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ECOSYSTEM SERVICES CONTRIBUTING TO LOCAL ECONOMIC SECTORS – CONCEPTUAL FRAMEWORK OF LINKING ECOSYSTEM SERVICES, BENEFITS AND ECONOMIC SECTORS

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ABSTRACT: The paper introduces the principles of the System of Environmental-Economic Accounting-Ecosystem Accounting. The aim of the work is to present the application of the conceptual framework of linking ecosystem services, benefits and economic sectors. The analysis relates to year 2012 and 2018. The case study area represents five municipalities that cross borders with the Ślężański Landscape Park and its buffer zone in the Lower Silesia region in Poland. Results show that cropland related ecosystem services contribute to 17% and 14% percent of all companies operating in the case study area. Direct link between agricultural benefits and five economic sectors was established. The ecosystem extent account is created, and the land cover flows analysed. The applicability of ecosystem accounting to local governance is discussed.

KEYWORDS: SEEA EA, natural capital, ecosystem accounting, ecosystem services, protected area

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Introduction

The concept of ecosystem services has gained a lot of attention as it proved to be useful in explaining complex human-environment relations and supporting local decision making. The ecosystem services (ES)' most common definition is that ES are benefits that people obtain from nature (MEA, 2005). However, as many ES have been researched, it became prominent that there are only a few ES that brings pure benefits without human intervention. Most of the time, humans enhance, support, or modify ecosystems to supply more benefits in terms of volume and diversity. Some ecosystems are highly transformed and controlled by humans, for instance, agricultural land, and the ES of food provision is highly dependent on human inputs into food production. Therefore, the definition of ES has been slightly modified into "ecosystem services are the contributions of ecosystems to the benefits that are used in economic and other human activity" (United Nations, 2021a). This definition directly links ES to benefits that are used by humans in their economic activities or for their wellbeing. From this point, we can start assessing the contribution of ES to economic sectors or GDP that is in line with the System of National Accounts. However, the relationship between the environment and economy is complex and difficult to put into tables (Becla, 2013). The statistical framework for integrating biophysical information of ecosystems, the ES measuring methods, compiling biophysical and economic accounts, and linking it to human economic activities has been a challenge for many years. Recently, the attempts to accept the international statistical standard of accounting for ecosystem services have been successful. The work of international experts within the System of Environmental-Economic Accounting – Ecosystem Accounting (SEEA EA) has brought significant developments in the methods concerning natural capital accounting. The System of Environmental-Economic Accounting (SEEA) is coordinated by the United Nations Statistical division as it represents a statistical system that combines environmental and economic information to describe both natural and economic capitals with the same units and measurements. The overarching aim of the system is to support decision making for sustainable development and provide more holistic information about the economic performance. The global consultation on the SEEA Ecosystem Accounting (EA) involved many scientists from around the world representing many different fields of expertise. The transdisciplinary character of the ecosystem services (Mizgajski et al., 2014) requires knowledge and skills from many scientific disciplines. The SEEA EA framework includes the following steps: first to identify ecosystem assets, their condition, then ecosystem services generated by the asset, and then the benefits and beneficiaries. The accounts created as the result of

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applying the SEEA EA are: ecosystem extent and condition accounts, ecosystem service supply and use tables both in biophysical and monetary terms and ecosystem asset accounts (United Nations, 2021b). The SEEA EA provides basic guidelines on how to measure the supply of ecosystems services and attribute it to direct use of them by economic units/sectors. The attribution of ES' contribution to a specific sector is supported by the logic chains frameworks (SEEA website: https://seea.un.org/ecosystem-accounting), but still case studies are needed to better understand how local implications should be considered in the natural capital accounting. In this contribution, we present the application of a conceptual framework of ecosystem services, benefits and economic sectors to a case study of Ślężański Landscape Park. This case study draws from previous experiences and contributes with subregional assessment and conclusions. The ecosystem extent accounts are presented, and based on that, the potential ecosystem services and benefits are explored, and economic sectors are attributed.

This is one of the very few case studies in the scientific literature that analyse the ecosystem accounting at the subregional scale (Hein et al., 2020a). Most of the SEEA EA applications are provided at the national (Hein et al., 2020b) or international scales (Vallecillo et al., 2019a). For the European case studies, the ecosystem extent assessment can be linked to the mapping and assessment of the ES (Maes, 2016). The ecosystem condition could be described by indicators reflecting the quality of the ecosystems (Keith et al., 2020). The ecosystem extent for the European case studies is often based on the Corine Land Cover (Farrell et al., 2021; Vallecillo et al., 2019b) as it provides data for regular time frames (2000, 2006, 2012, 2018) and enables comparisons. Ideally, national data sets (like in the Netherlands) and more precise satellite images are welcomed for the local and subregional case studies (Solon et al., 2017). However, for the case study in Lower Silesia at the time, the Corine Land Cover is the only option.

Case study area

The case study area represents five municipalities that cross borders with the Ślężański Landscape Park and its buffer zone in the Lower Silesia region in Poland. We do not consider in this study the sixth municipality that borders the Landscape Park – Świdnica, due to the very small share of intersected land. The municipalities included are as follows: Sobótka, Marcinowice, Łagiewniki, Dierżoniów, Jordanów Śląski. The total number of inhabitants of these municipalities in 2018 was 50435. The municipalities are located at the peri-urban areas of the city of Wroclaw, which is the main economic and developmental centre of the region. Two out of five municipalities

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belong to the Wroclaw County. The heart of the case study area – Ślęża mountain – is located about 40 km from Wrocław.

The Ślężański Landscape Park was established in 1988 and covers mainly the area of the Śleża massif. The mountain Ślężą is the highest point in the landscape of the park and municipalities, reaching the height of 718 m a.s.l. There are three nature reserves within the borders of the Landscape Park: Mountain Ślężą, Radunia and Sulistrowice meadow. The Ślęża Mountain is a popular spot for one day outdoor recreation for many inhabitants of Wrocław, but it also attracts recreators from all over the Lower Silesia region and few from beyond. The landscape of the Park and municipalities is mainly agricultural, with forest covering the slopes of the main hillsides (Figure 1). The housing estates are located along roads and concentrate around bigger towns, such as Sobótka.

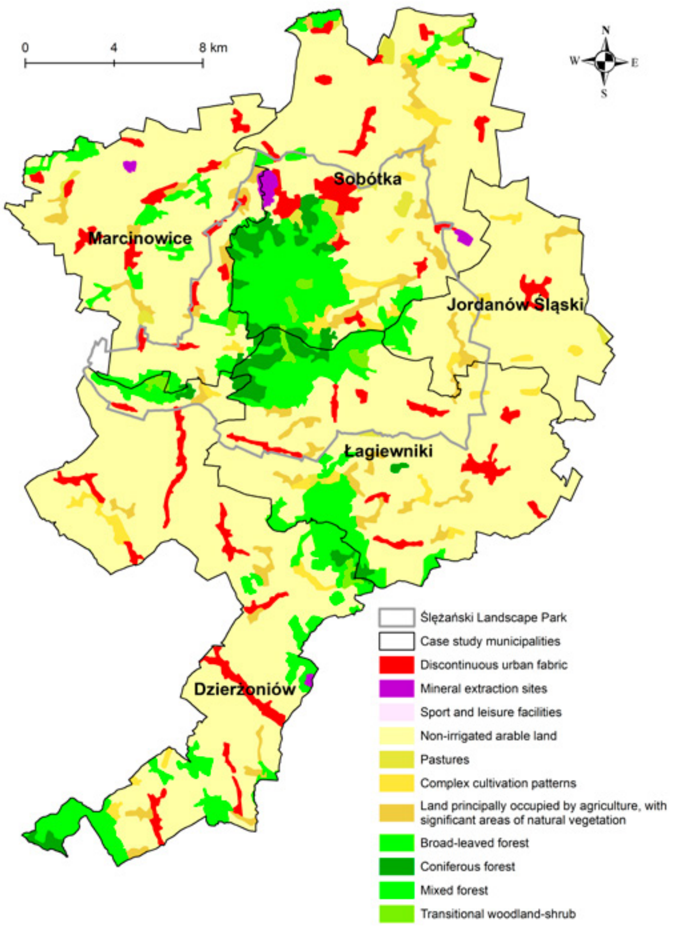

Figure 1. Case study area's land cover. For the location of the municipalities in Poland, please refer to Figure 3. Corine Land Cover 2018. Source: author's work based on Copernicus Land Monitoring Service [20-10-2022]

Source: author's work based on geoportal.gov.pl [20-10-2022].

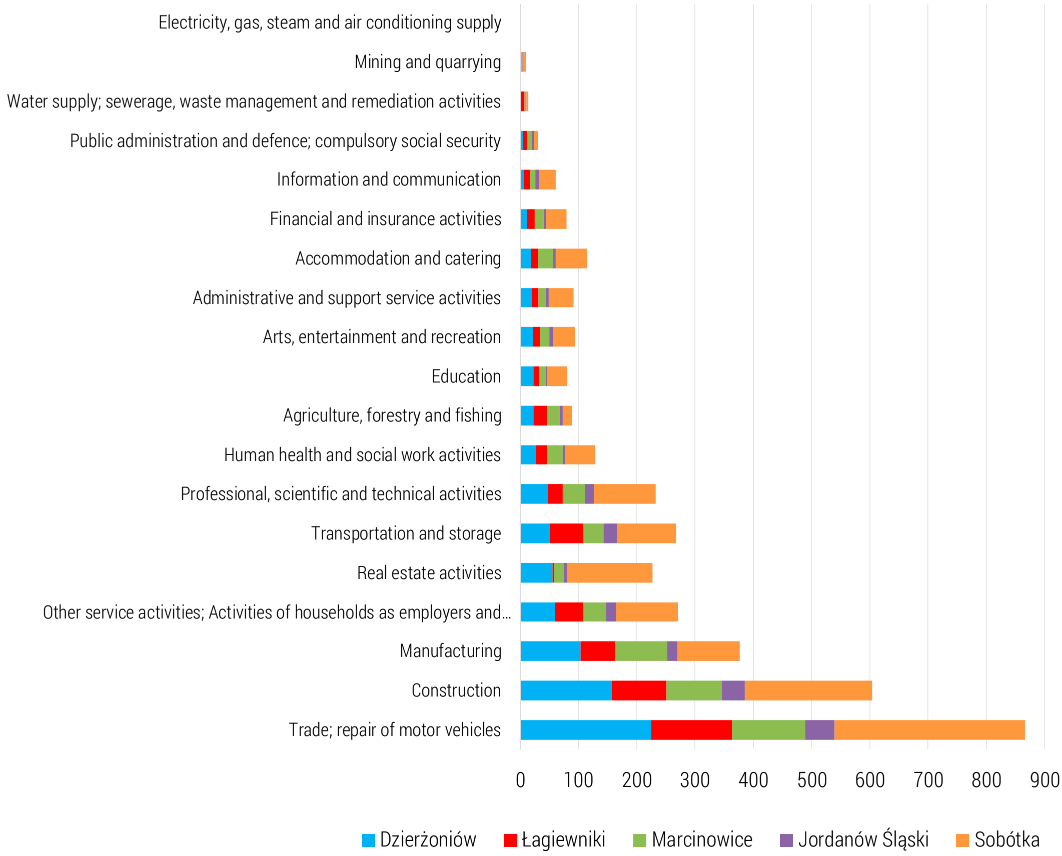

Figure 2. Number of companies by economic sectors in 2018 in case study municipalities
Source: CSO [20-10-2022].

The local economy seems to develop in the typical peri-urban way: the agricultural land is transformed into detached housing, the manufacturing outnumbers the services, and the construction sector is the strongest. In terms of the number of companies by economic sector in the case study area, there is a slight increase, however, the structure is stable. According to the International Standard Industrial Classification of economic activities, the biggest number of companies operated in 2018 within section G – trade and repair of motor vehicles, followed by section F – Construction (Figure 2) in the case study municipalities. The third most popular section was manufacturing. The biggest number of service companies operating within sections: H – transportation and storage, M – Professional, scientific and technical activities L – Real estate activities.

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The economic enterprises located in the case study municipalities are mainly small companies (Table 1). About 97% of all economic entities employ less than 9 people. Most of them are single-person businesses. The Sobótka municipality hosts the biggest number of companies. The number of companies is increasing in all municipalities, which is related to the rising number of inhabitants.

Table 1. Economic entities by size classes per 1000 population total (2012 and 2018)

Municipality	0 – 9		10 – 49		50 – 249		250 – 999		>=1000	
	2012	2018	2012	2018	2012	2018	2012	2018	2012	2018
Dzierżoniów	76.7	91.9	2.1	2.2	0.1	0.1	0	0	0	0
Łagiewniki	63.5	70.9	3.2	2.7	0.3	0.3	0	0	0	0
Marcinowice	75.5	87.6	3.9	3.4	0.2	0.2	0	0	0	0
Jordanów Śląski	61.8	66.8	2.9	2.2	0	0	0	0	0	0
Sobótka	97.6	109.3	2.9	2.6	0.6	0.5	0	0	0	0

Source: CSO [20-10-2022].

Interestingly, the number of people employed in the municipalities is, except for Sobótka, lower than the number of companies, according to CSO. This is the result of the self-employment, the small size of the companies, as well as attracting employees from other municipalities.

The information about the GDP is available in Poland at the NUTS 1 (macroregions), NUTS 2 (regions) and NUTS3 levels (selected subregions – mainly biggest cities). As GDP at the municipality level is not publicly communicated, other indicators reflecting economic development could be used to assess the level of economic performance within administrative units. For this purpose, the G-index – basic tax revenue per capita of the municipality adopted for the calculation of the equalisation subvention is used. According to the Law on Income of Local Government Units, the G-index for each municipality is calculated by dividing the amount of tax revenue by the number of residents. Tax revenues of the municipality come from property tax, agricultural tax, forest tax, tax on means of transportation tax and tax on civil law activities, proceeds from stamp duty and mining fee, share in proceeds from personal income tax and share of income tax revenue from legal entities. The more taxed activities are happening within the boundaries of the municipality, the higher the G-index while keeping the number of inhabitants constant. In 2018, the case study municipalities belonged to rather less wealthy municipalities in terms of tax revenue per capita (Figure 3). The closer to the city of Wrocław, the higher the tax revenue per capita. Figure 3 illustrates the spa-

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tial influence of Wrocław on surrounding municipalities. The Ślężą Landscape Park is located further south of this influence. The further away in the southern direction, the less of the tax revenue per capita is available in the municipalities' budgets.

Table 2. Number of people employed and the total number of companies (2012 and 2018)

	Number of people employed		Number of companies	
Municipality	2012	2018	2012	2018
Dzierżoniów	640	789	738	861
Łagiewniki	462	627	505	550
Marcinowice	443	481	515	591
Jordanów Śląski	189	274	203	218
Sobótka	1581	1714	1296	1442

Source: CSO [20-10-2022].

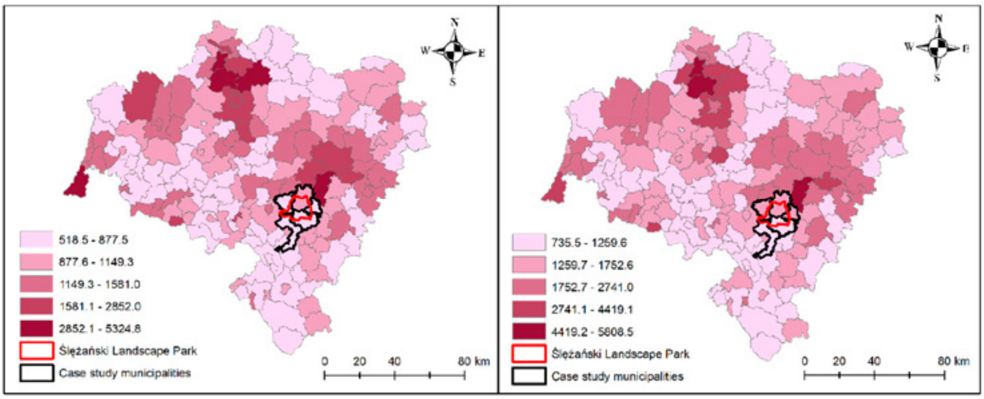

Figure 3. G-index – Tax revenue [PLN] per capita of the municipality in 2012 and 2018 for all municipalities of the Lower Silesia Region

Source: author's work based on data from the Ministry of Finance [20-10-2022].

Conceptual framework of ecosystem services, benefits and economic sectors

The conceptual framework for the assessment of the ecosystem services, benefits and beneficiaries is based on the logic chain. This framework starts from the ecosystem type that can be described by the spatial extent (e.g. in ha) and the condition (Figure 4). Very often, ecosystem type corresponds to land cover or land use. As it is described in the scientific literature (Affek,

2018) various ecosystem types have the potential to provide different ecosystem services. The actual use of ecosystem service brings benefits, which could be of direct or non-direct use (Bernués et al., 2014; Häyhä et al., 2015). The benefits are enjoyed by the beneficiaries who might represent different economic units, such as governments, society or individuals and private and public companies grouped according to the type of their main activities into different economic sectors (Figure 4). One of the internationally accepted classifications is ISIC.

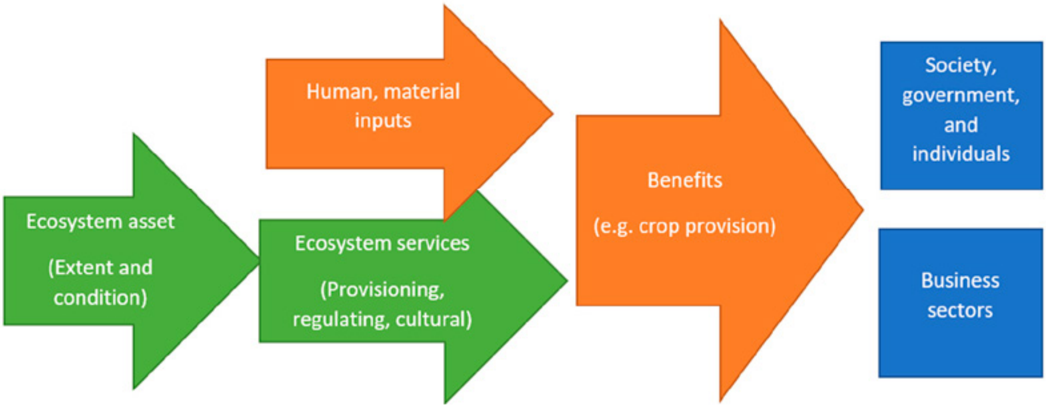

Figure 4. Conceptual framework

Source: author's work based on Keith et al. (2017).

Although the framework might seem straightforward, its practical implementation might cause difficulties (Sylla et al., 2021). While there are a lot of guidelines in the scientific literature (Yang et al., 2021) and grey literature (Burkhard et al., 2018) about the potential of different ecosystem types to provide ecosystem services, the link between benefits and economic units remains understudied. Ecosystem accounting might contribute to explaining the connection between the environment and the economy in different ways. Firstly, the aim is to consistently report information on the environment with the same units as the metrics of GDP. Therefore, the link between benefits helps to better present the welfare of nations, both in terms of direct and indirect use values (La Notte et al., 2022). The second need refers to between assessment of risk exposure of economic activities that depend on ecosystems, e.g. because of the ecological input to production, or the removal of negative externalities, and the protection from natural hazards (La Notte et al., 2022). Although the dependency of economic capital on natural capital has been widely discussed in reference to sustainable development (King et

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al., 2021), the ecosystem contributions need to be clearly assessed. The third need of estimating the flow of ES in monetary terms refers to the biodiversity financial gap, which is especially useful in cost-benefit analysis (Becla et al., 2012).

Results of the research

In order to be consistent with the aims of accounting, the Corine Land Cover data was to estimate the ecosystem extent and its changes. The magnitude of landscape changes in comparison to other Landscape Parks in Poland is average (Krajewski, 2019). The biggest flows are observed within the forest cover (245 ha) and are related to forest cuttings. The mineral extraction site was extended by 5 ha on the expense of non-irrigated arable land (Table 3). Sankey chart in Table 3 presents the source land cover type and what type it was changed into. Due to the high resolution (25m) of the data, the changes in the discontinuous urban fabric are not observed. However, the peri-urban areas experience intense housing pressures related to the process of urban sprawl.

Table 3. Ecosystem extent and land cover flows between 2012 and 2018

Land cover type	2012	2018	Land cover change flows
Discontinuous urban fabric	847.020	847.020	
Mineral extraction sites	107.087	113.048	
Non-irrigated arable land	8372.413	8366.452	
Pastures	171.069	171.069	
Complex cultivation patterns	375.298	375.298	
Land principally occupied by agriculture, with significant areas of natural vegetation	784.807	784.807	
Broad-leaved forest	1269.036	1210.609	
Coniferous forest	1182.129	1107.949	
Mixed forest	2543.591	2431.166	
Transitional woodland-shrub	45.0493	290.110	

The ecosystem types have certain potentials to provide ecosystem services (Burkhard et al., 2010; Jacobs et al., 2015). As the arable land is the dominant ecosystem type in the case study are, we are going to take a closer look into the links between this ecosystem, ecosystem services and benefits, as well as beneficiaries (Table 3). Cropland ecosystem may provide various

DOI: 10.34659/eis.2023.85.2.571

services (Power, 2010), belonging to all three types of ecosystem services: provisioning, regulating and cultural. The main provisioning service is food provision. The benefiting sectors from food provision is primarily the agricultural sector (Hełdak et al., 2022). Food is further processed, distributed, served and sold via food chains which are part of the economy. However, in order to avoid double accounting for the same benefit or product, the sector at the benefit's entry point to the economy is reported. Regulating services of arable land most often mention in the scientific literature are pest control, pollination, nutrient re/cycling, soil conservation, structure and fertility, water provision, quality and quantity and carbon sequestration. These bring benefits to the agricultural sector mainly, but also to water supply, sewage and waste management. Arable land could also provide cultural services, aesthetics being one of them (Table 4). The aesthetics are difficult to attribute to a specific sector they influence the most directly. However, based on the hedonic pricing experiences (Chwiałkowski & Zydroń, 2021; Sylla et al., 2019), we learn that aesthetic play an important role in the real estate businesses by influencing the price of housing estates. In the case study area, the aesthetics may also influence the artistic activities of small businesses which belong to the category of arts, entertainment, and recreation (Table 4). Recreational benefits can be linked to the sector of accommodation and catering, however, only in the part of the accommodation.

Table 4. Example of application of the theoretical framework

Ecosystem type	Ecosystem service type	Ecosystem service	Benefit	Benefiting sectors (CEIDG)
Cropland	Provisioning	Food provision	Crop provision	Agriculture
	Regulating and Maintenance	Soil retention control	Prevention of soil erosion	Agriculture
		Pollination	Crop provision	Agriculture
		Water storage	Water retention	Agriculture, water supply sewage and waste management
	Cultural	Aesthetic/ cultural	Aesthetic landscape	Real estate activities;
		Recreation	Recreation	Arts, entertainment, and recreation; Accommodation and catering

The benefiting sectors constituted 17% in 2012 and 14% in 2018 of all economic entities in the case study municipalities (Table 5). In the case study, the decrease in the contribution of the ecosystem stems from the pluming numbers of individual farmers. There is a country-wide trend of the falling number of farmers that follows that decrease in the number of small farms (Ambros & Granvik, 2020). The number of companies in the primary sector

DOI: 10.34659/eis.2023.85.2.571

of agriculture, forestry and fishing dropped by half, and so did the percentage of all companies. Although there is a nominal increase in companies in sectors of arts, entertainment and recreation, accommodation and catering and real estate activities, their share of the economic arena has not changed between the years 2012 and 2018 (Table 5).

Table 5. Estimating the direct impacts of benefits derived from nature to benefiting sectors

Benefiting sectors (CEIDG)	Number of companies in the sector 2012	Number of companies in the sector 2018	Percentage of all companies 2012	Percentage of all companies 2018
Agriculture, forestry and fishing	179	89	5%	2%
Water supply sewage and waste management	13	14	0%	0%
Arts, entertainment and recreation	83	94	3%	3%
Accommodation and catering	92	114	3%	3%
Real estate activities	203	227	6%	6%
SUM	570	538	17%	14%

Discussion and conclusions

The aim of this work is to present the application of the conceptual framework of linking ecosystem services, benefits and economic sectors. The framework guides the assessment in a straightforward way. It starts with the ecosystem type that can provide certain ecosystem services. Scientific literature supports the choice of ecosystem services with a rich portfolio of case studies. It is also recommended to consult stakeholders and, with their help, identify the ecosystem services and benefits (Kowalska et al., 2017). The last step is linking the benefits with benefiting sectors. The linking strategy depends on the needs of the assessment. If the need is to evaluate the contribution of ecosystems to the local economy and create the satellite environmental-economic accounts, then the direct link to sectors may be guided by the SEEA EA logic chain. However, other needs of natural capital accounting (Comte et al., 2022) could be linked to the assessment of risk exposure of economic activities that depend on ecosystems and refers mainly to regulating ecosystem services. The third need may be related to closing the gap in financing biodiversity conservation with the use of different economic instruments (Maestre et al., 2012).

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The presented application may be further developed for more detailed purposes of the analysis of the ecosystem services part of natural capital. The presented example uses publicly available data; therefore, the procedure could be repeated. However, there are certain limitations that needs to be acknowledged. Firstly, the number of companies only partially presents the economic situation of the municipalities (Przybyła et al., 2022). Moreover, the value added of the companies representing diverse sectors differs significantly. The precise contribution of ecosystems to sectors can be estimated with the use of different methods, such as the production function method (Grammatikopoulou et al., 2020), input-output analysis or with a separate methodological framework (Cerilli et al., 2020).

This paper is based on the SEEA EA, which refers to the ecosystem services part of the natural capital. There are several definitions of natural capital (Czaja, 2014; Dobrzańska, 2007; Pieńkowski, 2002), but all of them include natural resource stocks. In the presented case study, the mineral extraction site would enlarge the scope of results. On the other hand, this case study has not taken into consideration the depletion of the natural capital by degradation which is caused by the mineral extraction site. What is, however, included in the ecosystem extent accounts is the depletion of the forest cover. This would influence the provision of many ES, for instance carbon sequestration or erosion control.

To conclude, ecosystem accounting has a significant potential to serve as a tool to control the levels of natural capital. The principle of SEEA EA is to use available data to create information to support better informed decisions in spatial planning and governance (Spyra et al., 2020). Because of the fact that the conceptual framework presented in this article enhances understanding of the usage and dependence of local economy on natural capital, it can be useful to measure to the realisation of the sustainable development strategy of municipalities and understanding the conflict between environmental protection and economic development (Furmankiewicz & Potocki, 2004). However, as discovered by Stępniewska et al. (2018), the drivers of the implementation of ES concept in practice in Poland are mainly academic and international, it will be the European Union's legislative that drives the implementation of natural capital accounting in the country.

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