OpenNESS

Operationalisation of Natural Capital and Ecosystem Services

FINAL PUBLISHABLE SUMMARY REPORT

28 July 2017

SEVENTH FRAMEWORK PROGRAMME

From concepts to real-world applications

www.openness-project.eu

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1. An executive summary

OpenNESS has promoted a conceptual understanding about ecosystem services and natural capital by creating a Glossary with over 200 agreed terms and an Ecosystem Service Reference Book with a total of 27 Synthesis Papers published on the project website (www.openness-project.eu) and Oppla (www.oppla.eu). The application of the Cascade Model and CICES categories in the OpenNESS case studies, as well as the development of a translator tool using the HUGIN Bayesian Belief Network Software, has helped to provide an improved classification and better guidance to the wider community, enabling people working with the classifications used in the MA or TEEB or the UKNEA to cross reference their work in a rigorous and systematic way.

A policy analysis of key regulatory frameworks within Europe showed that the ecosystem services concept has not yet been mainstreamed across policy sectors but is confined to biodiversity, forestry and agricultural policies (Schleyer et al. 2015; Bouwma et al. 2017). Key policy messages related to regulatory frameworks are summarized in policy briefs on urban planning, water management, land use management and renewable energy policies as well as biodiversity offsetting. Four EU level scenario storylines were developed to assess the future impacts of multiple drivers, including policies, on land-use change, biodiversity and a range of ecosystem services. Only a few scenarios have been specifically developed with an ecosystem services focus, thus, the OpenNESS scenarios have subsequently been used in IPBES report 2(d) regional assessment for Europe and Central Asia.

The OpenNESS approach was based on applying the concept of ecosystem services in 27 real-life case studies covering different social-ecological systems in 23 European and 4 non-European countries (Wijnja et al. 2016). The results from the place-based applications are published in individual case study papers (www.openness-project.eu) and summarized across the case studies by Dick et al. (2017a) and Saarikoski et al. (2017). The key message emerging from the case studies is that ecosystem services knowledge is most effective, and operational, when decision-makers, practitioners and key stakeholders have been closely involved in the assessment process to ensure that they find the information relevant and reliable, and are ready to act upon it. The OpenNESS Conceptual Nexus (ONEX) (Haines-Young et al. 2017) provides a working environment for such deliberative processes.

The case studies also served as ‘test-beds’ for biophysical, socio-cultural and monetary methods to assess and value ecosystem services. The experience from testing 43 methods in the OpenNESS case studies resulted in an integrative ecosystem service assessment framework (Barton et al. 2017); a set of decision trees to help structure and guide the process of selecting individual methods (Harrison et al. 2017); a Bayesian Belief Network to filter methods based on user requirements; an analysis of the method combinations used in practice in the OpenNESS case studies (Dunford et al. 2017); an evaluation of the practical challenges of integrated ecosystem service appraisals (Barton et al. 2017); and 31 method factsheets. These guidance tools and fact sheets are available via Oppla.

The project results are synthetized into Oppla, a new knowledge platform to collate relevant information on ecosystem services. Developing Oppla was a joint effort between the OpenNESS and OPERAs projects,

and a non-profit entity European Economic Interest Grouping was established in September 2016 to manage and develop Oppla in the future.

The project contributed significantly to organizing ALTER-Net Summer School in August 2016, a Policy Day in Brussels in March 2016 as well as the European Ecosystem Services Conference in September 2016. 99 scientific articles and 79 other publications that are based on OpenNESS are published or in press by June 2017 and the work of OpenNESS was disseminated via over 200 local outreach events.

2. A summary description of project context and objectives

The overall objective of the OpenNESS project was to translate the concepts of ecosystem services and natural capital into operational frameworks that provide tested, practical and tailored solutions for informing sustainable land, water and urban management at different locales and scales. The specific objectives were the following:

1. To advance conceptual understanding of ecosystem services and natural capital and provide operational frameworks for application of the concepts in real-world management and decision-making situations.
2. To examine how existing and forthcoming EU regulatory frameworks and other key drivers of change can enhance or restore the benefits from ecosystem services and natural capital.
3. To develop and refine approaches for mapping and modelling the biophysical control of ecosystem services that can be used to assess the effectiveness of mechanisms, instruments and best management practices for sustaining ecosystem services delivery in the face of multiple uncertain drivers whilst conserving biodiversity.
4. To develop hybrid methodologies that address trade-offs, synergies, and conflicting interests and values in the use of ecosystem services through a combination of monetary, non-monetary and deliberative methods with multi-criteria and Bayesian approaches for decision support.
5. To apply the concepts and methods developed and refined in the project to concrete, place-based case studies in a range of social-ecological systems with stakeholders and analyse the implications of local, regional and EU level decisions on ecosystem services flows and use in other parts of the world.
6. To translate the results into policy recommendations and integrate the outputs in a Menu of Multi-Scale Solutions and associated datasets which are available for ecosystem services users and managers as well as decision-makers.
7. To disseminate the results to reach a broad audience and to promote and maintain science-policy dialogue on the use of the concepts of ecosystem services and natural capital.

The OpenNESS work programme integrated methodological advances and empirical analysis in an iterative cycle of application and refinement that drew on experience from real-world case studies (Figure 1 and Figure 2):

1. WP1 created the foundation for the overall work programme in advancing conceptual understanding and providing operational frameworks for the key ecosystem services and natural capital challenges related to human well-being, sustainable land and water management, governance and competitiveness.
2. WPs 2 to 4 developed the methods related to policy and scenario analysis. WP2 developed participatory multi-scale scenario approaches to analyse drivers of ecosystem change, including existing and forthcoming EU regulatory frameworks. WP3 focused on biophysical assessment of ecosystem services and developed a range of spatially-explicit methods for investigating the effects of multiple drivers on ecosystem services supply. WP4 focused on the demand for ecosystem services and developed a hybrid evaluation framework that takes into account both monetary and non-monetary value dimensions of ecosystem services. These WPs worked together to develop cross-cutting methodologies such as Bayesian Belief Networks and multi-criteria evaluation methods.
3. The focal point of the research was the application and testing of the methodologies and concepts from WPs 1 to 4 in a coherent set of real-world case studies in WP5 so that operational issues could be identified and good practice discovered.
4. Results from the case studies were integrated into coherent databases, guidelines and recommendations by WP6 into a Common Platform, currently called Oppla (www.oppla.eu).
5. WP7 promoted the science-policy interface and the uptake of results including by business.

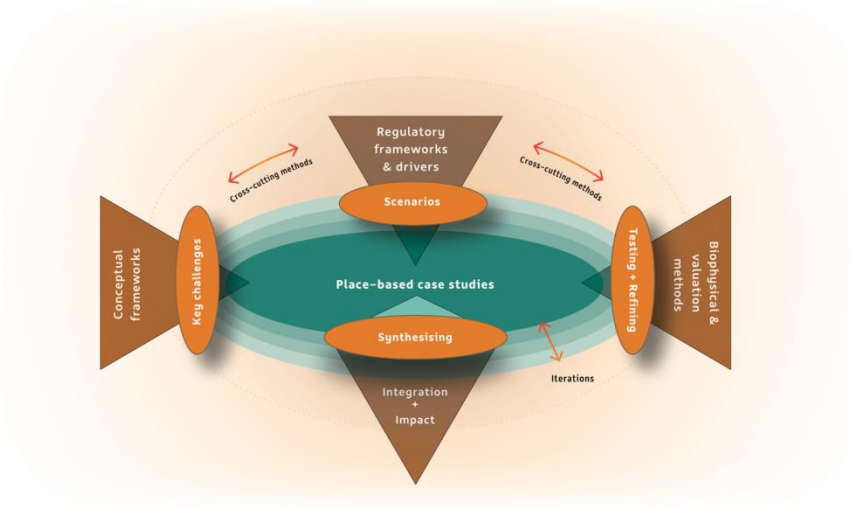

Figure 1. The OpenNESS approach (modified according to OpenNESS DoW, p.12).

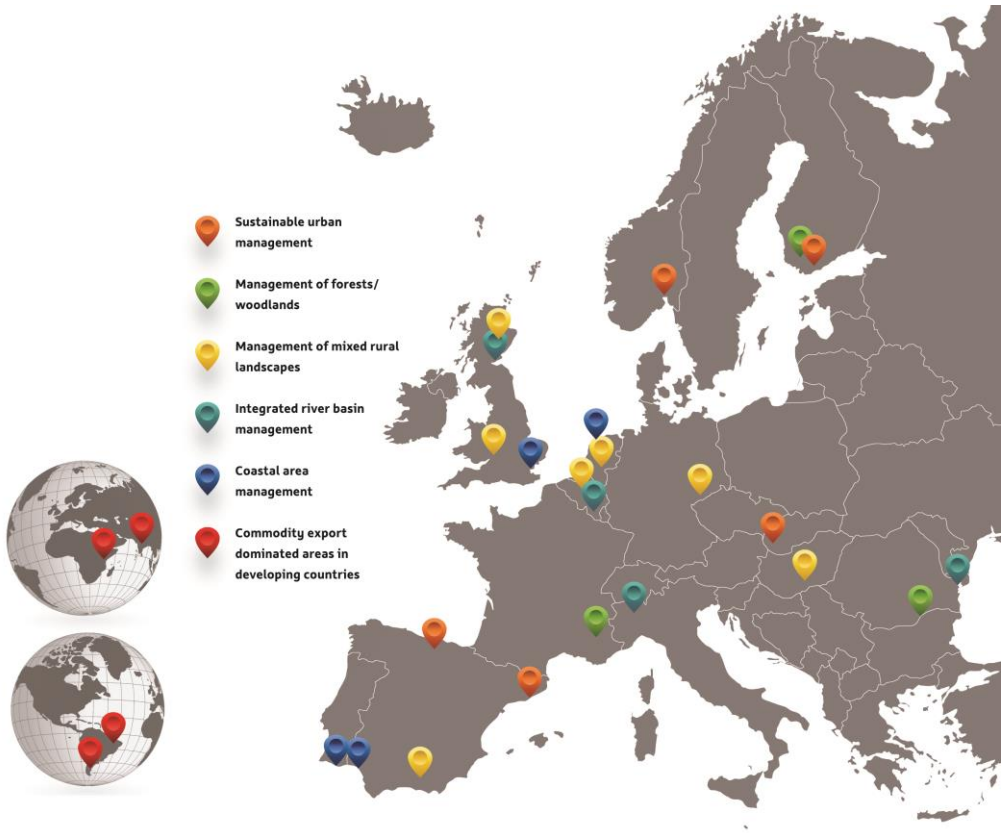

Figure 2. OpenNESS case studies.

3. A description of the main S&T results/foregrounds

3.1 OpenNESS approach

The OpenNESS approach was based on testing conceptual frameworks and methodological advances in integrated ecosystem service assessments and valuation in 27 real-life case studies covering different social-ecological systems in 23 European and four non-European countries (Figure 2). The real-world cases were designed to integrate the concept of ecosystem services into land and water management at local, regional and in some cases also national level, focusing on timely management or policy problems. For example, some case studies focused on integrating ecosystem services in urban planning (e.g. Oslo, Barcelona) while others looked at water management (e.g. Loch Leven and Lower Danube River) or multi-functional landscapes, like traditional vineyards in the surrounding landscapes of Doñana National Park in Spain or a flood control area in Belgium. The case studies are documented in more detail by Wijnja et al. 2016 and short case study descriptions can also be found in Oppla using the case study finder, which filters case studies according to scale, policy/management field and geographic area.

The case study research teams interacted closely with case study advisory boards (CAB), which were established by the research teams and the problem owners, and included natural resource managers and/or land-use planners, decision-makers, interest groups representatives and local actors. The role of the CABs was to define the ecosystem service management or decision-making problem at hand, to identify the research needs with the case study research teams, to discuss the premises as well as outputs of the analyses, and to provide local knowledge and value information needed by some assessment methods. This participatory action research approach was instrumental in producing shared understanding among the researchers, practitioners and place-based experts.

The case study research teams were effectively supported by conceptual and methodological experts who provided them with information and guidance on methods and approaches that could be suitable for addressing the assessment problems, given practical constraints related to time, resources and expertise. Following an iterative cycle of application and refinement that draws on the experience from the real-world case studies (Figure 3), the conceptual frameworks as well as biophysical assessment methods and monetary and socio-cultural valuation methods were introduced to the case study teams in the beginning or the project, in a cross-project workshop in October 2013 and a dedicated training event in October 2014. At the later stages, when the case studies had sufficiently progressed in the application of methods, feedback on the applicability of the methods was gathered via surveys and dedicated feedback sessions in project meetings and workshops in 2015-2016. The information from the case studies and the method experts was used to create a set of decision trees and other tools to help structure and guide the process of selecting individual methods that are fit for purpose (Harrison et al. 2017; Dunford et al. 2017; Barton et al. 2017; Jacobs et al. 2017) as well as the OpenNESS Conceptual Nexus (ONEX) (Haines-Young et al. 2017), which used the four key challenges—human well-being, sustainable ecosystem management, governance, competitiveness—as entry-points for linking the ecosystem services to societal needs, and hence becoming operational. The case studies also fed into policy analysis of the scope and extent of mainstreaming ecosystem service into EU level regulatory frameworks (Bouwma et al. 2017) and they provided input for policy scenarios that have later informed the work by IPBES.

An essential element of the OpenNESS approach was also an emphasis on Synthesis Papers (SP) which facilitated interdisciplinary interaction and helped the consortium to explore key concepts and ideas at the beginning of the project. These SPs have fed into the OpenNESS Ecosystem Service Reference Book (Potschin and Jax 2016) and a Glossary.

The conceptual and methodological advances as well as the case study descriptions, database on natural capital and ecosystem service linkages, and SPs as well as several scientific papers that have elaborated on the themes of the SPs are all synthetized into Oppla (formerly known as the Clearinghouse), which is a knowledge hub where the latest thinking on ecosystem services, natural capital and nature-based solutions is brought together. The Ecosystem Service Assessment Support Tool and associated Guidance Tools (formerly Menu of Multi-Scale Solutions) help Oppla users to navigate the information and structure an assessment process.

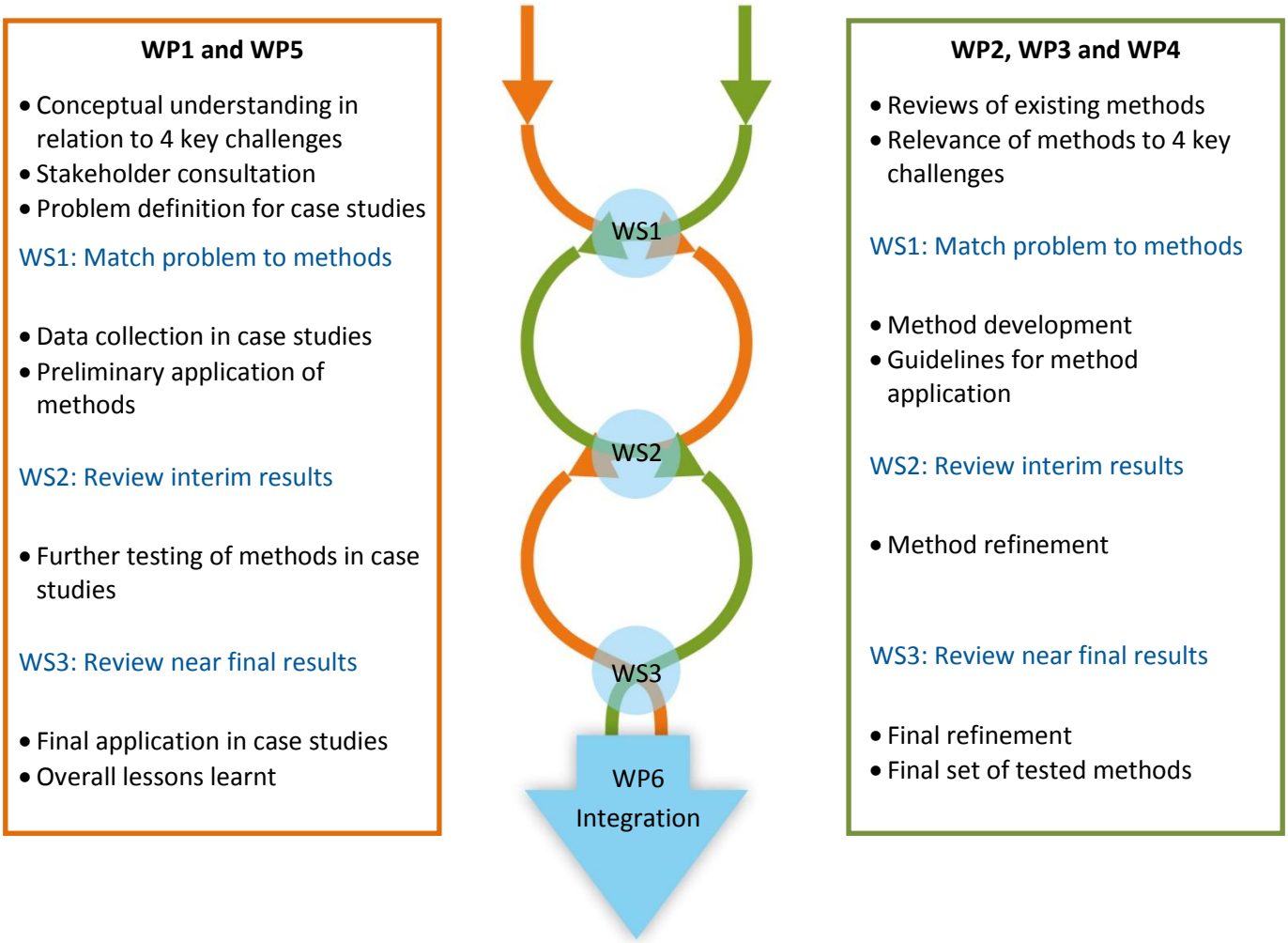

Figure 3. Schema illustrating the overall methodological approach (WS=workshop) (adopted from OpenNESS DoW, p. 15).

3.2 Advances in conceptual understanding of ecosystem services related to four societal challenges

During the rapid expansion of the ecosystem service field after the publication of the Millennium Ecosystem Assessment in 2005, a number of new ideas and issues were being actively discussed by the science and policy communities. Although the debate was significant and important, a number of different and often conflicting understandings of issues developed because the field had brought together people from a range of different disciplines and backgrounds. As the science matures, however, such issues need to be clarified and resolved so that ecosystem service concepts can be applied successfully in an operational context. The period covered by the work of OpenNESS has been one in which the science of ecosystem services has entered a mature phase, where we need to show how applications are rigorously grounded in evidence. One of OpenNESS's focuses was to test and hone the concepts and terminology used in the field of ecosystem services so that practitioners can be more precise about what they measure, and how those metrics inform understanding of the ways ecosystem services are generated and sustained.
The OpenNESS Consortium was large, and in many ways its diversity reflected in microcosm the state of the wider science and practitioner communities. Thus the conceptual work in OpenNESS consisted of two complementary elements: First, to build a common understanding of issues between the project partners. Secondly, to use this experience to develop and promote a conceptually consistent approach that could be applied by others beyond OpenNESS. These two elements were incorporated into the overall methodological approach(es) around which the OpenNESS work programme was designed (Figure 4). As this diagram shows this approach was iterative, with project partners coming together in a series of cross-cutting and integrative workshops intended to test and consolidate thinking across a broad range of issues. Within this process the conceptual work shaped discussions, and, by drawing on the lessons learned, eventually developed a set of operational guidelines that would help practitioners apply the concepts that make up the field of ecosystem services in a consistent and rigorous way.

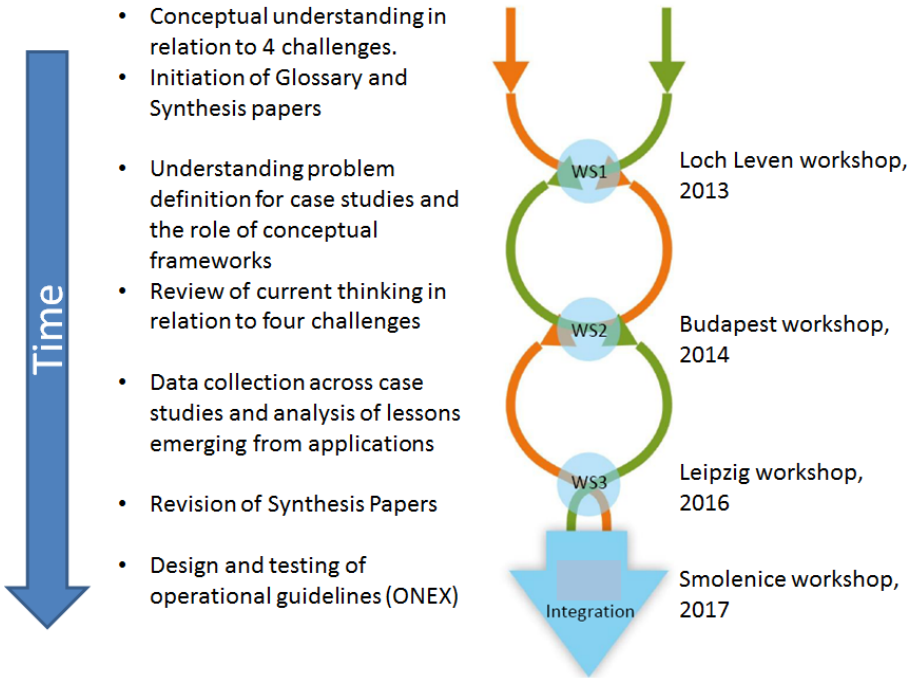

Figure 4: The trajectory of conceptual work in OpenNESS and its key tasks and outputs

Advancing conceptual understanding in OpenNESS

Early on in the project a comprehensive glossary of terms was developed:
The work drew on the different strands of understanding in the field of ecosystem services and through a process of consultation and peer review proposed a set of consistent and agreed terminology for use within the consortium. While there was no requirement for project partners to follow the terminology exclusively, the general understanding was that if people chose to depart from it they would explain the basis of their alternative approach. The glossary covers over 200 ecosystem service related terms, is 'web-enabled' and is now being used to help users navigate concepts on the OpenNESS and Oppla websites. The Glossary has also been taken up by other EU-funded Projects such as ESMERALDA (http://www.esmeralda-project.eu/) and OPERAs (http://www.operas-project.eu/).

Throughout the project partners from across the consortium have collaborated to publish 27 Synthesis Papers (SPs) on key concepts within the field of ecosystem services:
Again, this work was initiated at the start of OpenNESS (Figure 4) as part of the work designed to ensure members of the consortium had a common understanding of concepts and issues. The SPs are succinct and up-to-date reviews of the state of thinking around different key concepts such as (non-monetary) valuation, trade-offs, social justice, etc. that make up the field of ecosystem services, coupled with a reflection on the implications of the ideas for the work of OpenNESS. Before publication the SPs were open for review and comment by all consortium members. A formal and transparent editorial process ensured that comments were considered critically by the authors, whose responses were published alongside the final version of

the SP. The SPs were reviewed and updated in the later stages of the project, in 2016, to take account of the learning within the project and recent developments in the wider literature. As a legacy from the project they make up the 'OpenNESS Reference Book' that is available to the wider community through Oppla (http://www.oppla.eu/).

OpenNESS has examined and explained the role that conceptual frameworks have in ecosystem assessments and how they can be made relevant in different operational contexts:
This was the largest and most significant component of the conceptual work undertaken by OpenNESS, involving extensive and continued interaction with the OpenNESS case studies; again it took place in a phased and interactive way throughout the project (Figure 4). The work sought to combine two elements. First, to reflect on the use of conceptual frameworks by critically examining the way in which OpenNESS case study partners used or reacted to the 'ecosystem service cascade model' (Figure 5). Second, to explore how the *general* thinking represented by the cascade could capture the specific issues surrounding the major societal challenges of human well-being, sustainable ecosystem management, governance and competitiveness (Dick et al. 2017b). OpenNESS's main findings in relation to these two elements are as follows:

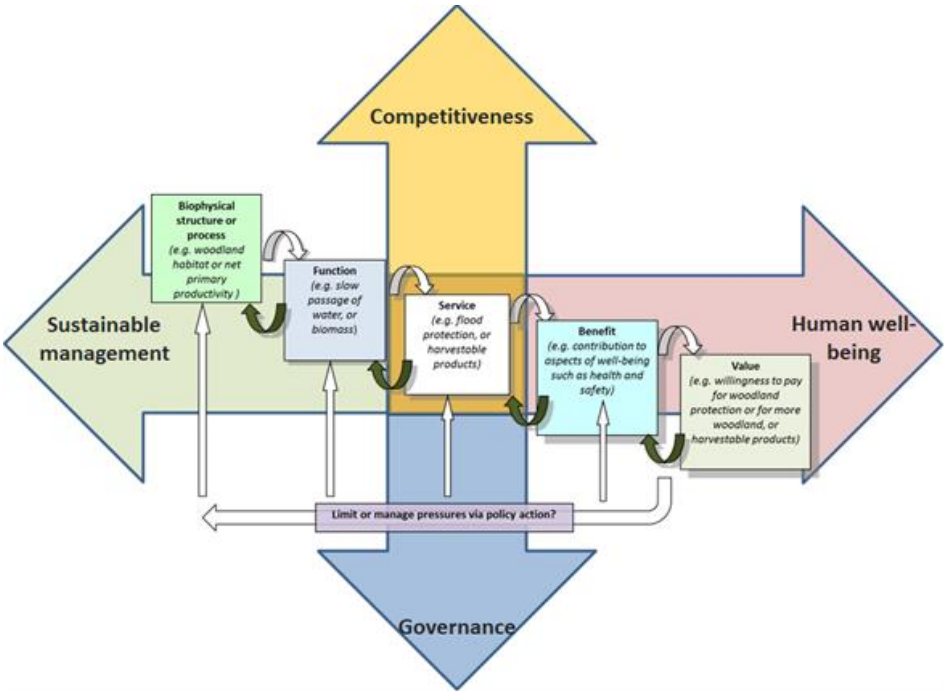

Figure 5. The cascade model and the four challenges (Source OpenNESS D.1.2, Potschin et al., 2014).

1) The cascade as a conceptual framework

The cascade model (Figure 5) seeks to show how society and nature are linked through ecosystem services; the most recent review of the thinking around the cascade is provided by Potschin and Haines-Young (2016) and Potschin-Young et al. (2017). Within OpenNESS the model was used to build on some initial

discussions from IPBES, which suggested that conceptual frameworks could be used to: 'simplify thinking', 'structure work', 'clarify issues', and 'provide a common reference point'. In our analysis we used it to examine how it had been used in recent published material and how it had been used across the OpenNESS case studies.

In our work we found that there are examples in the literature that show the cascade model being used as an 'organising framework', a tool for 're-framing' perspectives, an 'analytical template', and as an 'application framework'. Although the published materials on the cascade are rich, we found that these accounts lacked insights into the process by which the different versions of the model were created. To remedy this lacuna a set of OpenNESS case studies were consulted to explore how they read the cascade. It was found that the cascade was able to provide a common reference for this diverse set of studies, and that it was sufficiently flexible for it to be developed and elaborated in ways that were meaningful for the different place-based applications. The case studies showed that generalised models like the cascade can have an important 'awareness-raising' role when working with non-specialist stakeholders.

Despite its simplicity, it was found out that the cascade provides a suitable tool to structure projects which analyse or value ecosystem services. In addition to providing a common reference-point the cascade appears to be capable of providing an entry-point for groups to develop their own view of an operational problem or issue. We found that groups could adapt the model because of practical necessities, such as the need to accommodate different stakeholder perspectives and levels of knowledge, or to add complexity as groups came to understand their problem situation more deeply. In this sense we concluded that the model represented a conceptual framework in its broadest sense, and that models like the cascade can serve as a template or platform on which case specific applications can be built. This conclusion has been supported independently by recent work reported by Dick et al. (2017b).

2) <u>The cascade and the four societal challenges</u>

The four societal challenges of human well-being, sustainable ecosystem management, governance and competitiveness were used in OpenNESS to explore how ecosystem service thinking could be applied in different operational situations (see below). These themes were identified as being of broad concern at the EU level in the call for FP7 funding in 2011, to which the OpenNESS consortium responded. Although the four topics were not seen as covering all the circumstances to which ecosystem service thinking might be relevant, in practical terms they enabled us to examine what might be done conceptually to get the ideas more widely used or 'mainstreamed' in several specific contexts.

Summary of the four societal challenges and the contribution of OpenNESS to their operationalization:

- The OpenNESS review confirmed that **human well-being** is a central component of the ecosystem service paradigm, and decisions about what it represents and how it is to be assessed are of major importance in such work (Jax and Heink 2016). In OpenNESS, it was viewed as a state that is also intrinsically and not just instrumentally valuable (or good) for a person or a societal group (Jax and Heink 2016). This definition was thought to be sufficiently pluralistic to accommodate the different perspectives of the OpenNESS case studies. The definition means that operationally we need to go beyond economic wealth, to include such things as health and good social relations, but also relations to nature. When looked at in this way, the key questions that emerged were to

understand how different ecosystem services relate to different components of well-being, and what trade-offs are involved at individual and group levels.

- OpenNESS demonstrated that understanding how changes in the output of ecosystem services affect well-being are closely related to the challenge of **sustainable ecosystem management**, which entails issues of what is being sustained and why, as well as how human well-being and sustainability can be achieved by managing ecosystem services. In OpenNESS sustainable management was examined via a range of situations emphasizing the relationships between biodiversity and ecosystem services, and how through the management of natural capital, biodiversity might be conserved or restored. While on the one hand this connects to human well-being issues, this challenge was found to raise the question about how sustainable ecosystem management can be supported by governance processes and institutions.
- In OpenNESS, the analysis of **governance** covered a wide-ranging set of issues. In addition to exploring the operation and effectiveness of different polices and regulatory frameworks from the national and EU levels, it also involved the analysis in different place-based contexts, of who is affected by ecosystem change, who makes decisions and which power relations are involved, whether different actors or groups make their voices heard, and how account is rendered. We found such analyses to be complex because they can involve actors and organisations operating at different spatial and temporal scales, with different motives and responsibilities. Although the effectiveness of governance mechanisms and institutions has implications for human well-being and the goals of sustainable ecosystem management, it can also affect the standing or status of a region or country relative to others. This comparative aspect is covered by the final OpenNESS challenge, namely that of competitiveness.
- The OpenNESS review found that the notion of **competitiveness** is often equated with economic performance. However, our work identified that investment in natural capital can benefit a place or a region both socially and economically (Haines-Young et al. 2016). This view was promoted under the Lisbon Treaty, but it remains unclear yet whether environmental quality is instrumentalized as a means for economic competitiveness or whether it represents a goal in itself. The Lisbon Treaty set out the goal for Europe of a highly competitive social market economy founded on social progress and “a high level of protection and improvement of the quality of the environment”; investment in Europe’s natural capital is now one of the seven flagship initiatives under the Europe 2020 Strategy. In OpenNESS, the theme of competitiveness was therefore seen as a way of exploring how the ecosystem service concept can be applied beyond the ‘environmental agenda’.

OpenNESS’s work built on extensive reviews of the current scientific and policy literature thinking on the four challenges, which was made available in OpenNESS Deliverable 1.2 and the Synthesis Papers on each of the four topics (Görg et al. 2016; Jax and Heink 2016; Haines-Young et al. 2016; Smith et al. 2016). The effort also entailed working with case study partners to identify if, and how, the challenges related to their work and especially whether by reflecting on them they discovered new insights that could expand their thinking. It also involved examining how thinking around the four challenges could be integrated with the cascade model.

We found that while the topics represented by the four challenges were always central to the work of the case studies, discussion of them and especially the way they are linked can open up new lines of investigation. Moreover, we found that while the cascade was a useful template for case studies to

represent their own concerns and issues, it was more difficult for them to use the model to make connections to broader themes and issues which could nevertheless enrich their work. The conclusion was that there was a need for better supporting materials to enable the cascade to be read in different ways by users. The work on the four challenges suggests that in thinking about them there is probably no single place in which to locate them 'diagrammatically', but rather they are better seen as 'outputs' or 'performance characteristics' of the socio-ecological system that the cascade represents. This is the idea that is captured in Figure 5. It also formed the basis of the work that led to the development of the 'conceptual guidelines'.

In addition to shaping the conceptual discussions within the project, OpenNESS has sought to generalise experiences so that they can be used more widely beyond the lifetime of the project and hence contribute to its perennity. This can mainly be seen in the work that resulted in the development of the 'conceptual guidelines', a process that took place throughout the project, but was completed (design and writing) during the final phases of the project (Figure 4). The outcome was the creation of the OpenNESS Conceptual Nexus (ONEX), which is a 'working environment' for exploring and applying ecosystem service thinking that is based on social media tools available over the internet. The key features of the work on ONEX included:

Understanding how ecosystem service thinking is used operationally:
When the idea of ecosystem services is used operationally, it usually involves groups of people coming together to resolve an issue, or at least to identify strategies for doing so. As the work with the OpenNESS case studies showed, this type of problem solving can be complex because: it involves people sharing and criticizing ideas; it involves making judgments on the basis of uncertain or incomplete evidence; and, the positions of those involved may change over time as they learn more about the problem at hand. ONEX was designed as way of using social media (TRELLO) to help people manage these difficulties.

Supporting deliberative processes extending over time:
ONEX provides groups of users with access to a network of key ideas used by the ecosystem service community. In ONEX concepts are not treated in isolation, but captured in a set of more than 70 questions. By considering these issues and how one leads to another, users of the network can build up a richer picture of the problem that confronts them, and so identify what issues are relevant and need to be addressed first. The set of questions can also be an effective way of broadening the perspectives that users have on their particular issue. With the facilitation of a knowledge broker, experienced in the ecosystem service concept, ONEX helps people to see how ideas are linked to each other and how by looking at and discussing their juxtaposition, groups can develop a richer picture of the issue that has brought them together. It should therefore be seen as a tool for supporting structured decision making. The structure of ONEX means that the rationale for the question set can be provided, and in working with a knowledge broker responses and agreed positions can be documented in an open and transparent way. ONEX can be customised and it is therefore able to be tailored to meet the circumstances of a given problem situation, and the emphasis that we have placed on supporting deliberative processes means that different views can be taken into account in a way that does justice to those involved. The self-documenting nature of ONEX on the TRELLO platform means that participants are kept informed over the extended period that is often needed to solve the wicked problems that surround ecosystem services.

Using the four challenges as entry-points for discussion:
The structure of ONEX was based on the analysis of the way in which the OpenNESS case studies have applied the ecosystem service concept, and how local perspectives can be broadened by considering the ideas that surround the four OpenNESS challenges of human well-being, sustainable ecosystem management, governance and competitiveness. For ecosystem concepts to be used operationally they need to be understood and seen as relevant to society's needs. The work has shown that the four challenges are good 'entry-points' for place-based studies during the early stages of their work. However, ONEX is fully customisable and other topics or challenges can be added as experience develops within the user community.

Ensuring perennity:
ONEX is freely available and is covered by a Creative Commons license. It can be downloaded from the https://trello.com/ and changed in ways that makes sense to particular applications. The experience that people gain in using it can be shared with others via the Lab, thereby supporting the social learning that is necessary for the field of ecosystem services to develop. ONEX has been tested with three of the OpenNESS case studies, and the feedback we have gained suggests that the question set can indeed open up new perspectives on operationalising ecosystem service thinking. The four challenges represent useful initial archetypal issues that could provide entry-points for operationalising ecosystem service thinking in different application contexts.

3.3 Analysis on regulatory frameworks and drivers of change in relation to ecosystem services

Complex drivers and pressures, which are interacting with each other, affect the delivery of ecosystem services and a variety of policies respond to these drivers through regulating benefits and ameliorating possible threats. Such policies include not only environmental or nature conservation policies, but also policies and regulatory frameworks from a broad range of societal sectors, from agriculture and regional policies to infrastructure development and trade. Thus, for OpenNESS, three important research challenges exist: to analyse the interplay of drivers and pressures, to address the broad range of policies involved and their interplay, and to assess the knowledge needs decision makers have to deal with potential trade-offs or synergies. In the following sections, key results are provided, structured along the major research challenges: (1) policy analysis of existing and upcoming regulatory frameworks; (2) knowledge needs of decision makers; and (3) driver analysis via scenario approaches.

1) **Regulatory frameworks:**

Dealing with a broad range of regulatory frameworks raises the challenge of mainstreaming the ecosystem service concept in a broad variety of EU policies within and beyond the environmental sector. It is expected that the concept enables policy makers to exploit synergies and manage trade-offs between different categories and between individual ecosystem services. However, effective mainstreaming of ecosystem services, i.e. introducing the concept in a variety of policy fields, would go well beyond introducing some ecosystem service related terminology and/or assessment or evaluation tools and require more policy coherence and integration between policy fields. OpenNESS aimed at exploring opportunities and challenges for mainstreaming ecosystem services. This in-depth analysis of RF covered ecosystem-related policy fields and identified a broad range of direct and indirect drivers that pose problems for the well-being of society, including over-exploitation of ecosystems, climate change, pollution, demographic change, and increasing consumption.

Scope and strength of mainstreaming ecosystem services into EU regulatory Frameworks:
The results of the policy analysis carried out show that the ecosystem service concept has hardly been introduced yet in the Commission and most of EU Member States. The concept has not yet been mainstreamed across policy sectors, but remains confined to the policy arena that addresses natural ecosystems, forestry or agriculture. Only three of the regulatory frameworks that were investigated in depth, i.e. the Biodiversity Strategy and the Green Infrastructure (GI) Strategy, both led by DG Environment, and the Forest Strategy, refer to both ecosystem services and the ecosystem services concept explicitly and reflect the ecosystem services concept in the design of measures. Other regulatory frameworks mention ecosystem services indirectly via terms such as ‘soil function’ or ‘carbon storage’ that correspond to individual regulating ecosystem services. Thus, although the uptake of the ecosystem services concept is increasing over time even some of the more recent regulatory frameworks, such as TEN-T (Trans-European Network – Transport) or the Climate Adaptation Strategy, do not address ecosystem services explicitly. This is significant because the ecosystem services concept, with its focus on human-environment interactions, has great potential to improve policy outcomes in these sectors. Moreover, there is considerable variation in the range of ecosystem services covered. Although the RF that explicitly mention ecosystem services

usually refer to all three ecosystem services categories (provisioning, regulating, and cultural) as well as biodiversity, those that only mention ecosystem services indirectly tend to refer only to a small selection of regulating ecosystem services, such as carbon storage or water quality. In all of the RF, regulating ecosystem services are mentioned in much greater detail than the other ecosystem services categories, and there are relatively few references to cultural ecosystem services (Bouwma et al. 2017).

Governance modes:
All three RF in which the ecosystem services concept is fully embedded are strategies featuring an advisory mode of steering, perhaps reflecting the novelty of the ecosystem services approach and the reluctance of Member States to sign up to strict regulation across different ecosystem services categories, or reflecting trends in governance more widely. Similarly, very few RF require Member States to report on particular ecosystem services. Accounting for the environmental impacts of the respective policy is not standard for all policies, or it focuses only on very specific ecosystems (e.g., Water Framework Directive - WFD). In some cases, environmental impacts are measured indirectly by using proxies such as observed land-use changes.

Ways forward:
There is considerable scope to improve the mainstreaming of the ecosystem services concept, but a deeper understanding is required of the factors affecting uptake, including communication barriers, stakeholder attitudes to the ecosystem services concept, and tensions between policy sectors. Further research should be undertaken to address these issues, including investigations of relevant policy domains in the EC, and to facilitate communication across policy boundaries. There is also scope to improve uptake of the ecosystem services concept through dedicated financing mechanisms, common methods for monitoring and evaluation of ecosystem services (esp. cultural ecosystem services), and better tools to help policy makers exploit synergies and manage trade-offs between ecosystem services. Finally, while mainstreaming the ecosystem services concept might indeed help to systematically expand the assessment of environmental impacts of RF, and, thus, to improve coherence between different policy fields, we need to analyse and address the challenges of mainstreaming the ecosystem services concept carefully to achieve this potential. The ecosystem services concept is no silver bullet, but it can improve sectoral and cross-sectoral policy making significantly if applied properly.

Sector specific results:
Based on the results from various OpenNESS case studies, the possibilities to improve European policy making were investigated at a focus group discussion (February 2017) with policy makers. The discussion focused on two relevant EU policies:
A) For the Water Framework Directive (WFD) (and the EU Blueprint for Water) the workshop participants stressed:

- an urgent need for a better integration of the WFD and other water policies with other policy fields;
- the importance of improving the evidence base of the multiple benefits that can be realized and to better communicate this evidence to people to raise awareness of these multiple benefits;
- that local networks could play an important role, and that ‘local ownership’ of these ‘integration’ frameworks should be encouraged; and
- that both the concepts of ecosystem services and nature-based solutions have a great potential to foster these processes: both concepts would be able to make visible the benefits that are often

taken for granted and to aid discussion of synergies and trade-offs but need to be translated into more practical terms.

B) For the Green Infrastructure (GI) Strategy in the urban context the workshop participants highlighted:

- that GI in urban areas should be better promoted through either establishing stricter, binding standards, or through more motivating incentives for the private sector (e.g., land owners and users) coupled with improved communication of the multiple benefits of urban GI;
- open and deliberative processes engaging citizens and their concerns (e.g., inequalities in demand of and dependence on services provided by urban GI); and
- setting up a GI-related funding instrument at EU-level which would support several EU environmental policies and objectives, and would contribute to the uptake and clarification of funding and organizational responsibilities of stakeholders at the regional and local levels.

2) <u>Knowledge needs:</u>

Identification and analyses of knowledge needs for the operationalization of the concepts of ecosystem services was conducted across different contexts from a stakeholder perspective, involving researchers as well as those engaged with the project from practitioner and policy based communities. The cascade framework provided a useful entry point to begin to examine knowledge needs in the OpenNESS project. Knowledge can be defined in different ways, more narrowly knowledge can be defined as a product or more broadly (as in this study) knowledge can be viewed as a process. Data for this study was collected from nine case studies covering a range of different contexts, including focus group discussions (e.g., two focus group discussions with EU level stakeholders) and/or interviews with members of the case study research teams. Data analysis followed an inductive, grounded theory approach which does not rely on predefined categories to organise the data.

The findings highlight a number of knowledge need categories. These included methods, tools and their outputs, understanding and communicating the ecosystem services concept, the need for structuring and organising to facilitate action, and the need to bring knowledge and action closer together. The need for methods, tools and outputs was highlighted for the assessment and valuation of ecosystem services. Specifically, this involves the need to examine and integrate cultural and regulating ecosystem services from different spatial scales. Further, the need for clear methods to examine non-monetary values was also highlighted, for example to assess wider social values across a large geographic area. Another important knowledge need identified by the stakeholders involved integrating other knowledge types, such as local knowledge based on the practices and experiences of stakeholders on the ground. Here, the need to include different people and their knowledge was highlighted, particularly relating to the need to include local stakeholders, for example local people and businesses alongside the government stakeholders and researchers already engaged in the case study advisory boards. Creating multi-stakeholder processes and involving a full range of stakeholders from the start as collaborators were identified as useful to develop more relevant and therefore useful knowledge flowing out of the case study to help bridge the gap between knowledge generation, decision making, and action on the ground.

To help facilitate a better link between people, knowledge and action the need for a common understanding about the concept of ecosystem services, focusing on meaning and retaining the core principles within the concept, was identified. Effective two way communication was identified as important

to help achieve this, but the need to translate the ecosystem services concept to better align with the terms in use by stakeholders was also emphasised. Policy frameworks, organisational structures and processes were also identified as important to help shape action on the ground. This included strengthening policy frameworks but also understanding existing policies. The need to overcome structural and cultural barriers to develop more open processes and integrated ways of planning and delivering action on the ground was also identified.

3) <u>Scenario approaches:</u>

Work on scenarios within OpenNESS started with a review assessing the breadth of qualitative or quantitative assumptions concerning drivers of ecosystem change at the global and European level. In total, five global scenarios and six European scenarios were analysed in-depth. The analysis yielded a list of mostly quantitative extreme assumptions used in environmental scenarios, considered to affect ecosystems and ecosystem services either directly or indirectly. In most cases, it seems to be the demand for a certain service that drives ecosystem change. This becomes clear from the diversity of assumptions about land use change. Preferences for certain services determine the amount of set-aside land or grassland, kept or abandoned. The use of ecosystem services can also drive change of another or a range of other ecosystem services, for example the production of biomass for bioenergy competes with food production and biodiversity conservation. Beyond the food sector and in some instances the bioenergy sector (provisioning services), we found very little information and assumptions on the demands for other ecosystem services (regulating or cultural). These thematic gaps make it difficult for environmental modellers to assess whether – or under which (scenario) conditions – ecosystems and their functions would be capable of providing the ecosystem services required by society. While assumptions about political developments are mostly qualitative and are often rather implicit, they can be assumed to have a strong impact on most other drivers. Policies can be directed to avoid land use change, or to drive it. They may determine technological developments by strong or reluctant support and may influence climate change and biodiversity loss by acting or failing to act. Political processes are dominated by manifold interests, existing institutions and coincidences. For a scientist not involved in policy research or policy making processes directly, it can be difficult to assess which assumptions concerning political drivers are plausible even on a qualitative level. For this reason, we highly recommend the consultation of policy experts, both from the scientific domain as well as policy makers themselves. Such collaboration can provide ground-truthing for the development of management options, for example, by providing assistance in the selection of (policy) drivers but also for developing or adapting assumptions about minimal and maximal changes.

In OpenNESS, substantial work has been carried out analysing relevant EU policies influencing biodiversity and ecosystem services. In parallel, four EU level scenario storylines were developed and drivers were quantified. Furthermore, the impacts of the scenarios on land-use change and subsequently biodiversity and ecosystem services change within Europe were assessed using the CLIMSAVE Integrated Assessment Platform and IMAGE-GLOBIO models, while the latter was also used to account for interactions with the rest of the world. The aim of this work was to analyse how different research approaches contribute to a better understanding of policy options and policy impacts and how policy analysis can be combined with scenario processes and modelling. The results of the four quantified scenarios were used to assess changes in cropland, forest cover, and grassland, and identify and explore (types of) policy options that may have triggered, steered or contributed to these changes. More concretely, it was discussed which policies are

robust across many different scenarios and which policies work only under certain conditions. The maps (Figure 6) as an important outcome of the modelling exercise help visualise the changes in land use, based on assumptions of what impact different policies could have. Yet, it is important to point out that due to methodological uncertainties our findings should not be considered as recommendations, but rather as 'food for thought' when looking at future policy making. The issues with uncertainties become particularly visible when looking at the different modelling results for grassland. Due to differences in underlying assumptions of the two modelling approaches, outcomes in terms of changes in grassland coverage differ significantly, and policies could not be designed that would equally 'fit' to both models. However, while there are uncertainties concerning grassland, one thing did become clear across scenarios and models: pressure on grassland is significant in all scenarios, and if conservation of grassland is on the agenda, strong protection policies must be designed. Another more general lesson to be learned is that all scenarios and all modelling results show that policies lead to – or, at least, contribute significantly – to major, diverse/multiple, and 'parallel' changes in land use. This is indicated by the changes in all land uses in all scenarios, which are mostly at least 25% or even bigger. One potential conclusion, which can be drawn from this result, is that policies developed to strengthen one particular land use, can have significant consequences for other land uses, too. This highlights the need for cross-sectoral policy making, or at least for a broad look in policy impact assessment. Here, the ecosystem services concept might be helpful.

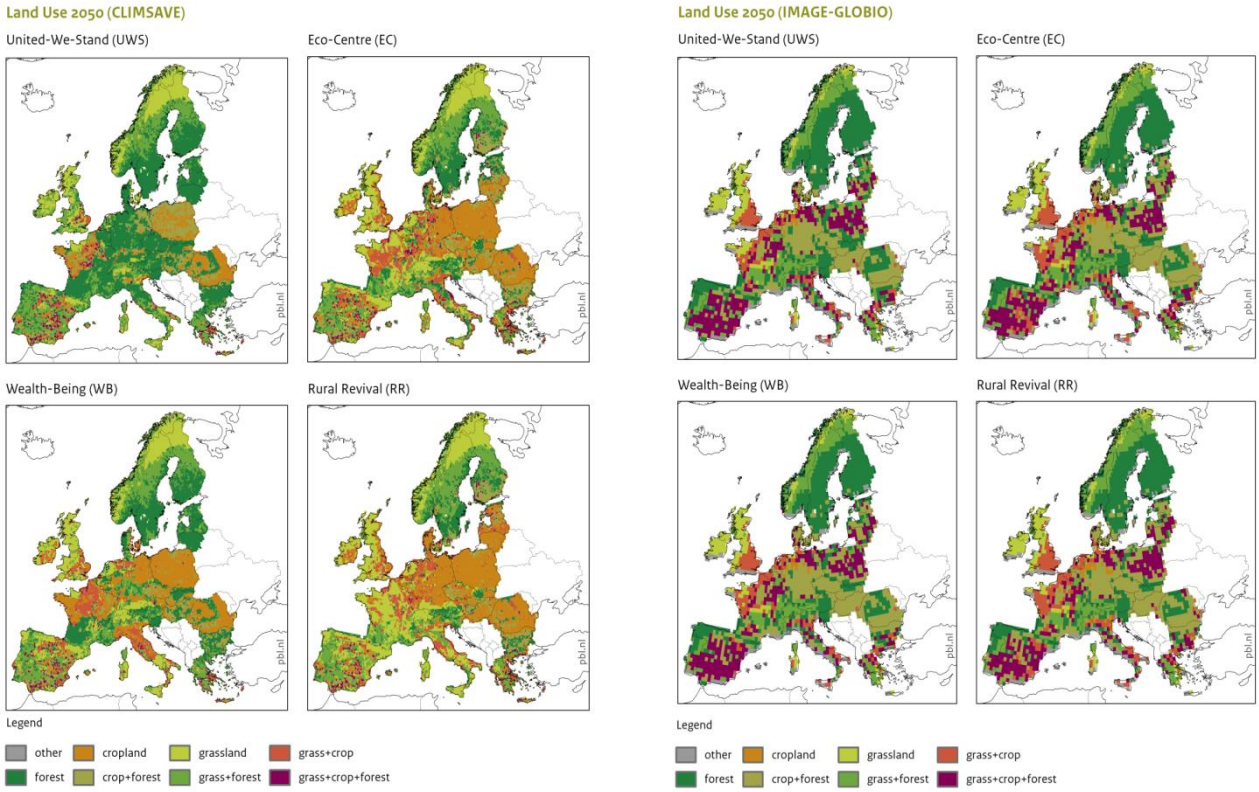

Figure 6. Modelling results of GLOBIO and CLIMSAVE for land-use changes in the four OpenNESS scenarios.

3.4 Methodological advances in ecosystem service research: integrated valuation of ecosystem services

As the ecosystem service concept has become more widely recognised, so the number of biophysical, socio-cultural and monetary methods available to assess ecosystem services has increased. Before OpenNESS there was relatively little guidance on how to select and combine these methods into hybrid approaches that address different study purposes. In this section we look across the OpenNESS 27 case studies, summarising a number of cross-cutting methodological findings in integrated assessment and valuation. Then we highlight advances in specific tools.

A wide variety of biophysical, socio-cultural and monetary methods covering 43 specific methods, categorised into 26 broad method groups, were proposed to the case studies as possible options for application. Classifying methods into broad groups can be difficult as some methods are integrative by nature and span the groupings. Figure 7 provides a schematic illustration of the method groupings highlighting some of the key inter-linkages between them. Some methods can be relatively easily classified as a biophysical technique, such as ecological or hydrological models, as a socio-cultural technique, such as narrative analysis, or as a monetary technique, such as cost-based methods. However, for other methods this classification is not straightforward as they use or can elicit different types of ecosystem services values or may be classified differently depending on the specific aim of the application. For example, advanced matrix approaches such as GreenFrame (Kopperoinen et al. 2014) involve multiple datasets representing different types of values which are related to ecosystem service provision potential through a stakeholder process. Furthermore, some methods aim to integrate different types of data and values for a more comprehensive assessment, such as multi-criteria decision analysis and Bayesian belief networks.

Linking of the methods to the OpenNESS case studies and providing guidance and training to implement the methods was an iterative process. Firstly, a questionnaire was circulated to the case studies to collate information on their decision-making and thematic focus (i.e. purpose of the case study, ecosystem services of interest, relevant stakeholders), the level of experience they had with different types of methods, the data they had available, and if they already had a method which they planned to use. Secondly, a workshop was held in which case study researchers and method experts discussed the different types of methods and how they fitted with the case study objectives and workplans. This led to a first matching of methods to case studies. A set of detailed guidelines were then written for all methods explaining the types of problem the method can be used to study, its data requirements, its constraints and limitations, the steps required to apply the method within a case study, worked examples of the practical application of the method, and further reading for use by the case studies in implementing their selected method(s). These method factsheets have been uploaded to the Oppla online platform for sharing information on natural capital, ecosystem services and nature-based solutions (see http://oppla.eu/marketplace). This written guidance was supported by a dedicated two-day training workshop and supplemented by various case study visits by method experts, and method clinics and specific training sessions at project meetings.

Once case studies had sufficiently progressed in the application of methods, a survey was implemented to gather information on the reasons why case studies had chosen particular methods. In parallel, groups of method experts within the project worked together to classify the key features of each method that related

to its application (e.g. requirements, strengths, limitations, scale, etc.) drawing on the method factsheets. A follow-up survey was also implemented towards the end of the project to check if case studies wished to amend their reasons for selecting methods after completion of the method application.

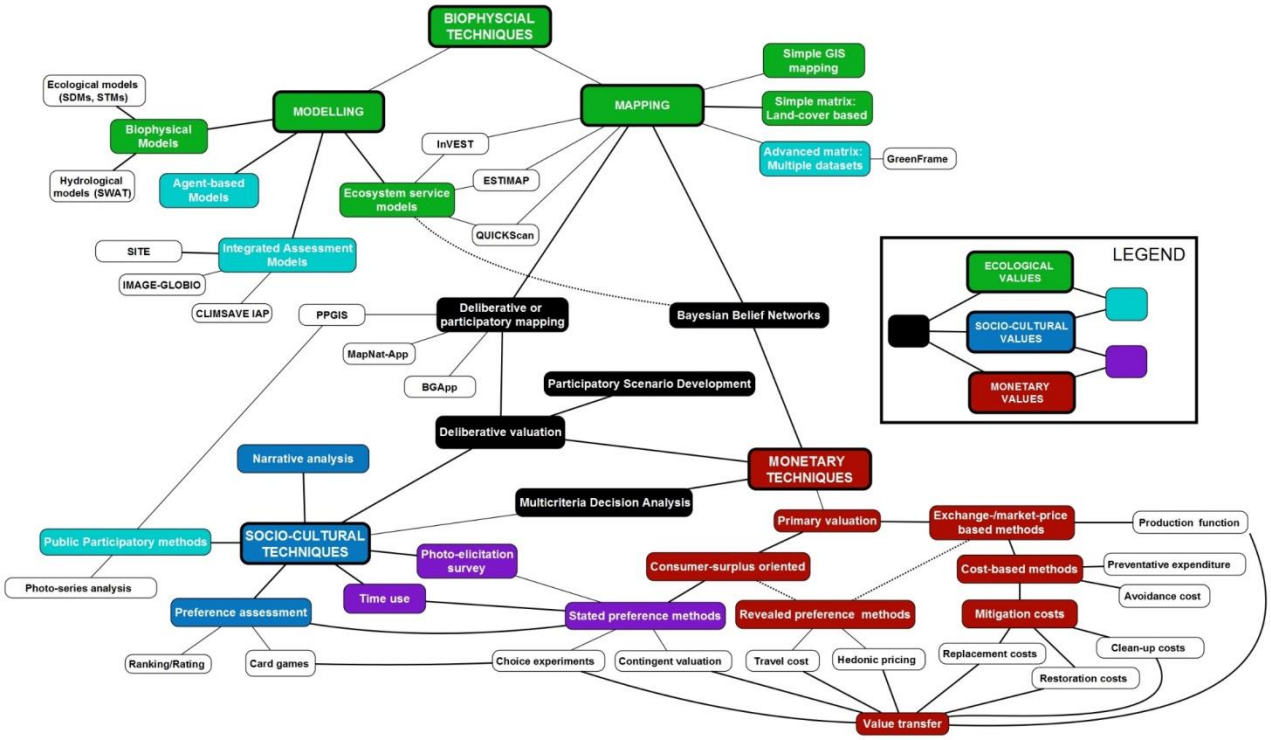

Figure 7. Schematic illustrating broad method groupings and the inter-linkages between them. Broad method groups are colour-coded by the types of values they encompass (individual or combinations of value types). Boxes with white background represent examples of specific methods.

The information from the case studies and the method experts was consolidated and used to develop guidance on how to select and combine different biophysical, socio-cultural and monetary methods. These included:

- A set of decision trees to help structure and guide the process of selecting individual methods (Harrison et al. 2017);
- A Bayesian Belief Network to filter methods based on user requirements (Harrison et al. 2017);
- An analysis of the method combinations used in practice in the OpenNESS case studies (Dunford et al. 2017);
- A mapping of valuation methods to different value types and an assessment of complementary valuation methods for covering multiple value dimensions (Jacobs et al. 2017);
- An evaluation of the practical challenges of integrated ecosystem service appraisals, focusing on how study purpose, information costs and stakeholder characteristics co-determine uptake and influence in governance (Barton et al. 2017).

Methodological findings

Selecting methods

- Numerous reasons for method selection were given by the OpenNESS case studies. **Stakeholder-oriented** reasons, such as stakeholder participation, inclusion of local knowledge and ease of communication, and decision-oriented reasons, such as the purpose of the case study and the ecosystem services at stake, were key considerations in selecting a method. Pragmatic reasons such as available data, resources and expertise were also important factors.
- Each biophysical, socio-cultural and monetary method has specific features which inform its relevance or appropriateness for application to a certain decision or problem context in a case study. Nevertheless, rather than being mutually exclusive, the methods are in many cases related and **mutually dependent** on one another. Different ecosystem service assessment methods are often complementary rather than substitutable.
- There are **no universally scalable ecosystem service assessment** methods. Biophysical, socio-cultural and monetary methods are often complementary in addressing different spatial scales and resolutions, as well as plural values.
- Monetary valuation methods provide different **decision-support information** from biophysical or socio-cultural methods, rather than more or better decision-support information.
- Participatory approaches to ecosystem service assessment support **communication, collaboration and shared visions** between different stakeholders for managing ecosystem services, which ultimately supports the operationalisation of the ecosystem services concept.
- **Decision trees** provide benchmarks or frameworks to think systematically about factors affecting method choice, with a view to accomplishing more integrated assessment and valuation of ecosystem services. Furthermore, thinking in terms of decision trees raises awareness about the context and path-dependency of the outcomes of ecosystem service assessment and valuation.

Methodological integration

- The full extent of ecosystem service **complexity** cannot be addressed head on. Biophysical, socio-cultural and monetary methods provide frames that reduce the complexity and make ecosystem service assessment operational.
- Methodological reductionism is at once a necessity and a weakness of all ecosystem service assessments. There is no one combination of methods that addresses the needs of all the case studies. **Methodological plurality,** flexibility and creativity are key if the ecosystem service concept is to address the practical challenges posed by real world situations.
- **Considerations** determining method selection and study design are complex and particular to case studies. A single method is often not enough to meet a given case study's needs.
- Tool selection is driven by **multiple goals** related to different ecosystem service assessment issues at different scales. In real world case studies research teams address a wide range of considerations *simultaneously*.
- Although individual methods may have strengths and weaknesses for different purposes, methods are combined to address these different considerations. Methods can be combined creatively in ways **that maximise the advantages and minimise the disadvantages** of both. Combining different 'method DNA' results in hybrid methods adapted to specific purposes.

- In OpenNESS, methods were combined in six different ways: (i) direct transfer of data between methods; (ii) direct transfer of ideas, concepts and learning between methods; (iii) hybridisation of methods; (iv) customisation of methods; (v) cross-comparison of methods; and (vi) direct transfer of methods between different issues.
- Practical constraints can limit method selection. Those performing the research will have their own **agendas and interests** which will influence the choice of methods. Case studies are dynamic and need to take into consideration **opportunities and constraints** as they arise.

Integrating plural values

- No single valuation method is able to capture the **full spectrum of values** of nature. Ecosystem service assessment approaches that target single value-types, be they ecological, socio-cultural or monetary values, can only represent part of society and its worldviews, interests and preferences.
- Every method is reductionist and has **blind spots,** which imply a specific framing of decision-making. After reducing ecosystems into separate structures, functions and services, integrating methods are needed to reconstitute *significant complexity* - as much integration as is needed to appreciate the uncertainty of the decision.
- To the extent that biophysical, socio-cultural and monetary appraisals are identifying the **importance** of ecosystem services, they are also valuation methods. Integrated biophysical assessments framed for decision-support are for all intents and purposes also **integrated valuation**.
- Performing integrated valuation does not necessarily require more resources. For every value dimension, methods with low to medium **operational requirements** are available. For each group of valuation methods, there is at least one method that can be reasonably applied with limited resources while satisfying methodological requirements.
- Valuation methods act as **value-articulating institutions,** *creating* value, rather than *eliciting* pre-existing value. As a practical implication the process of selecting the valuation methods might be as relevant for identifying importance of ecosystem services as the valuation method itself or its results.
- Ecosystem service **values are plural** also because they can be either objective, articulated or created. For example, values may exist outside a particular person and their choices (e.g. as market prices). Values may be articulated by a person through methods that help identify their choices and the assumptions about how their choices are made (e.g. non-market valuation). Values may also be created through methods that identify ecosystem services where previously a person had no awareness of them (e.g. biophysical modelling and mapping).
- Many, if not most, decisions entailing human-nature interactions are multi-dimensional. While a single-method valuation can seem more efficient, its limited capacity to **provide information about multiple values**, and the risks this involves for decision-making in real human-nature contexts, mean that such valuations are often *de facto* costly and ineffective.
- Covering all the value dimensions might require methods that are ontologically and epistemologically very different and represent **conflicting valuation languages**. Integrated valuation accepts and emphasizes these diverse values and languages, in order to truly consider them in decision-making.
- The application of integrated valuation application must **strike a challenging balance**: the number of values and elicitation methods should be enough to elicit the main value dimensions that exist in

a system in a fair and just process, but at the same time be kept at the minimum level required to meaningfully understand the problem at stake.

- Rational decision-makers must balance the information costs of more ecosystem service appraisal against the information value of reducing uncertainty and avoiding decision errors such as "**costly actions**" or **"missed opportunities".**

Operational ecosystem service appraisal

- **Research project design** in any given case study should be explicit about study **purpose** and what is meant by operationalisation. Ecosystem service appraisal designed for the purpose of method development or awareness raising, will have different accuracy and reliability **requirements** from support for priority-setting or technical policy design.
- **Knowledge co-production** is a necessary, but not sufficient condition for integrated assessment and valuation.
- In research settings **data, time and budget constraints** are not perceived as strong constraints in research compared to in e.g. consultancy for decision support.
- The costs of achieving requisite **reliability** for decision-support increase as we combine appraisal methods across the cascade of ecosystem structure-function-service-benefit-value.
- Understanding ecosystem services appraisal methods as value articulating institutions presents a challenge for decision-makers. If ecosystem service values and the valuation process are understood as highly contingent on the decision-making context, it has to be accepted that **values are less objective, generalisable and transferable**.
- Novel ecosystem service studies need to be *explorative* until their reliability is tried and tested. Such studies can also raise awareness about the importance of ecosystem services. However, **cautious decision-makers** will be less likely to use novel methods for *decisive* and *technical design* purposes.
- Ecosystem services appraisals can be sequenced; **explorative** studies preceding **informative,** followed by **decisive** and **technical design** studies. When institutions can **sequence** ecosystem service appraisals, information costs can be more easily controlled, as options and alternatives that need to be considered are reduced in a stepwise manner.
- Synthesis of information to support policy decisions represents **power**. Formal ecosystem service methods structure a decision-problem and by reducing uncertainty also reduce the role of political judgement in decision-making. This may be also be perceived by stakeholders as a loss of influence. If these kinds of power are important to stakeholders, researchers **mandate** will be limited to 'explore' and 'inform', rather than 'decide' and 'design' policy.

Addressing gaps between appraisal and governance

- Acceptability of ecosystem service appraisals also depends on the **reliability and accuracy** of the method relative to type of governance problem that is being addressed.
- Integrating additional methods may be more costly than the additional value of information gained, when compared to the benefits and costs that are at stake. Increasing reliability and comprehensiveness come at the price of increasing **information costs**. Simply adding valuation methods, and increasing value plurality, will not by itself solve complex ecosystem management problems.

- **Integrated valuation** recognises that valuing nature to inform more sustainable decisions requires a broader definition of 'value' and 'valuation', and the inclusion of a plurality of values in decision-making.
- Valuation of nature promotes **inclusion** of the different voices and interests of multiple **social actors** in decision-making. Therefore, selection of valuation methods should not solely be the researchers' decision.
- Integrated valuation aims at representing all three value-dimensions - **intrinsic, relational and instrumental values**. This will increase the likelihood of representing the interests of multiple stakeholders.
- Integrated valuation should be embedded in a process of stakeholder identification, characterization, involvement and engagement in order to deal with trade-offs and to contribute to **procedural justice**.

Advances in tools for integrated assessment and valuation:

Bayesian belief network software platform for decision support

Bayesian Belief Networks (BBNs) were identified as one of the cross-cutting themes within OpenNESS. The project developed a *Software platform for decision analysis (*http://openness.hugin.com/). The software platform for decision analysis is a suite of software tools for applying Bayesian networks (and extensions) to support decision analysis along with a dedicated website for hosting Bayesian networks developed in OpenNESS. The suite of tools is based on the HUGIN software product and it consists of tools for developing and testing Bayesian networks, as well as tools for deploying Bayesian networks for decision analysis on a web site and linking a Bayesian network to GIS functionality.

The software platform consists of existing general-purpose HUGIN software tools that have been enhanced to meet expected needs and requirements from the OpenNESS case studies. This includes GIS enabling the HUGIN Web Service Application Programming Interface (API), the development of a HUGIN GUI Java API for integrating HUGIN GUI functionality into other tools such as, for instance, QuickScan, the development of a python API enabling the development of a QGIS plugin and the support for Dynamic Bayesian Networks to represent processes that evolve over time and giving the possibility of encode state-transition models as Dynamic Bayesian Networks.

Using the software platform OpenNESS partners developed an online tool for ecosystem services assessment and valuation method selection which complements decision trees for method selection: http://openness.hugin.com/oppla/ValuationSelection

Methods for comparing ecosystem service supply with biodiversity conservation objectives to inform sustainable management practices

Systematic conservation planning tools were used to prioritize multi-functional areas, contributing to the supply of ecosystem services and supporting biodiversity. Three scenarios were developed to assess the impact of different drivers on the multi-purpose nature of green infrastructure (GI): (i) 'Nature for nature': where no specific spatial driver was included; (ii) 'Nature for people': areas closer to populated sites were preferentially selected; (iii) 'Nature to restore': where prioritization was favoured in areas with poorer ecosystem condition. The cost-effectiveness of ecosystem restoration was also analysed using the removal

of invasive alien species as a case study. Here, changes in habitat conservation status were used as a proxy for benefit valuation.

The comparative assessment of the spatial alternatives (scenarios) for GI shows synergies and conflicts. We found that GI could be efficiently established close to densely populated areas. However, restoration costs in these areas are typically higher given the poor ecosystem condition resulting from degradation. Investment in those places was the most cost-effective, but only if beneficiaries (i.e. people) were accounted for in the assessment. Given the scarcity of resources for investment in GI and ecosystem restoration, win-win situations should be identified where GI development can deliver to several policy objectives simultaneously.

Establishing a database of linkages between natural capital and ecosystem services
There is no unified evidence base to help decision-makers understand how the multiple components of natural capital interact to deliver ecosystem services. We systematically reviewed 780 papers, recording how natural capital attributes (29 biotic attributes and 11 abiotic factors) affect the delivery of 13 ecosystem services (Smith et al, 2017a). This was used to develop a simple typology that defines five groups of attributes that support specific bundles of services in different ways: A) the physical amount of vegetation cover; B) presence of suitable habitat to support specific species or functional groups that provide a service; C) the characteristics of particular species or functional groups; D) physical and biological diversity; and E) abiotic factors. This provides a consistent framework to inform further research, analysis and decision-making.

The evidence base can be used to demonstrate the value of natural capital, and can thus support decisions to protect, restore or enhance ecosystems in order to ensure the long-term provision of the range of services needed to underpin human well-being. We have also provided an overview of positive and negative interactions between services, and evidence on the impact of human management on service delivery. This can be used to identify opportunities to gain multiple ecosystem service benefits, and also to recognise situations where there could be trade-offs between ecosystem services, and determine suitable management actions to avoid or mitigate any problems. Finally, the review provides evidence on the value of physical and biological diversity both in enhancing short-term performance and underpinning the long-term resilience of ecosystem services to environmental change. This shows that the ecosystem approach, if applied correctly, can provide additional motivation to conserve healthy, diverse ecosystems that simultaneously deliver services for people and habitat for wildlife. The review thus supports the objectives of the Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services (IPBES) by providing pertinent evidence for the conservation and sustainable use of biodiversity, long-term human well-being and sustainable development.

3.5 Application and impact of concepts and methods in place-based case studies and stakeholder collaboration

In addition to major global initiatives such as the Millennium Ecosystem Assessment, the Economics of Ecosystems & Biodiversity , and the more recent Intergovernmental Platform on Biodiversity and Ecosystem Service, the concept of ecosystem services has become increasingly integrated in local-level decision-making, for example in urban planning, national park management and river basin management planning. In this section we report the work of the 27 case studies which identified issues where an approach focused on ecosystem services could aid decision making. The researchers in 25 case studies worked closely with local stakeholders in the form of the Case Study Advisory Board (CAB) while two examined the work conducted in other projects through the lens of the OpenNESS approach. The CABs were consulted on the design and implementation of an evaluation process which was carried out towards the end of the study. This process allowed the CAB members and other local stakeholders to provide their feedback on the place-based applications of the ecosystem service concept via a comprehensive survey, reported in Dick et al. (2017a) and summarised below. The results from the place-based applications are also published in individual case study papers and papers that look at a subsection of case studies (www.openness-project.eu).

Results and impact of the OpenNESS case studies

The 27 case studies, used as testing grounds to explore the challenges and opportunities for operationalising the ecosystem services concept, covered a range of geographical locations and land and water management issues (Figure 2). In many of the case studies, the results were used directly in planning processes at the local and regional level (e.g. SIBB, BARC, SACV) while some cases raised awareness at the national level (e.g. TRNA, BIOF). In some case studies, the ecosystem service concept was well understood prior to the commencement of the project (WCSO, ESSX) while in others e.g. Kenya (KEGA) it was a new concept, but by rising awareness in local villages the project empowered the citizens to protect their area. In most cases, the project researchers worked closely with local authorities and land-use planners who were involved in the selection of the tools to be tested and providing the data needed for the analyses. In these cases, the results will stay with the planners, public authorities or other relevant actors who can draw on them in the future.

A brief summary of the cases studies and their impacts is presented below:

- SIBB (Sibbesborg urban planning process in Finland): Provided Sibbesborg urban area planners an increased understanding of cultural ecosystem services, which was used in the planning process.
- TRNA (Landscape-ecological planning in urban and peri-urban areas in Trnava, Slovakia): The debate on the ecosystem services approach in Slovakia was opened, and stakeholders were mobilised through regular meetings, active work, and discussion of the results.
- OSLO (Urban planning in Oslo, Norway): Raising awareness, mapping and documenting the value of ecosystem services for town planners and empowering local people.

- VGAS (Urban planning in Vitoria-Gasteiz municipality, Spain): Inputs to a future monitoring system incorporating the ecosystem services concept to evaluate the effectiveness of the actions and measures implemented in the city.
- BARC (Urban planning in the metropolitan region of Barcelona, Spain): Ecosystem service maps integrated into the Territorial Information System for the Network of Open Areas in the Province of Barcelona (SITxell, www.sitxell.eu/en)
- ALPS (Multi-functional forest management for Vercors Mountains Range in the French Alps region): Improved understanding of multifunctional landscapes that provide a diversity of functions and services. The results used to plan tourism in the region.
- BIOF (Forest bioenergy production in Finland): Awareness raising amongst municipality officers, regional authorities, NGO representatives, business representatives, and interest group representatives on multiple benefits of forest bioenergy production options.
- CAPM (Forest management and illegal logging in Romania): Awareness raising amongst a wide range of stakeholders of ecosystem services concept considering both monetary and non-monetary values. Stakeholders responded better to monetary values than non-monetary ones.
- BIOG (Crop bioenergy production in Saxony, Germany): Transfer of stakeholder negative perception regarding ecosystem services associated with bioenergy crops from one area to another was shown to be unreliable indicating the need to consult with local stakeholders when making landscape scale policy.
- CNPM (An integrated management plan for biodiversity and tourism in Cairngorms National Park, Scotland): Park authority utilised results to help plan recreational access around a new settlement and engaged in constructive dialogue to enhance management of recreational use while protecting biodiversity in the park following recreational ecosystem services mapping. Stakeholders used ecosystem services communal planning events and natural capital calculations as evidence of community collaboration for funding proposal.
- SNNP (Ecosystem Services in Multifunctional Mediterranean Landscapes: Sierra Nevada protected area case, southeast Spain): Awareness raising about differences among stakeholder groups regarding their perception of the importance of ecosystem services in contributing to human well-being highlighting the need to include all effected stakeholders in decision making.
- WCSO (Biodiversity and ecosystem service offsetting, Warwickshire, UK): County Council ecologists found ecosystem services maps useful for visualising and communicating issues to policy makers and other stakeholders. Modelling showed, by the 2050s, potential climate mediated problems for biodiversity offset projects.
- KISK (Water management in semi-arid region in Kiskunság, Hungary): The stakeholders involved formulated recommendations to national and regional level policymakers that could support local communities in the transformation to adaptive and sustainable landscape management.
- CRKL (Farmland management and planning for green corridors in agricultural land in De Cirkel, Belgium): Awareness raising of the importance of including all stakeholders in decision making to avoid future conflict by the identification of locations where recreation could be improved and trade-offs between recreation and apple growing minimized
- GIFT Belgium (1GIFT– Green Infrastructure for tomorrow- together! An INTERREG IV-B project that ran from 2011-2015 and encompassed 5 case studies in UK, Belgium and Netherlands): ecosystem services assessment improved understanding of the use of green infrastructure amongst

communities, businesses and governments. Social learning is core of community-based green infrastructure planning.

- GOMG (Multipurpose wetland construction in a peri-urban area, Gorla Maggiore, Italy): Awareness raising and identification that green infrastructure is the best management option with citizens willing to pay about three times more for green infrastructure than for grey infrastructure, and much more if it is surrounded by a recreational park.
- LLEV (Management of lake Loch Leven, Scotland): Awareness raising of the benefits of improving the ecological quality of Europe's freshwaters for enhancing fishing, recreation, tourism, and nature conservation. Also highlighted impact of perceptions from the past on current ecosystem services.
- DANU (An integrated and adaptive management plan for Lower Danube River, Romania): The close cooperation with stakeholders and the transfer of knowledge related to the concepts of ecosystem services and natural capital, as well as the important contribution of traditional knowledge, strongly supported the process of designing, implementing and adapting the management plan in the Lower Danube River Watershed.
- STEV (Developing a shared vision for Stevoort flood control area, Belgium): Draft vision document for the project area was created based, in part, on the results of the ecosystem services research which delivered a pilot version of tools for assessing ecosystem services impacts and trade-offs.
- DONN (Management of Doñana National Park and the surrounding landscape in Spain): Stakeholder workshops helped to develop common goals and a common strategy. This was especially important because relations between different groups (viticulturists on the one side, and the public and nature protection agencies on the other) were previously marked by a lack of communication and exchange.
- WADD (A study following the economics of ecosystems and biodiversity (TEEB) protocol compared three options for disposing of dredged sediment in a shipping channel, Wadden Sea, Netherlands): The administrative process of awarding a permit for the navigational dredging has gone ahead largely without interaction with the TEEB study and its results.
- SACV (Management of Coastal Natural Park (Sudoeste Alentejano e Costa Vicentina), Portugal): ecosystem services maps used to support planning and management decisions, such as preparing the Park's management plan and deciding on the development of new recreational services.
- ESSX (Bioiversity and ecosystem service offsetting in Essex, UK): Awareness raising with ecosystem services maps visualising the way in which different parts of the area provide a range of ecosystem services and identifying options for improvement. Modelling revealed reduction in suitable climate space for some species by the 2050s.
- BKSU, (Cash crops driving land use changes in forest mosaic landscapes in East Godavari district, Andhra Pradesh, India): Community institutions were built. Participatory monitoring methods were tested and validated in ten other locations. Community and forest staff prepared a participatory biodiversity management plan and strategic actions to reverse the process of degradation.
- KEGA, (Kakamega Forest Ecosystem Management, Kakamega County, Kenya): Awareness raising of ecosystem services concept to support economy and human well-being with citizens and planners. Work revealed local hotspots for ecosystem services and confirmed areas important for biodiversity providing evidence for conservation.
- SPAT (Forest management in Southern Patagonia, Argentina): New methods adapted for areas where little information was available; biodiversity quality maps; primary productivity maps; estimation of the impact of beavers at landscape level; grazing impacts; carbon storage in soils; and

mapping of cultural ecosystem services revealed it was possible to define synergies and trade-offs between ecosystem services provision which influenced management planning.

- BIOB (Sugarcane bioenergy production in interior São Paulo, Brazil): The municipal government approved the implementation of a Payment for Ecosystem Service scheme in the Director's Plan bill – a law that determines the planning, use and activities to be undertaken in the municipality.

The case studies revealed that ecosystem services knowledge was used in the three common types of decisions namely:

- **Conceptual**, i.e. to raise awareness and reframe dialogue. For example, the Italian case study (GOMG) showed the added value of building artificial wetlands from different perspectives (technical, ecological, recreational). The respondents reported that there had been a change in the future vision in the area, i.e. a reframing of the dialogue locally. Water and planning managers also reported that they will use the results when updating the river basin management plan, and they asked to work with the research team again to develop other similar case studies.
- **Instrumental**, to make specific decisions. For example, the Brazil case study (BIOB) investigated a payment for ecosystem service scheme, which has now been included in the Directive Plan for the area, and is contributing to a change of legislation.
- **Strategic**, to build support for plans or policies. For example, in the northern Scottish case study (CNPM), the work was used strategically to help lever funding for development projects. A map showing the integrated valuation of recreational use of the area was used as evidence to support the development of walking trails. CAB members reported that they considered the work, which highlighted collaborative working and participatory planning, had helped to convince the awarding committee to approve the funds to develop recreational tourism in the area.

Stakeholder's evaluation of the case study work

After three years of work in close collaboration with case study stakeholders, a standard questionnaire approach was adopted to allow the stakeholders to feed back their experiences of the operationalisation of the ecosystem services concept conducted in their case study (Dick et al. 2017a). The questionnaire was a mixture of numerical and narrative questions and was structured to cover four topics. The four main topics were (i) self-characterisation of users, (ii) perception of the participatory process followed in the case study, (iii) perceived impact, and (iv) practical usefulness of tool(s).

The case studies show that the operationalisation of the ecosystem services concept, which embedded the transdisciplinary approach, can indeed lead change in human behaviours and change in social institutions. The stakeholders reported new insights and knowledge (91%), more collaboration (66%), changed understanding (65%), a change in the way information was used (68%) which led to a change in decision-making (53%), and ultimately the probability of a change in action (54%) (Dick et al. 2017a). The evidence for changes in social institutions was less obvious and in some case studies this was highlighted as a problem.

The analysis by Dick et al. (2017a) revealed that stakeholders considered that the probability of the ecosystem services assessment conducted in their case study resulting in a 'change in action' was positively associated with the following factors:

- a change in the decision-making process in their case study;

- all relevant stakeholders were represented in the ecosystem services assessment process;
- they had changed their understanding of the issue;
- the ecosystem services assessment process was inclusive and provided opportunities for stakeholders to get involved; and
- there had been a change in the way information and tools were used to support decisions-making in their case study.

Practical advantages of operationalising the ecosystem services concept included:

- Improved awareness or a deeper conceptual understanding of the issue investigated as well as awareness-raising among stakeholders more broadly;
- New information or data inputting to existing decision-making processes or management systems;
- Scientific evidence or academic approach, supporting credibility of decision-making;
- Ability to identify and compare values of ecosystem services
- Support to land-use planning by spatial, geographical, territorial analysis of ecosystem services;
- Empowering stakeholders through facilitated dialogue;
- Encouraging communication across interests and reducing conflicts.

Challenges to operationalising the ecosystem service concept included:

- Limitations in the implementation of the concept driven by lack of time, finances or interest, current legislation or decision-making settings;
- Problems in transferring the knowledge or low awareness generally of the concept, which resulted in difficulty in transferring information to the wider public;
- Decision-making or territorial planning institutions not harmonised with implementation of the ecosystem services concept.

Institutional challenges in putting ecosystem service knowledge in practice

A qualitative analysis of 22 case studies was carried out to examine the ways in which knowledge on ecosystem services was used to inform planning, policy-making and management in the place-based case studies (Saarikoski et al. 2017). None of the case studies reported instrumental use of knowledge in a sense that ecosystem service knowledge would have served as an impartial arbiter between policy options. Yet, in most cases, there was some evidence of conceptual learning as a result of close interaction between researchers, practitioners and stakeholders. The analysis highlighted several factors that constrained knowledge uptake, including competing interests and political agendas, scientific disputes, professional norms and competencies, and lack of vertical and horizontal integration. Ecosystem knowledge played a small role particularly in those planning and policy-making situations where it challenged established interests and the current distribution of benefits from ecosystems. The factors that facilitated knowledge use included application of transparent participatory methods, social capital, policy champions and clear synergies between ecosystem services and human well-being. The results are aligned with previous studies which have emphasized the importance of building local capacity, ownership and trust for the long-term success of ecosystem service research.

3.6 Synthesising project results into Oppla

The project results have been synthesised into Oppla (www.oppla.eu), which is a new knowledge platform where the latest thinking on ecosystem services, natural capital and nature-based solutions is brought together. Oppla has been developed jointly by the OpenNESS and OPERAs projects, and it is underpinned by a community of practice including research organisations and businesses. The perennity of Oppla is ensured by a non-profit entity European Economic Interest Grouping (EEIG), which was established on 20 September 2016 to manage and develop Oppla after the life-time of the two projects.

The current Oppla functionalities include:

Join: allows users to become members of the Oppla community and access its full range of services (free of charge).
About: summarising the purpose of Oppla and the services it offers.
Marketplace: a repository of user-submitted products and services for operationalizing ecosystem services (Figure 8). These resources have been generated from OpenNESS and OPERAs, as well as other projects and organisations. Content includes tools, software, data, guidance, training, events and consultancy services: all indexed and searchable via a keywords system.
Community: a directory of individuals to facilitate networking between Oppla members (Figure 9). Includes a 'Find My Match' facility, whereby users can instantly find other members who share similar expertise and interests.
Case studies: an interactive map of case studies generated by OpenNESS and OPERAs on integrating ecosystem services into land, water and urban management.
Ask Oppla: a crowd-sourced enquiry service, designed to help direct enquiries to relevant sources of information. Oppla members are able to ask short questions relating to natural capital, ecosystem services and nature-based solutions. Answers are then submitted in response from other members of the Oppla community.
Additional functionalities are a set of interlinked **Guidance Tools**, which include an **Ecosystem Service Assessment Support Tool** (ESAST), a set of **Decision Trees** and **a tool for filtering different methods** based on their requirements developed **using a Bayesian belief network** (BBN). The ESAST and the associated decision trees provide guidance for selecting fit-for-purpose methods and were earlier termed the Menu of Multi-Scale Solutions. The guidance tools synthesise the conceptual and methodological advances of OpenNESS as well as the evidence base of their application in sustainable land, water and urban management in case studies.

The ESAST offers practical, step-by-step guidance on how to carry out an ecosystem service assessment process and to integrate the results into management and decision-making (Figure 10). The starting point of ESAST is that ecosystem service assessment is essentially a process that is carried out in a close interaction with key stakeholders to ensure that they find the results reliable and relevant for decision-making, that is, they become operable. Therefore, the ESAST provides guidance for transdisciplinary research process through a link to the collaboration platform ONEX (Step 1). The next step is identification of the ecosystem services and the associated benefits and beneficiaries that are likely to be influenced by the management or policy decisions at hand (Step 2). The framework draws on CICES (www.cices.eu) and

the cascade model (Potschin and Haines-Young 2016), which offers a heuristic tool for identifying final ecosystem services and their linkages to underlying ecosystem structures and processes. To manage ecosystem services effectively it is important to understand the ways in which direct and indirect drivers of change influence ecosystems and their capacity to provide services (Step 3). In a similar way, it is important to understand the values that people assign to ecosystem services and the benefits that they derive from them (Step 4). The **Decision Trees** and **BBN tool for filtering different methods** provide guidance for selecting biophysical, socio-cultural and monetary assessment methods according to a user's needs (see section 1.3.4 and Figure 3). Finally, Step 5 provides case study examples on integrating ecosystem services into land, water and urban management as well as tools for integrating information about ecosystem services and their values in decision-making.

The ESAST will be promoted and tested in the "Oppla Lab": a new test area within Oppla, where tool developers can showcase their work to the Oppla community and receive feedback. By the end of 2017, the Oppla Team and ESAST developers will assess: 1) the development stage of the tool; 2) the level of usage and user feedback; 3) the potential for full integration of the ESAST in Oppla.

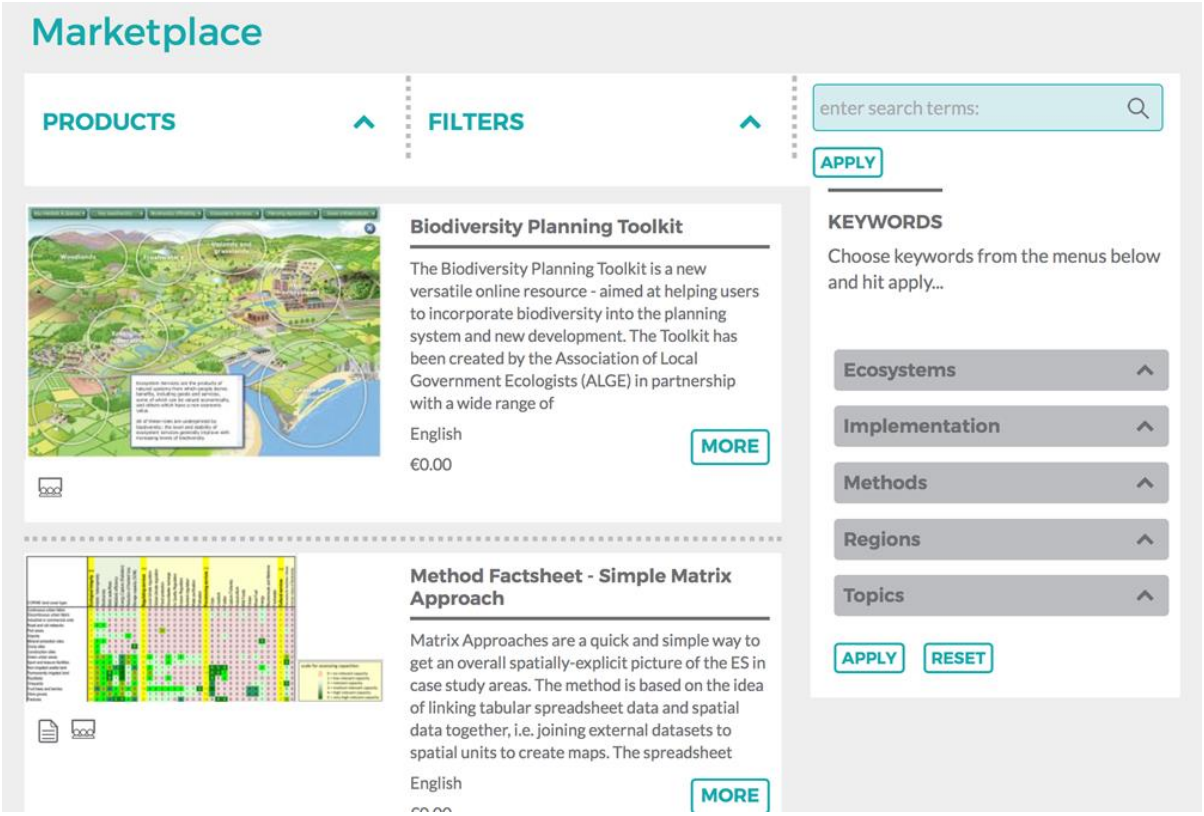

Figure 8. The layout of Oppla Market Place

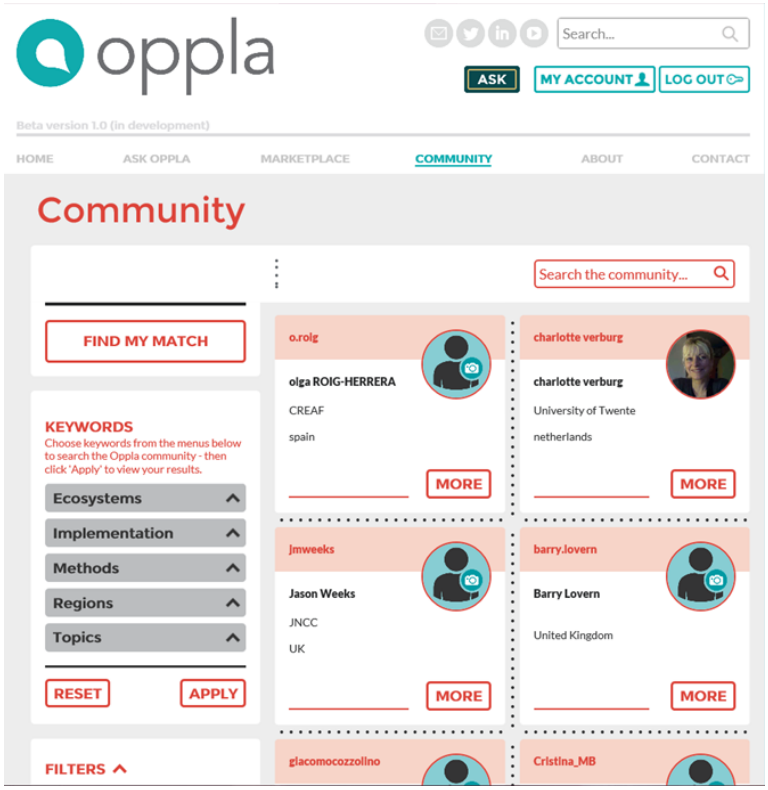

Figure 9. Oppla community

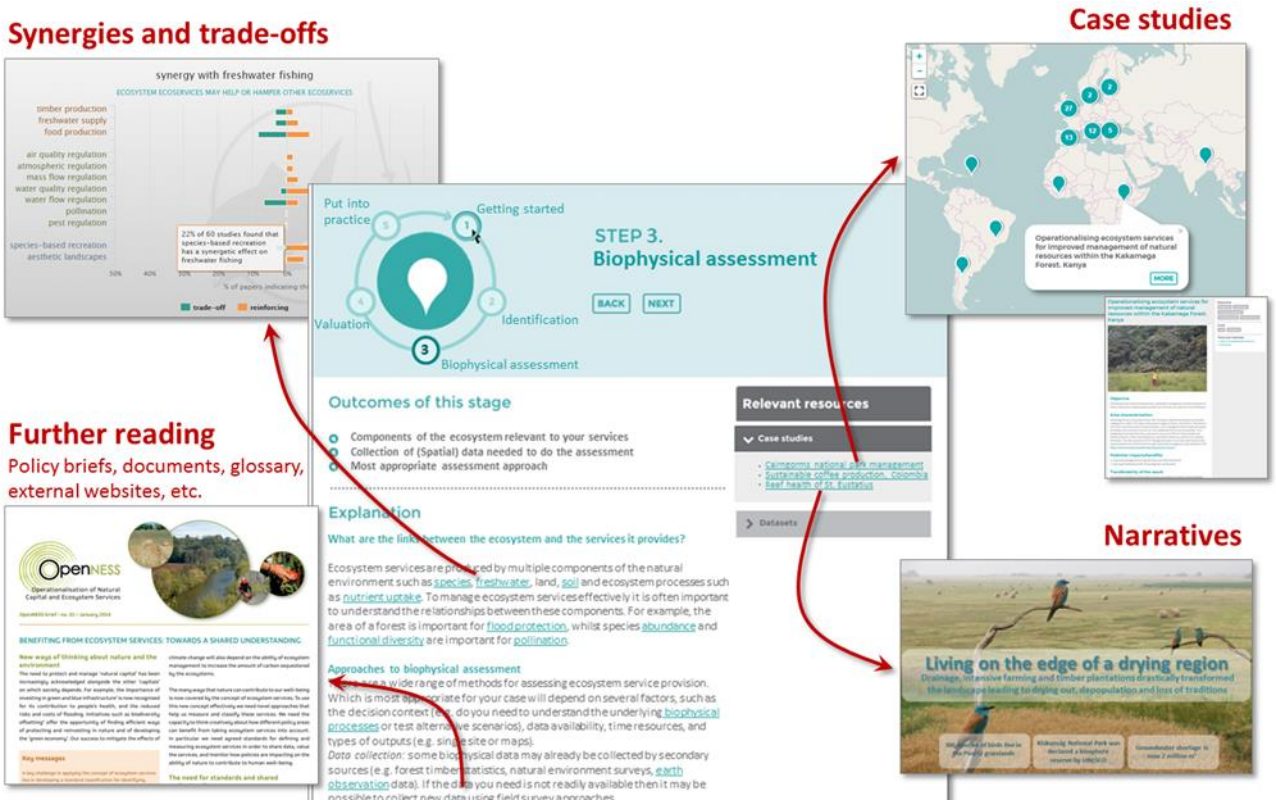

Figure 10. The five core steps of ESAST.

4. The potential impact and the main dissemination activities and exploitation of results

4.1 The potential impact: achievements from a societal perspective

The strategic impact relating to the four challenges of human well-being, sustainable management, governance and competitiveness

Human well-being

The conceptual understanding on the relationships between ecosystem services and human well-being are summarized in Policy Brief no. 01 and the SP on Human Well-Being (Jax and Heink 2016). The extensive work in 27 place-placed case studies, documented in Oppla as well as in scientific papers (www.openness-project.eu), has improved understanding of how ecosystem services and natural capital contribute to human well-being across locales, sectors, scales and time. The guidance on integrated assessment and valuation of ecosystem services, documented in D3.3-D4.4 and Policy Brief no. 5, provide guidelines and experiences with methods for monetary and socio-cultural valuation of ecosystem services which contribute to human well-being. The OpenNESS Conceptual Nexus (ONEX), a freely available internet-based 'working environment' (https://trello.com/b/sm1lX0S0/the-onex-lab), helps people identify the different dimensions of human well-being and how these may underpin the values they use in decision making (see OpenNESS deliverable 4.1).

Sustainable land and water management

A database of linkages between natural capital stocks and ecosystem services flows, documented in Deliverable 3.1, a paper by Smith et al. (2017a), in OpenNESS Policy Brief no. 6, and as an infographic in Oppla, inform the sustainable management of land and water. Comparative assessment of spatial alternatives for the development of GI that delivers both ecosystem services and biodiversity conservation objectives is reported in D3.3 and a paper by Vallecillo et al. (2017). The 27 case study examples of sustainable land, water and urban management as well as method factsheets and different forms of guidance on selection of biophysical, socio-cultural and monetary methods for ecosystem services management and appraisal are integrated into Oppla. The methodological guidance for more sustainable ecosystem management is also presented in D3.2, D4.3, D3.4/D4.4 and papers in the OpenNESS special issue, e.g. Harrison et al. (2017), Barton et al. (2017), Jacobs et al. (2017), Dunford et al. (2017), and Smith et al. (2017b). The Hugin OpenNESS Platform (http://openness.hugin.com/) hosts an assessment and valuation method selection tool that aims to help decision-makers select portfolios of tools to address ecosystem services valuation needs and considerations. ONEX shows that while sustainable ecosystem management is underpinned by ecological knowledge and understanding, effective decisions need to be looked at in the context of the other societal challenges. Oppla and the Guidance Tools hosted by it assist land use planners and natural resource managers in developing sustainable land and water management solutions.

Good governance

The SPs on good governance of ecosystem services (Görg et al. 2016) as well as stakeholder involvement, transdisciplinarity and social justice in ecosystem service assessment (see Potschin and Jax 2016) address inclusive and socially equitable management of ecosystem services. These materials can be accessed via Oppla, and they are linked to relevant steps in the ESAST (Ecosystem Service Assessment Support Tool). The ESAST provides guidance on stakeholder involvement and transdisciplinarity in ecosystem service assessment, and hence contributes to more effective and inclusive management of ecosystem services. A paper by Turkelboom et al. (2017) synthesizes the key insights by the case studies on balancing trade-offs in social and individual well-being.

EU competitiveness

The potential for increased EU competitiveness by innovative processes and services derived from operationalising the concept of ecosystem services and natural capital is explored in a SP on Competitiveness (Haines-Young et al. 2016) as well as in D1.4. The general message is that some case studies have discovered that competitiveness is more than an economic issue and an important part surrounding the issues of sustainability at local scales.

While each theme is individually important, OpenNESS has also provided an overarching conceptual framework that shows how these challenges are linked, and how new insights can be developed that can inform analytical approaches and decision making. The conceptual impact and legacy of OpenNESS is represented by the development of ONEX, which was based on a detailed review of the issues surrounding the four challenges and how they can be articulated at local scales. The structure of ONEX has been based on the analysis of the way OpenNESS case studies have applied the ecosystem service concept, and how local perspectives can be broadened by considering the ideas that surround the OpenNESS Challenges. The system now enables impact beyond the case study work through wider social learning. While the four challenges provided an initial focus for ONEX its impact is likely to be far wider because there it is an open framework that will allow other areas of concern to be developed, including those relating to ecological restoration, green infrastructure or resilience.

Policy impact in relation to international, European and national policies and/or policy processes

The version of CICES (Common International Classification of Ecosystem Services, www.cices.eu) that was released in 2013 (V4.3) was tested via the work undertaken by case studies in OpenNESS. The experience in OpenNESS enabled the practical barriers to using the classification to be identified so that an improved classification and better guidance could be provided to the wider community. The development of a translator tool using the HUGIN Bayesian Belief Network Software has enabled CICES to become a common reference system, enabling people working with the classifications used in the MA or TEEB or the UKNEA to cross reference their work in rigorous and systematic way. More significantly, the experience gained during OpenNESS has shaped the development of CICES V5.0 that continues to be the framework used in the EU MAES Process (Mapping and Assessment of Ecosystems and their Services). The legacy and impact of the work started in OpenNESS is therefore currently being taken forward respectively through (a) the EU-funded ESMERALDA Project , which is providing guidance to Member States on issues surrounding the mapping and assessment of ecosystem services in the context of Action 5 of the **EU** Biodiversity Strategy 2020; and (b) the Knowledge Innovation Project on an Integrated System for Natural Capital and Ecosystem Services Accounting (KIP INCA), which was set up by the European Commission in partnership with the JRC,

the Directorate-General for Environment, the Directorate-General for Research and Innovation, Eurostat and the European Environment Agency. In a similar way, the methods guidelines (Decision Trees, see Harrison et al. 2017) are a key input to ESMERALDA (which supports MAES) and the KIP-INCA to develop biophysical accounts of ecosystem services.

CICES has also been used by the wider accounting community as a framework for the development of experimental ecosystem accounts that is part of the revision of the System for Environmental and Economic Accounting (SEEA). The role of CICES as a reference system for accounting purpose has been explored by the UN-Statistical Division in recent workshops and Technical Reviews by exploring how it relates to other international systems by developed by the US-EPA, such as FEGS and NESCS.

The database on the links between natural capital and ecosystem services, hosted in Oppla, is considered as a key input to MAES to understand the link between ecosystem condition and ecosystem services; a link that is important for restoration under Target 2 of the EU Biodiversity strategy.

The work on integrated valuation of ecosystem services (D4.1) has had an impact on EU Science-Policy discussions with citation in Science for Environment Policy (2015), Ecosystem Services and the Environment.

OpenNESS Policy Briefs no. 02 and no. 03 contribute to the Thematic Strategy on the Urban Environment by clarifying the concept of nature-based solutions and the latter by illustrating encouraging examples of nature based solutions in urban case studies. OpenNESS brief no. 04 on bioenergy production contributes to the Renewable Energy Directive by arriving at the conclusion that policies advancing bioenergy use should be developed based on an understanding of the potential trade-offs between ecosystem services. OpenNESS Policy Brief no. 07 as well as scientific papers (Liquete et al. 2016; Masi et al. 2017) contribute to the Water Framework Directive (WFD) by synthetizing the key messages from water management cases in Gorla-Maggiore, Italy, Loch Leven, Scotland, and lower Danube River, Romania. OpenNESS brief no. 08 contributes to sustainable land use planning and Green Infrastructure (GI) strategy by synthetizing the lessons learned from several OpenNESS case studies addressing multi-functional landscapes. The role of GI in sustaining a flow of ecosystem services in OpenNESS case studies is documented also in scientific articles (Barton et al. 2015; Liquete et al. 2015). Implications for improving future design and implementation of the WFD and GI strategy were discussed with EU policy makers and NGO representatives in a workshop in Brussels in February 2016. Conclusions include the (still) open question if GI provisioning could be best served by developing a 'GI Framework Directive' and by formally requiring the integration of GI into other strategies and sectoral policies, or to focus on more targeted incentives for the private sector and improved communication of the multiple benefits of urban GI. With respect to the WFD, there is a need to improve the evidence base of the multiple benefits of good quality of water bodies, to better communicate this evidence to people to raise awareness, to provide appropriate levels of (financial and other) resources for implementation, to provide the 'right' incentives, to overcome the 'silo mentality' of water policies, to develop and implement 'integrated' policy tools and funding options, and to ensure a systematic public participation (see also Grizzetti et al. 2016).

A review of 12 EU policies (Bouwma et al. 2017, see also D2.1) shows that the coherence between existing policies and the ecosystem services concept is still relatively moderate, and there is no specific EU policy

devoted to governing ecosystem services. The ecosystem services concept is already embedded in the Biodiversity Strategy 2020 and the Invasive Alien Species Regulation. The most recent update of the Common Agricultural Policy (CAP) makes an explicit reference to ecosystem services, although not at the level of measure design. On the other hand, the WFD does not refer to the ecosystem service terminology but the general concept of the WFD includes the economic assessment of benefits from good quality of water bodies is close to the general idea of ecosystem service framework. Furthermore, the guidance documents on the implementation of the WFD refer to ecosystem service terminology and thinking. The review suggests several potential governance pathways to further integrate ecosystem services into EU policies.

The work in two case studies (CS11, CS22) considered the 'No Net Loss' Initiative through the lens of Biodiversity offsets, reviewing recent developments and the possible future direction of EU policy and law relating to biodiversity offsetting and habitat banking, from the 2006 EU Biodiversity Strategy and Action Plan to the current EU Biodiversity Strategy to 2020. The analysis included the EU Habitats Directive, Environmental Liability Directive and the EIA and SEA Directives, detailing relevant provisions under each of these directives.

Many of the case studies consider the implications of The Common Agriculture Policy (CAP) either indirectly through its influence on local management decisions (CS09, CS13, CS14, CS17, CS19) or directly (CS08), focusing on the role of CAP in bioenergy production in the mixed landscapes of Central Germany.

OpenNESS has had a major impact on international science-policy collaboration**,** especially in the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). The OpenNESS work on scenarios and models informed the IPBES Deliverable 3(c): Policy support tools and methodologies for scenario analysis and modelling of biodiversity and ecosystem services based on a fast track assessment and a guide. Many of the OpenNESS results could also be integrated in the regional assessment for Europe and Central Asia (ECA), and several OpenNESS partners are involved in the ECA process (3 Coordinating Lead Authors, 2 Review Editors and 4 Lead Authors). OpenNESS work on integrated assessments has also informed IPBES Deliverable 3(d): Scoping for the assessment and guide on methodologies regarding diverse conceptualization of values of biodiversity in 2014-2015 (contribution by six OpenNESS partners). IPBES regional assessments will inform the Aichi targets and Sustainable Development Goals. OpenNESS and OPERAs teams have also worked closely with the IPBES Secretariat to make Oppla to accommodate the IPBES policy support tools catalogue. Contributing OpenNESS expertise and experience to global networks, such as IPBES, results in multiplying outreach at global level. OpenNESS outcomes have also contributed to the work on the UN Agenda 2030 via the project coordinator's role as a member of the writing team of the UN Global sustainable development report 2019. Especially the understanding of the four societal challenges in ecosystem services implementation has value when considering the interlinkages between the various sustainable development goals.

Impact in relation to a variety of stakeholders

The case studies worked closely with a wide range of stakeholder through the CABs and through the participatory ecosystem services assessments conducted in the case studies. Almost all case studies reported that natural resources management authorities were active in their CAB (92% of case studies) (Figure 11). Other CAB members included scientists/consultants (72%), sector interest groups (68%),

regional or national NGO, environmental regulators and municipality or local government (all in 60% of cases) (Dick et al. 2017a).

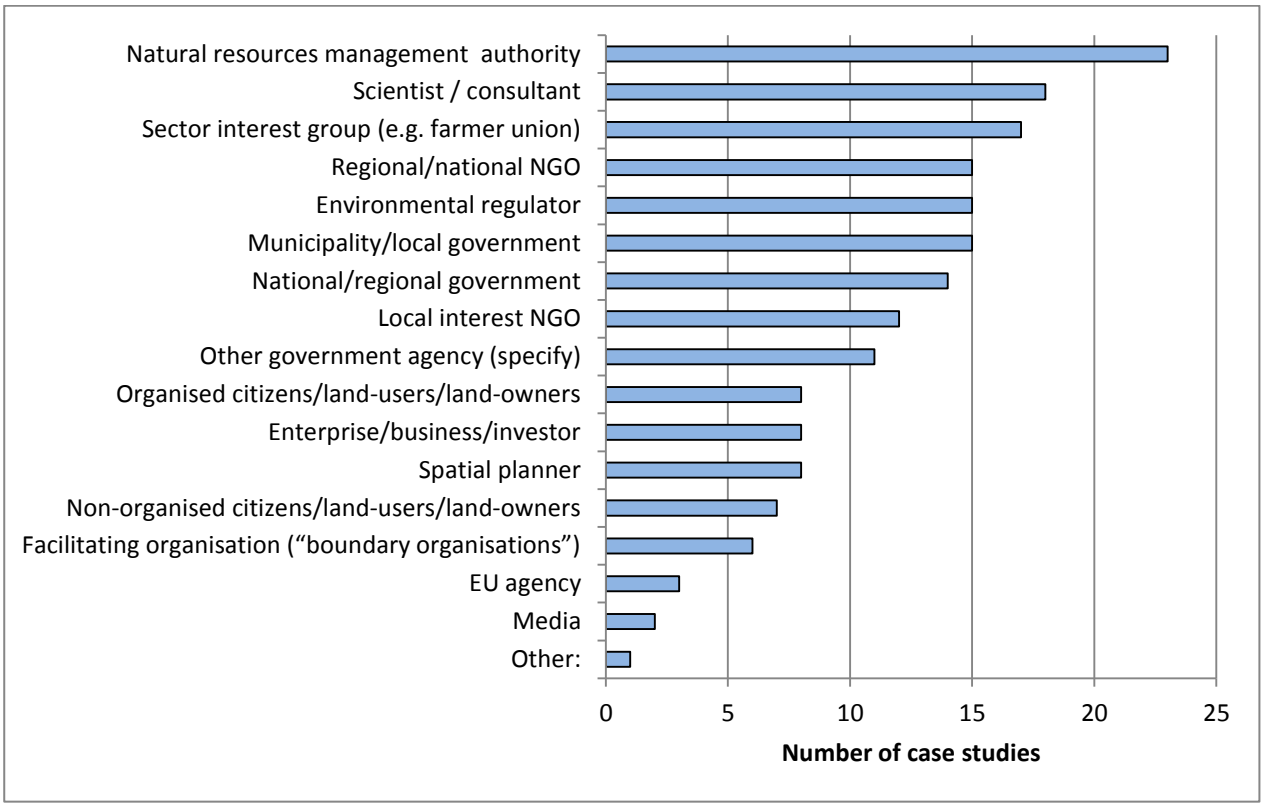

Figure 11. Type of CAB members in OpenNESS case studies (N=25 case studies as CS14 and CS20 did not constitute a CAB as they worked closely with other ecosystem services focused projects).

Typically when conducting ecosystem services assessments case studies worked with a municipality officers, regional authorities, regulatory authorities, NGO representatives, representatives from local universities, museum, research institutes, business representatives (e.g. farmers, foresters, fishermen), and interest group representatives such as local development trust representatives (Dick et al., 2017a, in review). Operationalisation of the ecosystem services concept, as conducted in the case studies, was reported by stakeholders to have had impact with 13% of the case studies reporting a change in action (e.g. management or policy change), and a further 40% anticipated that a change would result from the work. To a large extent the impact was attributed to a well conducted science-practice interaction process (>70%) (Dick et al 2017a).

The Antwerp Declaration, drafted at the European Ecosystem Services Conference in 2016, is a call to integrate ecosystem services into policy and business operation. The declaration contributed to strong common awareness and agreement in the research communities in Europe and beyond on priorities in ecosystem services and natural capital issues, with recognition of the importance of good governance, the contribution to more effective and inclusive management of ecosystem services balancing trade-offs in social and individual well-being'

Oppla, a new international knowledge platform developed by OpenNESS and OPERAs projects, serves a wide community of policy-makers, scientists, businesses, land use planners and natural resource managers, authorities and NGOs interested in the latest thinking on ecosystem services, natural capital and nature-based solutions. Oppla contributes to the implementation of EU and international policies in the field of biodiversity (CBD, EU), agriculture (CAP) and innovation and circular economy (EU).

4.2 The main dissemination activities and exploitation of results

OpenNESS communication and dissemination activities were an integral part of the overall work carried out in the project. Dissemination activities focused on integrating the content and outputs into the operations of multiple stakeholders as identified in the OpenNESS project and in particular in its communication and dissemination strategy. Overall, the impact of dissemination activities was high and sometimes even beyond expectations (such as the various stakeholder events organized by the case studies, the establishment of Oppla EEIG and the European Ecosystem Services Conference in Antwerp 2016).
Main dissemination activities included:

- OpenNESS communication with EC level policy makers and other policy oriented people and institutions. This took place in meetings, workshops and seminars such as those where analyses on experiences of policy implementation on local level or knowledge needs of future policies were discussed (e.g. Policy Day in March 2016 and EU policy-maker workshop in February 2017). Much of the communication also took place in written form, where the approach and outcomes of the entire project were presented from the perspective of the needs of future policy making (e.g. Furman et al. 2017 on the linkage of cultural and natural capital). The key target group of the nine policy briefs was also the policy makers on EC level.
- Stakeholder implementation plan, based on collecting information on the affiliation of all OpenNESS partners with other relevant networks and projects. This list was used to identify outreach opportunities by approaching individuals that are linked to projects/networks. A standard procedure for creating a list of relevant upcoming events was established. Information about relevant upcoming events was collected using the connections and affiliations OpenNESS researchers have with networks, other relevant projects and/or other initiatives.
- OpenNESS active participation or organisation of events for stakeholders, raising the awareness about the project and ecosystem services in general. Relevant stakeholder events included:
  - Presence with Oppla and OpenNESS posters, an interactive game and other promotion materials at the BEES/MAES Christmas Market, Brussels, Belgium (December 2015)
  - Attendance at meetings with European Environment Agency (January 2016)
  - Presence at Dutch EU Presidency stakeholder event ‘Unwrapping the Circular Economy Package’, Rotterdam, the Netherlands (January 2016)
  - OpenNESS-OPERAs-EC policy day on 1 March 2016;
  - Attendance at meetings with IPBES: (July 2016)
  - Presence with an OpenNESS breakout session at EU conference 'Evidence based policy making for sustainable cities', Utrecht, the Netherlands (May 2016)
  - Oppla launch at the Ecosystem Services Conference: 19-23 September 2016, Antwerp

  - Presentations and posters at the ESP Regional Conference for Latin America in Cali, Colombia (October 2016) and for Africa in Nairobi, Kenya (November 2016)
  - Presentation and poster at the third annual meeting of the EU Business @ Biodiversity platform, The Hague, the Netherlands, (November 2016)
  - Presence with a keynote speech about OpenNESS and its case studies at the Eurosite annual member's meeting, Serres, Greece (November 2016)
  - Presentation of Oppla at EC networking and clustering event "Sustainable Cities through Nature-Based Solutions" (December 2016)
- Stakeholder-based communication channels were identified as an ongoing process, with opportunities used when they arrived (e.g. see above for ELO and Future Earth).
  Final conference: First preparations for the final conference started in August 2015. It was agreed to join forces with OPERAs, the Belgian ECOPLAN project, and the Ecosystem Services Partnership to jointly hold the European Ecosystem Services conference in Antwerp, Belgium on 19-23 September 2016. The conference attracted more than 600 participants from all over the world, served as a networking and knowledge sharing event and resulted in the Antwerp Declaration, a call to integrate ecosystem services into policy and business operation.
- Oppla was created by OpenNESS and OPERAs, as a joint activity to keep the legacy of both projects alive beyond the project duration. It resulted in Oppla EEIG, which provides services to a wide range of stakeholders, research consortia and organisations. A communication plan, flyer, summary texts, abstract, website with Ask Oppla functionality, news items, policy brief, infographic and a poster were developed. An Oppla business plan has been drafted, exploring the key considerations in developing Oppla as a self-sustaining product.
- An OpenNESS SME event 'Businesses operationalising ecosystem services and natural capital' was held on 28 October 2015 in Brussels, resulting in increased awareness of a range of SMEs about ecosystem services and their relevance for commercial operations. The OpenNESS SME event brought together 40-45 participants from SMEs, SME representative bodies, business and biodiversity platforms, academia, governments and the EC. The Event shared recent advances and discussed future opportunities and needs for research and innovation (R&I) in the EU, related to new business opportunities and models that take account of, value and/or sustain natural capital and ecosystem services. See also: http://www.openness-project.eu/sme-event/. The outcomes of the SME Event were fed into the final conference in September 2016, which focused on implementation in practice, including by the business community.
- A project website (http://www.openness-project.eu/) was produced in January 2013 and expanded as well as kept up to date since then. It currently has about 2200 users per month. It serves as the main external resource for OpenNESS.
- A Twitter account and a LinkedIn Group were set up and a social media strategy was drafted early 2014 which is used as guidance for both. A case studies blog was discussed as well. It turned out to be difficult and time consuming to mobilize cases to contribute, even those ´within easy reach´.
- An OpenNESS Special Issue team was put together for the development of a Special Issue in a peer reviewed journal. The offer from the Elsevier journal Ecosystem Services to publish the Special Issue was accepted and the issue will be realized 01.11.2017. The Special Issue is likely to have 13 papers and all but one paper are in the process of review. At the moment one has been accepted and the other papers are in a review process. As soon as papers are accepted they will be assigned with a digital object identifier (DOI) and made electronically available by the publisher for those

that opted for Open Access. A major scientific contribution from OpenNESS is the 99 articles already published or in press.

- The work of OpenNESS was disseminated via over 200 local outreach events by the case study partners, and non-technical articles and news items about OpenNESS have been produced for non-scientific international, national and regional audiences (in English and national languages).
- At the ALTER-Net summer schools in 2014 and 2015 OpenNESS has voluntarily contributed to the summer school programme with lectures. In addition the summer school was advertised within the projects to get junior scholars to participate. Four OpenNESS speakers attended the 2014 summer school and three speakers attended the 2015 summer school. For 2016 eight speakers from the OpenNESS consortium attended the summer school and 6 students from the OpenNESS consortium participated. Speakers of the OpenNESS project were reimbursed by the project and they included general information about the project within their lectures. The project will be further reflected in 2017 summer school with speakers from the consortium.

References

Barton, D.N., Stange, E., Blumentrath, N. & Traaholt, V. 2015. Economic valuation of ecosystem services for policy. A pilot study on green infrastructure in Oslo. NINA Report 1114. 77 pp.

Barton, D., Kelemen, .E, Dick, J., Martin-Lopez, B., Gómez-Baggethun, E., Jacobs, S., Hendriks, C.M.A., Termansen, M., García-Llorente, M., Primmer, E., Dunford, R., Harrison, P.A., Turkelboom, F., Saarikoski, H., van Dijk, J., Rusch, G.M., Palomo, I., Yli-Pelkonen, V., Carvalho, L., Baró, F., Langemeyer, J., Tjalling van der Wal, J., Mederly, P., Priess, J., Luque, S., Berry, P., Santos, R., Odee, D., Martínez Pastur, G., Garcia Blanco, G., Saarela, S., Silaghi, D., Pataki, G., Masi, F., Vădineanu, A., Mukhopadhyay, R., Lapola, D. 2017. (Dis) integrated valuation: narrowing the gap between ecosystem service appraisals and governance support. Ecosystem Services. In review.

Bouwma, I., Schleyer, C., Primmer, E., Winkler, K.J., Berry, P., Young, J., Carmen, E., Špulerová, J., Bezák, P., Preda, E., Vadineanui, A. 2017. Adoption of the Ecosystem Services concept in EU policies. Ecosystem Services, In press.

Dick, J., Turkelboom, F., Woods, H. et al. 2017a. Stakeholders' perspectives on the operationalisation of the ecosystem service concept: results from 27 case studies. Ecosystem Services, OpenNESS Special Issue, In Review.

Dick, J ., Verweij, P., Carmen, E., Rodela, R. & Andrews, C. 2017b. Testing the ecosystem service cascade framework and QUICKScan software tool in the context of land use planning in Glenlivet Estate Scotland. International Journal of Biodiversity Science, Ecosystem Services & Management 13: 12-25.

Dunford, R., Harrison, P.A., Dick, J., Martin-Lopez, B., Barton, D.N., Rusch, G. et al. 2017. Integrating methods for ecosystem service assessment: experiences from real world situations. Ecosystem Services. In review.

Furman, E., Barton, D.N., Harrison, P., Kopperoinen, L., Mederly, P., Pérez-Soba, M., Potschin, M., Saarikoski, H., Schleyer, C., Smith, A., Watt, A., Young, J., Kelemen, E., Gómez-Baggethun, G. 2017. Operationalizing ecosystem services: Advancing knowledge on natural and cultural capital. In: Paracchini M.L., Zingari P.C., Blasi C. (eds.) Re-connecting Natural and Cultural Capital. Contributions from Science and Policy. European Union. Office of Publications of the European Union, Luxembourg. In press.

Grizzetti B., Liquete, C., Antunes, P., Carvalho, L., Geamănă, N., Giucă, R., Leone, M., McConnell, S., Preda, E., Santos, R., Turkelboom, F., Vădineanu, A. & Woods, H. 2016. Ecosystem services for water policy: Insights across Europe. Environmental Science & Policy 66: 179-190.

Görg, C., Keune, H., Primmer, E. and C. Schleyer. 2016. Good Governance. In: Potschin, M. and K. Jax (eds): *OpenNESS Ecosystem Services Reference Book*. EC FP7 Grant Agreement no. 308428. Available via: www.openness-project.eu/library/reference-book

Haines-Young, R., Kretsch, C. and M. Potschin 2016. Competitiveness. In: Potschin, M. and K. Jax (eds): OpenNESS Ecosystem Services Reference Book. EC FP7 Grant Agreement no. 308428. Available via: www.openness-project.eu/library/reference-book

Haines-Young, R., Potschin, M., Jax, K., Görg, C., Heink, U., Kelemen, E. and Schleyer, C. 2017. OpenNESS Conceptual Nexus (ONEX). Guidelines for testing the conceptual frameworks in case study areas using methods and data resources developed in WPs 2, 3 and 4. Deliverable 1.4. European Commission FP7. 83 pp plus internet application "The ONEX lab" available at: https://trello.com/b/sm1lX0S0/the-onex-lab

Harrison, P.A., Dunford, R., Barton, D.N., Kelemen, E., Martin-Lopez, B., Norton, L., Termansen, M., Saarikoski, H., Hendriks, K., Gomez-Baggethun, E., Czúcz, B., Garcia-Llorente, M., Howard, D., Jacobs, S., Karlsen, M., Kopperoinen, L., Madsen, A., Rusch, G., van Eupen, M., Verweij, P., Smith, R., Tuomasjukka, D. & Zulian, G. 2017. Selecting methods for ecosystem service assessment: A decision tree approach. Ecosystem Services. In review.

Jacobs, S., Martin-Lopez, B., Barton, D., Dunford, R., Harrison, P.A., Kelemen, E., Saarikoski, H., Termansen, M., Garcia-Llorente, M., Gómez-Baggethun, E.N., Kopperoinen, L., Luque, S., Palomo, I., Priess, J., Rusch, G.M., Tenerelli, P., Turkelboom, F., Demeyer, R., Hauck, J., Keune, H. & Smith, R. 2017. The means determine the end – pursuing integrated valuation in practice. Ecosystem Services. In review.

Jax, K. & Heink, U. 2016. Human Well-Being. In: Potschin, M. and K. Jax (eds): *OpenNESS Ecosystem Services Reference Book*. EC FP7 Grant Agreement no. 308428. Available via: www.openness-project.eu/library/reference-book

Jax, K., Furman, E., Saarikoski, H., Barton, D.N., Dick, J., Delbaere, B., Duke, G., Görg, C., Gómez-Baggethun, E., Harrison, P.A., Maes, J., Pérez-Soba, M., Turkelboom, F., Saarela, S-R., van Dijk, .J & Watt, A.D. 2017. Handling a messy world: Towards operationalising the ecosystem services approach for a variety of real-world problems. Ecosystem Services. In review.

Kopperoinen, L. Itkonen, P. & Niemelä, J. 2014. Using expert knowledge in combining green infrastructure and ecosystem services in land use planning: an insight into a new place-based methodology. Landscape Ecology 29(8):1361-1375.

Kretsch, C. & Schleyer, C. 2016. Final conceptual frameworks for the analysis of ecosystem services and natural capital in relation to the challenges of well-being, sustainable management, governance and competitiveness, and how these issues can be communicated and resolved in difference place based-contexts. European Commission FP7, 112 pp.

Liquete, C., Kleeschulte, S., Dige, G., Maes, J., Grizzetti, B., Olah, B. & Zulian, G. 2015. Mapping green infrastructure based on ecosystem services and ecological networks: A Pan-European case study. Environmental Science & Policy 54: 268–280.

Liquete, C., Udias, A., Conte, G., Grizzetti, B., Masi, F. 2016. Integrated valuation of a nature-based solution for water pollution control. Highlighting hidden benefits. Ecosystem Services 22: 392-401.

Masi F., Rizzo A., Bresciani R. & Conte G. 2017. Constructed Wetlands for Combined Sewer Overflow treatment: ecosystem services at Gorla Maggiore, Italy. Ecological Engineering 98: 427-438.

Potschin, M. and Haines-Young, R. 2016. Defining and measuring ecosystem services. In: Potschin, M., Haines-Young, R., Fish, R. & Turner, R.K. (eds.) Routledge Handbook of Ecosystem Services. Routledge, London and New York, pp. 25-44.

Potschin, M., Haines-Young, R., Görg, C., Heink, U., Jax, K., Kretsch, C. & Schleyer, C. 2016. Final conceptual frameworks for the analysis of ecosystem services and natural capital in relation to the challenges of well-being, sustainable management, governance and competitiveness, and how these issues can be communicated and resolved in difference place based-contexts. Deliverable 1.2, European Commission FP7, 114 pp

Potschin-Young, M., Haines-Young, R., Görg, C., Heink, U., Jax, K. and Schleyer, C. 2017. Understanding the role of Conceptual Frameworks: Reading the Ecosystem Service Cascade. *Ecosystem* Services (in press, OpenNESS Special issue, https://doi.org/10.1016/j.ecoser.2017.05.015).

Potschin, M. and K. Jax (Eds.) 2016. OpenNESS Ecosystem Service Reference book. Available Online@ www.openness-project.eu/library/reference-book

Saarikoski, H., Primmer, E., Saarela, S.-R., Antunes, P., Aszalós, R., Baró, F., Berry, P., Garcia Blanko, G., Goméz-Baggethun, E., Carvalho, L., Dick, J., Dunford, R., Hanzu, M., Harrison, P.A., Izakovicova, Z., Kertész, M., Kopperoinen, L., Köhler, B., Langemeyer, J., Lapola, D., Liquete, C., Luque, S., Mederly, P., Niemelä, J., Palomo, I., Pastur, G., Peri, P., Preda, E., Priess, .JA., Santos, R., Schleyer, C., Turkelboom, F., Vadineanu, A., Verheyden, W., Vikström, S. & Young, J. 2017. Institutional challenges in putting ecosystem service knowledge in practice. Ecosystem Services. In review.

Science for Environment Policy 2015. In-depth Report 11 produced for the European Commission, DG Environment by the Science Communication Unit, UWE, Bristol. Available at: http://ec.europa.eu/science-environment-policy.

Schleyer, C., Görg, C., Hauck, J & Winkler, K.J. 2015. Opportunities and challenges for mainstreaming the ecosystem services concept in the multi-level policy-making within the EU. Ecosystem Services, Ecosystem Services 16: 174-81

Smith, A.C., Berry, P.M. &Harrison, P.A. 2016. Sustainable Ecosystem Management. In: Potschin, M. and K. Jax (eds): *OpenNESS Ecosystem Services Reference Book*. EC FP7 Grant Agreement no. 308428. Available via: www.openness-project.eu/library/reference-book

Smith, A., Harrison, P.A., Perez-Soba, M., Archaux, F., Blicharska, M., Egoh, B., Eros, T., Fabrega, N., Irma Gyorgy, A., Haines-Young, R., Li, S., Lommelen, E., Meiresonne, L., Miguel-Ayala, L., Mononen, L., Simpson, G., Stange, E., Turkelboom, F., Uiterwijk, M., Veerkamp, C. & Wyllie de Echeverria, V. 2017a. How natural capital delivers ecosystem services: a typology derived from a systematic review. Ecosystem Services 26: 111-126.

Smith, R.I., Barton, D.N., Dick, J., Haines Young, R., Madsen, A.L., Rusch, G.M., Termansen, M., Woods, H., Carvalho, L., Giucă, R.C., Luque, S., Odee, D., Rusch, V., Saarikoski, H., Adamescu, C.H., Dunford, R., Ochieng, J., Gonzalez-Redin, J., Stange, E., Vădineanu, A., Verweij, P. & Vikström, S. 2017b. Operationalising ecosystem service assessment in Bayesian Belief Networks: experiences within the OpenNESS project. Ecosystem Services. In review.

Turkelboom, F., Jacobs, S., Leone, M., Kelemen, E., García-Llorente, M., Baró, F., Berry, P., Termansen, M., Barton, D., Stange, E., Thoonen, M., Kalóczkai, A., Vadineanu, A., Castro, A., Czúcz, B., Röckmann, C., Wurbs, D., Odee, D., Preda, E., Gomez-Baggethun, E., Rusch, G. Martínez Pastur, G., Palomo, I., Dick, J., Casaer, J., van Dijk, J., Priess, J., Langemeyer, J., Mustajoki, J., Kopperoinen, L., Baptist, M.J., Peri, P.L., Mukhopadhyay, R., Aszalós, R., Roy, S.B., Luque, S. & Rusch, V. 2017. When we cannot have it all: Ecosystem services trade-offs in real-life planning contexts. Ecosystem Services. In review

Vallecillo, S., Polce, C., Barbosa, A., Castillo, C., Zulian, G., Vandecasteele, I., Rusch, G.M. & Maes, J. 2017. Spatial planning for investment in green infrastructure and ecosystem restoration across the EU. Landscape and Urban Planning. In review.

Wijnja, H., van Uden G. & Delbaere, B. (Eds.) 2016. Ecosystem Services in operation: case studies. European Commission FP7.