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Commentary

Can the ecosystem services concept help in enhancing the resilience of land-sea social-ecological systems?

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ABSTRACT

The paper analyses the possibility of using the concept of marine ecosystem services to fuel public debate on the evolutionary resilience of land-sea interface regions. It is based on the experience of the interdisciplinary ARCH project-Architecture and roadmap to manage multiple pressures on lagoons (financed by the Seventh Framework Programme of the EU) that researched the development of selected European regions located around estuaries, fjords, and lagoons. The ARCH project aimed at elaborating interdisciplinary management plans for ten land-sea interface regions in the EU. Marine ecosystem services were used in this process and proved their usefulness as a spanning object bringing together different types of interests, expertise, and knowledge in a holistic way. The paper presents different ways of handling marine ecosystem services as a trigger for public debate on resilience in land-sea interface regions. It analyses the strong and weak points of the concept of ecosystem services to this end and suggests some key preconditions for the more conscious, effective use of the concept in daily decision-making processes in land-sea complex social-ecological systems.

1. Introduction

The objective of this paper is to examine the advantages and disadvantages of applying the concept of marine ecosystem services as a boundary spanning object for lagoon, fjord, and estuary regions in the EU for improving public debate on how to increase the socio-ecological (evolutionary) resilience of land-sea complex social-ecological systems. A boundary object in this paper means an object able to link different mental and management perspective. For details please see (Star and Griesemer, 1989; Slob and Duijn, 2013; Becker, 2011).

Marine ecosystem services have been examined in various contexts so far (Berkes, 2011; Nayak, 2014; Gilbert, 2008; Turner et al., 2014), but without sufficient emphasis on the prevailing development paradigm[1] and governance mechanisms. This paper fills in this gap. The starting point is acknowledgment of the specificity of the land–sea interface as an complex socio-ecological system i.e. the systems in which societal (or human) component (subsystem) is in constant interaction with the ecological (or biophysical) one (cf. Halliday and Glaser, 2011: 2; Glaser et al., 2008; Gallopin, 2003: 15). The land-sea interface regions provide the human system with important and sometimes unique benefits such as food for human and animal consumption, sport-, eco-, agro-tourism, raw materials for fertilizers and medicines, nutrient mineralization, water purification and CO_2 sequestration (Turner et al., 2014: 18). Moreover, natural marine systems also produce important non-use values such as biodiversity that enhances overall human well-being and quality of life (Ressurreição et al., 2012).

In comparison to the terrestrial social-ecological systems, the land-sea ones have the following characteristics:

- extremely complex governance patterns (in many cases, the land-sea border also separates different types of authorities with different agendas and management objectives,

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[1] According to Merriam-Webster dictionary paradigm means a model or pattern for something that may be copied.

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jurisdictions, responsibilities, and hierarchical levels) stemming from the fact that land-sea interface regions are influenced by a variety of socio-economic, political, and biophysical interactions and flows;

- ☐ the importance of knowledge integrity and the need for a multi-disciplinary approach in order to understand the complexity of socio-economic and environmental processes in land-sea interface regions (e.g., in addition to the "normal set of disciplines" the management of marine social-ecological systems requires additional knowledge specific to the sea);
- ☐ the high level of uncertainty regarding the dynamics of the marine ecosystem (as pointed out by Turner et al. (2014: 21) – our knowledge of many of the key aquatic processes is insufficient and, the data are hampered by "fragmented standards, formats and nomenclature, a lack of information on precision and accuracy, the pricing policy of some providers, and insufficient temporal or spatial resolution" (EC, 2010: 4);
- ☐ problems with perception and low level of awareness (e.g., asymmetry in popular knowledge on the importance of the role of different biotopes and taxa, especially those that are non-charismatic – e.g. Zarzycki, 2011; Ressurreição et al., 2012);
- ☐ usual high levels of self-identification and historical path dependence, thus, changing development paradigms in such regions might be difficult and time-consuming.

The long-term development of areas adjacent to lagoons, estuaries, and fjords depends on the proper combination, as well as maintenance, and accumulation of natural, human, social, moral, and physical capital (Stokols et al., 2013: Table 1). The importance of non-use values and phenomena is one reason why the development of such regions is (i) subject to market failure i.e., a sub-optimal level of well-being (Bator, 1958), and (ii) calls for public choice mechanisms and solutions, i.e., purposeful collective decision-making that balance growth pressure with dynamic coastal and marine processes (Dyckman et al., 2014).

For these reasons the traditional economic approach based on maximizing utility through the production of goods and services does not work. Moreover while developing land-sea interface one should take into consideration not only existing developmental processes, but also bias among stakeholders and natural uncertainty, i.e., the possibility of new interactions within the system and the occurrence of new pressures as well as opportunities and challenges both internal and external. For instance, according to Huber-Sannwald et al. (2012: 3160), one should allow inter-temporal (past, present, and future), cross-scale (focus on interactions) and cross-disciplinary analysis (simultaneous analysis of the biophysical, socio-economic/socio-cultural and cross-cutting domains) considering policy, governance, and management. Moreover, the author emphasizes the importance in this context of a "system memory" (e.g. in the sense of traditional local knowledge and social learning) and legacy (e.g. historic development of land-use change; path dependence).

Another difficulty is the result of an attempt to combine different temporal and spatial scales (Morgado et al., 2014). For instance, decisions made in Brussels on Natura 2000 or on maximum fish yield could influence the land-sea interface as strongly as changes in the consciousness of local people or the increase of local conflicts. This creates the problem of setting a commonly accepted definition of the spatial boundaries of lagoon systems. However, for functional regions in which water is the core unifying factor, this is a typical situation (Sneddon and Fox, 2012). There are multiple boundaries of such a region, and they

Table 1
Summary of content and issues in the case study sites.

Case study site	Engineered lagoons	Urban development, quality of life	Lack of social capital	Lack of management	Nature protection and development	Institutional borders	Fisheries, aquaculture	Harbour development	Climate change and sea level rise	Sediments and eutrophication	Pressures from tourism	Freshwater flow
Vistula lagoon, Baltic Sea												
Göta älv, Kattegat Gulf		X			X	X			X	X	X	X
Byfjorden, Norwegian Sea		X						X	X	X	X	
Elbe estuary, North Sea	X	X			X	X		X	X	X		X
Rhine estuary, North Sea	X	X			X	X		X	X	X		X
The Broads, North Sea	X				X	X			X	X	X	
Òbidos lagoon, Atlantic Ocean	X		X	X			X		X	X	X	
Lesina lagoon, Mediterranean Sea			X	X	X	X	X		X	X		
Amvrakikos lagoon, Mediterranean Sea			X	X	X	X	X		X	X		X
Razelm-Sinoe lagoon, Black Sea	X		X		X	X	X		X	X	X	X

Source: Zaucha and Breedveld (2013:39).

differ depending on the problem, the type of interactions, and the dominant developmental objective and/or vision. To address this problem in a proper way one need both interdisciplinary knowledge (combining different disciplines) and integration of different stakeholders.

Thus, management, analysis, or even structuring discussions on marine complex social-ecological systems would benefit from the existence of spanning objects capable of bridging various temporal and spatial scales, as well as different types of expertise and knowledge (helping to cope with uncertainty and lack of unique equilibrium).

2. Study sites and methods

This article is the result of a synthesis of the knowledge and experience of researchers from a range of social and natural sciences (ecology, economics, spatial planning, biology, geology). The research hypothesis was verified using case studies from ten European estuaries, fjords, and lagoons. The cases are named in Table 1 and presented at map no.1.

Map 1. Case study sites of the Arch project

These sites are very different not only in terms of their location but mainly with regard to challenges, problems and development patterns (Table 1). Some of them are remote and suffer from high unemployment and a lack of development perspectives (e.g., Amvrakikos, Vistula, Òbidos and Lesina lagoons), while others are prosperous, busy economic hubs (e.g., Byfjorden and the Elbe or Rhine estuaries). Yet others still are important natural and/or cultural heritage sites (e.g., Broads, Razelm-Sinoe Lagoon). Table 1 shows that all case studies are in need of complex management plans. This is due to either anthropogenic pressure from different, barely-related, sources or due to extraordinary natural or symbolic (cultural, historical) values that needs preservation. For instance Óbidos lagoon is subject to metal contamination (Carvalho et al., 2011) whereas Broads as well as Vistula, Lesina and Óbidos lagoons suffer from eutrophication or sediment problems (Zaucha and Breedveld, 2013). At all case study sites there is a need for tradeoffs between current and long term benefits" (Zaucha and Breedveld, 2013:33). In some of them management itself is a challenge, for example, the Vistula Lagoon is divided between Poland and Russia (Bielecka and Różyński, 2014). Thus, the chosen panel of land-sea interface regions offers a good testing ground for tools and methods enhancing public debate in relation to human—nature relationship. In-depth descriptions of the case study sites is provided by Zaucha and Breedveld (2013). For each case, a state-of-the-lagoon report was prepared (SoL) encompassing, among other things, an enumeration and analysis of the ecosystem services. Then these reports were discussed with various stakeholders in order to devise holistic management plans or at least their key outlines for the future use. Marine ecosystem services were an important part of this discussion.

The first part of our examination is based on a critical analysis of models and concepts published in the literature on resilience and ecosystem services, in the management of land-sea interface regions. The results were compared with the authors' own experience gained during the preparation of the ARCH management plans.

The second part of the research was devoted to examining the ARCH experience. The available ARCH reports were screened, and interviews were conducted with the most active actors regarding the practical use of the ecosystem service concept for stimulating debate on resilience. The actors interviewed were those responsible for preparing management plans for various sites, mainly scientist

specialized in various fields (e.g., natural and social scientists). Altogether, thirteen people from all ten case study sites were interviewed. Two questions formed the backbone of the interviews: (1) specify/list the ecosystem services you have dealt with in your (SoL) and/or in your management plan; (2) assess whether these ecosystem services provided a proper framework for discussions with stakeholders on management plans and explain how ecosystem services triggered and fueled discussions with stakeholders or why they failed to do so. The attitudes of other actors were screened by reviewing various documents and evidence describing the stakeholder process at each site.

On this basis and on the use of participatory observation, conclusions were drawn from the application of the ecosystem services concept to enhance the resilience debate. The resulting recommendations were presented at the final ARCH conference for review by the ARCH case study leaders and stakeholders attending this meeting. Finally, they were checked against the existing policy documents and strategies.

3. Results and discussion

3.1. Ecosystem services as a spanning object under evolutionary resilience

In this section, we examine the ability of the notion of ecosystem services to stimulate development debate in land-sea interface regions under the resilience paradigm. This means the ability of the concept to fuel the discussion on the complexity of land-sea socio-ecological systems by bridging different disciplines and professionals from different backgrounds and in the same time leading to concrete (measurable if possible) policy formulations.

First, we identify the key features of resilience as a development paradigm, then we examine to what extent ecosystem services are able to reinforce public discussion of them.

There is no single, commonly agreed-upon definition of the resilience concept (Olsson et al., 2015; Flood and Schechtman, 2014). It was first used by engineers (Davoudi, 2012), then it became into wide use in ecology and environmental studies, and only afterwards it was transformed into a universal concept viewed as appropriate for the social sciences. This is seen by some authors as counterproductive since resilience neglects core mechanisms of social sphere functioning such as agency, conflicts, knowledge, and power (Olsson et al., 2015). Others criticize it for its intended or unintended associations with neo-liberalism and the resulting (dis) empowerment of particular risk management strategies and the role of certain potential agents of change (Walker and Cooper, 2011; Davoudi, 2016). Despite these shortcomings, the concept of evolutionary resilience, which is also known as "socio-ecological resilience," is proposed for lagoon, estuary, and fjord regions within the ARCH project as a developmental paradigm for land-sea interface regions because it provides a common framework for examining interdependencies and understanding the development of the different components of such complex systems (Flood and Schechtman, 2014: 29; Davoudi et al., 2013). This type of framework was developed by Davoudi (2012), and was subsequently adapted for the needs of the ARCH project.

Evolutionary resilience is understood in ARCH as the ability of complex social-ecological systems to change, adapt, and transform in response to stresses and strains (Davoudi, 2012). It is the product of the physical features of the given socio-ecological system as well as interactions between different agents of change within a dynamic framework of societal institutions, norms, and values. In practice, this refers to the ability of a system to choose between persistence, adaptability, and transformability in line with societal values and agreed-upon goals. A resilient system is able to maintain the required trajectory of changes and avoid implosion or collapse by changing the processes, structures, or identities constituting the system. In the long run, this leads to preparedness. The presence of non-removable development assets, such as natural or social capital, is among the key prerequisites for such resilience and diminishes vulnerability to shocks (Zaucha et al., 2014:3).

Resilience was conceptualized within the ARCH project by defining its key components (based on Davoudi et al., 2013):

- **persistence and resilience** – comprising the ability of natural coastal and marine systems to self-respond to socio-economic and environmental (external and internal) changes and the ability of the social system to withstand future socio-economic and environmental changes;
- **adaptability** – encompassing flexibility (networking, flow of ideas) and resourcefulness (replacing resources that become scarce). This means the ability of the system to steer its development, choose among alternatives (also entirely novel and innovative ones), and doing it in an efficient, effective, flexible way with regard to the use of resources, including human resources and social capital. Important sub-dimensions of resourcefulness are efficiency, rapidity, and diversity;
- **transformability** – manning ability to achieve a new and more desirable trajectory after going through the adaptive cycles of changes;
- **preparedness** - the outcome of an interplay between persistence, adaptability, and transformability.

A key feature for the support of socio-ecological resilience of lagoon systems is the inter-temporal arbitration between satisfaction with current and future human needs based on sustainable and adaptive management principles and appropriate timing of interventions. Resilience indicates that long-term social well-being depends on the accumulation and maintenance of sufficient flows through time of various types of capital (including natural ones). This would be impossible without proper public debate and public choice. Therefore it seems that the concept of ecosystem services, if applied critically, might have considerable potential to translate this abstract message of temporal arbitration into an understandable and applicable axiom guiding routines for decision- and policy-makers as well as the public. It can also prompt discussions on other interdependencies as well pressure responses and links with the outer world.

Ecosystem services are an important subject of research and policy making in EU (Depellegrin and Blažauskas, 2013; Egoh et al., 2012; Guerry et al., 2012; Haines-Young and Potschin, 2011: 201; Maes et al., 2013, 2014; Turner et al., 2014; Haines-Young and Potschin, 2013). The Millennium Ecosystem Assessment (MA, 2005) describes ecosystem services as "the benefits that people obtain from ecosystems." and subdivides them into supporting, regulating, provisioning, and cultural services. Fig. 1 provides examples of such ecosystem services in reference to sea waters.

However, Fisher and Turner (2008) claim that there is an important distinction between ecosystem services and benefits based on the context that ecosystem services are aspects of the ecosystems utilized (actively or passively) to produce human well-being. Fisher et al. (2009) see ecosystem services as the link between ecosystems and the gains that humans benefit from and not the benefits themselves. The key feature of the Fisher et al. (2009) proposal is the separation of ecosystem processes into intermediate and final services, with the latter yielding welfare benefits (welfare gain/losses – Fig. 2).

The main weakness of ecosystem service concept lies in the utilitarian character of them and the over-simplification of

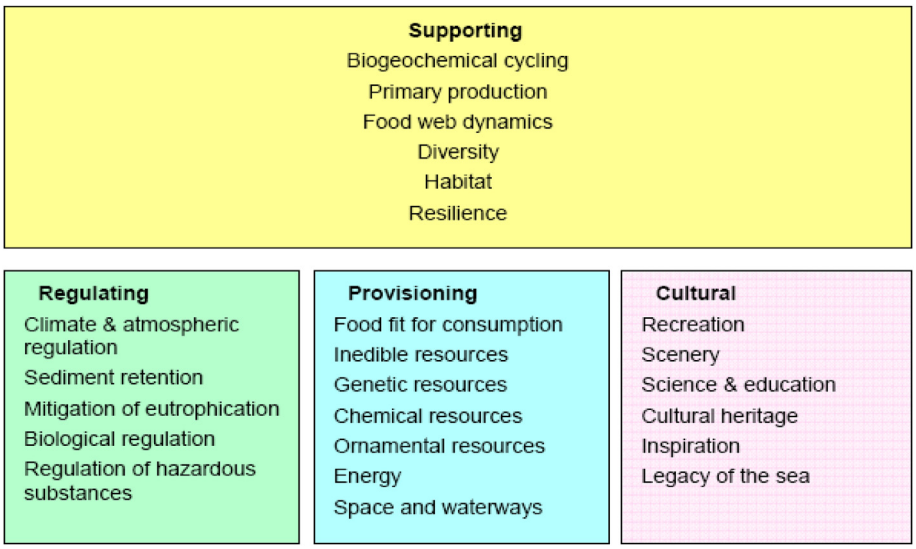

Fig. 1. Ecosystem services of marine and coastal areas.
Source: Garpe (2008: 26) same division as in the Millennium Ecosystem Assessment (MA, 2005).

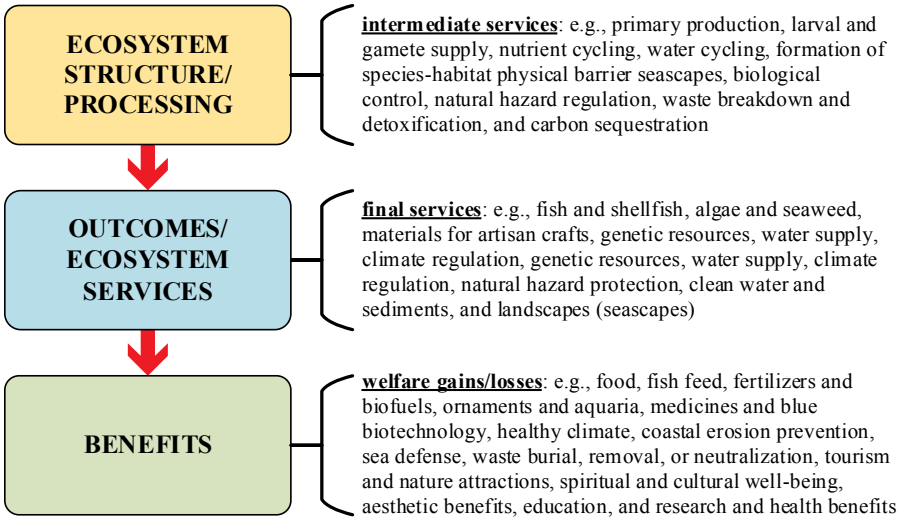

Fig. 2. Simplified ecosystem value typology suggested by Fisher and Turner.
Source: Zaucha and Matczak (2012: 30) adapted from Fisher et al. (2009), Turner (2011) and illustrated with examples of marine ecosystem services from Turner et al. (2014: 18).

ecological processes (for details see, e.g., Norgaard, 2010). This is seen implicitly in the constant drive towards their monetary valuation (in brief Söderqvist and Hasselström, 2008: 17–22; in detail, e.g., Gren et al., 2000) as an attempt to internalize the values of ecosystems into market processes. In this paper we argue, however, that such valuation is not so important since ecosystem services also work well as a trigger of development debates in land-sea interface regions. At the same time, this type of valuation does not permit considerations of their quality values. The ability of this idea to provide an intellectual link between different human and natural processes is of key importance in this respect.

Theoretical considerations show that the notion of ecosystem services fits well into the concept of evolutionary resilience and is able to frame important policy debated in this context. Details are presented in Table 2 that bridges together both concepts. However, one should keep in mind that such a nice fit might not be sufficient to ensure practical integration of the ecosystem services concept into strategic coastal planning and programming due to e.g. institutional barriers (Li et al., 2015).

3.2. *ARCH experience in the use of ecosystem services for stimulating the development debate*

In this section, we analyse the ARCH experience in the use of ecosystem services for stimulating the development debate. In general, ecosystem services proved their validity in ARCH cases as linking elements between natural and human systems in the developmental debate (Meerkerk and Slob, 2013: 36). They permitted the demonstration of the significance of natural capital as an immobile, non-movable, and non-reproductive asset, as well as the importance of interactions in the process of development. They became firmly inscribed into the concepts of building adaptive capacity since they enriched and advanced developmental debates in all ARCH cases.

Table 2
Relation of ecosystem services to the key features of evolutionary resilience.

Key features of evolutionary resilience	Contribution from ecosystem services
persistence	Regulating ecosystem services play an important role in securing the stability of marine ecosystems. However, the awareness of their importance seems much lower in comparison to other types of ecosystem services among stakeholders and the general public. Thus, highlighting, examining, and, if needed, protecting them adds to the persistence of land-sea interface regions.
adaptability	Ecosystem services of fjords, lagoons, or estuaries are the products of sea (water) ecosystems, but they are simultaneously comprised of the human perception of benefiting from them. They are among the important determinants of success (long-term well-being, prosperity) of socio-ecological systems. So, as a spanning object, they closely link ecological and societal components. They initiate the flow of ideas and networking (e.g., a high number of NGOs, EU, and national programs dealing with sea and coastal issues). They are the source of "innovative thinking," i.e., fresh, new ideas for the diversification of economies of the coastal regions (e.g., aquaculture for improving quality of the sea waters).
transformability	As a spanning object, ecosystem services provide a solid framework for more evidence-based, closer to the ground governance debate on these issues. Ecosystem services permit a proper framing of the debate on complex developmental issues. For instance, the development of off-shore energy within an ecosystem services framework prompts the examination of consequences for supporting services (food-web, habitats), regulating services (sediment retention, eutrophication, and co-location with mussel farming) and cultural losses (landscapes).
preparedness as an outcome of this interplay	Preparedness is based on the learning process. Because of high levels of uncertainty related to the functioning of sea ecosystems, ensuring evolutionary resilience requires pooling knowledge. In this process, stakeholders might bring their tacit knowledge thus facilitating mutual learning. Ecosystem services as a spanning object are able to attract very different types of stakeholders including fishers, representatives of the tourism sector, green NGOs, maritime authorities, and local governments.

Source: authors' own elaboration.

In particular, ecosystem services were considered by case leaders as a useful object for providing:

- ☐ proper common ground for understanding and discussions between stakeholders especially in the case of hostile stakeholders;
- ☐ a set of useful information that aids in defining the management and intervention time line, the definition of indicators to monitor progress, and the definition of measures to reduce possible impacts;
- ☐ a useful framework for stakeholder engagement;
- ☐ a more concrete ground for planning (and understanding objectives);
- ☐ a framework for mutual learning and experience sharing;
- ☐ a shared terminology to understand gaps and to bridge disciplines.

In one case (Broads, UK) the debate on ecosystem services has resulted in the decision to elaborate a new background document with even more emphasis on ecosystem services and welfare benefits.

Provisioning and cultural services entered easily into the public debate organized by ARCH. Moreover, among the problems identified in the debate, the most relevant, or the most frequent, ones have been those related to natural capital and its precautionary preservation and sustainable exploitation. Key issues included eutrophication, sediment quality, and nature conservation (Zaucha and Breedveld, 2013: 39). This is evidence that the slightly neglected or underestimated issue of supporting and regulating ecosystem services is now much better recognized, and not only in the environmental field, but also in terms of socio-economic development.

This, however, is a general picture, the actual situations in the various case study sites have varied. When asked to enumerate ecosystem services they have dealt with in practice (in background reports and management plans), case study leaders gave very different answers (Table 3) indicating that some ecosystem services have played much more important roles in the development debate than did others.

The reasons for these differences were discussed at the final ARCH conference. They might be related to the size of the region (i.e., a larger region means a larger palette of ecosystem services),

Table 3
Ecosystem services used in practice in ARCH case study sites.

Case study site	Ecosystem services used in SoL and management plans
Lesina Lagoon, Mediterranean Sea (Italy)	Cultural only (recreation)
Vistula Lagoon, Baltic Sea (Poland)	All types of services but more focus on provisioning (fish, navigation), cultural services (tourism, recreation)
Òbidos Lagoon, Atlantic Ocean (Portugal)	Provisioning (food) and cultural services (tourism)
Byfjorden, Norwegian Sea Norway)	Related to environmental benefits (regulating)
Rhine Estuary, North Sea (The Netherlands)	Mainly provisioning services (navigation) but also regulating (flood protection) and cultural (recreation) services
Elbe Estuary, North Sea (Germany)	Mainly provisioning services (navigation, port, fresh water supply) but also cultural services (recreation, landscapes)
Göta älv, Kattegat (Sweden)	Provisioning to a small degree as fish stocks have declined. Cultural (recreation) and supporting and regulating services are highly valued.
Razelm-Sinoe Estuary, Black Sea (Romania)	All types of services
Amvrakikos Lagoon, Mediterranean Sea (Greece)	All types of services, but of different importance
Broads, North Sea (United Kingdom)	Existing and potential benefits. In the first group four benefits are included: biodiversity conservation (existence value); land based and water based recreation; water provision for drinking as well as water for agricultural and industrial uses. The potential benefits group highlights the potential in the Broads to assist in the mitigation of and adaptation to the effects of climate change.

Source: authors' own elaboration.

Table 4
Valuation of the importance of different ecosystem services by Amvrakikos Gulf stakeholders.

Service type	Service description	Good/Benefit	Level of importance (0-low, 5-high)
Supporting	Nutrient Cycling	Nitrogen	3
		Phosphorus	3
Provisioning	Livestock (water buffalo) and fishing/ aquaculture	Meat	1
		Milk	1
		Fish	5
	Vegetation resources	Reed for weaving	1
Provisioning	Wild species diversity	High diversity	3
		Protected areas	5
		Nursery grounds for fish	5
Provisioning/ Regulating	Temporary or permanent ecological niche	Breeding, overwintering, feeding grounds for birds	5
Regulating	Purification	Water filtration: surface flow and seawater	3
Regulating	Climate regulation	Carbon sequestration	2
	Hazard defense	Sea defense	2
	Waste breakdown	Immobilization of pollutants usually in sediments	3
Cultural	Recreation/Tourism	Walking paths, bird watching	5
	Education/ecological knowledge	Resource for teaching, public information, scientific study	5
	Physical/mental health	Opportunity to exercise, local space, wilderness, personal space	3

Source: State of the lagoon report: Amvrakikos Gulf case study, Greece.

its current development status (e.g., more focus on provisioning and cultural services in less developed regions), as well as the prevailing paradigm of development shared by a given society (e.g., more emphasis on green growth in Scandinavian countries). The composition of the stakeholder groups involved in the discussion might also play a role, but better insight is necessary to judge this.

For instance, in the case of Amvrakikos Gulf, the evaluation of the importance of local ecosystem services shows bias towards provisioning and cultural benefits, although some supporting and regulating services also received high grades (Table 4). The main reason for this is the awareness among local stakeholders of the importance of the ecosystem for the long-term well-being of the region. This was achieved through their participation in various national and international projects. Through these projects and the local management framework, namely the Amvrakikos Wetlands Management Authority employing environmental and biological scientists and local officials, the stakeholders have access to current knowledge about ecosystem processes in the region as well as know-how and experience regarding all aspects of management ranging from local legislation and policies all the way up to EU policies.

However, it seems that the reasons for differences in the perception of the importance of ecosystem services in development debate in the land-sea interface regions still need further research.

4. Conclusions

The ARCH project has positively tested the usefulness of ecosystem services as an object triggering public debate on resilience as an overwhelming objective for the development of land-sea regions. It has also allowed to identify the key reasons why ecosystem services might play a crucial role as the core of debate on the resilience of lagoon, fjord, and estuary regions.

The ecosystem service concept:

- ☐ provides solid links between the ecological and societal components of socio-ecological systems through the consolidation of natural and social science understandings;
- ☐ highlights the multidimensional range of services provided by natural capital and raise questions about the cost of their disappearance or deterioration;
- ☐ enables the connection between natural capital and the developmental objectives of the lagoon region (they provide a framework for a more systematic answer to the question of which services are needed to achieve these objectives);
- ☐ performs an educational role as they illustrate the coherence of the ecosystem, i.e., the interdependence of services on each other and the coherence of the whole region's system at the contact point of water and land;
- ☐ creates a long-term, integrated, and adaptive perspective to the debate on development (on such grounds, the domination of sectoral interests becomes less probable);
- ☐ is provided in an easily understood form for the decision makers and the general public;
- ☐ creates an interesting bridging platform between different disciplines and societal groups allowing for interactions among them within the public choice framework.

The ecosystem service concept also allows upgrading the level of debate on coastal development from a general, axiological one (abstract) to a more concrete and personalized level. However, some gaps and shortcomings were also revealed in the process that require further attention from scientists and decision makers:

- ☐ It is important to recognize that researchers from different disciplines have differing opinions on what constitutes ecosystem services and how they should be classified. This does not stop the use of the ecosystem service concept, but requires an introduction and explanation on the use of different definitions.
- ☐ The perception of the importance of ecosystem services might be dependent on culture (values) and context. Thus, they should not be used alone, especially when other more concrete and objective scientific information exists on the functioning of ecosystems, particularly in the long run.
- ☐ The ecosystem service concept only encompasses some of the links between natural and human systems. For this reason, too much focus on it could result in omitting other important phenomena and fundamental concerns such as the efficiency and transparency of governance systems or the strength of vested interests. The concept, as it is now, cannot facilitate, for instance, discussing tradeoffs between different ecosystem services.

- The concept suffers from an insufficient spatial dimension. If maritime spatial planning (about this planning please see Jay et al. (2013) and Zaucha (2012; 2014a; b) is to become one of the key, cross-cutting planning procedures, the types of "spaces" related to the proper functioning and sound delivery of different ecosystem services must be understood. This is particularly important for supporting and regulating ecosystem services.
- Finally, the concept requires support from different scientific disciplines as well as tacit knowledge from different types of stakeholders. Therefore, it needs specific human resources, time, and patience, which are sometimes key limiting constraints in management processes.

Summing up, it is obvious that ecosystem services should be treated as one among numerous approaches stimulating debate in the context of evolutionary resilience. The following exhortations are suggested as the legacy of the ARCH project:

- Improve knowledge on the functioning of lagoon and estuarine ecosystems, especially their capacities as suppliers of ecosystem services, and present the results of this work so that they can be used in debates (easily understood language that demonstrates the consequences of change on well-being, etc.);
- Develop monitoring systems for ecosystem services. The results of monitoring should be easily accessible and understandable for decision makers and the general public. Monitoring should not be oriented toward ecological directives or sectoral policies; its objective should be to stimulate regional debate on development.
- Improve awareness, e.g., by supporting actions demonstrating the significance of ecosystem services (investigations into the willingness to pay for services and of motivation behind this willingness and supporting actions). The concepts of supporting and regulating services must be made operational in such a way that they will be understandable to people who are not engaged professionally in ecology or oceanography.
- Establish capable institutions and clearly defined institutional responsibility and jurisdictions. Ecosystem services require an interdisciplinary and flexible platform for debate on development. Depending on local conditions, such a platform could assume various forms. But it should be of a contractual character, be based on an agreement among actors operating on different scales of the development game, and on the honest reporting of results.
- Create interdisciplinary teams able to better provide more integrated analysis of ecosystem services and communicate the outcomes to decision makers and cover most or all aspects of ecosystems.

Author contributions

Zaucha drafted the idea and the design of the article and wrote substantial parts of the text.

Conides wrote and edited part of the text on the Greek case, proposed some conclusions and prepared and designed the structure and layout of the article and the figures and tables. He participated in the design of the article and finalized its submission.

Klaoudatos generated large parts of the data for the Greek case and edited part of the Greek case study text.

Norén made a critical examination of the conclusions proposed by Zaucha and Conides.

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