



Economic value of ecosystem services in Protected Landscape Areas in the Czech Republic

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Abstract: Daněk J., Vačkář D., Krkoška Lorencová E. 2017: Value of ecosystem services in Protected Landscape Areas in the Czech Republic – *Beskydy*, 10 (1, 2): 99–112

This study aims to explore spatially explicit economic values of ecosystem services provided by ecosystems and habitats in 25 Protected Landscape Areas (PLAs) in the Czech Republic, with a more detailed overview of three selected PLAs (Beskids Mountains, Český les Mountains and Odra River Basin). In the methodology, combination of the Consolidated Layer of Ecosystems of the Czech Republic (CLES) and the EKOSERV database allowed us to utilize the ecosystem and economic valuation data in a specific geographic context using a GIS-based approach. The total value of ecosystem services in all 25 PLAs reached € 51 billion/year, with the surface area significantly influencing the total average value of a particular PLA. When transformed to value per unit area, the values varied from €1.2 to €6.5 million/km²/year. The results suggest a dominant role of forest ecosystems in the composition of the economic value provided by ecosystem services in the PLAs. Economic valuation of benefits provided by protected areas can help to realize the social importance of these sites and to support policy and decision-making processes.

Keywords: ecosystem services, economic valuation, Protected Landscape Areas, forest ecosystems

Introduction

Protected areas and their ecosystems provide people and society with vital ecosystem services. However, the ecosystems might be subject to degradation, which has been mentioned on numerous occasions both in policy and scientific discourses (Costanza et al. 2017; Steffen et al. 2011; MA 2005). Some authors suggest the process can be influenced by expressing, unhiding or making visible the multiple values and benefits provided by nature to people (Frélichová et al. 2014; Daily et al. 2009).

The concept of ecosystem services has successfully made its way into an increasingly popular research topic over the last decades

(Kull et al. 2015). It has also become an important framework describing values of nature, often in monetary terms (Costanza et al. 2017; Bennett et al. 2015). Nonetheless, it is arguably an anthropocentric concept, and as such it has been the butt of criticism as well as counter-arguments (Schröter et al. 2014; McCauley 2006). However, it cannot be denied that this concept offers us a unique framework, allowing us to assess and communicate often invisible or overlooked values and benefits (but also some disservices¹, see Lyytimäki 2015) provided by nature to society or individuals. Various outcomes of ecosystem service research provide support

1 “Ecosystem disservices (EDS) are functions or properties of ecosystems that cause effects that are perceived as harmful, unpleasant or unwanted. Examples of EDS include pest damages to agriculture, pollen causing allergic reactions or fear related to night-time urban parks.” (Lyytimäki 2015)

tools for policy and decision-making processes, such as ecosystem assessments, economic valuation, mapping of ecosystems and ecosystem services.

In the European context, few countries have completed a national ecosystem assessment in its broad sense (Schröter et al. 2016). However, some countries are conducting related activities or have at least done some mapping of ecosystems or undertaken a pilot study on ecosystem assessment (MAES 2016). In the Czech Republic, two studies on ecosystem services assessment have been carried out at national level (Frélichová et al. 2014; Hönigová et al. 2012). Both studies included estimations of economic value of ecosystem services. The prime focus of the study by Frélichová et al. (2014) is on assessment of six ecosystem types (aquatic ecosystems, agricultural ecosystems, forests, grasslands, urban areas, wetlands) and 17 ecosystem services across the territory of the country. The study by Hönigová et al. (2012) focuses on a single ecosystem type – grasslands.

Protected areas have been traditionally declared to conserve natural values, based on the distributions of threatened and important species and habitats or features of geomorphological significance. However, it is widely recognized that protected areas are contributing to the maintenance of vital ecosystem processes which translate into the ecosystem services value for society (Durán et al. 2013). Despite the recent efforts in ecosystem services valuation, there are few studies on the economic value of ecosystem services in specially protected areas (Whitham et al. 2014; Ingraham & Foster 2008). Exploring, assessing and showing the economic value of ecosystems and the benefits they provide to society or individuals is one of the ways to express and quantify the extent to which nature contributes (directly or indirectly) to human well-being (MA 2005). Valuation of ecosystem services can be a useful starting point to highlight benefits provided by ecosystems in order to inform environmental management and related policies for nature protection and local development.

Research objectives

This study draws on the results from previous research by Frélichová et al. (2014), which provide an integrated assessment of ecosystem services in the Czech Republic. While having a different

research subject, protected areas, it further expands the usability of previously gathered data and databases. This paper applies the ecosystem assessment data in a new, more detailed context in order to expand the body of knowledge about ecosystem services in protected areas and their societal benefits, expressed as an estimation of economic value. Generally, the goal is to explore spatially explicit economic values provided by ecosystems and habitats in large-scale protected areas.

The primary task was to identify the factors regarding ecosystem and habitat structure which play a major role in estimating the economic value of Protected Landscape Areas (PLAs) in the Czech Republic. Ecosystem types and values were extracted using a previously developed methodology and valuation database by Frélichová et al. (2014) and applied in a new context. Selected PLAs were further analysed in order to answer the question whether the highest value of a single ecosystem relates to ecosystems with the largest surface area and which habitats contribute the most to the overall value of a particular PLA.

Material and Methods

Study sites

According to Act No. 114/1992 Coll. on Nature and Landscape Protection, there are six types of Specially Protected Areas in the Czech Republic – two large scale categories – National Park and Protected Landscape Area; and four small scale categories – National Nature Reserve, Nature Reserve, National Nature Monument, and Nature Monument. This study examines specifically PLAs which Act No. 114/1992 Coll. defines as extensive areas with a harmonic landscape, a specific relief, a significant share of natural ecosystems of forest and natural grasslands, and an abundance of woody species. The PLAs might also include some historical settlement relics. The management of the PLAs must be carried out according to specific 3–4 zones of protection in order to preserve and improve the natural state of the PLAs and to create and protect optimal ecological functions in these areas. Recreational use of the PLAs is allowed only if it does not damage their natural values.

Currently, there are 26 PLAs in the territory of the Czech Republic, covering 14.39 % of the country's surface area. This study includes 25

PLAs, because the latest PLA, Brdy Highlands, was created only recently (in 2016) and was not included in the CLES at the time of the research. The total area of the 25 PLAs covered in this study is 13.78 % of the country's surface area. Based on the results, three PLAs were selected for a further analysis.

Spatial data

Since ecosystem services are inherently linked to and depended on ecosystems, the first essential step is to identify relevant ecosystems, habitats or land-use, in order to assign to them relevant ecosystem services and value them. The source of the spatial ecosystem data for the PLAs was from the Consolidated Layer of Ecosystems of the Czech Republic (CLES), which has been made by CzechGlobe together with Nature Conservation Agency of the Czech Republic in 2012. The CLES utilizes Habitat Mapping Layer (originally made to identify the Natura 2000 sites), Corine Land Cover (2006), Urban Atlas, ZABAGED geographic data, and other specific data for water bodies (DIBAVOD) (Frélichová et al. 2014). The CLES consists of 41 habitat/land-use categories, hierarchically classified at four levels (Table 1 in the supplementary material). The

highest level comprises seven ecosystem types: aquatic ecosystems, agricultural ecosystems, bare land, forests, grasslands, urban areas, and wetlands. For example, the lowest level of Forests ecosystem type contains 13 habitat types: e.g. intensive mixed forests, alluvial forests, spruce forests or natural shrub vegetation. Fig. 1 provides an overview of 38 relevant habitat/land-use categories presented in three selected PLAs.

Classification of ecosystem services

Ecosystem services are classified into three basic categories, regulating, provisioning and cultural, in line with the most globally used classifications – MA (2005), TEEB (2013), and CICES v4.3 (Haines-Young & Potschin 2013). The fourth category of supporting services is not included as it might cause double counting errors (Frélichová et al. 2014; Bateman et al. 2011). Based on the existing ecosystems and environmental conditions in the Czech Republic, a selection of 18 relevant services was made (Frélichová et al. 2014). The complete list with the relevant ecosystems, where the economic valuation was applied, is presented in Tab. 1.

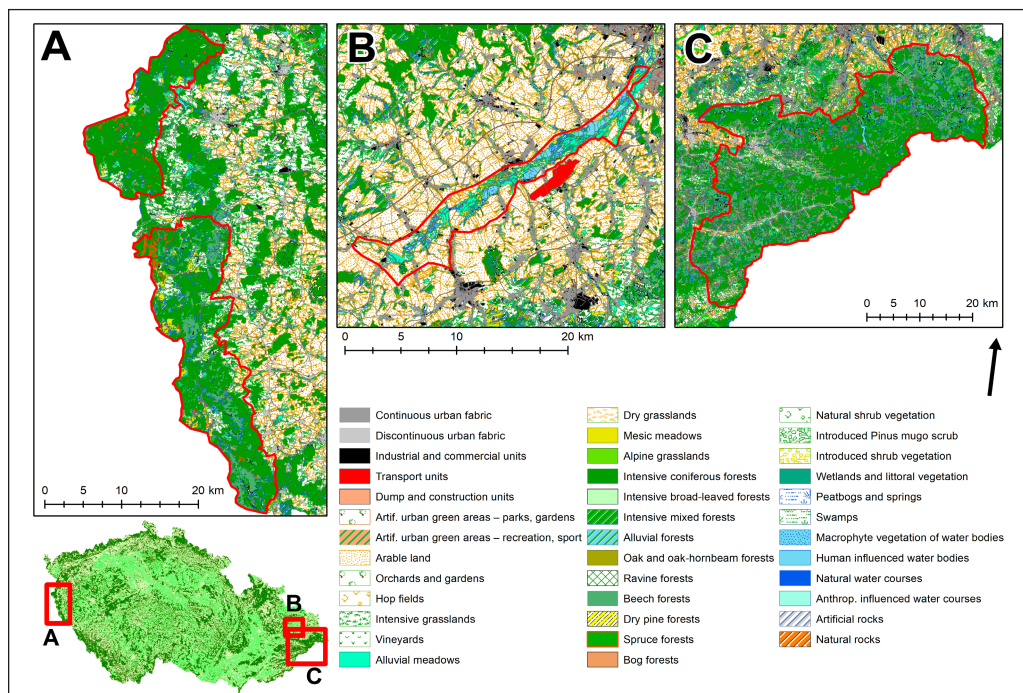


Fig. 1: 38 relevant habitat/land-use categories by CLES presented in three selected PLAs (A – Český les Mountains; B – Odra River Basin; C – Beskids Mountains). Data source: CLES.

Tab. 1: Ecosystem services (ES) researched and applied for economic valuation, adapted from Frélichová et al. (2014)

Ecosystem service category	Service/benefit	Relevant ecosystems
Provisioning	Crop	A
	Biomass	A, F, G, W, WET
	Fish	W, WET
	Timber	F
	Non-timber	F
	Game	F
	Water	W, WET
Regulating	Air quality	F
	Climate	A, F, G, U, WET
	Disturbance	W, WET
	Erosion	A, F, G, WET
	Nutrient	A, G, W, WET
	Pest control	A, F, G, WET
	Pollination	A
	Water cycle	A, F, G, U, WET
	Water quality	G, F, WET
Cultural	Aesthetic value	A, F, W, WET
	Recreation	A, F, G, U, W, WET

Explanation of acronyms: A – agricultural, F – forests, G – grasslands, U – urban, W – water, WET – wetlands

Economic valuation

Data from the EKOSERV database were used for a monetary valuation of ecosystem services in the PLAs. The database was set up by Czech-Globe in 2012–2013 as part of a project supported by the Technology Agency of the Czech Republic “Integrated assessment of ecosystem services in the Czech Republic” (EKOSERV), focused on quantification, mapping and economic valuation of ecosystem services in the Czech Republic. Outputs from this integrated application of the concept of ecosystem services were intended to support decision-making processes in the Czech Republic, e.g. by estimating the total monetary value of ecosystem services, which equals 150 % of the annual Czech gross domestic product (Frélichová et al. 2014). The method for estimating the monetary values of ecosystem services used when creating the EKOSERV database was benefit transfer, often regarded as a relatively fast and least data demanding method for ecosystem service value assessment (Frélichová et al. 2014; Wilson & Hoehn

2006). Generally, the benefit transfer makes use of available data for ecosystem service valuation and applies them in a new, similar context (Liu et al. 2010). The benefit transfer method can provide relatively appropriate indicative value estimates.

Based on a systematic (scientific) review of the literature, the benefit transfer method was applied and resulted in a database with nearly 200 monetary values for various ecosystem services. For a more detailed description of the process of the EKOSERV database creation including the valuation methods, see the full paper by Frélichová et al. (2014).

Results

Total value

The total value of ecosystem services in all 25 PLAs reached € 51 billion/year. The PLA with the highest total monetary value of ecosystem services was Beskids Mountains, totalling € 7.3 billion/year. Beskids Mountains are also the

PLA with the largest surface area (1,205 km²), and therefore, it was expected that the area might significantly affect the total value. Another important variable is the share of the most valuable ecosystems, which is further described in a relevant subsection. On the other hand, the PLA with the lowest total monetary value of ecosystem services was Odra River Basin, amounting to € 102 million/year. Similar to the previous one, Odra River Basin is the second smallest PLA with regard to the surface area (80 km²) and therefore, it was expected that the total value would stay on the lower end of the scale. Fig. 2 presents the total value of the ecosystem services in all the PLAs considered in this study, their spatial distribution in the Czech Republic and their classification into 5 categories regarding the total value of the ecosystem services provided in EUR per year.

Value per unit area

To facilitate the comparability between the PLAs, the monetary values were transformed and expressed as values per unit area (km²). As a result, this step regulates the influence of PLA size on the outcome value. The PLA with the highest monetary value per unit area was Český les Mountains, totalling €6.5 million/

km²/year. On the other hand, the lowest value per unit area was that of Odra River Basin with €1.2 million/km²/year, which scored the lowest total value as well. The possible reasons and implications of this are discussed in the respective subchapter. A complete list of the PLAs and the value of ecosystem services in EUR/km²/year is shown in Fig. 3.

Exploring ecosystems with the highest value

To further explore the composition of the total value per PLA, the following analysis is focused on decoding which ecosystems have the highest share in the value, in other words, how it relates to actual habitat/ecosystem structure of the PLA. Of a total number of 25 PLAs, three were selected for this analysis, based on the results from the previous section (total value and value per unit area). The first detailed overview is given for Beskids Mountains, which scored number one for the total monetary value of ES, possibly due to its largest surface area. Second was Odra River Basin, which scored the lowest number for the total value and, at the same time, for the value per unit area of the PLA. Third PLA for a deeper analysis is Český les Mountains, which scored highest in the value per unit area.

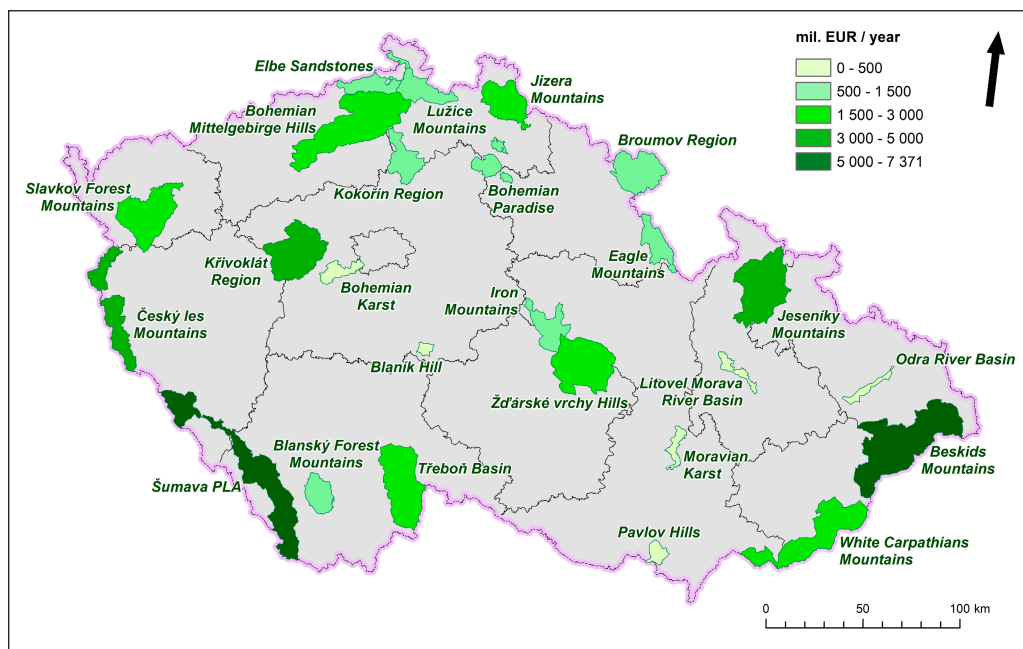


Fig. 2: Total monetary value of ES in PLAs per year.

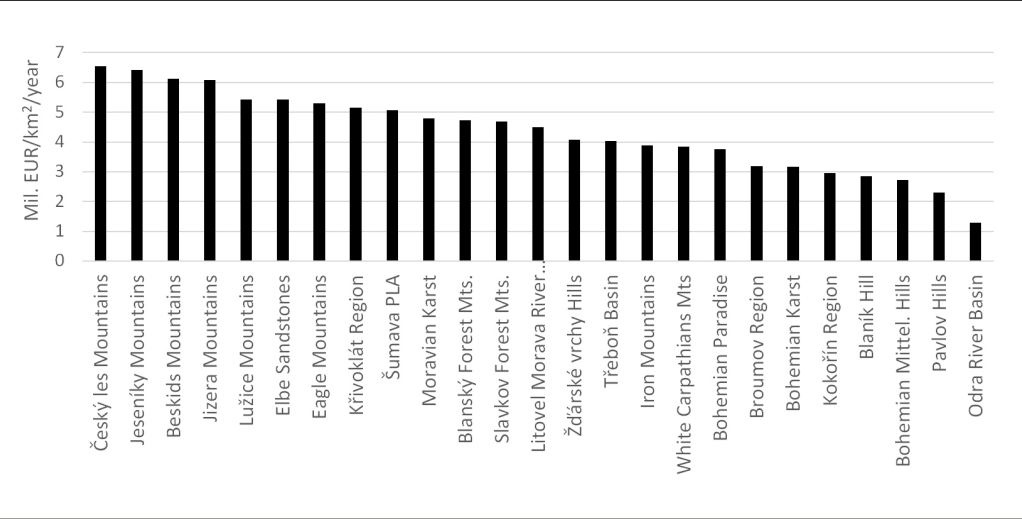


Fig. 3: Average monetary value of ES in PLAs per unit area (EUR/km²) per year.

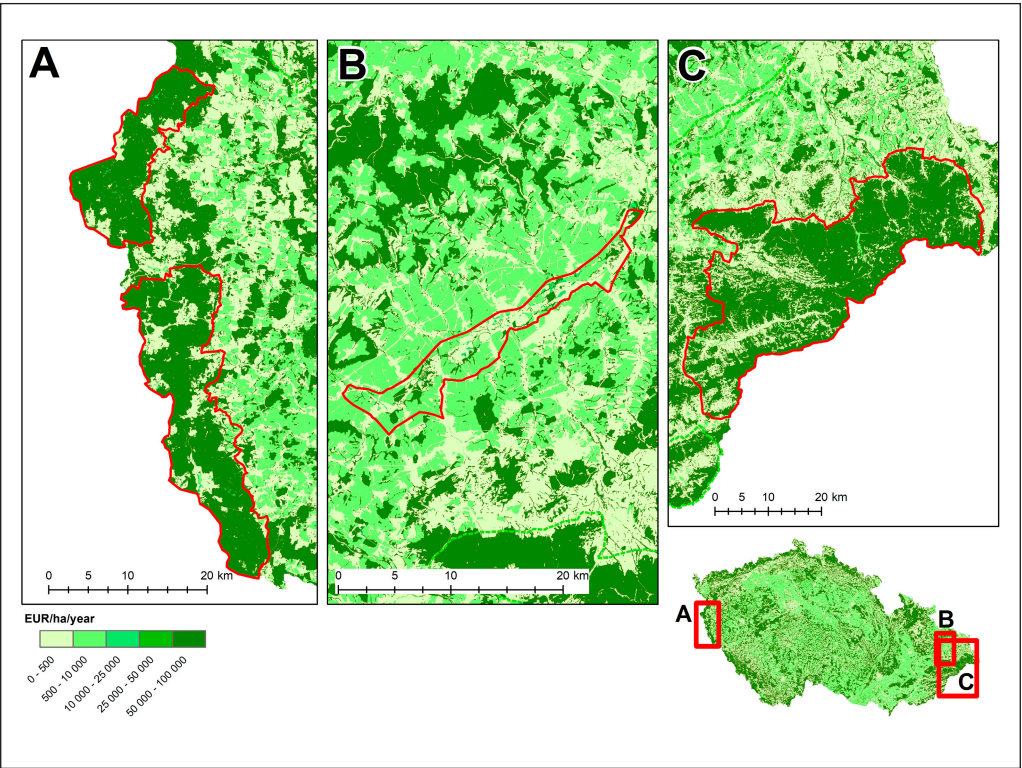


Fig. 4: Value per unit area in three selected PLAs (A – Český les Mountains; B – Odra River Basin; C – Beskids Mountains).

The Fig. 4 presents the three selected PLAs; the values per unit area are graphically divided into 5 categories to capture the whole gradient from very low to very high values.

Beskids Mountains

The largest PLA in the Czech Republic, Beskids Mountains, is a dominantly forested mountainous area bordering Slovakia in the western part of the Carpathian mountain range. It has a surface area of approximately 1,205 km² and ranges from 326 to 1,319 metres above sea level (AOPK 2015).

In Beskids Mountains PLA, the value of ecosystem services from forest ecosystems covers nearly 100 % of the total monetary value, possibly due to the high share (76 %) of areas with forests in the total surface area. To investigate what habitats contribute the most to the estimated economic value, the value of the forest ecosystems was broken down to the lowest level of habitat categories. From a total of 13 forest habitat types considered in the CLES, 9 of them contribute to the economic value of ecosystem services in Beskids Mountains. The highest value is brought by intensive coniferous forests (67 %), followed by beech forests (21 %), and intensive mixed forests (8 %). A full list of relevant forest habitats and their share in the total value of ecosystem services from forest ecosystems is presented in Fig. 5.

Odra River Basin

Odra River Basin is among the smallest PLAs in the Czech Republic, with approximately 80 km² (AOPK 2015). The PLA is nested around the Odra River and its natural meanders with a number of tributaries, cut-off meanders, oxbows, periodical or temporary pools, ponds and other water bodies. It lays in a lowland landscape, ranging from 212 to 309 metres above sea level (AOPK 2015).

In Odra River Basin PLA, the value of the ecosystem services from forest ecosystems covers about 92 % of the total value, compared with the share of the afforested area – 16 % of the total surface area. Other considerable shares on total average value are those of agricultural ecosystems (4 %) and wetlands (3 %). Grasslands and aquatic ecosystems have both 1 % and urban ecosystems almost zero.

As forest ecosystems contribute the most to the overall value, the interesting part was to unhide what particular habitats are behind those values. Seven forest habitat categories contribute to the economic value of ecosystem services in Odra River Basin. Most of the value is created by alluvial forests (70 %), followed by oak and oak-hornbeam forests (13 %) and intensive mixed forests (9 %). A full list of relevant forest habitats and their share in the total value of ecosystem services from forest ecosystems is shown in Fig. 6.

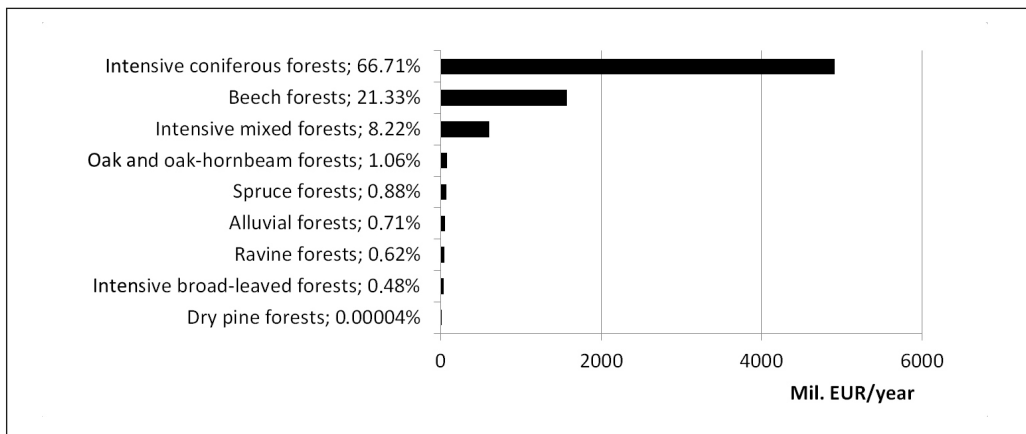


Fig. 5: Share of forest habitats on the monetary value of ES in the forests, Beskids Mountains PLA.

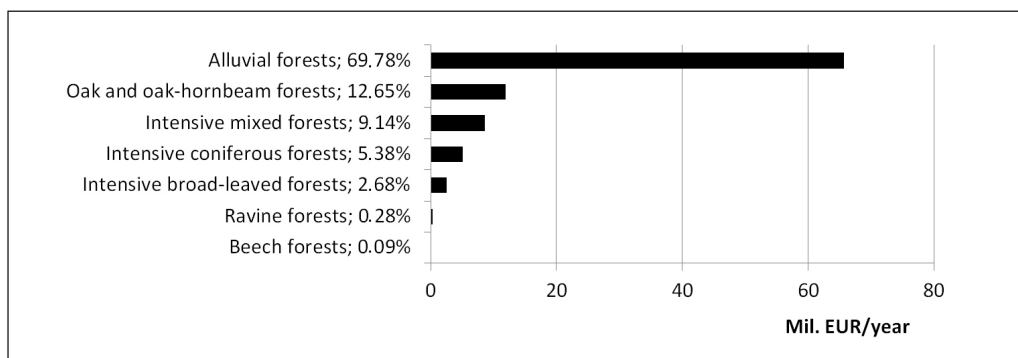


Fig. 6: Share of forest habitats on the monetary value of ES in the forests, Odra River Basin PLA.

Český les Mountains

Český les Mountains, as its name suggests², is an extensively afforested highland and mountain landscape area bordering Germany in the western part of the Czech Republic. It has an elevation between 442 and 1,039 metres above sea level and has a surface area of approximately 466 km² (AOPK 2015).

In Český les Mountains PLA, the value of the ecosystem services from forest ecosystems accounts for nearly 100 % of the total monetary value and the share of the afforested area accounts for 80 % of the total surface area. This suggests that the forest ecosystem services are dominant regarding the monetary value in this PLA. To investigate what habitats contribute the

most to the total average economic value, the value of forest ecosystems was broken down to the lowest level of habitat categories. Similar to the results in Beskids Mountains, 9 forest habitat types contribute to the economic value, but the composition is slightly different. The highest value is brought by intensive coniferous forests (75 %), followed by beech forests (12 %) and intensive mixed forests (7 %). Two more habitats have a considerable share in the value – alluvial forests and spruce forests, both with 3 %. All other forest habitats account for 1 % or less. A full list of relevant forest habitats and their share in the total value of ecosystem services from forest ecosystems is presented in Fig. 7.

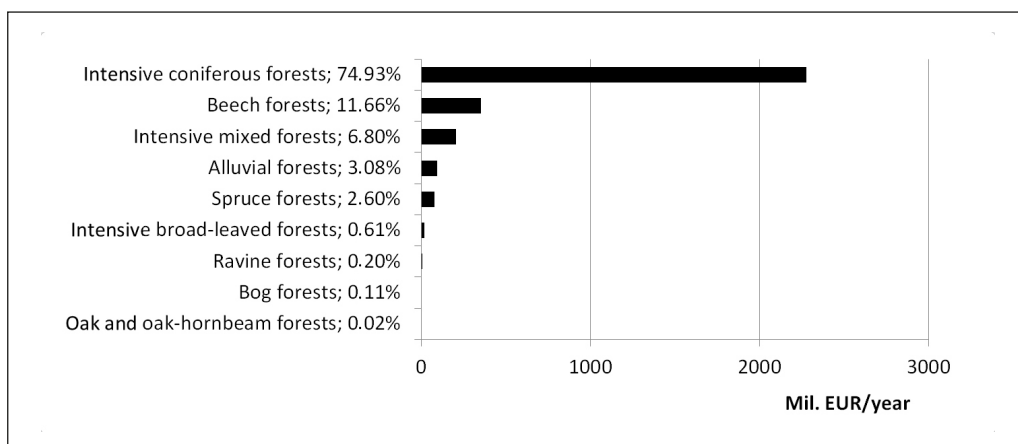


Fig. 7: Share of forest habitats in the monetary value of ES in the forests, Český les Mountains PLA.

2 “les” means forest in the Czech language.

Discussion

Regarding the study sites covered in this study, Brdy PLA was excluded from the assessment because the data were not available due to the recent creation of this site. Therefore, the total value of ecosystem services in the PLAs would be higher if all PLAs were considered in this assessment. Concerning the figures, it is important to note the varying precision of the benefit transfer method used for the economic valuation (Eigenbrod et al. 2010; Plummer 2009; Troy & Wilson 2006). However, the accuracy and validity of values can be refined by following certain guidelines, established by economists (Plummer 2009). Nevertheless, this method provides convenient flexibility in cases where data and time are limited resources, and a rapid ecosystem services evaluation affords us important inputs for environmental management (Jadhav et al. 2017).

The total value of ecosystem services in the PLAs was significantly influenced by the surface area, though this was not the only determinative variable. To evaluate the role of ecosystem type composition or particular habitats on a finer scale, three PLAs served as case studies. Český les Mountains as well as Beskids Mountains had nearly 100 % of their total economic value generated by forest ecosystems. After the role of surface area was dismissed using the value per unit area ratio, Český les Mountains had an average value of ecosystem services totalling €6.5 million/km²/year (the highest score for unit area assessment), and Beskids Mountains had €6.1 million/km²/year (third highest score for unit area assessment). The third case study, the Odra River Basin PLA had “only” €1.2 million/km²/year which resulted in the lowest value in both analyses, because of its relatively small area (second smallest surface area), and a relatively small share (16 %) of forest ecosystems in its surface area. These results suggest a dominant role of forest ecosystem services in the estimated economic value.

A similar study conducted by Hein (2011) on economic benefits of protected areas in the Netherlands showed a conservative estimate of €0.2 million/km²/year for eight ecosystem services researched, compared with the 18 ecosystem services included in this study. A study from Central European region by Getzner (2009) estimates a mean value of €3.5 million/km²/year for seven ecosystem services provided by the Tatra

National Park in Poland, and €1.1 million/km²/year for nine ecosystem services provided by the Slovak Paradise National Park in Slovakia.

Conclusion

The total economic value of ecosystem services in the PLAs in the Czech Republic varied from € 102 million/year to €7.3 billion/year and from €1.2 to €6.5 million/km²/year in the value per unit area assessment. Forest ecosystems create from 92 % to nearly 100 % of the total monetary value in the three case studies.

In the history of creating of the protected areas in the European region, arguments and justifications have varied to a great extent – from creating hunting grounds to conserving biodiversity and acknowledging the intrinsic value of nature (Jones-Walters & Čivić 2013). Nowadays, even the PLAs are facing economic challenges, which are generally omnipresent for institutions of any type (Jones-Walters & Čivić 2013). In order to explore possible arguments for protected areas, their monetary valuation may be a useful tool, translating the multiple benefits of ecosystems and their services for people and society into a common language. Nevertheless, an economic valuation or “putting a price on nature” should be treated with care to avoid a senseless commodification of nature (Hansjurgens et al. 2016; Schröter et al. 2014), which is certainly not the goal (Costanza et al. 2014). It should be largely considered as an informative argument and a communication tool for supporting nature protection, e.g. by establishing and maintaining protected areas. It is important to stress that a monetary valuation provides extra information in addition to the basic conservation goals: protecting biodiversity and natural habitats. This study expands the body of information on the economic benefits delivered by the protected areas. Furthermore, it can also help to identify and realize the social importance of these sites in other than conservation language. These results can be used to support policy and decision-making processes, even though it is still rather difficult to achieve outcomes positive both for human well-being and biodiversity (Pullin et al. 2013). Another example of applicability of such economic valuation might be an assessment of cost-benefit analysis for various objectives in the management of PLAs.

Acknowledgement

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Supplementary material

Tab. 1: Hierarchical classification of the Consolidated Layer of Ecosystems of the Czech Republic.

Level 1	Level 2	Level 3	Level 4
Urban areas	Continuous urban fabric	Continuous urban fabric	Continuous urban fabric
	Discontinuous urban fabric	Discontinuous urban fabric	Discontinuous urban fabric
	Industrial and commercial units	Industrial and commercial units	Industrial and commercial units
	Transport units	Transport units	Transport units
	Dump and construction units	Dump and construction units	Dump and construction units
	Green urban areas	Natural urban green areas	Urban nature
		Artificial urban green areas	Parks, gardens, cemeteries
			Recreation and sport areas
Agricultural land	Arable land	Arable land	Arable land
	Permanent cultures	Orchards and gardens	Orchards and gardens
		Hop fields	Hop fields
		Vineyards	Vineyards
	Permanent grasslands	Intensive grasslands	Intensive grasslands
Grasslands	Natural grasslands	Natural meadows	Alluvial meadows
			Dry grasslands
			Mesic meadows
			Alpine grasslands
			Heaths
Forests	Forested areas	Intensive forests	Intensive mixed forests
			Intensive broad-leaved forests
			Intensive coniferous forests
		Natural forests	Alluvial forests
			Oak and oak-hornbeam forests
			Ravine forests
			Beech forests
			Dry pine forests
			Spruce forests
			Bog forests
	Scrub	Areas with no forest cover naturally	Natural <i>Pinus mugo</i> scrub
			Natural shrub vegetation
		Areas with introduced no forest cover	Introduced <i>Pinus mugo</i> scrub
			Introduced shrub vegetation

Level 1	Level 2	Level 3	Level 4
Wetlands	Wetlands	Natural wetlands	Wetlands and litoral vegetation
		Natural peatbogs	Peatbogs and springs
		Anthropogenic swamps	Swamps
Aquatic ecosystems	Water bodies	Natural water bodies	Lakes
		Anthropogenic water bodies	Ponds
	Water courses	Natural water courses	Natural water courses
		Anthropogenically influenced water courses	Anthropogenically influenced water courses
Bare land	Bare rock	Artificial rocks	Quarries and mining sites
		Natural rocks	Rocks and stones