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From regional environmental planning to implementation: Paths and challenges of integrating ecosystem services

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ABSTRACT

Planning and governance at the regional scale is a promising field for the application of the ecosystem service (ES) concept. The objective of this paper is to explore the potential implications of integrating the ES concept into regional planning and governance. We focus on two pathways of influence: (i) information on ES and their values as decision-support in planning and management, ii) the ES concept as a boundary object for facilitating cross-sectoral interaction and collaboration.

A case study illustrates the effects of applying the ES concept in planning processes. The usefulness of the ES concept as a boundary object was derived from focus groups with scientists and practitioners. Integrating the ES information into planning, facilitates the consideration of trade-offs and multi-functionality in decision-making. Furthermore, it helps people to recognize how individuals or societies are affected, thus, improving preconditions for public participation. Additionally, ES can serve as a mutual reference level within the valuation and monitoring systems of different environmental disciplines. Challenges are found in assessing utilized ES and differentiating benefits for public and individuals. Employing economic valuation could supplement existing planning procedures, but carries risks. There is a need for research in the field of applicable assessment methods and standardizations.

1. Introduction

'Governance' describes the collaboration of governmental agencies and non-governmental (private) actors (e.g. NGOs, companies, citizens), towards joint objectives, and within a system of rules and regulations (hierarchies, markets, networks, communities) (Bache and Flinders, 2004a,b; Benz, 2009, 2001). Consequently, governance includes both formal and informal coordination and cooperation processes among, across, and beyond different sectors of public administration.

It has been increasingly recognized that environmental problems can only be sufficiently handled in an integrative and adaptive way to include diverse policy fields from all scales and actors from different fields (Huitema et al., 2009; Pahl-Wostl et al., 2012). However, the administrative systems of many European member states are predominantly sectorally organized (Knüppe and Pahl-Wostl, 2013; Nielsen et al., 2013). Cross-sectoral coordination is emphasized as a challenge in administrative systems in Germany and other Western countries (Pahl-Wostl et al., 2012; Köck and Bovet, 2015; von Haaren, 2011; SRU, 2008; Schanze et al., 2006 (for flood protection); Evers, 2008 (for water/river basin management)). In light of this, governance requirements for improving collaboration between sector-administrations, governmental and non-governmental actors and new forms of governance were introduced, e.g. for key regions such as the integrated management of coastal zones (Bruns, 2010).

In the last few years, ecosystem services (ES) have been increasingly proposed as an integrative concept and boundary object that could help to address governance challenges and facilitate the development of more integrated planning and cooperative implementation. (Dendoncker et al., 2014; Hauck et al., 2013; Primmer and Furmann, 2012; Viglizzo et al., 2012; Opdam et al., 2015). Boundary objects are understood here as collaborative products, that include reports, maps, models, and voluntary agreements, which “are both adaptable to different viewpoints and robust enough to maintain identity across them” (Star and Griesemer, 1989; see also Cash et al., 2003; Star, 2010; Clark et al., 2011). The benefits of using the ES concept are seen in clarifying the dependence of human well-being on ecosystem services, illustrating trade-offs between decision-options in terms of ES costs and benefits, and in providing estimated values of ecosystem services for society (e.g. de Groot et al., 2010; Albert et al., 2014a, 2016). More specifically, the ES concept may contribute to spatial

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planning and governance in terms of cross-sectoral coordination (Abson et al., 2014) and by illuminating cross-scale trade-offs (e.g. global benefits for climate change mitigation vs. local action, trade-offs between downstream and upstream riparians; Laterra et al., 2012; Albert et al., 2015). Furthermore, the ES concept may help to communicate environmental aspects to stakeholders (von Haaren and Albert, 2011).

A broad range of approaches and methods for mapping and assessing ES have recently been developed for various scales, from local to continental, in order to support planning and decision-making (Maes et al., 2012; Pagellaand Sinclair, 2014; Albert et al., 2014b). Examples for ES assessment approaches at the regional level are diverse. They include mapping with expert-based estimates of provisioning capacities (Burkhard et al., 2012; Kopperoinen et al., 2014), the use of software tools such as GISCAME (Frank et al., 2014), participatory approaches (Plieninger et al., 2013), combined biophysical modeling and social assessments (Casado-Arzuaga et al., 2013), and mental model mapping approaches (Moreno et al., 2014). Applying the ES concept could add three types of new information to existing planning and governance procedures (von Haaren et al., 2014): quantifications of ES in terms of the contributions from ecosystems that may provide benefits to humans (termed "offered ES") and the actually utilized ES that are directly consumed or enjoyed by humans (herein called "utilized ES"), aggregated accountings of the amount of offered or utilized ES, and economic ES valuations. Additionally, it contributes to the assessment of multifunctional effects (Galler et al., 2015).

Nevertheless, the ES concept is usually not well implemented in actual planning processes, especially at the local and regional scale (Primmer and Furman, 2012; Hauck et al., 2013; Albert et al., 2014a). Indeed, regional planning, and landscape planning in particular, are already linked with the ES concept as they both consider societal interests for the preservation and sustainable use of environmental resources (German spatial planning act; Pahl-Weber and Henckel, 2008). However, existing environmental information in the landscape and spatial plans do not explicitly emphasize the benefits of offered ES for human well-being (see the evaluation by Rall et al., 2015). Conceptual attempts to integrate ES into planning frameworks are beginning to emerge (Schößer et al., 2010; van Oudenhoven et al., 2012; Helming et al., 2013; Albert et al., 2016). Barriers for implementation include a prevailing lack of awareness and interest among practitioners, a dearth of substantial data and resources for assessing and valuing ES, difficulties of integrating the ES concept within existing planning and management instruments (Scolozzi et al., 2012), and a lack of successful practical examples of implementation and the resulting added value. Furthermore, the ES concept is increasingly criticized for its supposed emphasis of economic valuation and commodification (e.g. Kosoy and Corbera, 2010; Bauler and Pipart, 2014). Additionally, the use of economic values for spatial planning is a subject of debate (Viglizzo et al., 2012; Carreño et al., 2012; McKenzie et al., 2014). Though strong counter arguments for the critiques have been provided (Schröter et al., 2014), the criticisms need to be carefully considered. A further and overarching challenge is that economic valuations of ecosystem services remain primarily a scholarly endeavor and very few examples exist in which such valuations have actually been used in decision-making (Laurans et al., 2013; Ruckelshaus et al., 2015).

The objective of this paper is to explore the potential implications of integrating the ES concept in regional planning and governance, within the context of Germany. In accordance with the aforementioned potentials and deficits, we focus on two pathways of influence: Firstly, information about ES and their decision-support value in planning and management are illustrated. Here, we explicitly emphasize how ES information can be used for the assessment of multifunctionality and how this contributes to their decision-support value. Secondly, the value of the ES concept as a boundary object for facilitating cross-sectoral interaction and collaboration is discussed.

A case study is used for illustrating how ES information can be generated on the basis of available environmental data. Furthermore, the case study highlights the characteristic features of the ES concept and compares them with conventional landscape planning, which encompasses only parts of the ES information. For this purpose, we refer to a recently suggested, practice-oriented ES evaluation (PRESET) model (von Haaren et al., 2014) that introduced the disaggregation of offered and utilized ES mentioned above and provides clear links to different value bases as relevant in public planning and management.

The following section describes the methodology utilized in this study. The subsequent section provides the case study results. Section 4 first gives a characterization of the governance context with which we are dealing (Section 4.1). The innovations of including ES assessment in regional (environmental) planning are then emphasized (Section 4.2) and the added value for multifunctionality assessment (Section 4.3) is highlighted. We then point out the potential of ES as a boundary object for facilitating collaboration between administrative actors (Section 5). In Section 6 the results are discussed and conclusions are drawn.

2. Methodology

Investigating the two above mentioned potential influences of ES information in planning requires several methodological approaches: (i) A case study explores a differentiated evaluation of ES indicators and compares the results with conventional planning information. (ii) The values of information on ES in planning and decision-making, and also the role of the ES concept as a boundary object for facilitating cross-sectoral interaction and collaboration, were derived on the basis of recent governance literature and the results of expert workgroups.

The case study demonstrates procedures for ES assessment and preparation for decision support. It focusses on climate change mitigation through carbon sequestration of soils in the Region of Hanover. This case study shows the relevance of spatially explicit assessment and points out the added value of using and further developing the well established regional landscape plan. With the example of climate change mitigation and water quality, the case study includes an assessment of multifunctional effects and ES trade-offs. Effects were calculated for different scenarios.

The assessment builds upon available data from landscape planning. The potential carbon sequestration of soils was assessed in a GIS analysis by applying the method presented by Saathoff et al. (2013). The assessment uses habitat types to acquire land use information and soil type maps are used for identifying soils with high carbon storage. Effects on water quality were estimated with respect to nitrogen (N) input. The net amount of N-input was calculated according to Osterburg and Runge (2007). For the estimation, we used the mean value for N-input and calculated a difference in N-input between cropland and grassland use of 50 kg N/ha/year. Delivery radii of biomass plants were calculated assuming an average crop area of 0.36 ha for the production of 1 kW power. Based on that, we assumed radii of 1.5 km for plants with less than 255 kW, 3 km for plants with 256–400 kw, and 5 km for plants with more than 400 kW capacity.

Governance structures and processes, within the context of spatial planning at a regional scale, were analyzed on the basis of a literature examination. The opportunities and challenges for fostering the integration of sectorial administrative actions were illustrated by using the example of the German spatial planning system. Additionally, findings concerning the role of the ES concept as a boundary object, for facilitating cross-sectoral interaction and collaboration, were also derived. These findings are based on the results of two expert workgroups composed of scientists and practitioners from the German Academy of Spatial Research and Planning (ARL). The workgroups explored institutional settings within regional environmental planning (von Haaren and Galler, 2011; Karl, 2015).

3. Status quo, paths and challenges of integrating ES information in landscape and regional planning

3.1. Assessment of ES using the example of ES 'carbon sequestration of soils'

3.1.1. Quantification of site specific CO_2 retention and emissions

Up till now, landscape planning has provided spatially explicit information about the capacities of the landscape to provide multiple ES. Landscape planning usually assesses landscape functions which are similar to the offered ES (von Haaren and Albert, 2011). For climate protection ES, this involves mapping the area specific function of the soil and the land use form (as shown in Fig. 1). In this way, areas of relevance to ES (sensitive areas) are identified. They are differentiated into areas with impairments (e.g. agricultural land use on organic soils, colored in red), and areas with (more or less) optimal functionality (colored in green). For the latter areas, in the instance of land use change, a risk of CO_2-emission exists (Fig. 2).

These valuations are usually ordinally scaled because, for spatial planning designations, only an importance prioritization of the areas is usually needed. In addition, cardinally scaled information bears the risk of expressing a false accuracy if uncertainties are not communicated.

Assessments of ES tend to use quantitative approaches on cardinal scales in order to better illustrate trade-offs and as a basis

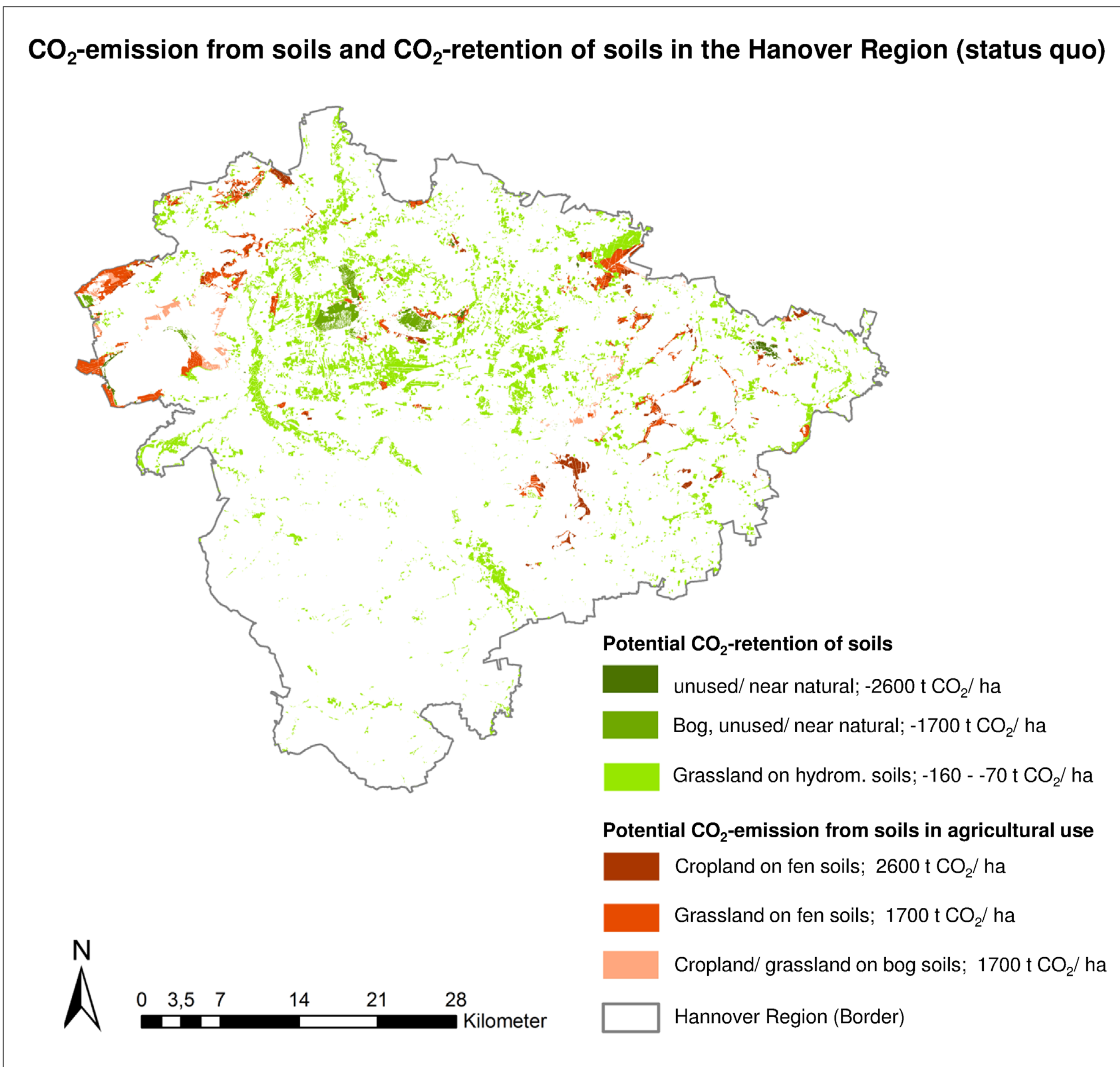

Fig. 1. Site specific quantification of CO_2-emission/-retention (provided ES) for the region of Hanover (applying the calculation of Saathoff et al. (2013)). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

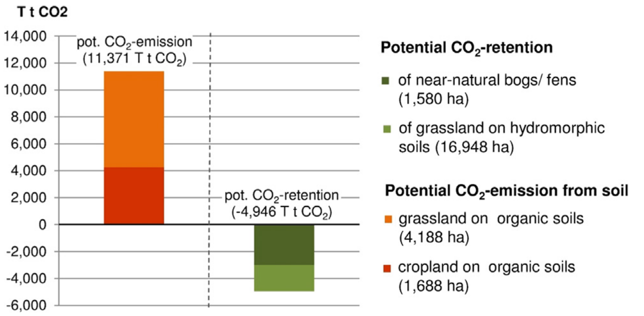

Fig. 2. Potential CO_2-emission and -retention of soils (in T t CO_2), accounting for the Region of Hanover (calculation according to Saathoff et al. (2013); for single values in tons CO_2 per hectare see Fig. 1).

for valuation. Irrespective of whether or not an ordinal assessment and mapping or a quantification is done, the result relates to soil based CO_2-emissions and neglects other production related CO_2-emissions, and also other greenhouse gases (GHG). Therefore, the proportion of soil based CO_2 from the total GHG-emissions should be estimated in order to point out the limitation of the quantification.

The assessment of climate protection ES includes classifying and mapping of functional area units (including sensitive areas and impairments) and, in addition, quantifying climate protection effects. Quantifying the offered ES in different land use scenarios (in tons CO_2 stored in the soil) would be an initial innovation. It would show the differences and the magnitude of CO_2 sequestration of soil and its relation to other CO_2-sources. Furthermore, it offers the possibility of accounting.

3.1.2. *Accounting of CO_2-retention for a reference area*

On the basis of area specific quantification, the (offered or utilized) ES can be quantified for specific reference units, e.g. for area units such as administrative units (city, county, region) or areas delineated by ecological processes. This can be done in physical measuring units (e.g. tons CO_2 sequestration, see Fig. 2) or in different forms of economic valuation (e.g. damage costs, see Fig. 3).

In landscape planning, accounting has been of little interest until now. This is in direct contrast to environmental impact regulation where specific accounting methods have already been developed and applied.

For climate protection, accounting of the offered ES sums up the site specific CO_2-sequestration potential (CO_2-retention potential of the soils or their respective emission potential). In the case study, this was done for the Region of Hanover (Fig. 2). However, accounting could also be relevant for functional areas or

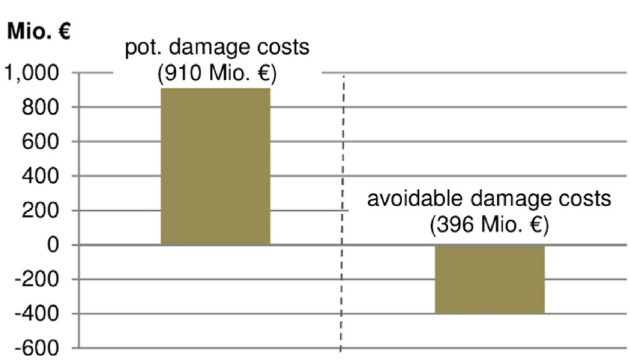

Fig. 3. Potential damage costs of CO_2-emission from soils (assuming no land use changes) and avoidable damage costs (due to CO_2-retention of natural bogs and fens), accounted for the Region of Hanover (societal damage costs of 80 € per t CO_2 are calculated according to UBA (2012)).

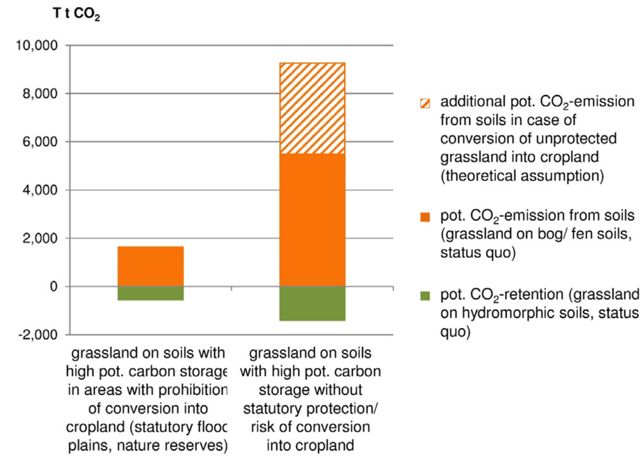

Fig. 4. Potential (pot.) CO_2-retention and -emission of grassland on soils with high pot. carbon storage, in protected and unprotected areas in the Region of Hanover (status quo), and pot. additional CO_2-emission from possible conversion of unprotected grassland into cropland (calculation according to Saathoff et al. (2013); for single values in tons CO_2 per hectare see Fig. 1).

for smaller administrative units.

Furthermore, accounting may contribute to specific planning issues, e.g. generation of an implementation strategy for maintaining and developing soils with high carbon storage, an important issue for climate change mitigation (von Haaren et al., 2012). This planning issue faces pertinent problems namely, competing land uses (agriculture, nature protection, recreation), expansion of arable land by converting grassland into cropland (i.e. due increased cultivation of maize crops for energy use), and consequently, an increase of land use related CO_2-emissions from soils (in quantity and speed). The main task is to avoid a conversion of grassland into cropland, on soils with high carbon storage. Possible implementation instruments include, for example, the protection of areas or site specific funding for grassland cultivation (e.g. within agri-environmental programs).

A first step in this study was the identification of areas where conversion of grassland into cropland is prohibited (in statutory flood plains and nature reserves). In fact, about a quarter of all relevant grassland in the case study area is already protected. Consequently, all other grassland sites are potentially at risk for conversion into cropland.

Secondly, the potential effect of converting grassland into cropland was quantified (CO_2-emission in t/ha that potentially emit during the entire process of decomposition of organic soil material (> 25 years), s. Fig. 4 and 5). In the case of ploughing all unprotected grassland, the additional CO_2-emissions would amount to 3.78 Mio. t CO_2. In fact, this would increase the total CO_2-emission in the region by about 33%.

In the case study region, grassland management (on soils with high carbon storage) is responsible for a large portion of the CO_2-emissions and also (to a smaller part) for CO_2-retention. This is a good example of the added value gained from accounting in planning processes: Although cropland on fen soils leads to higher CO_2-emissions per hectare than grassland, the impact of grassland on organic soils on CO_2-emissions in the region is (in sum) much higher due to its large spatial coverage in the region. However, annual emission rates of grassland (especially extensively used wet grassland) are much lower than that of cropland (Flessa et al., 2012). This makes it reasonable to prioritize forced conversion of cropland into grassland and to avoid the ploughing of grassland. Hence, the assessment provides useful information for generating development and implementation strategies.

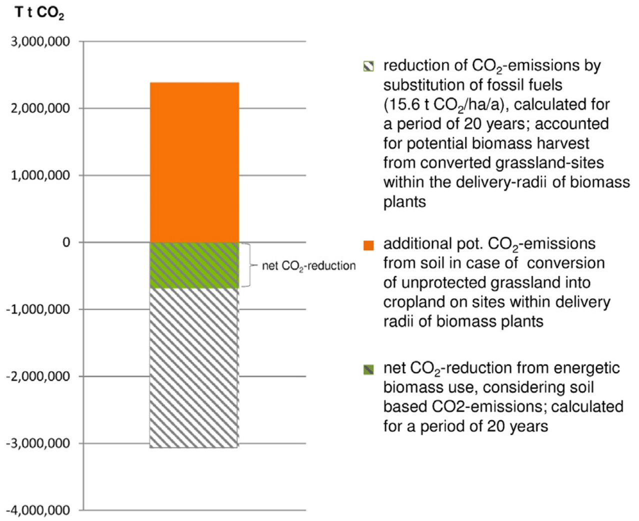

Fig. 5. CO_2-balance when converting unprotected grassland on organic/hydromorphic soils located within delivery radii of biomass plants in the case study region, assuming an energetic biomass use which corresponds to a substitution of 15,6 t CO_2/ha/a, assumptions (FNR, 2012, Enquete-Commission, 1994): biomass production (maize) of 50 t/ha (fresh mass); biogas harvest of 200 m^3 biogas/t biomass (fresh mass); energy content (kilowatt-hours) of biogas of 6 kWh/m^3 biogas; CO_2-emission from the combustion of heating oil (light) of 0,26 kg CO_2/kWh; we assumed radii of 1.5 km for plants with less than 255 kW, 3 km for plants with 256–400 kw, and 5 km for plants with more than 400 kW capacity. They correspond to an average crop area of 0.36 ha for the production of 1 kW power.

3.1.3. Economic valuation

Economic valuation of ES changes is based on the concept of total economic value (TEV, Pearce and Moran, 1994). This concept emphasizes that economic valuation may include a broad range of benefits for humans. These include direct use values, indirect or non-use values, and option values that could potentially become direct use values in the future (TEEB, 2012).

While weighing between legally mandated decision-options in practice often focusses on benefits of direct use value and costs, they represent only a fraction of the diversity of ES values that can be captured with using the TEV model and diverse valuation methods (Bateman et al., 2013, TEEB, 2010).

Diverse methods for economic valuation are available (see, e.g., Brouwer et al., 2011), which include market prices and revealed preferences and stated preferences approaches. However, economic valuation methods cannot elicit all value categories and fall short of assessing intrinsic values, certain ethical values, and - to a certain degree - shared or social values. Deliberative methods can help taking these value categories into account (Lienhoop et al., 2015). An important issue to raise is that economic valuations of ecosystem services consider only societal preferences for marginal changes of ES, i.e. under two different management scenarios. As such, economic valuation helps to elicit how the enhancement or deterioration of an ES influences human well-being. Along this line, economic values should by no means be confused with the price of an ES (Liekens et al., 2014).

Landscape planning rarely applies economic valuation. In assessing and evaluating ecosystem services, landscape planning refers to common value considerations as derived from democratically legitimated laws and directives, norms and standards. These value considerations are used for prioritization of land uses or implementation measures. Landscape planning integrates individual preferences through public participation and adapts or modifies objectives to local preferences and implementation conditions. This approach has worked well for landscape planning as stipulated in the German Federal Nature Conservation Act, but still implementation deficits exist. Implementation deficits exist especially in cases where no legally binding nature conservation objective is provided and when no weighing of interests takes place. Integrating economic valuation in these instances could help elicit and thus better consider stakeholders' preferences in decision-making process.

Environmental Impact Regulation, a German spatial planning instrument for avoiding, minimizing or compensating a projects impacts on nature and landscape, so far only uses regeneration costs for estimating compensation payments. As regeneration costs often cover only a fraction of the societal economic value, extending the procedure with other economic valuation approaches might be a useful opportunity to consider.

In the case study, societal damage costs of 80 € per t CO_2 are used according to the German Federal Environmental Agency (UBA, 2012). In using this average value, without temporal differentiating, we disregard the fact that the quantified sum of CO_2-emissions emits over a long time period. Because damage and mitigation costs will increase over time, short, middle, and long term cost rates should be applied (UBA, 2012). However, this would require a temporal differentiation of the CO_2 emissions.

For the Region of Hanover, societal damage costs induced by CO_2-emissions amount to (in sum) 910 Mio. €, when land use does not change and all areas with CO_2-emission keep emitting. On the other hand, conserving natural bogs and fens leads to an avoidance of damage costs of 396 Mio. € (Fig. 3). An example for an accounting of trade-offs that includes diverse economic indicators can be found in DE TEEB (2014).

Economic valuation should not replace an area specific physical assessment of ecosystem services and the evaluation of each area's significance for providing different services, based on objectives as stipulated in laws and standards. For example, drinking water treatment can be cheaper than preventing pollutants and nutrients from infiltrating into groundwater. Nevertheless, society usually attaches a higher value to clean groundwater resources. In landscape and spatial planning, legislation and political programs are the valuation background and should not be replaced by economic valuation. However, economic valuation can complement decision-making by prioritizing alternative options for development in cases where no clear objective for protection or restoration is given by legislation.

3.2. Taking multifunctional effects and ES trade-offs into account

In all planning tasks and decisions within environmental and spatial planning, multifunctional effects and ES trade-offs need to be considered (cf. Galler et al., 2015). They are relevant in terms of both conflicts and synergies. In conventional spatial and landscape planning, ES trade-offs are highlighted by designating areas where conflicts exist between the provision of ES and pressures exerted by unsustainable land uses. Emphasis is placed on explicitly defining the spatial areas where trade-offs occur, while quantification and accounting of the trade-off is of minor interest. Although the effects of synergy are considered within the development concept by using map overlays, their effects on offered ES are not quantified and outlined transparently. Perspectives of the ES approach can be used for additionally expressing ES trade-offs and multifunctionality of implementation measures in the form of quantified accounting of physical or monetized losses and gains of offered ES.

We give two examples of quantifying the risk of trade-offs: trade-offs between two different ES (climate change mitigation and water quality) and contradictory effects on the same ES (climate change mitigation). For the worst case scenario (A) we assume that unprotected grassland, which is located within the delivery radii of biomass plants, is ploughed for cropland use. To identify these high risk areas (areas with urgent need for action), we used the locations of biomass plants and their (approximate) biomass delivery radius. In fact, for about 64% (9845 ha) of the unprotected grassland, a high risk of conversion into cropland can be stated. In the best case scenario (B) we assumed that all existent grassland can be kept by implementing safeguarding measures (e.g. agri-environmental measures).

In scenario A, the conversion of grassland into cropland leads to an increase of CO_2-emissions by 2.38 Mio. tons, while the N-input increases by about 492 t N per year. Implementing measures for climate change mitigation (scenario B) would avoid an increase of N-input. Hence, measures for climate change mitigation will lead to multifunctional effects on water quality conservation. From the perspective of water quality conservation, measures (extensive grassland cultivation) need to be targeted at the respective soils in order to achieve synergies for climate change mitigation.

Contradicting effects on climate change mitigation are a prominent example of service trade-offs that might occur if implementation instruments are not optimized. For instance, on the one hand, the funding and increased cultivation of biomass substitutes for fossil fuels lowers CO_2-emissions. On the other hand, biomass cultivation causes CO_2-emissions from soil when fields are located on organic or hydromorphic soils and, consequently, contradicts the effect of climate change mitigation (Greiff, 2010). Fig. 5 shows trade-offs for climate change mitigation in scenario A. Extending biomass production on organic and hydromorphic soils would lead to 2.38 Mio. t of land use related CO_2-emissions, while the substitution of fossil fuels amount to a reduction of 3.07 t CO_2-emissions, calculated for a period of 20 years. For economic valuation of these trade-offs, both damage costs and public costs for funding renewable energy from biomass should be taken into account.

The applied accounting method calculates the influence of site specific conditions and land use change on the effectiveness of biomass production. However, the considered variables do not conform to lifecycle assessment standards which include all CO_2-emissions along the production chain, for example from machinery use or transportation.

Evidently, assessing only two ES gives an incomplete impression of all possible ES trade-offs. Other than the trade-offs referred to in this study, there are further potential ES trade-offs correlated to climate change mitigation because of functional interrelations. Trade-offs might occur for the ES biodiversity, flood protection and cultural services. Assessing ecosystem service trade-offs should include the total bundle of ES (Maes et al., 2012; Bennett et al., 2009; Lovell and Taylor, 2013) and ES flows should be considered in planning and governance processes. In environmental planning, the assessment of trade-offs between offered ES can be done on the basis of a spatial analysis. Landscape planning does already provide an information base for multiple offered ES (as long as ES are defined and clearly delineated). However, the quantification is based on a set of selected criteria that usually does not depict the ES in its entirety. Furthermore, not all offered ES are able to be precisely quantified. Planners have to be aware of these limitations and communicate them together with the assessment results. Nevertheless, the (average) quantification of trade-offs and their accounting could provide arguments to which decision-makers are open. In this way, cardinal quantification contributes for considering environmental aspects in political debates.

4. Innovations of ES information within governance processes of regional and environmental planning

4.1. The context of spatial planning

Although integrative strategies are necessary to solve environmental problems (Huitema et al., 2009; Pahl-Wostl et al., 2012), environmental policy fields are usually sectorally organized. Even policy fields which lie within the responsibility of the same administration, for instance water and nature conservation, are largely administered separately. Environmental planning, however, applies to many different policy sectors (e.g. nature conservation, water and climate protection, forestry, agriculture). Each policy sector has developed an individual set of planning, regulating and implementation instruments. Furthermore, they are distinguished from one another in that some sectors involve solely governmental actors while other sectors rely on input and support from strong non-governmental groups, which back administrative action (von Haaren, 2011).

Spatial planning is an important instrument for sector policy coordination. In Germany, it is carried out by or in the name of public authorities, and organized in a system of graded responsibilities (Federal Office for Building and Regional Planning, 2001). Spatial planning responds to the demands of society or specific interests, coordinates their spatial impacts, formulates objectives to control future activities, and implies an intervention in the physical space, often via statutory spatial plans (see compilation in Othengrafen, 2012, pp. 24,25). Beyond coordinating land uses and developments, spatial planning has recently expanded its scope for seeking to influence economic, social and political forces (“aspatial” (non-physical) processes; Greed, 2000, p. 2, in Othengrafen, 2012), p. 25) that determine the spatial (physical) development.

The German planning and administration system serves as an example for the sectoral organization of planning and how interrelations may be organized by spatial planning. However, in general the findings are applicable for spatial planning systems and their coupling with environmental planning in other European countries. For example water governance according to the European Water Framework Directive serves as integrative environmental planning and may include the ES concept (Knüppe and Pahl-Wostl, 2013).

German spatial planning is established on three spatial scales: on the national level, broad and spatially unconcrete objectives and strategies are defined (Pahl-Weber and Henckel, 2008). Upon these guiding principles, the federal states develop state plans for their territory, which are concretized at the regional level. The regional plans are usually developed by regional public authorities. Municipalities represent the basic planning level (subsidiary concept) (Scholl et al., 2007). Regional planning especially, serves as an instrument for cross-sectoral coordination. It compromises different interests, land use requirements and measures, and makes provision for certain land uses or functions. In this sense, the regional (statutory) plan is a core formal planning instrument (Fig. 6). Furthermore, regional planning serves for vertical coordination of urban development, considering the binding objectives of the state plan. Governance mechanisms for adopting the regional plan include formal participation from stakeholders and the public (in the context of the strategic environmental impact assessment). It also includes informal communication and cooperation mechanisms during the preparation of the plan and in the implementation process afterwards (Federal Office for Building and Regional Planning, 2001; Scholl et al., 2007).

In the shadow of formal planning instruments (and administrative procedures), informal integrative development concepts can be generated which react to specific situations/problems and involve diverse public and private actors. They can make use of additional implementation instruments. In this way, informal development concepts or strategies expand the scope of spatial planning towards cooperative and collaborative approaches.

With regard to spatial planning, landscape planning functions as an integrative environmental planning that (pre-) integrates and bundles different environmental sector approaches (e.g. safeguarding biodiversity, soil protection, water protection,

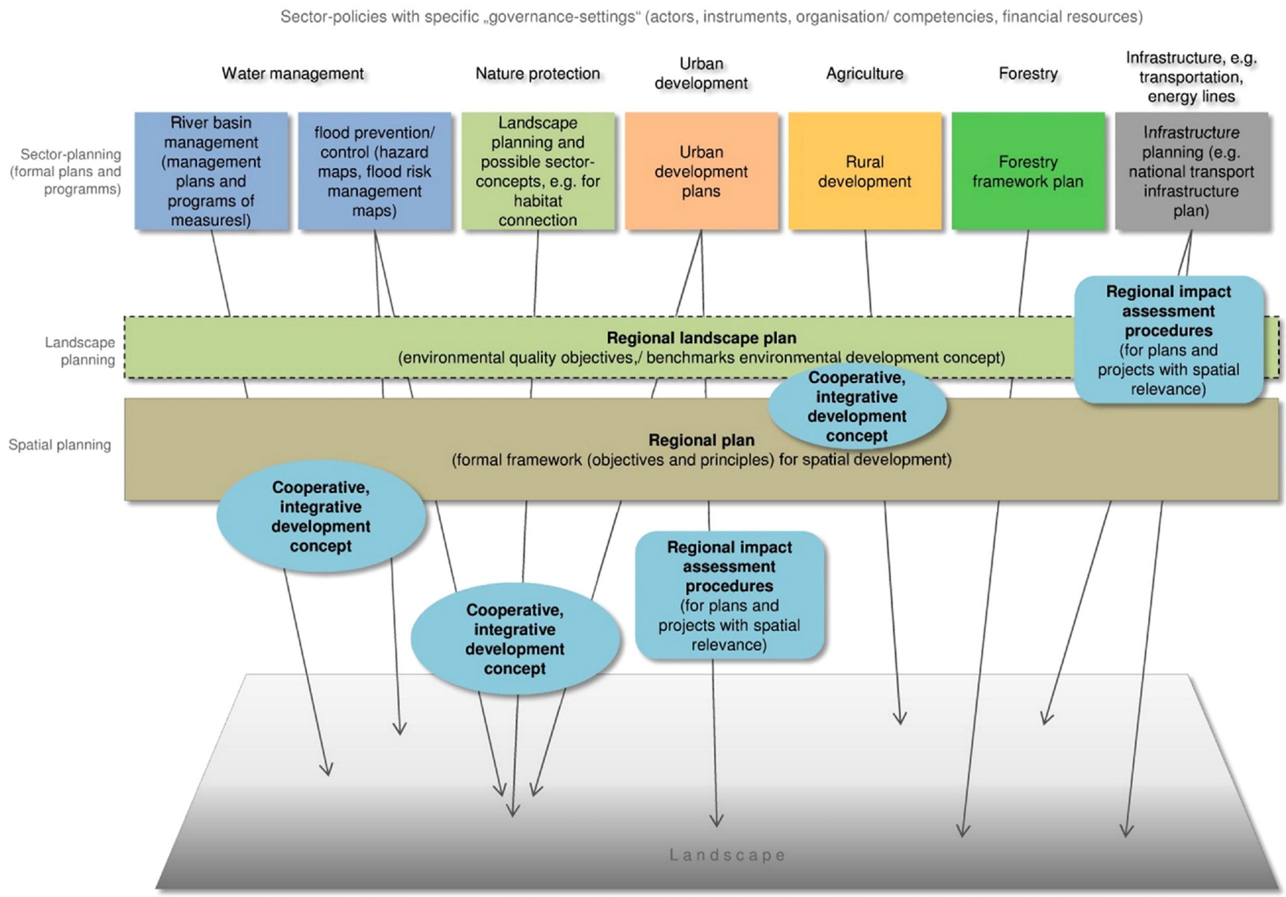

Fig. 6. Functions of the regional plan within the governance context (modified from Fürst, 2010, p. 39).

climate change mitigation and adaptation, esthetical functions of the landscape). While other environmental plans are oriented towards single (protected) natural resources (e.g. water, biodiversity), landscape planning provides a cross-sectoral and integrative view of the environment (von Haaren and Galler, 2012, 2007). However, whether the integrated objectives of landscape planning find their way into regional planning and even back into sectoral planning and implementation, this is not yet enforced. Except for a mandatory requirement that all involved decision makers give good reasons for deviating from a landscape plan, there is no strong institutionalized process for the integration of landscape planning objectives.

4.2. Added value of ES information within governance processes

For planning purposes it is important to assess the capacities of the landscape to offer ES and, additionally, to identify demands and the actual utilization of ES (Bastian et al., 2012). In this way, it can be analyzed whether and where high demands might exceed the capacities for providing ES.

The information about ES that are offered in specific areas of the landscape, including offered but actually not utilized ES, is substantial for sustainable decisions in planning and governance. In the face of increasing uncertainties about future developments, it is important to safeguard the ES which are not currently utilized but which provide use options for the future. Also those offered ES without actual use must be preserved (including continuation of supply). Suppliers of ES might need incentives for continuing their action, especially when there is no actual demand.

While sectoral environmental monitoring systems and landscape planning already provide a good information base for mapping and quantifying offered ES, area specific identification and quantification of utilized ES and ES demands remains difficult. For example, apart from user surveys in some case studies, we have little knowledge of how and in what quantities people actually use a particular landscape for recreation. Nevertheless, landscape planning approaches can be expanded with new approaches to take into account actual uses of landscapes and ecosystem services, for example by using georeferenced social media data as proxies for actual recreation numbers (see Wood et al., 2013).

The accounting of service provision for the whole region and the respective analysis of changes under different scenarios illustrates the relevance of land use decisions at the regional level for decision makers, stakeholders, and the public. On the basis of accountings, costs of proposed implementation instruments (e.g. funding programs) can be calculated. Furthermore, accounting of (offered) ES is an important step for defining (quantitative) regional quality objectives (with regard to human well-being). Benchmarks and regional objectives improve transparency of decision making (e.g. by relating terms of the regional plan to regional objectives) and help communicate planning objectives and measures to politicians, stakeholders, and the public. Additionally, accounting provides reference benchmarks for evaluation and monitoring purposes or for valuing service flows. In this way, for example, the contribution of a specific site to regional ES utilization, and its part in regional objective fulfillment, can be estimated. The comparison of offered and utilized ES (as far as a demand exists) for a territory allows one to estimate the limitation of resources, and shows possible (regional) over-use or the risk of potential over-use. Furthermore, accounting can illustrate regional summative ES values and consequences for public and private benefits. They relate better to the interests of individuals and groups of citizens than landscape planning information.

Economic valuation of (offered) ES can enhance the consideration of true societal costs of development impacts in environmental impact assessments. It may also help in prioritizing alternative development options in cases where laws or directives allow for alternative options for land use and management. Furthermore, economic valuation of ES allows for the comparison of societal costs and benefits which often occur only at the level of the individual land user (von Haaren et al., 2014). Therefore, economic valuation can help eliciting and including societal environmental concerns in regional governance processes. The calculation of certain economic benefits of environmental measures can be used as a guidance for defining the compensations provided in respective policy regimes (e.g. by payments for ES), although there is of course a difference between an economic valuation and the compensation for foregone incomes. Furthermore, economic valuation may contribute to efficient spending of public funding, e.g. within agri-environmental programs, and foster result-based funding approaches. The economic value can be used as an additional argument for implementing environmental measures.

Indeed, economic valuation of ES is still challenging and harbors risks. Firstly, several values, such as existence values, are included in the Total Economic Value Model but often cannot be fully expressed in monetary terms and thus carry the risk of becoming disregarded if only monetary information counts. Secondly, indicated costs often do not completely reflect the economic value of ES. As in the presented case study, damage costs are given due to lack of a more comprehensive pricing systems. In the case of CO_2-emissions, damage costs do not exclusively arise within the planning region and costs that arise on a regional or local scale (e.g. for measures, transaction costs) are not included. While economic cost estimates incorporate all kinds of costs, the determination of monetary costs in practice often neglects certain kinds of costs such as environmental and resource costs and transaction costs. Therefore, transparency about the proxies used is necessary to clearly identify which aspects the economic value does express. While economic valuation can thus present valuable information to decision-making, it needs to be used within the framework of landscape planning. Legal environmental development targets and standards should be predominantly defined and put forward in political decision processes. Economic valuation can then be presented as complementary information and an additional argument to non-economic evaluation approaches.

A further deficiency is that only the actual economic value might be taken into account, whereas prices and economic values might fluctuate. In this context, it gives an incomplete picture when valuing ES flows rather than ES capacities (Viglizzo et al., 2012:80). Moreover, it has to be noted, that for regional planning purposes, costs are not always the crucial criterion. In fact, decisions on planning alternatives are mainly headed by contextual constraints rather than by costs. In addition, regional planners usually work under extreme time pressure and find it difficult to incorporate additional information (Albert et al., 2014a).

4.3. Added value of illustrating the multifunctionality of environmental measures on the basis of accounting and monetization of offered ES

The case study exemplifies possible ES synergies for the example of climate change mitigation and water quality conservation. Within another case study (Galler et al., 2015), the authors included other multiple (offered) ES in a trade-off assessment. The authors empirically proved that integrative management concepts increase multifunctional effects and, hence, lead to higher effectiveness and efficiency in offering ES than uncoordinated sectoral management concepts. This is due to the systematical consideration of possible synergies for multiple ES in decisions about the type and the allocation of environmental measures. Furthermore, with respect to utilized ES, conflicting actions are important because they might lead to negative trade-offs. For example, increasing biomass production (increase in demand for food or energetic use of biomass) may have negative effects on biodiversity and water supply (in terms of quality and quantity of provided water) and limits recreational services (e.g. Greiff et al., 2010).

Current environmental planning procedures include and assess trade-offs to different extents. Above all, landscape planning pursues an integrative approach (von Haaren and Galler, 2012) and takes multiple landscape functions into account. Proposed environmental measures are coordinated within a spatial concept with the aim to optimize effects for multiple environmental concerns. However, this is more or less done intuitively by the planners on the basis of map overlay and is not clearly implemented in transparent and replicable procedures (von Haaren and Galler, 2012).

Furthermore, strategic environmental assessment and environmental impact assessment explicitly include environmental interactions and cumulative effects (Directives 2001/42/EC and 2011/92/EU). Indeed, they focus on negative impacts and often neglect positive effects (Haustein, 2015). In addition, recently developed decision-making support systems, that are applied in specific planning and governance contexts (e.g. Evers et al., 2012), include multiple ES in their frameworks.

Scientists and practitioners have postulated the need for a more standardized procedure, using quantitative assessments for taking synergies and trade-offs into account (Galler et al., 2015; Galler, 2015; Weingarten et al., 2015, for Common Agricultural Policy). Quantification and accounting of ES, as illustrated in the case study, provide comparable reference scales for multi-functional effects (s. Galler et al., 2015). Furthermore, the ES concept can serve as a background to improve standardized consideration of trade-offs and multifunctionality in planning and governance processes. The scope for using the ES concept for multifunctional assessments is somewhat limited in current models which focus only on a few selected ES. Only a small number of models follow a broader approach to include bundles of (collateral) ES and, hence, allow for better assessment of ES trade-offs (e.g. Bateman et al. (2013) (UK NEA); Laterra et al. (2012) (ECOSER); Fürst et al. (2013) (GISCAME); Raudsepp-Hearne et al. (2010) ("ecosystem service-bundle analysis")). Furthermore, synergies and ES trade-offs, as well as response options, are highly dependent on landscape patterns and the spatial configuration of the landscape (Laterra et al., 2012; Frank et al., 2010; Power, 2010; e.g. buffer functions, habitat connectivity). The case study affirmed this for synergies between climate change mitigation and water quality conservation. It is in such an instance that ES assessment can learn from landscape planning practice. A spatially explicit assessment, which could be done on the basis of data from a landscape plan, enables the location of areas that have specific sensitivities or anthropogenic impacts. Such information is indispensable for evaluating and forecasting offered ES. Likewise, such information is indispensable for coordinating actions in a multi-functional sense and would improve ES assessment approaches for their application in planning practice.

Combining the ES concept with the integrative landscape planning approach reveals new perspectives for both sides: it helps to convey the ES concept into practice for planning and governance, especially on the regional and local scale. For landscape planning, the ES concept gives impetus for a more standardized assessment and a more transparent way of dealing with multifunctionality. This could also strengthen the development and implementation of integrative policies, such as the Green Infrastructure Strategy (Hansen and Pauleit, 2014).

By correlating offered ES with demands and benefits, this makes ES trade-offs more concrete, transparent and comprehensible for non-professionals. Furthermore, for governance within a spatial planning context, linking offered ES (and respective suppliers) to demands and benefits (respective beneficiaries) can contribute to vertical and sectoral coordination. This might, for example, encourage state payments to municipalities (cross-scale) for the provision of global services such as for carbon sequestration or for (cross-sectoral) compensation of cultural ES provided by agriculture. Furthermore, for specific planning tasks and governance settings, this can expose opportunities for integrative strategies and collaboration of actors, widening the scope for implementation (cf. von Haaren et al., 2014).

5. ES as a reference framework for facilitating coordination and cooperation between actors

Different environmental administration sectors (e.g. water, nature conservation, forestry, agriculture) are bound by their sectoral environmental objectives and particular evaluation systems. These are normally (methodologically and technically) generated independently from each other, sector to sector. Consequently, different assessment and valuation systems have been established for each sector (Fürst et al., 2012, for forestry and agriculture sectors). There are several examples for various assessment and valuation systems which are not sufficiently aligned: indicator- and monitoring systems based on the water framework directive (CIS-documents and guidelines of the German council of the national and federal states ministries with responsibility for water management), the monitoring programs and indicator sets that are based on the Convention on Biological Diversity (CBD) and national biodiversity strategy, assessment methods that are established from the Habitats-Directive, forestry site mapping, landscape planning methods and procedures within environmental impact regulation.

These evaluation systems are not coordinated to enable data exchange (Borchardt et al., 2011; Galler and Gnest, 2011; Bruns, 2010; Fürst et al., 2012; Galler, in press). Hence, sectoral methodological requirements and established standards may contradict a coordinated inventory and data management (for reducing duplicate efforts, parallel data storage and maintenance), as well as mutual integration of (additional) objectives. Disjoined action and varying competences of different sector administrations hamper efficient measures, and do not take into account the multifunctionality of responses to environmental problems and challenges. The integrative approach of European directives (e.g. WFD, Floods Directive; UNESCO, 2009) calls for coordination and cooperation between different policy sectors. However, the respective departments are not willing to create better preconditions by linking their information and evaluation systems and by coordinate implementation instruments, especially if this requires additional effort (Galler and Gnest, 2011). In the past, sectoral environmental planning procedures, as well as implementation instruments, were predominantly directed at sufficiently implementing sectoral concerns. Nevertheless, it has been recommended to better integrate planning and monitoring systems to ensure effectiveness and spending efficiency of environmental measures (Ekroos et al., 2014; Galler et al., 2015; Wendler, 2007).

The ES concept provides a basis for collaboration among different environmental disciplines, for the following reasons: Implementing the ES concept in sector-planning introduces an additional level of objectives that correlates to the sectoral environmental objectives. For planning practitioners of different disciplines it might be more acceptable to include ES as a new concept rather than to adopt methods and procedures from other sectors.

ES and the benefits derived from ES may serve as a common reference level (boundary concept) for the different environmental planning and valuation systems. Introducing a new term for common overall objectives, one that can be established in addition to “conventional” valuation systems, could lead to better cross-sectoral comparability and mutual understanding. Fürst et al. (2012) recommended the application of a compatible evaluation standard such as the ES concept in order to integrate information from sector planning (in particular forestry) into regional planning. Abson et al. (2014, p.36), in accordance with Reyers et al. (2010), argue that “the ecosystem service concept has the potential to act as a transdisciplinary boundary object, engaging different disciplines and non-scientists in shaping and achieving societal goals”. When looking at different environmental sector planning within the administrative system, this framing potential can be affirmed for several reasons: The ES concept might foster a harmonization of assessment and monitoring methods and agreements on data management and data exchange and, furthermore, integrative planning and cross-sectoral cooperation for concerted implementation strategies.

For sectoral authorities it might be more favorable to contribute to human well-being or to meet ES demands than to just provide additional environmental effects. Furthermore, the ES concept might foster a better perception and possibly compensation when a sector-administration's own actions provide ES that are outside their responsibility. For instance, water supply companies or the water department pay farmers to adhere to water protection requirements. This adherence may result in an added value for species or habitat protection.

By correlating specific environmental concerns to offered ES (respectively providers), as well as to demands and benefits (respectively demanders and beneficiaries), joint interests and identical actors, as well as contradicting interests and interest groups can be identified. This might promote alliances among different sectors or help for concerted governance initiatives.

6. Discussion and conclusions

The case study has clearly shown that the ES approach adds new information and perspectives to traditional information, its presentation, and its contributions to decision-support in landscape and spatial planning. The analysis reemphasized that established landscape planning methods provide a good basis for a spatially explicit definition and evaluation of offered ES. Supplementary features of the ES concept are quantification and accounting of offered and (if possible) utilized ES, economic valuation and reference to benefits. Providing this information can be beneficial for planning and governance processes for several aspects: on the basis of quantified information about multiple ES, a precise and transparent trade-off assessment is possible. Additionally, synergizing effects of environmental measures can be identified and quantified. This contributes to a more effective and efficient provision of ES. Furthermore, quantification and accounting of ES trade-offs may appeal better to political decision makers than area specific representation. Political success and principal differences of political paths can be shown in easily understandable figures. However, such figures cannot replace area specific information, which is particularly important for concrete implementation.

However, in certain respects, implementing the ES concept into regional planning and governance is still challenging. A substantial challenge lies in correlating utilized ES (e.g. drinking water supply) to benefits such as human health. While offered ES can be assessed on the basis of available environmental information (provided by landscape planning or sectoral environmental information systems) it can be difficult to identify and quantify utilized ES. However, an assessment of utilized ES is not likely to be possible within landscape planning. This would need an inclusion of social science and economic methods. Additionally, a further differentiation between benefits for the public and individuals could be a useful step, but this remains difficult. New media techniques have the potential to query users in order to consider their benefits and values in planning and decision making (Galler et al., 2014).

Despite a broad acceptance of an understanding of economic valuation that goes beyond monetary values, disagreement still persists as to which kinds of societal costs and benefits can and should be appropriately considered in economic valuation. For example, in planning cases and specific governance contexts, it has to be decided whether potential or actual used benefits (both perhaps expressed as preferences), damage costs or regeneration costs (cost for safeguarding natural potential and functional capacities of the natural environment) should be included in the economic valuation. Depending on the considered economic valuation indicators, there may be discrepancies between the identified "value" of an ES and costs of implementing appropriate landscape management measures for safeguarding a continued provision of this ES. Furthermore, spatial and land use planning decisions especially affect economic land value, i.e. through zoning decisions and the siting of parks or industry.

For planning purposes, valuation of ES should consider the normative background (von Haaren et al., 2014). Therefore, normative indicators, e.g. reversibility, should be included. Developed ES assessment approaches either lack a normative background or rely on sectoral objectives that differ between disciplines (Abson et al., 2014). ES should serve as a boundary object and a common normative framework that different sector policies can refer to, and consequently, ES approaches should refer to the same normative background (see also Abson et al. 2014). Experiences with using the ES concept in planning and policy debates suggest that even though the concept may well serve as a boundary object in early stages of collaboration in the form of identifying joint interests, its use as a unifying concept decreases over time. In the Naturkapital Deutschland – TEEB-DE Initiative, for example, substantially different interpretations of the concept between different land use and conservation sectors have become apparent and were difficult to overcome in the struggle to develop a coherent study. We therefore found that the ES concept does indeed have the potential to serve as a boundary object, but we recommend attention be paid to the different interpretations. Additionally, a common interpretation should be developed at the onset of the collaboration, in order to sustain its potential to provide boundary object characteristics.

To more closely interlink different sector planning, by integrating and applying ES assessments in different environmental planning and assessment instruments, this will require further work on data and method generation, and standardization. Despite these technical challenges, implementing the ES concept in regional planning and governance opens opportunities for coordination and cooperation among actors (respectively demanders and suppliers). Three aspects can be identified that encourage understanding and awareness of environmental concerns in discussion and decision processes: i) In emphasizing the correlation between human well-being, economic growth and environmental processes (and resources), the ES concept can be used to mediate between different interest groups. ii) Estimating and accounting for economic values and costs, and referring to public and/or private benefits, helps people recognize that they are individually, or as part of the general public, affected by certain developments. Furthermore, this helps citizens to become aware of benefits they derive from ecosystems and to get a more objective picture of the diverse public and private uses of ES. This improves preconditions for public participation. iii) ES can serve as a mutual reference unit for valuation within different valuation and monitoring systems that are established in different environmental disciplines. In this way, applying the ES concept to regional planning has the potential to contribute to the main task of spatial planning: improving coordination and cooperation among sectoral administrations and between government and non-governmental actors.

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