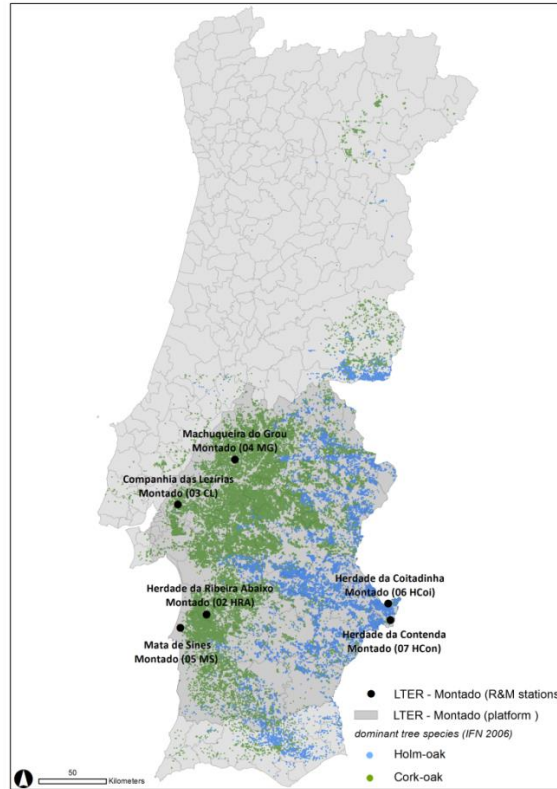


Figure 5. LTER Montado platform and R&M stations.

Site	Dominant Oak Species	Main Land Use	Vulnerability to dryness	Land use pressure
Ribeira Abaixo	Cork oak	Cork & Research	+++	-
Mata de Sines	Cork oak	Cork & Industry	+++	+++
Contenda	Holm oak	Acorns & Game	+++	++
Coitadinha	Holm Oak	Eco-tourism	++	+
Machoqueira	Cork Oak	Cork	+	+
Comp. Lezírias	Cork Oak	Cork & Cattle	++	++

Table 5. Contrasts between R&M Stations at LTER Montado Platform.

The different sites were selected in order to cover Montado of either holm or cork oak, as well as different land uses. The sites were also ranked according to their vulnerability to dryness and land use pressure, from minimal (-) to maximum (+++), by expert judgement.

Research at these stations focuses on improving our understanding of the long term consequences of land use practices and management options, and how these effects interact with

other socio-economic and environmental drivers operating at scales from local (e.g., agriculture intensification, cattle pressure) to global (e.g. climate change, desertification). Although still spread in space and time, available datasets refer to meteorological data, carbon dioxide and water fluxes (in one site), soil respiration and soil water content, vegetation cover and land use changes, growth and health of individual cork-oaks, acorn (and other fruit) production, plant and animal diversity, and biodiversity indexes, among others. Current efforts are concentrated in standardising ecological indicators and monitoring protocols between different levels.

Besides the accumulated data over the last decades on the Montado system, the strength of this site relies on the logistics and interest made available by the R&M stations (envisaging a long-term sustainability) and other stakeholders, such as the single largest cork producer, and also the largest cork manufacturing industry, in the world (Corticeira Amorim S.A.), local municipalities, and forestry and development state departments. Another strength of the site is the existence of lodging facilities in the majority of the R&D stations with emphasis in the field station of the University of Lisbon (Herdade da Ribeira Abaixo, Grândola), located in the core area of the Montado range and representing the LTER Montado site headquarters.

Research Questions

The main focus of research and monitoring activities conducted at the *Montado* Cultural Landscape exemplar is the quantification of ES/NC provision in the Mediterranean under scenarios of climatic and land-use change to predict the effects of change in the system long-term sustainability.

Related research questions are:

- Is it possible to reconcile conflicts between economic activities and conservation interests?
- How can cultural ecosystem services be valued?
- Is the incorporation of the ES/NC concept in the management planning easily understood by, and beneficial for practitioners?
- Are locally-based values suitable indicators at broader spatial and social scales in complex agro-forestry systems?

Exemplar Goals

Specific goals at the exemplar are to:

- Understand impacts of climatic and management-driven changes in ES provision for Montado landscapes.
- Evaluate stakeholder perceptions of ecosystem services provided by the Montado cultural landscape and how they are willing to incorporate these services into ecosystem-based management plans.
- Value cultural ES offered by the Montado and assess trade-offs and synergies with other ES currently more valued by practitioners and decision-makers.
- Introduce the ES/NC scheme as a problem-solving approach to ensure long-term sustainability of the Montado system.

Linking Stakeholders, Instruments, and Ecosystem Services

Stakeholder description

Research in the frame of the *Montado* exemplar will target three main focus stakeholder groups, at the local and regional levels, identified on the basis of their socio-economic activity (Montado land-users and Montado products end-users) or their environmental and/or planning responsibilities (decision makers and other actors of environmental governance):

1. Land owners/managers;
2. Business enterprises (e.g. Corticeira Amorim S.A. – the main cork end-user);
3. Governmental institutions (e.g., Institute of Nature Conservation and Forests, Alentejo Municipalities)
4. Environmental NGOs

Representatives of these three groups will be selected both for participatory workshops and for semi-structured interviews depending on the research goal (e.g., how to incorporate the ES/NC concept or values/perceptions assessments, respectively). Some of these will be engaged due to previous active participation in several research actions, logistical support, and/or own-initiative research contracts, but to increase power analysis other will be selected with the assistance of specialists on social approaches including the potential participation of the Prospex partner. Stakeholders' involvement in this exemplar will commence at the end of January 2014 with a Formal Launch Workshop.

Identification of stakeholder needs

Stakeholder needs will be framed by the ES/NC concept following, as suggested, the ES classification by CICES v.4.3, and several instruments will use the *Montado* Cultural Landscape as a testing ground. This is the case for Socio-Cultural Valuation (SCV), ES Mapping, ES indicator development and scenario building instruments (Table 6).

Land owners/managers and business enterprises currently lack the ability to value cultural ES, which prevents them benefiting from the added value of traditional non-monetary services. We will use SCV, conducted through workshops and other means, to elaborate and rank cultural values to enable these to be incorporated in decision making. These stakeholders are also frequently expected to decide on whether to change the type of land use over large areas – in this case, the intensification/ extensification of the exploitation of different *Montado* resources; these decisions will benefit if informed by detailed ES assessments.

Land owners/managers, governmental institutions and NGOs are often unaware how to map the ES provided by the lands they manage. Using their properties as case studies, they will be able to improve planning, to have insights on the differential values of different areas and this in turn will influence planning decisions.

All stakeholders will benefit from the development of scenarios concerning the impacts of both current and near future environmental drivers, as well of land use changes, that in turn will inform on trade-offs and synergies between wood and non-wood forest products, biodiversity and ecosystem services.

Additionally, we will link ecosystem research and politics by exploring how ES/NC based approaches fit with current institutional structures and governance systems, and where unforeseen policy conflicts may occur, thus supporting sustainable use of the *Montado* biodiversity and ecosystem.

Stakeholder Need	Instruments to address need	Ecosystem Service Addressed	Anticipated Outcome
Valuation of biodiversity and cultural services	Socio-Cultural Valuation	Physical and intellectual interactions; Spiritual, symbolic and other interactions	Preservation of cultural heritage Added-value of traditional non-monetary services into economic benefits
ES Mapping	Our Ecosystem Mapping	All services	Spatially-explicit management support tools
ES provision and indicator development to support management options and corresponding economic benefits	TESSA ToSIA	Provisioning (Cultivated crops; Reared animals and outputs; wild plants and animals and their outputs; Fibres and other materials from plants and animals for direct use or processing; Materials from plants and animals for agricultural use) and Regulation and	Multi-scale assessments of ES and economic valuation

		Maintenance (Carbon sequestration; Hydrological cycle and water flow maintenance; Pollination and seed dispersal; Maintaining nursery populations and habitats; Climate regulation)	
System response to impacts of land-use and climate changes	Scenario development	All services	Multi-scale projections Identification of threats and opportunities
Support to decision-making	Policy instruments	All services	Improvement of governance models

Table 6. Exemplar Plan to Address Stakeholder Needs and Improve ES Instruments

Collaborations within OPERAs

Work Package 2: Practice

Besides its individual role as an exemplar to be used to test tools and instruments developed and improved within OPERAs, the *Montado* exemplar is a candidate to integrate the Circum-Mediterranean Exemplar, in order to understand large-scale dynamics and explore the opportunity to explicitly incorporate the ES/NC concept into policy making.

Work Package 3: Knowledge

Within the knowledge Work Package, research in the *Montado* exemplar focuses on four main topics:

1. ES/NC quantification and links between biodiversity and ES;
2. Scenarios development (response to land use and climate changes);
3. Synergies and trade-off analysis between ES; and
4. Social valuation of ES, in particular of cultural services.

Potential collaboration was discussed with partner UCD (Craig Bullock) in respect to Socio-Cultural Valuation approaches and developments are to be expected. Other potential collaborations are under discussion, namely with the French Alps Exemplar (CNRS).

Still regarding Knowledge, the *Montado* exemplar was selected by partner ULUND (Lennart Olsson) to explore existing and potential governance models and a visit is expected soon.

Work Package 4: Instruments

First collaborative steps were established with different partners to further develop and test different instruments at the *Montado* exemplar, as follows:

- Information Tools: Our Ecosystem Mapping (ECM - Karin Viergever), TESSA (UNEP – WCMC - Lisa Ingwall-King);
- Decision support tools: Visualization (ETH - Thomas Klein); ToSIA (EFI - Diana Tuomasjukka)
- Management Instruments: ES indicator development (UNEP – WCMC – Lisa Ingwall-King), Social Valuation (UCD – Craig Bullock)

ToSIA training has already started with the participation of a PhD candidate in a training workshop held in Joensuu (Finland) late December.

Work Package 5: Resource Hub

Information gathered is expected to contribute to the Resource Hub and the OPERA dissemination strategy.

The team is analyzing the possibility of involving Prospex in the stakeholders' engagement process.

Work Package 6: Dissemination

Still under discussion dissemination/communication plans, besides presentations at scientific meetings and paper submission, also may include Summer Schools, Fact Sheets, Facilitated Workshops, among other, and these can be transferable to other Exemplars and the OPERAs project overall namely through cross-site activities.

Wine Exemplar

Kimberly Nicholas, Lund University

Klara Winkler, Lund University

Marc Metzger, University of Edinburgh

James Paterson, University of Edinburgh

Dariya Hadzhiyska, denkstatt

Marcus Lindner and Diana Tuomasjukka, EFI

Karin Viergever, Ecometrica

Lisa Ingwall-King, UNEP-WCMC

Dream Abstract

Vineyards are valued landscapes especially for the provisioning and cultural services they provide in unique geographic regions. The wine industry is rapidly expanding in Southern England, where soils and climate roughly similar to Champagne allow high-quality wines to be grown. Here we describe a proposed collaboration with wine producers in the emerging region of Southern England to apply tools and instruments to address their existing business needs and priorities to achieve economic, environmental, and social sustainability, while improving ecosystem services (ES) delivery and increasing natural capital. Economic sustainability will be targeted through calculating the cost of production, as well as economic costs and benefits of undertaking sustainability activities. Existing ES indicators, as well as new ones developed for this project, will be used to identify the highest priority areas for achieving ecosystem services improvements. Improving environmental sustainability will focus on better identifying productive planting sites that minimized conflict with biodiversity, and predicting vineyard yields through the Our Ecosystem tool. The industry's goal of benchmarking and reducing its carbon footprint will be addressed using two quantitative modelling tools, ToSIA and LCA. Finally, social sustainability will be addressed through the use of the Scenario Toolbox to support strategic planning. The contribution of cultural ecosystem services to social sustainability will be assessed using a method called Q-sorts to rank and sort personal stakeholder perceptions of the cultural and aesthetic values provided by vineyards and their role in neighbour relations. We hope to demonstrate that combining collaboration with stakeholders with cutting-edge tools and instruments has great potential to increase the delivery of ecosystem services and ultimately contribute to the sustainability of the wine sector in Southern England and beyond.

Study Rationale

We have chosen to focus on wine production because it offers a compelling case of tradeoffs and synergies between important ecosystem services (ES), such as provisioning (most notably, the harvested grapes to be made into wine), regulation and maintenance (such as greenhouse gas reductions and local climate regulation), and cultural (such as heritage, aesthetic, and experiential). In this Exemplar, we will operationalize ES by linking them with the existing sustainability plan of the UK Wine Association (UKVA, 2012), thereby raising the profile of the ES approach while simultaneously solving identified needs within the industry.

Exemplar Selection and Description

The Wine Exemplar was initially identified within the broader context of OPERAs as a case of traditional cultivated land use in the agricultural sector, strongly associated with historical cultural landscapes, spanning a geographic range across much of Europe. The case of winegrowing in England (Figure 6) was subsequently identified as an exciting area of focus because it is currently undergoing rapid expansion, with vineyard areas projected to triple in the coming decade, thus providing opportunity for targeted research to have a great impact in shaping industry practices

and promoting ecosystem services. The English wine industry is focusing on economic sustainability in the face of rapid expansion, and understanding the impacts of climate on potential yields and growing areas, which may expand under climate change. Initial research efforts are currently focused on establishing stakeholder partnerships in England, to take advantage of access and language benefits; a comparative case may be added later as war ranted.

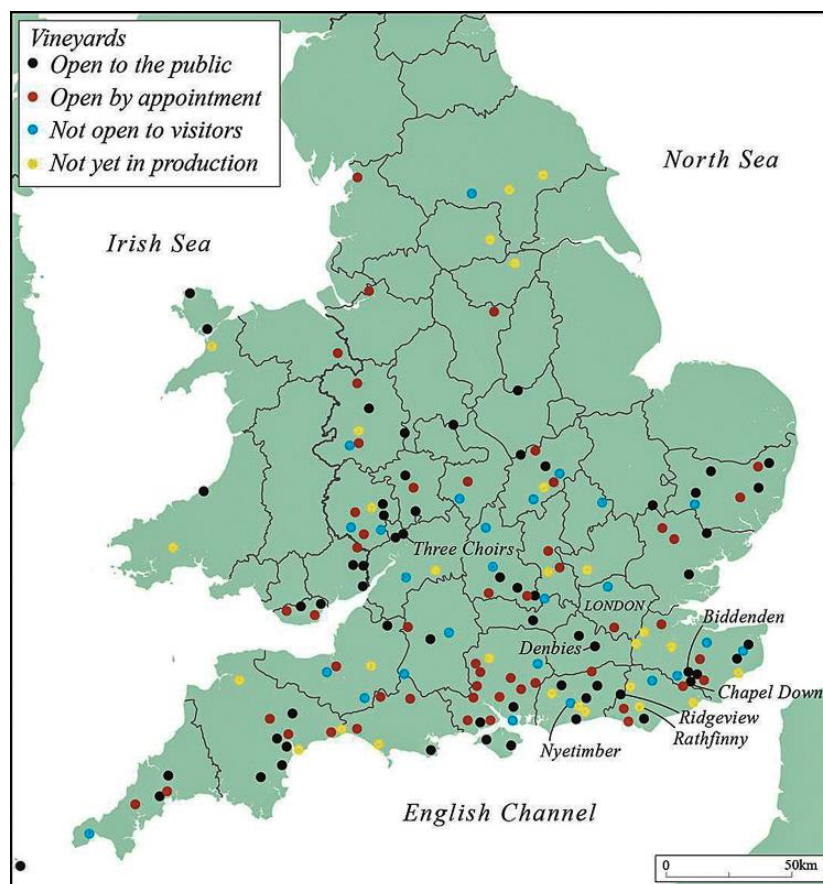


Figure 6. Southeast England Wine Production Sites. The study area is to the southeast of London.

Retrieved from: <http://echogeo.revues.org/docannexe/image/13333/img-1.jpg>

Research Questions

1. How can human decisions be explicitly integrated with an ecosystem services framework to more accurately model and manage a socio-ecological system like vineyards?
2. How can the concept of Ecosystem Services promote improvements in ecosystem function, delivery of services and benefits, and increase natural capital in the wine industry?

Goals

- Identify the main ecosystem services of vineyards, and quantify the tradeoffs between them under different management scenarios, as well as the tradeoffs between ecosystem services provided by vineyards compared with other land uses.
- Maintain and enhance vineyard ecosystem services such as wine production and carbon sequestration, while enhancing cultural services including tourism and aesthetic value.
- Develop and test a specific process for selection of the most appropriate management practices contributing to economic sustainability and conserving resources through application of life cycle and system thinking.
- Design a stakeholder-driven participatory process to identify possible futures of the English wine industry, including challenges and opportunities, and support the strategic planning of industry response.

Linking Stakeholders, Instruments, and Ecosystem Services

Stakeholder description

Stakeholders were initially identified through desktop research on the structure of the English wine industry. This led to identifying the United Kingdom Vineyards Association (UKVA, <http://www.ukva.org.uk/>) as an initial target for outreach. This is a group of winegrowers and winemakers focused on sharing information, having a political voice both at the national and EU level, and developing and promoting the industry. There are eight regional associations within the UKVA; a representative of each region sits on the UKVA Council.

The largest and most active regional association is the South East Vineyards Association (SEVA), which includes areas around Surrey, Sussex, Kent, and London South, <http://www.seva.uk.com/>. Mr. Chris Foss is the Chair of SEVA, and also the Chair of the Wine Department at Plumpton College, the only academic institution delivering training on wine production in the UK. We are focusing our exemplar collaborations to partner with SEVA and Plumpton, and are planning an initial site visit to refine definition of stakeholder needs in Spring 2014.

Identification of stakeholder needs

Stakeholder needs to date have been identified through industry reports published by the UKVA and conversations with industry members. Subsequent follow-up with stakeholders will refine these needs to make sure they represent what our stakeholder partners want. To date, there have been two main reports on the wine industry status and needs in the UK with an environmental focus (although they use the framework of sustainability, rather than ecosystem services). The first is the Policy Statement on Sustainability (UKVA 2010), which identified goals for the English wine industry including economic (promoting high-quality, economically viable wine production); environmental (including reduced resource use in the vineyard and winery, and carbon footprinting

and management in support of the UK’s binding policy of 80% carbon reductions by 2050), and social (focused on workforce training and safety, responsible alcohol consumption, and good neighbor relations). The second report, the 135-page UKVA Sustainability Project Final Report (UKVA 2012), identified industry and stakeholder needs from surveys and interviews with industry members. Key needs identified included the ability to account for the costs of wine production, which most operations in this new industry currently cannot do; improve yields; and build strategic planning capacity.

Complimenting these reports, stakeholder engagement to date has identified three core industry needs, which are the current focus of the Wine Exemplar (Table 7). Using OPERAs tools and resources to help meet these needs will make a substantial contribution to the industry’s ability to make better business and resource use decisions, for the benefit of ecosystem services.

1. **Increasing wine yields and quality.** Mapping and statistical analysis using the Our Ecosystem tool could meet the need to improve yields (which are lower than in France) and direct vineyard expansion to the most productive areas, away from biologically sensitive regions. Developing ecosystem service indicators of wine quality can be used to better understand and manage for quality.
2. **Identifying, measuring and enhancing vineyard ecosystem services.** We will use ES Indicators to link identified industry priorities (e.g., promote biodiversity, reduce agrochemicals, and improve soil management and water and energy efficiency) to the ecosystem services they represent or depend on. We will use life-cycle accounting (LCA) to provide decision-making support based on improved understanding of agricultural practices and their impact on ecosystems, as well as discover opportunities to lower environmental impact based on knowledge about the ecosystems. Linking ecosystem service indicators with economic and other goals will also be important, possibly through green communication.
3. **Enhance long-term strategic planning capacity.** First, we will identify threats and opportunities for plausible futures in the industry, and support strategic planning by stakeholders by using the Scenario Toolbox to allow stakeholders to develop and use their own scenario planning. This will be complimented on the quantitative side by the use of the ToSIA tool to integrate indicators and scenarios to provide decision support, and on the qualitative side by the results of the Q-sorts of cultural ecosystem services provided by vineyards.

Stakeholder Need	Instrument to address need	Ecosystem Service(s) Addressed*	Anticipated Outcome
1. Increase wine yields and quality	Our Ecosystem (Karin Viergever, Ecometrica), using data layers on yields provided by	Wine production (P1. Cultivated crops)	Direct development away from biologically sensitive areas. Promote optimal variety selection and vineyard management.

	stakeholders, on climate from in-house sources, and protected areas from Lisa Ingwall-King (UNEP-WCMC)		Minimize resource input needed and enhance and maintain supporting and maintaining services.
	ES Indicators (Lisa Ingwall-King, UNEP-WCMC)		Develop indicators of wine quality to better understand drivers of quality and improve the economic production of the industry
2. Identifying, measuring and enhancing vineyard ecosystem services	ES Indicators (Lisa Ingwall-King, UNEP-WCMC)	Multiple, depending on stakeholder needs (e.g., R20. Climate regulation by reducing GHGs; C5. Heritage, cultural)	Linking of identified industry priorities with ecosystem services, and weighting of most important priorities to achieve maximum results. New ES as well as economic indicators that guide and monitor the improvement of ES and NC which are in line with highest-return investments for wine producers.
	LCA (Dariya Hadzhiyska, denkstatt)	Carbon sequestration (R20. Climate regulation by reducing GHGs)	Reduced CO ₂ footprint, in line with UK policy of 80% reduction by 2050; better link between industry priorities and ES by identifying product stages with greatest environmental impact
3. Enhancing long-term strategic planning capacity	Scenario Toolbox (James Paterson, University of Edinburgh)	Multiple	Identify threats and opportunities for plausible futures in the industry; support strategic planning by stakeholders
	ToSIA (Marcus Lindner & Diana)	Multiple	Integrate indicators and scenarios; compare scenarios and use data from

	Tuomasjukka, EFI)		stakeholders and project collaborators to support stakeholder decision-making
	Q sorts (Klara Winkler, Lund University)	C7. Aesthetic, C5. Heritage, cultural	Understand non-monetary value of vineyards, and thus how to better manage them to maximize overall value, including long-term marketing and tourism strategy

Table 7. Plan to Address Stakeholder Needs and Improve Ecosystem Services Through Instruments

**Following the classification of Ecosystem Services from CICES v.4.3 (January 2013), contained in the “CICES” tab of the BluePrint Protocol.*

Collaborations within OPERAs

OPERAs partners work through one of six Work Packages (WPs) divided by task. The first WP is project management, engaged with the oversight and coordination of the entire project. Collaborations with OPERAs partners and their associated institutions are described below. The Wine Exemplar team currently consists of partners from WP 2 (Practice), who lead the design and implementation of the project, and WP 3 (Instruments), who develop and run instruments that can be used in the settings of Exemplars to measure, monitor, value, and better understand ecosystem services. A brief description of project partners and their roles is given below.

Work Package 2: Practice

- Kim Nicholas (Lund University)- Exemplar lead; coordinating stakeholder identification and engagement, project management, study design and implementation.
- Marc Metzger (University of Edinburgh)- Stakeholder outreach and engagement, study design and implementation.
- Collaborations with other Exemplars: potential linkages with Montado cork oak, possibility to test instruments developed in our Exemplar there.

Work Package 3: Knowledge

We are still establishing contacts and the possibilities for collaboration in WP 3, to be further refined at the May 2014 OPERAs meeting in Lisbon.

Work Packages 4: Instruments

- Marcus Lindner and Diana Tuomasjukka, EFI- ToSIA:
 The Tool for Sustainability Impact Assessment (ToSIA) could be used as the integrating tool to present a synthesis of alternative management options, as well as for different value chain scenarios. Those scenarios can describe user-specific management options (organic, traditional, innovative), marketing/distribution change options, consumption and quality management options, or other scenarios of stakeholder interest. We can use ToSIA to incorporate new Ecosystem Service indicators (cooperation with Lisa Ingwall-King); carbon footprint (LCA output; Dariya Hadzhiyska); energy and water use; pollution; recreational use; traditional and cultural values; protection and maintenance function indicators; and other social, economic or environmental indicators you are interested in. We can quantify, aggregate and disaggregate the impacts both as numeric values, as comparative graphs, or as basic values on top of which an MCA (Multi-Criteria-Analysis) or CBA (Cost-Benefit-Analysis) can be performed. We can also offer assessing the potential impacts of certification and labelling regimes in wine production.
- Dariya Hadzhiyska, denkstatt
Life cycle assessment: work with stakeholders to identify their primary ecosystem services of interest, and further develop Life Cycle Assessment (LCA)-based tools (e.g., CFT at the farm level) for management decision support and green communication (product labeling or information) at a regional level. The goal is to further bridge the gap between theoretical and practical models, and develop an instrument that is easily used by non-experts to meet producer needs.
Stakeholder engagement and communication: The overall aim is to develop a close relationship with the local stakeholders, with the idea to become part of the Community of Excellence. This will include stakeholder identification and mapping, individual meetings and workshops connecting stakeholders and OPERAs partners; match stakeholder needs with OPERA goals; setting up regular communication channels; and developing communication strategies for different stakeholder groups (B2B, consumers), as demanded by the stakeholders.
- James Paterson, University of Edinburgh- Scenario Toolbox
 The Scenario Toolbox is designed to allow managers to explore how they can sustainably manage ecosystem services in the future and support their short- and long-term decision-making through the use of a web-based platform. The tool is designed to ensure that users develop a comprehensive and strategic understanding of how different socio-economic, demographic, policy, and technology drivers may affect their businesses, livelihoods and even the wider environment.
 Through a participatory process, users will develop their own customized scenarios encompassing a range of plausible and salient alternative futures. For example, land managers may wish to analyse differences between adopting biodiversity-friendly management, or an input-intensive maximum-yield approach.
 A web-based platform will allow the users to develop their own suite of scenario storylines, following some initial training in a workshop; pre-formatted dialogue boxes in the toolbox will

aid the stakeholders in creating this qualitative element. The toolbox will have an online guide, glossary, case studies, information on drivers of change, and other resources, as well as a secure log-in page. If sufficient local data are available, these scenarios can then be used to map out land use changes, ecosystem service provision and other environmental management options.

- Karin Viergever, Ecometrica- Our Ecosystem:

Planning and coordination of wine exemplar Our Ecosystem app, in close collaboration with exemplar partners and stakeholders. Our Ecosystem (OE) is a webmapping platform that offers a new approach to accessing, using, and sharing the spatial information needed to manage and report on land and water resources. OE's powerful technology avoids the need for downloading data to desktop PCs and makes detailed analysis simply available via a user-friendly web interface. Ideas for the app set up should be based on outcomes of stakeholder communication, but may include planning areas of expansion/development for new vineyards, e.g. identify suitable areas for high-quality production that spare the most biologically sensitive areas; promoting optimal variety selection and vineyard management; understand social and environmental risks; and tracing natural capital certificates back to their source.

- Lisa Ingwall-King (UNEP-WCMC):

Developing ecosystem services indicators helps measure and monitor the ecosystems that the wine industry depends upon. In close participation with identified stakeholders, relevant ecosystem service indicators will be developed (for example: pest control, soil conservation, wildlife habitat, and carbon sequestration, among many others). A close relationship exists between the financial return and the state of ecosystem services. Therefore, being able to monitor their state will allow wine producers to take more strategic decisions to maximise returns, and make their businesses more resilient. Indicators of wine quality may also be of interest to develop, to better understand drivers of quality and improve the economic production of the industry.

- Klara Winkler, Lund University- Q sort

Vineyard landscapes provide cultural ecosystem services, such as aesthetic, recreational, and tourist values, but these are often poorly understood and difficult to observe or measure. The Q Method allows the systematic study of personal values and helps to reveal different social perspectives on a topic, such as the aesthetic value that people give to vineyard landscapes. Different stakeholders reveal their preferences and viewpoints by sorting around 40 statements, which are then statistically analyzed. The results can help to reveal unique features of the local landscapes to manage them in a way that creates support of the local community, as well as contributes to the touristic potential and the value of the product itself.

Work Packages 5 & 6: Resource Hub and Dissemination

- We are working to identify the appropriate stakeholder to nominate to the UserBoard, and to refine our stakeholder engagement strategy with Prospex.

References

- United Kingdom Vineyards' Association (UKVA). (2010). Policy Statement on Sustainability, Consultation draft for Sustainability Symposium 22nd Mar 2010 (pp. 6).http://www.ukva.org.uk/images/documents/symposium_2010/ukva_sustainability_strategy_statements_mar_2010.pdf
- United Kingdom Vineyards' Association (UKVA). (2012). UKVA Sustainability Project Final Report.http://www.ukva.org.uk/images/documents/ukva_sustainability_benchmarking_project_final_report.pdf

Dublin Urban Rural Fringe Exemplar

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Dream Abstract

Fingal in North County Dublin is an example of a peri-urban exemplar. The case study area is one of the four counties of Dublin and contains both strong rural and urban characteristics with a rich variety of ecosystems, including coast, upland, island, estuaries, rivers, and a variety of manmade landscapes: parkland, agricultural and open space as well as riparian and other green infrastructure. The ecosystem services these landscapes provide are valued by both the local and regional stakeholders, for multiple of reasons. The county has experienced significant (and ongoing) urban development pressures, particularly during Ireland's construction-led boom. Residents and communities have expressed resentment that Fingal has become "a dumping ground" for development for the wider city area (RPS (2013)) with a planning approvals granted, or being sought after, for large urban housing developments, strategic waste and energy infrastructure, airport, retail centers, and motorway infrastructure. An analysis of the landscape of socio-cultural values of ecosystem services (ES) may provide a means to inform better outcomes in decision making in this spatial planning context. The analysis will comprise a (i) **Literature review** on the concept of social and cultural values and their importance within decision making; (ii) **Consultation exercises** using qualitative and quantitative methods, including Focus Groups, stakeholder meetings and semi-structured interviews and a quantitative survey, to establish the range and ranking of socio-cultural values in the Exemplar; (iii) **Discourse analysis** of planning documents including submissions on planning applications and the County Development Plan (CDP) to extrapolate values and an analysis of the activities, documents and social media output of local NGOs; and (iv) **mapping of markers** (e.g., storyboards, walking trails, look out posts) for socio-cultural value across and within the landscape; and finally (v) **mapping of socio-ecological values of stakeholders using the TESSA indicators**. Key outputs of the research are the development of a set of social and cultural value **indicators** and the development of a **methodology** for the assessment of socio-cultural values at the forward plan or project level. The work will consider how the process of assessing the social and cultural value of ES can be used within planning consultation to inform decision makers of the *landscape of values* that may exist (or change over time) in a given location.

Study Rationale

Fingal is a dynamic site containing many of the issues and characteristics of interest to the OPERAs research group: urban-rural fringe, a rich and varied ecosystem service (ES) baseline (Table 9), development pressures, and potentially contested issues, such as the development of waste water infrastructure, and recent demographic changes including newly established communities moving into older, more culturally established communities. Fingal has a rich variety of ecosystem services throughout the county including *provisioning* services, such as agriculture, horticulture and fisheries; *regulating* services such as flood protection and water quality maintenance, and *cultural* services such as the recreation, aesthetics and cultural identity offered by the landscape of the county including upland, coastal, river, and parkland ecosystems, including 27 EU designated sites. However the county's ecosystem baseline is under constant pressure from development.

The literature on the cultural services (CS) aspect of ES suggest that one must also consider what people 'value' in terms of ES, and value most, when considering the importance of particular

services and any decisions affecting them. Chan refers to an interlinked “web of values” (Chan et al, 2011, p. 9) associated with ES, which are determined by many factors, including the location, use and interaction of individuals and communities with ES. This research is concerned with the examination of human values relating to *cultural* services within the Millennium Ecosystem Assessment ES typology. What is significant about *cultural* services is they cannot exist without the other services and they influence how ecosystems will be valued or perceived within a given location (MA, 2005 (a), p. 257). CS can therefore make important contributions to the total benefits accruing to people from many of the other services within the typology and they represent the soft values that people hold for the environment. The “intertwinement” (Daniel et al, 2012, p.2) of CS across and amongst the other services makes them important to assess as they represent many important human well-being benefits (Ibid, Chan et al, 2012(b), p. 745) and offer added value to the other services provided by ecosystems.

Ecosystem Services: Direct use values	Ecosystem Services: Indirect use
<ul style="list-style-type: none"> ▪ Provisioning services: <i>production outputs</i>: for example providing food, water, timber and fibre; ▪ Regulating services: such as the regulation of climate, floods, disease, wastes, water quality; ▪ Supporting services (systems maintenance): such as soil formation, photosynthesis, and nutrient cycling. 	<ul style="list-style-type: none"> ▪ Cultural services: a type of <i>added-value of ES</i> – the services are not directly provided by nature/ES but they exist and deliver benefits to society at individual and collective level: recreational, aesthetic, communal, spiritual, psychological, social cohesion, sense of place and other social and wellbeing benefits.

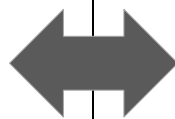


Table 8. Typology of Ecosystem Services.
Adapted from MA (2005b), p. vi

The literature on the scope, definition and contribution of cultural services to human well-being is emerging, with a recent review of the research pointing to the “eclectic” nature of cultural ecosystem services and the methodological approaches to analysing them (Milcu et al, 2013, p. 7). This review established a number of fundamentals about the characteristics of cultural ecosystem services that are agreed across all the recent literature: (i) intangibility, (ii) assessment of the benefit and value of CS is very subjective, and (iii) it is largely non-consumptive (p. 1). The MA defined *cultural services* as being “the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experience” (MA, 2005 (b)). They have also been characterized as providing *psychological*, alongside *biophysical or economic* benefits (Kumar and Kumar, 2008, p. 812). The literature also highlights other benefits such as contributing to shaping way of life, social cohesion and sense of place (Raymond et al., 2009, p. 1305). The concept of socio-cultural value (SCV) of ecosystem services (de Groot et al., 2002, p. 403) combines both the cultural and societal benefits of ES and also includes mental health, social, psychological, way of life, and identity values “that are a crucial source of non-material well-being and indispensable for a sustainable society” (Norton, 1997 in de Groot, 2002, p. 403). Shared values or “citizen values” such as those linked to ethics and “social rights or wrongs” linked with existence values or an appreciation of a seascape or particular natural

area, are also represented by cultural services (UK NEA, 2011, p. 1185). Health and wellbeing components are also deemed to include the contribution of ecosystem services to positive physical, social and mental state (Ibid, p. 32) and seasonal and spiritual rituals associated with ecosystems enhance social capital (WHO, 2005, MA, 2005(a)). Cultural ES therefore represent a myriad of benefits and values for people, beyond one single ecosystem function (see Table 8). In fact the values that are attached to cultural ES may be more deeply felt than those attached to other ES as they are “directly experienced and intuitively appreciated [and] often helping to raise public support for protecting ecosystems” (Daniel, 2012, p. 1).

These values are subjective and closely relate to community, place connection and place identity. In the land use planning arena, it is suggested therefore these values may provide important socio-ecological information on the context for plan and decision making. Cultural values represent many of the human well-being values but have been largely ignored in ES valuation because they are difficult to measure due to their intangibility (Chan et al, 2012(a); Milcu et al 2013). In an urban context, CS are said to have high social heterogeneity making their articulation more difficult (Gómez-Baggethun, D.N. Barton, (2012), p. 242). Sense of place values are those that may be deeply felt within communities as they arise from “emotional and affective bonds between people and ecological sites” (p. 240). Research on the benefit of different ES within a given setting has shown that cultural ES can score highest over the other ecosystem services, i.e., provisioning, regulating and supporting (Raymond et al, 2009, p. 1308), and changes in *cultural* services are said to matter more to people than the impact on production function of other ES, if change alters a way of life (Chan et al, 2012(b) p.745).

In Ecosystem Services Valuation (ESV) there is a priority to have public values for environmental services identified and put at the forefront of decisions, before they are made (Chan et al, 2012(b), 745; USEPA, 2009, 3; Sherrouse et al, 2011, 748). For example, the cultural (aesthetic service) value of an agricultural landscape to a rural community may be impacted upon by particular land use planning decisions, e.g., wind farms. The ‘value’ of this landscape to the affected community and relevant stakeholders (public and private) needs to be identified, mapped and assessed in order to understand the socio-ecological context of the decision.

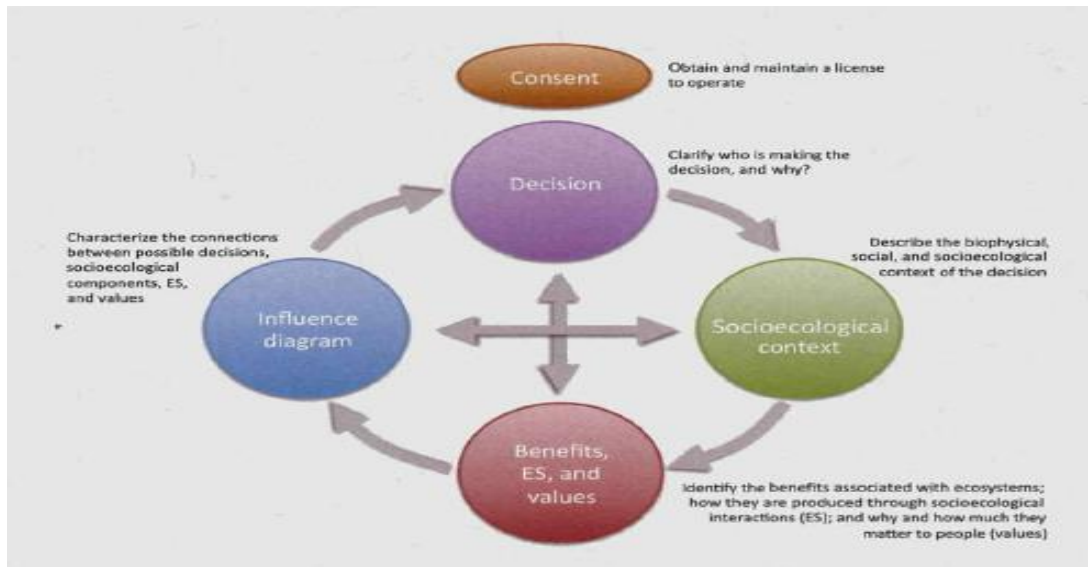


Figure 7. Proposed framework for characterizing ecosystem services (ES) that might be affected by management or planning¹.
Image from Chan et al. (2012).

This process may help to identify 'social value hotspots' (Sherrouse et al, 2011, 749) and the ranking of values for particular ES by different stakeholders and thereby provide a greater understanding of trade-offs within decision making or to help to highlight the values (and benefits) attached to particular ES by different decision makers. An ES approach within spatial planning might also suggest that people be consulted on what ES they value most (and why) before a decision is made or before strategic planning frameworks, such as County Development Plans, are formulated. It might also follow that an ES approach to spatial planning would involve consultation with the governance and public service stakeholders on the value of ES as a contribution to the delivery of their *own* service objectives (e.g., flood attenuation) so the ES *service contribution* values are identified as part of the process (e.g., for CDP development).

An analysis of the landscape of socio-cultural values of ES across different stakeholders (i.e., practitioner, NGO and public) may therefore provide a means to inform better outcomes in decision making within a spatial planning context. The focus of this research is to explore the non-monetary *social and cultural values* associated with ecosystem services within the context of spatial planning and to inform on the socio-cultural landscape in which decisions are made. Fingal County Council's Green Infrastructure (GI) Strategy (Fingal County Development Plan (2011-2017))

¹ Chan et al explains: "...Although the arrows depict the possible routes by which understanding of the system might be deepened, such understanding might be reached in many ways (e.g., understanding of benefits, ES, and values might call for a deeper characterization of the socioecological context, or it might call immediately for further elucidation of the benefits, ES, and values). Like Haines-Young and Potschin (2010), we distinguish among benefits, ES, and values: "Services are the production of benefits (which may take the form of activities), which are of value to people" (Chan et al. 2012(b), p. 9).

identifies the principle GI/ecosystem services within the county. This research will assess the socio-cultural values of the public, users, practitioners, NGO stakeholders and public representatives within the context of this strategy (see Table 10).

Exemplar Selection and Description

Fingal is located in the north of Dublin, Ireland, is the second largest of the four Dublin counties and is the most westerly point in Europe. The county has a population of approximately 270,000. During Ireland's economic boom in 2002-2006, the county experienced the fastest increase in population in Ireland and three times the national average. Fingal is still a relatively new local governance area, with Fingal County Council having been established in 1994. The county is part of the wider Greater Dublin Area (GDA) which is governed by the Dublin Regional Authority (DRA). The county has experienced significant development and land use change since its formation, particularly during the boom years. This has placed pressure on infrastructure services and on the receiving environment and ecosystem services. Fingal is sited along the coast which has a high landscape quality and is considered the most important recreational and biodiversity resource for the county. The county is host to EU 27 designated sites, including Natura 2000 designations, coastal, Ramsar, Natural Heritage Areas (Fingal County Council, 2011). Many of its coastal fishing and tourism villages have experienced development pressure and change in recent years. The upland and rural areas of Fingal are largely undeveloped and remain important for areas for agriculture and horticulture. The open countryside is also an important amenity for the growing population and is the setting for the many rural small towns and villages dotted across the county, with their distinctive heritage. The county also has many public historic houses and landscapes (known as demesnes), as well as parklands that are used for passive recreation by both the local and wider Dublin population. The county has very diverse economic and infrastructural characteristics including large retail centres in newly developed urban areas (Blanchardstown, Swords, Balbriggan), strategic infrastructure (airport, motorway), retail warehousing as well as a range of small rural and coastal villages supported by agriculture, horticulture and fishers. In addition Fingal's coast is a hub for tourism recreation and outdoor activity, particularly for the wider population of the GDA. A key challenge in the planning and development context is to manage growth, while taking account of the negative externalities that may be associated with development. For example population growth places different pressures on the quality of coastal ecosystem services, both in terms of on-site pressure for recreational use and urban waste water pollution of the marine ecosystem. The Council is currently working on compliance with the Water Framework Directive by supporting the large Greater Dublin Strategic Drainage project, including new marine outfall, drainage network and waste water treatment works for the GDA region as whole. This project has been subject to significant opposition from the receiving community. Management of development impacts may give rise to stakeholder conflicts that are associated with different values and priorities. The focus of this research is to explore the social and cultural values of ecosystem services within Fingal and to examine them in the context of peri-urban pressures.

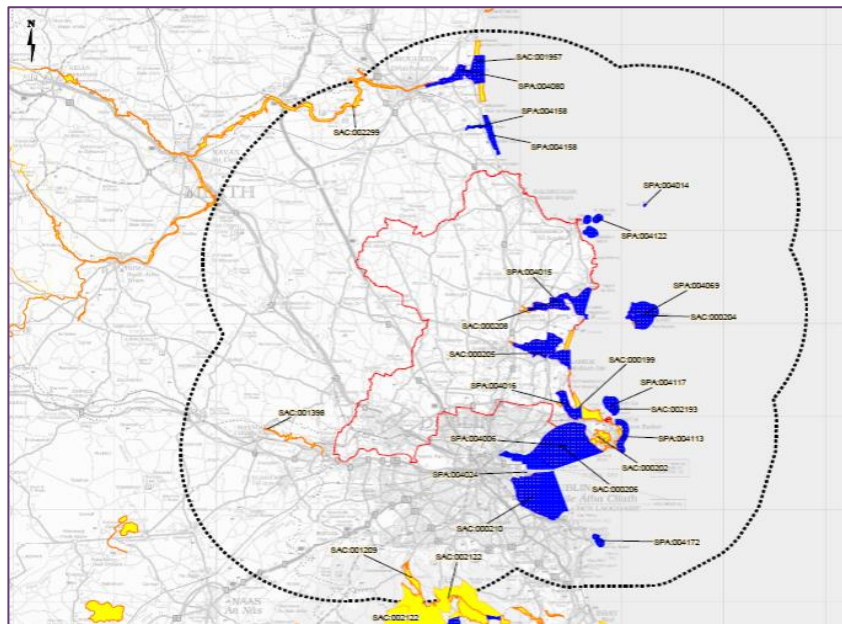


Figure 8. Fingal Special Protection Areas and Special Areas of Conservation (27 sites) © Fingal County Council

Figure 8 illustrates the breadth and quality of the ecosystem baseline of this Exemplar. The county's coastline provides the bulk of the social and cultural ES to the local population and those visiting from the wider Greater Dublin Area. The county also contains many parklands, open space and high amenity areas which are adjacent to a number of the urban centres of the county. The Exemplar is therefore a good demonstration of the dynamics of the interface between development pressures (and utilisation of ES resources) on the one hand, and the management and/or protection of the ES baseline on the other.

Green Infrastructure	Local description
Biodiversity sites	<ul style="list-style-type: none"> - Designated Shellfish Waters - Fingal Ecological Network including the following: Core Biodiversity Conservation Areas: Ramsar sites, Natura 2000 sites (SPAs and SPAs), National Heritage Areas (NHAs), Statutory Nature Reserves, Refuges for Fauna, Annex I habitats outside designated sites, habitats of protected or rare flora - Ecological Buffer Zones - Nature Development Areas - River Corridors along major Rivers. - Areas within 100m of erodible coastline
Parks, Open Space/ Recreation	<ul style="list-style-type: none"> - Lands zoned open space and/or in use as public open space
Water	<ul style="list-style-type: none"> - Watercourses including rivers and streams - Riverine Floodplains - Coastal areas liable to flooding - Groundwater Source Protection Areas
Landscape	<ul style="list-style-type: none"> - Special Amenity Areas on Howth Head and in the Liffey Valley - High Amenity Areas - Highly Sensitive Landscapes - Public Beaches

Table 9. Exemplar Landscape Features. Fingal County Development Plan 2011-2017.

Research Questions

- What are the differences between practitioner and publically held values for ecosystem services?
- How can indicators of different social and cultural values be identified within a given setting?
- Can the social and cultural values of stakeholders be expressed through public consultation in planning?
- Can social and cultural values influence decision outcomes in planning?

Goals

- To understand and develop indicators and typology of different stakeholder socio-cultural values.
- To understand people's knowledge of ecosystem services and how this impacts on values.
- To demonstrate and educate stakeholders of the SCV of ES.
- To understand if the ES concept and social and cultural valuation methodology can provide a new contribution to the consultation process and decision making for sustainable land use planning.

Linking Stakeholders, Instruments, and Ecosystem Services

Stakeholder description

UCD is delivering the project by means of consultation and engagement with a range of different stakeholders, rather than partnering with any specific stakeholders in the Exemplar. UCD has however developed a close relationship with the Fingal County Council and will be meeting with them and providing feedback to them throughout the project. In addition Fingal County Council's Heritage Officer will be available to participate in the Userboard Workshops as part of WP 5 of the project. The main focus of the research therefore is to assess social and cultural values of a different cross section of stakeholders and the public, the views of which are currently unknown. The key stakeholders to be consulted were identified as the stakeholders who were consulted or made submissions on large scale planning applications and those who made submission on the County Development Plan and Local Area Plans. These include statutory and non-statutory bodies, the general public, politicians, members of the local authority, NGOs, ENGOs, community organisations, representatives from business, food, agriculture, horticulture, fisheries, educational, health, community development, residents associations, tourism, recreational groups and users of ecosystem services right across Fingal. In addition further stakeholders were identified via snowball sampling and through the identification of the key ES governance agents within the Exemplar. This is an iterative process and new stakeholders will be identified and contacted throughout the research.

Identification of stakeholder needs

Fingal Local Authority has expressed an interest ES education tools and methods for communication/consultation on the topic. UCD will be identifying the needs attached to other stakeholder consultees as the research progresses. UCD will be developing indicator tools and public education tools in conjunction with the World Conservation Monitoring Centre (UNEP-WCMC). These tools will be used/tested in the field at stakeholder workshops.

Stakeholder Need	Instrument to address need	Ecosystem Service(s) Addressed*	Anticipated Outcome
Indicators of Social and Cultural values	TESSA (Lisa Ingwall-King, UNEP-WCMC)	All (social and cultural values relate to all not just one service)	Newly informed set of indicators will assist in decision making (Strategic Environmental Assessment, EIA, Appropriate Assessment, CDP development etc.)
Education on ES	To be developed/researched	All (social and cultural values relate to all not just one service)	New education tools will enable the mainstreaming of the ES concept
Public Consultation methods/communication methods	To be developed/researched	All (social and cultural values relate to all not just one service)	New public consultation tools will enhance and inform decisionmaking at the forward plan and project level
Methodologies/tools to assess social and cultural values	To be developed in conjunction with WP 3.2 (e.g., valuation methodologies; social media tools etc...)	All (social and cultural values relate to all not just one service)	Methodology or social media tools will become part of the practice of social and cultural valuation

Table 10. Plan to Address Stakeholder Needs and Improve Ecosystem Services through Instruments.

**Following the classification of Ecosystem Services from CICES v.4.3 (January 2013), contained in the "CICES" tab of the BluePrint Protocol.*

Collaborations within OPERAs

Work Package 3: Knowledge

The Dublin Exemplar is undertaking research to assess socio-cultural values (WP 3.2) as they apply to ecosystem services within a planning context. The Dublin Exemplar is also participating in WP 3.2 to examine socio-cultural valuation in other Exemplars including Scotland, the French Alps, and possibly also Montado and the Balearic Islands.

Work Package 4: Instruments

The Dublin Exemplar intends to evaluate the practical use of the following and then utilise in the field with the support of OPERAs partners:

Information Tools: TESSA: toolkit for rapid assessment of ecosystem services at sites.

Work Packages 5 & 6: Resource Hub and Dissemination

The Dublin Exemplar will endeavour to identify and confirm a relevant key stakeholder in advance of the next Userboard meeting in November 2014.

References

- Chan, K., Satterfield, T., Goldstein, J., (2011). Power Point Presentation. Rethinking ecosystem services to better address and navigate cultural values. *Ecological Economics* 74 (2012), pp. 8-18. cdn.f1000.com/posters/docs/17276108. **Valuations**
- Chan, K., Satterfield, T., Goldstein, J., (2012(a)). Rethinking ecosystem services to better address and navigate cultural values. *Ecological Economics* 74 (2012), pp. 8-18
- Chan, K. M.A, Guerry, A.D., Balvanera, P., Klain, S., Satterfield, T., Basurto, X., Bostrom, A., Chuenpagdee, R., Gould, R., Halpern, B.S., Hannahs, N., Levine. J., Norton, B., Ruckelshaus, M., Russell, R., Tam, J., Woodside, J. (2012(b)). Where are Cultural and Social in Ecosystem Services. A Framework for Constructive Engagement. *Bioscience* 62, pp. 744-756
- Daniel, T.C., Muhar, A., Arnberger, A., Aznar, O., Boyd, J. W., Chan, K., M.A., Costanza R., Elmqvist, T., Flinck, C.G., Gobster, P.H., Grêt-Regamey, A., Lavek, R., Muhar, S., Penker, M., Riben, R.G., Schauppenlehner, T., Sikoro, T., Soloviy, I., Spierenburg, M., Taczanowski, K., Tame, J., and von der Dunk, A. (2012). Contributions of Cultural Services to the Ecosystem Services Agenda. *PNAS*. Early Edition: 1-8
- Fingal County Council. Fingal County Development Plan 2011-2017: Appropriate Assessment
Fingal County Council. Fingal County Development Plan 2011-2017. Chapter 3: Green Infrastructure Strategy
- de Groot, R.S., Wilson, M.A., Boumans, R.M.J. (2002). A typology for the classification, description and valuation of ecosystem functions, goods and services. *Special Issue: The Dynamics and Value of Ecosystem Services: Integrating Economic and Ecological Perspectives* *Ecological Economics* 41 (2002). pp. 393–408
- Gómez-Baggethun, E., Barton, D.N. (2013). Classifying and valuing ecosystem services for urban planning. *Ecological Economics* 86 (2013) pp. 235–245
- Kumar, M. and Kumar, P. (2008). Valuation of the ecosystem services: A psycho-cultural perspective. *Ecological Economics* 64. pp. 808-819
- Millennium Ecosystem Assessment (2005(a)). *Ecosystems and Human Well-being: Current State and Trends*. De Groot, P.S., and Ramakrishna, P.S. Chapter 17: Cultural and Amenity Services. Island Press. Washington, D.C., USA.
- Millennium Ecosystem Assessment (2005(b)). *Ecosystems and Human Well-being: A Framework for Assessment*. Island Press. Washington, D.C., USA.
<http://www.unep.org/maweb/en/Reports.aspx#>
- Milcu, A.I., Hanspach, J., Abson, D., Fischer, J. (2013). Cultural Ecosystem Services: A Literature Review and Prospects for Future Research. *Ecology and Society* 18(3):44
- National Ecosystem Assessment UK (UK, NEA), 2011. Chapter 24. Shared Values .Technical Report. UNEP-WCMC. Cambridge
- Norton, B.G., 1987. *Why preserve natural variety?* Princeton University Press, Princeton, New Jersey.

Raymond, C.M., Bryan, B., A., MacDonald, D., H., Cast, A., Strathearn, S., Grandgirard, A, Kalivas, T (2009). Mapping community values for natural capital and ecosystem services. *Ecological Economics*. 68 (2009). pp. 1301-1315

RPS (2012). Public Consultation Report on 'Alternative Sites Assessment and Routes Selection (Phase Two): Emerging Preferred Sites and Routes.

Sherrouse, BC; Clement, J,M; Semmens, DJ (2011). A GIS application for assessing mapping and quantifying the social values of ecosystems. *Applied Geography* 31 (2011), 748-760

United States Environmental Protection Agency (US EPA). 2009. Valuing the Protection of Ecological Systems and Services. A Report of the EPA Science Advisory Board. Washington, DC. EPA-SAB-09-0-012. May 2009. www.epa.gov/sab.

WHO (2005). Corvalan, C., Hales, S., McMichael, A. Ecosystems and human Well-Being: Health synthesis: A report of the Millennium Ecosystem Assessment

AQUATIC EXEMPLAR CLUSTER

Barcelona Exemplar

Meriwether Wilson, The University of Edinburgh

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Anna Ferrés, SGM sl

Glòria Feliu, SGM sl

Dream Abstract

Can an ES/NC based management strategy be the way to boost the management and conservation of the Mediterranean urban dune ecosystems?

A great part of the sand beaches on the Mediterranean coast of Spain, France and parts of Italy endure the combined impacts of intensive recreational use, increasing erosion and flood risk, and mono-functional management practices. So, there is a need to go beyond the Integrated Coastal Zone Management (ICZM) concept and test new strategies based on the ES/NC vision, taking into account coastal morphodynamics, dune ecology, shore governance structure, the sustainable economic use of sand beaches and its recreational use by millions of citizens.

This exemplar will conduct a systematized analysis of the coastal defence and regeneration projects executed by the central administration on the shore of Catalonia during the last 20 years and will also test some real experiments focused on the reconstruction of dune morphology, control of invasive species, and reduction of impacting behaviours as trampling.

Through those analysis and experiments, it is expected to improve methodologies on control of invasive species, dune rejuvenation and use of social media strategies for trade-off management between the intense use of the beach and the conservation needs of the dune ecosystems.

So the basic aim of the project is to show that it is possible to get a healthy (but intensely managed) dune ecosystem on Mediterranean urban beaches with improved efficiency of the management structures and with new ways to share the cost and repayment of the coastal defence and dune regeneration works.

Study Rationale

The prevailing managing approaches have been traditionally monofunctional, aimed to control erosion processes, or to provide urban infrastructure to visitors (e.g., clean sand, showers, lifeguards). The ES approach will promote a multifunctional management plan which will include societal aspects (promoting respectful use of the beach and dune landscape) and promote a knowledge base to get more efficient methodologies on urban dune conservation and coastal defence; but also finding new ways to share both decision environment and economic burden on a more efficient governance structure.

The image of an urban beach with a healthy dune ecosystem will not only promote economic activity and biodiversity, but also improve the brand “Barcelona” as an environmentally friendly place.

Exemplar Selection and Description

Catalonia has more than 580km of coastline, 280 km of which are sand beaches (Figure 9). Approximately 2/3 of those sand beaches are urbanized to some extent. The length of beaches managed as urban (with systematic cleaning of sand by mechanic means) is probably bigger. Those beaches are visited by 12.4 million foreign tourists and by a similar quantity of national tourists coming from other parts of Spain and the interior lands of Catalonia. And to this approximated 25 million visitors can be added an undetermined quantity of visitors from local neighbourhoods, so going to possibly more than 30 million visitors each year. So the Catalan coast can be considered as a clear example of the intensive exploitation of the ecosystem services provided by urban Mediterranean dunes.

The beaches of the Metropolitan Area of Barcelona are visited mainly by local residents but also by a relevant portion of the tourists visiting Barcelona. So they are a clear example of intensively used and managed urban beaches. The beach of Calafell is an urban beach visited mainly by Spanish tourism. Another relevant aspect is the loss of seasonality, with increasing numbers of visitors visiting the beaches the whole year. The loss of seasonality is much more evident on the beaches of the metropolitan area of Barcelona.

Going southwards, the projected set of experimental works starts at the sand bar of the mouth of the Besòs river, where small trial of plantation of *Ammophila arenaria* and installation of barriers to prevent trampling and preserve the reproduction of Kentish plovers is planned. From there, 22km southwards, the most relevant works will be conducted at the beaches of the delta of Llobregat river, which historically held some of the best dune ridges of Catalonia until 25 years ago. On those beaches the experiments will be about dune rejuvenation, reconstruction of dune morphology, blowout creation, and understanding of the factors which trigger recent pine tree invasions (a recent process not verified before 1980, so it is not just an ecological succession process). Finally Calafell, placed 50 km south of Barcelona, will be the place where it is planned to excavate a brackish wetland and, by the use of the extracted sand volume, construct a new dune system.

The whole project will have a specific communication plan using “in situ” QR codes linked to different audio-visual content to explain the aims of the project and also to generate conversation with visitors and bi-directional information flows. On the Metropolitan Area of Barcelona a citizen science project (crowdsourcing) will be also conducted in order to find out measurable aspects of the dune process recovery. There will be also online surveys and analysis on Twitter (Storify) to get information about the response of public opinion and stakeholders.



Figure 9. Map of study area and location of Metropolitan Area of Barcelona.

Research Questions

- Which are the most efficient practices of dune management on urban beach environments?
- Which are the best ways to communicate with and involve people in the change of behaviour of beach use by local population and tourists?
- Which are the best ways to share the economic burden and management decisions on shore defence and dune management?

Exemplar Goals

By the implementation of the projected research and experiments, alongside with the communication Plan, the basic aim is to find out management methods to meet the challenges posed to maintaining such a dynamic ecosystem as dunes are on fixed places (keeping seafront promenades free of sand), with impaired aeolian sand transport system, with intense trampling impacts that flatten dune relief, and with unknown processes which conducts to plant cover of 100%, blowout disappearance and pine tree invasion. So the major goals of this exemplar are:

- Define and refine the concept of urban dunes on the grounds of ecosystem processes, and more specifically, identifying which dune ecosystem processes are impaired and to what extent.
- Find alternative ways to reduce afforestation and plant cover over blowouts. There is a research need to find out the causes of dune stabilization by increase of vegetation cover and afforestation. So there is a need of science to inform management and complementing the simpler method of periodic dune rejuvenation by pine extraction, blowout excavation and dune relief reconstruction. And, at least, there is the goal to define the extent and periodicity of such works.
- Provide an objective standardized method for assessing existing coastal defence and beach nourishment projects in order to identify optimizing strategies and so reduce ecological impacts and economic burden. From this criterion, produce a set of decision trees to select the best alternative on future projects.
- Design a communication plan in order to inform, change habits, and involve people in dune knowledge and conservation using social media platforms.
- Provide a first best practice manual (white paper) of Mediterranean urban beaches.

Linking Stakeholders, Instruments, and Ecosystem Services

Stakeholder description

There are two stakeholder groups:

1. Administrations and managers:

Central Government: Lola Ortiz, Subdirectora General Adjunta en la Subdirección General para la Protección de la Costa has accepted to be stakeholder of the project. The Metropolitan Administration of Barcelona is going to pay for the experimental works on dune management and will organize an international workshop on urban dune management. The city council of Calafell is already managing a project of dune construction on his beach.

2. NGOs and public opinion:

The interaction with NGOs is at a preliminary stage. First presentations to environmental NGOs have been already done. On a future stage, the use of QR codes on beaches with links to AV contents and different engagement and conversation strategies through social media platforms is planned. All interactions will be assessed with different instruments including those available at social media, as for example STORIFY (www.storify.com).

Identification of stakeholder needs

Decision makers, managers, and project designers need to take choices from well informed positions. OPERAs will facilitate a blueprint protocol to assess projects (with the help of partners from the Work Package Knowledge and the use of the mDSS instrument). With this strategy it is expected to get a "normalized" assessment scheme of all the projects previously done in Catalonia about beach nourishment and stabilization. This advice will be used on the proper design of coastal defence policies made by central government and local authorities.

The assessment of ecosystem services and the monitoring of the experimental projects of dune rejuvenation and construction of new dunes will be supported by WPs Knowledge, as noted above, and Instruments, specifically using mDSS, ES indicator, and TESSA (Table 11). All those support responding mainly to manager's needs (municipalities, metropolitan administration).

Visitors, tourists and neighbors need to be informed and engaged on dune knowledge and conservation projects. This is one of the core goals of this exemplar. Volante CANVAS will be the basic instrument on the communication plan of the project.

Stakeholder Need	Instrument to address need	Ecosystem Service(s) Addressed*	Anticipated Outcome
A well informed system to select the best strategy on beach defence projects.	mDSS	R9. Flood protection. R10. Storm protection	A normalized method (blueprint protocol) to identify best practices on beach defence and management.
The need of science informed best practice management strategies for urban dune conservation and management.	TESSA: toolkit for rapid assessment of ecosystem services at sites. Ecosystem services indicator development.	P13. Ground water for non-drinking purposes P20. Non metallic minerals. R6. Mass stabilization and control of erosion rates. R8. Hydrological cycle and water for maintenance. R9. Flood protection. R10. Storm protection.	A best practice (white paper) manual for urban dune management on an adaptive management environment.
Trade-off management between conflicting beach and dune uses (mainly by consumers).	Social media, static in situ information with QR codes, crowdsourcing projects to follow dune recolonization processes. Online surveys, Volante CANVAS tool.	P13, ground non-drinking water. P20 Mass stabilization and control of erosion rates. R9 Flood protection. R10 Storm protection. C2. Physical use of land-/seascapes in different	A system to inform visitors, involve part of them on crowdsourcing research projects, and a system to know the response of society to the modification of previous behaviours.

		environmental settings, C3. Scientific, C4. Educational, C6. Entertainment, C7. Aesthetic, C10. Existence, C11. Bequest	
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Table 11. Exemplar Plan to Address Stakeholder Needs and Improve ES Instruments

Collaborations within OPERAs

The following diagram (Figure 10) synthesizes the interactions within OPERAs.

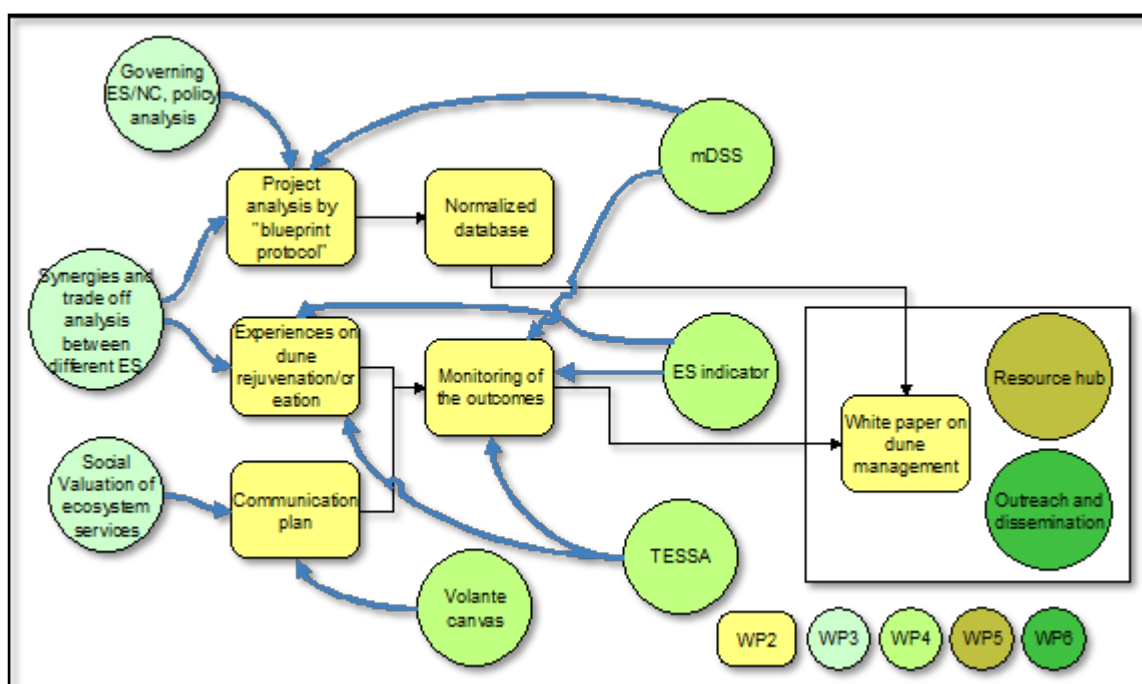


Figure 10. Interactions within OPERAs.

Work Package 2 – Practice

The collaboration with other exemplars is by now limited to explore the common aspects of for example coastal issues (Scotland, Balearic islands). There is also a chance to use the posidonia debris coming from posidonia meadows as a way to protect dunes against storms.

Work Package 3 – Knowledge

Blueprint protocol for project assessments.

Similarly to the tasks of creating a blueprint protocol for the reporting of the exemplars, and meta-analysis, the same staff will help to develop a blueprint protocol to assess engineering projects on beach defence and management, in order to create a new database useful not only to create an environment of adaptive management, and provide tools for selecting the best strategies for future projects.

Synergies and trade off analysis between different ecosystem services / natural capital; which ES/NC types are mutually exclusive or inclusive?

As the social and economic use of the beaches and its dunes are the location of strong trade-offs between some forms of exploitation of the ES of the dunes, IU-IVM will help on providing a robust and objective analysis framework.

Social Valuation of ecosystem services

UCD will provide complementary insights and will help to design survey strategies and response analysis to the online and on-site surveys.

Governing ES/NC, policy analysis

ULUND will provide the necessary conceptual framework to understand and assess the different governing and governance strategies involved on the decision making of shore policies.

Work Package 4 – Instruments

mDSS

TIAMASG will help to create a robust decision environment from the data extracted from the normalized analysis of beach nourishment projects add from the outcomes of the monitoring program of the dune rejuvenation works.

TESSA Toolkit for Ecosystem Services Site-based Assessment / Ecosystem services indicators tool

UNEP-WCMC will help on the identification of ES/NC, and will develop a tailored set of ES/NC indicators.

Volante CANVAS

UEDIN will help to inform the process of social participation on the project as a complementary mean to the social media campaign that will be conducted.

Work Packages 5 & 6 – Resource Hub and Dissemination

The Resource Hub has a central role on this exemplar, as it is most exclusively oriented to real world users and managers involved on sand beach management, tourism, and the sustainable recreational use of sand dunes.

So, the different administrations have decision makers, managers and technicians who know the project (and what is most, probably the Metropolitan Administration of Barcelona is willing to pay for a project of dune rejuvenation and dune creation), but they are not so involved on the general concepts of ES/NC and on the global OPERAs project.

There is a need also to make some progress with the economic stakeholders linked to tourism activity. The proposed international workshop on urban dune management proposed to be held on the Barcelona Metropolitan Administration's installations on 2014, can be an opportunity to engage this sector of stakeholders.

Parallel to the beginning of the physical works on dune rejuvenation/construction, there will be a campaign of information based on social media platforms.

Balearic Islands Exemplar

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Dream Abstract

Seagrass meadows are important carbon sinks that are declining globally. There is rising interest for seagrass conservation as a pathway to mitigate CO₂ emissions, leading to the development of Blue Carbon strategies. In this exemplar we aim to assess the co-beneficiary management of seagrass ecosystems for Blue Carbon in the Balearic Islands archipelago. We will do so by examining (1) the magnitude of seagrass carbon sinks in the Balearic Islands, the risk of carbon emissions from these sinks if disturbed, and their role for climate change mitigation and adaptation, (2) the socio-economic value of seagrasses of the Balearic Islands and (3) the economic cost of *Posidonia oceanica* protection vs. the value of carbon sink/emissions in seagrass meadows, including co-benefits of protection. The methodological approach will include the compilation of data sets of in situ measurements and available data in published papers and reports, as well as the implementation of socio-economic and mapping instruments. This exemplar will provide estimates of the magnitude of ecosystem services provided by seagrass meadows in the Balearic Islands, a socio-economic assessment of these ES in the region and an assessment of the tradeoffs between economic cost of *P. oceanica* protection vs. value of carbon sink/emissions in seagrass meadows, including co-benefits of protection. The results of this exemplar will contribute to develop Blue Carbon strategies for mitigation of CO₂ emissions through conservation of coastal marine ecosystems.

Study Rationale

Because seagrass meadows rank among (1) the biggest carbon sinks, due their capacity to sequester (Duarte et al 2005, Nelleman et al 2009) and store (Fourqurean et al 2012) high amounts of carbon over millennia (Nelleman et al 2009), and are (2) one of the most threatened ecosystems (Waycott et al 2009) in the biosphere, there is rising interest for seagrass conservation as a pathway to mitigate CO₂ emissions. Seagrass loss compromises the carbon sink function, not just by decreasing carbon sequestration but enhancing the risk of CO₂ emissions from stored carbon deposits. Currently, Blue Carbon strategies are being developed to mitigate climate change through seagrass conservation and restoration (e.g., UNEP, IPCC). Seagrass meadows, moreover, provide other ecosystem services, including nutrient retention and increased seawater quality (e.g., oxygenation, transparency) as well as a chemical refuge against ocean acidification and physical coastal protection, highly relevant for climate change adaptation (Duarte et al 2013). Thus, conservation of seagrass meadows through Blue Carbon strategies would provide additional benefits beyond climate change mitigation.

Seagrass (*Posidonia oceanica*) meadows are the dominant coastal marine ecosystem surrounding the Balearic Islands (Mediterranean, Spain), extending between 0.5 m to 40 m depth. Regional economies largely rely on the quality of coastal areas. Local threats by human populations to the Balearic seagrass meadows have been increasing due to the resident and tourist population growth over the last decades. Since the 1950s, the resident population in the Balearic Islands has doubled and the island now is among the top Mediterranean touristic destinations, receiving about

11 million tourists annually. Global warming is also emerging as a threat to seagrass meadows (Marbà and Duarte 2010, Jordà et al 2012). Because of the ecological importance of seagrasses and their vulnerability to the growing human population, conservation efforts are being implemented in the Balearic Islands, and since the 1990's, the amount of legislation aiming to reinforce seagrass conservation has been growing. The magnitude of ecosystem services provided by seagrass meadows in the Balearic Islands, however, remains unknown, preventing an assessment of the actual natural capital of the archipelago. Quantification of the natural capital of Balearic seagrass meadows would, in turn, help to reinforce the implemented conservation measures.

Exemplar Selection and Description

This exemplar quantifies the carbon sink capacity of the seagrass meadows and assesses the co-beneficiary management of seagrass ecosystem for Blue Carbon in the Balearic Islands (Spain). This exemplar is assessed at a regional (i.e., Balearic Islands, Spain) scale and covers a southern European geographic area. The ownership of the seagrass ecosystem is public, and the regional government is responsible for its management.

The extent of seagrass (*Posidonia oceanica*) habitat in the Balearic Islands is estimated as approx. 600 km², accounting for about half of the total extension of *P. oceanica* meadows along the Spanish coasts. *P. oceanica* is a Mediterranean endemic marine species that can form meadows several millennia old (Arnaud-Haond et al 2012). The highest seagrass soil carbon deposits have been reported in meadows of *P. oceanica*, and they can become 4-6 m thick after 4000 years (Mateo et al. 1997, Lo Iacono et al. 2008). Net loss rate of *P. oceanica* meadows in the Balearic Islands is 5 % yr⁻¹ (e.g. Marbà et al 2005), mostly attributed to coastal eutrophication (e.g. Calleja et al 2007), anchoring, dredging, coastal rigidification and Mediterranean warming (Marbà and Duarte 2010).

Since 1950, the population of residents in the Balearic Islands has doubled and the region has become one of the top Mediterranean tourist destinations. Residents and tourists are the users of the archipelago's coastal (including land and marine) zone. In 2009, the touristic sector accounted for 43.2 % of the GDP of the Balearic Islands.

P. oceanica habitats are regulated by EU directives (Habitat, WFD, Marine Strategy), national and regional legislation and international conventions (Barcelona Biodiversity Convention). Protected marine areas in the Balearic Island region include the Biosphere Reserve of the Island of Menorca, while the only seagrass meadow worldwide listed as a UNESCO heritage site is in the Balearic Islands, which also contains several marine Sites of Community Importance (SCI) and ZEPA (Figure 11) which enclose marine reserves, and one National Park.

Ecosystem services to be considered in this exemplar, following the CICES classification system, belong to the regulation and maintenance sections, and include the following specific examples of ecosystem services (listed by their CICES class):

- Carbon sequestration (burial rates and stocks, class “Global climate regulation by reduction of greenhouse gas concentrations”)
- Coastal protection (sediment accretion vs. sea level rise; dissipation of wave energy, class “Mass stabilisation and control of erosion rates”)
- Nutrient retention (classes “Filtration/accumulation” and “Chemical condition of salt waters”)
- Refuge from ocean acidification (class “Chemical condition of salt waters”)
- Beach sand production (class “Mass stabilisation and control of erosion rates”)
- Water quality (transparency, oxygenation, class “Chemical condition of salt waters”)

This exemplar study is conducted during the full period of the OPERAs project and is built on:

- Available cartography of seagrass meadow extent in the Balearic Islands (Figure 12) and estimated extent in unmapped areas
- Quantification of carbon stocks and burial rates in Balearic seagrass meadows
- Compilation of available data on seagrass ecosystem services other than carbon sequestration
- Socio-economic valuation of seagrass carbon sequestration, and other ecosystem services when possible
- Data on stability of seagrass meadows in the Balearic Islands for the last decades
- Cost estimates for seagrass ecosystem conservation

Depending on available data, the quantification of ES will be conducted from data collected in seagrass meadows along the Balearic Islands (single station points) or from global data sets. A small scientific expert workshop will be organised to address the role of seagrass meadows on coastal protection. The economic valuation of carbon sequestration will be conducted based on prices of CO₂ in societies with a carbon tax in place. The socio-economic value of other ES and the link of seagrass services to human well-being will be obtained from available sources as well as from workshops with stakeholders of target groups. Results will be up scaled to the regional level by using available maps of seagrass extent in the Balearic Islands.

The research team of this exemplar will be working in close collaboration with stakeholders and OPERAs partners from WP Instruments.

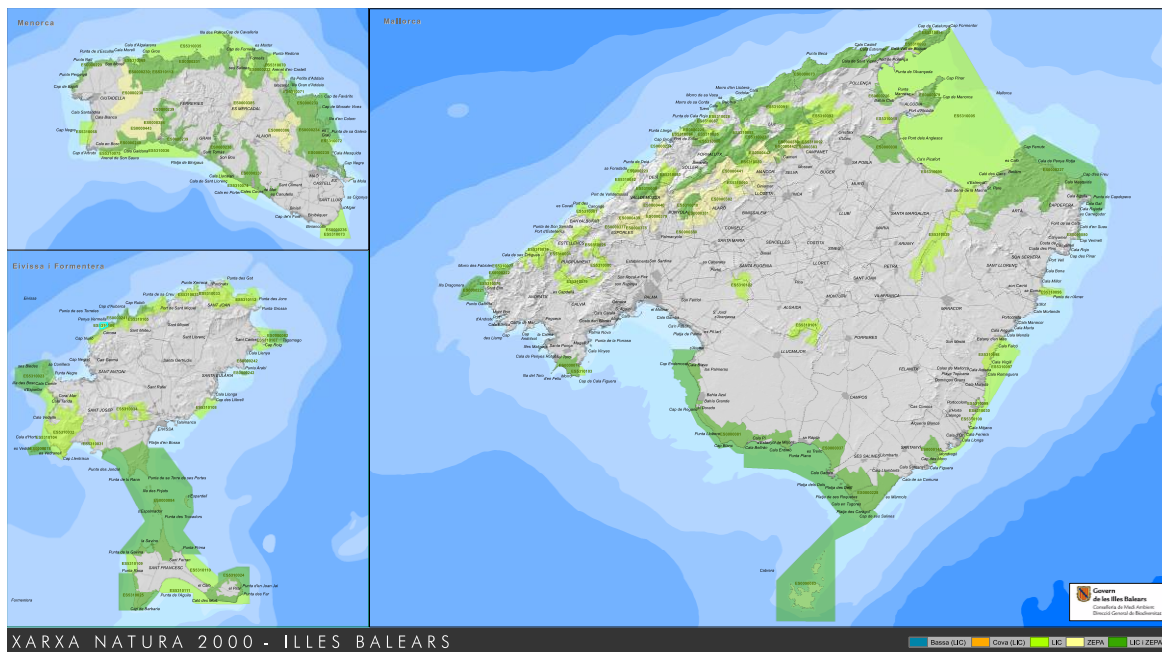


Figure 11. Distribution of SIC (in the map they are identified as LIC) and ZEPA sites in the Balearic Islands. Source: http://www.xarxanatura.es/pdfs/xn2000_illesbalears.pdf



Figure 12. Coastal areas of the Balearic Islands where the extent of *Posidonia oceanica* meadows have been mapped. Source: http://lifeposidonia.caib.es/user/index_cs.htm

Research Questions

- What is the magnitude of seagrass carbon sinks in the Balearic Islands, the risk of carbon emissions from these sinks if disturbed, and their role for climate change mitigation and adaptation?
- What is the socio-economic value of seagrasses of the Balearic Islands?
- What is the economic cost of *P. oceanica* protection vs. the value of carbon sink/emissions in seagrass meadows, including co-benefits of protection?
- What other ecosystem services are provided by the Balearic Islands and, in particular, what are the inter-linkages (e.g., functional and socio-economic) between these services and seagrass carbon sinks?

Exemplar Goals

- To assess the carbon sink capacity of seagrass meadows of the Balearic Islands, the security of these carbon sinks and their role in climate change mitigation.
- To assess ES other than carbon sequestration of seagrass meadows in the Balearic Islands.
- To evaluate the effect of seagrass management policy on carbon sink security and its co-benefits (i.e., conservation of other seagrass ES).
- To assess the trade-off of economic costs of *Posidonia oceanica* protection vs. value of carbon sink/emissions in seagrass meadows, including co-benefits of protection.
- To elaborate recommendations for an optimal management regime for the exemplar area, taking into consideration the possibilities for maximization of carbon sink capacity, maintenance and sustainable use of other ES, and biodiversity conservation objectives of seagrass meadows.

Linking Stakeholders, Instruments, and Ecosystem Services

Stakeholder description

The stakeholders so far engaged in this exemplar encompass administrations and a private company:

- Government of the Balearic Islands. The following persons have been identified:
 - A. M. Grau, Head of the Service of Nautral Resources (marine resources including management of marine reserves), Government Balearic Islands

- M. Sansó, Head of the Department of Environment (biodiversity), Government Balearic Islands
- M. Femenia, Head of the Service Climate Change, Government Balearic Islands
- Private company: Fundació Baleària. The company Baleària is the second largest Spanish ferry company. In September 2013, our institute (Imedea) and Balearia signed an agreement for collaboration on the role of seagrass ecosystem for mitigation of CO₂ emissions.

In addition, other stakeholders to be engaged in the exemplar by organizing a workshop:

1. Other administrations:

- Consells Insulars (i.e., government of each island)
- Town halls of Ibiza (Ibiza Island), San Francesc Xavier (Formentera Island)
- Other agencies: UNESCO World Heritage at Ibiza
- Ports Authority of the Balearic Islands
- Coasts Authority of the Balearic Islands, **belonging to the Spanish Ministry of Agriculture, Food and Environment**

2. Other stakeholders in the Private sector:

- Chamber of Commerce of Mallorca, Chamber of Commerce of Ibiza and Formentera, Chamber of Commerce of Menorca
- Association of tourism business of the Balearic Islands (including representatives of hotel, restaurant, boat charting companies, marina's owners, diving shops,... owners)
- Associations of recreational fishing

Identification of stakeholder needs

The list of stakeholders relevant for this exemplar encompasses stakeholder providers and users. Stakeholder providers are those involved in seagrass ecosystem management, and thus the Government of the Balearic Islands. Stakeholder users are all stakeholders listed above.

The specific needs and interests of stakeholders in relation to seagrass ES in the Balearic Islands will be identified by organizing a set of workshops and interviews with representatives of target groups. Stakeholders will be also asked to prioritize the seagrass ES and identify their threats. At the same time, stakeholders will provide inputs to assess the socio-economic value of the seagrass meadows of the Balearic Islands. Similarly, the stakeholder Government of the Balearic Islands will provide information to estimate the cost of seagrass conservation in the region.

The implementation of social and economic valuation, and related analyses, requires establishment and maintenance of good communication with targeted stakeholders. Specifically, the cost-benefit analysis (CBA) related to the shift from unsustainable to more ecosystem-friendly practices will be based on the following data: information about land and water users, economic costs and benefits, future plans and needs of these stakeholders (Table 12). Biodiversity will be a key point in this analysis, especially with regard to defining future development scenarios. Given the wide focus of the study, the CBA will follow a stakeholder analysis based on which specific activities and sectors will be taken into account for the further analysis.

Stakeholder need	Instruments to address need	ES addressed	Anticipated Outcome
Ecological and socio-economic value of seagrass meadows	CBA (WWF) – Analysis of changes and costs related to shifts to greener land-use practices for furthering public/private payment mechanisms for ES	<ul style="list-style-type: none"> • carbon sequestration • coastal protection • nutrient retention • refuge from ocean acidification • beach sand production • water quality 	<p>CBA related to the shift from unsustainable to more ecosystem-friendly practices</p> <p>Compilation of information about coastal (land and water) users, economic costs and benefits, future plans and needs of these stakeholders</p>
Socio-economic (scoping) assessment of seagrass meadows	PA socio-economic assessment / Step-wise and practice-oriented approach and guidance on how to identify, assess and communicate various ES and related benefits from PAs, with a specific focus on their socio-economic	<ul style="list-style-type: none"> • carbon sequestration • coastal protection • nutrient retention • refuge from ocean acidification • beach sand production • water quality 	<p>Scoping assessment to systematically identify (mainly in qualitative and quantitative manner) the range of ecosystem services and related benefits provided by seagrass meadows. The purpose of this assessment is to establish an overall picture of the socio-</p>

	valuation		economic role of seagrass meadows, providing a useful context for the detailed work on carbon sinks and basis for concrete management recommendations.
Capturing the value of seagrass meadows	PES – Payment for Ecosystem Services (PES) is a type of market-based instrument that is increasingly used to finance nature conservation	<ul style="list-style-type: none"> • carbon sequestration • with possible links to coastal protection, nutrient retention, refuge from ocean acidification, beach sand production and water quality 	A feasibility assessment of the development and implementation of PES scheme to capture the value of seagrass meadows as carbon sink, with possible links to other relevant ES, and provide a tool for sustainable management of marine resources.
Geographical distribution of seagrass ecosystem services	OE –web-based land use and ecosystem mapping platform	<ul style="list-style-type: none"> • carbon sequestration • coastal protection • nutrient retention • refuge from ocean acidification • beach sand production • water quality 	Maps of ES associated to seagrass meadows in the Balearic Islands

Table 12. Plan to address stakeholder needs and improve Ecosystem services through instruments.

Collaborations within OPERAs

Work Package 3: Knowledge

The exemplar team is also participating in WP 3, namely in Task 3.3.1. (Provide operational means to link ecosystem function, biodiversity and ES provision) Task 3.1.2 (Embed ecosystem processes into to the operational ES/NC domain). Findings from WP 3 will be applied in the exemplar.

Work Package 4: Instruments

The following instruments will be used in the exemplar:

- CBA (WWF) – Analysis of changes and costs related to shifts to greener land-use practices for furthering public/private payment mechanisms for ES. Person involved: Maya Bankova-Todorova (WWF-Bulgaria)
- PES – Payment for Ecosystem Services (PES) is a type of market-based instrument that is increasingly used to finance nature conservation; persons involved: Daniela Russi and Patrick ten Brink (IEEP)
- Systematic framework for PA socio-economic assessment / Regulations - Step-wise and practice-oriented approach and guidance on how to identify, assess and communicate various ES and related benefits from PAs, with a specific focus on their socio-economic valuation. Person involved: Marianne Kettunen (IEEP)
- Our Ecosystems platform –web-based land use and ecosystem mapping platform. Person involved: Karin Viergever (Ecometrica)

Work Packages 5 & 6: Resource Hub and Dissemination

The research team will be in close contact with the stakeholder Government of the Balearic Islands who will provide information to estimate the cost of seagrass conservation in the region.

In addition, workshops will be organised with the stakeholders listed above (section 6) in order to:

- Identify the specific needs and interests of stakeholders in relation to seagrass ES in the Balearic Islands, and
- Obtain inputs from stakeholders to assess the socio-economic value of the seagrass meadows of the Balearic Islands.

The stakeholder identified to represent the exemplar in the OPERA Userboard is Mr. A. M. Grau, Head of the Service of Natural Resources, from the Government Balearic Islands

The results of the Exemplar will be disseminated through:

- OPERAs website and the other tools designed in the project

- Regional and national media through publication of press releases
- Facilities available in the Balearia Ferry Company (e.g., magazine Balearia, monthly distributed in all ships of their fleet; panels and screens in the vessel Posidonia transporting about 100 000 passengers between Ibiza and Formentera Islands annually)
- Scientific publications and international conferences
- Participation in international working groups on Blue Carbon

References

Arnaud-Haond, S., Carlos M. Duarte, Elena Diaz-Almela, Núria Marbà, Tomas Sintes, Ester A. Serrão. Implication of extreme life span in clonal organisms: millenary clones in meadows of the threatened seagrass *Posidonia oceanica*. *PlosONE*, 7 (2) e30454. doi:10.1371/journal.pone.0030454. (2012)

Calleja M, Marbà N. and Duarte C. M. The relationship between seagrass (*Posidonia oceanica*) decline and porewater sulfide pools in carbonate sediments. *Estuarine, Coastal and Shelf Science* 73:583-588. (2007).

Duarte, C. M., Middelburg, J. J. & Caraco, N. Major role of marine vegetation on the oceanic carbon cycle. *Biogeosciences* 2, 1-8 (2005).

Duarte, CM, Losada, I. J., Hendriks, I E., Mazarrasa I. & Marbà, N. The Role of Coastal Plant Communities for Climate Change Mitigation and Adaptation. *Nature Climate Change* DOI: 10.1038/NCLIMATE197 (2013)

Fourqurean, JW. et al. Seagrass ecosystems as a globally significant carbon stock. *Nature Geoscience* DOI: 10.1038/NGEO1477 (2012)

Jordà, G., Marbà, N. & Duarte, C. M. Mediterranean seagrass vulnerable to regional climate warming. *Nature Clim. Change* 2, 821–824 (2012).

Lo Iacono C, et al. Very high-resolution seismo-acoustic imaging of seagrass Meadows (Mediterranean Sea): Implications for carbon sink estimates *GEOPHYSICAL RESEARCH LETTERS*, VOL. 35, L18601, doi:10.1029/2008GL034773, (2008)

Marbà N., C. M. Duarte, E. Díaz-Almela, J. Terrados, E. Álvarez, R. Martínez, R. Santiago, E. Gacia , A. M. Grau. Direct evidence of imbalanced seagrass (*Posidonia oceanica*) shoot population dynamics along the Spanish Mediterranean. *Estuaries* 28: 51-60. (2005).

Marbà, N. & Duarte, C. M. Mediterranean warming triggers seagrass (*Posidonia oceanica*) shoot mortality. *Glob. Change Biol.* 16, 2366–2375 (2010).

Mateo MA, Romero J, Perez MM, Littler DS (1997) Dynamics of millenary organic deposits resulting from the growth of the Mediterranean seagrass *Posidonia oceanica*. *Estuarine and Coastal Shelf Science* 44: 103–110.

Nellemann, C., Corcoran, E., Duarte, C. M., Valdes, L., DeYoung, C., Fonseca, L., Grimsditch, G. (Eds). 2009. *Blue Carbon. A Rapid Response Assessment*. United Nations Environment Programme, GRID-Arendal, www.grida.no

Waycott, M. et al. Accelerating loss of seagrasses across the globe threatens coastal ecosystems. *Proc. Nat. Acad. Sci. USA* 106, 12377_12381 (2009)

Lower Danube Exemplar

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Irene Lucius, WWF DCPO

Dream Abstract

The Lower Danube is one of the last free-flowing stretches of the river in Europe. Its ecosystems provide multiple benefits. The range of all these benefits is not yet fully evaluated and recognized, giving precedence to economic factors in decision-making at the expense of ecosystem and social ones.

The goal of the Lower Danube exemplar is to research and demonstrate the link between Danube ecosystems and a range of environmental benefits for communities in the area as well as in the Danube river basin, given the application of appropriate set of instruments to safeguard or improve them.

The exemplar will begin with socio-cultural and economic valuation of ecosystem services, which will be built upon targeted surveys and collection of social, economic and environmental data. The results of these will serve as a starting point for the development of a set of instruments enhancing the values of ecosystem services. The exemplar, therefore, unfolds on several levels: local - to assess the value of wetlands for local communities and economies; regional-national - to test a decision-making support tool for the protection and management of Lower Danube ecosystems; river basin (international) - to test the applicability of the no net loss concept for finding and incorporating the real cost (loss) of nature in the cost and benefit analysis of river infrastructural projects on the Lower Danube.

Some of the main issues during the implementation might be the low level of awareness and understanding of ecosystem services by different stakeholders and at different levels, as well as data availability.

This Exemplar has relevance for the whole Danube river basin as it seeks to develop a set of tools for sustainable freshwater ecosystems management. By the end of this project, the Lower Danube exemplar is envisaged to provide models for sustainable management and use of ecosystems and their services for the whole Danube and other river basins in Europe.

Study Rationale

The Lower Danube exemplar is the only exemplar to specifically focus on freshwater ecosystems under the OPERAs project. According to the ICPDR, some 80% of the historical floodplains in the Danube basin have been lost over the last 150 years. Among the remaining 20%, the sections of the Lower Danube between Bulgaria and Romania and in the Danube Delta are among the largest and ecologically most valuable. They play an important role in hydrological processes, in particular in flood protection and groundwater recharge, as well as for habitat and species diversity. However, these benefits are not assessed, which is diminishing their socio-economic role. Many of these wetlands are under pressure from navigation, infrastructure development and agriculture. This, in return, reflects on decision-making, dominated by economic concerns without integrating environmental ones.

The OPERAs project provides the opportunity to find the socio-economic value of freshwater ecosystems of the Lower Danube. It will allow for integrating these values into decision-making by developing and testing a decision-making support tool and the no net loss (NNL) concept on the ground. All this will be tested using real-life data and development scenarios relevant for different stakeholders at local, national and regional levels, including users and providers of ecosystem services, local institutions (environmental and governmental), river basin managers, decision makers at national level and capital providers. The Lower Danube team, in collaboration with relevant project partners, will work closely with all these identified groups of stakeholders to ensure the operationalization of the natural capital concept

Exemplar Selection and Description

The Lower Danube, stretching from the Iron Gates between Romania and Serbia & Montenegro down to the Danube Delta and the Black Sea, and flowing for the most part along the Romanian and Bulgarian border, is one of the world's most outstanding freshwater eco-regions. The Danube floodplain between the river bank and the flood protection dike has relics of oxbow lakes as well as flood channels (in parts temporarily dry) and depressions, islets (particularly the smaller islets with no human intervention), relics of wetlands and floodplain lakes in the disconnected floodplains, small water courses (particularly at the base of the terrace fed by groundwater) – all typical habitats for the Lower Danube and of particular importance from the ecological point of view, a number of them protected under the Ramsar Convention as well as the Annexes of the EU Habitats Directive.

The Lower Danube exemplar, as it can be seen below, has a wide policy context. It has a relevance to the Water Framework Directive, Flood Directive, Habitats and Bird Directives, Green Infrastructure, Climate Change Adaptation.

The intervention area in the Lower Danube under the OPERAs project focuses on a representative case study area - Persina Nature Park.

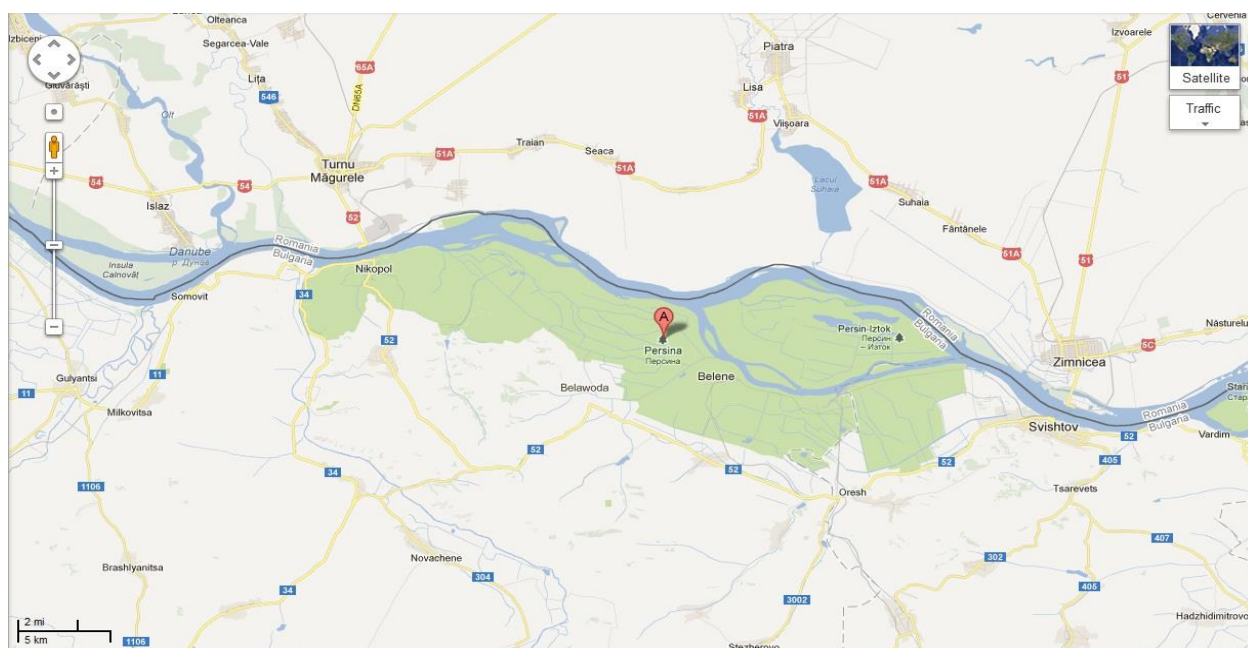


Figure 13. Map of Persina Nature Park

Persina Nature Park is located in North Bulgaria, along the river valley of Danube, with a total area of 21,762.20 ha (Figure 13). The main purpose of designating Persina as a nature park has been to conserve and restore the wetlands near the Danube River. Special attention is paid to the numerous islands (the biggest Bulgarian and the fourth biggest in Europe Danube island), inland marshes and flooded forests. Besides a nature park, Persina is the biggest Ramsar site in Bulgaria (6898 ha) and lies within four “Natura 2000” sites. The conservation value of Persina

Nature Park is formed by over 743 higher plants species, most of which are connected with the availability of water, and 1,100 animal species, including 250 zoo-plankton and 99 zoo-benthos species, over 770 kinds of invertebrates with 35 snails species and 16 kinds of mussels, over 200 bird species and almost all of them of conservation statute.

Some of the main ecosystems within the Nature Park are the Danube River and the wetlands connected to it, including: marshes on the Belene Island, the remnants of the former Belene and Svishtov marshes, the Osam River and the flooded areas around it, the drainage canals in the lowlands, the flooded forests (the flora of which is not rich but quite specific), and the mesophyllic high grass meadows.

Farmlands in Persina Nature Park comprise 75% of land use, while marshes and wetlands comprise 15% and 10%, respectively.

Over 60% of the land is public, owned by the state and the municipalities. State property is mainly on agricultural lands (40%) and on almost all forests (90%). Municipal ownership is mainly of pastures (75%), unpaved roads (50%) and arable lands (4%). Privately owned lands are highly fragmented: the average size of lots is 1.7 ha, ranging from 0.7 ha to 2,500 ha, and more than 70% of landowners have less than 1 ha. Over half of agricultural arable lands, two-thirds of orchards and gardens, and one-third of the natural meadows are under private ownership.

The lands of highest conservation value are located on the islands and forests in the 200 m strip along the Danube bank. The main conservation challenges include changes in water regime after building coastal dikes leading to a disconnection of the marshes, wetland deterioration, loss of carbon sinks, and loss of spawning grounds.

Persina Nature Park is also representative for the Lower Danube in terms of socio-economic features. It is a typical rural area, comprised of three municipalities with a total population of nearly 19,637 inhabitants (2011 Census, National Statistics Institute). Agriculture and fisheries are the main economic activities in the rural area. The area provides limited employment opportunities at the moment and faces the challenges of migration and ageing of population. Because of this and the unexplored potential of wetlands and their ecosystem services, freshwater ecosystems have very low recognition, if not a bad reputation among locals. This is a challenge that this exemplar will work on, based also on previous work of WWF in the area.

The relevance of the Persina Nature Park case study area extends beyond the local level - currently the remaining natural features of the river are under threat of being lost because of infrastructural development supporting energy and transport sectors. This is a potential threat not only to biodiversity but also to the society because of the loss of ecosystem services.

Research Questions

1. What are the socio-cultural and economic values of wetlands?
2. What, if any, is the link between restored and sustainably managed wetlands and socio-economic welfare?
3. Optional: What are the ecosystem impacts and benefits of improving navigation conditions through grey infrastructure measures, compared with dredging?

Exemplar Goals

The goal of the Lower Danube exemplar is to research and demonstrate the link between Danube ecosystems and a range of environmental benefits for communities in the area, as well as in the Danube river basin, given the application of an appropriate set of instruments to safeguard or improve them. The following objectives are set to reach the goal:

- Successful demonstration of the socio-economic values of Danube wetlands, besides environmental, providing rationale to decision-makers in the Danube river basin (and local stakeholders) for prioritizing and allocating financial and technical capacity for their restoration, sustainable management and maintenance, as well as for incorporating the losses of values in the assessment of infrastructural projects.
- Raise awareness among local governmental and non-governmental stakeholders of the socio-economic opportunities of restored and sustainably managed wetlands.

Linking Stakeholders, Instruments, and Ecosystem Services

Stakeholder description

The following stakeholders have been identified as relevant for this Exemplar:

- Local level - direct users and providers of ecosystem services as well as managers of the natural capital: fishermen, farmers, biomass processors of reed and agri-residuals for the production of briquettes and pellets; the Directorate of Persina Nature Park, local authorities (municipality), river basin authority (based in Pleven), citizens of the Pleven (biggest city in the exemplar location), and local media.
- National level: important stakeholders include ministries of Environment and Water, Agriculture and Foods, Economics, Finance, Bulgarian Academy of Science, national media, coalition of NGOs in Bulgaria, and the National Statistics Institute. These players are all linked through the natural capital work (ongoing process of Mapping and Assessment of Ecosystem Services at the EU level). However, some of them are actively involved, such as the Ministry of Environment and National Statistics Institute, while others are not yet a part of this process but important for the delivery of the approach on the ground, for example the Ministry of Finance.
- Regional (basin level)/ international level: this group includes users of ecosystem services, such as fishermen and farmers downstream in Romania, Bulgaria and Ukraine; users such as

river transport, energy companies, and tourism businesses; and association and organisations, such as Danube strategy countries, ICPDR, UN, and RAMSAR.

- How were they identified?
- Local level: direct contact / interviews, pilot activities, during trainings
- National and regional: participation in working groups at ministerial / regional level, questionnaires, direct contacts
- Media: direct contact and feedback from media representatives, trainings for media
- How have they been engaged so far?
- In other projects of the WWF through capacity building events, pilot activities, demonstration of the involvement with local stakeholders at national / international specialised events (e.g., local food fests, campaigns, etc.), media trips to the pilot site(s).

Identification of stakeholder needs

As described previously, this Exemplar will work on several levels to address the diversity of needs of:

- improving the awareness of local communities of the value of Lower Danube ecosystem services (Table 13)
- improve decision-making by developing baseline information with economic values of ecosystem services, and developing and providing a tool for the decision-making process incorporating these values showing their variability upon different development scenarios
- At the regional level, the exemplar will answer the needs of the conservation communities, public capital providers, and European decision-makers to assess how much natural capital is lost when pursuing a given infrastructural solution, showing the way to potential mitigation strategies.

Linking Stakeholders, Instruments, and Ecosystem Services

Stakeholder Need	Instrument to address need	Ecosystem Service(s) Addressed*	Anticipated Outcome
Socio-cultural values of Lower Danube ecosystem and their services	Socio-cultural valuation/ IVM TESSA	Regulating, Provisioning and Cultural Services	Awareness raised of the role and importance of Lower Danube Ecosystems for local communities
Economic values of Lower Danube ecosystem and their services	Economic valuation/ together with the IEEP TESSA	Regulating, Provisioning and Cultural Services	Find the economic value of ecosystem services - important for decision-makers and the process
Prioritization of funding and improving the sustainability of infrastructural projects (incl. project appraisal)	No Net Loss/ Biotope Decision Support System (mDSS) / TIAMASG	Regulating, Provisioning and Cultural Services	Provide a framework and a tool for enabling decision-making

Table 13. Plan to Address Stakeholder Needs and Improve Ecosystem Services through Instruments.

**Following the classification of Ecosystem Services from CICES v.4.3 (January 2013), contained in the "CICES" tab of the BluePrint Protocol.*

Collaborations within OPERAs

Work Package 3: Knowledge

Socio-cultural valuation, VU- IVM, the Netherlands:

Sociocultural values of ecosystem services in the exemplar are evaluated from the perspective of existing and potential future users - 100 interviews are planned to be carried out in the local area. IVM will design the questionnaire, which will be conducted by WWF in the case study area.

Work Package 4: Instruments

Protected area benefits assessment, IEEP

- Social and Economic Benefits of Protected Areas - An Assessment Guide

- The assessment guide will be used to perform the economic valuation of Persina Nature Park.

Environmental CBA, WWF DCP

Decision Support System (mDSS), TIAMASG

- Develop a decision-making support tool to enable managers of the exemplar to manage and prioritize ES. There will be indicators and scenario development, carried out by WWF in active dialogue and coordination with relevant stakeholders at local, regional and national level.

TESSA, UNEP-WCMC

- TESSA will be used to assess a number of ecosystem services (water quality and quantity, carbon regulation, wild harvested goods and potentially the new cultural ecosystem service module) to trial its use in a new context and to compare result with other decision-making tools, and potentially to develop appropriate ecosystem services indicators.

Work Packages 5 & 6: Resource Hub and Dissemination

Feed in information to the Resource Hub, TIAMASG

The team will also work with Prospex to ensure a representation in the Useboard.

Communication activities planned under the project to be carried out by the WWF include:

- Annual newsletters to WWF network and the environmental NGOs
- Internet site of WWF DCPO, www.panda.org/dcpo
- Communication materials explaining the instruments, and infographics
- Local and cross-border (Bulgaria-Romania) workshops
- Field trip for media representatives to Persina
- Active participation at national, Danube basin and EU level in expert working groups on ecosystem services, their assessment and mapping, and financial instruments design and application for their protection. These includes but does not limit to: Economic expert group, under the Danube River Basin Management working group of the ICPDR, Working groups at national level under the Ministries of Agriculture, of Environment and Economics, EC MAES working group

Scottish Multi-Scalar Exemplar

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Dream Abstract

The Scottish Government shows international leadership in its ambitious environmental policy, and has placed the ecosystem approach and ecosystem services central to its land use and biodiversity policies. In many ways these policies are ahead of science and the required information and assessment methods to support the policies are not available. It is therefore a challenge to provide useful policy support, despite significant research funding. Here we describe how OPERAs collaborates with other research initiatives in Scotland to establish an Ecosystem Services Community (ESCom), which will help align research and build an operational and engaged science–policy–practice interface. ESCom will help identify user needs, and increase the relevance and impact ecosystem science for policy and practice. Within this context, we will implement a multi-scalar exemplar, supporting reporting and assessment for the national context, strategic planning regionally, and sustainable management at local scales. Much of the OPERAs research will be carried out in collaboration with other research initiatives to ensure added value, whilst we will also carry out a limited set of focused studies, e.g. on sociocultural valuation and coastal realignment. The Scottish exemplar will provide internationally relevant lessons on establishing ecosystem sciences communities, benefits of common frameworks, specific insight for coastal realignment and social cultural valuation of ecosystem services.

Study Rationale

Scotland has a devolved government from the UK, with its own environmental policy platform. There is strong willingness from Scottish government to show leadership in environmental policy. Its Land Use Strategy and Biodiversity Strategy use an ecosystem approach, but the required ecosystem services and natural capital information and assessment methods to support the policies are often not available. Although there are many (research) initiatives to operationalize ecosystem services and natural capital concepts, these are currently not aligned.

Within OPERAs we will contribute to the operationalization of the ecosystem services concepts in three ways (summarized in Figure 14). Firstly, OPERAs will support the establishment of a Scottish Ecosystem Service Community (ESCom), a community of practice for ecosystem services research, decision-making and natural resource management in Scotland. Secondly, we will collaborate with other research initiatives and policy and NGO stakeholders to improve national ecosystem service assessment and support decision-making. Finally, we will carry out a number of regional studies to better understand how national objectives can be implemented, regional user-needs and co-develop knowledge and ecosystem service instrument with relevant stakeholder groups.

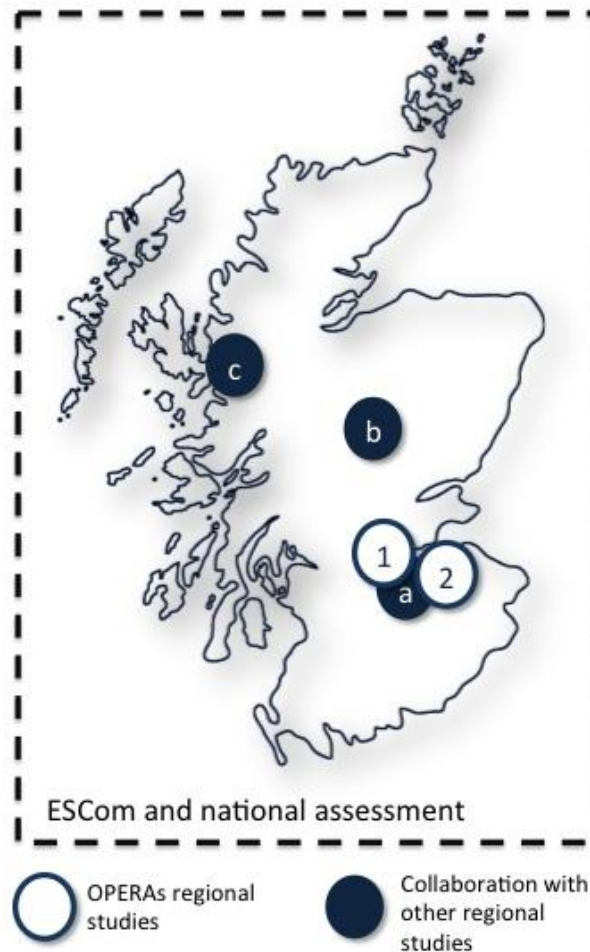


Figure 14. OPERAs will contribute to ESCom, national assessments, and two regional studies

1. The Inner Forth Futurescape; **2.** The Edinburgh peri-urban region). OPERAs will also collaborate with a number of other regional studies. (**a** Edinburgh City (in collaboration with the FP7 project Green Surge; **b** Caringorms National Park (in collaboration with the FP7 project OpenNESS); **c** Lochaber Forest District (in collaboration with the FP7 project Simwood).

Exemplar Selection and Description

Scotland is an environmentally diverse country, facing many of the challenges encountered across Europe within one relatively small country. There is considerable political will to improve management of Scotland's environment, and ecosystem and natural capital concepts are central to the ecosystem approach that underpins its national Land Use Strategy, Biodiversity Strategy, and Marine Plan and associated regional and sectorial plans. These policies have ambitious objectives, which require appropriate national ecosystem services assessments, but also place considerable challenges on regional strategic planning and local management. Scotland is therefore an appropriate exemplar for operationalizing the ecosystem service concept within the multi-scale implementation of environmental policy.

Scotland covers 78,772 km² with over 7k miles of coastline. The population of about 5 million is mostly concentrated in the central belt between Edinburgh and Glasgow. The nation has some interesting characteristics for OPERAs including diverse landscapes and gradients in climate and land use intensity, listed in Box 1.

Box 1. Environmental diversity in Scotland

- the densely populated lowland urban central belt
- the remote and sparsely populated Highlands and Islands
- intensive arable agriculture in East Lothian and Perthshire (highest potato yields in Europe!)
- intensive livestock farming in the lowlands, but extensive grazing in the uplands
- vast commercial forest plantations in the Highlands
- 7500km of coastline, parts of which are susceptible to sea level rise
- 31460 fresh water lochs, and numerous salt water lochs supporting aquaculture and fisheries
- large and expanding hydro energy-electric power sector (1.33 GW, 10% national consumption)
- great interest in renewable energy, including wind and bioenergy crops
- vast soil carbon stocks in peat soils
- valuable biodiversity, including Alpine vegetation and migrant Arctic bird species, which are sensitive to climate change
- great reliance on landscape services for tourism and cultural identity

Regional studies within Scotland will focus on particular ecosystem management challenges. These studies have been selected to complement other regional studies in Scotland, and test OPERAs instruments based on identified user needs. Currently two regions have been identified, but further studies are being discussed.

Firth of Forth Estuary – Inner Forth Futurescapes - The Firth of Forth is representative of many post-industrial seascapes, where coastal marshes and seabed habitats, have been filled, dredged, dyked and overfished to support centuries urban growth in Edinburgh and beyond. Pressures to restore coastal habitats for coastal biodiversity, sea level rise management, and fisheries is high. Ecosystem services tools will greatly enhance emerging guidance on how to integrate coastal ecology and restoration as part of adaptation strategies needed for old and new built environments in the foreshore. Additionally, both short and long-term trade off analysis will be conducted in balancing socio-economic needs, policy influences (e.g. EU Water Framework Directive) and biophysical measures and trajectories to restore, recreate and, or protect critical networks of coastal marine environments.

Edinburgh and its peri-urban region – There is a strong urban-rural gradient from Edinburgh to the surrounding countryside. There is great interest from Edinburgh City Council, the Pentlands Regional Park and the surround local authorities to develop methods, assess, and understand the socio-cultural values of ecosystem services in the wider region.

Further details about the study design are described per component (i.e., ESCom, the national assessment, and regional studies).

Establishing a Scottish Ecosystem Services Community (ESCom)

Research Questions

3. What are science, policy and practitioners user-needs from an ecosystem services community of practice?
4. What are critical factors in establishing an ecosystem services community of practice?

Goals

ESCom aims to become a community of practice for ecosystem services research, decision making and natural resource management in Scotland. To achieve this aim ESCom will:

- Attempt to align Scottish ecosystem services research, to maximise value, identify synergies, and avoid duplication.
- Work with Policy and Practice to gain better understanding of user needs, provide relevant research, and achieve impact.
- Organise and promote events to support knowledge exchange.

Linking Stakeholders, Instruments, and Ecosystem Services

Stakeholder description

ESCom emerged as a bottom-up collaboration between researchers from The University of Edinburgh, The James Hutton Institute, The Centre for Ecology and Hydrology and Forest Research (see <http://escomscotland.wordpress.com>). However, ESCom should become an inclusive and open community with a wide constituency including:

- National and regional government (National and local authorities)
- Government Agencies (SEPA, SNH, FC)
- Research organisations and universities
- NGOs
- Professional organisations
- Trade bodies
- Private sector companies, including SMEs

Identification of stakeholder needs

ESCom activity currently focuses on the preparation of its formal launch. A full day workshop on 30th April, 2014 will focus on two central questions: *'What would you like to gain from ESCom?'* And *'What could you contribute to ESCom?'*

The detailed stakeholder table will be completed following the ESCom launch in April 2014.

National assessment

There is considerable national interest in ecosystem services and natural capital assessment, but there are funding constraints and research challenges. OPERAs research in WP 3 (Knowledge) will test and compare a range of approaches, which will complement on-going research in Scotland. OPERAs partners working at the national scale in Scotland include: VU-IVM, KIT, and UEA. This builds on and extends a recent national ecosystem services assessment for England.

Research Questions

4. How did the provision of ES in Scotland change over the last decades? (KIT)
5. Which regions are due to their environmental conditions particularly suited to provide specific ES? (KIT)
6. Where are there win-win situation between multiple ES? (KIT)
7. What is the relationship between landscape heterogeneity and ecosystem service provision? And which indicators capture this relationship? (VU-IVM)
8. How does the provision of multiple ecosystem services change along gradients of landscape heterogeneity? What are the implications for trade-offs and synergies between multiple ecosystem services? (VU-IVM)
9. What are the effects of policy changes on ecosystem service provision in Scotland? (UEA)
10. What is the economic value of Scotland ecosystem services? (UEA)
11. To what extent do synergies exist between the supply of ecosystem services and their economic value (VU-IVM, UEA, KIT)

Exemplar Goals

- To quantify ESS provision in Scotland over space and time under policy and climate scenarios (1, 4, 6)
- Identify synergies between landscape potential for ESS provision and actual provision (2, 3, 5)
- Quantify economic values of ecosystem services (7)
- Identify synergies / trade-offs between alternate methods for ecosystem services quantification/valuation (8)

Linking Stakeholders, Instruments, and Ecosystem Services

Stakeholder description

Stakeholders for the national assessment are primarily the Scottish Government, and its agencies (Scottish Natural Heritage, Scottish Environment Protection Agency, Forestry Commission Scotland). In addition, national analyses will be of interest to national NGOS (e.g. the Scottish Wildlife Trust and the RSPB).

Identification of stakeholder needs

Broad stakeholder needs for nation ES maps and assessment have been expressed by Scottish Government. More specific needs, and alignment with existing work will happen through involvement in the ESCom initiative, and should be clarified over the coming year.

Regional assessment – Inner Forth Futurescape

Through OPERAs, the University of Edinburgh is working in partnership with the Royal Society for the Protection of Birds (RSPB) an international, UK based conservation organization, in helping to operationalize and deliver one of several “Futurescapes” projects, this one focusing on the Inner Forth area of the Firth of Forth estuary (RSPB, 2013²), as illustrated in Figure 15. Stirling sits at the head of the Forth, while Edinburgh is located downstream where the Forth flows into the North Sea. Like many post-industrial port cities, the coastal wetlands of Inner Forth area have been radically altered since the 1700s as shoreline has been armoured and converted into agricultural land and to provide coastal defences from the sea (Smout and Stewart 2012³). Over time this has resulted in a complex ecological and socio-economic mosaic of farmland, nature reserves, coastal towns and a large petrochemical factory at Grangemouth. The area is of international significance, both as a major European waterway and as Ramsar site (JNCC, 2001⁴). The overall Firth of Forth is designated as a Natura 2000 Special Protection Area (SPA) for waterbirds, a national level “site of special scientific interest” (SSSI) and contains many habitats that are listed by OSPAR (Baxter, et al, 2011⁵).

As much of the Inner Forth is near sea-level, susceptible to both upstream flooding and storm surge, there is an urgent need to reconsider the current ecological condition and functionality trajectories for the coastal wetland habitats with regard to future provision capacities for ecosystem services and climate change adaptation. Key services include: wildlife, nutrient cycling, carbon storage and most critically coastal protection (Sniffer, 2008⁶). Throughout the UK and Europe, coastal realignment is increasingly being considered as a viable alternative to hard-structure coastal defences, which block cross-shore and long-shore sediment and water movement processes (Turner et al, 2007⁷). Coastal realignment involves removal of hard-structure defences to allow coastal wetlands to revert to more natural state of water movement, while increasing ecological complexity and biodiversity and an increasing spectrum of ecosystem services over time.

The policy climate for the Inner Forth (and similar urbanized estuaries in Europe and beyond) is also complex, providing both challenges and opportunities. At the EU level, the Water Framework

² RSPB, 2013. Pamphlet on Inner Forth Futurescape Project. http://www.rspb.org.uk/Images/inner-forth_tcm9-253585.pdf (accessed 6 Feb 2014).

³ Smout, T.C. and Stewart, M, 2012. Land Claim from the Sea, Chapter 8 in: The Firth of Forth, An Environmental History, Birlinn Publishers, Edinburgh.

⁴ JNCC, 2001. Ramsar Information sheet on Firth of Forth. <http://jncc.defra.gov.uk/pdf/RIS/UK13017.pdf>

⁵ Baxter, JM et al, 2011. Scotland's Marine Atlas. Scottish Government.

⁶ Sniffer, 2008. Coastal Flooding in Scotland: A Scoping Study. http://www.sniffer.org.uk/files/7013/4183/7993/FRM10_final_030908_with_security.pdf. (Accessed 6 Feb 2014).

⁷ Turner, R.K, et al, 2007. A cost-benefit appraisal of coastal managed realignment policy. Global Environmental Change 17: 397-407.

Directive requires river basins (including coastal areas) to establish good ecological status by 2015 (WFD Scotland, 2014)⁸. Managed realignment can facilitate enhanced water quality and diminish flood risk, yet conversion of coastal farms back into wetlands impacts on agricultural subsidy options, and can require resettlement of local communities and/or infrastructure. In Scotland, a new Flood Risk Management Act (2009), requires flood risk assessments and coordinating planning at all levels (SEPA, 2012)⁹, requiring joined up consultation across various government partners, conservation and citizen groups and academia. Additionally, management actions in dynamic coastal inter-tidal settings are further challenged by long-standing spatially static zoning policies and confusion over coastal ownership and responsibilities on-site and beyond.

The RSBP, whose primary remit is to encourage habitat measures supporting both wildlife and people, have conducted preliminary assessments of coastal inter-tidal wetland sites in the Inner Forth for which managed realignment is a potentially viable option and can potentially support range of ecosystem services in the short and long-term (RSPB 2012)¹⁰. There is also a pilot site (Skin Flats), which through hydrological management now functions as both a wetland reserve and flooding buffer. Yet, as noted above, the dynamics of ecosystem, policies and stakeholders in the Inner Forth requires innovative approaches to ecosystem management which engages stakeholders in a range of actions to determine future coastal wetland scenarios and horizons. It is within this context that OPERAs will be working with RSPB and other partners to extend the research and application on how management realignment can be viewed as an ecosystem service, both in process and outcome. This partnership will be further enhanced through coordination other Scottish exemplar components (e.g. ESCOM discussed earlier) as well as linkages with other aquatic OPERAs exemplars and comparative insights application of instruments across similar settings and challenges.

⁸ <http://www.scotland.gov.uk/Topics/Environment/Water/15561/WFD> (accessed 6 Feb 2014).

⁹ SEPA, 2012. Flood risk management planning in Scotland: Arrangements for 2012-16.

http://www.sepa.org.uk/flooding/flood_risk_management/planning_for_floods.aspx (Accessed 6 Feb 2014).

¹⁰ RSPB, 2012. Inner Forth Futurescape – Feasibility Study.

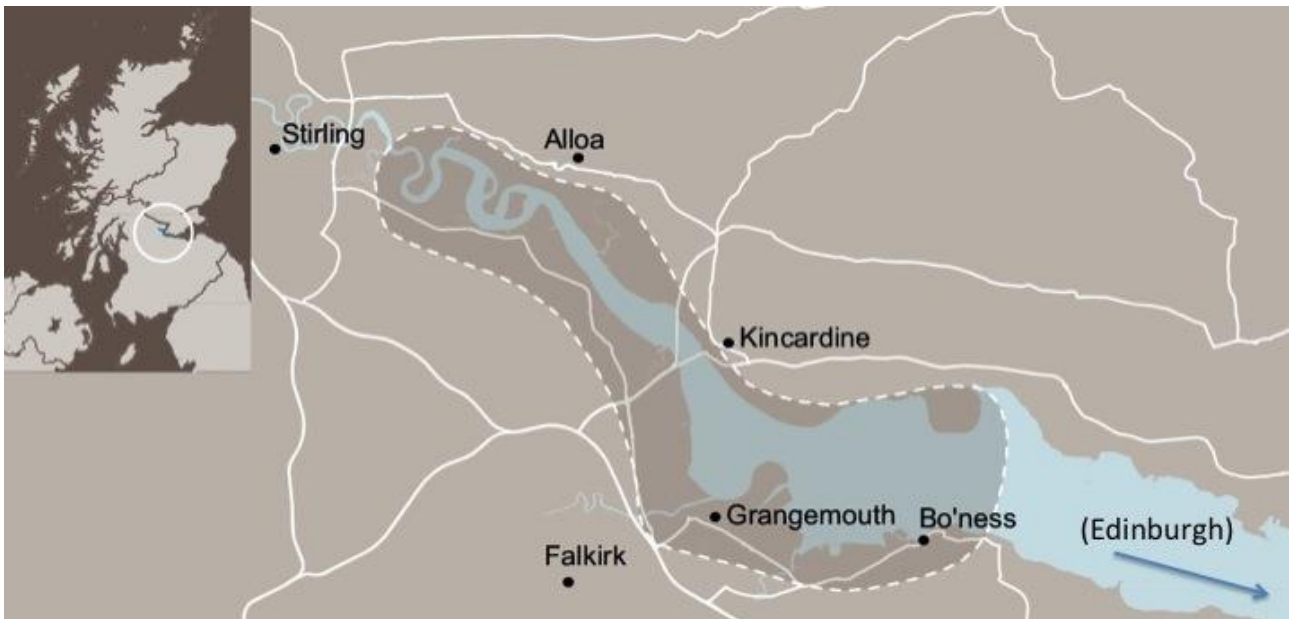


Figure 15. Dashed lines showing Inner Forth coastal wetlands. (Adapted from RSPB 2013)

Overall Research Questions

- How can hybrid habitats of ecosystem ecologies and built environments be designed and managed to support trajectories of ecological connectivity and enhancement over time?
- To what degree is managed realignment supported or compromised by relevant policy instruments?
- Related, is the concept of no-net-loss an optimal policy when starting with degraded coastal wetlands, or can net ecosystem improvement be achieved?
- How to vision plausible futures of large-scale ecosystem recovery and regeneration under different scenarios that also align with socio-economic needs

Targeted Exemplar Goals and Activities – Inner Forth

To extend and operationalize key findings of a recent feasibility study on coastal sites in the Inner Forth which are suitable for managed realignment and inter-tidal habitat creation (RSPB 2012). In this context the exemplar will support research the following goals:

- a) determine how much intertidal habitat can be created overall in the Inner Forth area;
- b) determine how such would change the overall characterization, integrity and connectivity of the existing and created habitats over time,
- c) to determine the scope of benefits and ecosystem services that targeted coastal intertidal enhancement would provide for wildlife and to minimize flood and sea-level rise risk to local inhabitants; and
- d) through the above, to fully understand the effect that if all of all of the suitable Inner Forth habitat creation projects were implemented, to what degree this would contribute to EU Water Framework Directive objectives and flood risk management in the short and long term.

- e) To achieve these goals, a range of activities will be supported through OPERAS as listed below. (These are also indicated in the stakeholder / instruments matrix in 6.3 below and the timing chart in section 9.) These activities will be lead by UoE and RSPB, along with input and guidance from other stakeholders noted below, inter alia.
- PhD student over 4 years focusing on the above goals and research questions (2014-2017).
 - 1-2 MSc students per year (e.g. 4 months / year) researching specific aspects of the above goals and collectively contributing to the PhD work and also connections with the other aquatic system exemplars in OPERAS and OPENESS.
 - UoE, RSPB and student participation at relevant conferences and meetings on related these topics in Scotland, and annual OPERAs project meetings throughout Europe.
 - Conducting field visits and stakeholder workshops for information generation and engagement.
 - Targeted collaboration with Instruments as indicated below throughout as key tools to answer the above research questions and goals.

Linking Stakeholders, Instruments, and Ecosystem Services – Inner Forth

Stakeholder description

The stakeholder community of the coastal area of the Inner Forth of Firth is diverse and includes: local land owners, community users and residents; conservation interests and statutory bodies spanning across local to international horizons. Sectoral stakeholders are diverse including: energy, urbanization, ports and harbours, fisheries, water management.

Key stakeholders which are envisaged as collaborators in this Inner Forth component of the Scottish exemplar include the following, many of which will also be part of ESCOM described earlier. In addition to on-going dialogue with local land owners, stakeholder partners will also be: the RSPB, Scottish Environment and Protection Agency (SEPA), the Scottish Natural Heritage (SNH) and the Forth Estuary Forum. While the University of Edinburgh is the lead academic partner on this sub-component, there will also be collaboration with the Scottish Association of Marine Science (MASTS), which a consortium of Scottish universities working on coastal marine science, policy and ecosystem services.

Identification of stakeholder needs

There have been initial meetings with RSPB and UoE to scope the above collaboration and study design. Further meetings with SNH and SEPA will be held to refine collaborations. The ESCOM launch in April 2014 will be a further near-term platform to also advance this Inner Forth component. The upcoming May 2014 OPERAS full-project meeting will advance refinement of activities between the exemplar and WP Instruments contributors (Table 14).

Stakeholder Need (INNER FORTH)	Instrument to address need	Ecosystem Service(s) Addressed*	Anticipated Outcome
<p>Ecological needs:</p> <ul style="list-style-type: none"> - Sea level rise management - Engineering, hydrological considerations - Ecological networks and corridors functionality 	<p>TESSA Toolkit: For rapid assessment of ecosystem services at sites, based on simple winner vs. loser assessments, resulting from land use changes and ecosystem services delivery.</p> <p>Offsetting & No Net Loss: Building on biodiversity offsets (measurable conservation outcomes from actions to compensate for adverse biodiversity impacts from project development)</p>	<ul style="list-style-type: none"> - Coastal protection - Carbon sequestration - Nutrient retention - Water quality - Biodiversity 	<p>Understanding of ecological functioning, connectivity and critical scale to achieve range of ecosystem services.</p>
<p>Spatial needs:</p> <p>mapping, visualization, analysis and scenario planning</p>	<p>Mapping Information Tool Our Ecosystem (OE): web-based land use and ecosystem mapping platform for access, sharing, organisation and querying of spatial data.</p> <p>Scenario Tool: Multi-scale scenario toolbox for strategic planning to: (i) explore implications of change on current decisions, (ii) assessing the viability of future targets including pathways with indicators</p>	<ul style="list-style-type: none"> - Coastal protection - Carbon sequestration - Nutrient retention - Water quality - Biodiversity - cultural services (recreation, ecotourism, aesthetics) 	<p>Imaging to document existing condition, in comparison with past conditions;</p> <p>Visualization of future scenarios under different use and management strategies</p>
<p>Governance/Policy needs:</p> <ul style="list-style-type: none"> - Roles of EU<>local law and policies - Biodiversity off-setting for ecological recovery 	<p>PA socio-economic assessment / PA Regulations: Step-wise and practice-oriented guidance on identification, assessment and communication of ES and related benefits from PAs, targeting socio-economic valuation.</p> <p>Offsetting & No Net Loss: Building on biodiversity offsets (measurable conservation outcomes from actions to compensate for adverse biodiversity impacts from project development)</p>	<ul style="list-style-type: none"> - Coastal protection - Carbon sequestration - Nutrient retention - Water quality - Biodiversity - Cultural services 	<p>Understanding of how managed realignment MA is supported by exiting policy frameworks at different scales,</p>

<p><u>Socio-economic needs:</u></p> <ul style="list-style-type: none"> - Conflict resolution between land owners, NGOs, government - Socio-economic analysis and tradeoffs 	<p>Scenario Tool: Multi-scale scenario toolbox for strategic planning to: (i) explore implications of change on current decisions, (ii) assessing the viability of future targets including pathways with indicators</p>	<ul style="list-style-type: none"> - Coastal protection - Carbon sequestration - Nutrient retention - Water quality - Biodiversity - Cultural services 	<p>Comprehension of impacts of different future trajectories of coastal realignment on different stakeholders, under different management and biophysical outcome scenarios .</p>
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Table 14. Exemplar Plan to Address Stakeholder Needs and Improve Ecosystem Services Through Instruments for the Inner Forth Futurescape.

*Following the classification of Ecosystem Services from CICES v.4.3 (January 2013), contained in the “CICES” tab of the BluePrint Protocol.

Regional assessment – Edinburgh peri-urban region

Two teams of OPERAs researchers will work on socio-cultural valuation of ecosystem services in the Edinburgh peri-urban region. The teams are coordinating their research efforts, searching for complementarity and synergies. The University of Potsdam will work in Pentland Hills, Outer Edinburgh and selected green spaces within the city. VU-IVM is currently refining their specific study areas.

Research Questions

Case Study 1 (VU-IVM):

- How does factual ecosystem service and biodiversity information influence socio-cultural values of ecosystem services?
- How can socio-cultural valuation methods for ecosystem services be improved by including such information?
- How are socio-cultural values of ecosystem services affected by the spatial attributes of the services under study?

Case Study 2 (University of Potsdam):

- How do socio-cultural values of ecosystem services vary across different interest groups?
- How are socio-cultural values spatially distributed across the study area?
- What are suitable techniques to elicit socio-cultural values? How robust are these techniques?
- What role does socio-cultural valuation play in managing ecosystem service and natural capital?

Exemplar Goals – Edinburgh

The planned research aims to improve knowledge on local ecosystem services and especially the importance of such services to local residents and visitors. Furthermore studies aim to further develop ecosystem service valuation tools that offer a more comprehensible view of the full spectrum of socio-cultural values of ecosystem services. To achieve this aim we will:

- Identify key ecosystem services from the societal perspective
- Assess socio-cultural values of ecosystem services
- Apply, test and further develop ecosystem service valuation methods

Linking Stakeholders, Instruments, and Ecosystem Services – Edinburgh

Stakeholder description

Case Study 1: To be determined

Case Study 2: Pentland Hills, Outer Edinburgh

- Officials from the councils of West Lothian, Mid-Lothian, East Lothian and the City of Edinburgh and Regional Park Management and the Scottish Wildlife Trust
- Visitors: People (mostly residents from Edinburgh and the Lothians) who visit the Pentland Hills predominantly to recreate
- Landowners: farmers, City of Edinburgh Council, Midlothian Council, West Lothian Council, West Lothian Council, Scottish Water who own and maintain the Pentland Hills in and outside of Regional Park boundaries
- Pentland Hills Natural Heritage Service: manage and maintain the Pentland Hills Regional Park, their work includes wildlife surveying, patrolling the hills, working with school and community groups, being the contact for landowners and the public, designing management plans and reports
- Further organizations with an interest in the sustainable development of the Pentland Hills Regional Park: Scottish Wildlife Trust and Scottish Natural Heritage, Friends of Pentlands
- Special interest groups: angling, cycling, orienteering, hill running, Pentland Produce

Identification of stakeholder needs

Stakeholder Need	Instrument to address need	Ecosystem Service(s) Addressed*	Anticipated Outcome
Elicit social values of local ecosystem services for local residents and visitors	Valuation tool ES ranking, non-monetary choice model, deliberative methods (Katja Schmidt, UP)	Experiential use of plants, animals and landscapes in different environmental settings C1, physical use of landscapes in different environmental settings C2, educational C4, heritage, cultural C5, aesthetic C7, symbolic C8, sacred and/or religious C9, Reared animals and their outputs P2, Wild plants, algae and their outputs P3, Surface water for drinking P7, Filtration/sequestration/storage/accumulation by ecosystems R3, Maintaining nursery populations and habitats R13	Overview of socio-cultural values for ecosystem services in Edinburgh area
Test and compare methods to elicit socio-cultural values of ecosystem services	Valuation tool questionnaire: face-to-face and online, qualitative interviews, augmented reality, focus groups (KatjaSchmidt, UP)	Experiential use of plants, animals and landscapes in different environmental settings C1, physical use of landscapes in different environmental settings C2, educational C4, heritage, cultural C5, aesthetic C7, symbolic C8, sacred and/or religious C9, Reared animals and their outputs P2, Wild plants, algae and their outputs P3, Surface water for drinking P7, Filtration/sequestration/storage/accumulation by ecosystems R3, Maintaining nursery populations and habitats R13	Better information about ecosystem service valuation tools and clear idea how to improve such methods
Test the impact of additional information on socio-cultural valuation of ecosystem service and natural capital management	Valuation tool (questionnaire: structured face to face interviews, ES ranking, non-monetary choice model, deliberative methods)	Provisioning, regulating, cultural ecosystem services	Provide landscape policy and management with an improved understanding of how knowledge on ecosystems and their services change socio-cultural values thereof
Understand the role of spatial composition/	Valuation tool (questionnaire: structured face to	Provisioning, regulating, cultural ecosystem services	Provide landscape planning and policy with an

configuration of landscape attributes on the socio-cultural values that people assign to landscape attributes	face interviews; ES ranking; ES visualization)		improved understanding of how socio-cultural values for ecosystem services depend on spatial composition of the landscape that provides them.
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Table 15. Exemplar Plan to Address Stakeholder Needs and Improve Ecosystem Services Through Instruments.

**Following the classification of Ecosystem Services from CICES v.4.3 (January 2013), contained in the "CICES" tab of the BluePrint Protocol.*

Collaborations within OPERAs

Work Package 3: Knowledge

WP 3 has expressed an interest to use the Scottish exemplar as a 'common testing ground in order to allow detecting synergies and trade-offs between the various approaches developed in WP 3. These include contributions from:

- Task 3.1 on Ecosystem function and quantification:
 - KIT will provide an ecological assessment of Scottish ecosystem services using a process based vegetation model. The model simulates the development of land vegetation and ecosystem structure in response to driving factors in the environment such as climate and land use. Simulated ecosystem state variables are translated into multiple ecosystem services in their current and historical provision. (see National assessment, section 5.1, goals a-c)
 - VU-IVM will study the relationship between landscape heterogeneity and the supply of multiple ecosystem services. A literature review on the importance of landscape composition and configuration for individual ecosystem services will be compared with the spatial detail of current ecosystem indicators. Moreover, the effect of landscape composition and configuration on ecosystem service supply will be assessed independently to highlight the differences in both level and location of ecosystem service supply. (see National assessment, section 5.1, goals d-e)
- Task 3.2 on Socio-cultural values of ES/NC
 - VU-IVM and UP will develop and test socio-cultural valuation methods in a regional case-study around Edinburgh (see regional assessment, Chapter 7)
- Task 3.3 on Economic valuation of ES/NC
 - UEA will develop a new econometric land use model for the UK and focus on the economic valuation of ecosystem services under a number of policy scenarios for Scotland. (see National assessment, section 5.1, goals f-g)
 - VU-IVM will develop meta-analyses databases on economic values of water and forest are developed. Information in these databases, and models estimated on the data, will be applied to the Scottish exemplar in order to derive economic values of water areas and forests at different geographical scales.
 - IEEP will develop guidance on the added value of environmental-economic accounting for environmental policy making; the Scottish exemplar could usefully be used to explore the added value of accounts for Scotland.
- Task 3.4 on Governance of ES/NC
 - ULUND has expressed an interest to work on governance issues in Scotland, but details still need to be discussed.
- Task 3.5 on Trade-offs and synergies in ES/NC and alternative valuation perspectives
 - VU-IVM will coordinate a study where alternative valuation/quantification perspectives (socio-cultural, ecological and economic, from the respective initiatives above) are compared to identify synergies and trade-offs (see also National scale study, section 5.1, goal h).

Work Package 4: Instruments

- UEDIN will develop a scenarios toolbox, that is likely to be used in the InnerforthFuturescape
- UEDIN hopes to develop a crowdsourcing application to assess national values of ecosystem services
- ECOMETRICA will use its 'Our Ecosystem' mapping platform within ESCom to map ES studies in Scotland
- UNCEP-WCMC will expand its TESSA toolkit for use in the InnerforthFuturescape
- IEEP may use its PA socio-economic assessment toolkit in the InnerforthFuturescape
- BIOTOPE, VU-IVM and IEEP are interested in working on No Net Loss in Scotland; This study links to the European policy perspective of the European exemplar.
- ETHZ will provide the technical tools and expertise for the augmented reality experiment for social valuation of the Pentland Hills.

Work Packages 5 & 6: Resource Hub and Dissemination

The process of establishing ESCom should provide a model for collaboration elsewhere in Europe, and have strong links to the resource hub. However, since both are still in its early stages of development it is impossible to be more specific at this stage.

LARGE SCALE EXEMPLAR CLUSTER

Pan-European regulatory Directives Exemplar

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Dream Abstract

There are a number of recent and forthcoming developments at the European policy level that affect land use in Europe. These include the reformed Common Agricultural Policy 2014-2020, the Green Infrastructure Communication adopted in 2013, a Land Communication that is expected for 2014, and a No Net Loss of biodiversity and ecosystem services initiative that is expected for 2015. These policy developments, to which we refer as 'land based policy initiatives'¹¹ here, interact with existing policies like the Birds Directive, the Habitats Directive and the Water Framework Directive. By affecting land-use decisions, these various policy initiatives explicitly or implicitly affect the levels of ecosystem services and natural capital (ES/NC) in Europe. This exemplar studies the synergies and trade-offs that individual policy initiatives may have on the supply of ES/NC in Europe, and explores what synergies and trade-offs may occur through policy interactions.

We employ a number of approaches to assess how these land based policy initiatives can maximize synergies and minimize trade-offs, including: 1) modeling land use change for a range of policy scenarios; 2) quantification of ES/NC levels and changes therein through indicators and metrics; and 3) case study analyses (with links to other OPERAs exemplars). The No Net Loss (NNL) initiative and the associated instrument of offsets for impacts on biodiversity, ecosystems and their services act as a backbone throughout the exemplar study design, and comparisons to other policy initiatives are made in specific sub-studies with stakeholder engagement.

Study Rationale

There are a number of recent and forthcoming policy developments at the EU level that are related to land use in Europe. Some are being developed as ways to implement the 2020 Biodiversity Strategy¹². We term these developments 'land based policy initiatives'¹¹. The partners in the European exemplar have either led or participated in projects to develop a number of these initiatives. The European exemplar builds upon this expertise and brings together these individual policy lines to evaluate them from an ES/NC perspective. In particular we consider (Figure16):

1. **The No Net Loss initiative.** The EU has set targets to achieve no net loss of biodiversity and ecosystem services by 2020 (...), and in line with this has committed itself to the development of a No Net Loss Initiative by 2015. To achieve no net loss, a mitigation hierarchy needs to be applied to developments that are expected to impair biodiversity and/or ecosystems and their services. This hierarchy implies that impacts are to be avoided as far as possible, reduced,

¹¹ Note that 'land based policy initiatives' refers to a range of EU policy developments such as Communications, Initiatives, Strategies, and Directives, and is thus not limited to formal 'policy initiative' by the Commission.

¹² COM (2011) Our life insurance, our natural capital: an EU biodiversity strategy to 2020. Commission of the European Communities. COM(2011)244 final. 16p.
http://ec.europa.eu/environment/nature/biodiversity/comm2006/pdf/2020/1_EN_ACT_part1_v7%5B1%5D.pdf, Brussels

mitigated and lastly, that any residual impacts will have to be offset by enhancing or restoring biodiversity and/or ecosystems and their services elsewhere, in quantity and quality equivalent to the residual impact losses ('like-for-like' or better). The goal, then, is to achieve no net loss (or a net gain). In the context of Action 7b of the Biodiversity Strategy, IEEP has recently led a large study for the DG Environment, European Commission, involving VU-IVM, in which potential alternative options for a NNL policy were developed and analysed for their effectiveness. Fabien Quétier (Biotope) has been a member of the NNL Working Group convened by the European Commission to advise it on the process, and has served as an external advisor on this NNL study.

2. **Green Infrastructure Strategy.** In 2013 the European Commission published a strategy entitled: "Green Infrastructure (GI) — Enhancing Europe's Natural Capital"¹³, which is considered a key step in implementing the EU 2020 Biodiversity Strategy and specifically Target 2 that requires that 'by 2020, ecosystems and their services are maintained and enhanced by establishing green infrastructure and restoring at least 15% of degraded ecosystems'. In 2011, IEEP supported the development of EU's Green Infrastructure Communication through a consultancy project for DG Environment (European Commission) whose aim was to assess the effectiveness and efficiency of policy initiatives to support Green Infrastructure across Europe. It identified the main existing policy measures that can help to support Green Infrastructure initiatives and their implementation. The study further reported on the contribution Green Infrastructure makes to the resilience of ecosystems, and on indicators to measure its impacts. It attempted to quantify impacts on ecosystems and their services, and the resulting socio-economic and health benefits. These benefits were compared with costs; and four different policy scenarios on the implementation of Green Infrastructure in Europe were assessed. The Commission's communication on Green Infrastructure includes a proposal for continuing to explore the opportunities for setting up innovative financing mechanisms to support GI and a commitment to assessing the opportunities for developing an EU TEN-G initiative. While Cohesion Funds will for the first time provide explicit support for green infrastructure, under Rural Development funding, 5% of resource are intended to be spent on "integrated sustainable urban development measures", which can equally be used to finance urban green infrastructure.
3. **Ecosystem restoration targets.** Target 2 of the EU Biodiversity Strategy requires at least 15% of the degraded ecosystems to be restored by 2020. VU-IVM is currently involved in a study that will take stock of the degree to which Member States have defined targets for ecosystem restoration and the degree to which these are coherent across the EU and across ecosystem types.
4. **Land communication.** The European Commission aims to set up a suitable framework (targets, objectives, indicators, etc.) for measuring and tracking the status and progress on land-related aspects. Targets which are currently considered include land take, land recycling, EU land demand in third countries, land multi-functionality and similar concepts, as well as soil

¹³ COM (2013) Green Infrastructure (GI) — Enhancing Europe's Natural Capital. Commission of the European Communities. COM(2013) 155 final. 11p. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2013:0249:FIN:EN:PDF>, Brussels

erosion and soil organic matter. VU-IVM is involved in a study that assesses the proposed targets and, when relevant, suggests alternative and complementary ones. This study shall deliver an integrated approach which analyses both benefits and costs, and addresses all significant economic, social and environmental impacts of the proposed targets.

5. **Common Agricultural Policy (CAP).** The CAP has been revised for the period 2014-2020 and of particular interest for ES/NC are the green direct payments, which rewards farmers for respecting three obligatory agricultural practices namely maintenance of permanent grassland, ecological focus areas and crop diversification. The spatial allocation and nature of the ecological focus areas can be expected to have major implications for ES/NC in agricultural landscapes. In 2013 IEEP finalised a consultancy study for DG Environment (European Commission) on the issue of **Land as an environmental resource**. The purpose of this study was to consider the range of demands facing different types of rural land use and related ecosystem services in the EU to 2050 and, in light of these, to examine the various ways in which these demands could be met. In so doing, it considers the extent to which there is potential to increase the production of food, bioenergy and timber for material use on rural land in Europe while also meeting the EU's environmental objectives. Alternative means of achieving these demands sustainably, including non-land based alternatives, increasing imports and constraining demand are reviewed briefly.

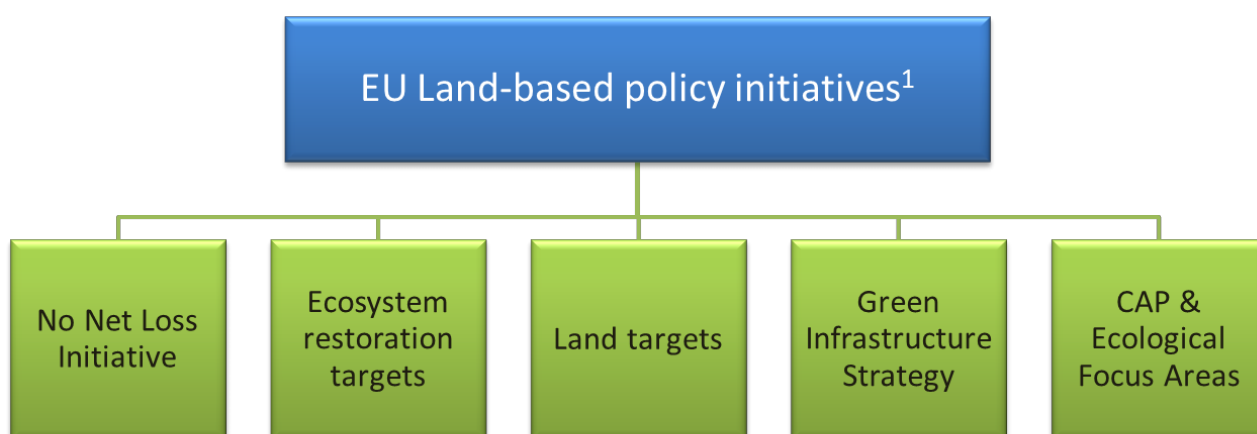


Figure 16. Key European policy initiatives¹ with spatial implications for ecosystem services and natural capital.

The various initiatives outlined above are driven by different goals, and address different socio-economic sectors, yet they all aim to affect land-use decisions and the provision or access to ecosystem services. In the European exemplar, their interactions will be explored to identify synergies and trade-offs between policy goals to pin-point in which circumstances this might raise difficulties and compromise ES/NC, and investigate some of the knowledge and tools that could help solve some of these difficulties. Case studies will provide concrete illustrations of some of

these difficulties and the operational potential of the instruments and tools being developed as part of the various policies being investigated (e.g., offsets, indicators and metrics). This will be coordinated with other exemplars in OPERAs (e.g., Scotland, Danube, French Alps).

Given this, work in the European exemplar will be developed along the following main lines:

1. **Quantifying trade-offs and synergies between a range of ecosystem services and biodiversity in space and time**, using land use modeling and prioritization analysis for specific policy scenarios and objectives (*led by VU-IVM*).
 1. Quantitative assessment of no net loss policy options. Building on the scenario analysis work that was conducted for IEEP/IVM et al.'s NNL study for the European Commission, this work will assess synergies and trade-offs among and between indicators for biodiversity and ecosystem services for a number of no net loss scenarios, as compared to a Business as Usual Scenario for land use change. Results will highlight the extent to which policy measures may be able to enhance synergies and reduce trade-offs.
 2. Identifying priority areas for biodiversity and ecosystem services, and their vulnerability under a Business as Usual scenario. This work will identify the priority regions in terms of their contribution to EU level biodiversity, ecosystems and their services (as measured by the indicators for from the IEEP/IVM et al.'s NNL study), both for individual indicators and for the full set of indicators. Subsequently the vulnerability of these "complementary hotspots of ES/BD" to land use change under a Business as Usual scenario will be assessed, and regionally specific drivers of loss can be identified. Such information can be helpful in distilling effective no net loss policy measures at a regional level in order to contribute to an overall EU objective of no net loss of BD/ES.
 3. Quantifying potential benefits for biodiversity and ecosystem services from targets regarding the Land communication and Ecosystem restoration. The outcomes of the currently ongoing Land target study and Restoration target study will serve as input for a quantitative assessment of the likely benefits for ecosystems and associated services for a range of spatial levels (regions, Member States, EU). Outcomes will be compared with the outcomes of (1b) to identify spatial matches and gaps between measures and needs.
2. **Assessment of the complementarities between EU land based policy initiatives** (see a-b below). These complementarities are to be developed through stakeholder engagement and dedicated workshops.
 1. Complementarities between no net loss ambitions and Green Infrastructure, based on a review of offsetting experiences in Germany (*led by IEEP*). This work would draw together the results from different case studies on German offsetting practice that were prepared in the context of recent projects (including the DG ENV NNL study, a Biodiversa study of eco-points offsetting scheme and a study of the costs of offsetting under the German Building Code). The paper would focus in particular on the extent to which the German offsetting approach could contribute to achieving no net loss of ecosystem services and supporting the development of a green infrastructure (both overarching EU objectives), and whether the tools on which it relies have the potential to be further optimised in view of achieving these

two objectives in particular. Based on an analysis of the channels through which the German Impact Mitigation Regulation is being implemented this work identifies where in EU policy there could be entry point for introducing requirements for offsetting and applying the approaches that are used in Germany.

2. Complementarities between offset mechanisms for biodiversity and ecosystem services and Ecological Focus Areas (*led by Biotope*) Understanding the conditions under which EFAs and Offsets for biodiversity and ecosystem services can complement each other to produce improved outcomes in terms of food production, biodiversity, and associated ecosystem services is crucial for sustainable and cost-effective landscape management across Europe. These conditions are however largely unknown to date, or do not recognize the dynamic nature of farmed landscapes, while research has shown that incorporating land use dynamics is essential for understanding the effectiveness of these policy instruments (Johst, 2011¹⁴; Van Teeffelen, 2012¹⁵). This work seeks to identify policy design criteria for EFA and offsets that show robust outcomes for biodiversity, ecosystem services and food production.
3. **Potential offsetting metrics and delivery mechanisms for ecosystem services** (*subprojects led by Biotope & IEEP*). To date most international offsetting schemes focus on biodiversity and use biodiversity metrics to establish whether NNL objectives are attainable or attained. The incorporation of ecosystem service goals into offsetting poses a challenge as ES and their beneficiaries are highly context-specific, and metrics for measuring them are less developed and easily applied (in part due to inherent trade-offs between conflicting goals and expectations of heterogeneous beneficiaries). This work would therefore draw on experiences where offsets have multiple targets (as in France, under co-existing permitting procedures; linking to OPERAs tasks 4.2 and 4.3) and where ecosystem services are included as such in offset metrics, such as in Germany's eco-point systems (linking to 2a). Appropriate yet practical ecosystem metrics and objectives for NNL policies and legislation will be identified and further developed through this work.

¹⁴ Johst K, Drechsler M, van Teeffelen AJA, Hartig F, Vos CC, Wissel S, Wätzold F, Opdam P (2011) Biodiversity conservation in dynamic landscapes: trade-offs between number, connectivity and turnover of habitat patches. *Journal of Applied Ecology* 48 (5):1227-1235. doi:10.1111/j.1365-2664.2011.02015.x

¹⁵ Van Teeffelen AJA, Vos CC, Opdam P (2012) Species in a dynamic world: Consequences of habitat network dynamics on conservation planning. *Biol Conserv* 153:239-253. doi:10.1016/j.biocon.2012.05.001

Exemplar Selection and Description

The European exemplar is focused on European directives, and in particular the forthcoming No Net Loss initiative and its interactions with the recent reform of the Common Agricultural Policy, the EU's 15% habitat restoration targets, and other land-based policies. These are highly relevant and rapidly changing policy developments for ecosystem services and natural capital, and outputs of this exemplar can therefore be of direct relevance to EU policies regarding ecosystem services and natural capital, and provide lessons for the implementation across Europe.

The European exemplar takes the EU as its geographic coverage, and EU policy as its scope. The basis for most land use analyses is the CORINE land cover map (at 250x250m or 1x1 km), or a representation thereof as included in the CLUEScanner model for simulating land use change, available at a 1x1 km resolution (Figure 17), which considers 17 different ecosystem and land use types.

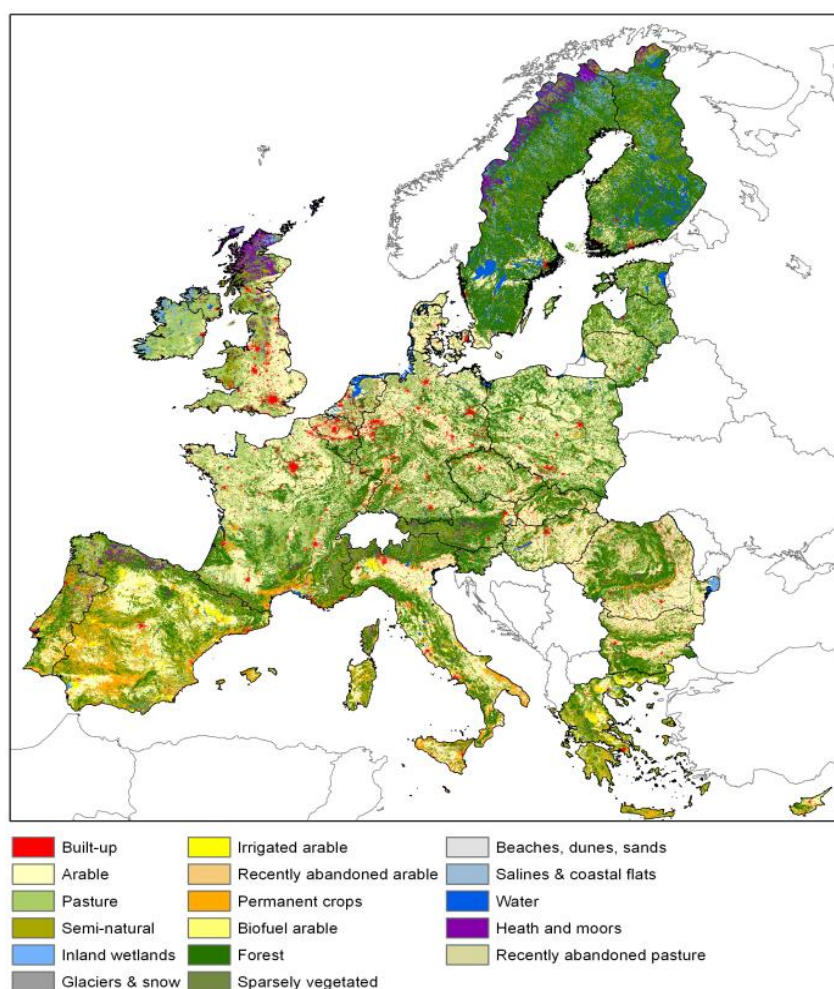


Figure 17. Land use map in the year 2000

Research Questions

1. What is the effectiveness of policy options for no net loss on biodiversity and ecosystem services in the EU?
2. Where do synergies and trade-offs between ecosystem services and biodiversity occur in space and time?
3. Can land use patterns or land use transitions be identified that underlie the synergies and trade-offs?
4. How can the insights from this study improve metrics to assess and quantify impacts and offset requirements in order to achieve no net loss of biodiversity and ecosystem services at larger spatial scales?

To complement the above core research questions, we would also seek to explore to what extent ecosystem capital accounts tools can offer added value to measure changes in natural capital and related ecosystem services, help in assessing the impacts of the policies and hence help support policy design and implementation.

Goals

The various initiatives outlined above are driven by different goals, and address different socio-economic sectors, yet they all aim to affect land-use decisions and the provision of or access to ecosystem services. In the European exemplar, their interactions will be explored to identify synergies and trade-offs between policy goals to pin-point in which circumstances this might raise difficulties and compromise ES/NC, and investigate some of the knowledge and tools that could help solve some of these difficulties (Table 16).

Linking Stakeholders, Instruments, and Ecosystem Services

Stakeholder description

Key stakeholders include policy officers from the European Commission, given that the exemplar evaluates EU Policy options that are identified in close collaboration with policy officers at various DGs. The relevance of the policy initiatives and their potential consequences in land use for the regional level will be further assessed in collaboration with regional level stakeholders from policy, planning and management.

Identification of stakeholder needs

The work in the exemplar builds on recent and ongoing work for the DG Environment (e.g. NNL study coordinated by IEEP, progress towards 15% habitat restoration target project where VU-IVM is partner), which creates a direct interaction with policy officers from DG Environment on these matters, allowing for a good understanding of the stakeholder's needs. Moreover, OPERAs Userboard brings together stakeholders and OPERAs researchers. The exemplar is represented through WP 3 co-leads (Peter Verburg, Astrid van Teeffelen). At present, relevant stakeholders

representing DG ENV and the EEA are members of the Userboard. At the regional level, all project partners are collaborating with stakeholders on OPERAs work, e.g., all are involved in *ESCom* in Scotland, the newly established ecosystem service community in Scotland that brings together practitioners, policy makers and researchers.

The exemplar team, in collaboration with PROSPEX, will organise two dedicated workshops in the context of the land based policies. The first workshop is envisaged to be held in 2014 to scope work in the exemplar. The second workshop is envisaged to be held in 2015 or 2016 to flesh out potential synergies and trade-offs between the policy initiatives across scales of governance.

Stakeholder Need*	Instrument to address need	Ecosystem Service(s) Addressed**	Anticipated Outcome
Quantify where and what kind of impacts on biodiversity and ecosystem services are expected up to 2020 under a business as usual scenario, and To what extent can those impacts be avoided / minimised / mitigated / offset under a number of policy scenarios (1a)	Land use change modelling, indicators for biodiversity & ESS, policy scenario development (<i>VU-IVM, IEEP</i>)	Multiple	Quantification of impacts for Nuts2, Country and EU levels.
What are regional differences in ESS/BD occurrence and vulnerability to land use change? Appropriateness of nnl instruments? (2b)	Prioritization analysis, trade-off analysis,	Multiple	Spatial maps on priorities and vulnerabilities and an assessment of NNL / offset instrument applicability for different levels of priority and threat.
Identify critical “friction points” between policies (1c, 2)	Policy analysis, spatial modelling	Multiple	***

Identify possible solutions to address these “friction points” (2)	Policy analysis	Multiple	***
Appropriate yet practical ecosystem metrics and objectives for NNL policies and legislation (3)	Quantitative assessment	Multiple	***

Table 16. European Exemplar Plan to Address Stakeholder Needs and Improve Ecosystem Services Through Instruments.

** derived from studies commissioned by DG ENV – but to be explored further in first workshop*

***Following the classification of Ecosystem Services from CICES v.4.3 (January 2013), contained in the “CICES” tab of the BluePrint Protocol.*

**** These lines of work are preliminary, for which it is not meaningful to provide more detail at this stage.*

Collaborations within OPERAs

Work Package 2: Knowledge

Issues of no net loss and offsets for biodiversity and ecosystem services are being investigated in several other exemplars, including French Alps, Danube, and Scotland. The changes in EU policy in this regard have consequences for the regional cases. Results from the European exemplar can therefore be used as input for the regional cases, and regional case findings can be compared to the EU scale findings in a cross scale comparison.

The work in the exemplar will contribute to filling some knowledge gaps regarding ecosystem service research, which are identified by Lautenbach et al. (OPERAs Milestone 2.3 report):

- ESS categories: a range of ESS will be addressed;
- ESS & Scenarios: multiple land use and policy scenarios will be employed
- Countries studies: most findings will encompass the EU, with specific links to regional levels.
- Use of models: ESS and BD are quantified using indicators that are sensitive to land use changes. The indicators are derived from process-based models or expert based look up tables, using the best available knowledge for the given resolution and extent.
- Uncertainty: This is specifically addressed for a number of indicators that are used at the EU scale in a study for Task 3. 1 by Sculp et al (in review).
- Stakeholder involvement: This is an explicit objective for the work in OPERAs, and the work proposed for the exemplar will be further scoped in interaction with EU and regional exemplar stakeholders (see section 6.1)

Work Package 4: Instruments

Policy analysis will contribute to the assessment of demand and needs, under task 4.1 (led by IEEP). Work on metrics will contribute to task 4.2 (by Biotope). Scenarios analysis and indicator developments are instruments that are available from WP 3.

Work Packages 5 & 6: Resource Hub and Dissemination

Findings from this exemplar are, at least partly, directly fed into the European Commission due to close collaboration with DG ENV projects the context of no net loss and the habitat restoration targets. Biotope and IEEP will participate in mainstreaming these findings in their (non-academic) work on biodiversity policy and practice beyond OPERAs. Selected methods and results can be made available through the Resource Hub.

Mediterranean Exemplar

Wolfgang Cramer, IMBE

Alberte Bondeau, IMBE

Rob Tinch, IODINE

Dream Abstract

The origin and development of human civilisation, culture and well-being are inextricably linked to the provisioning of diverse and ample services from Mediterranean ecosystems, from the ocean itself and from the surrounding land. During recent centuries and into the foreseeable future, the nexus between well-functioning and diverse ecosystems, and human well-being, has been and will continue to undergo a huge transformation. Current changes pose significant risks for the sustainability of almost every service, from adequate supply of food and wood resources to human health and the conservation of biological diversity. The environment, through climate and direct human management, determines the functioning of all ecosystems, and most involved processes are non-linear. With the development of circum-Mediterranean countries over time, in terms of demography, affluence and lifestyle, the demand for services is bound to change (in type, quality and quantity). Socio-political dynamics (the economic crisis, political turmoil) profoundly affect the situation of stakeholders that have influence of the management of the provision of services. Governance of sustainable ecosystem services is thus increasingly affected by external (climate, global economics) and internal drivers (societal developments, lifestyles).

For all these processes, the Mediterranean is probably the most dynamic place on Earth, with dense human populations, massive economic and political transformations and significant powers providing opportunities for active management. To support sound decision-making in ecosystem management, a process-based ecosystem model has been adapted to Mediterranean agro-ecosystems, chosen as a key ecosystem with importance for service provisioning and human well-being. The goal is to estimate long-term (multi-decadal) trajectories of sustainability for ecosystem service provisioning, including trade-offs between them, as a function of conceivable changes in the environment as well as the human appropriation of services for the coming decades. Key quantities supporting the service estimations include yields of common Mediterranean agricultural products (cereals, maize, rice, sunflower, olives, fruits, grapes, potatoes, fodder), accounting for different intensities of agricultural management including irrigation.

For this study, and to demonstrate the potential of operational simulation tools, production estimates explicitly account for climatic conditions and resource inputs, as well as providing reliable estimates of risks for long-term degradations of the resource base, notably soil organic matter. Alongside estimations of forest dynamics, and basic assumptions about peri-urban landscapes, a full assessment of ecosystem carbon storage in the shorter and longer term is made. Characterizations of landscape structure and habitat diversity will also be made, including the interactions between agricultural practice and landscape diversity. Output from this model is delivered to state-of-the-art valuation methods in order to estimate the monetary value, as well as its expected future development, of services derived from Mediterranean ecosystems under a range of scenario assumptions. In addition, qualitative assessments of services lost due to habitat degradation are embedded in the scenario assessments.

Study Rationale

Both ecosystems and human society are highly dynamical complex systems, and they are linked to each other. Very likely, the high diversity and richness of ecosystems, and the services they provide (including, but not limited to, the supply of food, fibre and clean water), have been key factors for the development and long-term sustainability of human civilization on Earth, with one main point of origin being in the Mediterranean. Despite ongoing globalization, providing goods and services from elsewhere in the world to consumers in the region, Mediterranean ecosystems, on land and in the ocean, still are a key resource for millions of people. Regionally important services include basic life-supporting services such as food, wood, clean water and the regulation of local climate, but also importantly other services such as attractive and diverse landscapes, recreational opportunities including the basis of tourism, and the conservation of important biodiversity.

To date, nearly all countries around the Mediterranean are in fundamental crises that risk radically altering their use and management of natural resources. There is significant and widespread public concern in most countries of the region about the possible loss of productivity and diversity of ecosystems, driven by unsustainable use, pollution and climate change. There also appears to be substantial complacency, of the kind “we have to sacrifice something in order to assure ongoing economic growth and competitiveness,” or similar views that indicate that the sustainable functioning of ecosystems might be considered, by some decision makers, to be of lesser importance for the development of human society.

There is broad international momentum for greater understanding of national wealth and improved measurement and accounting for natural capital and its benefits. A clear statement of intent comes from the revised and updated Strategic Plan for Biodiversity from the CBD COP in Nagoya, 2010, which includes a set of 20 targets (the Aichi targets) of which the second is “*By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.*” Within the EU, Action 5 of the EU Biodiversity Strategy to 2020 calls Member States to map and assess the state of ecosystems and their services in their national territory with the assistance of the European Commission.

The work in this exemplar seeks to support the operationalization of ecosystem service concepts for achieving these targets in the Mediterranean basin. A key, but often insufficiently treated, foundation for sound decision making about ecosystem service management in this context is knowledge about likely future trajectories in ecosystem functioning, accounting for ongoing broad changes in the global environment as well as for local processes. Likewise, anticipation of possible demand for ecosystem services is critical for future quality of life in the Mediterranean, as it is affected both by economic and social processes, many of which are currently in turmoil. While many decisions in ecosystem management are of local nature, and need to be based on specific knowledge in different regions, there is increasing recognition that also international drivers increasingly affect the flows of ecosystem services at local and international levels, as well as the trade-offs between them.

As societies in Mediterranean countries develop, their demands for services change. An increasing share of the population lives in urban areas: there is globalisation of previously largely regional food markets; and the availability of resources for investment in urban and agricultural intensification and even land ownership may all change. These trends are very visible for many Mediterranean countries, showing that services demand changes not only in quantity, but also quality and type. With the development come changes in who actually manages the natural elements that provide the services and on which spatial and temporal scale this takes place. Governance of sustainable ecosystem services is increasingly affected by external drivers and knowledge is needed to ensure ecosystem provision in the future.

While services are drawn from practically all ecosystems in the Mediterranean region (forests, grasslands, agro-ecosystems, freshwater and marine ecosystems), **this exemplar focuses primarily on agro-ecosystems**. As a consequence of spatially variable socio-economic conditions and equally variable habitats, the diversity of Mediterranean agroecosystems is very large. Nevertheless, most agricultural products stem from a limited number of crops (cereals, maize, rice, sunflower, olives, fruits, grapes, potatoes, fodder). The productivity of these crops is relatively well understood and depends mostly on climatic conditions (notably temperature, frost risk and drought), soils, input of nutrients, and agricultural practice (technology, irrigation, soil conservation, landscape management, etc.). Likewise, the economic benefits, in terms of direct use of agricultural products and also through indirect services provided by agricultural landscapes are known. The core of the work therefore consists of building a functional system to support the assessment of sustainable use of agroecosystems under changing conditions. This system will be applied, using techniques co-developed with the Global Exemplar, for a set of societal narratives, in order to assess trade-offs and possible risks for future sustainability.

It is unrealistic to expect “full accounting” of all agro-ecosystem services in a region at any scale, locally, for the Mediterranean region, or for the globe. Instead, the objective is to demonstrate the implications of different societal narratives, similar to the scenarios of the Millennium Ecosystem Assessment, for longer-term sustainability of ecosystem provisioning the region. For example, a particular agricultural mode may offer short-term high benefits for many stakeholders, but deplete essential resources (notably soil organic matter) in the longer term, creating risks also for current investors (“peak soil carbon”). The operationalization developed here, based on process-based agroecosystem simulation, will offer new capacities to test policy options with respect to these sustainability objectives.

Exemplar Selection and Description

The study region for this exemplar comprises the entire land area of all countries bordering the Mediterranean Sea, plus Portugal (Figure 18). In these countries, under broadly similar climatic conditions, a wide range of semi-natural and managed ecosystems occur, providing significant benefits to more than 490 million people, as well as more than 200 million tourists per year in the coastal regions (a significant share of these tourists coming from Mediterranean countries). Disparities in social and economic conditions around the Mediterranean basin are massive, and most countries are currently undergoing a form of deep economic and political crisis, manifesting itself in different forms in each country. As a consequence, under relatively similar ecological conditions, different land use systems have developed, and these now undergo different, but rapid transformations.



Figure 18. The Mediterranean region

Operationalizing ecosystem service assessments for these ecosystems requires reliable estimates of the biophysical functioning of them, as a function of environmental conditions and local management. These functional estimates are based on: i) spatial datasets of environmental conditions (soils, topography, hydrology, climate, current land cover); ii) structured data of current agricultural practices, organized in a limited number of agricultural mode classes; iii) a process-based ecohydrological agroecosystem model (LPJmL), extended to cover all major crops and relevant agricultural modes of the Mediterranean region, iv) scenarios of changes in climate, land use (including urban sprawl) and agricultural practice, based on multiple socio-economic narratives as well as multiple models of climate and land use change.

Based on presently available statistics, as well as scenario outputs from the system outlined above, some services can be estimated and valued at local scales, and then be aggregated linearly (e.g., carbon sequestration), while others may require valuation at a higher spatial scale and/or may need to take account of service provision levels in other areas (for example, recreation). Linking model outputs to spatial valuation evidence is a key aspect of research. We will define, in consultation with stakeholders, the nature and purpose of the valuation components. For the Mediterranean, the following are of interest: i) mapping and accounting for changes in natural capital and ecosystem services; ii) demonstrating and communicating the importance of ecosystems and their services; and iii) strategic planning, exploring future scenarios and robust climate adaptation options.

Mapping service provisioning potential is a base for achieving the other two objectives. International standards in ecosystems accounting have been developed as the “System of Environmental-Economic Accounting” (SEEA) which contains internationally agreed standard concepts, definitions, classifications, accounting rules and tables for producing internationally comparable statistics on the environment and its relationship with the economy. The SEEA Central Framework is based on measurements in three main areas – we will explore the degree to which these measurements can be replaced by output from the process-based ecosystem model:

- the physical and value flows of materials and energy: supply and use in physical and monetary terms showing flows of natural inputs, products and residuals;
- stocks of environmental assets: accounts for individual environmental assets in physical and monetary terms showing the stock of environmental assets at the beginning and end of each accounting period and the changes in the stock; and
- economic activity and transactions related to the environment: sequence of economic accounts that highlights depletion adjusted economic aggregates, and functional accounts which record transactions and other information about economic activities undertaken for environmental purposes.

Human demands and locations also need to be considered. We can measure function, and *potential* service provisioning directly, but *realised* service requires consideration of societal dynamics. Cultural services such as recreation and aesthetic value depend on people going to the resource (often by motorised transport, and often using other resources once there). Regulating services also depend on humans and manufactured capital: water purification may be largely irrelevant (service-wise) where there is no human population with water abstraction infrastructure. This applies to service as opposed to function. Even non-use values may be dependent on the resources devoted to their communication and to the human education required to appreciate them.

It should be noted that there may be environmental assets that are recorded in the framework in physical terms but which have no measured monetary value and hence are excluded from environmental assets measured in monetary terms. Here the differences between *potential* and *realised* ecosystem service values are relevant. The physical state of a system is a strong determinant of potential value, but realised value depends on human inputs and demand. One interesting option is to consider the ‘slack’ between potential and realised values as a form of insurance/resilience value, or an option value. This is one way in which accounts could (a) take uncertainty partly into account and (b) give credit/cost for changes in natural capital states that do not directly convert into final service flows at present, but that do influence national natural wealth (future opportunities).

Implementation of the outlined procedures will occur on the basis of a spatial grid, covering the land area of all Mediterranean countries mentioned above, using the best available data sets. Naturally, the quality and resolution of these data sets differs widely between countries, and is generally lower outside the European Union. It is likely, however, that some data can be acquired for the entire region – interpretations will have to account for data-related uncertainties. In cooperation with other OPERAs Work Packages / exemplars, contrasting socio-economic

narratives will be developed that cover a wide range of possible future conditions. From these, scenarios of climate change, changing land use (including urban sprawl) and agricultural practices will be derived. Using the process-based model and the valuation methodologies outlined above, different trajectories of sustainability in Mediterranean land use systems will be compared.

Research Questions

1. What is the role of ecosystem services for the sustainable development of the human-environment system around the Mediterranean basin, considering both marketable and non-marketable benefits from ecosystems in the longer term perspective?
2. Are currently available methods adequate for the simulation of ecosystem processes in managed Mediterranean ecosystems, such as to estimate the longer-term (multi-decade) sustainability of land use systems?

Goals

A primary goal of the exemplar is to evaluate available methods for ecologically plausible and scientifically sound assessment of ecosystem services applied to the full range of Mediterranean land use systems, with an initial focus on agroecosystems. The main approach is to start with the well-proven global agroecosystem model LPJmL (Figure 19), adapt it to specific features of the region and validate it with respect to observed outputs of diverse land use systems.

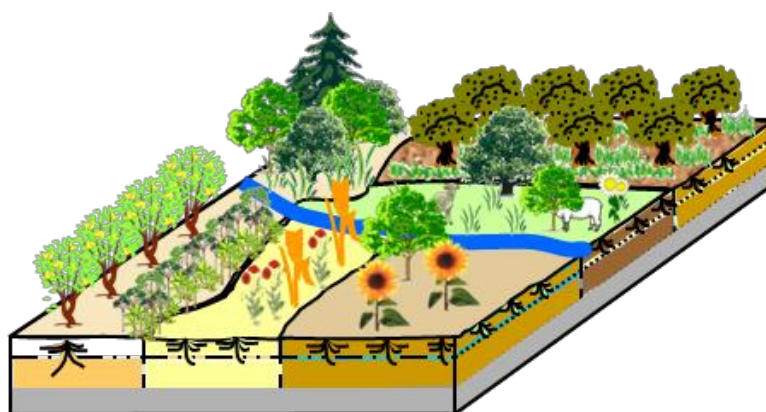


Figure 19. Symbolic description of the process-based agroecosystem model LPJmL

A further goal is to assess a broader range of ecosystem services, beyond agricultural productivity, and test suitable techniques for conducting scenario-based assessments of these services under Mediterranean conditions. The initial step for this assessment is the study of demand for ecosystem services under different social and economic conditions in Mediterranean countries.

A third goal is to test the applicability of the described model-based valuation framework for regional cases where better quality information is available. Although not a crop-based agricultural landscape, comparisons with the Montado cultural landscape service estimates will be undertaken.

Ultimately, in exchange with other research teams, the objective is to provide appropriate techniques to support policy as well as private decision making in ecosystem management in the region.

Linking Stakeholders, Instruments, and Ecosystem Services

Stakeholder description

A key stakeholder for policy issues in Mediterranean environmental management is the Plan Bleu Regional Activity Centre. Its main objective, established by the contracting parties to the Convention of the Protection of the Marine Environment and the Coastal Region of the Mediterranean, is to contribute to raising awareness of Mediterranean stakeholders and decision makers concerning environment and sustainable development issues in the region, by providing future scenarios to assist in decision-making. The exemplar team links also directly into the developing stakeholder mechanism of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES).

Identification of stakeholder needs

Stakeholder needs will be elaborated during the first six months in 2014.

Global Exemplar

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Peter Verburg, Institute for Environmental Studies, VU University Amsterdam

Astrid van Teeffelen, Institute for Environmental Studies, VU University Amsterdam

Almut Arneth, Karlsruhe Institute of Technology

Anita Bayer, Karlsruhe Institute of Technology

Bruno Locatelli, The Centre for International Forestry Research

Emilia Pramova, The Centre for International Forestry Research

Claire Brown, UNEP-World Conservation Monitoring Centre

James Paterson, University of Edinburgh

Karin Viergever, Ecometrica

Rob Tinch, IODINE

Diana Tuomasjukka, European Forest Institute

Lisa Ingwall-King, UNEP-World Conservation Monitoring Centre

Dream Abstract

International policy frameworks such as the Convention on Biological Diversity (CBD) or the United Nations Framework Convention on Climate Change (UNFCCC), as well as the pressing need to feed an increasing global population, strongly compete for land around the globe. Thus, there is a strong need to identify potential arrangements and land management solutions that do not jeopardise each other on the limited space available on Earth.

The Global Exemplar aims to create a better understanding of the impacts of major global policy and demographic pressures and potential conflicts and synergies for the provision of ecosystem services and the preservation of natural capital. It identifies key drivers of ecosystem service (ES) transitions, synergies and trade-offs between different pressures, as well as particularly vulnerable areas and the most critical ecosystem services. It uses the concept of ecosystem services as particularly promising to address such a multidimensional problem, and addresses these global key pressures in a multi-scale approach from regional to global scale.

Large-scale, low-resolution land use and ecosystem modelling will estimate the impacts of these global pressures over large areas around the globe on multiple ecosystem services with ecosystem service provision being derived by post-processing from simulation results of several models. Small-scale, high-resolution studies, e.g. in Peru, will provide insights on strongly contextualized impacts of the same global pressures and how they materialize within single regions. Here, the changes of ecosystem service provisioning in the past, as well as potential future changes within the context of the given scenarios will be investigated, reconstructing change from 1990, and then projecting into the future until about 2030 (2050 for the global models).

Ideally we will draw attention to the partly conflicting solutions offered by the global decision-making communities in climate change mitigation and adaptation, biodiversity conservation, and global food security, and inform them about potential synergetic policy options. In a perfect world, these communities would then stop elaborating single-goal solutions within their own community in favour of better-informed, more multi-dimensional policy solutions.

Study Rationale

A common general procedure, a common set of ecosystem services and a common set of global scenarios build the backbone of the Global Exemplar. These three commonalities will support assessing the transition of ecosystem services over time, across scales and regions, and the identification of synergies and trade-offs in ecosystem services provisioning under global policy scenarios. These results will constitute a spatio-temporal database accessible to the public and to decision-makers at all levels (see Figure 20).

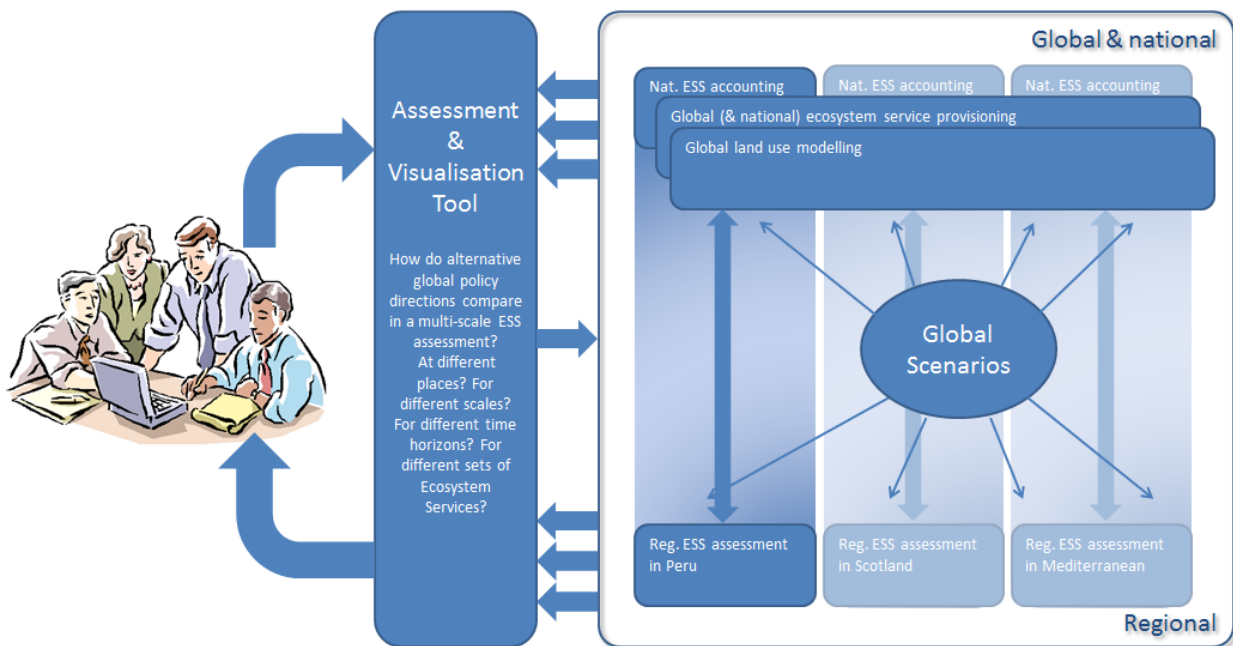


Figure 20. Conceptual framework of the Global Exemplar, see text for more details.

A common general procedure envisages the transition of ecosystem services over time and space with a strong emphasis on future development based on scenario analysis as the Global Exemplar's overarching analytical concept. Inspired by the forest transition theory, the development of changes in the past, as well as potential future changes within the context of the given scenarios will be assessed (see Figure 21 for anticipated output). The timeframe envisaged at this stage for the regional scale is going back between 20 and 30 years, reconstructing the current situation and then scenario based projections into the future until 2030. The models can be extended to longer time frames to simulate until 2050. While the large-scale models will simulate the future development of ecosystem provisioning, quantitative and qualitative methods will be combined within the regional scale case studies, e.g. in Peru.

Ideally, the global exemplar would include two to three regional case studies, if possible along a development gradient. These regional assessments would then be accompanied by a national-level aggregation of the large-scale, low-resolution modelling output and a national Ecosystem Service Accounting based on the outputs of these models (see Figure 1). At this stage, one regional case study is definitive. This case study will be located in Peru, mostly like on the Eastern slopes of the Andes. The Mediterranean and the Scottish exemplars will likely join the Global exemplar with regional case studies (as indicated in Figure 20).

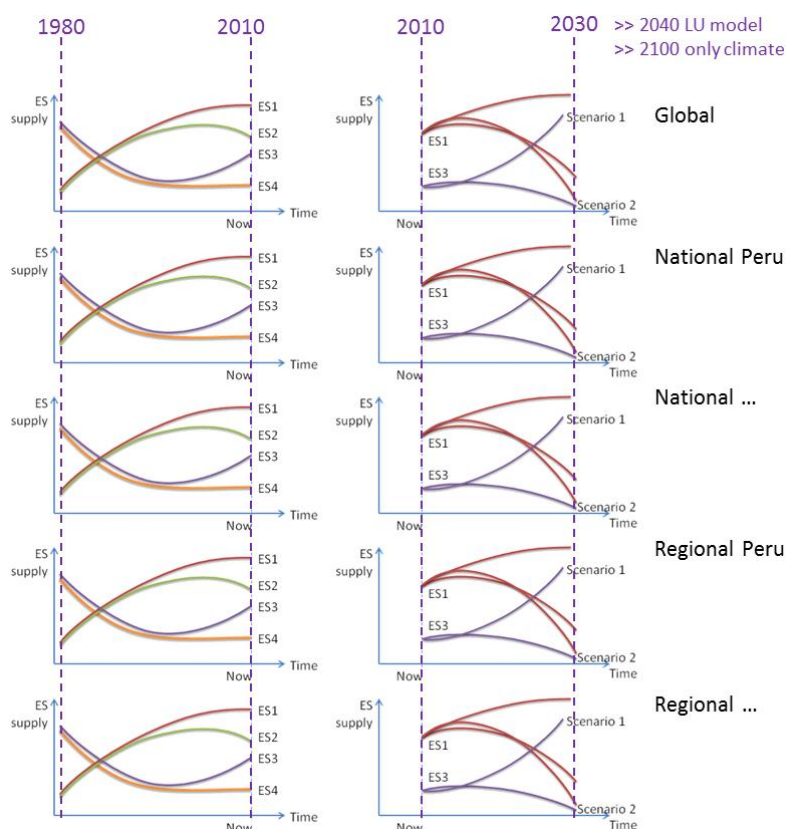


Figure 21. Anticipated outcome of the ecosystem service transition and scenarios analysis, which will then serve as a basis for the OE tool for online analysis and visualisation.

A common set of ecosystem services will be addressed in each of the contributing studies across scales and regions. This common set of ecosystem services is a subset of the ecosystem services addressed in the individual studies contributing to the Global Exemplar (see Table 18). It includes three regulatory services (climate regulation, water regulation and ecosystem integrity) and three provisioning services (food, timber and firewood production).

A common set of global scenarios will inform simulations at global and national scales, and will set the boundary conditions for the regional assessments. They will represent combinations of the most important global policy directions of relevance for land use patterns worldwide (see Table 17 for potential future states). These global scenarios include strong policy steering towards a) biodiversity conservation, b) climate change mitigation and adaptation, c) food production and d) combined approaches towards biodiversity, climate mitigation and adaptation, and securing livelihoods through REDD+-like global policy initiatives. While large-scale / low resolution land use and ecosystem modelling will help to estimate the impacts of global pressures over large areas around the globe on selected ecosystem services, small scale / high resolution studies will provide insights on strongly contextualized impacts of the same global pressures, i.e., how they materialize within single regions.

The elaboration of the scenarios will be conducted as a collaborative activity within the Global Exemplar team, and will include consultative input by individual stakeholders. As many global policy scenarios with similar foci have been developed over the past decade (such as the OECD Environmental Outlook, IPCC AR5, and the Millennium Ecosystem Assessment, among others), we will build on existing scenarios as much as possible and will also coordinate with the efforts within the OpenNESS project (e.g. to be used for GLOBIO).

Demand for food (=constant)	Biodiversity Conservation Goals	Climate Change Mitigation Goals
Food 1: Agroindustry Food 2: Mixed farming systems	Conservation 1: for each unit of area converted to agriculture the same area of forest is to be protected Conservation 2: for each unit of area converted to agriculture the same area of natural ecosystems will be restored areas	Climate 1: 550 ppm by 2100 with bio-energy use Climate 2: 550 ppm by 2100 without bio-energy use

Table 17. Main factors to be included into the scenario analysis with two potential development pathways for each.

Exemplar Selection and Description

Natural capital and ecosystem services have been threatened by European policy-making and consumption beyond European borders. The Global Exemplar goes beyond the bounds of Europe and investigates the impact of global key directions on land and ecosystem management and, ultimately, ecosystem services and natural capital.

These key directions are closely linked to biodiversity protection (through the CBD), climate protection (through the UNFCCC) and global pressures for increasing food production. Although potential synergies exist between all three goals, these synergies are not well achieved due to institutional structures of the global policy processes. In the Global Exemplar we therefore aim to develop an online application that allows decision makers to access and analyse global and national ecosystem service provisioning, ES values for a selection of countries, and regional case study examples. All this information will be communicated and visualised in the Online Application Tool, which will build on results generated from a variety of information tools and scientific techniques.

The multi-scale approach of the Global Exemplar includes global and national distribution of the impacts of policy scenarios, as well as regional case studies to illustrate how the global scenarios may materialise in individual regional contexts. Global land use and ecosystem modelling will provide information to quantify ecosystem service provision around the globe, based on policy and climate change scenarios. These global outputs will be aggregated for individual countries and

their economic value will then be assessed for single countries based on various economic valuation methods, including national accounting and cost-benefit analysis. At the same time the Global Exemplar envisages to work in two to three small-scale, high-resolution case studies along a development gradient, including a regional case study in Peru, Mediterranean countries and Scotland, with the case study in Peru being certain and best elaborated at this stage.

Peru has been selected because it experiences very dynamic economic, political and environmental changes, including decentralization, development of extractive sectors, and participation in global conservation and climate change mitigation agreements. It hosts ecosystems of high biodiversity value, large protected areas, ever-changing landscape mosaics with dynamic ecosystem transitions, and many indigenous communities and cultures. The drivers of change are diverse, and originate from the global to the local level. Peru is one of the countries with the largest extent of tropical forests in the world (approx. 68 million ha), but it is now experiencing rapid and extensive deforestation. Vulnerability to diseases, weather disasters, habitat loss and economic stress related to climate change is high in Peru. Mechanisms such as Ecosystem-based Adaptation (EBA) to support poverty alleviation, sustainable development, biodiversity conservation and climate change adaptation have a high potential in Peru's ecosystems, though their application in synergy remains under-explored. Various economic, environmental and social impacts as triggered by the above- mentioned policy changes will be assessed with a sustainability impact assessment on a small-scale case in Peru, based on defined scenarios with focus on land use change and its effects on livelihoods and the environment.

The multi-scale approach allows for integration of further regional case studies based on regional exemplars within OPERAs, in particular as the global scenarios used reflect important pressures experienced in these regional exemplars.

Research Questions

1. How do alternative global policy directions compare in a multi-scale ecosystem service assessment?
2. Where can we find synergistic effects between policy directions, i.e. increase of multiple ecosystem services? Where are hotspots of vulnerability of ecosystem services?
3. What effects do we miss when investigating ES/NC at the global scale versus the regional scale?
4. How can information from different scales be successfully communicated to inform global decision makers?

Goals

The major goal of the Global Exemplar is drawing attention of decision-makers to conflicting impacts of major global policy directions on ecosystem services and natural capital, and indicates potential synergetic solutions.

Linking Stakeholders, Instruments, and Ecosystem Services

Stakeholder description

We will involve stakeholders from global to regional levels in this exemplar. Stakeholder analyses for the large-scale approach as well as for the regional case studies will help us to identify the relevant types of stakeholders for the questions addressed.

For the large-scale approach, important stakeholders will certainly include the Convention on Biodiversity (CBD), the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) and the Biodiversity Observation Network of the Group on Earth Observation (GEO BON). Claire Brown from UNEP WCMC has confirmed she will play a central role in linking our activities to these ongoing processes. She agreed upon a two-fold communication path, addressing first the design of our study and the scenarios to be targeted, and then at a later stage presenting the results of our research back to these international bodies, either through flyers (IPBES & COP) or a 2h-side event (COP).

Parallel to these efforts, individual representatives involved in these international political processes will be approached with national agencies and governments. For instance, René and Ariane have been in touch with the German Environmental Agency and will discuss the expectations for a web-based application (Our Ecosystem, OE) with relevant persons there in March.

In relation with the Peru case study, consultations and discussions on research priorities have already taken place at different levels. At the international level, CIFOR and partners organized the Global Landscapes Forum (16-17 November 2013, Warsaw) during the climate change

negotiations (CoP19) and organized a side-event at CoP19 on linking climate change adaptation and mitigation in landscapes. At the regional level, CIFOR co-organized, with CATIE and other institutions, a Latin American conference on climate-smart territories in the tropics (Sept 30-Oct 4, 2013, Costa Rica). At the national level, meetings have taken place for example with NGOs and the Peruvian ministry of environment. These meetings have allowed discussion of major research questions related to climate change and ecosystem services in landscape management. For additional regional case studies in the Mediterranean and Scotland, similar involvement would be required, which can directly build on the stakeholder dialogue already started within the respective exemplars.

Identification of stakeholder needs

Key issues stakeholders will address are (1) indication of synergistic policy combinations and conflicting policy implementations, and (2) the specification of impacts (quantification, distribution over space and time, and partially also beneficiaries and losers). These needs have not yet directly been discussed with relevant stakeholders; discussing these anticipated needs with them is a central goal within the coming year. Therefore, a tool is needed that decision-makers can use themselves to analyse synergies and trade-offs between biodiversity, climate change adaptation, and climate change mitigation on ecosystem service provision. Such a tool will allow for a number of relatively simple analyses, based a spatio-temporal database, which are then visualised in a comprehensive format. This tool will build on results from large-scale modelling of ecosystem services as well as small-scale regional results. Hence, the models and tools used in the previous investigative phase of the project are pre-requisite for the visualisation. Further tools are needed for economic valuation of adaptation services and for valuation under different future scenarios (e.g. valuation of hydrological services under scenarios of increasing vulnerability to water problems). Useful, but not yet directly incorporated to the Global Exemplar, are also tools that support the design and financing of initiatives with multiple objectives and policy instruments for new ecosystem management responding to regional (CC adaptation) and global (CC mitigation) issues.

Stakeholders	Stakeholder Expectations	Instruments	Ecosystem Service(s) Involved*	Anticipated Outcomes
Representatives in international policy processes National Stakeholders	<p>(1) Indication of synergetic policy combinations and of conflicting policy implementation</p> <p>(2) Specification of impacts (quantification, spatial distribution, over time, and partially also beneficiaries/ loser)</p> <p>Through:</p> <p>Access to visualisation and analysis tool for synergies and trade-offs</p> <p>Relevant scenarios</p> <p>Global land use change under different scenarios</p> <p>Provision of ecosystem services under different scenarios</p> <p>Economic valuation / comparison between different scenarios</p> <p>Analysis of synergies and trade-offs</p> <p>Economic valuation</p>	<p>Our Ecosystem: Online Analysis and Visualisation Tool (Karin Viergever, Ecometrica)</p> <p>ES Indicators (Lisa Ingwall-King, UNEP-WCMC)</p> <p>Participatory Scenario Development Tool (James Paterson, Univ. Edinburgh)</p> <p>CLUMondo: Global land use change model (Peter Verburg, VU Amsterdam)</p> <p>LPJmL: Dynamic vegetation model (Ariane Walz, René Sachse, Univ. Potsdam)</p> <p>LPJGUESS: : Dynamic vegetation model (Almut Arneth, Anita Bayer, KIT)</p> <p>CBA-IODINE (Rob Tinch, IODINE)</p>	<p>P1. cultivated crops, P3. wild plants, P7. drinking water, P9. timber, P14. firewood, biofuels, P21. hydropower, R8. water yield, discharge, R17. soil carbon, nitrogen availability, R21. transpiration, carbon sequestration, NEP, C5/10/11: ecosystem degradation/health</p>	<p>(1) Increased awareness and support of synergetic policy solutions</p> <p>(2) Less global pressures on regional land use decisions</p> <p>Outcomes along the way: Online-application that fits the needs of decision-makers in international policy development</p> <p>Multi-scale ecosystem service scenarios assessment</p> <p>Methods to derive ES and indicators from ecosystem model outputs</p> <p>Model coupling of land use and ecosystem models</p> <p>Regional study on threats and opportunities</p>

Representatives in international policy processes National Stakeholders Regional Stakeholders	Support the design and financing of initiatives with multiple objectives Policy instruments for new ecosystem management Ecosystem services assessment and identification of alternative states to aid decision-making and improve ecosystem management Benefit analysis	ToSIA: Tool for Sustainability Impact Assessments of ES and NC in value chains (Diana Tuomasjukka, European Forest Institute) TESSA: Toolkit for rapid assessment of ecosystem services at sites (Lisa Ingwall-King, UNEP-WCMC)	Case study in Peru: P3. NTFPs, P9. timber, P14. fire wood, R8. water regulation, R17. soil carbon, C5/10/11: suitability of ecosystems for indigenous communities and ecotourism	regional study on threats and opportunities knowledge in benefit transfer
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Table 18. Exemplar plan to address stakeholder needs and improve ecosystem services through instruments.

**Following the classification of Ecosystem Services from CICES v.4.3 (January 2013), contained in the “CICES” tab of the BluePrint Protocol.⁰*

Collaborations within OPERAs

Work Package 2: Practice

Two further regional case studies might be integrated from the Mediterranean and Scottish exemplars.

Work Package 3: Knowledge

The global exemplar combines models for simulation of land system transition (CLUMondo; Peter Verburg) with global ecosystem models (LPJ-GUESS: Almut Arneth, Anita Bayer; LPJmL: Ariane Walz, René Sachse). Furthermore, knowledge about links between ecosystems, biodiversity and ecosystem services and functions is used for developing methods to quantify ES from these model outputs (Almut Arneth, Anita Bayer, René Sachse). For systematic scenario-analyses we aim to apply synergy and trade-off analyses based on methods developed in WP 3 (Astrid van Teeffelen).

Work Package 4: Instruments

The Scenario Development Tool will be used for scenario development and documentation. Simulated scenarios are planned to be visualized by the mapping tool OE to facilitate direct interaction with stakeholders. Economic valuation and simplified accounting over time on national scales is planned using CBA-IODINE (Rob Tinch, IODINE). ToSIA will be applied within the Peru case study for assessing economic, environmental and social impacts of policy changes on forest ES and forest-dependant livelihoods (Diana Tuomasjukka, EFI). TESSA (Lisa Ingwall-King, UNEP-WCMC) will also be applied in the Peru case study to assess a number of ecosystem services to assist in decision-making. UNEP-WCMC will also work on developing appropriate ecosystem services indicators to assist in monitoring on a global and regional scale.

Work Packages 5 & 6: Resource Hub and Dissemination

Coupled models and new post processing programs to derive ES and indicators from model output will contribute to the resource hub. Results of the multi-scale ecosystem service assessment will be presented to international bodies by flyers, whereas PROSPEX and UNEP-WCMC will support dissemination amongst stakeholders, e.g. at 2h-side events at COP and enable discussions in plenary or with single government representatives from the regional case studies like Peru (Claire Brown, UNEP-WCMC).

Appendix 1: Overview of Instruments Used in OPERAs Exemplars

Tool / instrument category and tool name	Short summary (content and ES)	Lead persons / institute
Scenario Tool	Multi-scale scenario toolbox for strategic planning: (i) exploring implications of change on current decisions, (ii) assessing the viability of future targets including pathways with indicators	James Paterson, Marc Metzger (UEDIN)
CBA	Assessment of long-term, broad scale strategic decisions regarding different land-use options. Quantification/Valuation based on land use typology, associated management and social features and benefit transfer. ES: timber production, GHG regulation, recreation, aesthetics, biodiversity	Rob Tinch (IODINE)
CBA	Analysis of changes and costs related to shifts to greener land-use practices for furthering public/private payment mechanisms for ES in agriculture. ES: Food provision, biomass provision, energy provision, cultural (bird watching and ecotourism) in protected areas	Maya Bankova-Todorova (WWF)
Business information tool – LCA, labelling and others accounting and rating systems being explored	Analysis of potential environmental impact of a product throughout life cycle. Working on identifying the needs of businesses to assess the environmental impact of their products and operations on ecosystem services.	Boyan Rashev, Peter Seizov, Apostol Dyankov, Denitza Pavlova, Dariya Hadzhiyska (Denkstatt)
EIA -ToSIA (Tool for Sustainability Impact Assessments of ES and NC in value chains)	ToSIA: Tool for sustainability (environmental, economic and social) impact assessment of changes in policies or external forces within the forestry sector. ES: Provisioning Energy, Water, Timber, NTFP, Biodiversity, GHG emissions,	Diana Tuomasjukka, Marcus Lindner, Bernhard Wolfslehner (EFI)

	Carbon stock, erosion and other protection functions, cultural, traditional and livelihood aspects, certification. ToSIA-MCA for guiding users through an evaluation process: (i) defining indicator (thresholds), (ii) weighting indicators, (iii) aggregation, (iv) uncertainty and sensitivity analysis	
MCDA –mDSS tool	mDSS tool for guiding users through three decisional phases: (i) problem identification: DPSIR, creative system modeling, (ii) option definition and modeling: Simile modeling environment by Simulistics (iii) evaluation based on MCDA	George Cojocar, Carlo Giuppani (Tiamasg)
MCDA – ALUAM	ALUAM designed to understand interplay between climate change, economy, LU change on the provision of ES and for evaluating policy measures. ES: timber production, agricultural food products, GHG mitigation, protection from natural hazards, biodiversity	Sibyl Brunner, Adrienne Grêt-Regamey (ETH Zürich)
Collaborative Web-Platform: User interfaces and visualizations –	Interactive collaborative modeling and visualization platform linked with objective indicators for identifying trade-offs and thresholds associated with ES. ES: timber, agricultural food products, GHG mitigation, protection from natural hazards, biodiversity	Tom Klein, Adrienne Grêt-Regamey (ETH Zürich)
Information - TESSA: toolkit for rapid assessment of ecosystem services at sites	Provide a simple gross assessment of ecosystem services at a site-specific application. Indicate who will be the ‘winner’ and ‘loser’ as a result of any changes in land use and ecosystem service delivery.	Lisa Ingwall-King and Claire Brown (WCMC)
Information - Volante CANVAS tool	Crowd –sourcing tool used to assess social values of targeted stakeholders. Visual app with much potential for development and application.	Lisa Ingwall-King and Marc Metzger (WCMC)
Ecosystem services indicator development	Developing ecosystem services indicators (UNEP-WCMC 2011) – by using and enhancing established framework to develop tailored indicators for exemplars.	Eugenie Regan, Lisa Ingwall-King and Claire Brown (WCMC)

	Ecosystem services indicator database is an online searchable database where users can find—and contribute—indicators that have been used to apply ecosystem services approaches or hold promise for doing so.	
Mapping Information tool - OE: Our ecosystem	Our Ecosystem (OE) is a web-based land use and ecosystem mapping platform (tool). It enables access, sharing, organisation and querying of spatial data. Can use outputs from other models and tools as input to the platform	Karin Viergever, Ecometrica
PES	Payment for Ecosystem Services (PES) is a type of market-based instrument that is increasingly used to finance nature conservation. PES programmes allow for the translation of the ecosystem services (ES) that ecosystems provide for free into financial incentives for their conservation, targeted at the local actors who own or manage the natural resources.	P ten Brink, D. Russi and M. Kettunen (IEEP)
PA socio-economic assessment / PA Regulations	Step-wise and practice-oriented approach and guidance on how to identify, assess and communicate various ES and related benefits from PAs, with a specific focus on their socio-economic valuation	Marianne Kettunen and Patrick ten Brink (IEEP)
SEEA framework	The System of Environmental-Economic Accounting (SEEA) provides a systematised framework to collect information on the state of the natural capital and its changes over time.	P ten Brink and Daniela Russi (IEEP)
EHS Toolkit		Patrick ten Brink (IEEP)
Offsetting / NLL	Building on biodiversity offsets (ie measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project development), exploring integration of ES / NC into offsetting and NLL	L. Mazza, P ten Brink, G tucker IEEP; F. Quetier Biotope; A. Teeffelen IVM etc.

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