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Using the system of environmental-economic accounting ecosystem accounting for policy: A case study on forest ecosystems

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ABSTRACT

Robust, regular and integrated evidence on the environment and its relationship with the economy and human well-being is needed to deliver effective environmental policy. This paper highlights the role the United Nations System of Environmental-Economic Accounting Ecosystem Accounting (SEEA EA) can play in delivering this 'policy-ready' evidence. We demonstrate this using forest ecosystems as a policy theme of high international concern, via structured reviews of evidence needs for two case studies: the EU Green Deal; and, Liberia's forest policy framework. The EU Green Deal case study highlights evidence gaps in a proposed regulation on environmental-economic accounting that are policy relevant and could be met using the SEEA EA. These gaps concern old growth forest extent, carbon storage, biodiversity, water regulation and erosion control ecosystem services. The Liberia case study highlights evidence needs for policy concerning the extent of natural forests important for biodiversity and ecosystem services of timber provisioning, global climate regulation and non-wood forest products, which could be met by the SEEA EA. Starting from these policy perspectives is critical to establishing evidence needs that the SEEA EA should be compiled to meet. This address concerns that the compilation of SEEA EA accounts has often been an exercise in best organising available data, rather than a demand driven exercise in response to policy evidence needs. We argue that addressing clear policy needs is essential for the SEEA EA to deliver on its potential to mainstream the many benefits from natural, as well as managed forests, into development planning.

1. Introduction

Robust scientific knowledge and data on the state and trends of the environment are imperative for effective policy-making (Rose et al., 2020; OECD, 2015). The Rio+ 20 Summit highlighted this in its outcome document 'The Future We Want'. Its section on institutional framework capacity for sustainable development aims to: "Promote the science-policy interface through inclusive, evidence-based and

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transparent scientific assessments, as well as access to reliable, relevant and timely data in areas related to the three dimensions of sustainable development – economic, social and environmental" (UN, 2012).

However, there are long-standing concerns that environmental policy has often been experience, rather than evidence, led (James et al., 2016), which is due to several factors. First, most monitoring programmes tracking environmental trends tend to be biased spatially, temporally or towards easy-to-measure aspects of the environment, creating limitations to understanding trends over time, and their attribution to causes (Scarano et al., 2018). Second, relevant environmental evidence may not be readily accessible or stored locally, making it time-consuming and expensive to understand (McKinnon et al., 2015). Third, the rapidly growing information flow poses challenges for policy-makers to select relevant evidence (Bayliss et al., 2012; open data movement). Fourth, as most environmental issues are interconnected to wider economic and social issues, policy-makers need scientifically grounded integrated evidence on ecosystem services and their contributions to the economy and well-being. Frequently this is poorly captured in monitoring programmes (Rose et al., 2018; Berghöfer et al., 2016; Scarano et al., 2018). Furthermore, the operation in silos of environmental agencies makes the creation of integrated environmental evidence a challenging process (Benson et al., 2014). Fifth, environmental data is often not processed into timely evidence that policy-makers and decision-makers can use (Scarano et al., 2018). Windows where good environmental-economic evidence can influence 'better' policy-making are often short, sometimes hard to anticipate, or linked to changing governments or crises points (Rose et al., 2020). Consequently, when environmental evidence is readily and routinely available, it is more likely to be considered in policy (Rose et al., 2020).

The System of Environmental-Economic Accounting (SEEA) is an international statistical standard that has been developed to, inter alia, overcome these challenges. The SEEA aims to extend the System of National Accounts (SNA) used for producing statistics and measures of economic activity (UN et al., 2014) and comprises two parts. The first part is the SEEA Central Framework (SEEA CF 2012). This multipurpose statistical framework delivers consistent, regular, and harmonised data on environmental resources (e.g., available timber resources), inputs to the economy (e.g., harvested timber) and returns to the environment (e.g., emissions to air and water). The second part is the SEEA Ecosystem Accounting (SEEA EA 2021), which organises evidence on the state of ecosystems and the services they deliver to the economy and society (UN et al., 2021; Edens et al., 2022) A key advantage of the SEEA EA is that it can institutionalise the regular production of information on ecosystems and the benefits they provide with the production cycles of the SNA by National Statistical Offices (NSOs). This improves the availability of this information when decision-makers need it and supports the integration of economic, social (e.g., census data) and environmental information. It also improves the robustness of this evidence via the data quality assurance frameworks that underpin national statistics.

The core accounting model of the SEEA EA is presented in Fig. 1, comprising ecosystem stocks and service flows in physical and monetary terms. The stocks of ecosystems and their changes over time are measured via ecosystem extent and condition accounts. The ecosystem services accounts organise information on the supply of ecosystem services by different ecosystem types and their use by different users (e.g., businesses, government or households) as physical and monetary flows over a period of time (an accounting period). The monetary value of expected future ecosystem services flows from stocks of ecosystems informs the monetary ecosystem asset accounts. The accounts are compiled for a defined geographical area called an Ecosystem Accounting Area (EAA), such as a country, watershed or ecosystem type. The UN Statistical Commission has encouraged nations to implement the SEEA EA in their territory in the coming years (UN et al., 2021).

This paper examines the important roles that the SEEA EA can play in delivering 'policy-ready' evidence on the environment and its connections to people and the economy across the policy cycle. The paper adds

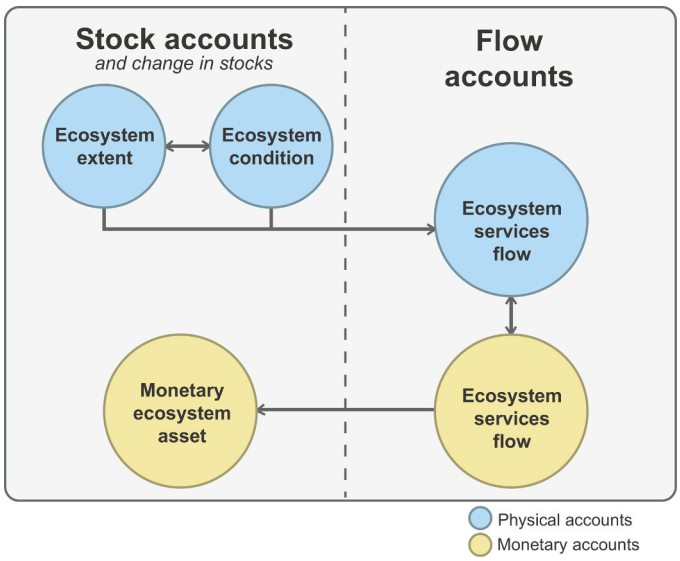

Fig. 1. Core SEEA EA Accounts (UN et al., 2021).

to the limited literature reviewing SEEA EA applications for sectoral policies (Grover et al., 2023), using forest ecosystems as a policy theme. We present two real-world policy case studies to assess how to best use the SEEA EA to meet the evidence needs of the policy framework for forests. However, we believe the insights gained from applying the SEEA EA to the forest policy framework can be generalised to other policy contexts.

The remainder of this paper is structured as follows. Section 2 describes the role that the SEEA EA can play in the policy cycle. Section 3 introduces forest ecosystems as a policy theme that the SEEA EA can inform on. Section 4 describes the evidence that the SEEA EA accounts can deliver on this policy theme. (Vardon et al., 2016) observe that the development of environmental-economic accounts has not been 'user driven'. Building on this, in Section 5, we describe an approach for elaborating a policy framework to inform the accounts compilation process that may encourage greater focus on users' needs, using the EU Green Deal and forest policy framework in Liberia as case studies. In Section 6, we discuss the case study insights, advantages of using the SEEA EA and the importance of starting from this policy perspective to deliver 'policy-ready' evidence. In Section 7, we conclude with recommendations for implementation of the SEEA EA to deliver forest 'policy-ready' evidence.

2. Policy cycles and the SEEA EA

If evidence is to be influential for policy, it needs to be synthesised in a manner that best meets policy needs. (Haynes, 2006) suggests an evidence-base for policy should be structured as blocks that build on each other. For instance, using research studies and systematic reviews to integrate and synthesise a wide range of knowledge and evidence, and condensing these to synopses or summaries that can flow into decision-support systems. These types of decision-support systems or tools sum up the overall scientific evidence, integrate across various scales, disciplines and stakeholder interests and needs, and feed them into a specific decision point (Dicks et al., 2014). A common way of conceptualising these decision-making points is the policy cycle.

(Vardon et al., 2016) highlighted a central role for the SEEA EA in organising and summarising basic data in a systematic way to produce key indicators and aggregates that provide evidence across all stages of the the policy cycle (Fig. 2). However, for the SEEA EA to deliver 'policy-ready' evidence, the accounts need to meet key evidence needs in a format appropriate to the analyses, processes and procedures that drive the policy cycle. Examples of these are shown around the periphery of

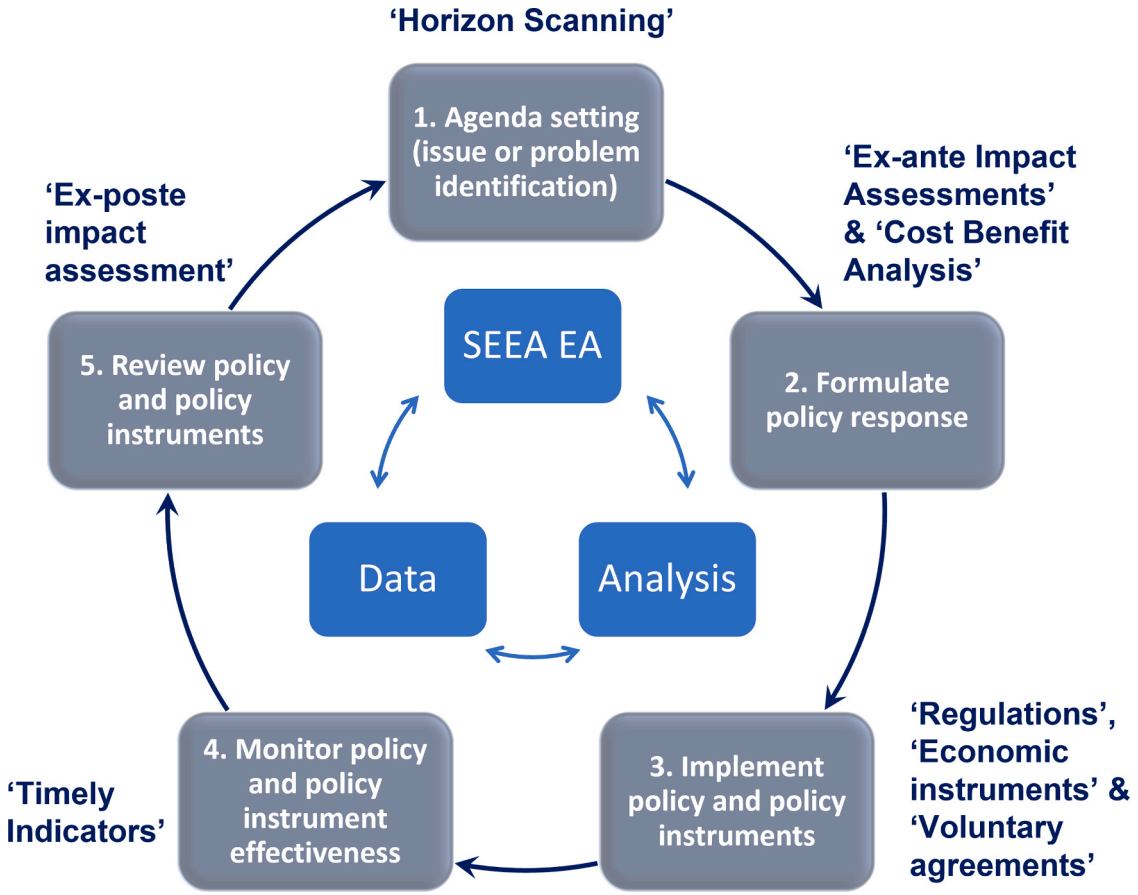

Fig. 2. Role of the SEEA EA in contributing evidence across the five stages of the policy-cycle (adapted from Vardon et al., 2016; Bass et al., 2017).

the policy cycle in Fig. 2. As (Grover et al., 2023) highlight, there are still few systematic reviews of SEEA applications in sectoral policies to help understand how to improve the use of ecosystem accounting as a tool in this context. We add to this literature by exploring the use of the SEEA EA in the context of the policy cycle in general in the following sub-sections. In Section 5, we test this general framing against the specific framing of forest sector policy frameworks for our two case studies.

2.1. *Agenda setting (issue or problem identification)*

In the agenda setting stage, trends in environmental data, pressures and their implications for economic and social welfare are used to identify emerging, policy-relevant issues (UNEP, 2014). The SEEA EA can support this by providing robust, regular evidence on the trends in the changing extent of ecosystems and their condition, as well as the ecosystem services they deliver. Links can be made between ecosystem extent and condition, and economic and social welfare via ecosystem service supply and use. Other links can be made between economic and social drivers of ecosystem degradation and ecosystem services loss. For example, showing the implications of deforestation on the ecosystem services related to downstream water flow regulation and water security. This evidence can inform exploratory, forward-looking scenarios that reveal threats and opportunities associated with ecosystems (e.g., expansion of agricultural land in response to increasing population demand, or degradation in response to pollutants). (Sutherland and Woodroof, 2009) describe this systematic search for potential threats and opportunities that are currently poorly recognized as 'Horizon Scanning' (see Fig. 2).

An example of using the SEEA EA accounts to set the agenda for government policy is demonstrated for a forest region in Australia where competing uses of ecosystem services causes conflict in society. The accounts showed that the value of provisioning services for commercial use was lower than the value of regulating services used by the whole of society. This evidence has informed debate and resulted in a government review of forest information systems and their management (Keith et al., 2019).

A key advantage of the SEEA EA is it allows for evidence on ecosystems to be linked with evidence on the economy and human well-being. This type of integrated information can help articulate 'Systems Thinking' approaches, which recognise these inter-connections and the need to pursue an integrative approach that addresses all development goals (Voulvoulis et al., 2022). (Weitz et al., 2014) characterises this approach to cross-sectoral interactions as a nexus approach. Barber et al. (2020) provide an example for the water, energy and food nexus to illustrate the multiple benefits of nature-based solutions. Policy-makers are now recognising the importance of these systems or nexus approaches in setting the agenda for a more integrated policy framework for sustainable development (Voulvoulis et al., 2022). The SEEA EA aligns well with evidence needs for such emerging integrative policy concepts (e.g., Environmental Policy Integration (EPI) and the Water, Energy and Land (WEL) Nexus approach described by Venghaus et al., 2019).

2.2. *Formulate policy response*

Policy targets are set and interventions and instruments to achieve them are proposed at the policy formulation stage. These targets set the policy objectives for interventions to address issues identified in the agenda setting stage. Ideally, they should be stated in a manner that is specific, measurable, achievable, relevant and time-bound (SMART) (UNEP, 2014). Policy instruments aim to change behaviours in a way that contributes to achieving these policy objectives. They include

regulatory (or legislative), economic and voluntary instruments (examples are provided for the forest policy framework in Table 1, Section 3.2).

The SEEA EA can demonstrate to policy-makers the types of interventions that can deliver on these and wider policy targets. For instance, by delivering a more systematic set of information that covers stocks, flows, benefits and beneficiaries, the SEEA EA allows nature-based solutions targeted at a particular goal, such as climate change mitigation, to be designed in a more integrated way that delivers additional benefits. These benefits include those linked to climate change adaptation, biodiversity conservation and human well-being (Keith et al., 2021).

At this policy formulation stage, the SEEA EA can support ex-ante policy impact assessments (see Fig. 2), which evaluate potential instruments to achieve policy targets in terms of their economic, social and environmental impact and their coherence with other objectives and monitoring options. This can produce better designed interventions and instruments that deliver multiple benefits, evaluate cost effectiveness and avoid unintended consequences. For instance, as shown in Fig. 2, by supporting environmentally extended cost benefit analysis, which is often used in public policy appraisal (Johnston and Rosenberger, 2010). The European Commission have published 'better regulation' guidelines that highlight the important role that such 'Impact Assessments' should play as part of the public policy and programming cycle (EC, 2021a).

2.3. Implement policy and policy instruments

The SEEA EA can inform the targeted design and deployment of regulatory, economic and voluntary policy instruments proposed in the policy formulation stage (Fig. 2). For regulatory instruments, such as protection of ecosystems or zoning of land-use activities, the SEEA EA can identify trade-offs between economic, conservation and ecosystem services outcomes associated with different land use activities (e.g., Keith et al., 2017). For financial policy instruments, the SEEA EA can support design of eco-compensation or payment for ecosystem services schemes (e.g., Ouyang et al., 2020). It can be envisaged that by providing a robust and transparent information framework, the SEEA EA could support the design of voluntary agreements with respect to ecosystem management and benefits access.

2.4. Monitor policy and policy instruments effectiveness

There are two distinct forms of monitoring; environmental monitoring to collect data that is compiled within SEEA EA accounts as part of the information system, and policy monitoring as part of the policy cycle that is used to assess policy effectiveness. Here we are discussing the latter, which involves the continuous and systematic generation of evidence to compare how well a policy is being implemented against expected results (EC, 2021a).

Monitoring policy effectiveness focuses on policy outcomes (i.e., progress towards policy targets) rather than processes (i.e., policy formulation and implementation activities) (Schoenefeld et al., 2019). Through regular production, the SEEA EA can support policy monitoring by providing integrated, regular and timely indicators on progress towards policy targets (Fig. 2). This can be achieved by linking ecosystem restoration and conservation actions to a range of economic and well-being outcomes and monitoring progress towards associated outcome targets. For instance, SEEA EA accounts of change in ecosystem extent and ecosystem services have been recommended within the monitoring framework of the Kunming-Montreal Global Biodiversity Framework (GBF) of the Convention on Biological Diversity, and several countries already implement and use accounts as a measure of biodiversity mainstreaming.[1]

[1] https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-05-en.pdf

2.5. Review policy and policy instruments

At this stage, ex-poste impact assessment of the effectiveness of policy instruments is undertaken to identify how they can be adapted to better achieve policy objectives and targets (see Fig. 2). This review of policy effectiveness is also referred to as policy evaluation. In the context of European environmental and climate policy, the EEA (2016) propose policy review should consider relevance (i.e., of policy targets), effectiveness (e.g., to what extent did the policy deliver on objectives), efficiency (e.g., returns on investment) and coherence (e.g., with other policy targets and instruments).

(Vardon et al., 2023) demonstrate the potential for the SEEA EA to support this stage of the policy cycle, applying it for integrated monitoring and reporting on changes in critically endangered Box-gum grassy woodlands and associated drivers of change. This allowed the effectiveness of biodiversity conservation laws and associated conservation efforts to be assessed (Vardon et al., 2023). (Ruijs et al., 2019), highlight the SEEA EA can support these assessments with respect to unintended consequences of the policies (e.g., unintended impacts on biodiversity, carbon storage and ecosystem services) and revealing ecological, well-being and economic returns on policies to invest in ecosystems. This can help policy analysts determine if instruments need to be adjusted.

3. The policy framework for forest ecosystems

A policy framework represents a government's set of policy responses and instruments (as per Fig. 2) to deliver improved outcomes for a given theme or sector and how these should be applied. Policy frameworks arise because no single policy response or instrument will have the capacity to address, in a balanced, holistic, and mutually reinforcing way, all the issues relating to a particular theme or sector (UNSD, 2020). Here we elaborate the policy framework for forest ecosystems and identify potential policy evidence needs that the SEEA EA can meet.

3.1. International commitments to forests

The forests of the world support approximately 80% of terrestrial plant, animal and invertebrate species (FAO and UNEP, 2020) and supply societies with provisioning, regulating and cultural services, such as food, wood and fibres, climate and water flow regulation and opportunities for recreation (UNEP, 2022; FAO, 2022). Forests have great significance for countries' socioeconomic development at both local, regional, and national levels, with the forest sector supporting 33 million jobs worldwide and contributing at least USD 1.5 trillion to global Gross Domestic Product (GDP) (FAO, 2022). In addition, forests provide cultural benefits and support the livelihoods of indigenous peoples (Dooley et al., 2022). Although all forest ecosystems provide multiple benefits, the magnitude, quality and diversity of benefits tends to be higher for natural forests, compared with intensively managed forests (e.g., plantations and agroforests) (UNEP and IUCN, 2021).

Despite the importance and diverse values of forests, these ecosystems continue to be converted into other land uses and degraded (Song et al., 2018; Winkler et al., 2021). In thirty years (from 1990 to 2020), 420 million ha was deforested, representing 10% of the world's forest coverage (4060 million ha) (FAO, 2020, 2022). Although more difficult to assess and monitor, degradation also has a substantial impact on the ability of forest ecosystems to deliver ecosystem services (Baccini et al., 2017; Bullock et al., 2020), with a total of 20% of the Earth's surface being degraded (UN, 2019). For these reasons, deforestation and forest degradation is a well-recognised threat to sustainable development.

In response, multiple global policies and international commitments have been made to halt forest loss and degradation and to promote conservation and restoration of forest ecosystems. The most developed international policy mechanisms are those aiming at mitigating the role

of deforestation in climate change and greenhouse gas emissions, led by the UNFCCC collaborative programme on *'Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries*' (REDD+; Nature editorial, 2009), which led to pledges to reduce deforestation in the Paris Agreement (UN, 2015). More recently, the Glasgow Leaders' Declaration on Forests and Land Use also highlighted that policy-makers can see the importance of forests in climate change mitigation, and agreed on clear 2030 and 2050 targets for halting deforestation pledged by the parties (Gasser et al., 2022).

There are also several international policy frameworks focused more on the preservation of forests with the aim to halt biodiversity loss and enable the sustainable development of communities that depend on forests. Pledges devoted to the conservation and restoration of forest habitats include the Bonn Challenge and the activities related to the current UN Decade on Ecosystem Restoration. Recently, the Kunming-Montreal Global Biodiversity Framework (GBF) was adopted at the Convention on Biological Diversity Conference of the Parties (CBD COP) 15 in 2022. The GBF sets out a vision of a world living in harmony with nature and 23 targets for 2030 to reduce threats to biodiversity; meet people's needs through sustainable use of biodiversity and for biodiversity mainstreaming.[2] These targets include for: Forest protection and restoration; Sustainable management of forests; Enhancement of forest ecosystem services; Integrating multiple values of forests into planning; Engaging of local communities and indigenous peoples in decision-making; and, Equitable forest management.

A broader overview of 18 of the main global policies and commitments for forests is provided in the Supplementary Material (S1). S1 provides a high-level description of the global objectives of these different commitments and demonstrates forests as a long-standing issue of high international policy importance. S1 is a representative sample of international forest policy commitments identified by the authors and from a review paper by (Sotirov et al., 2020). Whilst the set of policies and commitments captured in S1 is extensive, it is not intended to be exhaustive.

3.2. Regional and national policy frameworks for forests

Regions and countries have established policy frameworks to deliver on international targets described in Section 3.2 (e.g., the GBF), as well as their own objectives for forests to secure the many benefits they provide (as will be shown via the case studies in Section 5). According to the latest Global Forest Resources Assessment (FRA), most countries and territories assessed have specific national policies for forests (164 out of the 187 countries who responded to this question confirmed this) (FAO, 2020). National forest policies establish objectives, which may be elucidated via national plans or strategies, and implemented via policy instruments.

Table 1 provides an indicative and non-exhaustive list of potential policies and policy instruments that can be informed by the evidence on forests that is reported in SEEA EA accounts. This list was built using the main categories of policy instruments recognized by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). Forests' governance is also shared, across national (or federal), state (or provincial), and local levels. All these multilevel government bodies and their policies will impact the management of forests and the implementation of activities in forests. It is highlighted that using the SEEA EA as a common framework to organise information on forests can help bring coherence across these different scales of intervention.

Table 1
Policy responses and instruments of a regional or national policy framework for forests (indicative and non-exhaustive).

Policy responses	Policy instruments
Forest-specific	**Regulatory**
• Forest Sector Policy • Forest ecosystems and other native vegetation policy • National/Sub-national Forest or Forestry Plan	• Public Forests Protected Areas • Environmental damage regulations • Forest Concessions • Forest Zoning • Regulations on the conversion of forest lands to non-forest lands (or Land Clearing Regulations)
Other (sector-specific)	
• Tourism Sector Policy • Agriculture Sector Policy • Energy Sector Policy • Water Sector Policy • National Biodiversity Strategy and Action Plan (NBSAP) and other national responses to the Global Biodiversity Framework (GBF) • Climate Change Policy • Environmental Crimes' Policy	• Regional (EU)/National/Sub-national Forest Restoration Strategies, Policies and Plans • Timber Legality Regimes • Timber Industry Code of Practice (Mandatory) • Legislation on Threatened biodiversity including ecosystems • Forest Stewardship Plans
Cross cutting	**Economic**
• National Development Plan • Green Growth Development Strategy	• REDD+ National and Jurisdictional Strategies • Non-Timber Forest Products Exchange Programmes • Incentives to Sustainable Forest Value-Chains • Credit Lines for Sustainable Forestry and Agroforestry • Payment for Ecosystem Services (PES) • Forest Stewardship Plans (with payments to landowners) • Economic incentives to wildlife-friendly farming practices • Conservation easements • Sustainable finance instruments • Green and performance bonds
	Voluntary (Social, cultural, rights-based and customary norms / educational / informational)
	• Community based forest management (CBFM) • Forest Certification Schemes • Timber Industry Code of Practice (Voluntary) • Voluntary zero-deforestation agreements (e.g., Brazil's Soy Moratorium – SoyM) • Access and benefit-sharing policies • Voluntary Forest Stewardship Plans • Rights of Mother Earth • Community-based management (land, fisheries, water, hunting, etc) • Environmental certification

4. How the SEEA EA can support the evidence needs for forest policy

Whilst data from the SNA has been widely used for policy analysis, it fails to account for all the contributions from forests to the economy in a properly integrated manner (Castañeda et al., 2017). This means that it is of limited value for decision-makers in providing the evidence they need to formulate and implement forest policy instruments to deliver on the many global, regional and national forest policy commitments that exist. Here, we outline the progressive contributions of the SEEA to 'better', 'policy-ready' evidence that aligns with multiple objectives for forests.

The SEEA CF extends the SNA to facilitate accounting for the stocks of biomass in forests for both plantation and natural forests (UN et al., 2014). This delivers evidence on the depletion of natural forest stocks

[2] https://www.cbd.int/gbf/

Table 2
Examples of how the SEEA EA can meet the need for evidence at different stages in the policy framework for forests.

Policy response	Policy instrument	Policy cycle stage	How the SEEA EA aligns with evidence needs
Forest Sector Policy / Water Sector Policy / Climate Change Policy	Payment for Ecosystem Services (PES) (Economic)	Implement policy and policy instruments	Ecosystem services accounts reveal the wide range of contributions from forest ecosystems, this will inform more robust policy responses that promote protection and restoration of natural forests (FAO and UNEP, 2020) and address the lack of recognition of forest ecosystem services (beyond timber provisioning) in policy (Hernández-Morcillo et al., 2022; Sorge et al., 2022).
National/Sub-national Forest or Forestry Plan / Climate Change Policy / NBSAP	Regulations on the conversion of forest lands to non-forest lands (Regulatory)	Monitor policy and policy instruments effectiveness	Ecosystem condition accounts allow integration of a far wider set of variables on the condition (or quality) of forests beyond timber volumes (e.g., biodiversity and carbon storage) and key policy concerns for natural forest.
NBSAPs / Global Biodiversity Framework (GBF)	Public Forests Protected Areas (Regulatory)	Monitor policy and policy instruments effectiveness	Ecosystem extent accounts show trends in the extent of ecologically important forests. These trends can also be aggregated and aligned with the IUCN Global Ecosystem Typology (GET) (Keith et al., 2022), the reference classification for implementing SEEA EA (UN et al., 2021), to enable consistent international reporting.
Green Growth Development Strategy	Incentives to Sustainable Forest Value-Chains (Economic)	Formulate policy response	The set of SEEA EA accounts reveal trade-offs and synergies across different development objectives for forests to be explored, such as between forest biodiversity conservation, climate change mitigation and timber revenues (e.g.,Keith et al., 2017).
Sub-national Forest or Forestry Plan	Forest Stewardship Plans (Voluntary)	Formulate policy response	The SEEA EA is a spatially explicit framework and thus can better inform spatial planning for forest management (UN et al., 2021).

and connects it to the economic activities they support (e.g., timber and wood fuel production). Following the FAO Global Forest Resources Assessment, the SEEA CF uses physical accounts for tracking the extent of Primary forest; Other naturally regenerated forest; Planted forest; and, Other wooded land (UN et al., 2014). The SEEA CF includes the broader contribution of forests in terms of non-wood forest products (e.g., mushrooms, honey, edible fruit and insects) (see SEEA AFF in FAO and UNSD, 2020). The SEEA EA delivers far more detailed and ecologically meaningful evidence on forest ecosystems than the SEEA CF, via ecosystem extent and condition accounts. The ecosystem services accounts also reveal the wide range of contributions of forest ecosystems to economic and social well-being. Importantly, the focus of the SNA is on monetary values, whereas the SEEA includes accounts in both physical and monetary terms.

Table 2 provides some high-level examples of how the SEEA EA can meet the evidence needs of some of the policy responses and policy instruments identified in Table 1. Although the SEEA EA's general application for forest management have been described by several authors (e.g., Keith et al., 2017; Campos et al., 2019; Vardon et al., 2023), (Grover et al., 2023) highlight that the SEEA EA has not yet been widely implemented at statistical, governmental, or organisational levels for informing specific forest policy and management. In the next section, we explore the potential for this in practice via two case studies.

5. Case studies: structured approach to establishing policy evidence needs

The application of policy centred design to environmental accounting will better enable evidence from the SEEA EA to be brought into the mainstream decision-making processes of government (Vardon et al., 2016). A structured approach to assessing evidence needs for given policy frameworks will directly support this design process. We test this in the following regional and national case studies for forests.

5.1. The EU Green Deal for nature and the role of forest ecosystem accounts

Forest policy in the EU is considered by many to be fragmented and dominated with a framing of forests as providers of wood and non-wood forest products (Elomina and Pülzl, 2021; Hernández-Morcillo et al., 2022; Sorge et al., 2022). The EU Green Deal (EC, 2019) is a key policy response to set the agenda for better, more integrated forest policy that addresses pressures on forest ecosystems and secures associated ecological, economic and climate mitigation benefits. This redirection is reflected in its EU Forest Strategy to 2030, which explicitly recognises the central and multi-functional role of forests and aims at unlocking "the potential of forests for our future, in full respect for the principle of subsidiarity, best available scientific evidence and Better Regulation requirements" (EC, 2021b).

However, information on the state of the EU's forests, their social and economic value, the pressures they face and the ecosystem services they supply is patchy (EC, 2021b). Evidence from the SEEA EA can help address this by contributing integrated information that links forests and their ecosystem services to the multiple development objectives of the EU Green Deal. An EU regulation *introducing new environmental economic accounts modules* has been proposed for Member States to regularly compile and transmit 'Forest accounts' and 'Ecosystem accounts' to inform delivery of the EU Green Deal (described in EC, 2022). The scope of forest accounts proposed under this regulation broadly follows the SEEA CF. It includes accounts for the extent of wooded land that is available for wood supply and data on economic activity in the forestry and logging sector.

The proposed ecosystem accounts follow the MAES Ecosystem Typology (Maes et al., 2013), and will include accounts of all forest and woodland extent, condition (with indicators of deadwood per ha and tree cover density) and physical ecosystem services flows (wood provisioning, pollination, air filtration, global and local climate regulation, nature-based tourism) (EC, 2022). Ecosystem service users will be broken down by businesses (intermediate consumption), government, households, gross capital formation and exports. These build on the EU-level pilot ecosystem services accounts described by (La Notte et al., 2022). These ecosystem accounts can help shift forest governance from models focused on timber and non-timber forest products to ones that recognise the additional benefits both managed and natural forests provide, which are often non-market in nature (Sorge et al., 2022).

To explore the potential for these proposed ecosystem accounts to support the EU Green Deal, the evidence needs across this policy framework were reviewed. All the policies, strategies and instruments in the EU Green Deal that were considered to have some relevance to forests were identified. Then the new EU Forest Strategy was similarly reviewed, following the approach of (Elomina and Pülzl, 2021), given this strategy aims to harmonise policy interventions with respect to forests under the EU Green Deal (EC, 2022).

In total 17 policy documents were identified and reviewed, and 174 specific policy entry points identified (i.e., where evidence from the SEEA EA could inform decision-making). These entry-points covered all

stages of the policy cycle, including: Formulate policy response (41 entry-points); Implement policy and policy instruments (43); Monitor policy and policy instruments effectiveness (56); and, Review policy and policy instruments (34). The agenda setting stage is not covered in the review given these documents already recognise emerging issues. The full review of the EU Green Deal policy framework for forests is provided in Supplementary Material 2 (S2) in Excel format.

Table 3 summarises the full review. It includes forest policy evidence entry-points or demands that the SEEA EA can target (Column 2), at different stages of the policy cycle (Column 3) identified from different policy documents (Column 1), how the SEEA EA can meet these policy evidence needs (Column 4), and where the proposal under the EU regulation for introducing new environmental-economic accounts has limited coverage (Column 5). This review assists in identifying options for implementing more detailed ecosystem accounts (see Fig. 1) that could better meet the needs of the EU Green Deal for 'policy-ready' evidence on forests across the policy cycle (Fig. 2). Table 3 provides the following insights:

- Adopting a more ecologically refined forest ecosystem typology for the ecosystem extent accounts than the single 'Forest and woodland' MAES ecosystem type would deliver evidence on the role of different types of natural and managed forests in delivering the EU Green Deal (e.g., with respect to primary and old growth forests).
- Incorporating additional indicators in the ecosystem condition accounts, including compositional indicators for biodiversity and tree species, structural indicators on tree cover and size distribution and chemical indicators for soil carbon would align the accounts with the evidence needs of the provisionally agreed EU Nature Restoration Law. This would help identify emerging issues and support policy impact assessment and instrument design.
- Evidence on carbon storage in the ecosystem condition accounts by different forest types (including natural forest ecosystems) would support implementing the EU Climate Law and carbon accounting.
- Evidence on the supply of non-wood forest products, sediment and erosion control, water flow regulation and water purification in the ecosystem service accounts would inform more integrated forest policy and impact assessment, as well as demonstrating the wider role of natural forests to delivering the EU Green Deal.
- Monetary ecosystem services accounts would help inform policy impact assessments and the design of financial policy instruments, and support the case for better protection of natural forests.
- More resolved ecosystem service use accounts would help monitor the positive and negative impacts of different economic sectors and activities using forests.
- Spatially explicit accounting data would help prioritise where policy instruments should be applied.
- Integrating the accounting data with information on protection status and governance is useful for policy demands, especially with respect to natural forests.

5.2. Ecosystem accounting for forest policy in Liberia

Liberia is one of the most forested countries on the west coast of Africa, with an estimated forest cover of 69% or 6.69 million hectares (World Bank, 2020). A global biodiversity hotspot, Liberia hosts one of the largest populations of Western chimpanzees (Tweh et al., 2015), classified as "Critically Endangered" in IUCN Red List (Humle et al., 2016). Liberia's forests provide commercial timber products from which the government collects revenues (estimated forestry contribution to GDP of 8.8%; Central Bank of Liberia, 2021). Informal forest-economic activities (artisanal logging, charcoal production and non-timber forest product collection) also contribute significantly to employment and income, estimated at 3–4% of GDP (World Bank, 2020). The contribution of forests to food security cannot be ignored for a country where half of the population lives at or below poverty level. An estimated 35% of total household income is dependent on forests as a source of livelihoods and income (World Bank, 2020). Therefore, it is imperative that the formulation of forest policies, and the cross-sectoral policies that affect forests, are grounded on scientific evidence and data.

Liberia's 5-year national development plan, the Pro-Poor Agenda for Prosperity and Development (PAPD), serves as a core cross-sectoral development plan under the national Vision 2030 framework (Republic of Liberia, 2018a). It lays out the goal of raising per capita income levels and lifting Liberia's economic status to a middle-income country, while also setting ambitious goals for agriculture and fisheries, forestry, and service sectors. Liberia's forestry sector is governed by the Forestry Reform Law of 2006 (NFRL, 2006). The NFRL is currently going through implementation and monitoring stages of the policy cycle. Thus far, evidence from the monitoring stage is scarce for supporting the review of the policy and its instruments. Notwithstanding, the Forestry Development Authority recently published its approach and vision to Sustainable Forest Management (SFM) in Liberia based on "4Cs" balancing principles: Commercialization, Conservation, Community, and Carbon (Agyeman et al., 2022). It again emphasizes the importance of integrated evidence to appropriately balance the 4Cs outcomes.

As Liberia looks towards a period of continued economic and social development as envisaged in the PAPD, there is a clear incentive to harvest natural resources and modify the natural environment. For example, by converting forested land to high-value agriculture such as rubber, coffee, cocoa, and palm oil. While a natural resource extraction pathway is a well-trodden one, Liberia is in a position to evaluate the longer-term implications of this development path, both in terms of sustainability of the management of natural resources, and in terms of the distribution of benefits and costs that would result from the increased extraction of natural resources. Considering the interlinked streams of benefits provided by Liberia's forest at the global, national and household level, any decision to gain more of one benefit-stream may significantly affect others (Dade et al., 2019). For example, infrastructure development, mining concessions and expansion of high-value commodity products can significantly impact the extent, condition and delivery of ecosystem services provided by forest ecosystems, particularly at the local community level.

In this context, the Liberia Environmental Protection Agency (EPA), in partnership with other government agencies, and with support from Conservation International (CI), began implementation of the Global Environment Facility funded "*Conservation and Sustainable Use of Liberia's Coastal Natural Capital*" project. A particular focus of the project is establishing the statistical infrastructure and capacity for the Liberian government to implement the SEEA EA as part of their national statistics program.

To ensure that the accounting recommendations delivered under the project respond to policy evidence and user needs there has been an ongoing process of engagement with officials from various agencies within the Government of Liberia. A review of Liberian policies, strategies and instruments identified 17 policies that have relatively direct connections to the management of forest ecosystems, with five considered of most significance in terms of connection to forestry and forest ecosystems. These include: 1) the PAPD; 2) National Forest Management Strategy; 3) Liberia's Nationally Determined Contributions (NDCs) Implementation Plan; 4) National Biodiversity Strategy and Action Plan II; and 5) Liberia Forest Sector Project.

The insights from the review are summarised in relation to these five policy responses in Table 4. Table 4 highlights the most relevant policy entry points and specific evidence needs at different stages of the policy cycle, following the structure of Table 3. This review assists in informing the scope of proposed accounts (as per Fig. 1) in terms of their selection, design and the detail required to best inform the forest policy cycle and policy analysis in Liberia (as per Fig. 2). Key insights that emerge from Table 4 include:

Table 3
How the SEEA EA can meet the need for evidence at different stages in the policy framework for forests in the EU Green Deal.

Policy response or instrument	Policy entry-point for evidence	Policy cycle stage	Aligning the SEEA EA to policy evidence needs	Comments on scope of proposed regulation on new environmental-economic accounts
EU Biodiversity Strategy	Protect, conserve and enhance the EU's natural capital and forest biodiversity	Monitor policy and policy instruments effectiveness	Regular monitoring of indicators to track trends in forest extent, condition, ecosystem services and biodiversity at European scale	The MAES Ecosystem Typology for forests and woodland is very broad with poor ecological resolution (it really reflects a land cover, rather than ecosystem type classification). Condition indicators proposed are limited to structural indicators with no carbon or composition indicators.
Climate Change Law / Regulation on LULUCF / CAP / EU Strategy on Adaptation to Climate Change / Farm to Fork Strategy 2020 / EU Renewable Energy Strategy 2018	Make Europe Climate Neutral by 2050, increase supply of global climate regulation services (e.g., via carbon farming, payments for ecosystem services, eco-schemes), implement robust carbon accounting and ensure carbon emissions do not exceed carbon removals for different land accounting categories	Formulate policy response Implement policy and policy instruments Monitor policy and policy instruments effectiveness	Informing targets on carbon storage, carbon emissions from forest conversion and degradation, and global climate regulation services from forested lands Thematic accounting for climate change as described in the SEEA EA can help with demonstrating compliance with the EU Regulation on LULUCF.	Measurement of global climate regulation services is covered but information on stocks of carbon and changes in stocks is not. No information on the monetary value of global climate regulation services is available to inform impact assessment or financial incentives to boost supplies of this ecosystem service.
EU Forest Strategy / Biodiversity Strategy / Nature Restoration Law	Protect the EU's last remaining primary and old-growth forests	Monitor policy and policy instruments effectiveness	Indicators on the extent of primary and old growth forests protected and not protected	The MAES ecosystem typology does not include primary and old growth forests. The proposed accounts do not stratify forests according to protection status.
	Increase the extent of and quality of Europe's forests (including urban trees and agroforestry)	Implement policy and policy instruments	Identify which areas should be prioritised for afforestation or forest restoration based on ecosystem service and biodiversity benefits delivered	Limited information on non-structural condition indicators for forests is included and unclear where agroforestry and urban forests would be accounted for. The proposed accounts do not require them to be spatially explicit, limiting the potential to identify the best areas for afforestation / restoration
			Inform financial instruments to incentivise investment in forest protection, restoration and afforestation based on ecosystem service and ecological returns	No monetary ecosystem services accounts, which will help design financial instruments based on the value of ecosystem services returns
	Identify and map the agricultural and forest areas in need of restoration	Implement policy and policy instruments	Spatial data on forest extent, condition and services supply to prioritise restoration actions	No requirement for spatially explicit accounts. This limits their potential to inform policy interventions.
EU Forest Strategy / Nature Restoration Law	Ensure forest restoration and improve the condition of forests listed under Annex 1 of the Habitat Directive	Monitor policy and policy instruments effectiveness	Indicators should align with those under the provisionally agreed EU Nature Restoration Law: (a) standing deadwood; (b) lying deadwood; (c) share of forests with uneven-aged structure;(d) forest connectivity; (e) common forest bird index; (f) stock of organic carbon, each with associated reference levels, to identify areas for protection and restoration.	Only information on deadwood currently covered and no reference levels set out. Reference levels could be linked to the provisionally agreed EU Nature Restoration Law.
EU Forest Strategy / EU Strategy on Adaptation to Climate Change / Circular Economy Action Plan / EU Strategy for a Bioeconomy for Europe	Promote sustainable forest bioeconomy for long-lived wood products, wood-based resources for bioenergy and the non-wood forest bioeconomy (including ecotourism) Create financial incentives for forest owners and managers for improving the quantity and quality of EU forests, their resilience, forest biodiversity and the supply of regulating and cultural ecosystem services.	Formulate policy response	Identifying the full range of forest ecosystem services and their value that can contribute to non-wood-based forest economic activities	Ecosystem services linked to non-wood forest products, sediment and erosion control, water flow regulation and water purification are not included. These represent potential economic opportunities, including in the context of nature-based solutions to climate change adaptation. Monetary ecosystem services supply and use accounts are not covered, these will be helpful to support policy appraisal (e.g., cost benefits analysis) and instrument design.
		Implement policy and policy instruments	Inform financial instruments to incentivise investment in economic activities linked to forest ecosystem services	Monetary ecosystem services accounts are not covered. These can help inform the design of financial incentives for private investment in forests
		Monitor policy and policy instruments effectiveness	Indicators to track wood and non-wood-based forest economic activity	Economic activity associated with wood production is accounted for in the forest accounts but extended supply and use accounts (discussed in the SEEA EA, Section 11) are needed to

(*continued on next page*)

Table 3 (*continued*)

Policy response or instrument	Policy entry-point for evidence	Policy cycle stage	Aligning the SEEA EA to policy evidence needs	Comments on scope of proposed regulation on new environmental-economic accounts
				connect the supply and use of non-wood provisioning ecosystem services to economic activities.
		Review policy and policy instruments	Ex-poste impact assessment to understand if wood and non-wood forest-based economic activities are impacting on other forest ecosystem services, climate change mitigation objectives and biodiversity	No information on forest ecosystem sub-types, composition condition indicators relevant to biodiversity, carbon storage and emissions. Limited information on ecosystem services. This limits ability to understand trade-offs and synergies.
EU Taxonomy for Green Investments	Demonstrating which economic activities are contributing substantially to restoring biodiversity, enhancing ecosystem services and climate change mitigation	Monitor policy and policy instruments effectiveness Review policy and policy instruments	Indicators to track trends in forest extent, condition, biodiversity, ecosystem services supply (including global climate regulation), carbon storage from forest areas operated for different economic activities	Limited information on non-structural condition indicators for forests and no breakdown of forest ecosystem service users by economic activity
EU Renewable Energy Strategy 2018	Ensure biofuels, bioliquids and biomass fuels are not made from raw material obtained from land with a high biodiversity value or high carbon stocks. This includes primary forest and other wooded land which is species-rich and not degraded. It also includes continuously forested areas of > 1 ha, with trees > 5 m and > 10% canopy cover (subject to certain derogations)	Monitor policy and policy instruments effectiveness	Indicators of biomass provisioning ecosystem service and forest condition by forest sub-type (species-level composition, tree canopy cover, tree height)	The MAES forest and woodland ecosystem type does not distinguish primary forest and the proposed accounts do not cover condition indicators for species-level composition, tree canopy cover, tree height.

- Information needs to be organised for different forest ecosystem types, land uses and condition status, including forests used for timber production, agroforests, coastal forests / mangroves and other natural forests. This is relevant across the forest policy framework for Liberia and supports implementation and reporting under the CBD GBF (this will be accommodated by adopting the IUCN GET for different forest types).
- Integrating information on ownership, management arrangements (especially community management) and protection status is useful across the forest policy framework.
- Evidence on carbon storage and associated global climate regulation ecosystem services is important for delivering on Liberia's Nationally Determined Contribution for climate change mitigation.
- Whilst indicators on timber stocks and provisioning services are needed, these should be complemented with information on a broader range of ecosystem services, in particular those contributing to the market and non-market benefits received by people living in forests or adjacent communities.
- Spatially explicit information will be helpful in targeting forest conservation and restoration interventions where they are needed most, improving community welfare via forest ecosystem services and livelihoods, protecting and conserving forests most important for biodiversity and climate change mitigation.
- As Liberia's forests are critical to supporting the economic livelihoods of many people and communities, integrated evidence to inform holistic policy design that recognises the connections between economic, social and environmental outcomes is needed.

6. Discussion

If the SEEA EA is to deliver 'policy-ready' evidence that informs 'better' policy, a structured approach to engaging with the policy community is necessary to guide the accounts compilation. This includes selecting and designing accounting structures (Fig. 1), aggregates, classifications / cross-walks and the accounts production cycle. Essential to this is understanding the policy processes and analyses this evidence will feed in to (Fig. 2). In this paper, we explored this issue using a structured approach to evaluating the policy framework for forest ecosystems, a theme high on the international policy agenda (see S1), using the EU Green Deal (Table 3) and Liberia's forest policy framework (Table 4) as case studies.

The review of the policy framework for forests under the EU Green Deal identified 17 different policies where improved forest management can contribute to their success (Table 3 and S2). These include the EU forest strategy, biodiversity strategy, provisionally agreed nature restoration law, law on climate change, and circular economy action plan. Starting from this policy perspective allows a broad range of evidence needs to be established, which SEEA EA accounts can be designed and compiled to meet.

The EU Green Deal case study highlights key policy evidence gaps in the scope of 'Forest accounts' and 'Ecosystem accounts' in a proposed EU regulation *introducing new environmental economic accounts modules* (EC, 2022). The EU Green Deal policy evidence needs will be better met if:

- Ecosystem extent accounts differentiate natural and managed forests, and especially old growth forest.
- Condition accounts include additional indicators on tree species, biodiversity and carbon.
- Physical and monetary ecosystem services supply and use accounts include non-wood forest products, sediment and erosion control, water flow regulation and water purification services.

Without this additional evidence, the accounts will not provide the integrated information system needed to support the policy analyses, processes and procedures across the policy cycle of the EU Green Deal (Fig. 2).

The Liberia case study focused on five policies of relevance to national forest management (Table 4). Analyses revealed that policy evidence needs will be best met if:

- The ecosystem extent accounts differentiate types of both managed and natural forests, including forest for timber production and agroforestry and forests important for biodiversity (e.g., mangroves).

Table 4
How the SEEA EA can meet the need for evidence at different stages in the policy framework for forests in Liberia.

Policy response or instrument	Policy goals and entry points	Policy cycle stage	Aligning the SEEA EA to policy evidence needs	Comments on scope of proposed accounts
Pro-Poor Agenda for Prosperity and Development (PAPD)	Increasing the forest contribution to GDP from 9% to 12% Increasing forest cover from 44% to 100% in protected areas Reducing woody biomass use for energy from 95% to 80% of households Increase environmentally protected areas (both designated and proposed) to 30% of total forest area	Formulate policy response Implement policy and policy instruments Monitor policy and policy instruments effectiveness Review policy and policy instruments	Indicators of forest sector components of GDP (e.g., timber, firewood, charcoal, biomass, etc. and associated economic activity) not recorded in the SNA forestry sector Indicators of biomass provisioning ecosystem service (e.g., firewood, charcoal) and condition indicators on biomass and standing timber Identifying the full range of forest ecosystem services and their value that can contribute to non-timber-based forest economic activities Indicators on the extent of different forest ecosystem types that are protected and not protected	Initial focus should be placed on ensuring robust measures of the area of forest and associated timber resources, with additional data, such as protected areas, species and timber production incorporated over time. In the medium to longer term, information on other ecosystem services can be added
National Forest Management Strategy	Allocating up to approximately 2.0 million hectares of forest into timber sales contracts, forest management contracts, and private use contracts Managing existing protected areas (Nimba Nature Reserve and Sapo National Park) in accordance with the National Forest Reform Law and FDA regulations Defining new protected areas and allocating up to 950,000 ha to the National Protected Area Network.	Implement policy and policy instruments Monitor policy and policy instruments effectiveness Review policy and policy instruments	Indicators to spatially track timber provisioning ecosystem services, timber-based forest economic activity and ownership Indicators on the extent of different forest ecosystem types that are protected and not protected, their condition (including connectivity), the species they support and the ecosystem services they supply to different users Indicators on environmental expenditure Ex-poste impact assessment on impact of timber exploitation on other forest ecosystem services, climate change mitigation objectives and biodiversity	The key focus here should be on ensuring the area of forests and the stock of timber are well accounted for. Focus is needed on spatial mapping given the need to allocate individual areas of forest to specific contracts and purposes
Liberia's Nationally Determined Contributions (NDCs) Implementation Plan (Prioritized Projects)	Reducing the national deforestation rate by 50% by 2030 Reducing GHG emissions from forest conversion by 40% below BAU levels by 2030 Reforesting an average of 12,285 ha per year to enhance forest carbon stocks Restoring 25% of priority degraded forests by 2030 Improving protection and conservation measures in 30% of mangrove ecosystems Enhancing coastal carbon stocks by restoring 35% of degraded coastal wetlands and mangrove ecosystems by 2030 Increasing the number of equitably governed community forests	Implement policy and policy instruments Monitor policy and policy instruments effectiveness	Indicators on the extent and condition of different forest ecosystem types (including coastal forests and mangroves) and the species they support that are protected, not protected or under community management Indicators on biomass, standing timber, carbon storage, carbon emissions from forest conversion and degradation, and flows of global climate regulation services from forested lands Ex-ante impact assessment to identify priority areas for forest restoration-based biodiversity conservation, carbon mitigation, social welfare and poverty alleviation benefits	Beyond the robust measurement of forest area and timber stocks, the core focus for NDC related measurement is accurate assessment of carbon stocks and changes in stocks, and identifying the causes of these changes such as deforestation and degradation. A combination of on ground data collection (as conducted through the National Forest Inventory) and remote sensing is needed. The extension to incorporate data on mangroves is also needed. This has been a particular focus of one part of the GEF funded project in developing initial accounts for Liberia's coastal ecosystems
National Biodiversity Strategy and Action Plan II (will be reviewed and updated in light of the recent adoption of the CBD's GBF in 2022).	Ensuring at least 35% of mangrove forest of global importance is protected Increasing the number of PAs gazetted Restoring forests through afforestation and reforestation Establishing areas of woodland Placing areas of forest under conservation through the REDD+ project	Implement policy and policy instruments Monitor policy and policy instruments effectiveness	Indicators on the extent of different forest ecosystem types that are protected and not protected, their condition and the ecosystem services they supply to different users. Indicators on forest species and biodiversity that are protected and not protected Indicators on biomass, carbon storage, and flows of global climate regulation services from forested lands that are protected and not protected Indicators to inform monitoring for the CBD Global Biodiversity Framework for Goal A (integrity, connectivity and resilience of all ecosystems), Goal B (ecosystem services), Goal C (monetary and non-monetary benefits), D (funding of conservation and sustainable use of biodiversity and ecosystems)	Core to building these accounts will be the integration of data on ecosystem extent and the boundaries of protected areas. These data can be well supported by data on ecosystem condition, including on species, to provide performance measures of the effectiveness of the PA system in securing positive biodiversity outcomes.

(*continued on next page*)

Table 4 (*continued*)

Policy response or instrument	Policy goals and entry points	Policy cycle stage	Aligning the SEEA EA to policy evidence needs	Comments on scope of proposed accounts
Liberia Forest Sector Project	The Liberian Forest Sector Project operating within the World Bank's Country Partnership Framework focuses on the management of forests including: ● Agroforestry ● Natural resource management through Authorised Forest Communities ● Protected areas ● Benefits for people living in forests or adjacent communities	Formulate policy response Implement policy and policy instruments Monitor policy and policy instruments effectiveness	Indicators on the extent and condition of different forest ecosystem types (including agroforests) that are protected, not protected or under community management Indicators on the ecosystem services supplied by protected and not protected forests (particularly firewood, charcoal, fruits, nuts, firewood, honey, and medicinal products) and the location of associated users (especially nearby communities) and aggregate national use	The additional focus for this project concerns measuring a broader range of ecosystem services, in particular those contributing to the market and non-market benefits received by people living in forests or adjacent communities

- The ecosystem condition accounts include indicators on timber resources, carbon and ideally biodiversity composition.
- Physical and monetary ecosystem services supply and use accounts include both nationally important ecosystem services, such as commercial timber provisioning and global climate regulation, and locally important ecosystem services, such as community wood provisioning, non-wood forest products including food, fibre, medicinal plants and other ecosystem services important to local livelihoods and welfare.

For both EU Green Deal and Liberia case studies, there is a need for ecosystem accounts to be spatially explicit and integrated with spatial data on land use, especially protection status. Without the spatial detail, it will be extremely challenging to deliver effective interventions that benefit biodiversity and communities local to forests.

Both case studies illustrate forests are important across a range of policies, highlighting how the governance of forest resources is a complex endeavour because of interdependence with cross-sectoral policies such as biodiversity, climate change, agriculture, and national development plans. Consequently, achieving successful policy outcomes for forests will require substantial levels of co-ordination and balancing of interventions in different locations across a range of institutions, donors and initiatives to support policy design and implementation. To achieve appropriate levels of co-ordination, stakeholders have a significant advantage by working from a commonly agreed set of baseline information and a common language for describing the state, changes in state and services provided by forest ecosystems. This rationale for the use of the SEEA EA is supported by the reality that inconsistencies in information and language among different agencies can lead to significant confusion and increased costs in implementation.

Reflecting on the above, the policy review process itself is a steppingstone for engaging with stakeholders to raise awareness of the relevance of coherent and consistent evidence for 'better' decision-making. For instance, the application of the SEEA EA at national levels can generate the economic arguments needed to channel funds to nature-based solutions. A specific example is the UNFCCC Paris Agreement, where carbon markets (as a regulated and voluntary economic policy instrument), can contribute substantially to meet targets for Nationally Determined Contributions and the funds needed for forest-based mitigation (UNEP, 2022; UNEP and IUCN, 2021). At the same time, carbon finance supporting conservation, restoration or sustainable management of forests can help countries to fulfil socioeconomic needs, such as job creation through ecotourism or the sustainable exploitation of non-timber forest products and the conservation of forest-dependent species and ecosystems. Through the SEEA EA, countries have the appropriate tool to monitor if the investments supported by climate finance are leading to such expected environmental and socioeconomic benefits (Vardon et al., 2022).

Whilst the SEEA EA holds promise for delivering 'policy-ready' evidence for multiple forest and other ecosystem needs, it sits within a larger landscape of policy instruments and internationally agreed frameworks for structured data collation and synthesis. Biodiversity-focussed examples include the IUCN Red List of Ecosystems, the global standard for ecosystem risk assessment, which is applied by environmental agencies in many governments, research and NGO communities and has been proposed as one of the metrics to monitor progress against one of the goals agreed under the GBF (CBD/COP/15/2).[3] The FAO regularly collect, analyse and disseminate information on the status of and trends in the world's forests through the Global Forest Resources Assessments (FAO, 2020). As part of countries commitments towards meeting the Paris Agreement (UNFCCC 2015), Parties to the Convention provide data on their national greenhouse gas emissions from all sources, including land use, land-use change and forestry (LULUCF) to a Global Stocktake. Further research and investigation are needed about the complementarities and potential alignment between these existing frameworks for different objectives and the SEEA EA statistical standard, especially for capturing opportunities to improve the data bases serving the SEEA EA.

Co-design of environmental monitoring and reporting systems with the SEEA EA accounting format will clearly enhance alignment (Ruijs et al., 2019). For instance, the new EU framework for forest monitoring and strategic plans can deliver detailed, accurate, regular and timely information on the condition and management of EU forests, and on the products and ecosystem services that forests provide. This monitoring data is a critical part of the information system required to support forest ecosystem accounting in Europe. Developing this monitoring framework with the SEEA EA accounting classifications and structures in mind will greatly enhance the potential for mainstreaming information on forests across environmental, economic and social planning processes and policies.

7. Conclusion

This paper highlights the role the SEEA EA can play in contributing to evidence-led, integrated policy action by delivering robust 'policy-ready' evidence when it is needed across the policy cycle. Using case studies for the EU Green Deal and Liberia, we demonstrate how the SEEA EA can support policy evidence needs, using forests as a policy theme. The case studies highlight the benefits of undertaking structured reviews of forest policy entry-points and evidence needs at the outset of embarking on the compilation of the SEEA EA accounts described in Fig. 1. They demonstrate how SEEA EA accounts can be designed and

[3] https://www.cbd.int/doc/c/179e/aecb/592f67904bf07dca7d0971da/cop-15-l-26-en.pdf

compiled to inform on all stages of the policy cycle, and support associated analyses, processes and procedures (see Fig. 2). The EU case study identified some important evidence gaps the proposed EU regulation on environmental-economic accounts should address that are relevant across the policy cycle. It describes how ecosystem accounts can be best compiled to fill these. The Liberia case study identified evidence needs across the policy cycle for five national policy responses that ecosystem accounts can be compiled to meet. We believe the structured reviews for each case study can be replicated for policy themes and frameworks beyond forests.

These structured reviews provide a foundation for active engagement with the policy community on the EU Green Deal and on Liberia's policy framework for forests. Further engagement with these potential account users is needed to understand in detail what evidence they need, in what format and how it can be delivered to support the specific analyses, processes and procedures that will drive the policy cycle around these two forest policy frameworks. Institutionalising the SEEA EA into the policy-making processes in this way will greatly enhance the ability of governments to deliver better, more coherent and integrated policy responses that recognise the multiple benefits of forests. This can encourage transition from sector-by-sector responses to comprehensive policies that recognise the trade-offs between intensive management of forests for provisioning services and more sustainable management of all forests to achieve a range of environmental, economic and social objectives.

Disclaimer

This paper has been prepared by a group of authors working under the auspices of the SEEA Ecosystem Accounting Working Group on Forest Ecosystems. The views expressed herein are those of the authors and do not necessarily reflect the views of the United Nations.

CRediT authorship contribution statement

All authors have participated in the conceptualization, structuring, design, content, writing and revision of the manuscript.

Declaration of Generative AI and AI-assisted technologies in the writing process

Generative Ai was not used in anyway in the production of the manuscript.

Declaration of Competing Interest

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

Data Availability

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.envsci.2023.103653.

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