Ecological Indicators 61 (2016) 6–17

Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

Should the ecosystem services concept be used in European Commission impact assessment?

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ARTICLE INFO

Article history:
Received 30 September 2014
Received in revised form 30 June 2015
Accepted 2 July 2015
Available online 8 August 2015

Keywords:
Sustainability
Integration
European Union
Requisite variety
Policy assessment
Ecosystem services

ABSTRACT

Integrated impact assessment (IA) of policies in the European Commission takes place in an environment of competing problem frames, contested policy objectives and a multitude of interested actors. This paper sets out to discuss the potential value of integrating the ecosystem services (ESS) concept for improving the consideration of environmental benefits and values during framing and appraisal of new policies at European level. The discussion was based on a workshop conducted with experts encompassing their disciplinary fields to the science–policy interface. A review of recent literature and impact assessment reports from policy science and ecosystem services research allowed for a two-way contemplation. The potential integration of concepts was analysed for conceptual, technical, ethical and pragmatic aspects. It was found that indicator sets applied in the impact assessment reports follow a much less formalised structure than the reports or the procedure. An integration of the ecosystem services concept would enhance the requisite variety of indicators used, and thus contribute to the overall goal for sustainable development. Potentials for improving IA lie particularly in the up- and downscaling of benefits and values, policy relevant comparative studies and the prospective possibilities for innovation in indicator development. Based on this rationale of improving requisite variety for future decision making, the emphasis lies on a further development of the ESS concept along two pathways of operationalisation: the translation of the concept for a comprehensive approach at a higher level of abstraction (soft application), and the application of the concept for providing aggregated, quantitative and unit-based information at different steps of an IA (hard application).

> Les uns ont, ce me semble, beaucoup d'instruments et peu d'idées; les autres ont beaucoup d'idées et n'ont point d'instruments.
> Denis Diderot (1713–1784). De l'interprétation de la nature.

1. Introduction

Sustainability may be a critical concept, but it seems likely to abide as long as real problems demand attention to intertwined socio-economic, political and biophysical considerations in a long-term planning perspective (Gibson, 2006). The concern articulated in policy planning is that current strategies for sustainable development do not decelerate the depletion of natural resources, and that the time has come to consider structural changes in governance (OECD, 2012; Biermann et al., 2012). Implementation deficits can be ascribed to the sectoral organisation of government (Jacob and Volkery, 2004), use of knowledge in hierarchical governance arrangements (Atkinson and Klausen, 2011), the neglect of needs of future generations or a dominance of short termism (Siebenhüner et al., 2013).

The consideration of environmental issues requires a routine and systematic check of policies of all sectors. The commitment to evidence-based policy making is considered one approach to enable the consideration of side effects on the environment early on in the process, and provide legitimacy to policy makers (Hertin et al., 2008). However, while it is argued that there are enough scientifically sound indicators (e.g. Jesinghaus, 2012; Von Stackelberg, 2013) an assessment regime that is applicable to a broad range of political undertakings is missing (Hertin et al., 2009).

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http://dx.doi.org/10.1016/j.ecolind.2015.07.013

It is argued that the ecosystem services concept as described in the Millennium Ecosystem Assessment (MEA, 2005) is one scientifically respected framework capturing environmental concerns in ecological and socio-economic terms (Braat and de Groot, 2012; TEEB, 2009, 2010). Ecosystem services (ESS) are defined as the contributions of ecosystem structure and function to human well-being. ESS and the natural assets that produce them, represent a significant contribution to sustainable development that is increasingly recognised (Burkhard et al., 2012a).

Much of today's ESS science and the framework's further development for decision making is based on works done in the MEA that was called for by the United Nations in 2000 and was supported by 1360 experts from 95 countries (MEA, 2005). It had the overarching goal to synthesise information about the environmental status and trends, as well as the dependence of human well-being on natural capital, ecosystems and the services they provide. The ESS concept has since contributed to overall policy strategies such as the EU Biodiversity strategy to 2020, the EU Habitats Directive and the EU Blueprint to safeguard Europe's Waters. Strengths of the ESS framework are seen in cross-sector cooperation and the handling of ESS trade-offs and synergies at a landscape level, in the integrative character of the concept across environmental compartments, and in its applicability in communication processes as well as stakeholder-oriented valuation and weighting (Burkhard et al., 2012a; Geneletti, 2011). Eppink et al. (2012) describe the potential asset in policy design in addressing welfare gains and losses, but highlight the need for a common assessment framework with comparable data sets. Maes et al. (2013) ascertain that including the ESS concept into all social and economic policies would allow for a systematic review of consequences beyond conventional environmental assessments. This development calls for a debate on the incorporation of the ESS concept into effective and enduring institutions to manage and monitor the societal values of ecosystem services.

The European Commission policy impact assessment (IA) is a requirement for all major policy initiatives and therefore appears as a promising venue for an incorporation of ESS into decision making. Its intention is to consider all major impacts of planned policies on economy, environment and social aspects in order to maximise the benefits and minimise unwanted side effects. Furthermore, it is considered as an approach to ensure the coherence of policies with the overarching strategies of the European institutions.

During the past ten years, the relevance of IA has increased considerably: Commission directorates have set up support units, while consultants and researchers have been awarded framework contracts for supportive action, and training courses for officers have been developed. Furthermore, the process has been reviewed and evaluated. The Joint Research Centre (JRC) of the European Commission has set up a modelling group for IAs and a number of projects have been funded to develop models and data formats for the specific context of IA (Podhora et al., 2013; Radaelli and Meuwese, 2010; Lee and Kirkpatrick, 2006). As a result of this capacity development and learning, IA of policies has gained in terms of quality of the analysis and increased in importance for the decision making process. While the economic parts of the assessments were found to have improved over the years (Cecot et al., 2008), environmental impacts and benefits from environmental protection are still considered undervalued, particularly from the viewpoint of nature conservation (Jacob et al., 2011). Problems of data availability and stakeholder opinion remain, in particular for those impact areas that do not have an explicit market value, such as biodiversity or climate change (EC, 2013).

The overall question is, whether the ESS concept can be conceptually and technically integrated into European Commission impact assessment procedures at an operational level (van Wensem and Maltby, 2013; Jordan and Russel, 2014; Dunbar et al., 2013). A workshop conducted in Vigoni, Italy in October 2012 presented an opportunity to bring together scientific experts that encompassed their disciplinary field of research to address the interface with European level decision-making and decision support. The aim was to reach a deeper understanding of the potentials of an integration of ESS indicators in the decision making process by taking a dual perspective from policy sciences and environmental ecosystem research.

The objective of this paper is to take a forward looking perspective to reflect whether the concept of ESS should be used in European policy IA. Based on the workshop discussion, a review of the procedure and outcome of recent assessment reports as well as current literature addressing the link between ESS and decision making on the European level, the following questions will be addressed:

- Is the EC *ex ante* impact assessment procedure a suitable instrument to integrate the ESS concept?
- Can the ESS concept comply with the requirements and demands of an actual European impact assessment process in order to be operational?

By analysing the requirements of IA towards qualifying the process as suitable for an integration of the ESS concept, we aim to contribute to the ongoing discussion in the ESS research community on the potentials of the concept to "deliver" (Daily et al., 2009) at a European level of decision making.

2. The European Commission policy impact assessment process

Integrated policy impact assessment (IA) was introduced by the European Commission in 2003 to be conducted for all policy proposals as an obligatory activity in the EU legislative procedure *ex ante* actual implementation (EC, 2002). Motivated by an action plan for better regulation standards in 2001, the European Commission was determined to employ new instruments within the policymaking process in order to achieve the policy goals set down in the Lisbon agenda (Renda, 2006; Mandelkern Report, 2011). At the same time, the European Council agreed on the implementation of a European strategy for sustainable development (Göteborg European Council, 2001). An integrated assessment was to contribute to sustainable development by considering and comparing economic, social and environmental aspects for a set of strategic policy options during the formulation of new regulations.

The introduction of IA replaced a number of specific requirements for policy assessment in terms of environmental impacts, health or the competitiveness of small and medium enterprises. The development of one single and integrated procedure was to give the process more relevance at the political level, to avoid unnecessary additional burdens for policy makers, and to allow for an analysis of potential trade-offs between impact dimensions.

Planning of an IA in the Commission starts at an early stage of policy formulation. As soon as a policy initiative is published in the Commission's work program, the responsible policy unit initiates the IA. The Commission's guidelines for IA suggest inviting other Commission services to an inter-service steering committee if impacts can be expected in the domains of other directorates. Furthermore, it is a requirement to consult with stakeholders throughout the process. Thereby, the analysis should take into account all relevant aspects. A draft document is first reviewed by the Impact Assessment Board (IAB), composed of senior officers from various directorates. The IAB makes suggestions for including additional aspects or methodological improvements in the analysis. The IA report is then published together with the policy proposal

and the opinion of the IAB before the proposal is submitted to other European institutions, parliament and council to allow for public scrutiny (Radaelli and Meuwese, 2010).

The IA analysis of the European Commission addresses the following aspects: definition of the problem, description of the objectives, identification of policy options to achieve the objective, assessment of relevant economic social and environmental impacts of each option, and the comparison of options. The IA guidelines provide a set of impact areas covering the economic, societal and environmental impacts including guiding questions for their analysis (EC, 2009).

While the guidelines suggest a structured and systematic approach, IA takes place in a highly politicised context of policy making. What is considered as relevant for analysis and the justification of a policy depends on the world views and norms of the actors involved. IA is frequently considered as a process which merely justifies what has already been decided rather than an open learning (e.g. Turnpenny et al., 2008; Nilsson et al., 2008). It is suspected to put emphasis on economic analysis and the determination of costs for business, while social and environmental aspects are not always considered in sufficient detail (European Court of Auditors, 2010).

From a perspective of interaction between actors involved in the preparation of a policy proposal and an IA, the IA process can be split into three steps which can be distinguished by the purpose of communication: (i) framing of the objectives, stakeholder dialogue and data gathering, (ii) internal scrutiny of the report for consistency and evidence, and (iii) negotiation of the policy proposal by drawing on the impact assessment report and further substantiating assessment documents if appropriate (EU Smart Regulation, 2015). The first and last steps cross the boundaries of the Commission to the public, while the second step remains an inter-institutional interaction. The first two steps have in common that they are defined by analytical preparation work, whereas the third phase is defined by policy implementation. For practical reasons it may be added that the addressees for an actively initiated knowledge transfer differ according to the stage of proposal development. Stakeholder dialogue and data analysis are conducted under the responsibility of the leading policy unit and the interservice steering group, while the identification of scenario impacts and trade-offs are steered by policy actors, stakeholder groups and consultants involved in the process. The evaluation of impacts against societal and political paradigms and the political negotiation process is defined by the European Parliament, national EU member state parliaments as well as the Council of Ministers.

In such a setting of many different actors, viewpoints, values and expectations regarding a policy and the related IA, an adequate consideration of environmental impacts is prone to being neglected. The case of the biofuels directive serves as an example for an IA where indirect impacts on land use were not considered in sufficient detail although knowledge would have been available. Such examples pose questions of credibility and cause stakeholders to suspect merely symbolic and legitimising activities. IAs may then be challenged by stakeholders producing own assessments and counter expertise as it was the case in the European Chemical legislation REACH. In this case, more than 40 assessment reports were produced by industry associations, member states, regions and environmentalists, thereby triggering a battle of impact assessments (Jacob and Volkery, 2005).

The challenge within this setting of competing actors and interests lies in the need to focus on relevant aspects, and in the uncertainty and frequent ambiguity of scientific knowledge in the context of decisions. Based on the argument that integration and deliberation are at the core of the sustainability concept, assessment procedures at all stages require the consideration of a multitude of methods and tools adapted to the decision process (Bond and Morrison-Saunders, 2011; Gibson, 2006). Against this background we explore in what way the concept of ESS can provide substantiation for a robust and accepted IA that considers environmental aspects in an improved quality.

3. Methods

The study presented in this paper was framed in an international interdisciplinary workshop in Vigoni, Italy in October 2012. The participating experts were identified based on previous research on the development of methods and models for European Commission IA (Podhora et al., 2013), contribution to scientific conferences and literature, cooperation in impact assessment projects at European level and personal recommendations. The workshop was structured by three discussion rounds that addressed the specifications and nature of the science–policy interface during the IA process, the factors that may hinder and the requirements that may achieve an integration of the ESS concept in IA.

Building upon the questions raised in the workshop, this paper combines the scientific discussion on ecosystem services (identified in a literature survey) with the analysis of its application in IA (based on document analysis) (Fig. 1).

3.1. Literature survey

A literature review was conducted for the recent literature published by the initial round of experts in the different research traditions and scientific disciplines of ecology, economy and social sciences. It was complemented by electronic searching of scientific databases for research conducted on the conceptual, theoretical, methodological and instrumental use of the ESS concept in a European decision making context (Web of Science, Science Direct). We particularly focused review articles, representative studies and discussion papers (172 articles selected; 23 articles specifically addressing an integration of ESS for a European assessment). The choice of documents was led by the following criteria:

- The research is part of either ESS research or IA research,
- The research addresses the integration of environmental, societal and economic aspects of sustainability,
- The research contributes to policy integration and decision making.

3.2. Document analysis

For an illustration of current practice in the application of ESS indicators in European Commission IAs, we reviewed all 57 IA reports published in 2014. The aim was to further inform the discussion on the type and nature of indicator data taken up by the policy

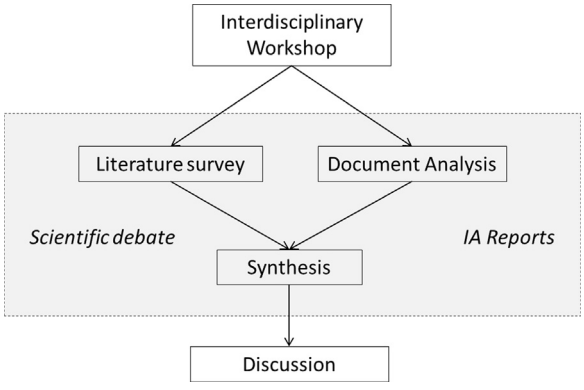

Fig. 1. Overview on sources and approach.

sector. For an assessment of the degree of embedding environmental considerations in the IA reports, we followed the classification proposed by Turnpenny et al. (2014). The classification ranges from no ecological or environmental knowledge referred to (0) over environmental assessment (environment mentioned (1), mentioned but weakly evaluated (2), strong environmental framing but not ecosystem services (3)) up to explicit assessment of ESS (framing around ESS (4), ESS fully embedded in the assessment (5)). We further distinguished whether the policy for which the impact assessment was conducted explicates environmental objectives and whether the described impacts have an implicit or explicit spatial dimension (Helming et al., 2013).

The focus on recent literature as well as the most recent IA reports (all reports published in 2014) is rooted in the understanding that ESS integration has only in recent years moved into the focus of European policy formulation and has considerably gained since.

3.3. Synthesis

The synthesis brings together results from the scientific debate and the analysis of current practice documented in the impact assessment reports (Fig. 1). We followed a practical approach for the appraisal of policy innovations in terms of conceptual, ethical, technical and pragmatic aspects as described by Lee (1999). This approach was adapted by rephrasing the questions from an *ex post* perspective to discuss the prospective potential of ESS to facilitate environmental policy integration in future IAs. Critical appraisal was conducted by grouping comparable studies together and extracting the key results along the following four questions:

- Does conceptual integration of the ESS concept into IA make sense?
- What could be potential benefits or misfits?
- What available evidence suggests that the (theoretical) idea of integration can be translated into practice?
- What evidence available proves prospective “fit-for-purpose”?

The methodology was chosen based on recommendations given by Pawson et al. (2005) for realist review approach and Greenhalgh et al. (2005) on systematic review using meta-narrative analysis. Initially designed for rapid reviews in decision support, a descriptive approach was found favourable particularly in cases characterised by a diversity of research approaches and the impossibility to structure initial findings into a single theoretical taxonomy. In this study, the methodology allowed for taking a stand in between policy research and ESS science, in order to discuss the potential integration of concepts with a perspective into both directions.

4. Results

Although the ESS concept is increasingly considered a viable tool for environmental integration in policy formulation within the scientific community, the documented IA reports draw a more differentiated picture. Overall, the application of indicator sets in the impact assessment procedure is far less formalised than the structure and standardisation of the process itself. A large variety of single and aggregated indicators is used, and there is no indication for a usable definite set of indicators available that fits all policy appraisals. The following sections will illustrate the results from the literature survey, the document analysis and the synthesis.

4.1. Literature review

Potentials for an integration of the ESS concept into European IA are seen in the illustration of direct and indirect sector impacts and in the development and application of ecosystem-based indicators (Helming et al., 2013; Maes et al., 2012). Sets of ESS indicators that are applicable on multiple levels of aggregation from the local to the global scale were provided (e.g. CICES; Haines-Young and Potschin, 2013). Mapping of biodiversity and various ESS on large areas across the European Union (Maes et al., 2012) or global estimates of the value of biomes (De Groot et al., 2012) have been tested next to the up-scaling of information from well-chosen in-depth case studies (Paracchini et al., 2011). Local subsets within an assessment matrix require expert-based integration of knowledge at local levels by attaining useful data from those that know their environment best (Jacobs et al., 2015), with the benefit of bringing out normative variations in valuation (Stoll et al., 2015; Dick et al., 2014). The general framing of ESS assessments was found useful for various types of decision in policy development, e.g. as a decisive tool for structuring participation and analysis, as a technical instrument for substantiation, or as an informative contribution to discussions (Apitz, 2013). In principle, this interpretation matches all three possible entry points for interaction and communication in the IA process described previously.

Contextual requirements due to different target groups at the science–policy interface are highlighted by the majority of authors. Practicalities, such as different potential target groups for interaction within one single assessment process, are not explicitly described in the reviewed literature. It was discussed, however, that the scientific community in particular is not sufficiently aware of the IA procedure in their model development. For a better integration, research framing would need to take into account the interface requirements between research and policy (e.g. Apitz, 2013; Matzdorf and Meyer, 2014; Anton et al., 2010). Beyond an adaption of technical language and improved awareness for sector targets, this would imply also a continuing confrontation with the link between environmental and societal impacts as well as improved approaches that translate feedback from valuation studies to the public and private sectors.

Improvements in attaining knowledge and understanding for informed decision making in IA was found to be discussed along two different lines of argumentation. Both address the points mentioned in Table 1, albeit at a different conceptual level.

I. The ecosystem services concept can aid a comprehensive assessment by structuring information for decision makers on the impact of framework legislations or policies. We suggest classifying this as the *soft application* of the ESS concept. This implies the assessment of the state and performance of ecosystem functionality to deliver ESS from a holistic perspective by building upon the existing variety of methods and approaches at different levels of scale and complexity, and for various types of decision support. Along this line of argument, requirements for better applicability are seen in the transparency of the ESS concept itself, in the communication of complex issues for integration and the development of management frameworks for a translation of the concept to specific decision making contexts (e.g. Matzdorf and Meyer, 2014; Apitz, 2013).
II. The ESS concept can be applied to quantify and monetise the benefits from functioning ecosystems from an anthropocentric socio-economic perspective. We suggest classifying this as the *hard application* of ESS. This implies providing quantitative and unit-based information about the impacts of human action on the functionality of for example service providing units (SPUs) and resulting changes in ESS delivery. Requirements for better

Table 1
Integrating ecosystem services with the EU policy impact assessment.

Arguments put forward in the scientific debate	Exemplary studies
Where can the ESS concept improve the impact assessment process?	
• Visualisation of existing data and trade-offs from different perspectives by using different filters • Translation of conservation necessities into sector policies • Communication of economic incentives for conservation planning and assessment • Application in diverse assessment approaches by matching targeted indicators to different levels of abstraction • Underpinning of argumentation for future benefits • Differentiation between problem-oriented research needs (need to act) and solution-oriented research needs (development of options)	Anton et al., 2010 Dunbar et al., 2013 Baker et al., 2013 Helming et al., 2013 Apitz, 2013 Jacob et al., 2013 Maes et al., 2013 Podhora et al., 2013 Matzdorf and Meyer, 2014
What factors may hinder the integration?	
• Relation to the European Commission targets (competition, better regulation and innovation) • Handling of technical and thematic uncertainties, particularly in relation to scales • Uncertainties in relation to land use and biodiversity • Limited experience with taking up accounting schemes; completion of accounting schemes • Description of the concept in a generic way to allow uptake in different assessment schemes • Clarification of responsibilities for implementation, measurement and monitoring of indicator mapping • Clarification as to which sectors need an integrated and which need a focused approach	Hou et al., 2013 Schägner et al., 2013 Laurans et al., 2013 Zulian et al., 2013 Dick et al., 2014
What requirements can achieve integration?	
• Consistent frameworks • Common language (versus technical language) • Common targets (versus economic or sector targets) • Action research for understanding of context • Integrity and linkage between basic science, applied science and implementation • Protocols and documentation for transparency • Adaptation to each given frame of scaling and legitimisation • Integration of the perception of stakeholders in the framing of scales • Handling of ESS valuation as a normative concept with a utilisation focus (also in regard to risks for crash or crisis)	Willems and de Lange, 2007 Paracchini et al., 2011 Maes et al., 2012 Von Stackelberg, 2013 Bertram and Rehdanz, 2013 Paracchini et al., 2014 Stoll et al., 2015 Laurans and Mermet, 2014; Everard et al., 2014

applicability are seen in standardisation of indicators, harmonisation of measurements at each scale and the development of interfaces between models for comprehensive assessments (e.g. Maes et al., 2012; Stoll et al., 2015).

One challenge of using data in an IA is due to the transparency of the IA reports. Policy officers appear to prefer sound scientific evidence which is unlikely to be challenged by stakeholder groups. In consequence, technical and methodological variances and quantitative uncertainties due to differences in units and scales applied in ESS studies are one major concern articulated from the policy side (Anton et al., 2010). Accordingly, this can lead to non-robust and ambiguous results, particularly in regard to valuation, monetisation or discounting. Hou et al. (2013) describe uncertainties in relation to landscape and ESS analyses and recommend that management strategies and learning cycles have to take account of uncertainty within the course of policy judgments. Laurans et al. (2013), however, point out that while ecosystem valuation studies address a number of technical, decisive and informative use cases for decision making, there is a blindspot in the literature regarding actual use practice.

Comparative studies between regions, between sets of experts at different decision making levels, or time frames give indications of uncertainties and scale-related deviations as long as the same set of indicators is used (Dick et al., 2014; Hou et al., 2013). Furthermore, Schägner et al. (2013) show that ESS studies are distributed evenly between local, regional, supra-regional and large-scale global studies, with most results presented in adherence to political borders. The application of the ESS concept to assess the effects of policies allows for a better understanding of the spatial distribution of such effects, and of the related issues of equity and conflict (Maes et al., 2012). This requires a case-specific display of relevant constituents to support the societal well-being and resilience for future well-being among different regions and also between different stakeholder groups.

Policy applications of ESS valuation have been tested for green accounting, land use policy evaluation, resource allocation and payments for ESS (Schägner et al., 2013). Existing studies are based on validated and non-validated as well as implicit models and require a high level of interdisciplinary integration. When applied in the communication about recent, past or potential future states of human-environmental systems, ESS indicators can identify gaps and trends to inform sustainable use in a policy-relevant representation. Problems of accuracy and precision, however, remain where an illustration of biological responses at different levels of organisation to ecosystem service delivery is required in a quantitative and predictive manner (e.g. alterations in biodiversity). One recent key action related to the EU Biodiversity Strategy to 2020 is the "Mapping and Assessment of Ecosystems and their Services in Europe" (MAES) initiative. The PRESS initiative (PEER Research on ESS) contributed case studies to help explore how such assessments for European policies might be developed (Maes et al., 2013). Results show that the inclusion of ESS indicators into policies would require a comprehensive effort for large-scale systematic review of indicator development and documentation of the consequences to achieve an improvement beyond conventional environmental assessments.

4.2. Analysis of IA reports

The majority of European Commission IA reports published in 2014 was conducted on governance measures such as subsidisation, risk prevention and market regulation. The objectives stated in the reports largely concerned competitive aspects (e.g. merger control), protective measures (e.g. organisation of working time), reporting (e.g. labelling of products or reporting on market transactions) or targeted support (e.g. state aid to reach strategic targets).

Environmental objectives were explicitly stated in 23 of the 57 IA reports screened. To a large extent, however, the environmental objectives had no direct relation to ecosystems. This was for example the case where ecodesigns of manufactured goods or emission regulations were targeted. Where the environmental objective was related to reporting, the policy objective may eventually have a significant impact on ecosystems. This was for example the case in the report on calculation methods and reporting requirements related to the quality of petrol and diesel requirements, and in the list of sectors and subsectors which are deemed to be exposed to a significant risk of carbon leakage for the period 2015–2019. Although these reports stated impacts regarding indirect land use change, air pollution and biodiversity as well as monetarised expressions of carbon leakage, the level of abstraction raises questions as to whether an integration of a full ESS-based assessment can be taken into account. In particular, since criteria and thresholds of regulations were in these cases laid out previously in respective directives.

For a better understanding, the IA reports were therefore also screened for their explicit or implicit spatial relevance. We found that of 57 IA reports, 9 reports explicitly addressed ecosystem-related issues (e.g. exploration of hydrocarbons such as shale gas, or the multi-annual planning of fish catch). 15 reports had an implicit spatial relevance, either at a concrete market level (e.g. labelling of products) or at a framework level (e.g. policy framework for climate and energy in the period from 2020 to 2030).

The impact section of all reports described economic, social and environmental impacts in separate chapters, thereby following the IA guidelines of the European Commission. Environmental impacts were described at different levels of elaboration in 28 of the 57 screened reports. Three reports focused environmental impacts including ESS and gave details in respect to the analysis (the policy framework on climate and energy, the Blue Energy Action Plan on the potential of ocean energy, the proposal for a regulation of the prohibition of driftnet fisheries). However, only the latter report explicitly stated an ecosystem-based framing. Furthermore, all three reports mention limitations in data and data aggregation, particularly for assessing biodiversity and land use change.

Only four IA reports explicitly described environmental assets in terms of benefits and constituents for an achievement of strategic goals (aid in the agriculture and forestry sectors in rural areas, exploration and production of hydrocarbons, prevention of spread of maize pest *Diabrotica*, and prohibition of driftnet fisheries). Six further reports stated limitations in methods and approaches for assessing potential benefits for human well-being, for example regarding integrated assessments of land use, land use change and biodiversity as well as benefits from a potential reallocation of resources from state aid. Table 2 gives a more detailed overview of the results from the documentary analysis.The indicator sets applied in the reports were largely sector-dependent, thereby addressing market regulation, production and consumer data as well as administrative handling. Data sources reached from member states to global institutions, stakeholder-based as well as statistical monitoring data and sector information. Environmental indicators in the impact sections often included GHG emissions, fuel consumption or emission rates, while in the evaluation and monitoring section hardly any indicator was suggested twice for reporting across all assessed IA reports. Overall, the indicators applied reportedly were to a large extent chosen in accordance with data availability. Levels of aggregation were compared for example at sector and subsector levels in the IA report on determining exposure of sectors to a significant risk of carbon leakage. A quest for new or aggregated indicators was articulated in other reports in regard to waste statistics, organic production impacts and biodiversity.

4.3. Synthesis

4.3.1. Does conceptual integration of the ecosystem services concept into IA make sense?

The European impact assessment process adheres to the paradigm of sustainability by its approach to balance benefits, values and trade-offs, and by drawing on foresight analysis and modelling tools to achieve accurate estimates about impacts (Bäcklund, 2009). At the same time, impact assessment is considered a learning process, carried out by interdisciplinary networks. The iterative adaptive learning during the decision-making process leads to an appropriate level of tension ("cognitive dissonance") that ultimately may lead to complex, adaptive behaviour (Bond and Morrison-Saunders, 2011). Adaptive learning networks have no legitimacy and must convince power networks by arguments, or by making use of positive feedback in the societal system. IA has led to processes where ministries cooperate at the highest level, and insiders indicate that for the first time the policy fragmentation that always has created barriers may have been overcome (Renda, 2006).

A core idea from complexity theories to dealing with dynamic systems, particularly in organisations which are of a multidimensional nature, is requisite variety (Nooteboom, 2007; Schwaninger, 1997). Requisite variety may be defined as the capability of systems to envisage the future changes in its environment and have a range of adaptive responses at its disposition (Nooteboom, 2007). The concept is loosely based on Ashby (1956) and has been linked with impact assessment procedures by Nooteboom (2007) and Rotmans (2006). Following their argument, the IA process provides support and structure in coordinating the integration of stakeholder perceptions and scientific data in formal decision making processes, with mandatory checks and balances. Thereby, impact assessment procedures can enhance the requisite variety in society in a changing world.

Table 2
Results from documentary survey of IA reports published in 2014.

IA reports 2014 ($n = 57$)	n	Example IA report	Example of indicators used for evaluation and monitoring
Environmental objectives	23	Calculation methods and reporting requirements relating to the quality of petrol and diesel fuels [COM(2014)617]	Fossil fuel greenhouse gas intensity; changes in EU refinery sector and supply of petroleum feedstocks; administrative burden on industry, including SMEs
Spatial dimension			
Explicit	9	Multiannual plan for stocks of cod, herring and sprat in the Baltic Sea [COM(2014)614]	Catch data (industrial, non-industrial); sampling of industrial landings; Stock abundance sampled by research vessels
Implicit	15	Policy framework for climate and energy in the period from 2020 to 2030 [COM(2014)15]	GHG emissions; GHG reductions; air pollution and related health impacts; GDP; GHG related to land use change
Environmental impacts			
No reference (0)	29	State aid for research and development and innovation [C(2014)3282]	Number of new researchers employed; new patents registered; productivity and gross value added
Not evaluated (1)	12	State aid to airports and airlines [C(2014)963]	Contribution to regional development by aggregate numbers of investment and employment
Weak evaluation (2)	5	Regulation on organic production and labelling of organic products [COM(2014)180]	Share of organic area; number of certified operators; value and volume of production by type of economic activity
Strong but no ESS (3)	10	Prevention of spread of *Diabrotica virgifera* [COM(2014)467]	Notification of outbreaks; crop rotation intensity; amount of insecticides used for control.
		Multiannual plan for stocks of cod, herring and sprat in the Baltic Sea [COM(2014)614]	Catch data (industrial, non-industrial); stock abundance sampled by research vessels
Framing of ESS (4)	1	Prohibition on driftnet fisheries [COM(2014)265]	Will be established with commission expert group in cooperation with the union fisheries control system and member states

The ESS concept is a tool for considering and managing societal obligations towards (a) the current generation of humans, (b) future generations of humans and (c) the natural environment (Abson et al., 2014). An operationalisation of ESS valuations accordingly holds a great promise as an instrument that can link policy makers and different scientific disciplines by bringing together transformative knowledge for collaboration towards sustainable development. Sustainability is recognised as an integrative and normative concept for decision making that is oriented towards system persistence and just allocation of resources (Abson et al., 2014; Pintér et al., 2012; Gibson, 2006).

Both assessment procedures (impact assessment and ESS) relate to the weak concept of sustainability. This implies the understanding that resources and benefits can be traded between different use options, regions and generations. The application of ESS as a link between environmental state descriptions (ESS and biodiversity) and human systems (human well-being) can bridge between scientific research and the organisation of decision support in policy appraisals (Helming et al., 2013; Müller and Burkhard, 2012). An obvious possibility would lie in the integration of the two concepts into adaptive management cycles at the operational level of policy formulation (Jordan and Russel, 2014; Dunbar et al., 2013).

By mapping ecosystems in juxtaposition to human systems and by translating environmental constituents in monetary economic and non-monetary social and biophysical terms, the ESS concept also links the three pillars of sustainability (Häyhä and Franzese, 2014; Braat and de Groot, 2012). The ESS concept can thus improve policies to achieve sustainable development by adding to the rather static idea of three separate dimensions (environmental, economic, and societal) currently assessed in the IA. By linking linear and non-linear relationships and illustrating cause and effect relationships the benefit will be an improved representation of impacts beyond the three dimensions of sustainability in the IA reports (Jordan and Russel, 2014; Maes et al., 2012; Hertin and Berkhout, 2010).

A framework has been proposed in the TEEB studies for policy decisions at international level, that sets human judgements and institutions determining the use of ESS at the centre of the ESS cascade (TEEB, 2009; Haines-Young and Potschin, 2009). Biophysical structures (including biodiversity) or processes translate into ecosystem functions, which are the base for ecosystem service delivery that translate into benefits and values in the socio-cultural context. In Fig. 2 this framework was adapted to the European Commission IA. Policy decision makers as well as regional and sector stakeholders are linked to the ESS cascade by feedback loops that illustrate how estimated and negotiated values can be coupled with framework programs as well as policy and management planning by the respective agents involved in an IA.

4.3.2. *What could be potential benefits or misfits?*

Many aspects of the ESS concept do not set it fundamentally apart from other integrated, comprehensive and stakeholder-led environmental assessments, such as environmental appraisal or sustainability assessment. Specific strengths are found in the following points (Cowell and Lennon, 2014; Baker et al., 2013; Dick et al., 2011):

- The positive way of framing ESS provision instead of the (often negative) impact on the environment leads to the description of benefits and suggests the accounting of environmental assets.
- Addressing questions of “use” and “perception” between stakeholders and decision makers and thereby also addressing conflicts between different sector arguments.
- Exploring the connectedness of social and ecological processes by making the different values (ecological and socio-economic) of ecosystems explicit for decision making while providing transparent evidence for policy formulation.

Another major concern relates to the danger that judgements regarding “good” management of ecosystems are based on implicit normative assumptions (Abson et al., 2014). However, the authors also argue that explicit regard for normative issues deepens the understanding of the role of ESS in relation to the broader societal goal of sustainability. Assessment of impacts, and thus also European Commission IA, requires a clear concept of sustainability as a societal goal, defined by criteria against which the assessment is conducted.

Political frameworks need information on human well-being in terms of health, food security, or risk avoidance. As long as available knowledge is not sufficiently linked to decisions, IA may raise awareness, but rarely seems to directly lead to sustainable strategic alternatives (Bebbington and Larrinaga, 2014; Nooteboom, 2007). Where a lack of data on monetary values exists, biodiversity and ESS can become a strategic goal for further policy development by addressing non-market goods and public goods. The application of intermediate tools used to integrate data, such as the often applied Driver-Pressure-State-Impact-Response approach, GIS-based tools or software-based indicator calculators, can change the form of research from problem-oriented analysis to a solution-oriented activity according to function.

4.3.3. *What available evidence suggests that the idea of integration can be translated into practice?*

Although much conceptual work has been conducted, there are few studies on the concrete application of the ESS framework for policies and decision making. Examples that explicitly test the concept for a particular impact assessment approach are the US National Environmental Policy Act to the US Forest Service (Presnall et al., 2014); or the embedding of the ESS approach in the UK National Ecosystem Assessment (Turnpenny et al., 2014).

The type and nature of indicator data needed by the policy sector is a common question in the debate of environmental research for decision making. On a national level, Turnpenny et al. (2014) found the inclusion of ecosystem services in existing assessments useful for requiring an analysis of environmental impacts, even where the final statement would be “no impact”. In the context of the UK NEA (UK National Ecosystem Assessment, 2014) being considered a driver for the inclusion of ESS, the limited uptake of indicators in principle provided by ESS research was however evident.

The application of indicator sets in the IA procedure is far less formalised than the structure and standardisation of the process itself. A large variety of single and aggregated indicators is used, and there is no indication for a usable definite set of indicators available that fits all policy appraisals. Aggregated and integrated indicators are called for in the impact assessment reports, particularly in regard to land use and land use change, as well as for an improved assessment of changes in biodiversity.

Previous studies found that in placing emphasis on ESS, the indicator level provides an entry point for transmission and integration (Paracchini et al., 2011; Müller and Burkhard, 2012). This becomes apparent in studies that show the overlaps in linking the different concepts of impact assessment and ESS, for example by structuring data, methods or impact areas along ESS categories (e.g. Bagstad et al., 2013 for decision support tools; De Groot et al., 2012 for market values per biome; Baker et al., 2013 and Helming et al., 2013 for policy impact areas; Burkhard et al., 2009 for land cover types). An improved illustration of these linkages can highlight potential synergies and gaps for innovative approaches towards the development of new indicators for safeguarding, management and risk assessment, but also monitoring or quality control. The

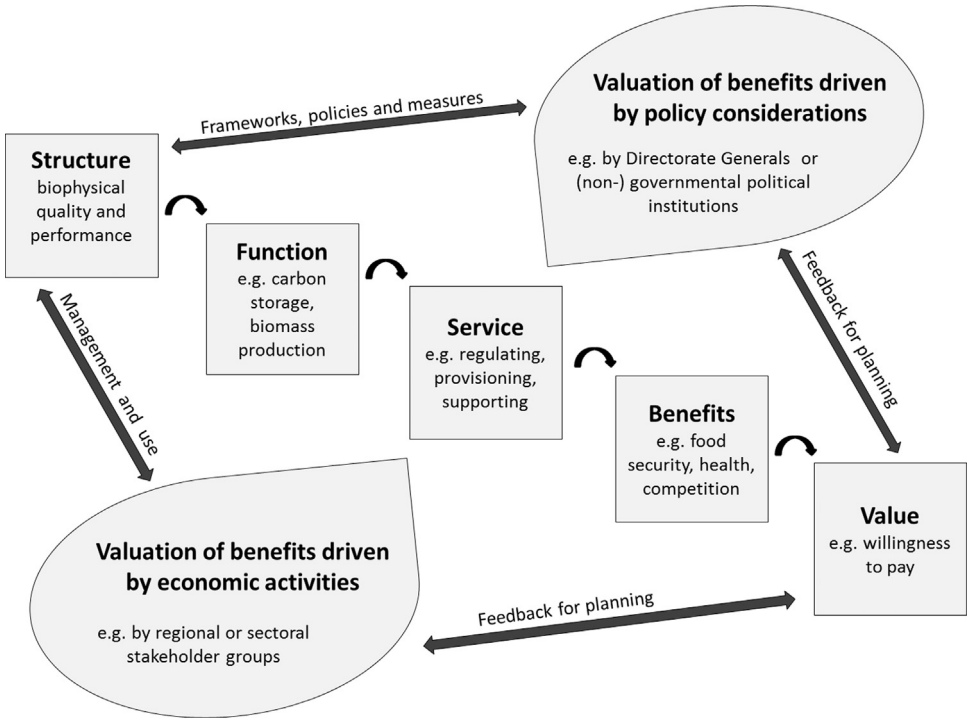

Fig. 2. Institutional constituents of European Commission impact assessment linked to the Economics of Ecosystems and Biodiversity (TEEB) overview diagram. Adapted from TEEB for Policy (2009) and Haines-Young and Potschin (2009).

Bellagio Sustainability Assessment and Measurement Principles (Bellagio STAMP) provide for example a practical framework for structuring indicator systems that measure progress towards sustainable development (Pintér et al., 2012; IISD, 1997). Current research in ESS focuses the definition of appropriate categorisation systems (Costanza, 2008) and indicators (such as CICES, see Haines-Young and Potschin, 2013). Further studies address the development of robust ESS quantification approaches and ESS data bases (Alkemade et al., 2014), spatial assessments of ESS supply and demand (Burkhard et al., 2012b) and the lack of transfer of scientific outcomes to policy, decision making and environmental management (Hauck et al., 2013).

4.3.4. *What evidence available proves prospective "fit-for-purpose"?*

The MEA and its associated outputs have resulted in nuanced conceptual models that allow explicit mapping of human-ecological systems based in environmental studies (Chapman, 2014). The monetisation of the quantitative relationships between ESS, human well-being components and environmental changes at first aimed at awareness raising, but soon it was followed by valuation studies for reasons of risk assessment, planning, assessment of trade-offs between different policy objectives or for the expression of relevance for degradation, intervention or restoration (Laurans et al., 2013; Braat and de Groot, 2012).

Although criteria and guiding questions are suggested for all three dimensions of sustainability, the IA reports do not follow a strict scoreboard type of exercise. Rather, the reports rely on indicators that are credible and may stand legal challenge in negotiations. The role of ESS in this context can fulfil several functions. Policy makers and stakeholders increasingly relate to the concept of ESS and would possibly agree on the relevancy of ESS as an integrated concept for environmental aspects as compared to an analysis of "all" impacts listed in the IA guidelines. The state of the environment (including biodiversity) and its functionality can be assessed based on respective indicators as well as on systemic interrelations of particular environmental properties and ESS.

From a technical point of view, ESS potentially provide additional data to be considered in assessing the cost and benefits of policy options. Measuring ESS can build on methods and comparable indicator sets as well as assessment schemes developed according to different research contexts. This leads to high flexibility for individually tailored solutions as well as widely accepted scientific knowledge in an international context, but also to difficulties in comparison between areas or research results (Hermann et al., 2011). Seppelt et al. (2012) provide a blueprint for documenting ecosystem service assessments for the benefit of researchers to enable comparison between studies, as well as for decision makers for structuring ES assessments or ES research studies, respectively. A comparable blueprint has been suggested by Crossman et al. (2013) for ESS mapping studies. This development is seen as a useful step towards improved monitoring methodologies and more standardised assessment approaches.

5. Discussion

ESS indicators are taken up in the European impact assessment reports to an overall low extent. This does not reflect recent discussion within the research community, where ESS are increasingly considered a viable tool for environmental integration in policy formulation. The question is whether the integration of the ESS concept is amenable to a possible time lag between its development in academia and use in policy practice or whether there are procedural or conceptual obstacles in regard to its applicability. This was considered an opportunity for discussing the integration of the ESS concept into European Commission IA for the means of improving the consideration of environmental benefits and values during framing and appraisal of new policies at European level. Here we come back to our initial research questions.

5.1. *Is the EU* ex ante *impact assessment procedure a suitable instrument to integrate the ESS concept?*

New policies can be viewed as innovations at the level of regulation. A baseline scenario for no-change will in general be favoured by all those adversely affected by the proposal for a new policy. In this context, the analysis of impacts in different pillars may lead to neglect or unconscious disregard of impacts, for example in assessments related to trade, transport or subsidy policies. The "virtuous circle" between benefits, beneficiaries and ESS is only connected when a broad range of ESS is recognised, and measures are taken to connect societal needs at broader spatial and temporal scales with local management "levers" (Everard et al., 2014).

For integration with the European Commission IA, we propose to explicate the "ecosystem service cascade" from Haines-Young and Potschin (2009) for the specific use at this level of decision making. The cascade model illustrates the entry points to the assessment procedure by emphasising the information flow to the different constituent institutions involved in an IA. Based on the rationale of improving the requisite variety for future decision making, the emphasis lies on the different entry points and possibilities for ESS application, rather than a limitation towards one single concept (Fischer, 2014).

An illustration of feedback links for the concrete case of European Commission IA would follow the proposition of Spangenberg et al. (2014) and Apitz (2013) to broaden the applicability of the "ecosystem service cascade" to different settings of policy formulation including the choosing between structurally different options at policy level. The ESS concept with its forward-looking affinity to scenario development and a positive planning-oriented approach matches the Commission's intention to look for viable solutions. Furthermore, it can provide for a meaningful simplification that allows for political negotiations between countries, sectors and regions.

The EU IA guidelines in turn would need to provide guidance for a more thorough implementation of ESS. Vlachopoulou et al. (2014) show at the example of the EU Water Framework Directive, how the objectives of the directive can be detailed and linked with ESS. This can be a first step to improve a *soft application*, given that the criteria are further conveyed to the description of the problem as well as the analysis of policy options and impacts. The *hard application* requires larger emphasis on evaluation studies that go beyond a comparison of costs for suggested measures within a policy framework to covering benefits and values of environmental services. A requirement for a more detailed description of the environmental state of the art in the baseline scenario can provide the basis for a later reflection of policy options. In many cases, however, as was also stated in the IA reports, this involves considerable advances in the availability of data and mapping.

There is a general consensus in the research literature that assessment criteria and indicators need to be put into the concrete context of the proposal. This finding is supported by the review of recently published IA reports, which shows little overlap in the indicator sets applied for assessment. The results of the literature review suggest the adaptation of ESS application to the respective step conducted in the IA (the successive sequence of framing of the problem, framing of options, analysis of impacts as well as monitoring and evaluation). For an improved operationalisation, previous studies have suggested to differentiate between explicit and implicit potential impacts on ecosystems, particularly in regard to spatial relevance (Helming et al., 2013). Further differentiation may be useful in regard to the level of abstraction conveyed in the IA conducted (policy framework or regulatory measures). This can give an indication whether the IA requires ecosystem-based framing at a conceptual level (*soft application*) or at an indicator level based on quantitative units and (monetary) values (*hard application*).

Advantages in practical implementation are seen particularly in three areas of application:

I. Up- and downscaling, including comparisons between different levels of aggregation in relation to time-related targets, sector-related impacts or spatial frames. This may improve particularly IA reports concerning monitoring, reporting or documentation issues.
II. Policy-relevant comparative analyses, including comparisons between different methodologies and aggregated indicators at different levels of scale.
III. Potential for innovation, including methodological approaches developed at the science–policy interface. This can lead for example to applicable aggregated indicators as well as suitable valuation and monitoring approaches for ecosystem-based resources in terms of benefits.

5.2. *Can the ESS concept theoretically comply with the requirements and demands of an actual European impact assessment process in order to be operational?*

Ecosystem service research is an example for transdisciplinary research that tries to move beyond the employment of several aspect visions to develop synthesised or novel perspectives (Buanes and Jentoft, 2009). Natural elements are analysed with a focus on their mutual impact and interdependency between each other and with the society, thereby drawing attention towards interactions and processes that occur at the system level. This resulted in its perception of an altogether too complex framework for decision making. Weaknesses relate to the complexity of the approach, and to the general problem of environmental issues not being central to human planning and decision making. On the other hand, research has increased almost exponentially over the last years, with new concepts coming up at great pace. The application of the ESS concept has moved forward substantially in taking up a solution-oriented focus on environmental management problems. It can thus be considered as an intermediate instrument that links primary research data with impact issues relevant for decision making.

Strength of the ESS approach lies in the combination of ecological and socio-economic data, tools and methods. Based on the considerable work in the mapping of ESS in recent years, the integration of the concept can effectuate new or improved integrated environmental indicators (Maes et al., 2012; Seppelt et al., 2012). The translation of ecosystem services into value systems involves monetary and non-monetary approaches as well as the communication of aggregated ESS indexes. Therefore, appropriate communication and mediation tools need to be created and applied, in order to achieve an integrated and even stakeholder-based approach to sustainable resources planning that involves ESS quantification, mapping and evaluation (Cowell and Lennon, 2014).

The Millennium Ecosystem Assessment and the TEEB studies have brought biodiversity into political considerations, resulting e.g. in the European Biodiversity Strategy. Moreover, natural capital and conservation of natural resources such as water and soil have moved up the political agenda. The realisation of agriculture as one important sector not only for food security but also for landscape management demands integrated assessments that are based on consistent frameworks coupling process models with ESS. Ecosystem services as well as natural capital and biodiversity issues will need to be factored in for adequately addressing land use-based issues at a strategic level.

The ESS concept complies with the requirements and demands of an actual European IA process by relating environmental aspects

to benefits relevant for societal impacts, and to value indicators that can improve the economic section of the impact assessment report. By linking environmental concerns to human benefits and economic values, ESS indicators encompass an application in the environmental dimension only and may also provide for new indicator sets. Open questions remain in regard to the high levels of abstraction in IA, and the applicability of the ESS concept in strictly governance-oriented regulations (market regulation, competition, merger control).

6. Conclusions

The aim of this paper was to analyse conceptual, technical, ethical and pragmatic aspects of a potential integration of the ESS concept in EC IA in order to reflect whether European policy IA is a suitable instrument for integration, and whether the ESS concept can comply with the requirements of an IA for operationalisation.

It was found that indicator sets applied in the impact assessment reports follow a much less formalised structure than the reports or the procedure. An integration of the ecosystem services concept would enhance the requisite variety of indicators used, and thus contribute to the overall goal for sustainable development. Potentials for improving IA lie particularly in the up- and downscaling of benefits and values, policy relevant comparative studies and the prospective possibilities for innovation in indicator development. Based on this rationale of improving requisite variety for future decision making, the emphasis lies on a further development of the ESS concept along two pathways of operationalisation: the translation of the concept for a comprehensive approach at a higher level of abstraction (*soft application*), and the application of the concept for providing aggregated, quantitative and unit-based information at different steps of an IA (*hard application*). Entry points exist at various interfaces of science–policy interaction. Furthermore, the translation from services to benefits, benefits to values as well as values to regulatory measures for policy planning responds to and feeds back to the state and performance of the biophysical environment via governance measures. The cascade model helps to illustrate entry points to the assessment procedure by emphasising the information flow to the different constituent institutions involved in the assessment.

The applicability of ESS was found to depend largely on the context and framing of the IA report, rather than on a limitation of approaches in ESS towards one single concept. This suggests the consideration of the level of abstraction addressed by the new regulation as well as a targeted application of suitable intermediate tools for data integration for different means at each step of an IA.

Acknowledgements

We express our gratitude to the expert researchers who engaged in the initial discussion in Vigoni 2012. We also thank Aranka Podhora and two anonymous reviewers for their constructive comments on an earlier version of this paper. The meeting itself and parts of this work were funded by the LIAISE Network of Excellence (FP 7 Environment; Grant Nr. 243826).

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.ecolind.2015.07.013

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