System of Environmental Economic Accounting

Forum of Experts in SEEA Experimental Ecosystem Accounting 2019

DRAFT Summary Report – 6 September 2019

26 – 27 June 2019

Glen Cove, New York, USA

United Nations

UN environment

THE WORLD BANK
IBRD • IDA

INTRODUCTION TO THE REVISION PROCESS OF THE SEEA EXPERIMENTAL ECOSYSTEM ACCOUNTING (SEEA EEA)

In March 2013, the United Nations Statistical Commission endorsed the System of Environmental-Economic Accounting 2012 – Experimental Ecosystem Accounting (SEEA EEA) as an important step in the development of a statistical framework for ecosystem accounting for commencing testing and further development of this new field of statistics. The SEEA EEA offered an initial synthesis of the knowledge in ecosystem accounting and served as a platform for its development at national and sub-national levels. It also provided a common set of terms, concepts, classifications, and an integrated accounting structure for measuring ecosystem services and ecosystem condition in both physical and monetary terms. In December 2017, the SEEA EEA Technical Recommendations were released to provide an update of knowledge about ecosystem accounting and clarifying various aspects of the original SEEA EEA.

The SEEA EEA has now been recognized as the main statistical framework for ecosystem accounting in several international and regional policy initiatives. These include, but are not limited to, the World Bank-led Wealth Accounting and the Valuation of Ecosystem Services (WAVES) partnership, the EU projects on Mapping and Assessment of Ecosystems and their Services (MAES) and the Knowledge Innovation Project-Integrated Natural Capital Accounting (KIP-INCA), the UNDP Biodiversity Finance (BIOFIN) initiative, the Convention on Biological Diversity (CBD) Aichi Biodiversity Targets (in particular Aichi target 2), the UNCCD initiative on Land Degradation Neutrality and the UN Environment-led initiative on The Economics of Ecosystems and Biodiversity (TEEB).

Reflecting the rapid progress in the development and practice of ecosystem accounting since 2013, in March 2017 the United Nations Statistical Commission endorsed a revision process of the SEEA EEA with substantive work commencing in early 2018. The objectives of the revision process are to move towards a consensus on concepts and methods on ecosystem accounting building on the testing and experimentation that has been going on since the release of the SEEA EEA, as well as learning from the experience of various initiatives working on related projects and topics, including, for example, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and natural capital assessment projects, and taking advantage of the availability of new technologies and data sources.

Under the auspices of the UN Committee of Experts on Environmental-Economic Accounting (UNCEEA), the United Nations Statistics Division (UNSD) supports the methodological development of the SEEA EEA and implementation of ecosystem accounting in countries through its regular work program and externally-funded projects including the recently-finished Norwegian-funded Advancing Natural Capital Accounting (ANCA) project and more recently the European Union-funded Natural Capital Accounting and the Valuation of Ecosystem Services (NCAVES) project. The latter project aims to assist five partner countries (Brazil, China, India, Mexico, South Africa) to establish an institutional mechanism in countries, compile selected ecosystem accounts based on countries priorities to measure ecosystem extent, condition and ecosystem services in physical and monetary terms. The project supports also global activities including this Forum, regional workshops and fosters sharing of experience among countries. There are currently around 40 countries undertaking piloting of ecosystem accounting at various scales.

THE 2019 FORUM OF EXPERTS

Introduction

This Forum of Experts builds on earlier Forums organized in 2013, 2015 and 2018 by UNSD to advance the theory and practice of ecosystem accounting, considering the fast-evolving nature of the topic and the increasing policy interest. Bringing together a broad range of expertise and experiences, the Forums have contributed to the development of guidance documents on ecosystem accounting, including the SEEA EEA in 2013, the Technical Recommendations in support of the SEEA EEA issued in December 2017 and the initial research and discussion papers developed for the current SEEA EEA revision process.

Objectives and structure

The Forum's main objectives were to:

- Build and share the motivation for ecosystem accounting to support decision making at multiple scales;
- Share best-practices in compiling and applying ecosystem accounts;
- Advance the research agenda in support of the revision of the SEEA EEA;
- Showcase methodological and technical advances; and
- Identify priority areas for testing and experimentation to support the advancement of the research agenda.

To meet these objectives a wide-ranging agenda[1] was established. It covered the policy context; the four main research areas of the SEEA EEA revision; advances in modelling and indicators; ecosystem accounting for themes of particular interest (namely, urban areas, marine areas, carbon and protected areas); accounting for biodiversity; scenario modelling using the accounts; biophysical modelling for ecosystem accounting; the linkages between SEEA and indicator initiatives: developments in corporate natural capital accounting; advances in wealth accounting and the sharing of experiences from various international initiatives and countries.

A key feature of the Forum was the mixture of plenary and breakout sessions. This combination provided substantial opportunities for engagement and discussion across the breadth of topics covered by ecosystem accounting. Around 120 people[2] participated in the conference with a wide geographic distribution and a broad variety of backgrounds and disciplines, including science, accounting, statistics, geospatial information and others. In terms of sector representation, the participants were primarily from government agencies, international organizations, non-governmental organizations, research institutes and academia.

This report provides a summary of the key aspects of the large number of presentations and discussions across the 10 sessions of the Forum. All information, papers, presentations and similar

[1] https://seea.un.org/sites/seea.un.org/files/forum_2019_agenda_public_26_june_2019.pdf
[2] https://seea.un.org/sites/seea.un.org/files/forum_2019_participant_masterlist_for_website_final.pdf

materials that were discussed at the Forum are available on the event website[3] and readers are encouraged to access these materials.

Session 1: The international policy context for ecosystem accounting

A highlight of the Forum was the opening session with a video address from Mr. Elliott Harris, Assistant Secretary-General for Economic Development and Chief Economist of the United Nations and a key note presentation from Sir Robert Watson, former co-chair of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). Both spoke directly to the important role that ecosystem accounting can play.

Mr. Harris highlighted the ongoing shift among policy makers to move beyond GDP and the relevance of natural capital accounting as a key tool in that transition. Indeed, nature- based solutions have been identified as a key focus for economic policy. To secure progress, he advocated ongoing engagement with the user community and articulation of case studies that reveal the potential of accounting to support policy.

Sir Robert Watson gave an extended address highlighting many aspects of the current state of ecosystems and biodiversity, referencing in particular the findings from the recent IPBES Global Assessment. There is clear evidence that the global trends are not good. A key aspiration at present is to ensure that biodiversity is considered of equal policy relevance to climate change, which in turn requires recognition that biodiversity is a social, economic and development issue as much as an environmental one. Recognizing the inter-connections between biodiversity and people is therefore fundamental for achieving biodiversity outcomes as well as the economic and social outcomes envisaged in the SDG goals and targets.

To pursue this agenda, Sir Robert Watson spoke to the relevance of ecosystem accounting and in particular to the relevance of bringing non-market and social values into standard economic policy discussions. In this context, the SEEA EEA's potential to harmonize measurement to a greater extent could be a powerful force for change. This would extend to finding ways to bring multiple stakeholders to the decision-making table, i.e. bringing environment, agriculture, finance, development and other ministers together. He observed that measurement of the past was important but not sufficient to motivate change. An increasingly important aspect of the discussion is the description of plausible future and scenarios that decision makers can evaluate. Supporting the development of these scenarios may be a key role for ecosystem accounts.

Sir Bob Watson emphasized the need to better connect the SEEA revision process with the IPBES process, in particular the value assessment for which a draft report will be produced in June. He encouraged representatives of the SEEA process to provide comments on the report and offered to inform the IPBES community of the progress made, notwithstanding the participation of a small group of SEEA experts in the IPBES report.

Collectively, these presentations reinforced the essential importance of biodiversity and ecosystems in underpinning economic activity and human life more broadly and highlighted the potential for accounting to play a key role in achieving the broad ambitions of the 2030 Sustainable Development Agenda.

[3] https://seea.un.org/events/2019-forum-experts-seea-experimental-ecosystem-accounting

Sessions 2 & 3: Advances in ecosystem accounting concepts and treatments

Sessions 2 and 3 focused on the findings across the four research areas of the SEEA EEA revision process; namely, spatial areas, ecosystem condition, ecosystem services and valuation and accounting treatments. Session 2 provided an overview of advances over the past 12 months to all Forum participants and Session 3 comprised four parallel discussion, one on each of the research areas, which allowed a deeper consideration of the issues. This section provided an overview of the main technical findings and directions that emerged from the Forum.

3a: Spatial areas

Spatial units provide the conceptual starting point for ecosystem accounting by delineating ecosystem assets that in turn are considered to generate ecosystem services. The basic model for the description of spatial units for ecosystem accounting was described in the SEEA EEA and, while refinements and improvements have been made over the past 5 years, the core design of ecosystem accounting areas, ecosystem assets of different ecosystem types and basic spatial units has remained consistent.

The research led by the working group identified some leading options for a reference classification of ecosystem types, specifically: (i) the classes developed for the IUCN Red List of Ecosystems; (ii) the classes developed by USGS/ESRI; and (iii) a combination of these two options. Presentations at the Forum by Emily Nicholson (Deakin University), Roger Sayre (USGS) and Patrick Bogaart (Statistics Netherlands) detailed each of these options. In general terms the discussion clarified that the selected classification should be hierarchical, maintain simplicity and have a limited number of classes at aggregated levels.

The discussion considered that all three classifications presented are good candidates based on a set of design criteria, with the IUCN classification receiving the strongest endorsement. Nonetheless, wider discussion and more extensive testing is required, especially since the options have not yet been used in practice. In particular the testing should focus on linking existing national classifications of ecosystems to these reference classifications and being able to link the ecosystem function concepts underpinning the classifications with spatial observations. In this regard, it was considered useful to explore the links to various human uses, potentially through overlaying land use maps and the proposed reference ecosystem type classifications.

While the definition and delineation of ecosystem types was the primary focus of research and discussion, other topics presented concerned the definition of spatial areas with respect to the atmosphere, marine areas and urban areas. In each of these cases, the working group has proposed various options but no clearly endorsed treatments have yet emerged.

3b: Ecosystem condition

The measurement of the condition of ecosystem assets is a key component of ecosystem accounting since it is the condition which drives the capacity of an ecosystem asset to generate services in a sustainable way. Monitoring the level of and changes in condition is thus a key feature of accounting for ecosystem assets and the measurement of ecosystem degradation and enhancement.

The working group on ecosystem condition has led a significant synthesis of current understandings of the measurement of condition and provided discussion papers outlining values-based framing for

ecosystem condition, a standard measurement approach and associated terminology, accounting structures and a typology of indicators. These have all received broad endorsement through initial rounds of review. Based on the research to date, three topics have been identified for ongoing discussion – the definition and setting of reference levels, the link between biodiversity and ecosystem condition, and the link to ecosystem capacity.

The parallel session provided the opportunity for the three discussion papers to be presented by Heather Keith (Australian National University), Amanda Driver (SANBI, South Africa) and Joachim Maes (EU JRC) and for two country examples of condition accounting to be shown (Mexico and Norway). Both country presentations were considered to be close reflections of the generic approach described in the discussion papers and have provided substantive input into practical application of the condition accounting principles.

Notwithstanding the broad endorsement of the approach, the discussion at the Forum suggested the need for ongoing discussion to clarify the accounting approach in respect of:

- Dealing with changes in ecosystem type over time, both gradual and rapid change, and the role of ecosystem extent accounts compared to ecosystem condition accounts
- The role of information about ecosystem processes in the measurement of condition
- The link between ecosystem condition and ecosystem services
- The role of pressure indicators as measures of ecosystem condition
- The challenges of aggregation and scale, including reporting on the condition of ecosystem types as distinct from individual ecosystem assets
- Reflecting intrinsic and instrumental values in practice

The discussion also confirmed the importance of continuing discussion on the definition and setting of reference levels, the need to establish clear connections to the measurement of ecosystem services and ecosystem capacity, and the requirement to effectively incorporate measures of biodiversity in the measurement of ecosystem condition.

3c: Ecosystem services

Ecosystem services is the concept that establishes the accounting link between ecosystem assets on the one hand and economic activity, including household consumption, on the other. Indeed, the concept of ecosystem services was a missing element of the discussion on accounting for ecosystem degradation in the early versions of the SEEA. The SEEA EEA development through 2011-2013 was able to take advantage of the rapidly increasing research and practice on the measurement of ecosystem services and used this to describe the core ecosystem accounting framework which links ecosystem assets and ecosystem services using a logic that is broadly analogous to the treatment of produced assets in the national accounting system.

While the core ecosystem accounting framework remains robust with ecosystem services providing the bridge between ecosystems and existing measures of economic activity, there remain a range of issues in the definition and measurement of ecosystem services for accounting purposes that are unresolved.

Presentations at the Forum by Lars Hein (Wageningen University) and Rocky Harris (DEFRA) highlighted the range of work that has been undertaken since June 2018, in particular the drafting of 10 research papers on individual ecosystem services, which documented the relevant definitions, current practices in measurement and valuation approaches. These papers highlighted the measurement potential but

also a level of inconsistency in definition and measurement across different services. Resolving these inconsistencies and clarifying a range of boundary issues was the focus for the discussion.

Two specific issues were discussed (i) the treatment of ecosystem services related to the provision of biomass (e.g. agricultural production) and (ii) the treatment of mediation services (e.g. air filtration and water purification). The discussions found some proposals that can be taken forward for further refinement and review.

For biomass provisioning services, it was clearly recognized that ecosystem services are one input into a joint production process and there was general agreement that measurement of the flow of ecosystem services may be proxied in physical terms by the total biomass available for harvest. In monetary terms, the value of the biomass provisioning service would need to deduct the costs of harvest and management. The exact wording and explanation of this treatment will require further thought and that the distinction between the theoretical and the practicable needs to be acknowledged.

For mediation services, the discussion provided a clear direction in terms of establishing a general model for analyzing regulating services subject to clarifying the distinction between stocks and flows in the relevant figures. Clarification was needed in terms of the identification of the beneficiary of regulating services, and in terms of an approach to treating intermediate regulating services.

Finally, two other areas were discussed briefly confirming that (i) there was not strong support for elaborating the concept of unmet demand; and (ii) further discussion is needed on the treatment of externalities and ecosystem disservices in an accounting context.

3d: Valuation and accounting treatments

The area of valuation and accounting treatments is commonly the most contentious area of ecosystem accounting due to the challenges and perceptions associated with environmental valuations. Nonetheless, for a full integration of ecosystem assets and services in national accounts in monetary terms is required and engagement with the broader economics and financial communities requires the capacity to talk meaningfully about approaches to the valuation of ecosystem assets and services.

Substantive advances in understanding among economists and accountants have been made in the working group over the past 12 months. These were captured in the three background papers provided to the Forum covering the valuation of ecosystem services, the valuation of ecosystem assets and accounting for ecosystem degradation. These papers provide a wealth of material on valuation and accounting. While there remains a significant body of work to draw all of the threads together and to broaden the discussion beyond the working group, the progress has been very good.

The three papers were presented by David Barton (NINA, Norway), Eli Fenichel (Yale University) and Carl Obst (UN consultant), followed by an open discussion on the topics and issues raised in the papers. Key points that emerged from the discussions were:

- The relevance of understanding current institutional contexts in the valuation of ecosystem services and assets
- The importance of attributing ownership for accounting purposes and whether ecosystems can be considered distinct institutions for valuation and accounting purposes. This, in turn will affect the types of transactions that are recorded and the structure of accounts. The general

view was that ecosystems should not be considered as distinct institutional units, in parallel with existing economic units.

- The need to clarify non-market valuation approaches for use in national accounting contexts
- The need to clarify SNA treatments and accounting boundaries, especially with respect to the scope of income
- The need for discussion on accounting for changes in land use and ecosystem type with respect to measuring ecosystem degradation.

These issues and topics are clearly part of the ongoing research agenda and will be considered further as the revision process continues. It was also recognized that the topic of treating ecosystem disservices and externalities would be the focus of a separate discussion paper.

Session 4: Parallel sessions on biophysical modelling and aligning data and indicators

In this session, participants were able to choose between two parallel sessions, one on the advances in biophysical modelling for ecosystem accounting and the other one on aligning the data and the indicators.

Session 4a: Advances in biophysical modelling for ecosystem accounting

A long-standing discussion point in ecosystem accounting has been how to harness the extensive literature and research on biophysical modelling of the environment and ecosystem services to support the compilation of accounts. The topic has been discussed at various events on ecosystem accounting. This session was aimed at updating the Forum participants on recent developments, noting that there is increasing recognition in the modelling community of the relevance of making the connection between biophysical modelling and ecosystem accounting outputs.

There were four presentations. The first one from Stephanie Tomscha (Victoria University, NZ) introduced the document under preparation as part of the NCAVES project that will provide guidelines for biophysical modelling in support of ecosystem accounting. The key focus will be on placing different models in context and describing tier 1 (coarse estimates using global data sources), tier 2 (global models with national spatial data) and tier 3 (sophisticated country specific models based on best available spatially explicit data) modelling approaches depending on data availability. Discussion in small groups on the proposed coverage of the guidelines highlighted the need to consider uncertainty, the assessment of accuracy, model calibration and evaluation, the nature of collaborative processes that are required and linkages to other ecosystem accounts (e.g. extent and condition).

The next three presentations provided updates on modelling innovations of relevance for the ecosystem accounting community:

- Ferdinando Villa (Basque centre for climate change) pre-recorded a video presentation on the novel ARIES webtool which allows users to apply a range of pre-programmed models using best available data for a chosen area of interest. The flexibility of the webtool was demonstrated including in terms of application at different scales, the potential to modify parameters within standard models and to produce a range of outputs including tables, indexes and maps.
- Bethanna Jackson (Victoria University of Wellington) presented on the development of the LUCI toolbase for the SEEA which will provide global coverage, spatially detailed datasets for

use in ecosystem accounting covering land cover, habitat, species richness, soils, land use, rainfall and, in the future water quality.

- Lars Hein (Wageningen University) demonstrated the potential to use machine learning techniques to support the derivation of spatially detailed information on, for example, carbon, rainfall patterns, deforestation rates, social media data (e.g. for visitation rates), sensor data on species occurrences. Lars noted that while the potential is real, there is more to do on understanding the accuracy of the outputs, the processes involved and the collaborations required.

Session 4b: Aligning data and indicators

This session considered developments in source data for ecosystem accounting and progress in defining indicators that might emerge from the SEEA EEA. The broader objective in this area of discussion is to develop a systematic and consistent approach on the use of SEEA accounts to derive indicators for national and global reporting purposes. Demonstrating the usefulness of the SEEA accounts for deriving policy relevant indicators, will support mainstreaming the use of environmental and ecosystem accounts in policy-planning and implementation.

The session involved six presentations providing various perspectives on data and indicators for ecosystem accounting, with a particular focus on the links between the SEEA EEA and reporting on progress towards the UN Sustainable Development Goals (SDG).

- Steve King (UNEP-WCMC) introduced the work on the development of indicators based on the SEEA EEA that is taking place in the NCAVES project, in particular highlighting the links to the SDGs. It was noted that methodological notes on using SEEA EEA to compile a selected set of priority indicators will be developed to support the indicator reporting at the country level. The NCAVES project countries will be testing selected indicators and other countries are welcome to test as well.
- Max Wright (Conservation International) summarised the GEO project on Earth Observation for Ecosystem Accounting (EO4EA) looking at the initial assessment of current earth observation products to provide data on extent, condition and ecosystem The programme of work of EO4EA is being defined but the intention is to support the revision of the of the SEEA EEA.
- Sjoerd Schenau and Patrick Bogaart (Statistics Netherlands) presented on using big data sets to compile national ecosystem accounts with a particular focus on using STRAVA and flickr data for measuring cultural ecosystem services.
- Sven Kaumanns (Destatis) and Viveka Palm (Statistics Sweden and co-chair of the IAEG-SDG) discussed using SEEA for the measurement of the SDGs recognizing the potential of SEEA to demonstrate the linkages across goals and targets. A paper is being developed for discussion at the IAEG SDG.
- P Bhanumati (Government of India) highlighted that almost half of the SDG targets require environmental information and this provided a strong rationale for the organization of data through the SEEA. It was noted that SEEA accounts can be used to compile indicators to inform SDG Target in India, such as Target 6.6, 11.7, 14.1, 15.2 and 15.3 .

- Alison Fairbrass (UCL) and John Maughan (GGKP) summarized the GGKP initiative on a natural capital indicator framework, which is structured on the basis of the SEEA EEA. The objective of the paper is to develop a natural capital indicator framework, focusing in particular on identifying which indicators are used by whom and organize the indicators according to a conceptual framework closely linked with the SEEA.

In discussion, the key challenge that emerged was not the availability of data per se but rather the need for regularly updated and officially accepted data for the preparation of official statistics and the derivation of indicators. It was recognized that there is a need for data processing to ensure data are fit for purpose. Building the relevant processes and standards is a key requirement for integration into the accounting framework. It was noted that the SDGs can provide an opportunity for the implementation of SEEA at national level, as demonstrated by the experience in India.

Session 5: Ecosystem accounting for specific themes

A common focus of ecosystem accounting is to compile accounts in relation to specific policy themes. This session consisted of four parallel sessions, each focusing on one policy theme for which there is a growing body of work and experience. The four themes were urban areas, marine areas, carbon and protected areas.

Session 5a: Urban areas

This parallel session was able to take advantage of the conceptual work on delineating urban areas that has been pursued as part of the SEEA EEA revision process as well as an increasing number of case studies where accounts and related measurements are being developed for urban areas. Five presentations were made:

- Francois Soulard (Statistics Canada) summarized the work on delineating urban areas, in particular the discussion paper 1.2 drafted by the working group on spatial units, and the alternative perspectives that can be considered
- David Barton (NINA) described the potential to use digital platforms to source and compile accounting data
- Joachim Maes (EU JRC) summarized the work on accounting for urban areas in Europe, highlighting measures of greenness and the potential supply of ecosystem services from urban areas.
- Per Arild Garnasjordet (Statistics Norway) described progress and issues in the development of urban accounts for Oslo, in particular the potential to use multiple spatial units
- Steve King (UNEP-WCMC) presented work on aligning compilation of the SDG indicator on access to public open space in cities (SDG 11.7.1) with the SEEA EEA extent accounts.

Collectively, the presentations and discussions highlighted (i) that urban areas are an increasingly important area of study and should be a focus for ecosystem accounting given the expected increase in area in coming years; (ii) that blue/green spaces in urban areas are very valuable in terms of ecosystem service supply because they impact a lot of people, even if small in extent; (iii) that there are a range of choices around resolution and scope to consider that will depend on the users and

analytical requirements; (iv) that there are clear connections to the SDGs; and (v) that flexibility is needed in the description of an accounting approach to allow for different data contexts and different policy requirements.

Session 5b: Marine areas

This parallel session built on the rapidly growing body of work on accounting for marine areas and the development of ocean economy accounts. The integrated ecosystem/economic approach of the SEEA and its spatial basis provides an excellent basis for organization of data to meet specific policy requirements. Six presentations were made:

- Michael Bordt (UN ESCAP / Statistics Canada) presented on the development of ocean accounts highlighting the range of different activities and initiatives now underway, including special note of the work of Statistics Canada and the commencement of the Global Ocean Accounts Partnership led by UNESCAP.
- Mose Topeto (Samoa Statistics Office) introduced Samoa's work to develop tourism satellite accounts with extensions to the environment, where the ocean is the underpinning environmental asset.
- Rocky Harris (UK DEFRA) outlined work in the UK on marine natural capital accounts where solid progress is being made in the measurement of extent, condition and services of the ocean.
- Amanda Clark (ABS) reported on the ABS' accounts for the Great Barrier Reef where, aside from the statistical story, a major point was the challenges in gaining institutional support across government agencies.
- Anthony Dvarskas (Stony Brook University) described his work on using the SEEA EEA to organize data for various bays around Long Island and highlighted extensions and future research to cover a wider marine area, consider additional ecosystem services and alternative data sources.
- Roger Sayre (US Geological Survey) presented his work on delineating spatial units for the world oceans, and in doing so, establishing a global database that delineates the world's islands.

The breadth of material in the presentations and the associated discussion highlighted both the complexity and the relevance of ocean accounts with discussion ranging across ecological, economic, social and institutional aspects. The importance of communication with and involvement of all the interested institutional actors in the preparation, compilation of accounts and communication of results of the accounts sparked a major interest among the participants. Engagement at the international level on designing the measurement framework for the oceans is very timely.

Session 5c: Carbon stocks and flows

This parallel session recognized the importance of making clear connections between the SEEA EEA and the SEEA Central Framework and carbon and climate change policy.

As part of the SEEA EEA revision process a particular focus was placed on clarifying the definition and measurement of carbon related ecosystem services and in this task the compilation of carbon stocks and flows account is an important aspect. One of the key things that was discussed in this session was whether in addition to carbon sequestration, carbon storage needs to be seen as a separate and additional ecosystem service.

Four presentations were given to support discussion:

- Heather Keith (Australian National University) outlined the policy demands for accounting comprehensively for carbon related services including carbon sequestration and carbon storage.
- Patrick Bogaart (Statistics Netherlands) presented the carbon and air emissions accounts of the Netherlands.
- Peter Elsasser (Thuenen Institute) focused on the definition and valuation of carbon related ecosystem services building on work undertaken for the SEEA EEA revision process.
- Bram Edens (UNSD) described options for recording carbon and related stocks and flows in the accounts including highlighting connections to the measurement of degradation.

The discussion concluded that the net ecosystem carbon balance (NECB) is an appropriate metric and carbon sequestration can be considered a final ecosystem service. There was agreement that the thematic carbon account which covers stocks and flows provides useful information for policy makers. A specific suggestion was made to disaggregate carbon stocks by different qualities and risk of release. There was however less clarity on whether carbon storage should also be considered an ecosystem service as there may be alternatives such as introducing loss of storage as a degradation costs in the accounts. As these discussions are inherently related to the general (and fundamental) topic of externalities and ecosystem disservices, it was proposed to discuss this further during the Technical Expert Meeting and subsequently draft a position paper for consultation.

Session 5d: Protected areas

This parallel session brought together a range of examples and lines of work around protected areas and the links to biodiversity policy. The focus was on protected area accounts and their development with presentations from:

- Amanda Driver (SANBI) who described the motivation for protected area accounts and provided a summary of work on protected area accounts in South Africa.
- Claire Brown (UNEP-WCMC) who introduced initial thoughts on the outline for a guidance document on the compilation of protected area accounts.
- Johannes Kruse (GIZ) who outlined BMZ's initiative on the Natural Capital of Protected Areas and GIZ's interests in the development of these accounts.
- Raul Figueroa (INEGI) and Fernando Tudela Abad (UN consultant) summarized Mexico's experience in the development of protected area accounts.

Based on these presentations it was clear that protected area accounts are policy relevant and provide a good opportunity for mainstreaming the SEEA, but better messaging and communication on the potential of accounting is needed. Information on protected areas was clearly available in many

countries, in large part because of their relevance in biodiversity conservation. The opportunity through the SEEA is to link protected areas to broader economic and social outcomes and also see protected areas in a landscape context. Other points raised in discussion included:

- The importance of seeing protected areas as a way to deliver outcome and benefit rather than as an end in themselves.
- The importance of using the breadth of accounting across the SEEA (Central Framework and ecosystem accounting) to integrate measurement of pressures on protected areas.
- The availability of existing resources such as the World Database on Protected Areas and the IUCN Protected Area Categories to provide data to support compilation of protected area accounts.
- A number of countries have experimented or are experimenting in this space (e.g. Philippines, Peru and Spain).

Overall, compiling protected area accounts and associated guidance was a clear priority recognizing the need for ongoing discussion on the ways in which accounts might be structured and how guidance might be developed.

Session 6: Biodiversity and ecosystem accounting

Biodiversity refers to the variety and variability of life on Earth, including three levels of ecological organisation – ecosystems, species and genes. With ecosystems being used as an organizing principle in the SEEA EEA, a clear and common understanding is needed about how the SEEA can best integrate information about all three levels of biodiversity. Further, there is a need to better communicate with the biodiversity community to understand how the accounts might be a flexible tool for organizing information related to the diversity of species and genes (if information is available).

Three presentations supported discussion in this session.

- Tom Brooks (IUCN) provided an overview of IUCN's approach to biodiversity measurement and analysis, highlighting the imperfect nestedness among levels of biodiversity, and the motivation and potential for better incorporating species level diversity in the SEEA.
- Carl Obst (UN consultant) provided an accounting perspective on the past work on incorporating biodiversity measures into the SEEA's accounting system, recognizing the need for a review of the current SEEA EEA framing, noting that there is no single "biodiversity account" but rather a suite of relevant accounts, and suggesting ways in which species-based accounts might be presented.
- Emily Nicholson (Deakin University) in her role as discussant, posed a range of questions and areas of focus for further work. She noted in particular the need to clarify the use of terms, the potential to distinguish between natural, semi-natural and anthropogenic biodiversity, dealing with ecosystem collapse and species extinction and understanding the conception of value in relation to biodiversity in an accounting context, especially concerning the link to ecosystem services.

A lively discussion revealed the need to continue the dialogue among various experts to ensure that the breadth of experience and perspectives in the measurement of biodiversity is included. In particular it was noted that:

- Past research had concluded that ecosystem services are a general concept to which both ecosystems and species contributed
- Despite the general perception that measurement of genetic diversity was limited, this level of diversity should be ignored in the short term since there are some key challenges and policy issues revolving around genetic diversity, particularly around the resilience of the agricultural sector, that accounting approaches should consider
- While usually three levels of ecological organization (ecosystems, species and genes) are distinguished, in reality these are not discrete levels and there is significant interaction between these levels. A resulting challenge to be confronted is how to best reflect these interactions in an accounting framework
- This challenge of interaction among levels will commonly be revealed differently at different scales of measurement and hence there are links to the definition of spatial units and the measurement of ecosystem services

Overall, the nature of the discussion pointed to the interest and relevance of accounting for biodiversity and the general encouragement to continue discussions among relevant experts. A group to discuss application of accounting for biodiversity was proposed to advance the discussion.

Session 7: Scenario modelling and corporate natural capital accounting

In this session, participants were able to choose between two parallel sessions, one on the advances in scenario modelling using ecosystem accounts and the other one on advances in data and tools in corporate accounting for natural capital.

Session 7a: Advances in scenario modelling using ecosystem accounts

In a number of sessions, including the opening key note address from Sir Robert Watson, the need was expressed for accounting to make a connection to the design and estimation of future scenarios and hence better contribute to the policy discussion, since scenario assessment and comparison is a standard feature of current approaches to policy development. While NSOs have traditionally only collected and compiled historical data and accounts, increasingly they are working with research institutes and other stakeholders to help to integrate accounting information into scenario modelling. Indeed, as a result of this interest, the NCAVES project is developing guidelines on scenario modelling using the SEEA accounts. This session was thus aimed not at changing the role of official statistics but rather at demonstrating the ongoing advances in scenario analysis and modelling that can highlight applications of ecosystem accounting data.

The session included five presenters: William Speller (UN Environment), Andrea Bassi (UNSD consultant), Onil Banerjee (IADB), Nelson Fernandez (Federal University of Rio de Janeiro) and Prof. Zhiyun Ouyang (Chinese Academy of Sciences). They presented a range of examples of tools and case studies.

- William Speller (UN Environment) described the work on scenario analysis being undertaken in the context of the NCAVES project especially the development of guidance materials, the potential for accounts to support different modelling techniques, and the key features of scenario analysis.

- Andrea Bassi (UNSD Consultant) explained the basic approaches to scenario analysis, defining scenarios and different methods of generating quantitative scenarios. Key benefits of linking SEEA EEA and scenario modelling are the potential to better integrate knowledge across disciplines, the integration of sectoral and physical indicators to add richness and realism to existing models and the use of accounting to reflect dynamics and accumulation. He used an example of work from Indonesia to demonstrate the potential.
- Onil Banerjee (IADB) presented work on the development of the Integrated Economic-Environmental Modelling (IEEM) approach to enhanced computable general equilibrium (CGE) modelling for public policy and investment analysis. He demonstrated the potential through an example from Guatemala, where the approach was used to consider the implications of different policy alternatives on multiple SDG targets.
- Nelson Fernandes (Federal University of Rio de Janeiro) described work on hydrological modelling in the context of changing land use in Brazil with a focus on changes in water availability and soil retention.
- Zhiyun Ouyang (Chinese Academy of Sciences) summarised a scenario analysis pilot in China where valuation of ecosystem services was used to inform ecological compensation standards for the Xijiang River Basin in Guangxi Province

The SEEA EEA and SEEA Central Framework accounts can provide inputs to support scenario modelling. The feasibility to integrate SEEA Central Framework based data into scenario modelling and the potential to incorporate ecosystem accounting information into the model were demonstrated. Detailed discussions will be required such that the design of the accounts and the levels of detail compiled can be appropriately matched to the designs of scenarios. Discussion highlighted the need to ensure that scenario analysis was well defined, that scenarios are realistic and dynamic to be of most value in decision making. The development of a guidance document would be very relevant.

Session 7b: Advances in data and tools in corporate accounting for natural capital

There is increasing recognition of the need to make the connections between work on natural capital in the private and public contexts, much of which has advanced in parallel over the past 10-15 years. This session presented advances in relation to the data and tools to support natural capital measurement in the corporate sector and highlighted areas of potential connection to the SEEA. Four presentations were made:

- Johan Lammerant (UNSD Consultant) introduced the session providing a summary of the state of play on corporate sustainability reporting on ecosystems. He provided an overview of standards and frameworks used in the corporate sector, including the natural capital protocol and environmental profit and loss accounts; noted that there is no globally accepted standard for business accounting on natural capital and, in fact, most focus is on site and project assessment rather than full accounting but there is general support for harmonisation; and described the plans for work in the NCAVES project to build the levels of understanding across the private and public sectors through targeted case studies.

- The presentation of Thomas Verheye (European Commission), delivered by Johan Lammerant showed a quick summary of advances in the EU driven in part by the desire to expand sustainable finance. The proposal for developing an E-GAAP (Environmental-General Accepted Accounting Practices) was also introduced.
- Carl Obst (UN Consultant) presented work by the IDEEA Group to apply the accounting principles of the SEEA EEA in the context of a forestry company, Forico, based in Tasmania Australia. The work demonstrated that the same accounting principles used for macro-scale accounting can be applied at the business level. Thus, there is potential for SEEA EEA to play a role in both corporate and national scale natural capital accounting.
- Claire Brown (UNEP-WCMC) summarised the recent findings of the Natural Capital Coalition's Data Information Flow Project, which is in phase 1 of 4 phases. The focus in the first phase was defining private sector data needs, which revealed the main requirements to be accessibility, infrastructure, data quality and capacity to use data. Each of these requirements had barriers to be overcome. Given the barriers, there is a clear need to bring together data providers, data collators and data users and this will be the focus of subsequent phases.

The discussion recognized the potential opportunities in this area including in terms of the potential for businesses to provide data to underpin the compilation of accounts, both SEEA EEA and SEEA Central Framework.

Session 8: Integrating SEEA EEA in sustainability and wealth accounting

From an economic policy perspective, wealth accounting provides a strong rationale for the compilation of SEEA EEA since it can support direct estimation of the natural capital components of total wealth. To support understanding the connections and role of SEEA EEA, this session explored the current state of development of wealth accounting with a focus on the relevant conceptual connections to SEEA EEA and approaches to applying the concepts in practice.

Three presentations were made:

- Glenn-Marie Lange (World Bank) spoke about the importance of balance sheets for analysis at the World Bank, particularly for low middle-income countries. She highlighted the need to take a broad view, as reflected in the Changing Wealth of Nations report, encompassing produced assets, environmental assets and human capital with the aim of understanding the sustainability of income at national level. In the context of advancing measurement of natural capital, the issues that the World Bank is exploring for possible inclusion in the next releases concern: ecosystem services, degradation of forests and agricultural land; renewable energy; ocean accounts; the impact of air pollution on human capital; and the use of purchasing power parities for comparisons across countries.
- Pushpam Kumar (UN Environment) presented the findings from the latest UNEP Inclusive Wealth report for 2018 and ongoing developments. He highlighted the long history of capital measurement and associated economic theory and the relevance to the broader development agenda. The presentation covered in detailed measurement approaches for the components of inclusive wealth and advances in some areas, particularly in the valuation of education and

health. An important finding from the 2018 report is that only natural capital is on the decline since 1992, all other types of capital are increasing.

- Eli Fenichel (Yale University) highlighted a few key points in his role as discussant. He noted the strong connection between net national product and changes in wealth and welfare (reflected in part in the inclusion of balance sheet in the SNA) but noted the practical yet fundamental challenge of appropriately defining the boundaries of income and wealth that underpin measurement. In defining the boundaries, he noted (i) the importance of considering issues of equity and access to capital (including for future generations), (ii) the potential for different accounting aggregates (e.g. wealth and income) to be compiled that reflect different measurement boundaries and hence suit different purposes, and (iii) the need to move away from a focus on a single aggregate.

Overall, there is a clear recognition of the need to consolidate the linkage between the SEEA EEA and the wealth accounting theory and practice as it pertains to natural capital. While ongoing discussions are required, the benefits of establishing the connection are clear in terms of providing the economic theoretic motivation for the aggregated measures in the SEEA EEA and also the institutionalized and ongoing measurement of natural capital required for wealth accounting. The relative similarity of the various approaches in practice also provides a sufficient basis for ongoing exchange of experience and research.

Session 9: Opportunities for advancing SEEA accounts

This session provided the opportunity for short (2 slide) summaries of ecosystem accounting projects and initiatives to be shared among the participants. Ten global initiatives and 14 country projects were shared as listed in Annex 1. The session demonstrated the wide range of contexts, countries, institutions and disciplines that are currently in engaged in the development and application of the SEEA EEA.

Session 10: Moving forward

In this session, UNSD outlined the next steps in the SEEA EEA revision process, presented the opportunities for the participants to get involved in the revision going forward and thanked all participants for their significant contribution to the rich and extensive discussions over the two days of the Forum. Based on the discussions, further planning will be undertaken to specify the timing and content of the next steps in the revision and implementation of the SEEA EEA and the processes by which contributions can be made.

In broad terms, all participants were encouraged to:

- Provide feedback on the various papers and documents, especially when approached through expert review processes and global consultations processes that will take place in the coming 18 months as part of the SEEA EEA revision;
- Consider opportunities for testing and application of ecosystem accounting at national and sub-national levels;
- Encourage the use of the SEEA EEA and invite others to contribute to its development.

Annex 1: Opportunities for advancing SEEA accounts

Global initiatives on ecosystem accounting

Organisation	Initiative
Convention on Biological Diversity (Markus Lehman)	Updating of the Strategic Plan for Biodiversity (Aichi targets) as part of the post-202 biodiversity framework
Conservation International (Rosimeiry Portela)	Applied R&D and pilot testing of ecosystem accounting (San Martin, Peru) and Liberia; Readiness assessments (Eastern Tropical Pacific Seascapes; GDSA countries in southern Africa); Implementation and Post-analytical work
European Environment Agency (Jan-Erik Petersen)	Release of report on natural capital accounting covering many aspects of SEEA Central Framework and EEA ; Development of geo-spatial data platform
Earth Observation for Ecosystem Accounting – EO4EA (Max Wright, CI)	Initiative to develop and test use of earth observation data for ecosystem accounting through wide ranging partnership
European Union – Joint Research Centre (Joachim Maes)	Leading research on the EU INCA project on extent, condition and ecosystem service accounts and supporting countries in the Horizon 2020 MAIA and We Value Nature projects
Eurostat (Anton Steurer)	Supporting research action in the MAIA project (led by Lars Hein, Wageningen), financial SEEA EEA pilot studies in EU member states
Ecosystem Service Accounting for Development – ESAfD (Juha Siikamaki)	5 year, 7 country research partnership on the valuation of three primary ecosystem services (pollination, urban amenity, water purification) funded by the Swedish International Development Cooperation Agency (SIDA)
UN Environment (William Speller)	TEEB Agriculture and Food focus incorporating studies in many countries and linking to policy change and generating success stories
UN Economic and Social Commission for the Asia Pacific (Rikke Munk Hansen)	Establishment of the Global Ocean Accounts Partnership with strong connections to all aspects of ecosystem accounting especially building links to different beneficiaries and communities
World Bank (Glen-Marie Lange)	Focus on mainstreaming discussion on natural capital in policy dialogue and linking to core programs on sustainability; WAVES partnership building beyond 20 countries and growing evidence base to support SEEA EEA

Country initiatives on ecosystem accounting

Country	Initiative
Australia (Anthony Beannie)	Many examples of ecosystem accounting in evidence, national strategy for the implementation of SEEA adopted with the intent of using a demand led approach
Brazil (Christianne Maroun)	Developing work program through the NCAVES project, pilots in Matopiba, SWAT modelling and data gathering all underway; Upfront and ongoing training critical
Canada (Francois Soulard)	Many areas of work, including ecosystem extent and condition; ocean accounts; and urban accounts, building on the MEGS project (2013); recognise the challenge of integrating data from multiple sources and with different characteristics
China (Feng Pei)	Through the NCAVES project, range of seminars and work plans developed for pilot areas, including in Guangxi and Xijiang River Basin, for both ecosystem accounting and scenario analysis.
Costa Rica (Johnny Aguilar-Madrigal)	Plans to estimate flows and values for various ecosystem services including carbon, pineapple, coffee and nature-based tourism
France (Francoise Nirascou)	No formal ecosystem accounts but a range of pilot studies concerning forest accounts, water data and wetlands; links to ongoing national ecosystem assessment (EFESE) and the MAIA project
Guatemala (Sara Ortíz)	Experimental ecosystem accounts completed, including maps, with initial national level extent and condition accounts, and ecosystem service accounts for selected services
India	As part of the NCAVES project compiling India is working at the national level on modelling and valuation of several ecosystem services such as crop provisioning as well as on ecosystem condition. A pilot study in Karnataka State is starting up.
Indonesia (Setianto)	Advancing development of multiple accounts including land, water and ecosystem accounts; special development of peat accounts and valuing associated ecosystem services; potential applications in measures of green GDP and payments for ecosystem services.
Mexico (Fernando Tudela)	As part of the NCAVES project compiling ecosystem extent and condition accounts, as well as piloting ecosystem services accounts for carbon sequestration, crop provision and surface water supply.
Netherlands (Patrick Bogaart)	Completed ecosystem accounts for terrestrial environment including also carbon and biodiversity accounts, piloting accounts for marine areas, for business and for sub-national areas; range of challenges including communication of monetary values.
Norway (Kristine Grimsrud)	Continuing to advance work on urban ecosystem accounts for Oslo, including use of hedonic pricing to estimate the monetary value of urban green space
Philippines (Vivian Ilarina)	Pilot studies underway as part of the WAVES program for mangrove accounts including forest inventory, carbon storage and sedimentation and other ecosystem services in Pagbilao Mangrove Forest; A key finding is the need for participation from many stakeholders and continuous training
South Africa (Gerhardt Brouwer)	As part of the NCAVES project compiling national land and ecosystem extent and condition accounts, species accounts for rhino and cycads and protected area accounts for terrestrial and marine areas. For KZN province developing a full suite of ecosystem accounts and extent accounts for selected metro areas.
United Kingdom (Rocky Harris)	Focus on national level accounts for various habitats and emphasis on monetary valuation for a range of services, some spatial modelling for selected services,

	some hedonics in urban areas, marine ecosystem accounts nearing completion. Increasing policy awareness and interest at all decision making scales.
United States (Marc Russell)	Project on Accounting for US ecosystem services at national and sub-national scales led by USGS and the National Socio-Environmental Synthesis Center. Wide ranging work program, including various condition metrics (e.g. air pollution), ecosystem service flows (e.g. recreation) and application of NESCS.