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Application of the ecosystem services concept at the local level – Challenges, opportunities, and limitations

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ABSTRACT

Theories, models, and studies of ecosystem services (ESs) are expected to be applicable to conservation practices. However, applying the ES concept becomes challenging, especially in terms of implementing theory into the local-level activities. We analyzed ten participatory mapping workshops involving conservation experts and local stakeholders to investigate theoretical challenges emergent in the ES concept implementation. Based on our results, we argue that local stakeholders are able to address practical problems in mapping ESs that are debated in the literature as major theoretical challenges to the concept. In particular, it considers the theoretical challenges of distinguishing ESs from the other levels of the ESs cascade; challenges in monetary valuation of the ESs, operationalization of service-providing units, service-benefiting areas, and ESs that are co-produced with humans, and the consequences of including the stakeholders' subjective perspectives in mapping ESs.

We claim that these challenges can be addressed to a certain extent by defining realistic objectives for the ES mapping, followed by clear rules adjusted for local conditions. The ES concept may serve as an effective tool for engaging local stakeholders in constructive discussions about nature and spatial planning. However, participatory mapping has limitations in relation to providing a comprehensive assessments of ESs.

1. Introduction

Although the ecosystem services (ESs) concept has had a significant influence on international conservation research and policy in recent decades, the design of appropriate tools to implement it effectively in practical applications remains challenging (Armsworth et al., 2007). Moreover, the ES concept is still under development at the theoretical level (Costanza et al., 2017; Diaz et al., 2018) and continues to face fundamental challenges in terms of consistent and reliable classification or identification of ESs (Diaz et al., 2018; La Notte et al., 2017). Meanwhile, the political consequences of the application of the ES concept to public policy, economic valuations, and the commodification of nature is a constant topic of debate (Daily et al., 2000a,b; McCauley, 2006; Norgaard, 2010; Schroter et al., 2014). This raises the question of whether the concept should be used predominantly in communication and education, as a compelling metaphor, or rather developed as a scientific framework for use in the conservation sciences and public policy development (Norgaard, 2010). Regardless of the direction in which the current debate moves, we will undoubtedly require a deeper understanding of the environmental and social contexts in which the ES concept is implemented (Fisher et al., 2009), as well as a careful examination of its usage at the local level. Although there have been numerous applications of the ES framework in various case studies (Brown and Fagerholm, 2015), there is an ongoing need to improve the connection between local-level studies and the theoretical challenges facing ESs.

As an example, the most popular and constantly developed ES framework, the ES cascade (Potschin-Young et al., 2018; Potschin and Haines-Young, 2011), proved to have limited consistency when applied to empirical studies (Boerema et al., 2017). The ES cascade model illustrates the sequential structure of biophysical processes, functions, services, benefits, and values that stem from one another (Barton et al., 2018). One challenge relating to the cascade model concerns separating a specific ES from its preceding (ES function) or subsequent (benefit) stage along the cascade. In practice, ESs *per se* are rarely measured in empirical studies, and the stage of the ES cascade that is actually

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measured varies depending on the ES category. Specifically, regulating services often refer to the use of "ecosystem functions" or even "ecosystem properties" indicators, while provisioning services are usually measured in terms of the benefits that they generate (Boerema et al., 2017).

The challenge of precise identification of ESs corresponds to the requirements of the former mainstream approach to ES inquiry that began in the 2000s (e.g. Nieto-Romero et al., 2014) and encompasses monetary valuation of ESs. Although monetary valuation was heavily criticized by ES theorists and methodologists (Gómez-Baggethun and Ruiz-Pérez, 2011; Redford and Adams, 2009), and has recently been replaced by more integrative approaches, such as nature's contributions to people (Diaz et al., 2018), it contributed to ES theory by adopting an economic perspective to prevent the double-counting of ES, whereby interlinked and difficult-to-separate services were allocated a value more than once (Fu et al., 2011). The resulting improvements in ES classifications have since been applied in many research contexts in addition to monetary evaluations. This debate inspired the development of the Common International Classification of Ecosystem Services (CICES) system (Haines-Young and Potschin, 2013, 2018). Nevertheless, in terms of practical application at the local level, stakeholders have found the CICES system inconvenient, and have opted to combine and/or rename some of the CICES categories (Haines-Young, 2016). This may once again result in overlapping and double-counting of ESs, as well as producing incomparable results between various local-level cases. Furthermore, in studies where stakeholders identify ESs at the local level, the concept requires translation into more general wording, such as "benefits from nature" or "landscape values" (Balmford et al., 2011; Fisher et al., 2009; Guerry et al., 2012), which in turn may influence how it is perceived and understood by various stakeholders.

Another theoretical and operational challenge stems from the fact that ESs are rarely produced solely by ecosystems. More often, they are the effects of ecosystem–human interactions (Palomo et al., 2016). This generates another question: at which stage and to what extent should anthropogenic contributions be included in ES studies, so as not to blur the foundations of the concept? These contributions not only involve technical or financial input from humans (Palomo et al., 2016), but may also be connected with the existence of various institutions that indirectly drive ES flows (Diaz et al., 2015). Some of these institutions (e.g. protected areas) have their own spatial extent, which further complicates the precise identification and description of ESs.

The ES concept inherently refers to "ecosystems," which are spatial entities. This implies a need to locate services within specific areas, most often to analyze their spatial distribution (de Groot et al., 2010; Naidoo et al., 2008). This requires a link between a theoretical approach and a mapping procedure, which is provided by two spatial constructs that refer to presentation ESs on maps: service-providing units (SPUs) and service-benefiting areas (SBAs) (Burkhard et al., 2014; Garcia-Nieto et al., 2013; Syrbe and Walz, 2012). Both of these approaches are widely used to map ES indicators (Andersson et al., 2015; Burkhard et al., 2014; Serna-Chavez et al., 2014; Wurster and Artmann, 2014). However, separating the flows of various SPUs and SBAs may be challenging for the spatial operationalization of cultural ESs and in the case of regulating ESs that are supplied by large-scale and complex ecosystems (e.g. an entire river valley). In addition, proxies for SPUs and SBAs tend to be used for ES mapping, usually in the form of land-cover categories (Barton et al., 2018).

Despite a theoretical background in the environmental sciences, many studies on ESs are performed using social science methodologies such as interviews and questionnaires (Dunford et al., 2018; Harrison et al., 2018; Jacobs et al., 2018; Kim et al., 2018; Wartmann and Purves, 2018). More recently, these have been combined with increasingly popular participatory mapping techniques such as the Public Participation Geographic Information System (Garcia-Martin et al., 2017; Pietrzyk-Kaszynska et al., 2017; Schroter et al., 2018). Participatory mapping of ESs faces numerous methodological challenges, from determining how the process should be performed and who should participate in it to ensure balanced representation of views and interests, to ensuring the accuracy and reliability of the results (Brown et al., 2015; Brown and Fagerholm, 2015; Willemen et al., 2015). While the majority of participatory spatial studies on ES are quantitative (Brown and Fagerholm, 2015), they are unable to provide significant insight into the participants' understanding of ESs and the mapping process. Conversely, qualitative studies involving face-to-face interviews or group discussions provide an opportunity to explore participants' presumptions regarding and interpretations of ESs, and to understand more fully their capabilities and limitations. Additionally, participatory mapping workshops allow for observation of how participants apply the concept by mapping ESs in a specific area.

In this study, we present the results of ten participatory mapping workshops and aim to assess to what extent and under what circumstances the ES concept is operative in participatory mapping, completed by stakeholders at the local level. Based on analyses of the participants' statements, arguments, and reflections presented during the workshops, we identified challenges that can be related to the theory of ESs, as well as practical and technical challenges that impose limitations on the use of the concept at the local level. Finally, we discussed opportunities related to the application of ESs at the local level and their potential to facilitate discussions and decision-making in nature conservation. Therefore, the analyses were based on the following three research questions:

(1) Which theoretical challenges identified in the ES concept are reflected in implementation at the local level?
(2) Which practical challenges should be considered when applying the ES concept to participatory processes at the local level?
(3) What are the opportunities related to applying the ES concept to participatory processes at the local level?

2. Methodology

We developed a methodology that combined focus group interviews with participatory mapping. The study consisted of ten participatory mapping workshops in five case study areas in Poland: (1) Pojezierze Gnieźnieńskie (Gnieźnieńskie Lake area), (2) *Otwocki* county and the surroundings of the Całowanie Marshland, (3) *Tatrzański* county, (4) the Beskid Sądecki mountain area, and (5) Dębniki, district VIII of the Krakow municipality (see Fig. 1 and Table 1). All study sites include both protected (incl. Natura 2000 sites) and unprotected territories within the communities' administrative borders. The case study areas were chosen to provide a diverse range of biophysical, social, and institutional contexts. They significantly differed in size, population and governance arrangement – number of administrative units (municipalities) and protected areas that govern various social, economic and environmental issues in and around the area.

In 2015, we conducted two facilitated workshops, each with up to 7–12 participants at each site: one with experts in nature conservation or spatial planning, and the other with "local leaders" – local community representatives who were not professionally involved but were interested in nature conservation and actively engaged in various activities in their community (Table 2, also see Appendix 1 for a detailed list of the workshop participants). Participant recruitment was preceded by stakeholders analysis aiming to assure political representativeness of the invited respondents (Raymond et al., 2014) – the recruitment procedure focus on covering diversity of interests, experiences and institutions in local nature governance. Invited participants were selected based on identification of the key institutions, whose members were invited to the workshops, and local informal groups of stakeholders that are involved in land use and resource management (including nature protection). We took advantage of nature governance documents (such as management plans of protected areas; grey and scientific literature on nature management and governance in the specific areas), and

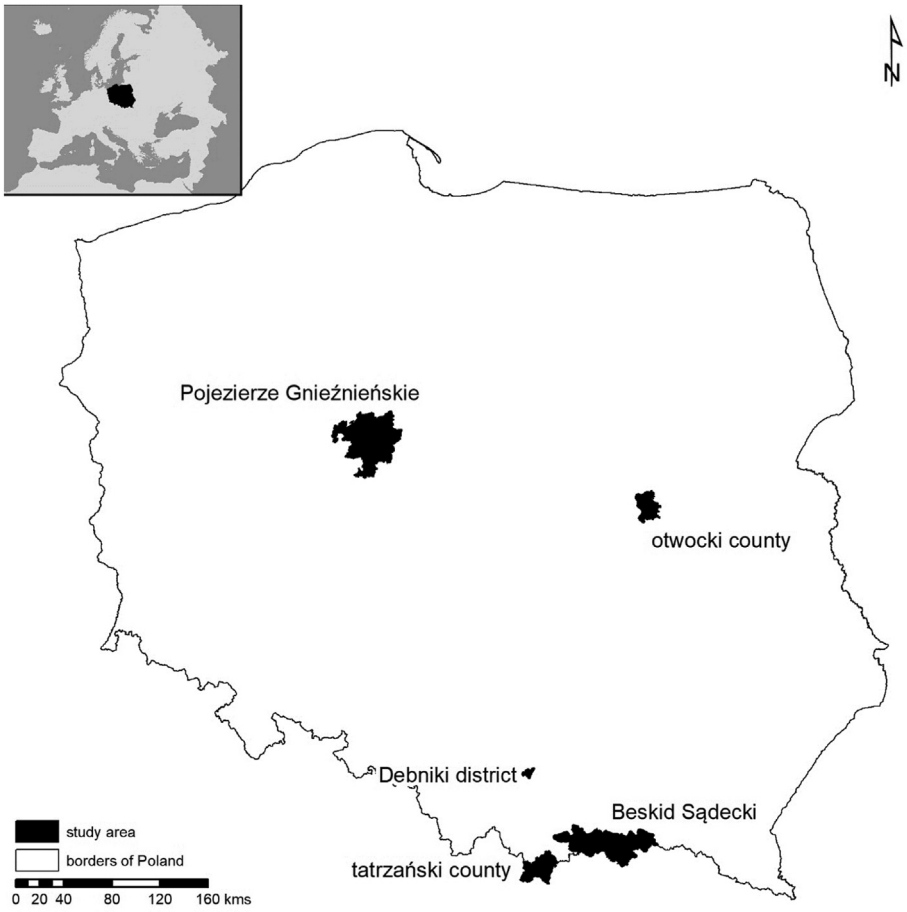

Fig. 1. Location of the case studies.

snowball sampling based on recommendations from contacted people (Prell et al., 2009).

The main aim of each workshop was to create a common map (agreed on by the group) of areas providing five ESs selected from a list of 25 (based on CICES classification – see Supplementary materials, Appendix 2) by each group based on the importance of the ES for the well-being of the local society. The researchers leading the workshops provided participants with a brief introduction, including a presentation of the study area, a definition of ESs (described as "benefits from nature"), and the aim of the workshop. The main goal of the study was repeated several times during the workshops. Participants were also asked to assess the importance of the ESs based on their own thoughts, opinions and reflections, and were told not to try to guess or imagine what others would think. The groups differed in their ESs selection, both between sites and between experts and local leaders groups (Table 2). The largest difference between experts and local leaders' choices was in the *Otwocki* county, where only two services were selected by the both groups: cultivated crops and wood and peat for heating. The most similar selection was proposed in Pojezierze Gnieździeńskie and Dębniki, where experts and leaders selected four identical services. Between the areas, the selection differed in types (categories) of services – in Dębniki and Pojezierze Gnieździeńskie respondents selected mainly cultural services, with one or two exception, while all three categories of ES (provisioning, cultural and regulating), were covered only in *Tatrzański* county and *Otwocki* county areas.

Each workshop lasted for between four and five hours and consisted of three parts. First, there was a general discussion lasting for one to one and a half hours about the participants' perceptions of the ES services at each site, culminating in the selection of five ESs for mapping. Participants individually selected their five preferred ESs (out of a suggested list of 25), presented their choices, and based on the frequency of choice of each ES appearance, the group selected the final five ESs. The group was also allowed to adjust or merge the categories. The second part of the workshop, which lasted for about two hours, involved mapping the areas of the selected ESs. The mapping process was performed using two large-format base maps: a land-cover map and a topographical map (see Appendix 3 for examples of these maps). The participants were free to collectively choose between the two alternatives before providing any input at that stage. The participants were asked to identify specific places and areas that provided particular ESs while the facilitator marked their information on the map. The last stage of the workshop involved a debriefing by the facilitator and final reflections of the participants. Each workshop was facilitated by two researchers, one of whom led the discussion and debriefing, while the other assisted with the mapping procedure.

The workshops were recorded with the participants' permission and transcribed. The transcriptions were then coded using the qualitative data analysis software QDA Miner. The coding was conducted over two rounds. The first round used an open coding approach (new codes were developed while reading the transcriptions) and four general coding categories (problems during the mapping process, success of the mapping process, differences in the understanding of ESs between stakeholders, and other aspects considered important in relation to the research question). This first, preliminary round of coding, as advised in a qualitative data analysis (Miles et al., 2014), was applied to confirm operationalization of the research goals and confirm a scope to which obtained research material (transcriptions from the workshops) can provide information for answering the research questions. Three documents were coded, resulting in a detailed list of codes categorizing respondents' problems with discussing ES in their areas and locating

Table 1
Characteristics of the case study areas.

Case study	Surface [km^2]	Scale of map	General/dominating character of an area	Natura 2000 sites codes	Other protected areas (selection)	Administrative units defining the borders of a case study	Population [2015 census data]
Pojezierze Gnieźnieńskie	1720	1:36 000	Glacial and glaciofluvial lowland landscapes – forest and agricultural character with elements of tourist and industrial functions	PLH300026, PLB040004, PLH040007	Powidzki Landscape Park, Nadgoplański Park Tysiąclecia Landscape Park, Powidzko-Bieniaszewski Landscape Protection Area, Landscape Protection Area of Lasy Miradzkie, 2 nature reserves	12 municipalities	131 406
otwocki county	336	1:18 000	Great valley landscapes with bogs and dune hills – agricultural and forest character	PLH140001; PLH140050; PLB140004; PLB140011; PLH140022	Mazowiecki Landscape Park, Warszawski Landscape Protection Area, Nadwiślański Landscape Protection Area	4 municipalities	37 474
tatrzański county	470	1:18 000	Highland and high mountain landscapes – a seminatural character; landscapes of erosive basins in mountainous areas – peri-urban character with a dominant tourist function	PLC120001, PLH120024, PLH120026	Tatrzański National Park, Południowomałopolski Landscape Protection Area	5 municipalities	67 835
Beskid Sądecki	1430	1:36 000	Highland landscapes – forest and agricultural character with elements of a tourist function	PLH120019; PLC120002; PLH120025; PLH120036; PLH120035; PLB180002; PLH120088; PLH120018; PLH120037; PLH120039; PLH120095; PLH120052	Popradzki Landscape Park, 17 nature reserves (e.g. Okopy Konferedackie, Homole, Biała Woda, Zaskalskie-Bodnarówka, Wysokie Skałki), Południowomałopolski Landscape Protection Area	12 municipalities	126 283
Dębniki district of the Krakow municipality	46	1:9000	Great valley and carbonate upland landscapes – peri-urban character	PLH120065, PLH120079	Bielańsko-Tyniecki Landscape Park, Skołczanka Nature Reserve	one of 18 districts of Kraków	60 073

them on the map, local context of the problems as well as opportunities for applying ES (see Appendix 4 for a complete list of codes and coding frequencies). The detailed codes were applied to all documents in the second coding round. In total, the ten documents that were analyzed were assigned 1095 codes. Segments of text assigned with the same code were compared to identify patterns and varieties of opinions, and segments assigned with multiple codes were analyzed to identify common issues. Respondents' problems with the ES concept were then interpreted in the context of ES theoretical challenges and practical application issues discussed in the scientific literature, linked with opportunities to overcome the challenges emerged from our study. Specific codes did not necessarily match one specific theoretical or practical challenge (e.g. the code "general problems with understanding ES" include multiple examples of theory-related challenges and practical issues; while the code "nature conservation, property rights regimes, other legal aspects" included both a specific theoretical challenge of co-production, as well as important context of other challenges), however the codes enabled researcher to understand respondents' perspectives and relate them to theoretical challenges, and organize chapters on practical challenges and opportunities. The following section presents quantitative insight into the structure and frequency of codes, which is followed by a qualitative summary of the main findings, exemplified by quotes from participants, regrouped to more directly address the main aims of the study regarding the theoretical and practical challenges of the ES concept and respondents' perspective on the opportunities. Differences in opinions between the experts and the local leaders were highlighted when they emerged.

3. Results

The most frequently applied codes were "economic vs non-economic benefits" (12% of all codes), "local problem through the lenses of ES" (11% of all codes), "general problems with understanding ES" (10% of all codes), "other problems with locating ES on the map" (10% of all codes) and "lack of awareness of ES among its users" (8% of all codes; Appendix 4). Reference to local problems through debating ES was discussed by local leaders more than two times more frequently than experts. General problems with understanding ES were almost four times more frequently coded in expert workshops than in the local leaders' discussions. Experts also discussed challenges with locating ES on the map about two times more often than local leaders, as well as they more often discussed: other ES than those proposed for the group discussion, differences between areas that provide ES and areas that benefit from ES, challenges with mapping past ES or areas with non-used potential for ES provision and the role of map characteristics (incl. the scale of a basemap) in completing the task of mapping ES. "Economic vs non-economic benefits" were about two times more often used by respondents in the urban context of Dębniki district of Kraków, than by respondents in other, predominantly rural areas. To our surprise, there were very few quotes coded with "Problems with distinguishing and mapping cultural services", mainly applied in two areas: Dębniki disctrict of Kraków and Tatrzański county.

The following chapters present a qualitative insight into the results that is structured into identified theoretical challenges (1), resulting practical challenges (2), as well as opportunities to benefit from application of ES at the local level, as perceived by our respondents (3; Table 3).

3.1. Theoretical challenges of the ES concept reflected in the mapping workshops at the local level

There were several theoretical challenges of the ES concept reflected

Table 2
Characteristic of workshop, participants and groups' of ES selection. The table footnote provides parallel CICES terms for ES if other, simplified naming was provided to the respondents or if respondents suggested to altered or combine ES proposed for mapping.

Case study	Number of participants	Institutions represented by participants	Gender	Five selected ecosystem services
Pojezierze Gnieźnieńskie local leaders	9	municipality, private business, environmental NGO and local action groups	4 men, 5 women	cultivated crops, reared animals, experiencing nature[1], tourism and recreation[2], aesthetic values
Pojezierze Gnieźnieńskie experts	10	municipalities, university, forest services, environmental NGO, regional directorate for environmental protection, county	3 men, 7 women	cultivated crops, experiencing nature[1], tourism and recreation[2], water purification[3], aesthetic values
Otwocki county local leaders	8	mayors of municipalities, private business, fire department volunteers	6 men, 2 women	cultivated crops, wood and peat for heating[4], wood and peat for other purposes[5], aesthetic values, heritage, mediation of noise impacts
Otwocki county experts	11	environmental NGOs, university, landscape park, forest services, agricultural advisory center, regional administration	8 men, 3 women	cultivated crops, drinking water[6], water for other purposes[7], wood and peat for heating[4], flood and draught prevention[7]
Tatrzański county local leaders	12	regional museum, municipalities (incl. mayor), cultural centre, local cultural associations, forest community	6 men, 6 women	water provision[6,7], experiencing nature[1], tourism and recreation[2], mediation of noise impacts, heritage
Tatrzański country experts	10	universities, national park, research institute, forest services	9 men, 1 woman	reared animals, water for other purposes[7], wood and peat for all purposes[4,5], tourism and recreation[2], heritage
Beskid Sądecki local leaders	7	cultural centre, local journal, local cultural associations, municipality	2 men, 5 women	reared animals, drinking water[6], tourism and recreation[2], heritage, aesthetic values
Beskid Sądecki experts	12	environmental NGOs, university, national park, regional directorate for environmental protection, landscape park, urban planning office	9 men, 3 women	tourism and recreation[2], heritage, wood and peat for all purposes[4,5], water for all purposes[6,7], reared animals and cultivated crops (*combined*)
Dębniki district local leaders	11	city district council, environmental NGO, local NGO, local cultural club, local journal	2 men, 9 women	experiencing nature[1], tourism and recreation[2], air purification[3], aesthetic values, health and safety[3]
Dębniki district experts	10	landscape park administration, municipality administration, environmental NGOs, universities	7 men, 3 women	experiencing nature[1], tourism and recreation[2], air purification[3], aesthetic values, bequest

1 – Experiential use of plants, animals and land-/seascapes in different environmental setting; 2 – Physical use of land-/seascapes in different environmental settings; 3 – Bio-remediation; 4-Materials from plants and animals as biomass-based energy sources; 5 – Materials from plants and animals (wood, peat, biomass) for direct use or processing; 6 – Surface water for drinking and ground water for drinking; 7 – Hydrological cycle and flood protection.

Table 3
Summary of theoretical challenges identified during the workshops, described with exemplary quotes from participants, practical and methodological limitations, as well as opportunities to overcome the challenges or benefit from application of ES concept despite them.

Main results – exemplified by respondents' quotes	Practical limitations	Opportunities and suggestions to overcome the challenges
Theoretical challenge of: ***Differentiation of ES per se from the other stages of the ES cascade***		
"These are basic issues … Local people's income depends on it … Directly and indirectly, it is connected with everything" [Tatrzański county, local leaders]	A problem of precise wording of ES ("benefits from nature"; "landscape values" etc.) in order not to turn respondents' focus away from the ES *per se*	Introducing ES concept as a compelling metaphor that is mainly used to highlight strength of connections between ecological and socio-economic systems
"We call it benefits, because it sounds good, but the truth is different. We have valuable nature, lakes, and farmlands, but they are not benefits, they are necessities." [Pojezierze Gnieździeńskie, experts]	A risk of restricting participants' ability to comprehend the general theory of the ES concept (a detailed explanation of the concept's specifics might overwhelm the participants' perceptive capabilities and end up becoming counter-effective)	
Theoretical challenge of: ***Diversity of criteria for socio-cultural ES valuation***		
"*From the local citizens' point of view, ecosystem services are located in areas from where financial benefits can be derived. But if we consider the entire society that uses the Tatry area, people prefer very different places*" [Tatrzański county, experts]	A problem of a non-comparable character of the results (the same scores indicating ES importance may result from different criteria)	Putting much attention to stakeholder analysis and recruitment in order to get best political representativeness of the interviewed sample
"*We selected mainly things that could be financially valuated, more or less accurately, while contact with nature, or aesthetics, was questionable − this meant different things to different people, and was impossible to value, because it had either no value or great value for some of us"* [Otwocki county, experts]	A problem of methodological inconsistency (stakeholders' willingness to refer to a monetary valuation, whereas the tool is not designed for that purpose)	Staying with the qualitative interpretation of the results of deliberative mapping – highlighting multiplicity of the views
	A problem of setting an objective threshold for a flow of an ES that is "valuable enough" to be mapped	Interpreting respondents' vision of monetary values only as proxies for ranking different ESs. Implementing "backward" ES valuation process as proposed by Jax et al. (2018) Implementing additional, temporal-scale criteria for valuing ES, allowing to differentiate between short-term and long-term benefits from nature Concentrating on changes in ES provision instead of providing a static image
Theoretical challenge of: ***Diversity of ES classifications***		
"I find here something like quality of life, peace of mind, clean air … I don't know what to call it, or whether it is simply aesthetic value or experiencing nature, but I think we have underestimated it" [Otwocki county, experts]	Operational inconvenience of CICES vs. overlapping character of the other classification systems	Allowing for a bottom-up formulation of the list of ESs and for classifying them in the deliberative processes
"*This [nature's] value is intrinsic and doesn't need to provide ongoing or instant benefits … It is the value we could lose if we seek only values that can be expressed in monetary terms*" [Pojezierze Gnieździeńskie, experts]	The question of including intrinsic values as an ES	Treating intrinsic values as inherent to the first stage of the ES cascade only, thus excluding these values from the list of ES. Instead, putting higher attention to communicating relational human-nature values that supplement instrumental values of some ES (Diaz et al. 2018)
Theoretical challenge of: ***Human co-production of ES***		
"(…) Education Centre, next to the Clove Marsh (…) It has its aesthetic value because of the whole area was managed by forester. There are various exhibitions about the nature of this area" [Otwocki country, local leaders]	A problem of setting objective threshold for human influence that is acceptable for the services to remain classified as ES	Using the mapping process to better communicate the role of humans in retaining ecosystems that are productive to us
"Legal situation of this place has been an important factor here. I suspect that if not the law that bans peat extraction and implements nature protection regulations (…) the Bagno Całowanie [this area] would be completely or partially destroyed long time ago" [Otwocki county, experts]	A question of including or not land tenures on the basemap	
"But it is illegal! (…) It is going on, but it actually should not be. This is wrong" [Otwocki country, experts]	A question of how to interpret "actual use" vs "potential supply " of ES ("actual" *de jure* or "actual" *de facto*)	
Theoretical challenge of: ***Complexity of service providing units and service benefitting areas***		
"Let's taka ski slopes in Białka. What ecosystem made them possible to be there, what are the boarders?" [moderator] *"There are no boarders of ecosystem. The whole hill with a slope made them possible"* [Tatrzański county, experts]	A problem of applying best proxies for SPUs to be included on the basemap (land cover units only or other map features that are not discrete – e.g. contours)	Discussing differences among ES as far as spatial levels of their SPUs and SBAs are concerned. Focusing on necessity to consider geographical connections between localities that provide or benefit from ES Accepting blurred character of SPU borders (ES provision as a continuum? – Burkhard et al., 2014)
"We walk the trail, but watch the surrounding landscape. Without the rest, sorry, but nobody would walk there [the trail]" [Tatrzański county, local leaders]		
Consequences of comprising stakeholders' different perspectives on ES		
"People come here for one day (…) and then go home. This doesn't translate into benefits for local people. There is no agritourism (…). We actually lose, because of the trash left by tourists, and they leave a lot of trash" [Otwocki county, local leaders]	Difficulties in getting agreement on importance of various ES in case of ES trade-offs, especially if they result from conflicting interests of stakeholders	Participatory mapping and discussing ES with stakeholders at the local level encourages dialogue which can potentially reduce conflicts

(*continued on next page*)

Table 3 (*continued*)

Main results – exemplified by respondents' quotes	Practical limitations	Opportunities and suggestions to overcome the challenges
"The land provides these ecosystem services and they are important [to local people], but people may be not aware of it" [Otwocki county, experts].	A question of mapping ES in case of stakeholders who gain benefits are not aware of importance and the source of these ES.	Focusing on identifying and discussing multiple values in a context of conservation and resource management, as a supporting tool for decision-making, aiding in prioritizing conservation and development goals and objectives
	Practical inability to assure representativeness of ES workshops and/or participatory mapping	High potential for social learning, education and awareness-raising about variety of perspectives that other stakeholders may have on benefits from nature

in the participants' discussions (Table 3). Participants argued about different processes of ES valuation and the definition of "benefits from nature" understood as ESs, often referring to the economic value of nature or the role of intrinsic vs. instrumental values. Also, they discussed the origin of ESs, including the issue of human co-production of the services, as well as the differences between service providing units and service benefiting areas. Finally, they paid attention to consequences of discussing these issues from multiple stakeholders perspectives, such as trade-offs and conflicts in relation to competing services, and the level of awareness of the benefits from nature among the local inhabitants.

3.1.1. Diversity of criteria for socio-cultural ES valuation, including differentiation of ES per se from other stages of ES cascade

Respondents discussed various meanings and interpretations of the "benefits from nature" in relation to specific ES categories: *"Everyone can consider [ES] from a different point of view, with an outsider or insider perspective" [Pojezierze Gnieździeńskie, experts]*. Although participants were explicitly asked to map ESs based on their own perceptions, this observation had consequences in relation to their decisions on what should be mapped and where: *"Personally, I followed economic criteria, because in my opinion an average citizen here thinks this way"* [Beskid Sądecki, experts]. An awareness of differences in interpreting ES categories was the reason why many participants tried to consider the opinions of other stakeholders, who were absent from the workshop, by either guessing or assuming the values they would have allocated to various ESs. In addition, some participants admitted that their own perceptions of ESs changed over the course of the workshop, and they became aware of new benefits offered by nature that they had not previously considered: *"I value nature more after this workshop"* [Otwocki county, local leaders].

Participants were also explicitly asked to map "the most important" benefits of nature for the local community's well-being. However, in some cases, they did not have a clear idea of the necessary level of importance in terms of delivery of benefits for an area to be mapped. They were unsure whether a particular place or element of nature was "valuable enough" in the context of "benefits from nature," and thus why some areas were mapped and others were not. For example, the group discussed an area with the potential to deliver a specific benefit (e.g. food production in the Dębniki area in Krakow), but decided that the benefit would not meet the demands of the local community, and thus did not mark the area on the map (e.g. in the context of the demand for local food or food security for the citizens of Krakow). Problems appeared when participants considered stakeholders' various expectations of nature: *"A person may have a need for contact with nature only in Planty* [urban park in Krakow Old Town]*, while if someone would like to see a corn crake, or other valuable plant and animal species, he/she needs to visit these* [marked on a map] *areas and experience it"* [Dębniki, experts, on experiencing nature ESs]. This issue was particularly visible when mapping aesthetic values or other ESs that cannot deliver direct economic profits, resulting in marginalization of cultural services in some cases, e.g. *Otwocki* county area. Some participants felt that the entire approach of assessing the inherently subjective importance of nature to humans should be replaced by a more objective measure of species or habitat rarity: *"The danger here is not protecting a species because it is rare or threatened, but because it has a value for humans"* [Dębniki, experts]. However, whenever possible, participants referred to the financial benefits that could be derived from a particular area as a commonly accepted measure of ES importance.

In general, we observed a bias toward economic benefits and monetary valuations during all workshops (coded under the most commonly applied code in the analysis: "economic vs non-economic benefits"). When the facilitators initiated a discussion on the "benefits from nature" that were most important for the well-being of local societies, the participants (especially local leaders) tended to focus on ESs that were crucial to securing the income of the local community: *"We call it benefits, because it sounds good, but the truth is different. We have valuable nature, lakes, and farmlands, but they are not benefits, they are necessities. Agritourism and tourism are opportunities, but at the same time there are multiple things people cannot do here because of a lack of roads and a ban on some types of production. We focus on nature because there are not many other things we can do here"* [Pojezierze Gnieździeńskie, experts]. Economic importance to the local community was one of most common criteria used for mapping by the participant.

3.1.2. Challenges in classifying ES (intrinsic vs. Instrumental values)

The preliminary focus on economic benefits resulted in references to the intrinsic value of nature (coded under the same code: "economic vs non-economic benefits"). Participants stated that benefits from nature should not only be regarded as a chance to make a profit and strictly financial, short-term oriented perspective may threaten nature and other benefits it provides. Reference to the intrinsic value of nature was a respondents' strategy to include values that might otherwise be underestimated in the mapping process, or values that were not easily identified and expressed by participants: *"Intrinsic value is what we often don't see, and it exists regardless of whether we use it or see it. For me, nature is an intrinsic value"* [Beskid Sądecki, experts]. The intrinsic value of nature was also used to justify the appreciation of nature without direct practical uses or benefits for people, or drawing attention to aspects difficult to name or define. While reflecting on the intrinsic value of nature, some participants criticized the idea of monetary valuation of ESs: *"Monetary valuation is fashionable nowadays (…) But put simply, I prefer to sensitize people so that they comprehend some things by themselves"* [Tatrzański county, local leaders].

3.1.3. Operationalisation of human co-production of ES

Participants were unsure about the origins of various benefits, and whether a particular ES was a product of nature or man-made (e.g. cycle paths on river embankments). They considered the extent to which human interference was not yet disturbing the "naturalness" of benefits and allowing them to be attributed to ecosystems. Their doubts also included the mapping of heritage places as they discussed whether cultural services had their origins in ecosystems or were inherently social constructs (e.g. a museum building with an additional exhibition space in the surrounding nature or a building located in an exceptional nature area). Similarly, the legal system and nature conservation

regulations create institutional conditions in terms of whether and how a certain benefit from nature can be experienced by people, e.g. recreation, sport, or resource extraction in strictly protected areas. Participants also discussed whether property rights (e.g. private or public land) influenced the activities that were undertaken, from cultivation of land to conducting scientific research. Consequently, the participants discussed whether the illegal use of resources should also be mapped as ESs in cases where people benefited from nature even though it was illegal to do so.

3.1.4. Operationalization of service providing units and service benefitting areas

Participants raised several issues in relation to deciding precisely where a particular benefit from nature should be located on the map. For some participants, this was a consequence of difficulties in understanding the process by which a particular benefit was delivered, that is, the link between ecosystem conditions or functions and the benefits provided to people. For example, there was confusion regarding whether a particular benefit of recreational skiing was only delivered by a specific part of the environment, such as deforested slopes, or whether the entire ecosystem of the hills should be seen as providing this benefit. Problems in understanding processes that contribute to ESs could also lead to confusion in deciding whether a particular benefit, such as clean air, was provided by nature (as a result of the clearing function of the ecosystem) or as a result of a lack of human pressure on the environment (e.g. a lack of pollution): *"Clean air can result from a lack of pollution. Thus, the inhabitants of the Białystok area can enjoy clean air either because of their proximity to large forests or because of a lack of polluting industry. In Warsaw, with its dense settlements and coal heating, the air is not clean, and without the forests, it is possible that it would be even more polluted"* [Otwocki county, experts]. Participants discussed whether they should map places where ecosystems delivered certain ESs or places where people could "use" such services: *"Water consumption is not the same as water provision – there are different places and systems that provide and consume water. Similar [spatial] differences could be seen in the case of floods – which areas are protected from flood and drought, and which increase the risk of flood"* [Otwocki county, experts]. This problem was also related to cultural ESs, such as experiencing nature, tourism, and recreation (e.g. should the ES refer to the entire landscape, or just the viewing points or hiking trails).

3.1.5. Consequences of comprising stakeholders' different perspectives on ES

Another topic raised during the workshops involved possible trade-offs between ESs, whereby intensive pursuit of certain benefits could result in the deterioration of other ESs, and therefore potential competition between stakeholders who benefited from these competing services. The most obvious conflict in terms of benefiting from nature described by participants was between local residents and tourists, in case when tourism industry is not providing a real income to the local people, while tourists use or pollute (litter) space shared with locals. Participants offered a lot of examples, such as *"intensive recreation may lead to ecosystem damage," "production of artificial snow increases winter tourism, but may decrease the groundwater level,"* and *"windmills produce clean energy but may have a negative impact on landscape values."* The conflicts can origin from such things as user types (e.g. locals or tourists, developers or inhabitants), frequency or intensity of use. This issue also appeared in the respondents' selection of five most important ES to by mapped during the workshop – the final lists differed not only between the areas, which could have resulted from differences in land cover or other characteristics of the area (Table 1), but also between local leaders and experts mapping the same area (Table 2). Only in two out of five areas experts and local leaders selected the same four (out of five) benefits from nature, while in other groups they selected only three (1 group) or two (2 groups) same benefits.

Finally, participants stated that a lot of ESs are unknown to the people who are the recipients of these services, and sometimes even depend on them. *"People move away from land that is rich in nature, peace, and quiet. This doesn't mean that this area doesn't provide such ecosystem services; it means that people also need other things, such as money and proximity to schools. Still, the land provides these ecosystem services and they are important, but people may be not aware of it"* [Otwocki county, experts]. In this context, participants doubted whether a particular ES should be mapped if it was not recognized by the people who benefited from it.

3.2. Practical challenges to be considered when applying the ES concept in participatory workshops at the local level

Participatory mapping workshops are based on qualitative research techniques. The composition of participants in our workshops followed well-established methodological guidelines for qualitative research, ensuring representation of a broad scope of perspectives, experiences and interests in the area. However, the limited number of participants was still problematic for some participants, particularly if the results would had practical implications at the local level. These participants raised the issue of representativeness, noting that only a limited number of opinions were presented during discussions, often by people with limited knowledge of the area. These participants felt that a different group of workshop participants could deliver different results, which reduced the credibility of the technique in terms of actual decision-making processes.

The relatively short duration of the workshops made it necessary to limit to the number of services that could be mapped. In the workshop design, participants were asked to select the five benefits from nature that they considered most important for the local community in a given area. The ES selection process was not particularly easy for the participants, and not all of them were fully satisfied with the final selections. However, even the mapping of only five services in around two hours proved to be an exhausting exercise for the participants. During final debriefing, many participants claimed that the final ES map of their area was incomplete because of the limited number of ESs: *"The idea was to represent our notion [of nature] spatially, but the question is whether a few hours is sufficient to avoid simply saying something that seems to be right, or we think is right, but about which we don't know all the details. Our discussion was simply a brainstorming session"* [Otwocki county, experts].

Our study areas (see Fig. 1. and Table 1) differed in terms of size and biophysical characteristics so that we could test the feasibility of ES mapping at various scales. The experts realized that mapping accuracy depended on the characteristics of a particular area, and the participants were able to map more specific and detailed information in smaller areas such as (5) Dębniki, district VIII of the Krakow municipality (46 km^2) and (2) *Otwocki* county and the surroundings of the Całowanie Marshland (336 km^2), while such details were missing in the case of larger areas such as (1) Pojezierze Gnieźnieńskie (Gnieźnieńskie Lake area) (1720 km^2), (3) *Tatrzański* county (470 km^2), and (4) the Beskid Sądecki mountain area (1430 km^2). The mapping process itself appeared to prove challenging to some participants, especially in terms of their ability to read a map.

3.3. Opportunities to implement the ES concept during the participatory mapping process at the local level

Participants in all groups found it inspiring to discuss the concept of ES and represent it spatially. The use of maps allowed them to better understand a particular ES by literally "placing it on the ground." The experts noted that while a participatory mapping workshop is unable to deliver any new ecological knowledge, it can deliver new ideas in relation to planning processes: *"You have provided an outsider perspective, scientific assessment from a distance. I see an opportunity in such a perspective"* [Beskid Sądecki, experts]. Participants confirmed that applying the ES perspective enabled positive and constructive discussion,

with many of them having previously participated in various meetings and consultations that led to intensification of conflicts: *"We are always considering cases of conflict, and this gives us an excuse to treat nature as a scapegoat. [In such cases,] nature is the reason for conflict and we all hate it [because of the restrictions that are imposed to protect it]. Therefore, the most important characteristic of this workshop is that it focuses on nature as something positive"* [Dębniki, local leaders].

In the case of local leaders, identifying ESs on a map made them proud of their locality: *"We should be proud of and happy about living here, because if we compare this area to other regions, we have such a wealth of everything here"* [Tatrzański county, local leaders]. Many participants stated that the mapping workshop made them much more confident about the area. They saw the potential of using their land to support a sustainable local economy and engaging the wider society in its protection. They felt that participatory mapping was a method that could be used to improve the engagement of local actors in decision-making. Moreover, mapping was perceived as a way of acknowledging the "human aspect" of nature. Importantly, this was recognized by the groups of interest, that is, locals using the ESs on a daily basis, not just the external experts: "*The majority of experts impose advice on what is important for a given region in a top-down manner. Here, we consider a common-man perspective, what is important for us to feel good, to live here and not need or want to emigrate"* [Beskid Sądecki, local leaders]. This bottom-up character of ES mapping was considered necessary for discussing ES with the local community, indicating that it was usually either absent or ignored in the decision-making process. Participants liked the scientific nature of the workshops and our active role in facilitating them in a gentle manner without any judgment. They felt that their interests had been acknowledged and they had not been manipulated by any party.

The participants stated that participatory mapping workshops have a potential role to play in achieving better identification of areas that are important to the local community. This approach allowed them to embrace not only the most popular localities but also the smaller and less well-known ones that were not accessible by tourist paths or included in any form of nature protection activity, but were nonetheless important to the local community: *"We are not experts, but we intuitively know the value of this land. We are proud of it, and I think that confirmation of it on a map is a good thing"* [Beskid Sądecki, local leaders]. Participants derived particular pleasure in identifying and mapping such places.

Despite the limitations of the monetary approach to ESs, mapping ESs was also perceived as a potential basis for such an approach. Monetary valuation was regarded by participants as an opportunity to better explain the importance of nature in the local context: *"This knowledge and measurable benefits … show how valuable this land and its resources are. Nice views, birds, animals, plants – it is a higher level of abstraction, while an actual monetary valuation can be really useful for planning"* [Otwocki county, experts]; and *"Some services are more important than others, while maintaining them costs money. Land users should therefore participate in meeting those costs; they should feel responsible for the land they use, and be aware that there are places that don't allow certain activities because they are more important for other purposes. This is an argument for us to use in discussions with various groups that would like to do something [different] in the same place – whether they can do it and if so, for how much"* [Tatrzański county, experts]. Monetary valuation was perceived as an "objective" argument to be used in the context of conflict management and decision-making, especially in discussions with private land owners or public administrators and governments, who make decisions based on available funding: *"It makes people aware of where we live, what provides our livelihood, what we pay for it, and where we earn money"* [Otwocki county, experts].

4. Discussion

The challenges in relation to the practical application of the ES concept and its operationalization in various ecosystems at the administrative and spatial levels are currently a popular topic in both academic and policy-making circles (van Dijk et al., 2018). Our study contributes to this discussion from the perspective of practical use of the ES concept (Blicharska and Hilding-Rydevik, 2018; Cowling et al., 2008; Inostroza et al.,2017; Jax et al., 2018), providing an insight into how theoretical debates regarding the ES concept can help overcome challenges to practical implementation at the local level. We argue that a local-level perspective in relation to theoretical challenges is crucial, as the ES concept is particularly relevant to case studies, local conservation projects, and the effective application of participatory approaches to nature conservation. The mainstreaming of ESs through the internalization and institutionalization of the ES concept in relation to conservation policy requires operationalization strategies that are consistent with stakeholders' needs and capacities (Cowling et al., 2008). The results of our study confirm that theoretical debates on the ES concept regarding inconsistencies in ES cascade models (Boerema et al., 2017), definitions and classifications of ESs (Felipe-Lucia et al., 2015; Haines-Young, 2016) valuation and double-counting (Fu et al., 2011; Redford and Adams, 2009), human co-production of the services (Palomo et al., 2016), and ES flows from SPUs to SBAs (Burkhard et al., 2014) were all evident while interpreting the results of a participatory mapping process at the local level. When given freedom to interpret the task of mapping the benefits from nature, participants discussed both theoretical and practical issues, including the details of what should be mapped, how and where, in particular focusing on: operationalization and prioritization of problems, trade-offs and competition in relation to benefits from nature, the traps inherent in financial valuation, differences in service provision and benefit areas, as well as the representativeness and objectiveness of the mapping process.

Similar to our study, other scholars have found the existing definitions of ES problematic in terms of practical application (Diaz et al., 2018; La Notte et al., 2017; Saarikoski et al., 2018). Existing conceptualizations of ESs have been criticized for limiting improvement in decision-making as a result of, among other conceptual shortcomings, the use of complex descriptive terminology and inaccurate estimations of the resources that are most relevant to local stakeholders (Saarikoski et al., 2018). Other authors have also suggested that the ES cascade approach may be too complex for application to empirical studies (Jax et al., 2018; Potschin-Young et al., 2018). Our experience shows that a highly specific operationalization of the ES concept in a mapping workshop generates at least two practical problems: 1) it restricts participants' ability to comprehend the general theory of the ES concept (a detailed explanation of the concept's specifics might overwhelm the participants' perceptive capabilities and end up becoming counter-effective), and 2) it limits the scope of possible interpretations of the concept among participants, which in turn limits the interpretative potential of the results. Anticipating such issues, we proposed a responsive approach to the participants' information needs in relation to the ES concept specifics. Every time the facilitators noticed disagreements regarding the subject of mapping among the workshop groups, an operationalization process was performed, which in turn provided us with detailed information regarding differences in the participants' understanding of ESs.

Some disagreements during the ES mapping process were recognized by participants as resulting from multiple perspectives on people–nature relationships, and failure in recognizing this was also noted by other scholars as a shortcoming of the ES concept (Diaz et al., 2018). Demand for (and subsequent appreciation of) ESs is determined by social and cultural factors (Castro et al., 2014; Martin-Lopez et al., 2014), resulting in multiple types of demand and perspectives on the importance of ES (Wolff et al., 2015). As Jax et al. (2018) suggested in his model of ES valuation for the purposes of well-being, the process of ES valuation proceeds backwards to the ES cascade, starting with the recognition of benefits and their values, and only then connecting benefits with ecosystem functions and processes. Therefore, multiple

perspectives can result in entirely different understandings of ESs and the processes occurring in the ecosystem that create a given service. Multiple points of view and value systems increase uncertainty in relation to ES identification and valuation (Barton et al., 2018). This seems to be especially challenging in the case of non-material ESs that have different degrees of importance at the individual and community levels (Small et al., 2017). People may have very different conceptions of nature. The view represented by the ES concept (Cooper et al., 2016) and the stakeholders' perceptions of the benefits of nature are products of various discourses (Sanna and Eja, 2017).

The participants' problems with understanding the entire concept of ES resulted in them seeking simple criteria by which to judge the benefits from nature, and thus to think of the economic value or overall financial benefits provided by nature. This is similar to other observations of stakeholders prioritizing or focusing on provisioning services, as it links to the basic short-term needs of humans (Rodriguez et al., 2006). In our study, the provision of direct or indirect income was one of the most compelling reasons to focus on a particular ES. Also, our respondents referred to economic valuation of ESs as an opportunity for convincing and engaging stakeholders in conservation. Economic valuation of ESs is widely discussed and criticized, but remains an important field within ES research (Daily et al., 2000a,b; Redford and Adams, 2009; Schroter et al., 2014). At the same time, economic valuation methodology cannot be applied within participatory mapping of ESs (Castro et al., 2014; Dunford et al., 2018; Martin-Lopez et al., 2014; Pascual et al., 2017). Therefore our respondents' suggestions to incorporate it to discussions on ES at the local level can be realized only partially, e.g. as a support for general discussion with input from existing results of economic valuations.

During the concluding stage of the workshop, the participants noted that the intrinsic values of nature are possibly even more important than financial benefits. However, stakeholders tended to share such an observation only after initially focusing on the provision of services or on other direct financial benefits that might affect the supply of other services (Rodriguez et al., 2006). This supports the findings of previous studies regarding the gaps and difficulties in including psychological and cultural perspectives in ES valuation approaches (Kumar and Kumar, 2008), as well as the need for further studies on services that are difficult to analyze using existing valuation approaches and that result in marginalized management and decision-making (James, 2015; Small et al., 2017). It is also acknowledged that different value systems require different valuation methods (Jacobs et al., 2018; Pascual et al., 2017), therefore a focus on any one valuation method clearly underestimates other types of values (especially cultural), as happened in the first part of our workshops.

Participants in our study discussed whether or to what extent man-made elements of ecosystems or landscapes could be regarded as producing certain cultural ESs. Another interesting aspect of cultural ESs concerns the influence of humans as opposed to "natural" factors in their provision (Cooper et al., 2016; Fish et al., 2016). This is a part of a wider debate on the role of different forms of capital (natural, social, human, financial, and technological) in the co-production of ESs (Diaz et al., 2018; Palomo et al., 2016), and may appear confusing to stakeholders in the context of practical implementation.

During our mapping workshops, participants were explicitly asked to map areas that provided benefits from nature. This approach was consistent with that of previous studies suggesting that either SPUs and SBAs should be mapped separately or that the focus should only be on one of those categories (Garcia-Nieto et al., 2015; Wei et al., 2017). Nevertheless, participants found it confusing, and spent time debating the differences between SPUs and SBAs, a problem that has also been reported by other studies (Garcia-Nieto et al., 2015). Confusion is particularly evident in case of cultural ESs (Pena et al., 2015; Wozniak et al., 2018), which has led some scholars to propose a new ES cascade to better reflect the complexity of interaction between humans, culture, and the environment (Fish et al., 2016). Confusion in relation to the interpretation of supply and demand aspects of cultural ESs is exacerbated by accessibility issues (Wei et al., 2017) and various perceptions of the co-production process (Fish et al., 2016).

The results of our study support the findings of previous studies on the use of the ES concept in relation to environmental assessment practices (e.g. Almenar et al., 2018; Geneletti et al., 2015), whereby perceptions of and demand for ESs differ not only spatially but also among different stakeholder groups. One area can provide benefits from the ES for a particular group of stakeholders, while diminishing or even failing to provide benefits for other groups. These observations reflect the ongoing debate regarding trade-offs and competition among stakeholders (Rodriguez et al., 2006) that examine a variety of trade-offs and underlying value systems (Martin-Lopez et al., 2014). Trade-offs are more likely to affect stakeholders in circumstances involving inequalities among actors, failures of management, and a focus on providing ESs that disregard other services (Howe et al., 2014; Felipe-Lucia et al., 2015; Garcia-Nieto et al., 2015; Turkelboom et al., 2018).

Another topic that was raised during the workshops was the possibility of trade-offs between ESs whereby the intensive pursuit of specific benefits could result in the deterioration of other services, and therefore potential conflict between stakeholders who stood to benefit from these competing services. Differences in perceptions of ESs in space among stakeholders are linked to two powerful factors: access to resources and value systems, both of which have been studied through various theoretical lenses (Small et al., 2017). Both aspects are important in mapping ESs, but as shown in our case studies, they can blur priorities or make it difficult to evaluate relative importance, making mapping efforts more difficult and the results more vague. For example, even if stakeholders value certain ESs similarly, they can do so for very different reasons (Elwell et al., 2018).

When attempting to transform these conceptual issues into specific features on a map, the participants debated whether a particular benefit was "important enough" to be included. In this regard, Burkhard et al. (2014) suggested that the provision of ESs should be viewed as a continuum. Other researchers have noted that there should be no strict boundaries to ESs, especially as they depend on constant interactions with stakeholders who are not geographically bounded (Evans, 2019). Further, the practice of ES mapping usually takes advantage of maps that already contain a certain layer that reduces the complex structure of ecosystems into a discrete collection of land-cover types. Barton et al. (2018) note that such a reduction adds to the overall uncertainty of the ES assessment process, and can also bias the focus of participants.

Another empirical ambiguity related to the interpretation of ES cascades is distinguishing between ecosystem functions and regulating ESs, which was reflected in participants' debates regarding the *actual use of ESs* compared with the *potential supply of ESs* (Burkhard et al., 2012). Further, ES assessment usually involves either a specific moment in time or the average situation over a period of time, but ESs are dynamic, seasonal, and change over time in non-linear ways (Evans, 2019). Some studies have suggested that, particularly in the case of non-material ESs, it is better to concentrate on their change, rather than on supply at a particular point in time (Burkhard et al., 2012; Small et al., 2017).

Consequently, the outcomes of participatory mapping cannot be viewed as any kind of "objective" list of ESs, but rather as a socially constructed vision of nature's role as viewed by various groups in society or in various local contexts (Boerema et al., 2017; Small et al., 2017). Participatory mapping workshops do not assess the correlation between perceptions and actual uses of ESs (Paudyal et al., 2015). As indicated by our participants, the choices that are made during participatory mapping of ESs are subjective, and depend on stakeholders' needs and their capacities (e.g. access rights or knowledge) to use certain benefits. However, this does not undermine the value of such research. On the contrary, it provides an important tool for identifying and incorporating multiple values in relation to conservation and environmental management, which is currently in high demand in ES

science and conservation practices (Bekessy et al., 2018; Cowling et al., 2008; Kumar and Kumar, 2008; Reed, 2008). Planning the composition of the workshop in terms of stakeholder representation is an important part of ensuring that there is a balanced representation of the values (Brown and Fagerholm, 2015; Paudyal et al., 2015) of users of various ESs (Darvill and Lindo, 2015), input from stakeholders with different levels of power (Garcia-Nieto et al., 2015), and expertise, as was the case in our study. It is also crucial that ES participatory mapping empowers various interest groups and creates a platform for open, transparent, collective decision-making processes (Ernoul et al., 2018), which was highly appreciated by our participants.

There are also issues in relation to the representativeness of participatory mapping processes (Jax et al., 2018), as a single mapping workshop cannot accommodate more than about 20 participants effectively. In addition, the number of ESs that is to be mapped should be limited, and the procedure used to select them should be clearly explained to stakeholders (Harrison et al., 2018). Particularly in the case of a larger area, non-experts are likely to focus on areas in their immediate neighborhood, while a collection of participants from various locations would lack a set of common issues for discussion. The results of a group mapping process are always dependent on the composition of the group, the experience and cognitive capacities of the participants, and various other personal characteristics. Thus, the accuracy of the results of participatory mapping workshops is clearly limited, as is the level of comparability between various case studies (Brown and Fagerholm, 2015; Ramirez-Gomez et al., 2015). However, not all outcomes from using this technique require a high level of accuracy (Barton et al., 2018). Thus, we argue that participatory mapping is best suited as a tool for social learning and enhancing participation (Brown and Fagerholm, 2015). Moreover, it increases the empowerment (Ramirez-Gomez et al., 2015) and awareness of locals (Paudyal et al., 2015), while providing a framework for constructive debate regarding nature and spatial development (Nahuelhual et al., 2015). Ultimately, it supports communication in relation to decision-making processes (Dick et al., 2018).

Several aspects need to be considered to organize an effective participatory mapping process. Mapping rules should be clarified and communicated prior to the mapping process. While allowing stakeholders to map the entire area would reduce the importance of hot spots, it also embraces the value of a region as a whole. Debating these issues took a considerable amount of time in our workshops. However, if such debates are not part of the process, decisions about the mapping procedure should be made and clearly communicated by the researchers. The aims of participatory mapping of ESs should be clearly specified, and it is suggested that the focus should be on collecting information on values, interests, and preferences (which should be clearly defined to participants), rather than on a broad assessment of ESs in the area. This approach can be used to prioritize conservation and development goals and objectives, and to engage stakeholders in constructive discussions regarding planning processes.

5. Conclusions

In our study we explored the ecosystem services concept from the local stakeholders' perspective. The research tool we used, i.e. facilitated focus group interviews with the participatory mapping process, gave us both the opportunity to test applicability of the ES concept at the local level and to extensively deliberate the challenges in its application with stakeholders. We noted that theoretical challenges to the ESs concept that are extensively debated in the scientific literature can be perfectly recognized by the local-level stakeholders in a bottom-up process. These are: a problem with defining the concept itself, diversity of criteria for socio-cultural valuation of ES, diversity of ES classifications (including the way intrinsic values are interpreted), human co-production of ES and complexity of concepts of SPUs and SBAs. What differs from the scientific literature is that stakeholders prefer to stress intertwining character of the challenges rather than introduce them in a systematized way. This hinders quantitative measurement of a bottom-up perception of the ES concept. At the same time, it makes a qualitative insight more needed in order to recognize connections between theoretical challenges and practical limitations when applying the concept *on the ground*. Such analysis was proposed in our study.

At the same time, we conclude that despite generating the limitations, the challenges can inspire guidelines for adjusting the ES deliberative mapping processes to make it more efficient from the practical perspective. Based on our results, the process should be guided by a goal of engaging stakeholders in a dialogue, highlighting multiplicity of views and broadening the scope of discussion beyond direct economic benefits. It may also work as a tool that facilitates stakeholders' understanding of the concept. However, it must be acknowledged that presenting the ES concept to the participants may not be sufficient to help them really comprehend it. What actually works, is experience from participation in the whole process of discussing and mapping ES. The concept itself should be introduced in a form of a whole cascade to enable "backward" valuation process, as proposed by Jax et al. (2018), as well as to make it possible to introduce of a concept of "intrinsic values" of nature. Finally, as the process can be more important than the spatial outcome, a focus should be placed on stakeholder analysis that precedes participant recruitment. The process should not only guarantee political representativeness of the participants but also their spatial representativeness. This is especially important as some of the SPUs covers areas that are larger than certain localities and otherwise they are unable to be fully recognized.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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