The SEEA Ecosystem Accounting: Making Nature Count through Official Statistics

Introduction

Gross domestic product (GDP), probably the world's most well-known statistic, has been around for nearly eight decades. Adopted in 1944, GDP is compiled by the national statistical offices (NSOs) of nearly all United Nations Member States. Gross domestic product is an often used statistic for good reason, as it can provide a valuable snapshot of the economy.

However, GDP is commonly misinterpreted as a measure of wellbeing and welfare. This misinterpretation means that it is often misused in policy analysis, particularly when it comes to the environment. For instance, GDP ignores the depletion and degradation of the environment and can even treat environmental depletion/degradation as economic output. In an extreme example, felling a forest for timber will increase GDP, even though destroying the forest may ultimately harm economic progress, as it is no longer able to provide ecosystem services such as flood mitigation, soil retention and air filtration. Similarly, GDP ignores the benefits that a healthy environment provides to the economy and humanity. Biodiverse, healthy ecosystems provide significant contributions to benefits such as clean water, productive soil and flood control. But the economic contributions provided by natural capital are not captured by GDP.

Thus, the adoption of the System of Environmental-Economic Accounting (SEEA) Ecosystem Accounting (EA) (UN et al., 2021) in 2021 by the United Nations Statistical Commission was hailed as ground-breaking. Upon its adoption, UN Secretary General Antonio Guterres proclaimed: "We will no longer be heedlessly allowing environmental destruction and degradation to be considered economic progress" (UN, 2021a). Indeed, the SEEA EA provides a response to the critique of many, that policy makers rely too greatly on GDP. The SEEA EA constitutes a statistical framework for organizing data on habitats and landscapes, measuring ecosystem services, tracking changes in ecosystems and linking this information to economic and other human activity. By linking information on ecosystems and biodiversity to the economy, the SEEA EA makes nature's contributions to the economy visible, thereby allowing for improved decision-making.

This paper provides an overview of the SEEA EA conceptual framework and how it is implemented in countries, including the Philippines. The paper will explain the core accounts of the SEEA EA, including ecosystem extent, condition, service and asset accounts. The paper will also review how the SEEA EA provides information for global policy frameworks, such as the 2030 Agenda for Sustainable Development and post-2020 global biodiversity framework, and how the SEEA EA encourages NSOs to act as data stewards. Finally, the paper will showcase new tools for ecosystem accounting, namely the ARIES for SEEA, an integrated, open-source modelling platform.

SEEA EA conceptual framework

The underlying premise of natural capital accounting is that natural capital is an asset that must be maintained and managed, just like produced capital (buildings, machinery, roads) and human capital (health, knowledge, skills). This view is espoused in the recent report *The Economics of Biodiversity: The Dasgupta Review*, which outlines the relationship between biodiversity and the economy. In recognizing the central role of natural capital in our livelihoods, the Dasgupta Review strongly advocates for an

approach that goes beyond GDP. It posits that it is not enough to measure flows, such as GDP. Stocks, including natural capital must also be measured (Dasgupta, 2021).

The SEEA EA, adopted by the United Nations Statistical Commission in 2021, is the agreed-upon international statistical standard for natural capital accounting.[1] As espoused in the Dasgupta Report, the SEEA EA takes a capitals approach in portraying ecosystems as assets which provide humanity with vital ecosystem services (air filtration, carbon storage, etc.). These ecosystem assets and services are measured in physical units (extent, condition and service accounts), and the SEEA EA also provides a framework for measuring ecosystem services and assets in monetary terms.

Like the SEEA Central Framework (CF), the SEEA EA has a strong relationship with the System of National Accounts (SNA). Whereas the SEEA CF extends the asset boundary of the SNA to cover individual natural resources which are outside of the economy, the SEEA EA also extends the production boundary to the environment to include ecosystem assets, which provide ecosystem services. The link between the SEEA EA (and SEEA CF) and SNA is also reinforced through the use of mutual definitions, concepts and classifications. For example, economic activities in the SEEA EA are also classified through the International Standard Industrial Classification (ISIC), and the monetary accounts of the SEEA EA use valuation principles consistent with the SNA.

Core accounts

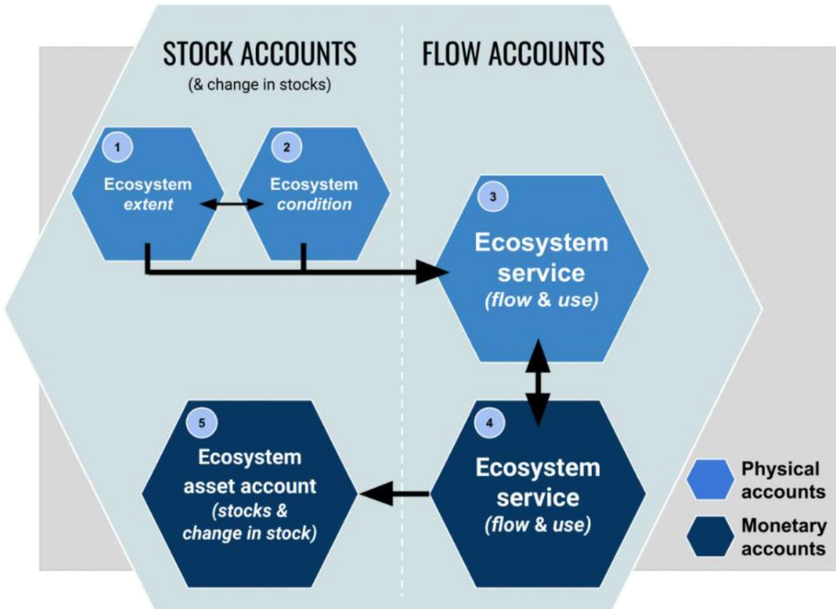
There are five core accounts which make up the building blocks of the SEEA EA. These accounts constitute an accounting system which provides a comprehensive and coherent view of ecosystems and their relationship with the economy:

- ***ECOSYSTEM EXTENT*** accounts record the total area of each ecosystem, classified by type within a specified area (e.g. nation, province, river basin, protected area, etc.). Ecosystem extent accounts are measured over time in this specified area, also known as an ecosystem accounting area, thus illustrating the changes in extent from one ecosystem type to another over the accounting period.
- ***ECOSYSTEM CONDITION*** accounts record the condition or health of ecosystem assets in terms of selected characteristics at specific points in time. Over time, they record the changes to their condition.
- ***ECOSYSTEM SERVICES*** physical and monetary accounts record the supply of ecosystem services by ecosystem assets and the use of those services by economic units, including households.
- ***ECOSYSTEM MONETARY ASSET*** accounts record information on stocks and changes in stocks (additions and reductions) of ecosystem assets using net present value principles. This includes accounting for ecosystem degradation and enhancement.

It should be noted that ecosystem accounts are commonly compiled sequentially, as listed above and shown below. This is because there are strong connections between (i) the focus of the extent account and condition account on the description of ecosystem characteristics; (ii) the condition of ecosystems

[1] Chapters 1 to 7 which describe the accounting framework and the physical accounts have been adopted as an international statistical standard. Chapters 8 to 11 contain internationally recognized statistical principles and recommendations for the valuation of ecosystem services and assets in a context that is coherent with the concepts of the SNA. Chapters 12 to 14 describe the applications and extensions of the accounts (See E/2021/24-E/CN.3/2021/30).

and their ability to supply ecosystem services in physical terms; (iii) physical ecosystem service accounts and monetary ecosystem service accounts, as the latter depends on the values of the former in addition to prices; and (iv) the monetary ecosystem service accounts and monetary asset accounts, as the latter requires estimation of future flows of ecosystem services.



Source: UN, 2022a

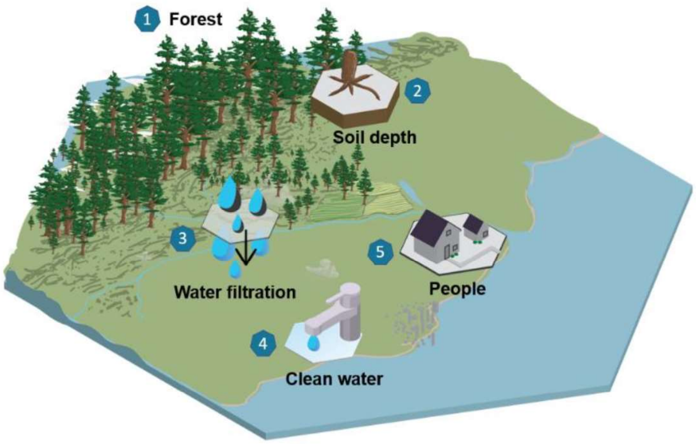
It is also important to note that while the core SEEA EA accounts are meant to be compiled in a specific sequence, the SEEA EA still takes a modular and flexible approach. The SEEA EA can be applied to an ecosystem accounting area as small as a watershed and as large as a multi-country region. For example, the Philippines has compiled accounts for mangrove ecosystem types but is also planning to embark on national-level ecosystem accounts. In addition, compilers can pick and choose the specific ecosystem services they would like to measure based on policy priorities. Finally, there is no requirement to compile both physical and monetary accounts. While monetary ecosystem accounts can support several assessments of wealth and can be combined with the monetary valuations of other types of assets, the SEEA EA recognizes that physical accounts are very much valuable tools in and of themselves.

Spatial approach

It is important to note that the SEEA EA is a spatially explicit approach, in contrast to the SEEA CF, which looks at individual environmental assets such as water, timber or energy. The SEEA EA takes a spatial approach because the benefits that society receives from ecosystems depends on where the ecosystem assets are in the landscape in relation to beneficiaries. Practically speaking, the spatial approach of the SEEA EA means that ecosystem accounts are often compiled and disseminated using maps, as well as tables.

A stylized example (below) shows how the SEEA EA makes use of spatial data to identify the location and size of ecosystem assets, the ecosystem services they provide, and the location of beneficiaries (households, businesses and governments). In this example, the forest is identified as an ecosystem asset that can be measured by its extent (e.g. hectares) and occurrence through maps (1). The health of

the forest asset can be further described in terms of its condition, through indicators such as soil depth which reflect its overall quality (2). Ecosystem services such as water filtration are provided by forests, as the biomass in forests can collect and filter rainfall before it reaches streams and rivers (3). The benefits provided by the filtration service take the form of cleaner water and reduced water treatment costs (4). These benefits accrue to beneficiaries in the economy such as businesses and households, and the contributions to these benefits can be measured using quantitative economic techniques (5).



Source: UN, 2022a

Thematic accounts

The SEEA EA suite of accounts also includes thematic accounts that can be compiled on a specific environmental theme. Thus, thematic accounts are not specific fixed SEEA EA accounts in and of themselves. Instead, they comprise select core accounts along with other relevant data from the SEEA CF and SNA. Links between the various accounts for a specific theme are possible because the SEEA EA, SEEA CF and SNA use many of the same definitions, classifications and concepts. This means that thematic accounts can convey a coherent narrative and facilitate the derivation of consistent indicators which can be used for models and other analytical tools. Common thematic accounts include accounting for biodiversity, climate change, ocean and urban areas.

Links to policy

Biodiversity

One of the strengths of the SEEA, in particular the SEEA EA, is its usefulness for biodiversity policy. While biodiversity plays a fundamental role in sustaining our lives and livelihoods, biodiversity's value is usually not captured or recognized in policy decisions. The continual 'undervaluation' of biodiversity means that it continues to be destroyed and degraded. Because the SEEA EA sits at the nexus of ecosystems and the economy, it provides an understanding of the economic drivers behind biodiversity loss (specifically that of ecosystems and species) and provides insights into how to better manage biodiversity to achieve more sustainable and efficient economies.

The importance of the SEEA in biodiversity policy is reflected in SDG indicator 15.9.1, which measures Aichi Biodiversity Target 2 of the Strategic Plan for Biodiversity (2011-2020).[2] Aichi Biodiversity Target 2 is the integration of biodiversity values into national and local development and poverty reduction strategies and planning processes and the incorporation of biodiversity values into national accounting, as appropriate, and reporting systems (CBD, 2020). SDG indicator 15.9.1 takes SEEA implementation as a measure of whether countries have achieved Target 2. Including SDG indicator 15.9.1, the SEEA can inform 40 SDG indicators over nine SDGs, and the SEEA EA supports several indicators for SDG 14 and 15 (UN, 2022b).

As the Strategic Plan for Biodiversity 2011-2020 has reached its end, negotiations are underway for the creation of a post-2020 global biodiversity framework. There is considerable demand for the new framework to be more rigorous and transformative than the Strategic Plan for Biodiversity. The 15th Convention of Parties of the Convention on Biological Diversity (CBD) will be held in December 2022 in Montreal and will contain a 2050 Vision for Biodiversity. As part of the negotiations for the framework, the CBD is also working to identify means of monitoring its implementation, including through the use of indicators, metadata and associated reporting. The included indicators should include those that have been agreed through a scientific or intergovernmental process and are globally and nationally relevant. Given the rigorous process in developing the SEEA EA (which included several rounds of expert and global consultations) and given the SEEA EA's focus on biodiversity, the SEEA EA provides a way for the official statistics community to ensure that high-quality and rigorous statistics are used to support monitoring of the post-2020 global biodiversity framework. It is anticipated that the SEEA EA may be used to monitor two goals (Goals A and B) and three targets (9, 11 and 14) (CBD, 2022).

Climate change

The SEEA EA also provides an important contribution to climate change policy. While SEEA CF air emission accounts provide valuable information on greenhouse gas emissions and environmental taxes, subsidies and expenditures, the SEEA EA provides an ecosystems perspective of climate change. In particular, the carbon accounts of the SEEA EA provide a comprehensive overview of how much carbon is stored per ecosystem type (and in carbon pools) and how this develops over time due to sequestration, deforestation, afforestation, harvesting, forest fires, etc.

This information is especially important for countries which contain ecosystems such as peatlands (including the Philippines). Although peatlands only cover approximately 3 per cent of the Earth's land surface, they contain between 32 and 46 per cent of the total soil carbon pool, potentially exceeding the amount of carbon contained in the world's vegetation (Page and Hooijer, 2016). While peatlands are prime land for agriculture, draining peatlands releases large CO_2 emissions. By providing information on carbon storage of different ecosystem types, the SEEA EA can help users take into account the full range of tradeoffs involved in ecosystem conversions (Pizarro, 2020).

In addition, ecosystems provide valuable protection against climate change risks and impacts, such as extreme weather events and other natural disasters. For instance, mangroves, other wetlands and coral reefs protect coastlines from waves and increased water levels, and urban greenspaces provide cooling during heatwaves. While ecosystem services help protect against climate change risks and impacts,

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[2] SDG indicator 15.9.1 is expected to be updated as appropriate with the adoption of the post-2020 global biodiversity framework.

ecosystems and ecosystem functioning are susceptible to rising temperature. Thus, adaptation policy must take into account sustaining ecosystems which provide valuable ecosystem services (Pizarro, 2020). By providing a framework to measure these ecosystem services, the SEEA EA can better inform adaptation policies and provide insights into potential nature-based solutions.

A model for data stewardship

Data stewardship is a concept which has recently increased in prominence in the official statistics community. The role of NSOs as data stewards challenges the traditional siloed approach of NSOs working separately and in isolation of other stakeholders and partners. This siloed approach results in duplication of effort and wasted resources on both the part of NSOs and line ministries and other data providers.

While there currently does not exist a global framework or definition for data stewardship, the United Nations Statistical Commission Working Group on Data Stewardship has identified some common elements of a data stewardship approach. This includes a focus on data as a strategic asset; the adoption of ethical standards and an inclusive approach throughout the data value chain; and the development of a whole-of-government approach to data (Working Group on Data Stewardship, 2022).

Perhaps more than any other area of statistics, the compilation of the SEEA EA necessitates NSOs to act as data stewards, particularly when it comes to a whole-of-government approach to data. The implementation of the SEEA EA is often led by the official statistics community and NSOs, but given the highly cross-cutting and spatial nature of ecosystem accounting, implementation necessitates a highly collaborative approach. The NSO cannot produce the accounts in a silo; instead, the data must be sourced from mapping agencies, ministries of environment, etc. For instance, ecosystem extent accounts may require land cover and topological maps from the mapping agency, vegetation and species data from the ministry of environment, and temperature and rainfall data from the meteorological agency. In order to combine these data in an integrated manner, NSOs must work with each of the relevant line ministries and other data providers to understand the technical aspects and data processes used to create the data.

In addition, NSOs must also ensure that the source data meet the quality requirements of official statistics. This means that NSOs often end up collaborating with data providers to improve data quality. This is often done through formal collaboration mechanisms. Many countries already have formal collaboration mechanisms to support SEEA compilation, including the Philippines, which has the Interagency Committee on Environment and Natural Resource Statistics (IACENRS) and several technical working groups, including the Technical Working Group on Natural Capital Accounting. The end result of interagency committees such as these is that the NSO generates a shared understanding of the data assets relevant to the accounts, provides guidance into how to improve the quality of source data to ensure that it is fit for purpose, and increases the quality and trust in the data for the public good.

Leveraging new tools and artificial intelligence

Amongst the various types of data needed for ecosystem accounts are big data and Earth observation. Many NSOs do not yet have expertise in working with these kinds of data. Moreover, given that primary

data on ecosystems and ecosystem services is often scarce, compilers often must make use of biophysical modelling to compile the accounts (another area in which NSOs may not have expertise in).

However, these challenges also present new opportunities. Countries just beginning ecosystem accounting which may not have sufficiently granular national data can make use of global data (in combination with what national data is available) and use global models to develop initial estimates for the accounts. These accounts can then be improved upon over time as the data and methodology is refined. Many countries have adopted this approach, releasing accounts on an experimental basis and then gradually improving them over time.

One tool aiding this approach is the Artificial Intelligence for Environment and Sustainability (ARIES) for SEEA,[3] an integrated, open-source modelling platform for environmental sustainability. The ARIES for SEEA can generate ecosystem accounts for any user-specified terrestrial area in the world (such as a country, administrative region, watershed, etc.), by using freely available global remote-sensing derived data and models.

The ARIES for SEEA application makes use of artificial intelligence—specifically semantics and machine reasoning to automate data and model integration. A core component of ARIES is the use of a set of consistent semantics, which comprise uniform and unambiguous definitions for the data and models involved, and the relationships between them. These semantics are constructed using an intuitive language readable by both people and computers. For example, different datasets and models are consistently labelled with clear, uniform and unambiguous descriptors.

Users can use their own local/national data and models or make use of global datasets and models. If users do not use their own local/national data and models, the ARIES for SEEA will automate data and/or model selection based on a user's specific request. It chooses the "most appropriate" model for the location, spatiotemporal resolution and account specified (e.g., an ecosystem service or condition account for a given country and year) and depending on the models and data sources accessible to the system. The ARIES for SEEA application currently contains models for land cover, ecosystem extent, condition and select service accounts (both physical and monetary).

The UNSD and the Philippine Statistical Authority (PSA) are currently making use of the ARIES for SEEA application in the three-year project, Environmental-Economic Accounting for Evidence-Based Policy in Africa and Asia (2020-2023). In the Philippines, this project will focus on land cover and ecosystem extent accounts. The PSA and the National Mapping and Resource Information Authority (NAMRIA) are currently working together to integrate national land cover data into ARIES. This land cover data (for 2015 and 2020) will be used to compile land cover accounts in ARIES. In 2023, additional data (national and/or global geospatial data) will be integrated into ARIES and used with the land cover data to derive ecosystem extent accounts. In the future, models can be run on the land cover and ecosystem extent data to derive ecosystem condition and/or service accounts.

Conclusion

Compiling ecosystem accounts has a range of benefits. Not only can the accounts help policy makers go 'beyond GDP' and inform a wide range of policy questions, from climate change to biodiversity, but they also promote the role of NSOs as data stewards.

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[3] https://seea.un.org/content/aries-for-seea

The benefits of ecosystem accounting have not gone unnoticed, and interest in ecosystem accounting is at an all-time high. In 2021 the UN released the UN Common Agenda,[4] the Secretary-General's blueprint for the next 25 years. In it, the Secretary-General declared "I urge Member States and others to already begin implementation of the recent SEEA EA" (UN, 2021b). Thus, the UNSD and the UN Committee of Experts on Environmental-Economic Accounting (UNCEEA) are now turning their focus to supporting country implementation. Earlier this year, the UNCEEA presented its global implementation strategy for the SEEA Ecosystem Accounting (UNCEEA, 2022). The UNCEEA and UNSD are working to support capacity building, develop guidelines, improve collaboration, develop data and tools, and strengthen communication and advocacy. The current efforts to implement the SEEA EA in the Philippines are an excellent example of the recommendations of the global implementation strategy being put into practice, and of national statistical offices ensuring that policymakers have the data to make nature count in their decisions.

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