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Accounting for protected areas: Approaches and applications

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ABSTRACT

The System of Environmental-Economic Accounts Ecosystem Accounting (SEEA EA) provides a statistical framework for measuring ecosystems and the services they supply, complementing the System of National Accounts (SNA). Although accounting for protected areas (PAs) is proposed in the SEEA EA and would provide consistent and useful information on PAs, it has not yet been widely implemented. This article examines different possibilities of applying the SEEA EA to PAs by reviewing existing work in that field, including case studies for South Africa, Uganda and Andalusia. We show that accounting for PAs using the SEEA EA would benefit PA planning, management and investment decisions, by i) bringing statistical rigour and consistent data over time and space, ii) compiling disparate data together and making them coherent, and iii) revealing the relationships between PAs, the economy and social well-being, enabling their integration into development planning and decision making. This information can help inform better decision making by allowing synergies and trade-offs between environmental, economic and social outcomes linked to PAs and their management to be explored, fostering a more integrated development approach. This will be essential if the flagship target of the Kunming-Montreal Global Biodiversity Framework to conserve 30% of the world's surface by 2030 is to be achieved in an ecologically meaningful, economically sustainable and socially inclusive manner.

1. Introduction

The System of Environmental-Economic Accounting Ecosystem Accounting (SEEA EA) framework was adopted as a set of international statistical standards and recommendations in 2021 (United Nations et al., 2021). The SEEA EA provides accounting principles, classifications and measurement boundaries for organising data on ecosystems and related themes, including protected areas (PAs). This can provide a flow of regular and consistent information on the state, trends and even benefits from PAs (e.g., ecosystem services, climate change mitigation, contributions to economic activity and human well-being). As the SEEA EA is consistent with the accounting rules and exchange value principles of the System of National Accounts (SNA), it can also facilitate mainstreaming PAs into economic planning and monitoring processes. Furthermore, the systematic use of the SEEA EA would help build consistency across countries. This may be particularly useful in the context of transboundary PA management and for building a better understanding of progress towards global objectives for nature protection. Accounting for PAs is mentioned as an option in the SEEA EA but has been little explored in practice to date.

PAs, as geographically defined areas "designated or regulated and managed to achieve specific conservation objectives" (Article 2 of the CBD), have long been a key management tool to conserve species and ecosystems, without which the loss of biodiversity would be even greater (e.g., Gray et al., 2016). Aichi Target 11 of the Strategic Plan for Biodiversity 2010–2020 of the UN Convention on Biological Diversity (CBD) set out to protect 17% of the land and 10% of the ocean by 2020 and drew attention to the importance of PA networks being ecologically representative, well connected and equitably managed.

Building on Aichi Target 11, the recently adopted Target 3 of the Kunming-Montreal Global Biodiversity Framework (GBF) calls for an expansion of protected areas and conservation areas to 30% of the

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earth's surface by 2030 (hereafter 30×30). Target 3 reaffirms, *inter-alia*, the commitment for PA networks to be ecologically representative, well connected and equitably managed. According to the World Database on Protected Areas (WDPA), as of June 2023, 16.1% of the land and 8.2% of the ocean were protected (UNEP-WCMC and IUCN, 2023). Achieving this flagship 30×30 target necessitates a substantial and rapid expansion of the global network of protected and conserved areas in both landscapes and seascapes around the world. The focus of this article is on protected areas; however, in principle, the same approaches discussed here would apply to Other Effective area-based Conservation Measures (OECMs), which are also considered to contribute to the 30x30 target (in June 2023, 17.2% of land and 8.3% of the ocean were protected when OECMs are also taken into account).

PAs are also recognised as fundamental for achieving many of the Sustainable Development Goals (SDGs). SDG 14 (Life under water) and 15 (Life on land) call for the conservation and sustainable use of marine and terrestrial ecosystems, including protection of Key Biodiversity Areas. Beyond the conservation benefits of PAs, there has also been an increased focus on protecting ecosystem services and social benefits delivered by PAs. Efforts to reframe what PAs are and their relationship to people increasingly recognise their role not only for conserving biodiversity but also for protecting ecosystems that deliver important services for climate change mitigation and adaptation (e.g., Smith et al., 2020), supporting rural livelihoods, local economic development, and job creation (e.g., Woodhouse et al., 2018). Therefore, PAs also have an important role to play in attaining SDGs other than SDG 14 and 15 (Dudley et al., 2017).

To manage PAs effectively and plan the necessary expansion of PA networks to meet the 30x30 target, decision makers will need clear and regular information on PAs and the benefits they provide that is consistent over space and time. This will allow them to consider benefits, synergies, trade-offs and opportunity costs associated with PAs and their expansion in the context of wider development objectives. This, in turn, is critical if PA networks are to be expanded in an economically sustainable and socially equitable way. In this context, provision of indicators offering robust, credible evidence on PAs is crucial to informing policy development, planning and for fostering management responses that are coherent across policy areas. This article examines the SEEA EA as a framework to support decision makers in providing these indicators, notably considering three case studies.

The remainder of this article is structured as follows: Section 2 describes the links between National Accounting and the SEEA EA; Section 3 reviews the existing literature on applying the SEEA EA for accounting for PAs; Section 4 provides three case studies, for South Africa, Uganda and Andalusia in Spain; Section 5 further discusses the advantages and limitations of applying the SEEA EA to PAs; and Section 6 presents conclusions.

2. Links between national accounting and the SEEA EA

For over half a century, governments and businesses have used information from the SNA in economic analysis and policy (Vardon et al., 2018). Gross Domestic Product (GDP), broadly the value added generated by national production activities (EC et al., 2009), is the ubiquitous monetary aggregate derived from the SNA. Whilst GDP has often been taken as a measure of welfare, the SNA makes no claim that this is so (EC et al., 2009). In particular, it is well known that the SNA fails to fully account for the environment, both in terms of the economic benefits it provides and the environmental degradation that results from various economic activities (Vardon et al., 2018; Vardon et al., 2019).

The SEEA emerged around the time of the 1992 UN Conference on the Environment and Development as an integrated accounting approach to address this failing (UN et al., 2014). The SEEA consists of two parts, the SEEA Central Framework (CF) and the SEEA EA. The SEEA CF complements the SNA by accounting for stocks, and changes in stocks, of environmental resources (e.g., minerals, timber, commercial fisheries) and the flows of environmental resources into the economy (e.g., timber) and flows back into the environment (e.g., emissions). The physical accounts of the SEEA EA, which were adopted as an international standard by the UN Statistical Commission in 2021, extend the SEEA CF thinking by considering ecosystems and the broad range of services they deliver. This includes ecosystem services that contribute to benefits already captured in the SNA (e.g., timber, termed SNA benefits) and benefits that are not captured in the SNA (e.g., recreation, flood protection, climate regulation, collectively termed non-SNA benefits). The SEEA EA also provides for monetary accounts for these ecosystem services and the underpinning ecosystem assets, describing statistical principles and recommendations for the valuation of ecosystem services and assets (United Nations et al., 2021).

The physical stocks of ecosystem assets are measured via changes in the extent of different ecosystem types and their condition over an accounting period, in the form of ecosystem extent and condition accounts. Information on the flows of ecosystem services over the accounting period is organised within physical and monetary ecosystem services supply and use accounts. These record the flow of ecosystem services from different ecosystems (suppliers) to different users (e.g., households, businesses, governments). The monetary value of expected future flows of ecosystem services from ecosystems (based on net present values) then informs the monetary ecosystem asset (stock) accounts (United Nations et al., 2021). These five core accounts of the SEEA EA are presented in Fig. 1. They may be compiled *in toto* or in modular fashion for a geographical area, termed an Ecosystem Accounting Area (EAA) (e.g., country, watershed, municipality, PA). The physical accounts provide the basis for monetary accounts and are an essential starting point.

Combining ecosystem accounting data with standard economic data is increasingly of interest as countries recognise threats to ecosystem services and implement policies to address these. Indeed, Target 3 of the GBF explicitly recognises the need for protecting areas of importance for ecosystem services as part of 30x30. Chapter 11 of the SEEA EA highlights how information on ecosystem services supply and use can be aligned with economic activities recorded in the SNA via extended supply and use tables. This is illustrated in the right-hand side of Fig. 1. Two further possibilities to align ecosystem accounting and SNA data are highlighted in this paper: Extending the production and generation of income accounts for institutional sectors by including the value of ecosystem service contributions; and, Extending the balance sheet of the SNA by including the value of ecosystem assets.

Recognising the above, Fig. 1 illustrates how the SEEA EA and SNA can provide a system's perspective on the state of environmental assets (including PAs) and their contributions to the economic activity. The principles, classifications, measurement boundaries and concepts consistently applied across this accounting mechanism brings coherence to disparate environmental and economic data, facilitating integration and bringing consistency across time and space to indicators on different environmental-economic themes.[1]

3. Applying the SEEA EA to protected areas: Review of approaches

The SEEA EA also supports 'thematic accounting', which recognises that policy responses are typically framed using themes, rather than specific accounts. Thematic accounting allows a focus on additional entities outside of the core accounts (e.g., species in the context of accounting for biodiversity), specific geographical areas or ecosystem types (e.g., urban areas or oceans) and for building a set of relevant SEEA EA and other accounts for a theme (e.g., climate change). Whilst

[1] It is highlighted that the use of the environment as a waste sink can also be captured in the accounting mechanism, via the SEEA CF accounts of emissions from the economy to the environment.

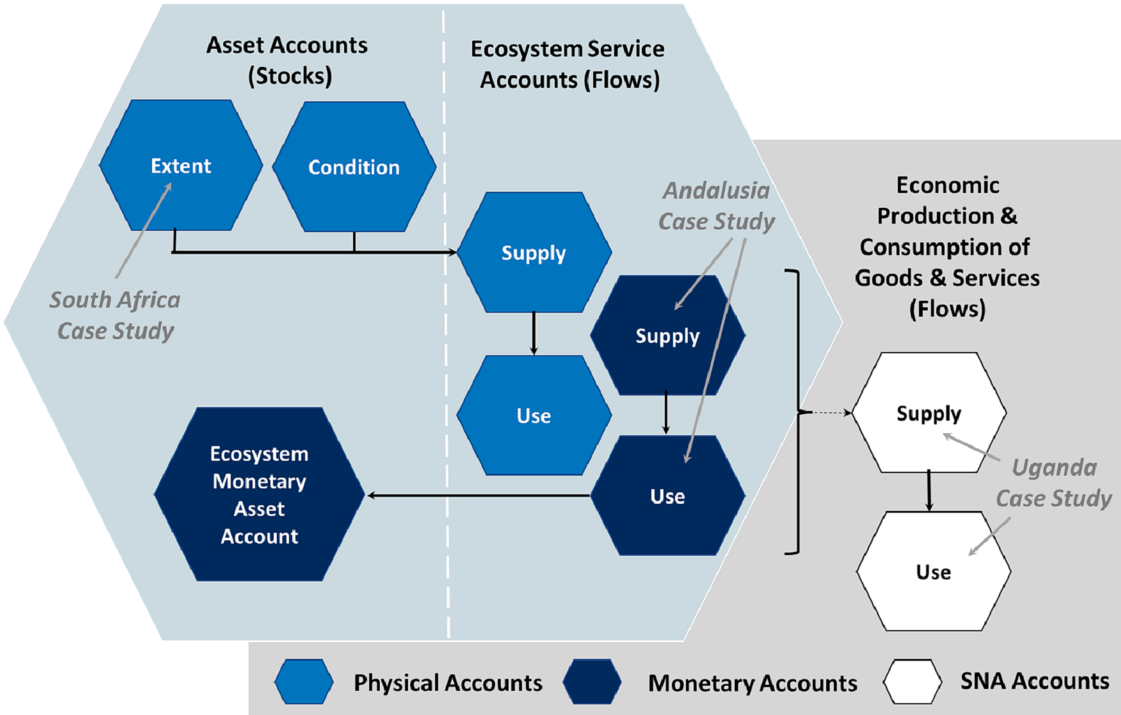

Fig. 1. Core SEEA EA Accounts and extended to SNA economic supply and use accounts. The physical accounts (light blue) have been adopted as an international standard, while principles and recommendations are provided for the monetary accounts (dark blue) (adapted from https://seea.un.org/ecosystem-accounting). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

thematic accounting for PAs is mentioned in the SEEA EA, there is no specific guidance on its implementation.

As illustrated in Fig. 2, the following approaches to thematic accounting for PAs can be envisaged (which may be implemented in combination):

1) PAs as accounting entities – this includes tracking the extent or coverage of PAs over accounting periods. Using a country as an Ecosystem Accounting Area (EAA) would enable countries to track progress towards 30x30 by PA type and the ecological representativeness of the PA network;
2) PAs as EAAs – this involves applying the SEEA EA more comprehensively to the area delineated by a PA boundary (or set of PA boundaries). This can reveal the composition and condition of ecosystem types within specific PAs as well as ecosystem services supplied by specific PAs and their use by households, businesses and government. This would allow the economic and social benefits these PAs provide to be integrated into national, sub-national and sector-level data and planning; and,
3) Accounting for PAs in landscapes and seascapes – this includes evaluating the synergies and trade-offs between biodiversity conservation, ecosystem services supply and economic activity options at the landscape or seascape scale, to assist planning in the context of different land and sea use possibilities.

The main difference between approaches 2 and 3 is that the PA boundary forms the geographic area, the EAA, for which accounts are compiled under approach 2. Whereas, in approach 3, a larger landscape scale EAA is considered in which information is stratified by protected versus non-protected area.

Whilst not widespread, several countries have now compiled SEEA ecosystem accounts with a focus on PAs. MoSPI (2020) have compiled

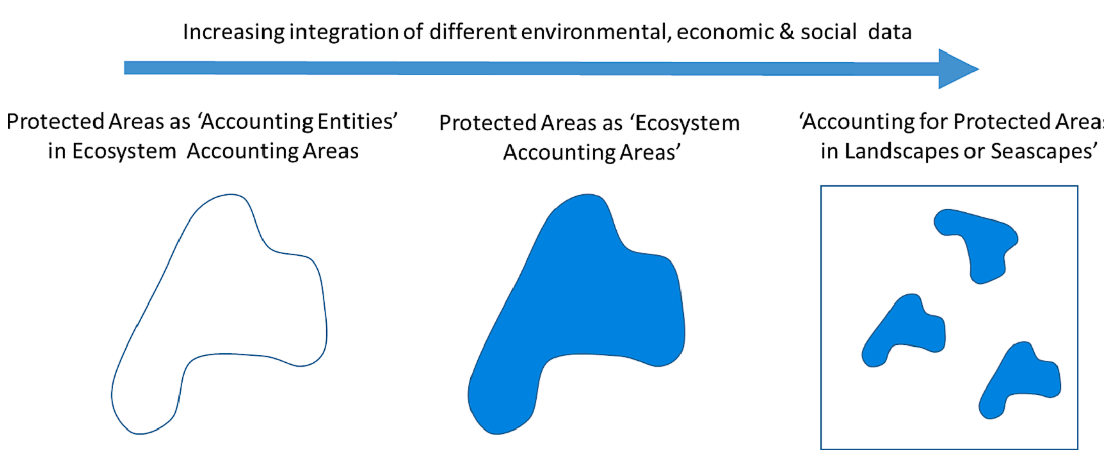

Fig. 2. Possible approaches to thematic accounting for PAs.

statistics on the number and extent (area) of terrestrial and marine PAs in India at state level from 2000 to 2019. This is essentially an account of trends in PA extent following approach 1 in Fig. 2 (i.e., PAs as accounting entities). For terrestrial ecosystems, the extent of PAs is disaggregated according to national park, wildlife sanctuary, community reserve, and conservation reserve designations. The extent of marine PAs is presented by state and designation type, together with year of establishment. These accounts readily reveal to policy-makers the PA coverage in India, as well as associated levels of protection.

White et al. (2015) compiled ecosystem extent, condition, physical flow and monetary flow accounts for several PAs in England and Scotland, following approach 2. The accounts were implemented to test principles and practical applications of spatially explicit accounting methodologies. They draw on a range of data for the period 2007 to 2013, including for extent (2007 only), condition (mostly 2013), ecosystem service flows (2007 and 2013) and asset values (2013 only). White et al. (2015) highlight that the accounting approach supports consistent comparisons across PAs and years, brings disparate data for PAs together in a coherent fashion, and facilitates comparisons alongside data in the SNA.

Varcoe et al. (2015) compiled physical and monetary ecosystem accounts for the parks network in Victoria, Australia, also following approach 2. The ecosystem extent and condition accounts track trends in native vegetation, wetlands, rivers and marine ecosystem types in different IUCN categories of PAs between 2010 and 2014. The ecosystem services accounts cover a range of provisioning, regulating and cultural services and provide yearly flows in physical and monetary terms based on data from between 2010 and 2014. The set of accounts were designed to help inform park management, investments in natural capital and public land-use planning. A key application of the consistent information the accounts can provide is evaluating the returns on investment in conservation programs or ongoing natural resource management activities in PAs (Varcoe et al., 2015). This more transparently demonstrates the return on investment in meeting government objectives for the environment, economic growth and community well-being.

Focusing on a specific PA (approach 2), IDEEA Group (2020) developed a range of pilot ocean accounts for Geographe Marine Park in Australia. The accounts were compiled to evaluate the potential of the SEEA EA to inform management of Australia's marine national parks, an important part of the government's approach to managing Australia's oceans (IDEEA Group, 2020). The accounts provide information on ecosystem extent (for 2014), condition (for 2014) and annual ecosystem services flows (various years between 2014 and 2019). The benefits of the accounting approach are the ability to consolidate disparate data, provide robust and consistent information, link ocean ecosystem assets to cultural, health and economic benefits, bring coherence between local and national decisions and support multiple uses based on one-off data collection.

Broadly following approach 3 in Fig. 2 (i.e., 'Accounting for PAs in landscapes'), UNEP-WCMC and IDEEA (2017) compiled a set of experimental ecosystem accounts for Uganda. These include national ecosystem extent accounts that track conversion of natural ecosystems to intensive land uses inside and outside of PAs between 1990 and 2015. One of the key policy applications of the accounts was to inform the national debate surrounding gazettement (or declaration) and degazettement (or downgrading or downsizing) of PAs. The accounts reveal that PAs have performed well in preventing conversion of natural ecosystems, against a background of continuing loss of these ecosystems in the wider landscape outside of PAs. They have also performed well in protecting the habitat of iconic species for wildlife-watching tourism, a key sub-sector in Uganda's economy, and important non-timber forest species (UNEP-WCMC and IDEEA, 2017).

In another example of approach 3, Forestry England (2021) produce annual natural capital accounts to reveal how both protected and non-protected forests within the landscape areas they manage contribute to different national objectives for forests. The accounts are compiled using a corporate scale adaptation of the experimental precursor to the SEEA EA (Eftec et al., 2015). The 2020–2021 accounts present economic benefits (from timber, mineral, plant, seed and food production), social welfare benefits (from carbon sequestration and public access / recreation) and indicators of forest biodiversity for both protected and non-protected forests. This allows different forest land-use options and associated synergies and trade-offs between biodiversity conservation, ecosystem services and economic activities to be considered across the entire estate (the overall ecosystem accounting area) that Forestry England manages.

4. Accounting for protected areas: Detailed case studies

The literature described above highlights that the SEEA EA framework can bring disparate data on PAs together and deliver consistent, reliable, and new data to decision-makers. The following case studies present more detailed applications of the SEEA EA to PAs in South Africa, Uganda and Andalusia, Spain, and illustrate how they can support decision-making. The case studies cover different parts of the SEEA EA framework as identified in Fig. 1, and different approaches described in Fig. 2. In each case study, account tables structured according to national accounting principles are compiled for one or (preferably) several accounting periods, providing a consistent basis for deriving indicators related to policy needs.

The South African case study focuses on accounting for PAs as discrete 'accounting entities' using the national scale for the EAA, the first approach in Fig. 2. Information on the trends in the extent of different PA types and their ecosystem composition is compiled in the accounts. This provides information on the stock of PAs, following the structure of the ecosystem extent account in Fig. 1. These accounts provide a tool to consistently monitor and report on changes in the PA network over 120 years and their performance with respect to ecologically representative coverage.

The Uganda case study focuses on PAs as distinct EAAs delineated by boundaries of national parks key to the wildlife-watching tourism sub-sector. This broadly reflects the second approach in Fig. 2. These accounts provide integrated information on the extent of natural ecosystems within specific PAs and the recreation-related ecosystem services they supply, which are used by different types of tourists. They follow the structure of the ecosystem extent and ecosystem services supply and use accounts in Fig. 1. They also include species accounts described in Chapter 13 of the SEEA EA and a form of the extended supply and use tables described in Chapter 11 of the SEEA EA. The extended supply and use tables link information on PAs to the supply and use of products and services recorded in the SNA, via the ecosystem services they supply.

The Andalusia case study presents monetary ecosystem services contributions to ten services supplied by Andalusian forests located in PAs (AFPAs) as part of the wider Andalucian landscape. The case study broadly follows the third approach for thematic accounting for AFPAs in Fig. 2. It applies the SEEA EA recommendations to value these services using 'residual value and resource rent methods' (See para 9.36 of the SEEA EA). As such, these monetary values reveal the hidden value of ecosystem service contributions embedded in respective outputs (or benefits) from AFPAs. These accounts follow the structure of the supply table in the ecosystem services supply and use accounts in Fig. 1. Possibilities to integrate this information with information from the SNA via production and generation of income accounts and extended balance sheets are also discussed (as mentioned in Chapter 11 of the SEEA EA).

4.1. South Africa

The importance of PAs is highlighted in the South Africa's National Development Plan (NPC 2012) as well as the National Protected Area Expansion Strategy (DEA, 2016). PAs are recognized as national assets that deliver important regulating, provisioning and cultural ecosystem services to people, playing a central role in the nature-based tourism sector, and often supporting rural development, job creation and social well-being (Skowno et al., 2019; Driver et al., 2019). Targets for PA expansion are set by government to meet provincial, national and international goals.

South Africa's first set of accounts for PAs (Statistics South Africa, 2021a) track the development of the PA network from 1900 until 2020, showing the size and changing composition in terms of different types of PAs, as well as the coverage of terrestrial biomes in the PA network. The geographical focus for the accounts is South Africa's terrestrial mainland, including all land-based PAs that are formally recognized in South Africa's PA legislation (National Environmental Management: Protected Areas Act (Act No. 57 of 2003)), as shown in Fig. 3.

The period 1900 to 2020 was divided into 11 accounting periods, with 20-year intervals from 1900 to 1960, ten-year intervals from 1960 to 2000, and five-year intervals from 2000 to 2020. The PA dataset (derived from the South African Protected Areas Database (SAPAD) maintained by the Department of Forestry, Fisheries and the Environment (DFFE)) was used to construct spatial data layers reflecting the PA network at the closing date of each accounting period. The accounts are non-monetary and yield four main indicators:

- Size of the PA network;
- Proportion of the country (or province or biome) covered by PAs;
- Percentage change in the size of the PA network for a given accounting period; and
- Composition of the PA network in terms of different designations / types of PAs.

Table 1 shows the PA extent account for the period 1990 to 2020 (which condenses five of the accounting periods from the full set of account tables into three). Declaration dates for PAs established in earlier decades are less certain, for a range of reasons, and it was important to emphasize this in presenting the account tables and results.

In addition to the PA extent accounts compiled nationally, accounts were also compiled for sub-national areas to report the growth and composition of the PA network across South Africa's nine terrestrial biomes and nine provinces. The biomes aggregate 458 terrestrial ecosystem types identified in the South African National Ecosystem Classification System (Dayaram et al, 2021), which also formed the basis for South Africa's terrestrial ecosystem accounts (Statistics South Africa, 2020). The PA network has expanded in all provinces and in all biomes across South Africa, but not evenly. The Savanna biome, which is the largest in South Africa, has the largest total area protected in absolute terms (5.54 million hectares) and has been relatively well represented in the PA network for a long time, including by well-known PAs such as the Kruger National Park. Although the Forest biome has the highest proportion protected (40.1%), it is a naturally rare biome, making up less than 1% of South Africa's area, so in absolute terms the amount protected is relatively small. The Grassland and Nama-Karoo biomes, both large, have the smallest proportion protected, highlighting the need for increased protection of the ecosystem types in these biomes.

The publication of these accounts by the South African National Statistical Office (NSO), Statistics South Africa, has helped to elevate the visibility of the PA network and to bring information about PAs to a wide audience. The report (Statistics South Africa, 2021a) sets out high-level

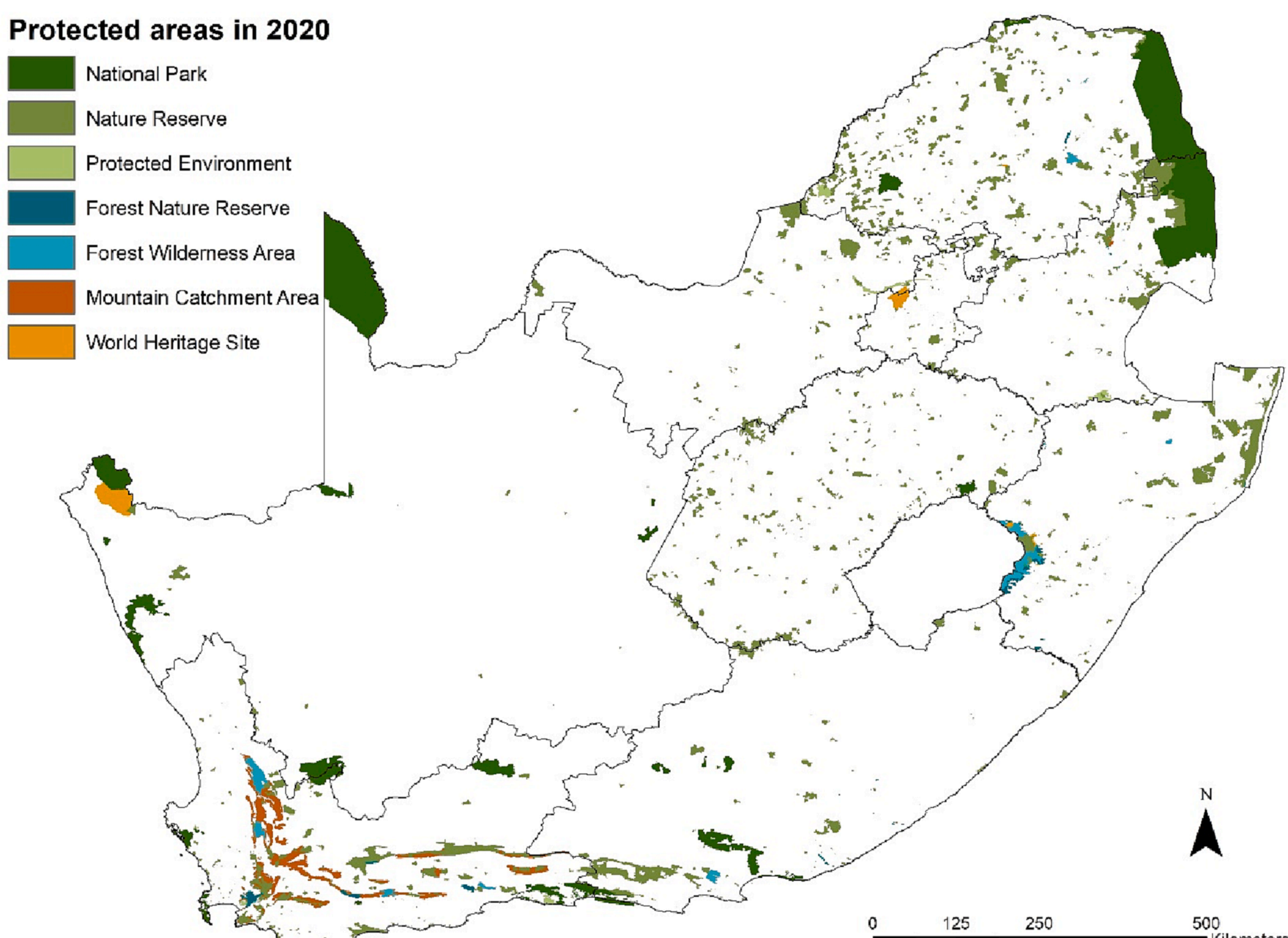

Fig. 3. South Africa's land-based PA network in 2020 was 11 280,684 ha, covering 9.2% of the terrestrial mainland and comprising six different types of PAs (Note: World Heritage Sites show only the portion that does not overlap with other PA types).

Table 1
Accounts for land-based PAs in South Africa for the period 1990 to 2020 (combining five accounting periods), by type of PA using the standard asset accounting structure of the SEEA.

	National Park	Nature Reserve	Protected Environment	Forest Nature Reserve	Forest Wilderness Area	Mountain Catchment Area	World Heritage Site*	Not protected	Total land area	Total protected (ha)	Total protected (%)
Opening Stock 1990	**3 604 693**	**3 089 386**	**12 022**	**121 996**	**277 433**	**559 421**	**–**	**114 301 502**	**121 966 453**	**7 664 951**	**6.3%**
Additions to stock	279 398	905 194	63 785	6 172	–	2	766	1	1 255 318		
Reductions in stock	–	− 3	–	− 1	–	–	–	−1 255 314	−1 255 318		
Net change in extent	279 398	905 191	63 785	6 171	–	2	766	−1 255 313	–	1 255 313	
Net change as % of opening	*7.8%*	*29.3%*	*530.6%*	*5.1%*	*0.0%*	*0.0%*		*−1.1%*	*0.0%*	*16.4%*	
Closing stock 2000	**3 884 091**	**3 994 577**	**75 807**	**128 167**	**277 433**	**559 423**	**766**	**113 046 189**	**121 966 453**	**8 920 264**	**7.3%**
Additions to stock	199 853	244 307	26 053	–	–	–	213 470	2	683 685		
Reductions in stock	− 2	− 3	–	–	–	− 1	–	−683 679	−683 685		
Net change in extent	199 851	244 304	26 053	–	–	− 1	213 470	−683 677	–	683 677	
Net change as % of opening	*5.1%*	*6.1%*	*34.4%*	*0.0%*	*0.0%*	*0.0%*	*27868.1%*	*−0.6%*	*0.0%*	*7.7%*	
Closing stock 2010	**4 083 942**	**4 238 881**	**101 860**	**128 167**	**277 433**	**559 422**	**214 236**	**112 362 512**	**121 966 453**	**9 603 941**	**7.9%**
Additions to stock	134 965	784 033	701 158	17 624	1	6	38 959	–	1 676 746		
Reductions in stock	–	− 3	–	–	–	–	–	−1 676 743	−1 676 746		
Net change in extent	134 965	784 030	701 158	17 624	1	6	38 959	−1 676 743	–	1 676 743	
Net change as % of opening	*3.3%*	*18.5%*	*688.4%*	*13.8%*	*0.0%*	*0.0%*	*18.2%*	*−1.5%*	*0.0%*	*17.5%*	
Closing stock 2020	**4 218 907**	**5 022 911**	**803 018**	**145 791**	**277 434**	**559 428**	**253 195**	**110 685 769**	**121 966 453**	**11 280 684**	**9.2%**

*Note that World Heritage Sites show only the portion that does not overlap with other PA types.

account tables and draws out some key policy-relevant findings but does not make policy recommendations because that goes beyond the mandate of the NSO as a producer, rather than user, of statistics. The report, together with the underlying datasets and detailed accounting tables, are freely available to inform policy, planning and decision-making by the environment ministry and conservation authorities, other departments/ministries such as tourism, agriculture and rural development and water, and other actors such as NGOs and the private sector.

The intention is to update the accounts for PAs on a regular basis, as part of the implementation of South Africa's National NCA Strategy (Statistics South Africa, 2021b). Future iterations of the accounts will include marine PAs, which in 2018 covered 5.4% of South Africa's marine territory (Sink et al., 2019). The aspiration is also to include demographic and economic information related to PAs, such as information from the population census on levels of income and employment among communities surrounding PAs, to provide information on the social and economic contribution of PAs.

A key challenge in compiling the accounts was to clean data and restructure datasets that had not been developed for accounting purposes into a time series of accounts-ready data. This was a time-consuming and technical process, which involved investigation with conservation authorities and DFFE to resolve inconsistencies, overlapping types of PAs and gaps in attribute data. The rigor required of accounts to avoid double counting and ensure consistency of classification of PA types resulted in better quality data overall and more accurate accounting tables.

Another lesson learnt was around allocating sufficient time to the process of interpretating the accounts to draw out key findings, including holding a validation workshop with key data owners and experts (such as conservation authorities). These workshops also helped clarify the fine line between drawing out findings that are policy relevant and making policy prescriptive recommendations. They were important both in terms of a quality product and for uptake and use of information from the accounts.

4.2. *Uganda*

The Uganda biodiversity and tourism accounts were compiled to help inform Uganda's Green Growth Development Strategy, which targets "Tourism and the Wildlife Sector" as one of four natural capital sectors for growth, aiming to quadruple the value of foreign tourism by 2030. They also serve to inform critical decisions to revitalise the wildlife-watching tourism sub-sector, attract tourists anew and sustain this major contributor to the economy post COVID-19. The geographical focus of the accounts was on 12 key PAs for wildlife-watching tourism in Uganda (Fig. 4). NEMA (2021a) presents the accounts in full, which most comprehensively cover the period 2000 to 2019.

Wildlife-watching tourists are attracted to Uganda to see iconic species in their natural environment. As such, the more natural ecosystems and species a PA contains, the more tourism it is likely to attract and sustainably support. These 'stocks' are tracked via natural ecosystem extent accounts (as per Fig. 1) and species accounts. Species accounts are proposed in the SEEA EA as part of thematic accounting for biodiversity, to better integrate this component of biodiversity into the framework. The natural ecosystem extent accounts are compiled from the land cover maps used for the national land physical asset accounts (UBoS, 2019). They present the extent of different natural land cover classes and non-natural land cover (essentially farmland or plantation) in aggregate over an accounting period. These can be extended to track changes in ecosystem types by intersecting with a map of natural vegetation type (following UNEP-WCMC and IDEEA, 2017). The species

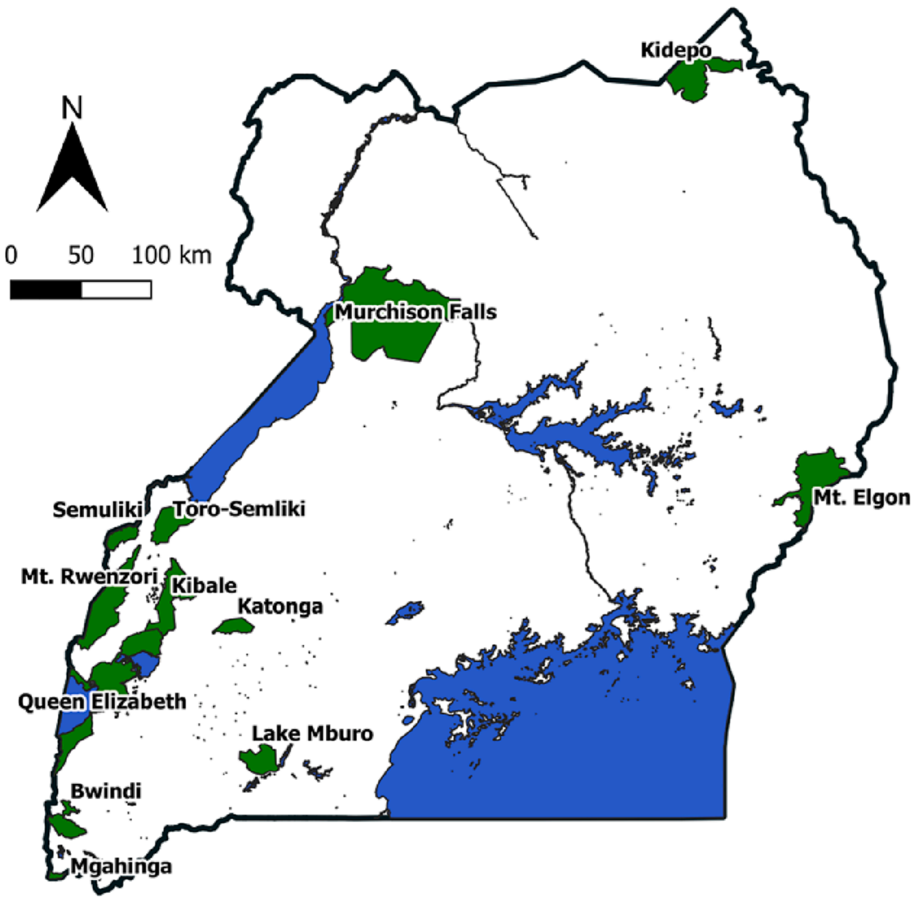

Fig. 4. PAs used for the Biodiversity and Tourism Accounts of Uganda (PA extent and location identified in green, water bodies identified in blue). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

accounts are compiled using data from the Uganda Wildlife Authority (UWA) State of Wildlife Resources 2018 report (UWA, 2018). They track the abundance of selected iconic species in different PAs over time.

A full set of results for each of the 12 PAs and for all 12 PAs in aggregate is provided in NEMA (2021a). As an example, the natural ecosystem extent for Queen Elizabeth National Park reveals that the extent of non-natural ecosystems within the park decreased to almost zero by 2017 (503 ha), from 6,263 ha in 2000. The species accounts show a reasonably high number of elephants (2,913 in 2014), buffalos (15,771 in 2014) and an important population of lions (144 in 2010) in the national park (three of Africa's 'Big Five' game species). The overall picture is that the quality of Queen Elizabeth National Park for wildlife-watching tourism is being maintained.

The ecosystem services accounts focus solely on 'recreation-related' ecosystem services for wildlife-watching tourism, and their use by visitors. These accounts were compiled using data from gate registers and receipts as visitors enter PAs. Following the conventions of the SEEA EA, the use of this cultural ecosystem service is attributed to the visitors experiencing the ecosystem, not to the government agencies or businesses managing or providing access to the PAs. The physical accounts for recreation-related ecosystem services reveal that visits to the 12 PAs combined increased from approximately 210,000 in 2011 to approximately 323,000 in 2019.

There are a set of monetary transactions at the 12 PAs that realise value from the use of the recreation-related ecosystem services by visitors. These fall within the measurement boundary of the SNA (i.e., these reflect real economic transactions between different economic units in the economy). This includes expenditure on park entrance fees (calculated from gate receipts) and expenditure on wildlife-watching activities in PAs (revenues advised by the UWA, e.g., for gorilla tracking). It also includes expenditure by international tourists on hotels, meals, retail and travel services associated with their visit to the PA. This was imputed from Tourism Expenditure and Motivation Surveys (TEMS) for Uganda (World Bank, 2013, 2020). This expenditure is recorded within a set of extended SNA goods and services supply and use accounts, as described in Chapter 11 of the SEEA EA framework. This expenditure is by users of the recreation-related ecosystem services only, as described above (i.e., the ecosystem service users and SNA Goods and Services consumers in Fig. 5 are the same set of individuals). The relationship between the set of accounts compiled for the 12 PAs in Uganda is summarised in Fig. 5.

The SNA goods and services accounts connect the stocks of natural ecosystems and iconic species of Uganda National Parks to the economic activities they support, via the supply and use of recreation-related ecosystem services. The SNA goods and services account for 2019 is presented in Table 2.1 (supply) and Table 2.2 (use). They describe expenditure on SNA goods and services produced by different economic units and their consumption by different types of tourists during their visits to the 12 PAs. They reveal that the total economic expenditure by tourists associated with their visits to the 12 PAs increased from around US$25 million in 2012 to nearly US$51 million in 2019. A large proportion of this expenditure can be linked to export revenues associated with visits by international visitors / tourists.

The ecosystem services and SNA goods and services accounts reveal that the wildlife-watching tourism sector developed strongly between 2012 and 2019 across the 12 PAs. Whilst the COVID-19 pandemic had a devastating effect on the sector, the accounts highlight the economic importance of maintaining funding to conserve and enhance Uganda's natural ecosystems and iconic species. This is essential to the success of the wildlife-watching tourism sector over the medium term and in the

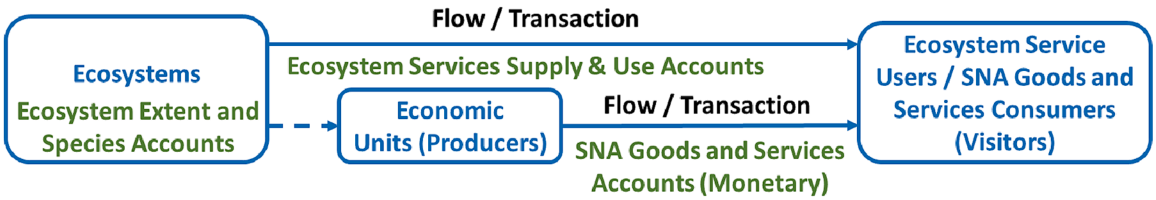

Fig. 5. Transactions between ecosystems, economic units and consumers (i.e., tourists), adapted from Eigenraam and Obst (2018)

Table 2.1
SNA Goods and Services Supply Accounts of goods and services supplied by UWA and businesses (producers) to different tourists (consumers) during their visits to PAs in 2019, using standard supply and use table structure.

Classifications ≫	PRODUCERS		
	Government (UWA run National Parks)	Businesses (Private operators)	Total
SNA Supply Goods & Services (2019, USD^)			
Park entrance	6,938	–	6,938
Vehicle entrance	213	–	213
Gorilla tracking	19,415	–	19,415
Other recreational activities	4,149	–	4,149
Hotels, bars and restaurants (International)	133	11,073	11,206
Retail trade (International)	–	2,756	2,756
Travel services (International)	–	3,950	3,950
Other services (International)	–	2,021	2,021
TOTAL	30,849	19,799	50,647

context of post-COVID-19 recovery.

Queen Elizabeth and Murchison Falls National Parks are well-established tourist attractions. More recently, the SNA goods and services accounts show gorilla trekking in Bwindi and Mgahinga National Parks has been an important revenue earner for UWA. This is expenditure is 'unallocated' in Table 2.2 but is understood to be largely expenditure by international tourists. Going forward, investment in innovative tourism packages, access and facilities could be promoted elsewhere. Kidepo Valley, the Rwezori Mountains and Mount Elgon national parks offer significant advantages due to their size and the natural ecosystems or species they contain. Poverty incidence around Kidepo Valley and Mount Elgon National Parks is also known to be relatively high, so boosting tourism activity there could deliver important livelihood and revenue sharing opportunities (see NEMA, 2021a).

In future iterations, it would be useful to include additional ecosystem services to better inform the overall contribution of Uganda's PAs to the economy and society. For instance, water related ecosystem services could be included, potentially making connections to water accounts recently published in Uganda (see UBoS, 2021), and provisioning services to local communities. A set of lessons learned from implementing the project is presented in NEMA (2021b). An important lesson was allocating sufficient resources for engaging data producing institutions from the outset. As ecosystem accounting is a new area of statistics, it is also important to build a broad and common understanding of concepts and familiarity amongst stakeholders at an early stage in the account compilation process, to support both the production and use of the accounts.

4.3. Andalusia

The forests of Andalusia provide a wide range of economic goods and services that are either omitted or undervalued in the gross value added by the economy, as measured by the SNA. The absence of explicit information on the contribution of forest ecosystem services to the economy motivated the regional government of Andalusia (Spain) to contract the RECAMAN project to the Spanish National Research Council (CSIC) (Campos et al., 2015). The aim was to design and implement the Agroforestry Accounting System to estimate the total income and capital associated with market (included in SNA) and non-market (not included in SNA) outputs (goods and services) from the Andalusian forests for the year 2010, providing a baseline year against which to measure changes over time (Campos et al., 2019).

Campos et al. (2019) focused on forests in Andalusia when implementing the Agroforestry Accounting System, irrespective of their protection status. Their definition of 'forests' includes hardwood forests, which account for 43% of the total forest area, coniferous forests (20%), eucalyptus plantations (4%), shrublands (28%), natural grasslands (3%) and other forests (2%). As the results are georeferenced, it is possible to use this information to study only PAs. Andalusian forests located in PAs

Table 2.2
SNA Goods and Services Use Accounts of expenditure by different tourists (consumers) on goods and services supplied by UWA and businesses (producers) during their visits to PAs in 2019, using standard supply and use table structure.

Classifications ≫	CONSUMERS					
	Foreign Non-Residents (International Visitors)	Foreign Residents (Domestic Visitors)	EAC Visitors	Students (Domestic Visitors)	Unallocated	Total
SNA Use Goods & Services (2019, USD^)						
Park entrance	6,139	340	405	54		6,938
Vehicle entrance	–	–	–	–	213	213
Gorilla tracking	–	–	–	–	19,415	19,415
Other recreational activities	–	–	–	–	4,149	4,149
Hotels, bars and restaurants (International)	11,206	–	–	–	–	11,206
Retail trade (International)	2,756	–	–	–	–	2,756
Travel services (International)	3,950	–	–	–	–	3,950
Other services (International)	2,021	–	–	–	–	2,021
TOTAL	26,071	340	405	54	23,777	50,647

(AFPAs) make up 31% of Andalusia's forests (Fig. 6). This is the geographical focus of this case study, where monetary estimations obtained for 10 ecosystem services are reported on for 2010.

RECAMAN applied a methodology developed by the authors over many years, the Agroforestry Accounting System (Campos et al., 2019). The ecosystem services values presented here have been re-calculated following the internationally recognized statistical principles and recommendations for valuation of ecosystem services of the SEEA EA (United Nations et al., 2021).

A key challenge for compiling the accounts was estimating these ecosystem services values in a manner that is consistent with national accounting principles (i.e., as exchange values reflecting cash values at which one would observe exchanges in markets). This was overcome by estimating monetary ecosystem service values (i.e., the contribution of the ecosystem to benefits or outputs consumed) based on residual exchange values and production functions (for timber, cork, firewood, grazing, farmers private amenity and public recreation), imputed market prices (for mushrooms and carbon sequestration) and hedonic price (water runoff). This was achieved by first estimating a 'transaction price' for a benefit or output from AFPAs, then subtracting the values of raw materials and services, labour compensation and imputed return to manufactured (produced) capital used to produce it. The remainder, or residual value, reflects the monetary value of the ecosystem service (i.e., the contribution of the ecosystem service) embedded in the value of benefits or outputs consumed.

For ecosystem services embedded in final outputs consumed that are not traded in markets (e.g., non-SNA benefits such as farmers private amenity, as well as recreation enjoyed by the public), a further challenge was estimating an initial transaction price. This was overcome using the simulated exchange value method (SEV) (described in Campos et al., 2019; Caparrós et al., 2017; Caparrós et al., 2003 as well as the SEEA EA). The SEV method simulates the market value (or transaction price) that one could obtain from a given non-SNA benefit (or output) that ecosystem services contribute to. This is achieved by first estimating demand values for the non-market outputs consumed using an appropriate non-market valuation method (e.g., contingent valuation or choice experiment). Information on a supply function and structure for a similar market (e.g., demand for free access recreational visits to a national park) is then used to estimate a transaction price where demand and supply intersect. More details on the set of valuation methods employed are provided in the Supplementary material, S1.3.

Table 3.1 presents the value of ecosystem services embedded in outputs supplied by AFPAs owned by farmers (private owners of forest areas) and the government (where the government is the 'ecosystem trustee', the collective owner ecosystem services that are not embedded in privately consumed outputs from the private and public forest areas). Table 3.2 presents their corresponding use by the agricultural sector, the government, households and others. These accounts present the value of ecosystem services embedded in the transaction values of private and public outputs from AFPAs consumed in 2010.

As Tables 3.1 and 3.2 reveal, the total value of ecosystem service contributions to total outputs generated by AFPAs in 2010 was €502 /ha, on average across the PAs identified in Fig. 6. Table 3.1 shows the supply of ecosystem services from the farmers is €261/ha and from the government (APFAs ecosystem trustee) is €241/ha. Table 3.2 reveals that households are the main users of these ecosystem services, using approximately two thirds of the total value of ecosystem services supplied by AFPAs (€340/ha).

Tables 3.1 and 3.2 reveals that AFPAs provide a wide range of ecosystem services that contribute to human well-being that are not recorded in the SNA, including high value cultural (€327/ha) and regulating (€43/ha) services. Generating these estimates for ecosystem service values provides policy makers and land managers in Andalusia with critical information for land use planning. It provides a benchmark against which to compare other land use options, such as more intensive farming activity or forestry. This can be used to make the case for further protection of forests within Andalusia for different objectives (e.g., water supply, climate change mitigation, public recreation, landscape

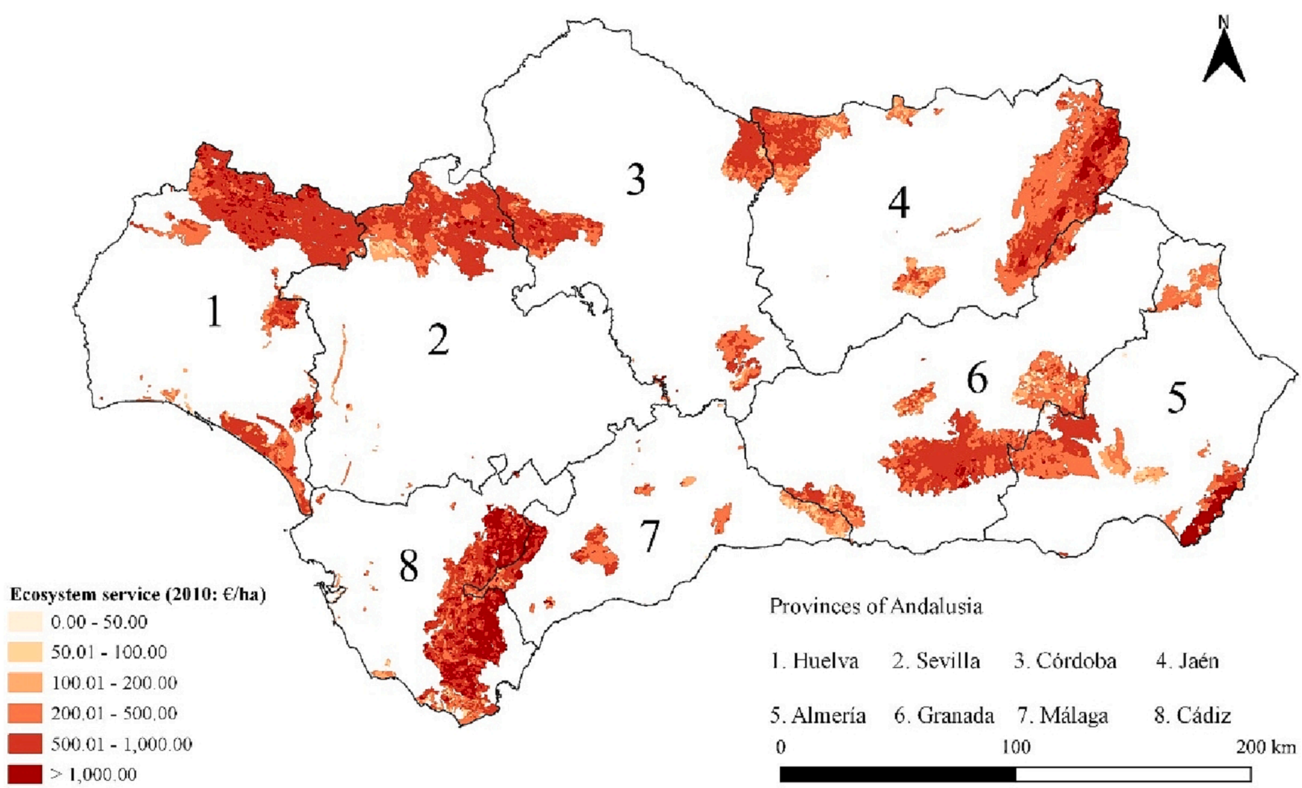

Fig. 6. Monetary exchange value of Andalusian forests PAs ecosystem services. Source: Author elaboration based on the primary data, concepts and methods used in RECAMAN's VICAF (Campos et al., 2015).

Table 3.1
Extended ecosystem services supply accounts for Andalusian protected forest areas (AFPAs), Spain (2010: €/ha).

Classifications ≫	SUPPLIERS		
	Privately owned ecosystem services by farmers	Publicly owned ecosystem services by government (ecosystem trustee)	Total
Provisioning ecosystem services (Sub-total)	***36***	***96***	***132***
Timber logging	2		2
Cork striping	15		15
Firewood harvesting	*		*
Nuts gathering	*		*
Grazing	19		19
Mushroom		13	13
Water runoff supply		83	83
Regulating-maintenance ecosystem services (Sub-total)		***43***	***43***
Net carbon sequestration		43	43
Cultural ecosystem services (Sub-total)	***225***	***102***	***327***
Private amenity enjoyed by private landowners	225		225
Public free access recreation visits		102	102
TOTAL	**261**	**241**	**502**

*Firewood and nut (pinecone and chestnut) values less than 0.5€/ha considering total Andalusian Forest extent.

conservation and threatened species preservation).

In Table 3.1, the economic rights to ecosystem services that contribute to products that are recorded in the SNA (e.g., timber and grazing) are assigned to the institutional sectors of non-financial corporations, the private and public landowners. The economic rights to ecosystem services that contribute to publicly consumed products that are outside of the SNA (e.g., carbon sequestration and recreation) are assigned to the government, as the 'ecosystem trustee' (a new institution proposed by the SEEA EA who holds stewardship over these types of ecosystem services). The approach to allocation of ownership facilitates the compilation of an extended sequence of accounts for institutional sectors, which presents the value of ecosystem services embedded in market (SNA) and non-market (non-SNA) outputs from AFPAs. The Supplementary material S1.1 and S1.2 provides more details on this approach and how to integrate information on ecosystem services supplied by AFPAs and the SNA outputs from AFPAs using production and generation of income accounts.

The estimates of ecosystem service values in Tables 3.1 and 3.2 can also be used to compile the monetary ecosystem asset accounts presented in Fig. 1. These accounts are compiled by estimating the net present value of ecosystem services supplied over the assumed lifetime of the AFPA asset, to generate a value for the protected area. This information can be used to extend the balance sheet of the SNA, so the full value of PAs can be considered in the ledger of a nation's wealth (e.g., with respect to recreation, climate change mitigation and regulation and maintenance of local environmental conditions benefits, as described in Chapter 11 of the SEEA EA).

An important outcome of the work was demonstrating the use of non-market valuation stated preference methods to estimate consumers demands, and particularly the SEV for electing transaction prices in valuing ecosystem services of key public policy concern (e.g., those related to public free access to recreation services). This allows better consideration of the trade-offs in environmental, social and economic development objectives in land use planning for the Andalusia region.

As Fig. 6 reveals, the value of aggregate ecosystem services supplied by different areas of forest in the region varies substantially. The georeferenced ecosystem services results are very useful for spatial planning for improving ecosystem services supply at minimal opportunity costs. Although, when dealing with issues such as biodiversity existence value, maximising the monetary value of ecosystem services returns should not be the sole objective.

A lack of environmental-economic data in statistics offices is often highlighted as a major challenge for implementing the SEEA EA. The initial costs of compiling such data for the Agroforestry Accounting System for Andalusia for the various ecosystem services assessed was one euro per hectare. This is considered relatively low in terms of overall public forest management costs. Given the work to date, an update of the accounts could be done at a fraction of these costs.

5. Discussion

The literature review and case studies presented in this article demonstrate the existence of at least three possible approaches for thematic accounting for PAs using the SEEA EA, as shown in Fig. 2. It is highlighted that these approaches are not mutually exclusive. Indeed, implementing them in combination would deliver a wide range of insights on PAs, their status and the benefits they provide at different scales.

The three detailed case studies demonstrate the potential for thematic accounting for PAs to address multiple analytical and policy

Table 3.2
Extended ecosystem services use accounts for Andalusian protected forest areas (AFPAs), Spain (2010: €/ha).

Classification≫	USERS				
	Agriculture	Government[1]	Households	Others	Total
Provisioning ecosystem services (Sub-total)	***90***		***13***	***29***	***132***
Timber logging				2[2]	2
Cork striping				15[2]	15
Firewood harvesting				*	*
Nuts gathering				*	*
Grazing	19				19
Mushroom			13		13
Water runoff	71			12	83[3]
Regulating-maintenance ecosystem services (Sub-total)		***43***			***43***
Net carbon sequestration		43			43
Cultural ecosystem services (Sub-total)			***327***		***327***
Private amenity enjoyed by private landowners			225		225
Public free access recreation visits			102		102
TOTAL	**90**	**43**	**340**	**29**	**502**

Notes: [1] used by general government on behalf of the community. [2] used by manufacturing industries and exports sectors. [3] used by other industries, government and exports sectors. *Firewood and nut (pinecone and chestnut) values less than 0.5€/ha considering total Andalusian Forest extent.

objectives. They provide real-world examples of how accounts for the different components of the accounting mechanism described in Fig. 1 can be compiled. From this accounting perspective, the South Africa case study highlights how the SEEA EA can organise information on PA extent and type and integrate it with biophysical information on ecosystem types. This follows the approach of PAs as accounting entities within Ecosystem Accounting Areas (EAAs) (approach 1, in Fig. 2). This case study contributes to national statistics that communicate the effectiveness of the national PA network in achieving an ecologically representative coverage of important natural biomes in the country. The Uganda case study integrates additional information on species-level biodiversity, as well as recreation-related ecosystem services and their contribution to the economy. It follows the approach of using PAs as EAAs (approach 2). The accounts communicate the effectiveness of national parks in maintaining natural ecosystem extent and populations of iconic species. They also reveal to decision-makers the importance of maintaining this biodiversity to support economic activity linked to the tourism sector. The Andalusia case study reveals to decision-makers the broad range of ecosystem services supplied by protected forests so they can be integrated into land use planning and aligned with the economic accounts for this region. It follows the approach of accounting for PAs in landscapes (approach 3).

All three case studies benefited from direct engagement of government partners at national (South Africa and Uganda) and regional (Andalusia) levels. This illustrates that the value of applying the SEEA EA to PAs is recognised as a worthwhile and policy relevant investment by public institutions. It also demonstrates that the SEEA EA can act as an effective framework to bring institutions together and establish necessary arrangements for both compiling and using accounts in decision-making.

Three key benefits of applying the SEEA EA in accounting for PAs are distinguished by the case studies and literature review. First, as highlighted by the South Africa case study, the accounting framework brings statistical rigour and data that is made consistent over time and space, allowing information to be compared with confidence across many years. This readily supports policy makers by communicating trends and revealing emerging issues. Having the compilation of the PA accounts being coordinated by national statistics offices brings further robustness via the data quality assurance that underpins national statistics. It also brings statistics on PAs into the mainstream of national government, making it visible to a range of audiences beyond the environment sector. This can then inform a wide range of decision-makers and national reporting obligations.

A second benefit of applying the SEEA EA framework to organise information on PAs is the ability to bring disparate data together and make them coherent using accounting principles, classifications, measurement boundaries and standard tables. The Uganda case study shows how the SEEA EA allows information on ecosystem extent, species abundance and tourism activity from different data sources and data types to be presented in the same framework. The Andalusia case study allows for a wide range of data from different sources to be used to estimate ecosystem services flows from PAs and for these to be presented alongside information on wider benefits from economic activities in the Andalusian landscape. This allows comparisons of trends in ecosystem assets and species with trends in ecosystem services and benefits, and land-use (or sea-use) activities. This is often crucial information for PA management.

The third benefit of applying the SEEA EA to PAs is to open a range of possibilities for better integrating PAs as economic and social assets into decision-making. The Uganda case study illustrates how substantial economic activity recorded in the SNA can be attributed to PAs and the species they support by aligning information from the SEEA EA and SNA via the national accounting mechanism. The Andalusia case study highlights how the values of ecosystem services that are omitted or undervalued in the SNA can be revealed and aligned with information on different institutional sectors.

Linking information on ecosystems, ecosystem service supply and use and economic activity facilitates integrating PAs into formal economic and sector level planning. It also helps to reveal the institutional relationships between PAs and different economic units with respect to the full range of economic and social benefits provided by PAs. This provides a coherent and integrated picture of the relationship between PAs and the economy that can support planning for 30x30 in a way that maximises benefits for national and local economies, as well as social well-being and biodiversity conservation. This can transform the rhetoric associated with 30x30 as a conservation and economic opportunity cost into one where PAs are also recognised as a social and economic investment opportunity.

Accounting for the above, applying the SEEA EA to PAs could greatly assist in planning attainment of the Kunming-Montreal Global Biodiversity Framework's flagship 30x30 target in a way that best delivers on environmental, economic and social development objectives. For instance, having comparable and reliable information on PAs can help achieving a more ecologically representative network of biogeographical regions in PAs. Having information on ecosystem services important for social well-being, climate change mitigation and adaptation supplied by PAs allows them to be better considered in landscape scale management. The supply and use perspective the accounts bring also allows the contributions of PAs to household welfare and incomes to be revealed. Linking this with socio-economic information (e.g., census data) could highlight opportunities for delivering 30x30 to help improve household well-being and incomes. Revealing the contributions of PAs to benefits outside of the SNA also highlights the role they can play in nature-based solutions to development issues. This is especially true for regulating services, such as global climate and water flow regulation, storm mitigation, and soil and sediment retention services.

It is also the case that the different ecosystem types in a PA may contribute in combination to ecosystem services supplied by the PA as a whole, and it is challenging to attribute supply to constituent ecosystems. For instance, in the case study for Uganda, visits to a national park may be motivated by tourists wanting to observe natural features such as waterfalls, game in savannah ecosystems and primates in forest ecosystems. In such cases, it may not make sense to disaggregate the supply of the ecosystem service to individual ecosystem types. Furthermore, by explicitly aligning ecosystem service supply to PAs, rather than individual ecosystem types, the important role of PAs themselves (not just their constituent ecosystem types) in supporting economic activities and social welfare is directly revealed.

There are multiple possibilities to extend the accounts for PAs in the case studies presented here. Links can be made with data on the social contributions of PAs. Whilst not presented here, the Uganda accounts include statistics on revenue sharing from PA entrance fees with local communities (see NEMA, 2021a). Future analyses could assess the links to jobs supported by PAs to further evaluate their role as a mechanism for social development. It would also be worth making the links to expenditure on PAs, as this could provide further insights into ecological, social and economic returns on investment in PAs. This has been identified as a direction for future work in South Africa, following the conventions for environmental protection expenditure accounts in the SEEA CF (see Driver et al., 2021).

The monetary accounts of the SEEA EA do not include ecosystem services that have non-use values (sometimes referred to as "passive use values"). The SEEA EA adopts the view that these passive uses do not reveal ecosystem service flows, on the basis that "there is no direct or indirect interaction with the environment associated with non-use values" (United Nations et al., 2021: para 6.72, p. 137). Campos et al. (2022) present an extended application of the SEEA EA for Andalusia, which includes passive use values linked to landscape conservation and threatened biodiversity preservation. This extension could help address the important issue of underestimating the full total income value society places on PAs and the ecosystem services they provide in decision-making.

6. Conclusions

This article has demonstrated different approaches to 'Accounting for Protected Areas' using the SEEA EA. It shows how PA planning, management and investment decisions can benefit from applying the standardised framework of the SEEA EA to PAs. It can contribute to a consistent and statistically robust flow of information to inform better decision-making across PAs and over time. The accounting framework allows for multiple sources of information on PAs to be systematically organised and made coherent. This includes data on ecosystem types in PAs, the ecosystem services they deliver and the economic and well-being benefits these contribute to. Ecosystem service accounts also help reveal the benefits PAs deliver that are currently hidden in the SNA, or are undervalued or omitted from it. The common principles, concepts, classifications and measurement boundaries of the SEEA and SNA accounting mechanism provide additional opportunities for better alignment of information on PAs and the economy.

In summary, accounting for PAs using the SEEA EA provides an integrated picture of the state of PAs, their relationship with the economy and their contribution to social well-being. This can inform a more integrated development approach, which recognises PAs as socio-economic assets, captures synergies across environmental, social and economic objectives and avoids environmental trade-offs that deliver little in the way of social and economic returns. Implementing this type of approach will be essential for achieving the Global Biodiversity Framework's target of protecting and conserving 30% of the world's landscapes and seascapes by 2030 in an ecologically meaningful, economically sustainable and socially equitable manner.

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Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Steven King reports financial support was provided by the European Commission.

Data availability

Data used in the case studies presented is available from the sources given.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ecoser.2023.101544.

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