

## Institutional challenges in putting ecosystem service knowledge in practice



Heli Saarikoski<sup>a,\*</sup>, Eeva Primmer<sup>a</sup>, Sanna-Riikka Saarela<sup>a</sup>, Paula Antunes<sup>b</sup>, Réka Aszalós<sup>c</sup>, Francesc Baró<sup>d,e</sup>, Pam Berry<sup>f</sup>, Gemma Garcia Blanco<sup>g</sup>, Erik Goméz-Baggethun<sup>h,m</sup>, Laurence Carvalho<sup>i</sup>, Jan Dick<sup>i</sup>, Robert Dunford<sup>f,j</sup>, Mihail Hanzu<sup>k</sup>, Paula A. Harrison<sup>j</sup>, Zita Izakovicova<sup>l</sup>, Miklós Kertész<sup>c</sup>, Leena Kopperoinen<sup>a</sup>, Berit Köhler<sup>m</sup>, Johannes Langemeyer<sup>d,e</sup>, David Lapola<sup>n</sup>, Camino Liqueste<sup>o</sup>, Sandra Luque<sup>p</sup>, Peter Mederly<sup>q</sup>, Jari Niemelä<sup>r</sup>, Ignacio Palomo<sup>s</sup>, Guillermo Martinez Pastur<sup>t</sup>, Pablo Luis Peri<sup>u</sup>, Elena Preda<sup>v</sup>, Jörg A. Priess<sup>w</sup>, Rui Santos<sup>b</sup>, Christian Schleyer<sup>x,y</sup>, Francis Turkelboom<sup>z</sup>, Angheluta Vadineanu<sup>v</sup>, Wim Verheyden<sup>z</sup>, Suvi Vikström<sup>a</sup>, Juliette Young<sup>i</sup>

<sup>a</sup> Finnish Environment Institute, P.O.Box 140, FI-00251 Helsinki, Finland

<sup>b</sup> CENSE Centre for Environmental and Sustainability Research, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, 2829-516 Caparica, Portugal

<sup>c</sup> Institute of Ecology and Botany, Centre for Ecological Research, Hungarian Academy of Sciences, Alkotmány u. 2-4, H-2163 Vácraátót, Hungary

<sup>d</sup> Institute of Environmental Science and Technology (ICTA), Universitat Autònoma de Barcelona (UAB), Edifici Z (ICTA-ICP), Carrer de les Columnes s/n, Campus de la UAB, 08193 Cerdanyola del Vallès, Spain

<sup>e</sup> Hospital del Mar Medical Research Institute (IMIM), PRBB, Carrer Doctor Aiguader 88, 08003 Barcelona, Spain

<sup>f</sup> Environmental Change Institute, University of Oxford, South Parks Road, Oxford OX1 3QY, UK

<sup>g</sup> Fundación Tecnalia Research & Innovation, Energy and Environment Division, Parque Tecnológico de Bizkaia, C/Geldo, Edificio 700, E-48160 Derio, Bizkaia, Spain

<sup>h</sup> Department of International Environment and Development Studies (Noragric), Norwegian University of Life Sciences (NMBU), P.O. Box 5003, N-1432 Ås, Norway

<sup>i</sup> Centre for Ecology and Hydrology, Bush Estate, Penicuik, Midlothian, EH26 0QB, UK

<sup>j</sup> Centre for Ecology and Hydrology, Lancaster Environment Centre, Bailrigg, Lancaster LA1 4AP, UK

<sup>k</sup> Romanian National Institute for Research and Development in Silviculture, 13, Cloşca, 500040 Braşov, Romania

<sup>l</sup> Institute of Landscape Ecology of the Slovak Academy of Science, Štefánikova 3, P.O.Box 254, 814 99 Bratislava, Slovak Republic

<sup>m</sup> Norwegian Institute for Nature Research (NINA), Gaustadalléen 21, 0349 Oslo, Norway

<sup>n</sup> Center for Meteorological and Climatic Studies Applied to Agriculture – CEPAGRI, Universidade Estadual de Campinas - Unicamp, Cidade Universitária “Zeferino Vaz” – 13083-970 Campinas, SP – Brazil

<sup>o</sup> European Commission – Joint Research Centre (JRC), Via E. Fermi 2749, 21027 Ispra (VA), Italy

<sup>p</sup> IRSTEA, National Research Institute of Science and Technology for Environment and Agriculture, UMR TETIS, 500 rue JF BRETON, Montpellier 34000, France

<sup>q</sup> Department of Ecology and Environmental Sciences, Constantine the Philosopher University in Nitra, Tr. A. Hlinku 1, 94901 Nitra, Slovakia.

<sup>r</sup> Department of Environmental Sciences, P.O. Box 65, FI-00014 University of Helsinki, Finland.

<sup>s</sup> Basque Centre for Climate Change (BC3), Sede Building 1, 1st floor, Scientific Campus of the University of the Basque Country, 48940 Leioa, Spain

<sup>t</sup> Centro Austral de Investigaciones Científicas (CADIC CONICET), Houssay 200, Ushuaia (9140) Tierra del Fuego, Argentina

<sup>u</sup> Instituto Nacional de Tecnología Agropecuaria (INTA)-Universidad Nacional de la Patagonia Austral (UNPA)-CONICET, CC 332, Río Gallegos (9400) Santa Cruz, Argentina

<sup>v</sup> University of Bucharest - Research Center in Systems Ecology and Sustainability, Splaiul Independentei 91-95, 050095 Bucharest, Romania

<sup>w</sup> Helmholtz-Centre for Environmental Research – UFZ, Permoserstraße 15, 04318 Leipzig, Germany

<sup>x</sup> Alpen-Adria-University Klagenfurt – Institute of Social Ecology, Schottenfeldgasse 29, 1070 Vienna, Austria

<sup>y</sup> University of Kassel – Section of International Agricultural Policy and Environmental Governance, Steinstraße 19, 37213 Witzenhausen, Germany

<sup>z</sup> Research Institute for Nature and Forest (INBO), Kliniekstraat 25, 1070 Brussels, Belgium

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### ABSTRACT

The promise that ecosystem service assessments will contribute to better decision-making is not yet proven. We analyse how knowledge on ecosystem services is actually used to inform land and water management in 22 case studies covering different social-ecological systems in European and Latin American countries. 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. We observed 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

\* Corresponding author.

E-mail address: [heli.saarikoski@ymparisto.fi](mailto:heli.saarikoski@ymparisto.fi) (H. Saarikoski).

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.

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## 1. Introduction

The premise in the Millennium Ecosystem Assessment (MEA, 2005), The Economics of Ecosystems and Biodiversity (TEEB, 2010) and other significant research interventions on ecosystem services (e.g. de Groot et al., 2010; Kareiva et al., 2011; Maes et al., 2012; Braat and de Groot, 2012) is that knowledge of ecosystem services and their values can be used to inform, and improve, decision-making. Yet the ways in which knowledge on ecosystem services is actually used to inform decision-making at different governance levels is overlooked (Laurans et al., 2013; Jordan and Russel, 2014; Primmer et al., 2015; Mann et al., 2015; Russel et al., 2016). As literature on the role of scientific knowledge in policy making suggests, the knowledge-decision making dynamics are far more complicated than the linear knowledge transfer model assumes (Weiss, 1979; Jasanoff, 1987; Owens, 2012), implying that simply providing more knowledge does not automatically lead to better and more informed decisions. Therefore, there is a need for studies to better understand the patterns of ecosystem service knowledge use and associated enablers and barriers in different institutional, sectoral and operational contexts. As Russel et al., (2016, p. 588) point out, “The debate within the ecosystem services community (both researchers and practitioners) about the conditions in which new knowledge is or is not used, by whom and for what purpose, has barely begun”.

In the few studies that have addressed ecosystem service knowledge use, a core message is that direct use of the concept or the approach in supporting decision-making is limited. This is the case, for example, in Australian natural resource management (Plant and Ryan, 2013), German and Finnish land-use planning (Albert et al., 2014; Rinne and Primmer, 2016), the UK National Ecosystem Assessment (NEA) (Waylen and Young, 2014) and other environmental assessments (Cowell and Lennon, 2014; Turnpenny et al., 2014), as well as in European decision-making more generally (Hauck et al., 2013). Waylen and Young (2014) find that despite its original rationale, the UK NEA has provided little operational support for decision-making. In an analysis of environmental assessments in general, Cowell and Lennon (2014, p. 278) find that an initial take-up of knowledge occurs mainly in places that already share environmental concerns. The authors find no support for the assumption that environmental values would be given greater weight if they are represented in economic terms: “[W]here novel assessment approaches lead to conclusions that challenge economic priorities, the fact that environmental values might come clothed in economic language of ‘capital’ or ‘services’ offers little protection against them being criticized or set aside”. Turnpenny et al. (2014) find that there are still significant obstacles standing in the way of the systematic embedding of an ecosystem service approach in UK policy appraisal documents. They maintain that understanding the use of knowledge on ecosystem services in decision-making requires an understanding of the barriers and enabling factors operating at different levels within institutions. On a more optimistic note, Haines-Young and Potschin (2014), McKenzie et al. (2014), Ruckelshaus et al. (2015) and Saarela and Rinne (2016) observed that local actors were able to form an

agreed evidence base on ecosystem services in concrete case studies in which knowledge users have been involved in knowledge generation.

In this paper we examine the ways in which knowledge on ecosystem services, generated in the OpenNESS project ([www.openness-project.eu](http://www.openness-project.eu)), was used to inform planning, policy-making and management in 22 case studies covering different social-ecological systems in thirteen European and two Latin American countries. The real-world cases were designed to integrate the concept of ecosystem services into land and water management. The work was carried out in close collaboration with place-based experts, practitioners, policy-makers and other stakeholders throughout the research process, from 2013 till the beginning of 2017, applying participatory action research and unstructured observation methods. Drawing on the case study experiences, we address the following questions:

1. How did practitioners, decision-makers and other stakeholders take up and use the research and findings on ecosystem services provided by the case study research teams?
2. What were the successes and failures in applying the ecosystem services concept and knowledge in planning and decision-making at different governance levels, from national to operational site level?
3. What were the factors that conditioned the consideration of ecosystem services knowledge in different social-ecological systems and socio-political contexts in the case studies?

## 2. Theoretical background

Literatures in the fields of public policy, science and technology studies, interpretive policy analysis, and new institutionalism have addressed the questions of knowledge utilization and policy learning: what is learned, by whom and what are the conditions under which it may or may not have effects on policy. This literature usually distinguishes three main modes of knowledge use (Weiss, 1979; Waylen and Young, 2014; McKenzie et al., 2014; Russel et al., 2016): (i) instrumental or technical use, when knowledge directly informs decisions and helps to select the appropriate means to reach the goal; (ii) political or strategic use, when knowledge is employed to attain political objectives or to argue for a particular case; and (iii) conceptual use, when knowledge informs decision-making by introducing new ideas, challenges existing beliefs and opens up new opportunities for policy change.

Knowledge utilization can be seen both as a process and an outcome. Elaborating on this insight, Rich (1997) has provided a typology of the various stages of knowledge use (see also Jordan and Russel, 2014). In the simplest form, knowledge is ‘used’ when it has been received and taken in. It has ‘utility’, when a user judges knowledge as having potential value but the purpose for which has yet to be identified. It has ‘influence’ when it has contributed to a decision, and finally, it has ‘impact’ when information has led to clear and concrete action. These categories recognize the fact that knowledge can have multiple pathways, including the framing of

policy problems and proposals as well as putting forward, defending and rejecting arguments in policy processes (Kingdon, 2003). It can generate both visible, short term responses as well as more subtle and diffuse changes in policy frames that are time-lagged but traceable—and in some case also untraceable but nevertheless existing (Owens, 2015).

The analyses of knowledge use are not only about the modes and impacts of knowledge but importantly also about the reasons why knowledge is used, or not used, in decision-making. Some authors emphasize the role of competing interests and political agendas (Cashore et al., 2001; Owens et al., 2004; Nykvist and Nilsson, 2009) or advocacy coalitions (Sabatier, 1988) in the complex and contested areas of public policy as well as the underlying political climate and power relations, which contribute to the success of interests and agendas as well as the related ideas and knowledge claims (Kingdon, 2003; Juntti et al., 2009). In highly contested policy-making situations, imperatives located in the political sphere often dominate scientific evidence, and knowledge is used not to inform decision-making but to legitimize pre-existing positions (Sharman and Holmes, 2010). Others have focused on formal and informal institutions and looked at the ways in which knowledge is actually used to shape decisions and management processes in general (March and Olsen, 1984) and on ecosystem services in particular (Loft et al., 2015; Primmer, 2016). Formal institutions, such as laws, regulations and policies, set the framework for the use and management of ecosystems, and often define the types of information that can be used in decision-making (Primmer, 2016; Bouwma et al., 2016; Ruhl, 2016). Integrating the concept of ecosystem services into planning and policy-making processes is seen to require vertical policy integration between different levels of government (EU-level, national, regional and municipal) as well as horizontal integration across different policy fields and thematic objectives. Competencies to address the management of ecosystem services are dispersed over several political and administrative levels, and strategies to improve effective decision-making on ecosystem services must be balanced vertically. In a similar way, the management of ecosystems is affected by several policies (e.g. agricultural, urban and regional developmental) which might have contradictory objectives (Schleyer et al., 2015). Another key determinant is property rights, which define the ownership of ecosystems and ecosystem services, as well as the access to them (Vatn, 2010). Poorly defined, inadequately enforced or non-existent property rights have been identified as a major driver of natural resource exploitation (Loft et al., 2015; Rinne and Primmer, 2016). Informal institutions, such as professional norms and practices as well as organizational routines and standard ways of operating, play a major role in how formal rules are interpreted and implemented on the ground (Primmer et al., 2013; Loft et al., 2015). Waylen et al. (2015) use the term ‘sticking points’ to denote the legacy effects of formal rules and informal norms, pre-existing ways of framing and knowing, and pre-existing power relations and interests. They point out that these categories are overlapping as it is often difficult to distinguish between ways of working (institutional sticking points) and ways of knowing (cognitive sticking points). Furthermore, they observe that cognitive and political sticking points often reinforce each other as certain framings are used to defend existing interests. Finally, modes of governance influence the relations between societal interest and the state, for example, by specifying how citizens and interest groups can participate in the policy processes and bring up knowledge and ideas to influence public policy (Cashore et al., 2001). Multi-level participatory governance processes, by which the use of common pool resources, such as most ecosystem services, are decided upon by a broad range of societal actors, are seen to be more open to new ideas and innovations than tradi-

tional hierarchical, top-down governance processes (Muradian and Rival, 2012; Primmer et al., 2015).

Some scholars have approached knowledge use from a policy learning perspective. Through policy learning, individuals and collectives acquire new information, assess and evaluate it, and accept, adopt and act on it (Heikkilä and Gerlak, 2013). The degree of policy learning depends on several factors (Cash et al., 2003; Rydin and Falleth, 2006; Heikkilä and Gerlak, 2013), including (i) knowledge co-production between relevant actions to increase the ownership, relevance, credibility and legitimacy of knowledge for stakeholders and policy-makers; (ii) social capital, which refers to trusting and reciprocal patterns of relationships, and supports open communication and sharing of ideas and knowledge; (iii) the presence of policy champions, or brokers, who can bridge the knowledge producers and users, and foster new ideas and openness to information sharing; and (iv) intellectual capital, such as knowledge and expertise of individuals and organizations, as well as technical resources and tools like databases and information systems, which can determine the type of information that collectives will be interested in learning, seeking out, or having access to (Heikkilä and Gerlak, 2013).

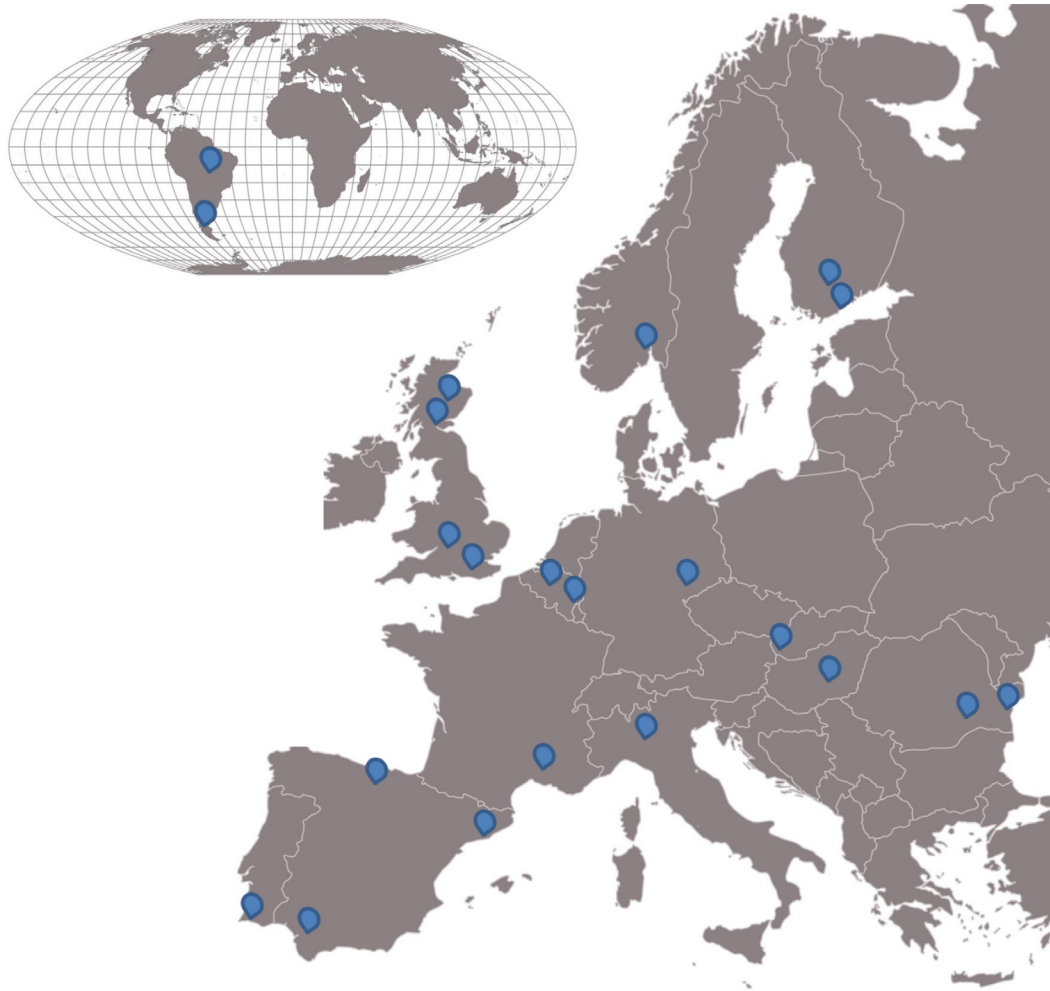
The issues that influence knowledge uptake and function either as constraining or enabling factors are summarized below. We have used them to structure our analysis (Section 4) but as we explain in the methodology (Section 3), we added a few categories that arose from the data and not from the theoretical literature.

- Competing interests and political agendas (Section 4.2.1)
- Power relations and modes of governance (Section 4.2.2)
- Contested knowledge claims (Section 4.2.3)
- Regulatory frameworks and property rights (Section 4.2.4)
- Vertical and horizontal policy integration (Section 4.2.5)
- Professional norms, competencies and codes of conduct (Section 4.2.6)
- Knowledge co-production (Section 4.3.1)
- Social capital (Section 4.3.2)
- Policy champions (Section 4.3.3)
- Intellectual capital (Section 4.3.4)

### 3. Materials and methods

Our analysis is based on the researchers' first-hand experiences in working with policy-makers, practitioners and place-based experts to put the concept of ecosystem services into practice in 22 case studies (Fig. 1) of the OpenNESS project (see Jax et al., 2018), covering thirteen European and two Latin American countries. The case study research design aimed at comparing similar types of land and water management situations, such as urban and land use planning, and forest and farmland management, in different geographical and institutional contexts (Table 1). The boundary conditions for case study selection—focus on European land and water management case studies with some research effort in non-European countries—were set in the call for FP7 funding in 2011, to which the OpenNESS project responded. A further case study selection criterion was that the cases involved real-world planning and management processes, or timely policy problems, and that the key actors involved in these processes, the ‘problem owners’, were interested in working with the case study research teams and participating in a transdisciplinary research project.

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 (see Table 1). The



**Fig. 1.** Case study locations.

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/or value information needed by some assessment methods. This participatory action research approach allowed the case study researchers to assess the ways in which the CAB members received and processed the ecosystem service knowledge and planned or indicated an interest in acting on it, as well as the institutional constraints and opportunities for integrating the knowledge in management and decision-making processes. The CAB members' feedback on the ES assessment methods and their results were also collected through questionnaires, semi-structured face-to-face interviews, focus groups discussions and workshops with the CAB members and/or other knowledge users. The details of the research methods in each case study are presented in [Table 1](#).

To crystalize the lessons on knowledge use across the case studies, a two-hour workshop with the case study researchers was organized in April 2016. The members of the case study teams discussed the successes and failures in knowledge uptake, as well as associated constraints and enabling factors, in facilitated cross-case study breakout groups. The results of these discussions were written down by the facilitators and constituted part of the data. The main body of data was written narratives by the case study team members, addressing the same questions as the break-out groups, collected in templates in May 2016.

In analyzing the data, we used thematic analysis, which aims at identifying patterns, or themes, across the data that are important to understand the research question ([Silverman, 1993](#)), in this case the factors that conditioned the successes and failures in introducing the concept of ecosystem services in planning and decision-making. The coding of the data was informed by the theoretical framework, which sensitized us to the categories listed at the end of [Section 2](#). However, the coding was partly inductive as some of the categories such as conceptual and methodological shortcomings ([Section 4.2.5](#)) and links between ecosystem services and human well-being ([Section 4.3.4](#)) arose from the narrative case study descriptions and not from the theoretical literature. We organized the coded data in initial [Appendices 1 and 2](#), and sent the tables back to the case study teams for completion and validation. This procedure helped to enrich the data as case study teams were invited to consider whether the categories and observations by other case studies were relevant for their case studies. If this was not the case, they were asked to mark N/A to make sure that they covered all categories systematically.

The analyses were carried out throughout the research process and right after it and therefore we could not trace the long-term effects of the new knowledge in ensuing management and policy processes (see e.g. [Owens, 2015](#)). On the other hand, we could examine closely the ways in which actors in the transdisciplinary research processes under study received the information, judged its usefulness and indicated an interest in or plan to act on it. We

**Table 1**

The case study code, focus, impact, participants and sources of data.

Code	Case focus	Utilization of ecosystem service knowledge	Participants engaged in the research process	Sources of data
ALPS	Multi-functional forest management for Vercors Mountains Range in the French Alps region	Participatory work helped to identify knowledge gaps in economically and ecologically viable management options that are not sufficiently understood in French forest policy-making, and opening a debate on the compromise between forest productivity and conservation. The research contributed to a learning process among the key stakeholders; the results are available for next regional rural development planning exercise. The CAB had a very good representativeness at the regional level but missed national level actors. Local actions for conservation were undertaken improving biodiversity targets	Representatives of the National Forest Office and other regional stakeholders including forest owners, farmers, landowners and policy makers at the municipality level	Participant observation of three Case Study Advisory Board (CAB) meetings (n = 20); e-mail survey (n = 8) at the end of the process + field visits
BARC	Urban planning in the metropolitan region of Barcelona, Spain	The ES approach provides a link between ecosystems conservation and human well-being, which was very much appreciated by planners and policy-makers. The Provincial Council was very interested in integrating ES maps in their decision-support tool. However, the CAB didn't have an explicit mandate to integrate the ES approach in landscape/urban planning	Representatives of local and regional authorities, public agencies, research institutes, farmer's union and NGOs	Participant observation of three CAB meetings; e-mail survey (n = 11) at the end of the process
BIOB	Sugarcane bioenergy production of from in interior São Paulo, Brazil	The decision-makers were particularly interested in the water-related ES of the PES scheme	Decision-makers, sugarcane and food producers	CAB meetings; participatory workshops. Open-ended interviews (n = 5); semi-structured questionnaire with break-out groups (n = 50)
BIOF	Forest bioenergy production in Finland	The regional CAB was an ad hoc group, set up as a sounding board for the research results, without any specific role in decision-making. The national level CAB included key actors in forest policy making, and we tried to engage them in knowledge co-production. However, it was difficult to engage national-level actors in a process which required frequent interaction	1 <sup>st</sup> stage: Regional level stakeholders including forest owners, forest industries and environmental authorities (CAB1). 2nd stage: Representatives from the relevant ministries, NGOs and forest owners and bioenergy lobby organisations (CAB2)	Participant observation of four CAB1 meetings; CAB member face-to-face semi-structured interviews (n = 10); focus group and questionnaire (n = 10) in the last meeting; participant observation of two CAB2 workshops; CAB2 member face-to-face semi-structured interviews (n = 10); questionnaire (n = 6) at the end of the process
BIOG	Crop bioenergy production in Saxony, Germany	The CAB members were very interested in the perspective of ES and the results, and they found the exchange of ideas with other stakeholders helpful. However, the land use planners were reluctant to adopt the concept of ES; they felt that it did not add value to the previously used concepts GI and Multifunctional Landscapes	Policymakers, representatives of federal and national scale institutions, NGOs and associations	Formal and informal discussions during the four CAB meetings; questionnaire (n = 6) at the end of the process
CAPM	Forest management and illegal logging in Romania	Local authorities were not interested in ES provided by the forests, one of the main arguments was: "If we have the chance to cut forest and we do not do it, our competitors will say we are stupid"	The local forest administration service, local authorities including mayor, local council, local police and local forest inspectorate	Correspondence and collaboration with the local decision-makers, the general public perception on the forests was surveyed. 53 interviews based on cognitive-psychological method with ordinary members of the communities. 51 semi-structured interviews conducted with mayors, forest inspectors, prosecutors, police officers, members of the local councils, forest management planners, forest guards and 5 priests
CNPM	An integrated management plan for biodiversity and tourism in Cairngorms National Park, Scotland	Transdisciplinary research is still relatively new in Scotland, and the participants were cautious of the process and wished to explore the concept, tools and outputs without a commitment to make a decision based solely on the results of a piece of research which they did not exactly understand	Local decision-makers and residents	Participant observation of three CAB meetings (n = 10) and informal discussions with CAB members. Three workshops (n = 5, 6 12) and face-to-face interviews with CAB chairmen. Two stakeholder evaluation of specific methods (n = 15, 15) and questionnaire with stakeholders at the end of the process (n = 15)
CRKL	Farmland management and planning for green corridors in agricultural land in De Cirkel, Belgium	The land user planners committed themselves to consider the research results seriously, and to act upon them (if useful and feasible)	Project coordinators of the land consolidation project 'De Cirkel', representatives of local administrations, nature conservation NGO, social employment NGOs, farmers, local businesses and schools, local residents	Participant observation of two participatory stakeholder events with focus group discussions on four main project themes; regular discussions with project coordinators; 18 individual interviews and questionnaire at the end of the process (n = 18)
DANU	An integrated and adaptive management plan for Lower Danube River, Romania	Participatory processes were well appreciated at the CAB level, but the process would have needed national level participants to have a policy impact. However, there is evidence that the long-term work by the research team in the area has contributed to	Representatives of management authorities, decision-makers, local residents, local SMEs and professional associations, tourism operators, NGOs etc.	Focus-group discussions (n = 6); semi-structured interviews (n = 5); observation of participants in the 10 CAB meetings and other stakeholders meetings (n = 15); face-to-face interviews and discussions with key stakeholders representatives (n > 25);

*(continued on next page)*

Table 1 (continued)

Code	Case focus	Utilization of ecosystem service knowledge	Participants engaged in the research process	Sources of data
DONN	Management of Doñana National Park and the surrounding landscape in Spain	an integrated and adaptive governance of Delta region The recent decline of the vineyard sector made its representatives to welcome the ES approach as an opportunity to highlight the importance of the sector in providing multiple and synergistic ES	1st stage: ES beneficiaries; 2nd stage: Representatives from: natural park development agency, environmental NGO, wine farmers, municipalities, regional government, etc. Planners, wildlife trusts, offset providers, developers etc.	questionnaire at the end of the process (n = 11) 1st stage: Semi-structured interviews with key stakeholders (n = 10); survey (n = 172) administered to local population. 2nd stage: Participant observation of three CAB meetings, oral interviews (n = 9) with key stakeholders; e-mail questionnaire (n = 2) at the end of the process Meetings with key stakeholders and participant observation of two participatory workshops. Questionnaire (n = 11) at the end of the process
ESSX	Bioiversity and ecosystem service offsetting in Essex, UK	The research intervention had limited impact on planning practice due to lack of data. The environment has also been seen as a barrier to growth	Representatives of local administration, regional institutions and NGOs	Observation of three CAB meetings; a focus group discussion; questionnaires at the end of the process (n = 11)
GOMG	Multipurpose wetland construction in a peri-urban area, Gorla Maggiore, Italy	The actors involved in the case study showed a lot of interest in the functioning and feasibility of multipurpose wetlands to treat sewage overflows. The final application of the knowledge created in the case study by water managers is uncertain and beyond the control of the case study researchers	Representatives of local water management authority, water management experts, land users, nature conservationists, regional development agencies, NGOs, local school teachers, churches, healthcare workers etc.	Preference assessment study by photo elicitation (n = 150); participant observation of five CAB meetings and four stakeholder workshops; Drawing competition for local youth (n = 45); semi-structured interviews + questionnaires at the end of the process (n = 10)
KISK	Water management in semi-arid region in Kiskunság, Hungary	By identifying the main problems and involving local stakeholders the basis was laid for the resolution of the water-management conflicts in the area and the introduction of ES perspective. However, despite its initial intent, the research did not change the water management in the area	Representatives of local management and decision-making, representatives of anglers and recreational users of the area	CAB meetings; focus group discussions with the CAB members (n = 10) and questionnaire following CAB meeting (n = 5)
LLEV	Management of lake Loch Leven, Scotland	The CAB meetings helped to build consensus between some stakeholders who had previously been at odds with each other (e.g. fishing vs nature conservation). Through this process they learnt they had some common goals that they could work together to achieve (e.g. more control on water level management)	Representatives of the Urban Environment Agency, the Planning and Building Agency and the Water and Sewage Agencies	Eight CAB meetings and a one day seminar where 15 method tests were carried out and evaluated; questionnaire at the end of the process (n = 3); semi-structured interviews with involved researchers (n = 4)
OSLO	Urban planning in Oslo, Norway	The participatory process was characterized by a fruitful cooperation between the research team and the main stakeholder in this case – Oslo Municipality's Urban Environment Agency	Representatives of the SACV Natural Park authority, association of local nature-based tourism operators, municipalities, farmers' association, local actors, environmental NGOs, fishermen's association, regional water administration	Participation and input collected in CAB meetings and five stakeholder workshops. Individual semi-structured interviews in the initial scoping stage. Individual meetings with some actors to clarify key aspects. Interviews with CAB members and experts. Questionnaire at the end of the process (n = 14)
SACV	Management of Coastal Natural Park (Sudoeste Alentejano e Costa Vicentina), Portugal	The case study was not conducted in the scope of an actual decision context and participants had no mandate to take decisions. Top-level decision makers did not participate in the participatory events, although they were always invited and showed interest. However, the Association of Local Tourism operators is currently using the information that was generated in the case study, in particular recreation ES maps, to draw a plan for the expansion of the existing network of Nature Trails in the area. Furthermore, the farmers participating in the research process changed their perception regarding the role of natural vegetation in providing nesting and foraging resources for pollinators	Municipal planners, planning consultancy and local stakeholders	Participating in early stage planning workshops and CAB meetings; questionnaire at the end of the process (n = 7)
SIBB	Sibbesborg urban planning process in Finland	The researchers worked closely with municipal land use planners, first in establishing criteria for a planning competition to convert a rural area to residential area, and then providing information about ecosystem service provisioning of alternative planning options. The report by the case study researchers was included as background material of the Local Master Plan	Representatives of the government, local authorities and producers (owners of ranches and sawmills), forest offices, universities etc.	CAB meetings with web based semi-structured interviews and questionnaires (n = 8); web based semi-structured interviews (n = 8) with the final inputs
SPAT	Forest management in Southern Patagonia, Argentina	Industry and private sector representatives actively participated in the study and in several instances also adopted the suggestions arising from the case study work, even though this was not a compulsory requirement by of the Forest Office	Local stakeholders including policy makers, water management experts and NGOs	Stakeholder analysis report; observations during two CAB meetings; regular discussions with the project coordinator; questionnaire (n = 2)
STEVE	Developing a shared vision for Stevoort flood control area, Belgium	Some important stakeholders were absent (especially private forest owners). Tapping on an on-going planning process limited the degree of freedom: some of the issues were already decided and the planners did want to have them re-opened.		

	Although water management already works on multiple functions of the river landscapes, the ES-approach added some extra layers		
TRNA	Landscape-ecological planning in urban and peri-urban areas in Trnava, Slovakia	The case study is one of the first examples of ES assessment and certainly the first attempt to implement ES concept in land use planning process in Slovakia. Trnava case study is serving as a pilot study for the Slovakian Ministry of Environment and the findings feed directly into Slovakian MAES process	Participant observation of five CAB meetings and five meetings with selected key stakeholders; results of face to face interviews with 25 representatives of municipalities; questionnaire with CAB members at the end of the process (n = 11)
VGAS	Urban planning in Vitoria-Gasteiz municipality, Spain	The concept was already well known by the city planners. Now, they are even more conscious about how this could be useful to the city interventions in the future. The research provided a new approach that may be used in future urban planning	CAB meetings; questionnaire at the end of the process (n = 2)
WCSD	Biodiversity and ecosystem service offsetting, Warwickshire, UK	District planners took a keen interest in the research process and were happy to provide their data-sets for the researchers	Meetings with key stakeholders; participant observation of two stakeholder workshops with key stakeholders and a questionnaire (n = 5) at the end of the process
		Representatives of local and regional authorities, Ministry of Environment, university, land use planning company, NGO and private business sector	
		Representatives of the municipality, environmental experts and urban planners within the local administration	
		Planners, wildlife trusts, offset providers, developers etc.	

could also identify the reasons why the actors found the information useful and actionable, or why they did not make use of it.

## 4. Results and discussion

### 4.1. Utilization of ecosystem service knowledge in the case studies

All case studies engaged a broad range of stakeholders, including public authorities and decision-makers, and looked at real-life policy or management problems in actual decision-making context. Furthermore, the case studies were highly successful in terms of adopting a holistic approach and addressing multiple ecosystem services instead of thinking about the environment in terms of single issues or problems (cf. Waylen et al., 2015). However, most cases were mainly research driven interventions, not commissioned by the authorities or policy-makers, and hence it is not surprising that there were not many instances where knowledge informed management and decision-making directly. For example, water regulation in Kiskunság Sand Ridge (KISK) aimed at influencing water retention management and combatting a drop in ground water level resulting from drainage, carried out in the last century to convert wetland area to agricultural land, and currently used to protect farmlands from inland water. Yet because of a lack of mandate of the researchers, and a mismatch in timing of the research intervention and management decisions, the researchers found that they did not have a significant impact on the decision-making process: the project did not change the water management system in the region, nor did it provide more water for traditional land-uses such as pastures small-scale arable fields, vineyards and orchards. Lack of mandate (e.g. BARC, BIOF, GOMG) and attention by national level policy makers (e.g. ALPS, DANU, SACV) was a major impediment of knowledge uptake also in other cases.

However, knowledge was used in most case studies in the sense that it was received and taken in by the key actors involved in the CABs. Knowledge also had utility in several cases (ALPS, BARC, CNPM, CRKL, DANU, DONN, GOMG, KISK, LLEV, OSLO, SACV, SPAT, STEV, TRNA, VGAS, WCSD) in which 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 (see also Harrison et al., 2018). In these cases, the results will stay with the planners, public authorities or other relevant actors who can draw on them in the future. Moreover, some cases succeeded in having an actual impact on decision-making. An example is the Sibbesborg urban case (SIBB) in Finland, in which researchers worked closely with municipal land-use planners, first in establishing criteria for a planning competition to convert a rural area in southern Finland to housing for 100,000 residents, and then providing information about ecosystem service provisioning of alternative planning options. The report by the case study researchers was included as background material of the Local Master Plan. In a similar vein, the ecosystem service maps developed for the metropolitan region of Barcelona by the case study researchers (BARC) have been included in a decision-support tool by the city of Barcelona. Another positive example is from Portugal, where the Association of Local Tourism operators is currently using the information that was generated in the case study (SACV), in particular recreation ecosystem service maps, to draw a plan for the expansion of the existing network of Nature Trails in the area. The potential for knowledge feeding into decision-making is also quite high in the Trnava case study (TRNA), which was serving as a pilot study for the Ministry of Environment and fed into mapping and assessment of ecosystem services (the MAES process) in Slovakia.

None of the case studies reported instrumental use of knowledge in the sense that ecosystem service knowledge would have

been the ‘missing piece’ of information needed to make decisions (see Weiss, 1979). This is quite understandable because most cases involved trade-offs between ecosystem services and related interests and values; knowledge as such cannot serve as an impartial arbiter in such decision-making situations (Bijker et al., 2009). Even in cases like Gorla-Maggiore (GOMG), which demonstrated the benefits from multi-purpose wetlands (Masi et al., 2016; Lique et al., 2016), authorities were cautious and needed more proof of the functioning of nature-based solutions. Strategic use of knowledge was reported in the Doñana case (DONN) in which wine growers used the research results to support their argument, that is, to ensure the viability of traditional vineyards, which provide multiple provisioning, cultural and regulating services.

In most cases there was some evidence of conceptual use of knowledge as a result of close interaction between stakeholders in the CABs. For example, stakeholders in the Oslo case felt that the mapping and valuation research process resulted in changed understanding of the importance of green spaces, and green structures such as city trees, and that it will contribute to the ways in which nature will be seen in urban planning in the future. In a similar vein, the Patagonian case study (SPAT) increased understanding of the synergies between biodiversity and forest ecosystem services among stakeholders who previously had focused mainly on provisioning services (Martinez Pastur et al., 2017). In the Costa Vicentina Natural Park case in Portugal (SACV), farmers participating in the research process changed their perception regarding the role of natural vegetation in providing nesting and foraging resources for pollinators, and agreed that agricultural planning and practices could be changed accordingly.

In the next two sections we discuss in detail the factors that prevented or slowed down the real uses of ecosystem service assessment and valuation results in the case studies as well as the factors that facilitated their employment in practice.

## 4.2. Constraints to the use of ecosystem services information

### 4.2.1. Competing interests and political agendas

Most of the case studies lent support to the observation that environmental knowledge alone does not shift priorities from unsustainable development to environmental protection (Nykivist and Nilsson, 2009; Cowell and Lennon, 2014), especially when strong economic interests and established political priorities like job-growth are at stake. For example, the economic drivers to develop Sipoo Bay to attract affluent taxpayers replaced the original idea to save the unique bay with fjord-like characteristics and natural values (SIBB). In a similar way, the traditional trade-offs between provisioning services (timber, biofuels) and regulating (water purification, erosion control) and cultural services (landscape, recreation) were at play in the forest management case studies (ALPS, BIOF) and bioenergy case studies (BIOG, BIOB). The ecosystem services concept also did not succeed in erasing conflicting interest-group goals in several other cases (CAPM, CNPM, CRKL, DANU, DONN, ESSX, KISK, OSLO, SACV, SPAT, STEV, TRNA), reflecting the fact that the same spaces cannot provide all ecosystem services at the same time.

An interesting case in point are the two biodiversity and ecosystem services offsetting cases in the UK, which had a similar focus, but different trajectories of success. Warwickshire (WSCO) is a rural county where nature and landscape beauty is considered an important asset and attraction, whereas Essex (ESSX) is a growing county, which houses commuters to London, and hence experiences greater pressures to develop and expand. Both were UK offsetting pilots, but in Warwickshire district planners have taken a very positive approach to offsetting, and were keen to collaborate with the project researchers, while Essex planning authorities were more cautious and initially had no time to offer support for the

research. Therefore, it seems that a view of the environment either as an asset or a barrier to growth determined the success of research initiatives. This observation agrees with Cowell and Lennon (2014), who noted that assessment techniques which mobilize conceptions of environmental limits, such as ecosystem services and biodiversity offsetting, resonated most strongly in locations where popular politics and institutional norms embody a sense of threat to the countryside and wider environmental quality.

### 4.2.2. Power relations and modes of governance

Policy-making is shaped by the participating actors and their concerns reading the political, technical and financial feasibility of the policy options, often conditioned by the relative power of these actors (Mann et al., 2015; da Conceição et al., 2015). Power differences have shaped forest policy-making in Finland, where forest owners and forest industries have traditionally had a privileged access to national forest policy formulation (Ollonqvist, 2002). Promoting forest bioenergy ranks particularly high on the current right-wing government agenda, and critical voices on the negative consequences of forest bioenergy on biodiversity and carbon sequestration have not had much influence in decision-making. Against this backdrop, and in the political climate of economic recession, the Finnish forest bioenergy case (BIOF) did not succeed in contributing much to the national-level policy debate. The privileged position of business sector representatives, and consequent lack of interest in voicing their concerns via the case study work, was observed also in other cases (e.g. DANU, TRNA).

Several of the case studies, especially the local level land use planning and nature park management cases, could be characterized as multi-level governance processes (Muradian and Rival, 2012) in which the managers and planners worked closely with the stakeholders and researchers to seek new solutions to ensure the flow of ecosystem services. These cases (e.g. CRKL, LLEV, SACV, SIBB, VGAS) were also the ones which allowed more openings for ecosystem service research (see also Loft et al., 2015). In contrast, ecosystem service knowledge played a minor role in cases with more hierarchical modes of governance. In the forest management case study in Romania (CAPM), the centralized policy regime did not allow public concerns for forest ecosystem services important for local communities to enter the decision-making agenda at the higher levels. The legacy of hierarchical policy regime was also observed in the Hungarian case study, where rigid regulatory frameworks made it very difficult to adapt scientific results into the management process in Kiskunság (KISK).

### 4.2.3. Contested knowledge claims

In some cases the strong interests and political agendas took the form of scientific conflicts and contested knowledge claims. For example, the arguments about net greenhouse gas (GHG) emissions from forest bioenergy in Finland (BIOF) were highly contested as some studies maintained that forest bioenergy is carbon neutral (Kilpeläinen et al., 2016; Torsson et al., 2016) while other studies predicted increases in GHG emissions as a consequence of increased use of forest bioenergy (Repo et al., 2015a,b). The conflicting results left the stakeholders puzzled and undecided and allowed policy-makers to select information which matched their preexisting attitudes and assumptions (see Heikkilä and Gerlak, 2013). Conflicting knowledge claims were an issue also in the Patagonian case (SPAT) where scientists habitually disagree on the merits of traditional vs. retention forestry, and in the Kiskunság case (KISK), where the scientific disputes on the role of drainage in desiccation have paralyzed decision-making and played an important role in inaction to save the region from desiccation.



#### 4.2.4. Regulatory frameworks and property rights

The EU Biodiversity Strategy to 2020 asks Member States to map and assess their ecosystem services and to value them (by 2020). Yet the existing regulatory frameworks that were relevant for the decision-making contexts in the case studies did not provide any specific methodological or other guidance on – or even induce or encourage – ecosystem services assessments or valuations. For example, while ecosystem services are recognized in national level strategy documents, operational guidance for considering ecosystem services in municipal level planning and impact assessment is largely lacking in Norway. Therefore, ecosystem services knowledge could not be utilized in building permitting processes (OSLO). An exception was the Water Framework Directive (WFD) in the Loch Leven case study (LLEV), as it emphasizes the good ecological quality of water bodies and potentially includes valuation of ecosystem services in the cost-benefit analysis in management action plans. The stakeholders in this case felt an ecosystem service approach could help the WFD deliver wider policy imperatives of sustainability and live up to the directive's original ambition, rather than just the technical goal of good ecological status.

Existing legislation can also become a direct or indirect obstacle for the implementation of the ecosystem services concept on the ground (see also Waylen et al., 2015; Ruhl, 2016). For example, the Stevoort case (STEV) explored deforestation of poplar plantations as a possible strategy for creating more open landscapes for specific species living in relatively open river-habitats. However, the current legislation regarding compensation for deforestation in Belgium, and the uncertainty induced by an ongoing revision of this piece of legislation, ruled out deforestation as a management option to be considered. Another example is the Hungarian national park regulations that restrict the supply of some provisioning services such as hay and crop production in Kiskunság (KISK), and thereby also traditional land-uses such as grazing (Kovács et al., 2015).

Ecosystem services assessments and valuations, both processes and outcomes, as well as policy instruments like payments for ecosystem services (PES) schemes, can influence property rights and land market prices. For example, in the Brazilian case (BIOB), there was a danger that introducing a PES scheme would give rise to land speculation on farmland (Silva et al., 2016). They might also impose restrictions on specific land-uses, for example through legal protection status. Furthermore, while ecosystem services like air purification and carbon sequestration are common pool resources, the ecosystems that contribute to them are often private property. The Vercors Mountains case (ALPS) demonstrates that privately owned forest tend to remain dominant use regimes (Ruhl, 2016), which prioritize one land use over others, in this case timber, despite attempts to promote multifunctional forest management. Finally, there might be significant discrepancies between formal rights and duties with respect to natural resource use and de facto use demonstrated by the case of illegal forestry activities in Romania (CAPM).

#### 4.2.5. Lack of vertical and horizontal integration

Lack of horizontal integration between central and local government agencies across different thematic objectives was a key issue in some urban and peri-urban planning cases (BARC, SIBB, TRNA, VGAS), as well as water management (DANU, LLEV, SACV) and natural resource management cases (BIOF, DANU, STEV) where sectoral legislation and planning processes held back advancing the cross-cutting concept of ecosystem services. For example, green areas provide water storage and infiltration services, but these cannot be taken into account by sewage planners unless they work closely with green area planners to develop multi-functional green and blue infrastructures (GOMG, SIBB) (see also Grizzetti et al.,

2016). In some cases, ecosystem services did serve as a boundary concept (Schleyer et al., 2015; Saarela and Rinne, 2016) that facilitated communication across different sectors, in the Oslo case between urban planners and managers in the Urban Environment Agency, Planning Agency and Water and Sewage Agency (OSLO) and in the Costa Vicentina case (SACV) between people from nature conservation, agriculture and tourism.

Vertical integration between different levels of government was a key problem in the French Alpine forest management case (ALPS), Lower Danube River case (DANU), and the Doñana case study (DONN) where lack of communication between management authorities at the local, regional and national level did not allow ecosystem services information generated at the local level to enter regional and national level decision-making. In a similar way, rigid regulatory frameworks, as well as hierarchical modes of governance, made it difficult to communicate local case study results to decision-makers and initiate adaptive management in the Kiskunság case (KISK). Even the multipurpose wetland construction case in Gorla Maggiore (GOMG), which was highly successful in terms of demonstrating an innovative, multifunctional and affordable solution for drainage water purification at a local level (Masi et al., 2016; Liqueste et al., 2016), struggled with upscaling the results and promoting them to national decision-making arenas.

#### 4.2.6. Professional norms, competencies and codes of conduct

Traditional ways of working were an impediment to introducing the ecosystem service approach in several cases (BIOF, CAPM, DANU, GOMG, OSLO, KISK, SIBB, SPAT, STEV, TRNA, VGAS). The Oslo (OSLO) and Vitoria-Gasteiz urban planning cases (VGAS) demonstrated that part of this kind of institutional inertia resulted from professionals being burdened with their day-to-day commitments and responsibilities, which led to them holding on to their routines and established practices. The case studies showed that outside initiatives by researchers were welcomed if they provided assistance to immediate problems; the challenge was to get the new ideas and practices sustained after the projects would be over. This was identified as a key problem in the cases of wetland construction in Gorla Maggiore (GOMG) and the Cairngorms National Park (CNPM).

Professional norms as a source of friction for taking up a new concept extended beyond routines and resources. This was illustrated by the reluctance of land use planners in the German bioenergy case (BIOG) to use the concept of ecosystem services. In their view, the concept did not provide any added value to the concept of multifunctional landscapes that they had been working with for several years. Another example is the Sibbesborg urban planning case (SIBB), in which the planning process had started out as a very ambitious attempt to take ecosystem services and biodiversity as a starting point in developing a new residential area in Southern Finland. However, the initial ethos of planning with nature was gradually replaced by a traditional planning approach (Kopperoinen, 2015) consistent with the established landscape architectural and technical design principles.

#### 4.2.7. Conceptual and methodological shortcomings

In general, the concept of ecosystem services was well received by the stakeholders in most of the cases. However, in some cases it was found to be too abstract, descriptive and difficult to understand, especially for local actors and practitioners (ALPS, BARC, BIOB, BIOF, BIOG, CAPM, DANU, LLEV, OSLO, SIBB, STEV, TRNA). In some case studies the conceptual problems were countered by fine-tuning the ecosystem services terminology using the local language and concrete terms like fishing and tourism (BIOB, CRKL, DONN, KISK, LLEV).

In some cases, the ecosystem services concept did not capture concerns that were paramount for some stakeholders. For example, in the Finnish bioenergy case (BIOF) provisioning services 'bioenergy' and 'timber' were insufficient approximations of the related aspects of human well-being like forest owner income, employment and regional economy. Sustainability assessment criteria, including ecological, economic and social sustainability, fared better in representing the aspect of the natural resource management situation that mattered to local stakeholders. Traditional economic and employment indicators were also found necessary to complement ecosystem service indicators in the Doñana National Park case (DONN). In the Loch Leven case study (LLEV) and the Stevoort flood control case (STEV), several stakeholders, notably conservation agencies, felt the ecosystem service approach ignored existence value of biodiversity and so there would be a real risk of under-valuing some services or species.

In others, shortcomings of the methods and opaqueness of the results were considered to undermine their effectiveness (see also Harrison et al., 2018). For instance, difficulties in obtaining reliable economic value information (ALPS, DANU, GOMG, LLEV, TRNA) and lack of transparency of some methods like QUICKscan (STEV) or ESTIMAP Air Quality model (BARC) turned out to be a problem in some case studies (see also Zulian et al., 2018). The BBN method was found helpful in some cases (LLEV) while in others (BIOF) the complexity of the method, especially the probability tables, discouraged stakeholder involvement (see also Smith et al., 2018). In the Cairngorms National Park management case (CNPM), the participants were cautious of the process and wished to explore the concept, tools and outputs without a commitment to make a decision based solely on the results of a piece of research which they did not exactly understand (Dick et al., 2016). In Oslo, the officials in Urban Environmental Agency felt that while the concept of ecosystem services has great potential, it will take some time before research on ecosystem services is sufficiently reliable to be used in the daily work of the municipality (OSLO).

#### 4.3. Enabling factors in the use of ecosystem service information

##### 4.3.1. Knowledge co-production

Most case studies succeeded in engaging a broad range of actors with divergent interests and agendas, and managed to keep them engaged and interested throughout the research process. In some cases, the stakeholder interaction even helped to build some consensus between stakeholders who had previously been at odds with each other: in Loch Leven between stakeholders interested in fishing vs. nature conservation (LLEV); in Spain between traditional wine farmers and managers of the Doñana National Park managers (DONN); in Italy between designers of traditional grey infrastructures and innovative green infrastructures to treat sewer overflow in Gorla Maggiore (GOMG); and in Portugal between nature conservation officials and farmers in the terrestrial part of the Park and between fishermen and tourism operators (dolphin watch) in the Marine Park (SACV). An action research approach in which the land-use planners co-designed the research approach was instrumental in making the knowledge useful for land-use planning in the De Cirkel area (CRKL). In Sibbesborg (SIBB), researchers supported the planning process throughout the project, from the idea stage to the planning phase, which increased mutual understanding between planners and researchers.

Participatory scenario analysis turned out to be a particularly helpful method in facilitating stakeholder interaction and creative thinking (ALPS, BIOG, KISK). It seems that the future orientation of the scenario methodology created a 'safe place' (Innes and Booher, 1999) which allowed participants to play with ideas freely without commitment to certain management or policy options. In a similar way, spatially explicit methods like ESTIMAP (Zulian et al., 2014;

2018), Greenframe (Kopperoinen et al., 2014) and QUICKScan (Verweij et al., 2016) turned out to be useful 'boundary objects' which assisted stakeholder interaction and enabled the use of local knowledge e.g. about areas that are important for recreation (BIOB, BARC, CNPM, KISK, LLEV, SPAT, SACV, SIBB, TRNA) as well as for bird habitat and production of hay and honey (KISK, LLEV, OSLO). Transparency of the methods and a possibility to participate in generating the knowledge base, like scoring recreation potential in ESTIMAP, or participatory model building in BBN, was regarded as positive by the stakeholders in several cases (BARC, BIOF, CNPM, KISK, LLEV, SACV, TRNA).

##### 4.3.2. Social capital

The level of social capital was particularly high in those cases in which the case study researchers had worked with the CAB members previously (ALPS, DANU, DONN, SACV, SIBB, SPAT, TRNA), or invested a lot of time building trust in the beginning of the research process (CRKL, KISK, OSLO), and these were also the cases with good experiences in knowledge acceptance and uptake among participating stakeholders. For example, in Doñana (DONN), the fact that the researchers had built trust and rapport among the local actors during previous research projects facilitated the strong commitment of several stakeholders to the research process. In Warwickshire (WCSO), an organizational structure in which planning officer, wildlife trust member and an Environment Bank Ltd staff member worked closely, and even shared an office, facilitated information exchange and learning on the potential of ecosystem service offsetting.

##### 4.3.3. Policy champions

Some of the cases also benefitted from policy champions who took an active role in connecting different actors and promoting the ecosystem services approach. The arrival of a person tasked to commission research on Essex's natural capital meant Essex (ESSX) was more able to join the research effort toward the end of the project. The backdrop was the economic opportunities and political clout behind Natural Capital arguments. Policy champions played an important role also in the early stages of Sibbesborg (SIBB) innovative planning-with-nature approach and in the Trnava case (TRNA), where a former Slovakian Minister of Environment and high-level authorities at the Ministry lent political weight to the research process. In the Cairngorms National Park case (CNMP), an influential CAB member helped to open doors for the researchers in the area, and in the De Cirkel case (CRKL) a local planner acted as a bridge builder, helping to mobilize local people and providing necessary contacts. In the Costa Vicentina Natural Park case (SACV), the commitment of a member of the Natural Park authority to the research process encouraged the engagement of other stakeholders.

##### 4.3.4. Intellectual capital

In countries like the UK and Spain, influential national ecosystem service assessments had already introduced the concepts of ecosystem services and natural capital and helped to establish a common language on ecosystem services. The effects of conceptual learning were evident in the Essex (ESSX), Warwickshire (WCSO), Loch Leven (LLEV) and Cairngorms National Park (CNPM) as well as Victoria-Gasteiz (VGAS) and Barcelona (BARC) cases where the ecosystem service concept was well-known and the CAB members readily adopted it. These experiences are in line with Waylen and Young (2014) and Berry et al. (2016) who suggest that the persuasive power of national ecosystem service assessments can open doors to productive collaboration that would later allow their content to be used in more efficient policy making and problem solving.

The level of knowledge and expertise of managers and decision-makers on ecosystem services as well as technological resources and tools, such as databases, influenced the ways in which these actors received the case study results. For example, Warwickshire (WCSO) had an extensive land-use data-set, which was suitable as a basis for assessing ecosystem services. The planning authorities took pride in the database and were keen to work with the project researchers to make further use of it. Conversely, Essex (ESSX) had no consolidated land-use data, which initially reduced the interest of the planning authorities to join the research effort. In the de Cirkel case (CRKL), the concept of ecosystem services was new to the landscape planners but their familiarity with a similar notion of multifunctional landscapes helped them to grasp the idea of ecosystem services easily and adopt a shared language with the researchers. Interestingly, in some cases (BIOG), the existence of similar concepts made the practitioners reluctant to adopt new ones, which they found superfluous and even confusing (see Section 4.2.7).

#### 4.3.5. Links between ES and human well-being

Clear synergies between ecosystem services and aspects of human well-being were reported in some of the case studies (BARC, CRKL, DONN, LLEV, OSLO, SACV, SIBB, SPAT, VGAS, WCSO). These were also the cases where the local practitioners were keen to adopt the concept of ecosystem services and work with the researchers to find management options to ensure ecosystem services provisioning. For example, vineyards located close to the Doñana National Park (DONN) provide regulating services like erosion control and ecological corridors; uprooting and abandonment of the vineyards due to lack of economic profit have resulted in erosion and siltation in the park (Gaitán-Cremaschi et al., 2017). The local farmers and the vineyard sector readily adopted the concept of ecosystem services and joined the researchers in searching for options to counter the decline of the vineyard sector, and ensure the ecosystem services (erosion control, grapes, wine, cultural identity, aesthetic value, wine tourism) and the related economic benefits. Likewise, CAB members of the Loch Leven case study (LLEV) felt that the ecosystem service approach can help to illustrate how human well-being is dependent on ecological health, demonstrating how good ecological status of water bodies supports wider societal goals, such as recreational fishing and nature-based recreation and tourism. In Slovakia (TRNA), the ecosystem service approach had the potential to widen the scope of traditional landscape-ecological planning to include ecosystem-based benefits, including social and economic benefits, for the whole society and thereby strengthen the role of landscape-ecological planning in urban and territorial planning (Bezák et al., 2017). In Oslo, outdoor recreation ('friluftsliv') is an important part of the Norwegian lifestyle and information on the economic value of natural areas ("The nature in Oslo is worth of billions of kroner") resonated well among Oslo city authorities and policy-makers (Barton et al., 2015). In Barcelona, the ecosystem services with direct link with human health and well-being (air purification, outdoor recreation) (Langemeyer et al., 2017) were considered particularly relevant by planners and policy-makers.

## 5. Concluding remarks

The findings from the 22 case studies, which aimed at integrating the concept of ecosystem services in real-life planning and decision-making processes, largely agree with earlier studies (Waylen and Young, 2014; McKenzie et al., 2014; Ruckelshaus et al., 2015) showing that ecosystem service knowledge can be used conceptually to alter beliefs and understandings about the role of ecosystems for human well-being, and strategically to help

stakeholders to articulate their interests and concerns for distribution of benefits from ecosystem services. However, our case studies show less room for instrumental knowledge use, understood as impartial arbiter among policy options, than previously observed (e.g. McKenzie et al., 2014). It was evident that the concept of ecosystem services as such cannot erase the tensions between economic and ecological goals (see also Cowell and Lennon, 2014; Turnpenny et al., 2014; Mann et al., 2015; Waylen et al., 2015). Instead, they surfaced as conflicts between regulating and/or cultural services and provisioning services.

Ecosystem service knowledge had particularly little bearing in those planning and policy-making situations where it challenged established interests and the current distribution of benefits from ecosystems and their services. This was manifested especially in case studies with hierarchical modes of governance and centralized policy regime. Schleyer et al. (2015) have suggested that the ecosystem services concept has the capacity to promote horizontal and vertical policy integration. However, this capacity was not fully realized in our case studies, where lack of horizontal cross-sector collaboration and vertical multi-level governance between central and local government agencies were major impediments for effective knowledge use. The concept of ecosystem services is not yet integrated into national level regulatory frameworks and hence the knowledge generated in the case studies was mostly perceived as useful but voluntary add-ons lacking policy driven substance and momentum. One critical factor, which prevented knowledge uptake, was also established professional norms, competencies and codes of conduct, which made practitioners to rely on traditional solutions, like grey infrastructure instead of green-blue infrastructure. Cognitive sticking points, which often go hand-in-hand with individuals' training and previous working experiences, have also previously been observed a major challenge in implementing ecosystem approach (Waylen et al., 2015).

However, we also detect several instances in which ecosystem service knowledge is utilized by the key actors involved in the research process, is helpful for them and even influence decision-making (see Russel et al., 2016). Influence and impact are evident in cases where researchers have worked with the planners and managers over a long time, building rapport and working relations. From practitioner and policy-maker perspectives, new ideas can be risky and require experimenting before they can be mainstreamed into planning and policy-making processes. Our analysis indicates that a key determinant of ecosystem service knowledge use is also the presence of policy champions (see also Cowell and Lennon, 2014; Rall et al., 2015; Sattler et al., 2015) and the ways in which new knowledge matches the pre-existing knowledge-use and intellectual resources like data-bases of planning and natural resource management agencies. Most importantly, the research interventions were more effective the better they were integrated in the actual planning and decision-making processes from early on and were aligned with the aims and timelines of decision-making agendas. In a similar way, transparent and spatially explicit methods, which facilitated interaction between key actors, are particularly helpful in building trust and shared knowledge-base that was deemed useful by the key actors (see also Harrison et al., 2018).

The implications of our findings for future practice are that increasing the use of ecosystem service knowledge in planning and policy-making practices requires support on micro, meso and macro level (see Turnpenny et al., 2008). At micro level, practitioners need training and education to develop and utilize new kinds of knowledge and competencies that transcend the established professional norms and codes of conduct. They also need support to uptake and maintain these new competencies in their daily practices. Furthermore, the concept of ecosystem services needs to be 'translated' for each assessment purpose in a way that the services

and related benefits make sense to local practitioners and stakeholders. At meso level, there is a need for new organizational procedures and management structures, such as cross-sectoral networks, which can break the current ‘silo’ effect, and assist urban and land use planners as well as sectoral authorities to jointly develop nature-based solutions and multi-functional green and blue infrastructures. Knowledge brokers (Saarela and Rinne, 2016) could be used purposefully to facilitate this kind of cross-sectoral interaction. There is also a clear need for more effective science-policy-society interface mechanisms (Roux et al., 2006; Vadineanu et al., 2014; Carmen et al., 2015), which can ensure the relevance and reliability, and consequently also effectiveness, of ecosystem service knowledge from planners and policy-makers perspective. At macro level, it would be important to integrate ecosystem services into EU level regulatory frameworks such as the Thematic Strategy on the Urban Environment (Bouwma et al., 2018), as well as national level policies and other regulatory frameworks guiding spatial planning and natural resource management (see Bezák et al., 2017). In particular, Strategic Environmental Impact Assessment process could provide an entry point for integration of ecosystem services into land and water management and planning.

Lastly, the usefulness of the concept of ecosystem services for a particular problem needs to be carefully considered at the outset. Our findings suggest that the concept of ecosystem services did provide added value in most cases, but in some cases familiar concepts like green infrastructure, multi-functional landscapes or sustainable development could have been more helpful. To make the ecosystem service framework more useful for real-life planning and policy problems, it is also necessary to pay more attention to the socio-economic benefits—or aspect of human well-being—like employment and regional economy, as well as the distribution of benefits among different societal groups.

The analysis in this paper is based on the ways in which the practitioners and policy-makers involved in a four-year research process received and used the results in the short term. As a next step, it would be very interesting to carry out longitudinal studies on the ways in which ecosystem service knowledge contributes to longer term processes of policy learning and change (see e.g. Owens, 2015). Further research is also needed on the preconditions of effective integration of ecosystem services into management, planning and policy-making practices, focusing especially on case studies in which the concept of ecosystem services has successfully served as a boundary object and promoted horizontal and vertical policy integration. The case study finder functionality of a new knowledge platform Oppla ([www.oppla.eu](http://www.oppla.eu)) can provide a very rich source of data for comparative case study analyses as well as a community of practice to share experiences and good practices in ecosystem service research.

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## Appendix

See [Tables A1 and A2](#).

**Table A1**  
Factors that constrained the use of ecosystem service information in the case studies.

Case	Competing interests and goals; power relations and modes of governance & scientific conflicts	Regulatory frameworks, property rights and lack vertical and horizontal integration	Professional norms and codes of conduct, professional competencies	Conceptual issues	Lack of knowledge and methodological shortcomings
<b>ALPS</b> Multifunctional forests in Vercors Mts Range, France	Competing interests between private owners and the public sector (Forest office); landowners are reluctant to increase forest protection	Too many layers of decision complicated integration between the different municipal levels and the national targets. Authorities cannot steer landowners who have private property rights and are reluctant to reduce loggings for BD protection	N/A	Ecosystem services as a framework has been too conceptual and descriptive, rather than problem-oriented	Lack of financial economic information to translate final maps into real monetary values was perceived as a problem
<b>BARC</b> Urban planning in the metropolitan region of Barcelona, Spain	Competing interests between urbanization, provision of certain ES and BD conservation. However, our CAB was mostly composed by stakeholders that recognize the value of green areas for the well-being of urban dwellers	Urban planning is a responsibility of municipal authorities, yet it must comply with regional landscape planning guidelines. Reconciling sectoral planning with urban planning is difficult and sometimes conflicting. SEA could be an entry-point for ES integration in urban planning, yet there are no explicit references to ES assessment in the Catalan/Spanish SEA regulations	N/A	Most stakeholders in the CAB were familiar with the ES concept. Yet, some of them associated the concept basically to monetary valuation while others were mostly interested on the biophysical flows. Moreover, there was some confusion in relation to the ES cascade components (e.g., ecological function versus ES)	The lack of reliable data for some ES might have undermined the credibility of some modeling and mapping outputs
<b>BIOB</b> Bioenergy production in	Conflicts between sugarcane production and the impacts of large-scale monocultures on biodiversity.	There is no national piece of legislation specifically oriented to implement and operationalize PES.	Lack of knowledge among small-scale uneducated farmers is an impediment of PES scheme	Local actors in particular found the scientific language of ES difficult. The ‘translation’ of the concept of ES to	N/A

	interior São Paulo, Brazil	Rural food producers are not sufficiently organized and are mistrustful of the local government	Small-scale farmers mostly do not comply with Brazilian forest legislation	implementation	the local circumstances facilitated PES-scheme construction	
<b>BIOF</b>	Forest bioenergy in Finland	Competing interests between the forest cluster and stakeholders interested in BD and recreational values. The forest sector has traditionally had a privileged access to policy-making. Scientific disagreements about the carbon neutrality of forest bioenergy	National level policy making is not sensitive to local contexts; different sectors such as forest management and energy policy, at different levels, use a limited set of information sources. No requirements for impact assessment on large scale forestry operations	Forest sector practitioners have a traditional focus on timber production; competencies in BD protection (and even less ES) are still largely lacking	The ES concept did not capture well social considerations like employment and regional economy; the category timber as a provisioning service was too narrow	The BBN method was quite complicated which might have discouraged the CAB members to participate in the process. However, the stakeholder appreciated the participatory model building phase of BBN
<b>BIOG</b>	Bioenergy production in Saxony, Germany	Competing interests between landowners producing bioenergy crops and stakeholders interested in the recreational and landscape values of farmlands	The spatial scale at which research was conducted only partly matched the scale at which CAB members are working. Thus, results were informative but only partly useful for decision making	N/A	The concept of ES is not well-known in Germany. It also overlaps with well-established concepts such as multi-functional landscapes; this hinders adoption of a new concept	N/A
<b>CAPM</b>	Forest management and illegal logging in Romania	Despite attempts to influence local ES policies there was a strong opposition of external actors, which were very interested in maintaining the status quo. The general public tends to obey to illegal practices, even if they disagree with it. This might be a result of the centralized political regime which existed in Romania before 1989	Inadequately enforced legislation of loggings in national parks	Traditional focus on timber production, no competencies on multifunctional forestry (including multiple ES provisioning)	Unfamiliarity of the concept in Romania	N/A
<b>CNPM</b>	Management of the Cairngorms National Park, Scotland	Recreational use (tourism, hunting) vs. wildlife management	N/A	N/A	N/A	The actors were unsure of the process and wished to explore the concept, tools and outputs without a commitment to make a decision based solely on the results of a piece of research which they did not exactly understand
<b>CRKL</b>	De Cirkel: Nature development in an agricultural area, Belgium	Conflicts between farmers (apple growers) and people using the area for recreational purposes. Some important stakeholder groups were initially absent, especially private sector and tourism representatives	N/A	Some initial skepticism by planners who had experience in multi-functionality. However, they finally admitted the added value of the ES approach in the course of the project	N/A	Some initial errors in a recreation map undermined the reliability of the maps in the eyes of the planners. The maps have been improved since then
<b>DANU</b>	Adaptive management plan for Lower Danube River, Romania	Different interests of stakeholders were a barrier for knowledge uptake. For example, the interests of big economic agents who manage large and intensive farms vs. land-waterscape integrity; or hydropower generation and waterway transport vs. recovering longitudinal connectivity enabling migration of endangered fish species to the upstream spawning river. Agriculture scientists and engineers argue for maintenance and rehabilitation of existing infrastructure as an effective flood-protection measure, while ecologists and environmental engineers argue for floodplain restoration	The policies are designed at national and EU level without any recommendations for implementation at local level. Lack of communication between management authorities at different levels (e.g. central and local), and between sectoral authorities. ES concept does not appear frequently within regulatory frameworks. However, they are covered by terms like renewable natural resources and reduction of nutrient loads and discharges	Due to their education and training, but also day by day routine and commitments to implement sectoral policies and management plans many stakeholders consider it to be difficult to apply the ES approach	Due to time constraints, the common understanding of terms was not always reached	Due to incomplete data sets and information or/and their availability prevented effective application of all selected tools and methods for the case study (e.g. integrated monetary and non-monetary valuation of the supplied services; and scenarios)

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Table A1 (continued)

Case	Competing interests and goals; power relations and modes of governance & scientific conflicts	Regulatory frameworks, property rights and lack vertical and horizontal integration	Professional norms and codes of conduct, professional competencies	Conceptual issues	Lack of knowledge and methodological shortcomings
<b>DONN</b> Doñana National Park management, Spain	Competing interests between traditional vineyards and other cash crops with higher economic returns. Some policies in the case study resulted from top-down processes originating at broader scales	A scale mismatch between the case study (local) and the scale at which incentives for the maintenance of vineyards are implemented. The scale of the later is in several cases regional or European. Governance at broader scales has highly influenced the case study through subsidies, agro-environmental schemes, etc.	N/A	N/A	Updated information on the current trends of vineyards (extension, production, number of employees) would be useful
<b>ESSX</b> Bioiversity offsetting in Essex, UK	Conflict between BD protection and ES provision; pressure to develop and grow (the county very much feeds commuters to London); the environment has often been seen as a barrier to growth	N/A	Little coordination between districts, no overall data layer or holistic approach to data capture	N/A	The absence of data limited engagement in the issue
<b>GOMG</b> Multipurpose wetland construction and landscape restoration in, Gorla Maggiore, Italy	N/A	Scale issues: Local and regional stakeholders welcomed and praised the local results, but they would need more case studies to upscale the results to the river basin (management) level	Lack of time by the regional managers (who finally implement and fund the solutions) and lack of power by the local stakeholders (the ones with high interest)	N/A	All stakeholders (especially managers) requested simple guidelines to implement this kind of studies in other sites. ES concept and specially ES economic valuation are too complex to be used by them
<b>KISK</b> Water management Kiskunság, Hungary	Very strong conflict between stakeholder groups, some of which fight for land drainage, others for water retention. Knowledge on the main cause of the drop of water level is debated. Ecologists state that artificial drainage is the ultimate cause while water management authorities blame intensive farming and timber plantation for the desiccation. Political decisions are still centralized and bureaucratic in Hungary to a very high degree. The whole institutional process is weak to accommodate real adaptive mgt at the landscape level	The relations between institutional stakeholders in agriculture, nature protection, forestry, and water management are rather volatile at national level. This makes the local level collaboration difficult	Water management and forestry practitioners have their own institutionally well-regulated codes of conduct focusing on drainage and timber production, respectively. These norms are a major obstacle in shifting the focus to ES	N/A	N/A
<b>LLEV</b> Loch Leven, Scotland	N/A Synergies between good quality of water bodies and nature tourism (fishing)	EU policies (e.g. CAP) may be a barrier to embracing the ES approach as they have single services (agricultural production, hydropower) as their priority	N/A	The concepts of ES were regarded difficult by the public, farmers, and landowners; discussing services by their more specific names (fishing, tourism) was widely supported. Several stakeholders (notably conservation agencies) felt the ES approach ignores "existence value" of biodiversity	The lack of data on ES at many freshwater sites prevented further elaboration of general relationships between policy (WFD status) and services. The lack of simple methods for valuing ES and including non-monetary benefits were also a barrier
<b>OSLO</b> Urban ecosystem services in Oslo, Norway	Competing interests between housing development & related economic interests vs. preservation of urban green spaces. Contention regarding the extent to which	Planning takes place within the framework of the Municipal plan to 2030. ES are not planning criteria as such. Implementing ES in administrative procedures such a	Municipal employees have limited time to participate in research initiatives, unless they are directly related to problem solving	At times ecosystem services as a framework has been too conceptual and descriptive, rather than problem-oriented. It was also hard to establish information and decision-making	Initial lack of detailed GIS data on blue-green structures across the whole city. Lack of data for quantification of biodiversity and ecological functions (e.g. interactions

<b>SACV</b> Operationalising ecosystem services in the Sudoeste Alentejano e Costa Vicentina Natural Park, Portugal	recreational urban bee keeping activities threatens red listed wild pollinators within the city Conflict between agriculture (expansion of intensive irrigated agriculture) and nature conservation goals. Also conflict between nature-based tourism activities and agriculture and also with Natural Park objectives	building permitting is complicated and expensive  Sectoral policies, defined at EU and national level, do not adjust to local contexts. Scale mismatch might hinder use of the results: the boundaries of the Natural Park do not match with the area for planning at several levels. Authorities are increasingly interested in applying the concept in planning processes but existing regulatory frameworks do not explicitly require consideration of ES	N/A	tools parallel with other on-going/past concepts and ways of management N/A	between native and domestic bees in the pollination sub-project)  Lack of data at the required spatial and temporal resolution has constrained or delayed the production of useful results. This difficulty is even more acute when dealing with marine ES. Lack of field data to validate the results was an issue for some ES (pollination)
<b>SIBB</b> Sibbesborg urban planning, Finland	Conflict between environmental values (saving a unique Fjord-like Sibbesborg bay area) and pressures to develop the bay area (profitable building sites)	The Finnish Land Use and Building Act refers to the need of recreation areas and the connectivity of green infrastructure but there is no clear guidance on how these should be taken into account	Planners trained in landscape planning and architecture followed their professional norms and architectural notions of beauty instead of taking into account the natural contours of the planning area	The planners welcomed the ES concept but it was first found difficult by the stakeholders. However, they become familiar with it, even with the intangible cultural ES categories	Knowledge gained by participatory methods could have been even better integrated in the planning
<b>SPAT</b> Sustainable forest management in Southern Patagonia, Argentina	Conflicts between conservation, tourism and timber production. The government and private sector tends to focus primarily on provisioning services. Some scholars support the traditional silviculture, some the combination of different ES supply to design a new management strategy	National policy focuses in the northern Argentina where deforestation is the main issue (land use change from forest to crops). Argentinian legislation basically allows protection of a supply of a broad range of ES but the implementation is lacking	The Government policy and regulations tend follow the traditional alternatives (e.g. shelterwood cuts) rather than the new paradigms (e.g. retention forestry)		Local specific knowledge is limited, especially at landscape level. This limits the implementation of environmental management policies in the field
<b>STEV</b> Stevoort flood control area, Belgium	Deforestation in Flanders is often contested, even when this is planned for nature conservation. Also some of the forest owners – especially poplar plot owners – might not accept deforestation. Finding the right balance is always a challenge (whether the ES-approach is used or any other concept)	The current legislation regarding compensation for deforestation narrowed down the possibilities for the Stevoort project area (and for a wide-open participatory discussion).	Traditional ways of working: top-down development of an ecological vision with consensus-building only amongst major institutes/ stakeholders involved instead of a real bottom-up participatory process	Conservationists criticized the ES concept for being anthropocentric; did not help to articulate the value of biodiversity with respect to the high value of timber production	Some methods like QuicScan were not transparent
<b>TRNA</b> Landscape-ecological planning in urban and peri-urban areas in Trnava, Slovakia	Different interest groups value ES differently; currently preference is given to interest-group goals instead of public benefits from ES. Industrial sector participated only in the first CAB meeting and since then there has not been interest from their side to participate	Persistent sectoral decision making based mainly on partial and sectoral legislation. Missing legislation tools for ES assessment and implementation in Slovakia	Misunderstanding of the comprehensive ES issue by some participants of the process (persisting sectoral management and planning)	The ES approach is and probably will be too abstract for some (mainly local) stakeholders	Missing financial/economic values for most of ecosystem services; the project did not succeed in finding an economic language for expressing the value of ES
<b>VGAS</b> GI Strategy in Vitoria-Gasteiz municipality, Spain	Consultants already working for the municipality provided sometimes contradictory recommendations	The governance setting is complex and although the coordination instruments exists, the procedures are somewhat tedious	Planners are not always capable to get involved, possibly due to their day to day commitments and responsibilities	N/A	N/A
<b>WCISO</b> Biodiversity Offsetting in Warwickshire, UK	N/A	N/A	N/A	N/A	N/A

**Table A2**  
Factors that facilitated the use of ecosystem service information in the case studies.

Case	Knowledge co-production	Social capital and policy champions	Intellectual capital, incl. methods and data	Links between ES and human well-being
<b>ALPS</b> Multi-functional forest management for Vercors Mountains Range in the French Alps region	Participatory work helped to identify knowledge gaps in terms of economically and ecologically viable alternative management options that are not sufficiently understood in French forest policy-making, and opening a debate on the compromise between forest productivity and conservation. The research contributed to a learning process among the key stakeholders	The researchers had established good working relations with the local actors, including forest management authorities, during previous work in the area. Trust was build up with local actors allowing a good exchange of experience and views	The participatory territory game method helped to incorporate the different visions and goals of forest management practices. Scenario analysis was also useful in envisioning alternative futures and making projections into the future	The ecosystem service approach was helpful in drawing attention to the role of biodiversity for sustainable forests including the needs from visitors and forest users
<b>BARC</b> Urban planning in the Barcelona metropolitan region, Spain	Stakeholder participation was instrumental in identifying relevant ES in the case study area as well as the relevant implementation scales of ES-based or green infrastructure strategies/policies	The case study benefited from the interest of the Barcelona Provincial Council (CAB member). They were very interested in integrating ES maps in their decision-support tool for landscape/urban planning processes so they were keen to provide data for the case study research and chair CAB meetings	Most stakeholders in the CAB were familiar with the ES concept/approach. ES maps facilitated stakeholder interaction and made the ES concept more 'usable' for landscape/urban planning. The ESTIMAP recreation model was generally clear for stakeholders since it was based on (their) expert knowledge (for the scoring). The ESTIMAP air quality model was more complicated to understand since it was based on a land use regression model	Environmental planning in the case study area was traditionally based on BD conservation criteria. The ES approach provides a link between ecosystems conservation and human well-being, which was very much appreciated by planners and policy-makers. Especially the ES with direct/straightforward link with human well-being / health were considered relevant (e.g., air purification, outdoor recreation)
<b>BIOB</b> Sugarcane bioenergy production in interior São Paulo, Brazil	Participatory methods were instrumental in bringing up local actors' perspective, which is important to understand the potential for PES scheme implementation	N/A	Land use map was helpful in identifying ES and participatory methods provided information about the feasibility of PES implementation	The decision-makers were particularly interested in the water-related ES provisioning of the PES scheme
<b>BIOF</b> Forest bioenergy production in Finland	The public debate about forest bioenergy had been quite polarized but the MCDA application showed a wide agreement among the regional stakeholders about using above the ground logging residue but leaving stumps in the forests	N/A	No previous intellectual capital to build on. The actors were not familiar with the ES concept and had not carried out previous research. MCDA was helpful to illustrate trade-offs and find a solution with balanced the pros and cons	The research highlighted the links between soil productivity and long-term impacts on timber production
<b>BIOG</b> Crop bioenergy production in Saxony, Germany	CAB members were very interested in the perspective of ecosystem services and the results presented and discussed with the CAB. CAB members also stated that liked the exchange of ideas with other stakeholders	N/A	Scenario methodology was felt useful by the CAB to explore the ideas freely without committing themselves to any specific policy option	N/A
<b>CAPM</b> Forest management and illegal logging in Romania	N/A	N/A	A survey was helpful in capturing the values of the general public	N/A
<b>CNPM</b> An integrated management plan for biodiversity and tourism in the Cairngorms National Park, Scotland	Transdisciplinary research is still relatively new in Scotland.A major success was the consultation of local people about local recreational use of the area by using a questionnaire	An influential CAB member helped to open doors for the researchers in the area	The stakeholders were generally quite familiar with the ES concept, which facilitated the participatory research process	N/A
<b>CRKL</b> Farmland management and planning for green corridors in agricultural land in De Cirkel, Belgium	The land user planners co-designed the research so that it answered their knowledge needs. A key issue was that researchers were willing to adjust their research agenda to the local knowledge needs. The concept of ES was discussed with the local people in terms that made sense to them ("translation")	One of the planners had been working in the De Cirkel area for 15 years, and had built up good relationships with local stakeholders. Therefore, she could easily mobilize local people, and provide necessary contacts	ES concept was new for the landscape planners. However, as they work on multifunctional landscapes already a long time, they grasped the ES idea fairly easy. Socio-economic valuation methods were helpful in bringing in the views of local people	Clear synergies between green corridors and cultural ES to which there was a strong demand



<b>DANU</b> An integrated and adaptive management plan for Lower Danube River, Romania	Stakeholders were open to new concepts like the ES and were willing to collaborate with the researchers. The successful stakeholder interaction was based on appropriate identification of key stakeholders and a transdisciplinary research approach. The researchers also succeeded to use language that was understandable to the stakeholders	The case study research benefitted from capacity building in previous research efforts focusing on Lower Danube River	The previous work within the Lower Danube watershed has created also intellectual capital which could be drawn upon in this case study; it was one success factor	The concepts of NC and ES were perceived as useful both biodiversity conservation and traditional economic activities; stakeholders appreciated the possibility of combining these
<b>DONN</b> Management of Doñana National Park and the surrounding landscape in Spain	The case study included a close collaboration with local stakeholders including the private sector (individual and cooperative wine producers), NGOs, municipalities, in all phases, including problem framing, elaboration of alternative policies and strategies to sustain ES, as well as the selection of criteria and the evaluation of impacts of each alternative on these criteria	The ES delivered by vineyards were well known by local actors but they felt that having 'outside' neutral and credible researchers to articulate them to decision-makers is likely to have a greater impact on policy	The ES concept was easily understood and accepted by the stakeholders in the vineyard sector. This is possibly due to the fact that the concept was introduced to highlight the positive aspects of vineyards. Further reasons were the intuitiveness of the concept and the attempts by researchers to translate the concept into local language and terms. The MCDA process incorporated economic revenues and employment generation as evaluation criteria. This facilitated an assessment of ES related to traditional economic and employment indicators	There were clear synergies between erosion control provided by the vineyards and the provisioning (grapes, wine, and vinegar), and cultural services (cultural identity, aesthetic value or wine tourism). The recent decline of the vineyard sector made its representatives to welcome the ES approach as an opportunity to highlight the importance of the sector in providing multiple and synergistic ES
<b>ESSX</b> Biodiversity and ecosystem service offsetting in Essex, UK	N/A	The arrival of person tasked to commission research focused on Essex's natural capital facilitated identifying pieces of research that might be useful for Essex County Council	The ES concept was familiar for the stakeholders and local practitioners from the UK NEA	The importance of Natural Capital for human wellbeing, including economic wellbeing, was recognized
<b>GOMG</b> Multipurpose wetland construction in a peri-urban area, Gorla Maggiore, Italy	Inviting and involving stakeholders with different and contrasting opinions and backgrounds (e.g. from NGOs to SMEs, from grey to green supporters, from local to regional managers) increased the credibility of the process and usefulness of the research	N/A	Local measurements allowed providing accurate data to the stakeholders. It increased the credibility of the research. MCDA process increased transparency and was found helpful by the stakeholders. They also received the results of a WTP and CBA with interest but also lots of criticism	The holistic and interdisciplinary ES approach highlights multi-functionality and the sometimes hidden multiple benefits
<b>KISK</b> Water management in semi-arid region in Kiskunság, Hungary	The research problem was defined with the stakeholders; this, as well as a balanced and inclusive approach, ensured that they were motivated to participate in the process throughout the whole process. Participants maintained that the process provided a great opportunity to exchange ideas with professionals in different fields, which is not usual	Some of the researchers had established good working relations with the local level stakeholders	Some stakeholder groups (like bird-watchers, bee keepers and farmers) liked the fact that the map of their own ES was developed in a participatory way. The concept of ES was new for most of the stakeholders. By means of using more familiar phrasing like "benefits from nature", the stakeholders easily learnt and applied the concept of ES, e.g. conflicts of interests or trade-offs	The link between ESs and human well-being is easy to understand in the case study site which the study group characterized as "living on the edge"; i.e. the water provision and water quantity regulation obviously affect almost every aspects of human and non-human life there
<b>LLEV</b> Management of lake Loch Leven, Scotland	Stakeholders became more aware of the language and concepts of ecosystem services. The CAB meetings helped build some consensus between some stakeholders who had previously been at odds with each other (e.g. fishing vs nature conservation). Through this process they learnt they had some common goals that they could work together to achieve (e.g. more control on water level management)	N/A	The familiarity of UK NEA facilitated the discussions with stakeholders. The maps produced by ESTIMAP analysis were well received. The CAB saw the maps as useful at visualizing recreation potential and hot-spots for examining conflicts with nature conservation, but found it difficult to understand precisely what the maps represented. The GIS behind the maps was also not available providing limited usefulness. The CAB liked the fact they could access the BBN tool online and it was easy to use for predicting the outcomes of future management and water quality improvements	Stakeholders felt the ES approach can help illustrate how human well-being is dependent on ecological health; demonstrating how good ecological status supports wider societal goals
<b>OSLO</b> Urban planning in Oslo, Norway	The participatory process was characterized by a fruitful cooperation between the research team and the main stakeholder in this case –	A lot of time was invested in building trust by between researchers and the Urban Environment Agency. The CAB coordinator At	GIS data of blue-green structures, in particular detailed data on particular structures such as city trees, enabled biophysical quantification	"Friluftsliv" (outdoor recreation) is a strong part of Norwegian identity, and it was important to take that aspect up in the urban

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Table A2 (continued)

Case	Knowledge co-production	Social capital and policy champions	Intellectual capital, incl. methods and data	Links between ES and human well-being
	Oslo Municipality's Urban Environment Agency	Agency has been a "critical champion" for ES in municipal planning	and was the basis for economic valuation. ES is a bridging concept that has in part facilitated communication between planners and managers in Urban Environment Agency, Planning Agency and Water and Sewage Agency	context; it facilitated an uptake of knowledge concerning recreation as a cultural value. Reports highlighting that nature in Oslo is worth "billions" of kroner annually were well received in the media
<b>SACV</b> Management of Coastal Natural Park (Sudoeste Alentejano e Costa Vicentina), Portugal	Local actors' knowledge was fundamental to adjust to local conditions and to validate the maps of ES that were produced for recreation, pollination and coastal and marine ES	The commitment of a member of the Natural Park authority as a central actor in the process has encouraged the engagement of other stakeholders. The coordinator of a network of local tourism operators also acted as a local champion	Some stakeholders were familiar with the ES concept, while others were not. However, all stakeholders adopted the ES language relatively easily and were able to relate it with their interests and activities. ES maps facilitated interaction among stakeholders and triggered discussions about future development paths for the area and on how agricultural practices can be adjusted to promote wild pollinators	The link between nature conservation and well-being of local actors, such as nature-based tourism operators, was very clearly demonstrated by the results of the recreation ES mapping exercise. Also the dependency of agricultural production from land management practices that are wild pollinator-friendly was acknowledged by participants in the pollination workshop
<b>SIBB</b> Sibbesborg urban planning process in Finland	Participation was helpful in sharing the knowledge and ideas about ecosystem services	The urban planners who wanted to adopt a novel and innovative planning approach and the urban ecologist they selected to set up the criteria for sustainability targets acted as policy champions	Maps facilitated stakeholder interaction and made the concept of ES tangible	Unique environment, local food production and other ES were one of the selling points of the new residential area
<b>SPAT</b> Forest management in Southern Patagonia, Argentina	Industry and private sector representatives actively participated in the study and in several instances also adopted the suggestions arising from the case study work, even though this was not a compulsory requirement by of the Forest Office	The case study researchers acted as a nexus between the private sector and the Government	The CAB members were familiar with the ES concept, and the research process contributed to further conceptual learning. Combination of maps that indicated supply and values of multiple ES, including BD, allowed detection synergies and trade-offs among the ES, and were considered helpful by the participants	The case study demonstrated that it is possible to improve biodiversity conservation by new forest management practices (retention forestry) without a significant decrease of provisioning services. The possibility of achieving multiple objectives at the same time contributed to the positive reception of the research results by the Government
<b>STEV</b> Developing a shared vision for Stevoort flood control area, Belgium	A stakeholder analysis was carried out. Key stakeholders (except forest owners) were actively engaged in the research process. Amongst the participants, there was a lot of expertise available (for instance regarding nature management)	The local project coordinator was a champion of the ES-approach within the government agency he is working in and he is also familiar with the project area. He knew a lot of local people, which helped the process a lot when mobilizing them	ES concept was rather new to most stakeholders. The list of ES was considered a useful checklist to see how they could contribute to the goals for the project area. ES maps have also been helpful for local planners	The most obvious links with well-being are all benefits related to the flood protection (as the project area was selected as a flood control area)
<b>TRNA</b> Landscape-ecological planning in urban and peri-urban areas in Trnava, Slovakia	Most stakeholders participated actively in the process; only industry representatives opted out at an early stage	A CAB member (General Director of Nature Protection Unit of the Ministry of the Environment) ensured that the information generated in the case study was directly available for the national level decision-makers. He also acted as a 'champion' of the research outputs	Most of the used tools were considered as interesting and promising by city planners (QuickScan, GreenFrame)	The ES concept emphasizes a wide range of ecosystem based benefits for the whole society, and therefore it was more easily acceptable to most policy makers, including "economically-oriented" actors than traditional landscape-ecological planning in Slovakia, which aims at ecological optimization of land-use
<b>VGAS</b> Urban planning in Vitoria-Gasteiz municipality, Spain	Close interaction with researchers and practitioners was helpful	N/A	The concept was already well known; existence of common language facilitated stakeholder interaction. Spatially explicit methods such as the Blue Green Factor were particularly helpful and interesting to city planners	Vitoria-Gasteiz is a pioneer city not only in the Spanish context but internationally in introducing long-term green vision and strategy for Green Infrastructure in the urban planning. The city was awarded as European Green Capital in 2012 for that reason
<b>WCSO</b> Biodiversity and ecosystem service offsetting, Warwickshire, UK	N/A	The Warwickshire Wildlife Trust member who had coordinated the survey was based in the same open-plan office as the Warwickshire planning officer coordinating offsets – similarly the Environment Bank (an SME looking to link offset targets with developers) had a staff member in the same office. This facilitated a greater buy into the ES concept	The ES concept was familiar from the UK NEA. The Warwickshire case study was very data rich (they had very detailed maps of land use – down to the field scale with a high level of habitat classification information associated)	One of the attractions of Warwickshire is its rural beauty; the idea of BD off-setting is consistent with maintaining the rural landscape and environmental quality. The district planner has taken the line that if people want to develop they have to offset –it was also a UK biodiversity offsetting pilot and they have kept on with offsetting

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