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A new ecosystem services approach to enable identification of pro-biodiversity businesses of protected karst areas in Central and South-Eastern Europe

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Abstract

Protected areas are a leading conservation tool for preserving biodiversity. However, the restrictions on human uses often engender resistance of local communities to the idea of living in protected environment. This paper describes the preparation of Biodiversity Investment Opportunities (BIO) maps for seven case areas in Central and South-Eastern Europe, using participatory methods. BIO maps have been further developed with the involvement of local stakeholders to define areas that can support economic activities while achieving a no net loss or even benefits for nature. The BIO maps can then be used to foster the development of Pro-Biodiversity Businesses (PBBs). PBBs are enterprises that generate financial returns without compromising the natural environments they depend on. PBBs were found to be a viable solution, effective in changing the perceptions of both the park managers and the local people towards the protected areas. Moreover, these enterprises can improve the local livelihoods, as well as actively protect nature and biodiversity. Therefore, the approach presented in this paper can be adopted as a model for managing any protected area and conserving cultural landscapes.

Keywords: biodiversity, conservation, pro-biodiversity business, ecosystem services, protected areas, cultural landscapes, local populations

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Introduction

Global biodiversity loss remains one of the leading environmental challenges, not only for the environment but also for human societies worldwide (World Economic Forum 2022). The conservation of nature often requires the protection of vast areas of land. These protected areas (PAs) have been made part of numerous international and EU policies, such as the Convention on Biological Diversity (CBD), as well as EU Birds and Habitats Directives (Natura 2000 Directives), among others. It is undisputed that nature provides a wide array of ecosystem services indispensable to humanity's survival. Yet, nature conservation is often seen as a hindrance to economic development (Houdet, J. *et al.*

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2012). Particularly, PAs are often perceived as severely limiting human economic growth and wellbeing, thus creating a potent sectoral conflict (Mariki, S.B. *et al.* 2015). Additionally, the history of PAs is often associated with mistreatment of local inhabitants (Han, F. 2008; Duffy, R. 2014), lacking stakeholder involvement, and consequently mistrust of local inhabitants towards nature conservation, thus introducing further challenges for PA managers.

Different approaches exist to conserve biodiversity: setting aside PAs (i.e. land sparing) or integrating nature conservation and economic development (i.e. land sharing, Fischer, J. *et al.* 2013). While land sparing (large PAs, entirely devoid of human activities) is often seen as being more effective in terms of biodiversity benefits (Phalan, B. *et al.* 2011; Nagel, T.A. *et al.* 2017), such an approach also leads to substantial social and economic drawbacks and has been linked to humanitarian disasters (Duffy, R. 2014). Additionally, some of the most recent literature points towards utilising a matrix of land sparing and sharing approaches to produce the greatest benefits (Grass, I. *et al.* 2019; Batáry, P. *et al.* 2020). Moreover, in European contexts, land sparing is even more challenging to implement due to thousands of years of human alterations of the natural environments and high population density (Fischer, J. *et al.* 2013). The European Environment Agency (EEA) reports that Europe is one of the places where such cultural landscapes are widely protected, both through the EU Natura 2000 network and national designations (EEA 2019, 2020). It is therefore imperative to find solutions that reconcile local economic development, needs of local inhabitants, and nature conservation.

Recently, farmland and especially traditional land-use practices are increasingly disappearing in Europe. A gradient within Europe can be observed; towards the East and South-East of the continent, remnants of the traditional land management persist, while in the Western parts they have almost completely disappeared (Filho, W.L. *et al.* 2016; Van der Zanden, E.H. *et al.* 2017). This gradient has considerable environmental, socio-economic, and landscape implications (Lasanta, T. *et al.* 2017). Significant biodiversity loss and reduced populations of adapted species have also been observed in abandoned agricultural areas, as well as in areas experiencing agricultural intensification (Guerrero, I. *et al.* 2012). It is therefore urgent to find ways to protect biodiversity and revive traditional agricultural landscapes (Munroe, D.K. *et al.* 2013).

European environmental policies and regulations often clash with both local communities and other sectoral policies, due to the complex and sometimes contradictory nature of the legislation used to manage and protect the environment (EEA 2019). Despite the concerted efforts of European states, the biodiversity targets on land and sea were not met by 2020 (European Commission 2020). Additionally, the new EU Biodiversity Strategy 2030 sets the EU Member States on the road to still increase the PAs until they cover 30 percent of the EU (European Commission 2020). This will likely introduce further tensions in the social and economic realms.

Some areas in Europe, particularly in South-Eastern Europe, which are recovering from recent civil unrest and war, are classified by the World Bank as developing countries (The World Bank 2020). Economic development is particularly important in those countries since most of the population cannot afford comfortable living (Golusin, M. *et al.* 2011). This is also one of the reasons the care for the surrounding environment cannot yet be prioritised, therefore the natural environment is often overexploited. Incidentally, it is also in this part of Europe where karst phenomena are widespread, which due to their surface and underground phenomena produce unique, rich, and often very fragile biodiversity, which needs to be protected (Golusin, M. *et al.* 2011; Tanács, E. 2016). Therefore, the development of local economies that take advantage of the natural features and preserve them and improve their status at the same time is even more important in these regions (Leone, F. and Zoppi, C.

2019). These challenges introduce a number of problems for PA managers (Defries, R. and Nagendra, H. 2017). If PAs are seen as social-ecological systems, integrating both ecosystem resilience and the social systems which have evolved in the same areas (Cumming, G. and Allen, R. 2017) and they are to be managed effectively, it is vital to overcome the conflicts between nature conservation and development. The increasing complexity of the PA management situations has often led to widening the gap between the managers, experts, public authorities, and the local populations (Andrade, G.S.M. and Rhodes, J.R. 2012).

The ecosystem services (ES) concept has been developed as an approach to reconcile human aspects with nature conservation (MEA 2005). The ES concept aims to represent the multi-faceted interdependence of ecological and socio-economic systems in a simplified way (Haines-Young, R. and Potschin, M. 2010). As such ES have often been used to quantify the benefits that ecosystems provide in monetary terms in order to generate a wider and economic rationale for their protection (Houdet, T. *et al.* 2012). However, the financial evaluations of nature have not been perfected yet and the ways of how to integrate economic valuation into nature conservation remain problematic and often serve as a basis for distrust towards the whole ES approach (Ellis, E.C. *et al.* 2019, Vári, Á. *et al.* 2022). Additionally, the ES approach is usually used by managers, public authorities in decision-making and for communication of conservation or sustainable development rationales; however, it has been rarely employed in order to foster better cooperation between the PAs and their local stakeholders.

In this paper, we present a new way to reconcile seemingly contradictory targets of development by using the ES mapping concept as a basis for the creation of pro-biodiversity businesses (PBBs) in PAs. The approach was developed within ECO KARST Interreg project (2017–2019) that aimed to contribute to the protection and sustainable development of karst bio-regions in the Danube region based on their valued ecosystem services. A PBB is an enterprise that generates financial returns and at the same time makes a positive contribution to preserving biodiversity, such as for example eco-tourism (Houdet, T. *et al.* 2012). While the concept of a PBB is not new (Keesstra, S. *et al.* 2018), PBBs have mainly been utilised within the context of solely green entrepreneurship. This paper presents a way to develop PBBs based on ES that PAs provide in a particular area. This is a novel approach, which sidesteps the often critiqued monetary evaluations of ES, and uses the entire ES approach to build connections with PAs' local communities and directly identifies possibilities for biodiversity-friendly business and development opportunities. Thus, PBBs contribute to both the preservation of biodiversity and improvement of living standards of local people and are fully in line with regulations of the PAs (Lindsey, P.A. *et al.* 2005). Moreover, since the proposed approach closely follows the principles of adaptive and participatory management, local stakeholders, PA managers, and experts are all equally involved in the process of identifying both the ES and PBBs. Although even PBBs can have unknown effects on the environment or can become damaging if not appropriately controlled (e.g. Lescuyer, G. *et al.* 2016), we argue that PBBs that are based on the ES maps generate good opportunities to provide benefits for people and protect nature. We demonstrate on the example of Central and South-Eastern European Karst PAs (1) how ES maps can be used in a participatory approach to create Biodiversity Investment Opportunity (BIO) maps; (2) how to use ES and BIO maps to identify opportunities for the development of PBBs; (3) which ES are most commonly used by the local communities for the creation of PBBs.

Study area

The study area included seven karst PAs in the Danube region in seven countries *(Figure 1).* Karst means the terrain with distinctive landforms and underground drain-

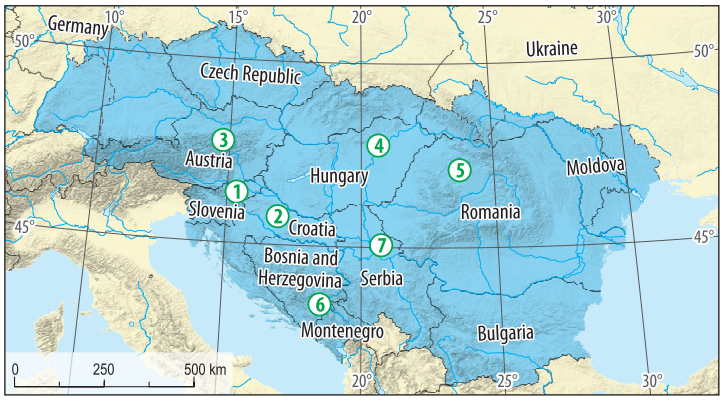

Fig. 1. Map of pilot PAs. 1 = Notranjska Regional Park (Slovenia); 2 = Žumberak-Samoborsko gorje Nature Park (Croatia); 3 = Kalkalpen National Park (Austria); 4 = Bükk National Park (Hungary); 5 = Apuseni Nature Park (Romania); 6 = Bijambare Protected Landscape (Bosnia and Herzegovina); 7 = Tara National Park (Serbia)

age systems that form as a consequence of the solubility of certain rock types, particularly limestone, in water (Simms, M.J. 2005). The selected PAs, despite having different socio-economic backgrounds, were chosen due to their karstic nature, similar nature conservation challenges, and the prevalence of traditional land uses. The selection ensured that a wide variety of societal concerns and different protection regimes could be considered. The PAs were also selected for their diversity of designations, protected habitats, and different management regimes. The selected countries, despite some weaker social indicators, score quite highly in the 2019 United Nations Development Programme's (UNDP) Human Development Index Rankings, ranging from 20th place (Austria, 0.914) to 75th place (Bosnia and Herzegovina, 0.769) out of 189 countries assessed (UNDP, 2019). All selected PAs have designated managements, however the level of detail in their management plans, as well as the capacity of individual PA managers varied.

All the pilot PAs are characterised by karst features. One of the areas (Kalkalpen National Park) lies in the Alps, four in the Dinarides (Notranjska Regional Park, Žumberak-Samoborsko gorje Nature Park, Bijambare Protected Landscape, and Tara National Park), and two in the Carpathian Mountain Range (Bükk National Park and Apuseni Nature Park). All of the pilot PAs are also part of Natura 2000 or the Natura 2000 equivalent Emerald networks, attesting to their high and varied biodiversity and European importance, as defined by Habitats and Birds Directives and the Bern Convention.

Materials and methods

In each pilot area, ES were identified, mapped, and used to produce local action plans that incorporated both nature protection and its use, as well as ideas for PBBs. The entire process was done in constant collaboration between ES experts, sectorial experts (e.g. foresters, nature conservationists, water management experts), park managers, and local stakeholders.

Ecosystem services mapping

ES mapping was carried out in line with the European Commission's methodologi-

cal guidance on how to map and assess ES, as required by Action 5 of the EU Biodiversity Strategy to 2020. These guidelines were elaborated in comprehensive European cooperation projects such as the ESMERALDA project (Burkhard, B. *et al*. 2018). For each pilot PA, precise boundaries were delineated to define the area to be considered when mapping ES (see below). In cases of strictly protected PAs, the mapped areas were extended to the surrounding buffer zones with local villages to represent more of the relevant social-ecological system. The boundaries of buffer zones were set in collaboration between the PA managers and local stakeholders. They were based on the criteria of either people living there who can influence the conditions within the specific pilot area, or people using the proximity of a PA as a marketing strategy for their businesses.

After the delineation of the pilot areas, the ES mapping started with the identification of ecosystem types and creation of ecosystem type maps. These maps provide the spatial units and basic input necessary for the ES assessment and mapping. We used the EUNIS (European Nature Information System) habitat classification (Davies, C.E. *et al*. 2004) as standard, mainly relying on level 3. The EUNIS-based ecosystem type map was produced by compiling and transforming already existing datasets (e.g. vegetation/habitat maps). Some of these original maps used local classification systems, others the CORINE (Coordination of Information on the Environment) Biotope and Palaearctic habitat classifications, or Annex I of the Habitats Directive. These were converted into EUNIS categories and maps with the use of crosswalks. In some cases, the underlying data only allowed the use of EUNIS level 2 categories. In others, a few customised categories had to be included to adapt to the regional and geological (karst) specificities of the selected pilot areas.

The ES mapping started by overviewing the scientific literature to identify karst-specific and potentially important ES. At the same time, a series of semi-structured interviews were held with experts from each pilot area. The Common International Classification for Ecosystem Services (CICES v5.1, www.cices.eu, Haines-Young, R. and Potschin, M. 2013) was used as a foundation for the identification of ES categories and for establishing the conceptual basis of the work with ES. Based on this, an adjusted list of ES was provided *(Supplement)*, which were subsequently mapped in each pilot PA.

For the actual mapping of ES, we mainly used rule-based extended matrix models (Tier 2 models, see also Arany, I. *et al*. 2019). The mapping process followed four general steps *(Figure 2)*:

1. Customising the ecosystem typology and creating an appropriate ecosystem type map;
2. Creating a simple matrix model by assigning base scores (relative values) to the ecosystem types based on expert decision (with the participation of locals and other experts, through stakeholder workshops, see the next chapter on stakeholder involvement);

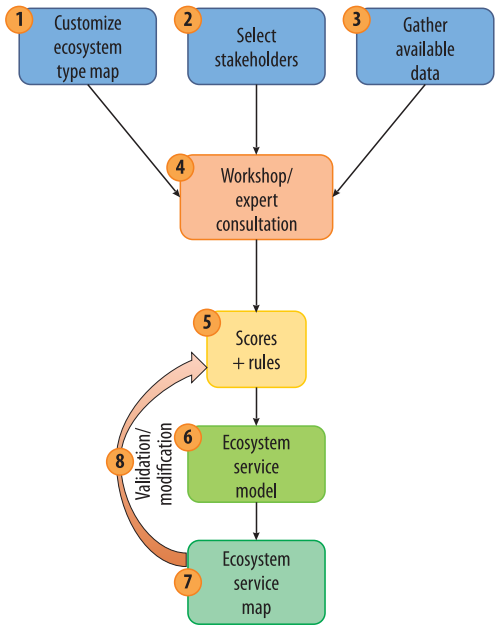

Fig. 2. Workflow of modelling and mapping of ecosystem services

3. Extending the model: identifying additional spatial variables relevant for the ES and integrating these into the ES model in the form of rules that modify the base scores;

4. Validating the draft maps at the next stakeholder workshop.

Besides the ecosystem type and the maps of ESs, the assessment process included the mapping of ecosystem condition. Data availability was a crucial point throughout the process, as the existing databases and data quality varied widely between participating areas.

Stakeholder identification and involvement

A series of three workshops for the elaboration of ES and BIO maps were carried out in each pilot area. Each workshop aimed to involve the highest possible diversity of stakeholders, which were identified using various databases, partnerships and NGO networks, supplemented with a survey among local stakeholders. Involved land users were categorised according to their influence and dependence on ES (Felipe-Lucia, M.R. *et al.* 2015). This approach enabled park managers to take into account not just various strategies of land use, but also power relations, which play a crucial role in decision-making on every level. Three positions needed special attention in the participatory process (see also Kuslits, B. *et al.* 2021): (1) Administration: usually high power and low dependence on ES. These actors usually make decisions in themselves, while their connection with the landscape is rather abstract. (2) Major land users: forestry, water management authorities etc. These stakeholders usually control significant ESs, which highly influence the whole landscape. Given their high leverage in decision-making and direct impact both on the regulatory and the ecological level, these players sometimes tend to ignore other smaller players. (3) Small-scale farmers: this was a diverse group with high dependence on ES while having virtually no formal decision-making power. They had the highest stakes in the participatory process but limited chances to enforce their will. During Stakeholder Network Analysis), four main steps of data collection and analysis were followed:

A. Identifying stakeholder groups during a participatory workshop. Following the framework of Felipe-Lucia, M.R. *et al.* (2015), stakeholders were categorised into groups based on their decision-making power and dependence on ESs *(Figure 3).*

B. Designing a questionnaire survey to reveal relationships within and among stakeholder groups. As recommended by Prell, C. *et al.* (2011), we used predefined groups in the questionnaire and set a limit in the number of possible answers in each section. Example: "Who do you communicate with regularly from restaurant owners in the study.

D. Data collection was done partly in person with paper-based surveys and partly online. Paper-based surveys provide higher quality responses, especially in communities where the basic idea of SNA may be strange or suspicious for respondents. Online surveys, on the other hand, make data analysis much easier, while also hiding misunderstandings, as questions and options may be more easily misunderstood.

Analysis. SNA has a broad literature focusing on cases and methodologies (e.g. Bodin, O. and Prell, C. 2011). In our case, analysis was done at an individual level: looking at positions, such as centrality measures. In a communication network, the in-degree of a node may indicate its power in the network or the trust in his views. Betweenness centrality may highlight players with a high ability to connect distant others, bridging groups in case of conflicts etc. Besides analysing individual nodes in the network, the structure as a whole can be analysed as well. Subgroups, strength of connections between groups, and external factors influencing the likelihood of a connection (such as the role of geographical or ecological features) can be all indications of interesting features both for research and policy-making. The analysis was done by Gephi, an open-source software.

The resulting networks were used in identifying and involving the right stakeholders at every workshop (see *Figure 3*).

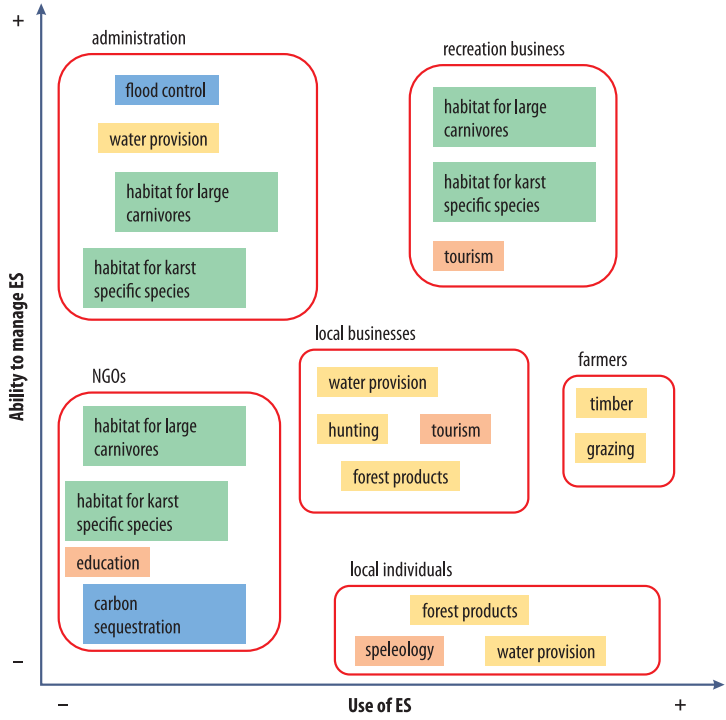

Fig. 3. Example for identification of major stakeholder groups and the most important ESs they interact with

Each pilot PA carried out three workshops, thus totaling 21 workshops across the region. The first workshops focussed on validation of ES maps, the second ones on preparation and validation of BIO maps, and the last series of workshops focussed on PBB identification and preparation of inputs for local action plans. The workshops altogether involved 277 people representing a variety of different interests *(see Supplement)*, with numerous participants engaging repeatedly and attending numerous workshops (these have been counted only once).

Creation of BIO maps

Based on the finalised ES maps, an additional workshop with local stakeholders was organised in each pilot area. The participants (PA managers, experts and local stakeholders) discussed which ES were available to them, which ones they already utilise, and where they see the potential for future development. The BIO maps were then created as future development potential of the area, by using the ES maps and delineating areas where nature-friendly businesses – PBBs – could be implemented. These newly delineated areas were later digitised, and in this manner, the BIO maps were produced. The experts were present at these workshops and ensured that the future developments proposed by the local stakeholders remained within the recognised carrying capacity of the area and that they would not endanger the long-term and sustainable provision of ES. For delineating areas for PBBs, the zonation of PAs was taken into account, as well as special features/species needed to be protected, as well as vulnerability as assessed by the experts and some aspects of business suitability (e.g. closeness to settlements).

Creation of local action plans and identification of PBBs

Taking into account the produced ES and BIO maps, inputs from stakeholders, and knowledge of experts, as well as pilot area managers, local action plans for every pilot area were prepared by PA managers and then finalised with their local stakeholders. These action plans included a list of measures and activities each PA and its stakeholders could implement, in addition to their existing management plans. A number of PBBs were identified by the PA managers and their stakeholders through the above-mentioned workshops, as well as through the process of additional gap analyses. These were included in the action plans.

Results

All seven PAs considered touristic attractiveness and hay production as important ES *(Figure 4).* Timber production was also recognised as essential in all but one PA, where all logging activities are prohibited. Given that all areas are situated on limestone and dolomite substrate, it is not surprising that most water-related ES were not recognised as important, apart from water quality regulation and pollutant removal (57%).

Figure 5 demonstrates a set of BIO maps created for Apuseni Nature Park, Romania. The maps show the areas where the use of the identified ES would be both profitable and not harmful to nature. Special PAs or most sensitive areas were not considered for any kind of economic development.

Among the PBBs *(Figure 6)*, the development of eco-tourism products was identified in all PAs as important, thus creating a bridge between park management and local stakeholders. While not a PBB on its own, it has been widely recognised that the branding and marketing of any local product need to be improved (86%) in all but one park area. Since all of the PAs in this study are predominantly forested, it is not surprising that sustainable forestry practices (71%) and wood processing (43%) were often found to be viable economic options for PBB development. Similarly, most PAs (57%) identified honey production and the development of various agribusinesses as important sustainable development options.

Figure 7 shows the proportions of individual local action plans devoted to particular topics. The largest parts of the action plans were devoted to measures encouraging touristic activities, which followed the sustainable tourism guidelines (43.0%). Measures linked to sustainable forestry and agricul-

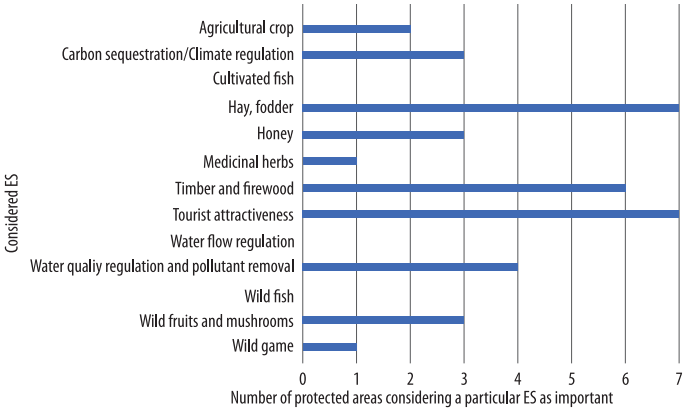

Fig. 4. Number of pilot areas where a particular ES was selected from the suggested list and mapped

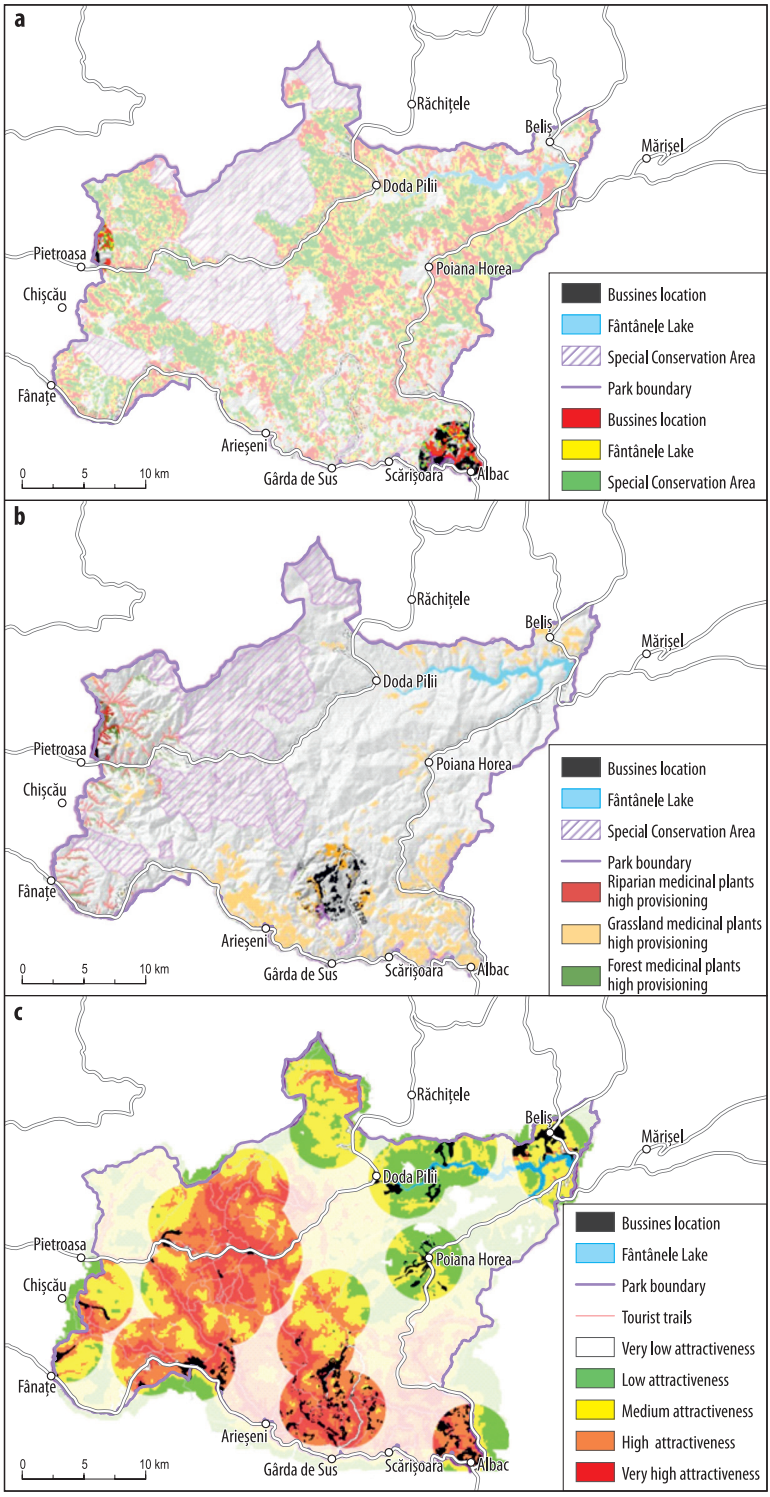

Fig. 5. BIO maps from Apuseni Nature Park, Romania, showing the areas' potential for provisioning timber (a), medicinal plants (b) and their touristic attractiveness (c) together with the areas available for developing business without harming conservation goals (featuring in the legend as business location). Intense colours: available/accessible areas of high potential; faded colours: areas with potential ES (according to colour scale in legends), but not PBB-compatible

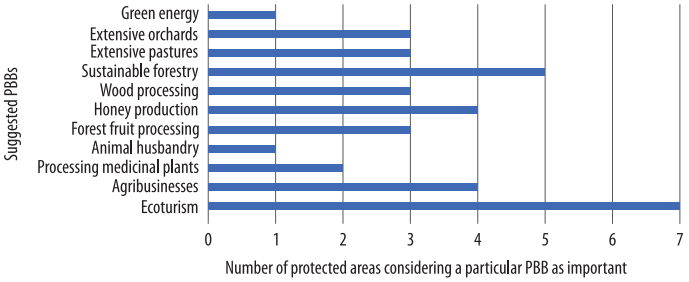

Fig. 6. Most commonly identified PBBs in seven pilot PAs

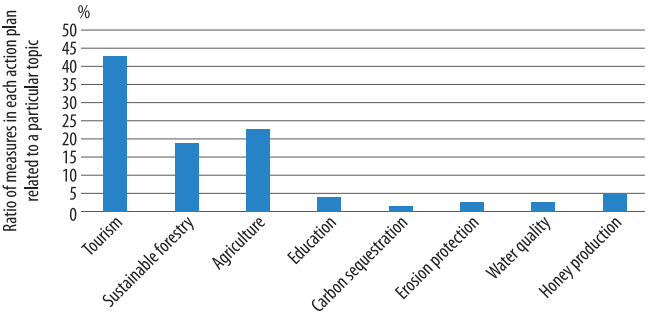

Fig. 7. Average proportion of measures including in the individual local action plans from all pilot PAs related to a particular topic

tural activities followed with 19.0 percent and 22.7 percent of action plans devoted to them, respectively. One PA focused most of their action plan on agricultural activities, in order to reverse depopulation trends, while the others focused more on nature conservation aspects. To better illustrate the types of measures included in the local action plans, *Table 1* presents examples of the measures for the three most commonly addressed themes.

Discussion

Ecosystem services for supporting development of PBBs

We suggested and tested a method to combine ES maps with BIO maps and develop a set of PBBs together with local communities in karst PAs in Central and South-Eastern Europe. These maps and planned measures make the first step towards reconciling two aspects that often collide: regional (economic) development and nature conservation. Involving stakeholders and putting together the plans on a basis that shows potential ES delivery of the areas in a spatially explicit way enhances the understanding and commitment to keep economic development within a sustainable range (Wood, S.L.R. *et al.* 2018).

Our results demonstrate that the managers of the karst PAs and the local communities value their natural environments for a diversity of ES they obtain from nature. It seems that they recognise that the intactness of these natural areas holds significant touristic attractiveness and potential for develop-

Table 1. Examples of planned measures from each of the pilot protected areas for the three most common themes covered by the local action plans

Name of protected area	Tourism	Sustainable forestry	Agriculture
Notranjska Regional Park (Slovenia)	Establishment of a new nature- friendly glamping site	Designation of forest reserves (on state-owned land plots)	Establishment of a network of local producers of (seasonal) food and products with restaurants and tourism sector
Žumberak-Samoborsko gorje Nature Park (Croatia)	Establishment of an eco-camping site	N/A (Not considered a relevant activity)	Production of cosmetic and medicinal products
Kalkalpen National Park (Austria)	Create new signpost concept and infrastructure to improve visitors experience	N/A (Any forestry interventions are prohibited within the park)	Establish a wooded pasture with larch
Bükk National Park (Hungary)	Establish the Bükk Region Geopark (nomination and ratification of the geopark status by UNESCO)	Initiate the adjustment of logging in the protected area forests (by introducing continuous cover forestry)	Monitor the interest of the locals for the PBB development (e.g. mowing, herb collection or link to tourism)
Apuseni Nature Park (Romania)	Create three bicycle trails (one per county)	Support foresters to obtain FSC certificate	Establish local collection centres for milk and meat
Bijambare Protected Landscape (Bosnia and Herzegovina)	Creation of an educational-recreational eco-camp	Establishment of an association for better representation on the market	Establishment of a local ''producers' cluster or a cooperative
Tara National Park (Serbia)	Establish destination management for the wider area of the NP Tara	Effective management with forests and primary and final production of timber	Increasing the funds for supporting of extensive pastures

ment. This is clearly reflected in the fact that the PA managers decided to map touristic attractiveness as part of ES, and that they dedicated the largest proportions of their local action plans to this topic. New eco-tourism products and different agri-businesses, linked with touristic offers, are amongst the most prospective PBBs to be developed in these areas. However, while the development of eco-tourism can provide significant economic returns, and if planned correctly, it can have a minimal footprint on nature, extreme caution still has to be exerted (Han, F.L. and Li, C.T. 2019). Overcrowding, even in well managed PAs, is particularly dangerous (Stronza, A.L. *et al.* 2019). This is why local action plans following sustainable tourism guidelines and coordination of activities between park management and local stakeholders can more effectively address this issue, than if tourism management is left to develop sporadically and by individual stakeholders living within the parks.

The hay and fodder production ES was also considered important in all PAs. Given that the meadows are of anthropogenic nature in most of Europe, conserving this ES will require continued human management in terms of mowing or pasturing. However, due to rural depopulation and abandonment trends in Europe (Lasanta, T. *et al.* 2017), the habitat mosaics typical for traditional extensive land use are gradually disappearing, with their outstanding, valuable biodiversity (Babai, D. and Molnár, Z. 2014). The conservation of open meadows in the Alps (Lasen, C. *et al.* 2018), as well as dry karst meadows, has gained prominence in recent years and encouraging hay production in these areas has the potential to both conserve biodiversity and generate some economic benefits (Lasanta, T. *et al.* 2015; Akeroyd, J. and Page, N. 2020). However, these benefits were not widely recognised by the local stakeholders, as extensive agricultural land uses did not feature so prominently within the suggested PBBs.

Carbon sequestration was also not recognised as highly important. Given that a

number of pilot areas are in a developing part of Europe, the action on the climate crisis might not have been prioritised yet. Additionally, there could be a widespread perception that local action has little meaning when addressing global threats. Our results also show that apart from the most-developed (Austrian) PA, none of the others included any measures related to carbon sequestration in their action plans. Carbon sequestration is not one of the ES that can be exploited directly by the local population, and therefore it was expected that PBBs linked to it would be few and the interest low. However, it is more troubling that the PA managers and other national or regional-level stakeholders (who were expected to have a more extensive overview) that took part in these activities did not discuss it in more depth.

The vast forests that cover much of the Dinarides, the Carpathians and the Alps offer large quantities of timber, which can generate significant profits. All but two PAs in this study recognised forestry to be one of the topics that they have to address with their action plans. In Croatia, Hungary, and Romania many forests are still managed in a conventional rotation system, often even in the protected parts. As clear-cutting has a temporal but strong impact on the local provision of the other ESs and the ecological condition of the forests, this is a major source of conflict between sectors (e.g. between forestry and nature conservation). Close to nature forest management seems to be the most appropriate way to support biodiversity conservation goals and the multi-purpose use of forests in karst PAs. Close to nature forest management emphasises minimal altering of natural processes, while the financial profitability and ecological suitability of forest management are maintained or even increased through other ES (Diaci, J. 2006; Bončina, A. 2011). That enables the preservation of the forest as a natural ecosystem with all its diverse life forms and the relations between them. This is particularly true for karstic PAs where forests have important protective functions (see e.g. Tanács, E. 2016) and provide a number of other ES and marketable products beyond timber and firewood.

More focus should also be directed to the use of non-timber forest products, forest fruits, and mushrooms, as well as medicinal plants. The results suggest that while the potential is somewhat recognised in some PAs, there is more that could be done, particularly at a time when consumers are demanding more organic, wild, local, and seasonal products (Vári, Á. *et al.* 2017, 2020; Keesstra, S. *et al.* 2018). For example, the production of more organic forest honey, the sustainable use of wild vegetables and wild fruits such as berries, chesnuts, mushrooms would all contribute to the better coexistence of nature and people, while minimising the anthropogenic disturbance of natural processes in the forests (Simončič, T. and Matijašič, D. 2013; Shackleton, C.M. *et al.* 2015; Affandi, O. *et al.* 2017). The boutique production of wooden products especially from more exclusive/minority tree species could be also an important PBB. On the other hand, if PAs wish to conserve and strictly protect larger parts of their areas, a firm strategy of concentrating gathering activities, similar to the visitor management for eco-touristic use is needed.

Conclusions

Due to the increasing pressure to preserved natural environment, tools that would allow both nature and people to thrive together are urgently needed. While the approach in this paper was applied in karst PAs in Central and South-Eastern Europe, the ES mapping and subsequent PBB identification can be used more widely in any protected area that provides diverse ES. The presented approach has been shown to be useful in a variety of different PAs with different stakeholder profiles. Through the proposed procedure, it is possible, in a participatory and open manner, to protect nature, generate economic returns (through PBBs), and support effective participation of local communities in the conservation efforts, increasing their

effectiveness. Therefore, this method could be widely used in developing countries, as well as developed countries to improve the status of biodiversity and foster local, sustainable, and nature-friendly development endorsed by local people.

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