

**13th Meeting of the Advisory Expert Group on National Accounts,
1-3 October 2019, Washington D.C., USA**

Agenda item: 2.4.3

**Linking the SNA and the System of Environmental-Economic Accounting Experimental
Ecosystem Accounting**

Introduction

The development of the System of Environmental-Economic Accounting (SEEA) from the early 1990s has consistently applied the accounting concepts and principles of the System of National Accounts (SNA) to the organisation and integration of environmental data with standard economic and financial data. The adoption of the SEEA Central Framework by the United Nations Statistical Commission in 2012 reinforced the importance of a greater focus on mainstreaming environmental information within the regular production process of the statistical system, to respond to increasing user demands in support of sustainable development.

The content of the SEEA Central Framework implied no specific conceptual issues for the SNA since the monetary scope of the asset boundary was aligned, although the boundary for environmental assets in physical terms was extended. The development of the SEEA Central Framework through 2007-2012 did however highlight the challenges that national accountants have faced in fully accounting for environmental and ecosystem degradation. For this reason, a separate volume was developed, SEEA Experimental Ecosystem Accounting (SEEA EEA), which describes a comprehensive approach to accounting for ecosystems.

One of the particular features of ecosystem accounting is that it has opened the door to a discussion of national accounting principles and boundaries concerning production, income and assets. This discussion arises since ecosystem accounting aims to incorporate into the accounting framework a wider set of benefits that people and society receive from the environment. The first SEEA EEA completed in 2013 described possible SNA based approaches to this accounting challenge, recognising however that more work was needed to test the approach and to further develop the accounting concepts. In 2018, a SEEA EEA revision process has commenced to establish agreed concepts and definitions for ecosystem accounting. An important part of this work is arriving at agreed valuation and accounting treatments, and a working group commenced discussions in early 2019 and five discussion papers have been produced. The group consists of experts from different disciplines such as environmental economists, ecologists, environmental and national accountants from national statistical offices, international organisations and academia.

This paper provides a short introduction to the ecosystem accounting approach, and then discusses at some length how the integration of ecosystem accounting with the SNA's sequence of accounts might take place and the issues that need to be considered. Key among these issues is the issue of ownership, which for natural resources and ecosystems more widely is less straightforward than for produced assets. The wider ambition of this work is to develop a robust and meaningful set of data that supports the discussion of ecosystems in economic decision making and hence contribute more effectively to the important discussion of sustainable development. It should be noted here

that the issues raised in the context of valuation, and in particular the valuation of and the accounting for degradation, are still under discussion and active participation from the national accounts community is sought.

A paper on: Linking the SNA and the System of Environmental-Economic Accounting
Experimental Ecosystem Accounting (SEEA EEA)

Documentation

See list of references at the end of the document.

Main issues to be discussed

The AEG is invited to express their opinion on the following points:

- whether the current guidance of the 2008 SNA regarding the asset boundary is adequate when it comes to the delineation of natural resources, more specifically biological resources (see the discussion in paragraphs 41 – 42, and 58 – 61);
- whether the allocation of social transfers in kind should be extended beyond transactions between households and NPISHs to resident households, noting that this may also be relevant for more traditional services such as education and health (see paragraphs 50 and 68);
- the proposals around the valuation of ecosystem assets, related services and degradation, including the alignment of the accounting for these assets with the principles of national accounts;
- whether members of the AEG have proposals for alternative ways to account for ecosystem assets;
- how the AEG, and the national accounts community more generally, could/should be involved in the further process of drafting the new standards for ecosystem accounting, in particular when it comes to valuation and accounting for ecosystems in line with national accounts principles.

Linking the SNA and the System of Environmental-Economic Accounting Experimental Ecosystem Accounting (SEEA EEA)

*Paper prepared for the Meeting of the Advisory Expert Group (AEG) on
National Accounts*

Washington D.C., October 1 - 3, 2019

Lead authors: Carl Obst and Peter van de Ven¹

Final version: September 3, 2019

1. Introduction

1. The development of the System of Environmental-Economic Accounting (SEEA) from the early 1990s has consistently applied the accounting concepts and principles of the System of National Accounts (SNA) to the organisation and integration of environmental data with standard economic and financial data. The adoption of the SEEA Central Framework by the United Nations Statistical Commission in 2012 reinforced both the importance of a greater focus on environmental information and sustainability and the relevance of using accounting concepts and principles such that environmental and economic information can be readily compared and integrated.

2. The content of the SEEA Central Framework implied no specific conceptual issues for the SNA since the monetary scope of the asset boundary was aligned, although the boundary for environmental assets in physical terms was extended. The three main areas concerned accounting for physical flows between the environment and the economy (for example extraction of water, energy, emissions, waste); identifying and re-presenting environmental transactions already recorded in SNA accounts (e.g. environmental protection expenditures, environmental taxes and subsidies, rents paid for access to natural resources); and accounting for natural resources and land. In this third area, the SEEA Central Framework (chapter 5) deepens the discussion of natural resource accounting presented in the SNA (for example concerning accounting for timber and fish resources, measuring depletion, etc.), but retains – in monetary terms – de facto the same asset and production boundary as applied for these resources in the SNA.

3. The development of the SEEA Central Framework through 2007-2012 did however highlight again the challenges that national accountants have faced in fully accounting for environmental and ecosystem degradation. These challenges were evident in the original SEEA 1993 where various approaches were proposed that allowed for adjustments for the capital costs of this degradation to be incorporated into measures of national income and wealth. Rather than incorporating proposals with respect to degradation in the SEEA Central Framework, a separate volume was developed, SEEA Experimental Ecosystem Accounting (SEEA EEA), which describes a comprehensive approach to accounting for ecosystems.

¹ The lead authors are first and foremost to be considered as the penholders of this paper, which builds upon the massive work, including extensive discussions, within the SEEA community, especially the people directly involved in the revision of SEEA Experimental Ecosystem Accounting.

4. One of the particular features of ecosystem accounting is that it has opened the door to a discussion of national accounting principles and boundaries concerning production, income and assets. This discussion arises since ecosystem accounting aims to incorporate into the accounting framework a wider set of benefits that people and society receive from the environment – for example benefits from air filtration, water purification, recreation opportunities, etc. The first SEEA EEA completed in 2013 described possible SNA based approaches to this accounting challenge, recognising however that more work was needed to test the approach and to further develop the accounting concepts.

5. Based on the significant interest in SEEA and ecosystem accounting in particular that has arisen since 2012, in 2018 a SEEA EEA revision process has commenced to establish agreed concepts and definitions for ecosystem accounting. An important part of this work is establishing agreed accounting treatments and boundaries. A working group on valuation and accounting treatments commenced discussions in early 2019 and through rounds of discussion five discussion papers have been produced for comment. These papers cover topics such as the link between exchange values used in accounting and welfare values used in environmental economics, approaches to valuing ecosystem assets, the recording of ecosystem degradation and enhancement, and the treatment of externalities.

6. This paper provides, in section 2, an introduction to the ecosystem accounting approach, and then discusses, in section 3, at some length how the integration of ecosystem accounting with the SNA's sequence of accounts might take place and the issues that need to be considered. Key among these issues is the issue of ownership, which for natural resources and ecosystems more widely is less straightforward than for produced assets. The ambition is not to discuss how the SNA might be changed but rather to consider the most appropriate ways for the principles of the SNA to be applied in the context of ecosystems. The wider ambition of this work is to develop a robust and meaningful set of data that supports the discussion of ecosystems in economic decision making and hence contribute more effectively to the important discussion of sustainable development. It should be noted here that the issues raised in the context of valuation, and in particular the valuation of and the accounting for degradation, are still under discussion and active participation from the national accounts community is sought. Section 4 provides a summary of the main conclusion and remaining research questions.

2. Summary of ecosystem accounting

Key components in ecosystem accounting

7. The components of the ecosystem accounting conceptual framework follow a national accounting logic. This national accounting logic envisages a breadth of coherent information about stocks and flows and underpins the approach to the organization of data and their potential applications. The key components of ecosystem accounting are as follows:

Spatial structure and ecosystem assets

8. The **ecosystem accounting area**, for example, a country or a region within a country, defines the spatial scope of a set of ecosystem accounts in a similar way to the concept of economic territory in the SNA. The ecosystem accounting area will comprise multiple ecosystems of various ecosystem types, such as forests, lakes, deserts, agricultural areas and wetlands. Ecosystems themselves are defined following the Convention on Biological Diversity (CBD). Ecosystems are

a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.

9. While the total area being accounted for will generally remain stable from one accounting period to the next, the composition and configuration of ecosystems, in terms of their area, will alter over time through natural and human-induced changes. This is similar to the way in which the composition of establishments and industries will change over time within a single economic territory.

10. For accounting purposes, each ecosystem is considered an **ecosystem asset** that is defined by mapping mutually exclusive spatial boundaries such that each asset is classified to a single ecosystem type. Ecosystem extent accounts record the total area of each ecosystem type within an ecosystem accounting area and, over time, record compositional changes within an ecosystem accounting area.

Ecosystem condition

11. Each ecosystem asset changes in **ecosystem condition** over time. An ecosystem condition account for each ecosystem asset is structured to record the condition at specific points in time and, over time, records the changes in condition. These changes may be due to natural factors or human/economic intervention (e.g. deforestation or restoration activity). Ecosystem condition is measured by assessing a set of selected ecosystem characteristics that will vary by ecosystem type. Ecologists have well established methods for measuring condition for different ecosystem types. Examples of characteristics used to assess the condition of a forest include tree age and density, canopy cover and diversity of local species.

Supply of ecosystem services

12. Ecosystem assets supply **ecosystem services**, either directly from a single ecosystem asset (e.g. timber from a forest) or by multiple ecosystem assets operating collectively (e.g. water flow regulation by various ecosystems along a river catchment). The main focus of ecosystem accounting is on the supply of final ecosystem services to (groups of) economic units, including businesses, households and government. In this context, *final* should be interpreted as services being directly supplied to economic units, as distinct from *intermediate* ecosystem services which are flows between ecosystem assets. From a national accounts perspective, it is recognised that final ecosystem services may well be used as an intermediate input into the production of goods and services (e.g. agricultural outputs).

13. Most commonly, a single ecosystem asset (e.g. forest, wetland, coastal area) will supply a basket of different ecosystem services. The intent in accounting is to record the supply of all ecosystem services over an accounting period for each ecosystem asset within an ecosystem accounting area.

14. Ecosystem services encompass a wide range of services, and are typically grouped into the following categories:

- provisioning services (i.e., those related to the supply of food, fibre, fuel and water);
- regulating services (i.e., those related to activities of filtration, purification, regulation and maintenance of air, water, soil, habitat and climate); and
- cultural services (i.e., those related to the activities of individuals in, or associated with, nature, such as recreation).

15. As noted, the ecosystem accounting framework also supports the recording of flows of intermediate ecosystem services. Recording these flows supports an understanding of the dependencies among ecosystem assets, for example, within a water catchment.

Use of ecosystem services

16. For the supply of ecosystem services to be recorded, there must be a corresponding use. That is, in accounting terms, the flow of ecosystem services reflects a *transaction*. The matching of the supply of final ecosystem services to their use by different economic units is a fundamental element of accounting. This is undertaken in the SEEA EEA using supply and use tables.

17. In the SEEA EEA, the measurement boundary for final ecosystem services is defined so as to support integration of ecosystem accounting data with data on the production of goods and services that is currently recorded in the standard national accounts. Thus, for forestry production, the timber harvested from the felling of trees in natural forests is recognised to be already recorded in the SNA and hence ecosystem services are defined such that they reflect the growth of the trees. Depending on the ecosystem service, the user (e.g., a household, a business or a government unit) may receive that service, while it is located either in the supplying ecosystem asset (e.g., when it is catching fish from a lake) or elsewhere (e.g., when it is receiving air filtration services from a neighbouring forest).

Linking to benefits

18. Flows of ecosystem services are distinguished from flows of benefits. This distinction allows the contribution of ecosystems to production to be separately identified in the same way as recording the compensation of employees allows the contribution of labour to production to be explicitly identified. Further, the valuation of benefits will differ from the value of the contribution of the ecosystem and this is a common point of confusion. The term *benefits*, as used in SEEA EEA, encompasses:

- *SNA benefits*: goods or services (products) produced by economic units (e.g., food, water, clothing, shelter, recreation) currently included in the economic production boundary of the SNA; and
- *non-SNA benefits*: benefits that accrue to individuals, or society generally, which are not produced by economic units (e.g., clean air). By convention, the measurement scope of non-SNA benefits for ecosystem accounting purposes is limited to the flow of ecosystem services with a direct link to human well-being.

19. In ecosystem accounting, benefits are not equivalent to the well-being or social outcomes that arise through the use of ecosystem services. The measurement of well-being is not the focus of ecosystem accounting, although the data that are recorded in ecosystem accounts can support such measurement.

Principles of valuation

20. The issue of valuation can complicate the discussion of ecosystem accounting for many reasons. From one perspective, valuation implies that an inappropriate and misleading “monetary value” is being placed on environmental assets and services. In particular it is noted that monetary values will not encompass intrinsic values associated with our connection to the environment. Another contention is that the environment is far too complex a subject to lend itself to the compilation of useful measures in monetary terms and there are differing views on the application of various concepts and techniques.

21. In the SEEA EEA, valuation is considered in two ways. First, there is description of the appropriate concepts and techniques for compiling ecosystem accounts in monetary terms such that these data can be integrated with standard economic accounting data compiled using the valuation principles of the SNA. This is referred to as monetary valuation.

22. Second, since the ecosystem accounting framework records an extensive range of biophysical data about ecosystems, including their changing extent and condition and the degree of use by people (reflected in flows of ecosystem services), data from SEEA EEA accounts can support discussions on, for example, intrinsic values. This is referred to as non-monetary valuation.

23. When discussing valuation, most focus in the SEEA EEA is on valuation in monetary terms, although the relevance of valuation in non-monetary terms is explicitly recognised.

Monetary valuation of ecosystem services and assets.

24. Given the aim of integration with economic accounts, the core valuation concept applied in ecosystem accounting is the SNA concept of exchange value, i.e., the value of the service at the point of interaction between the supplier (the ecosystem asset) and the user, i.e. (groups of) economic units. Using a common valuation concept enables the derivation of, for example, measures of gross domestic product (GDP) adjusted for ecosystem degradation, extended measures of production and consumption, and the estimation of extended measures of national wealth.

25. The use of exchange values is not common practice in environmental economics where most techniques focus on the measurement of consumer and producer surplus. Much effort has been placed on understanding the relationship between these environmental economic valuation techniques and the national accounting requirement to apply exchange values and there is now a good understanding of the theoretical connections.

26. It should also be noted that, in certain institutional contexts, the exchange values may not provide an appropriate reflection of the environmental sustainability of natural resources and ecosystem assets. For example, freely accessible fish stocks may have an exchange value of zero, while from a sustainability perspective they are being depleted/degraded as reflected in the loss of physical stock of a resource or its quality. In this respect, the SEEA EEA will also provide guidance for the compilation, as supplementary measures, of monetary values from a sustainability perspective.

27. For accounting purposes, each individual instance of the supply and use of ecosystem services is considered a transaction. In physical terms, each transaction is considered to be revealed in the sense that it reflects an actual exchange or interaction between economic units and ecosystem assets (including, for example, the appreciation of nature generated by the exploration of ecosystems). Yet, although the transaction is revealed, in most circumstances an associated price is not revealed because markets and related institutional arrangements for ecosystem services have not been established. A range of techniques have been developed for the valuation of non-market transactions, most of which, with appropriate adaptation, can be applied for the purpose of estimating exchange values for the supply and use of ecosystem services in monetary terms.

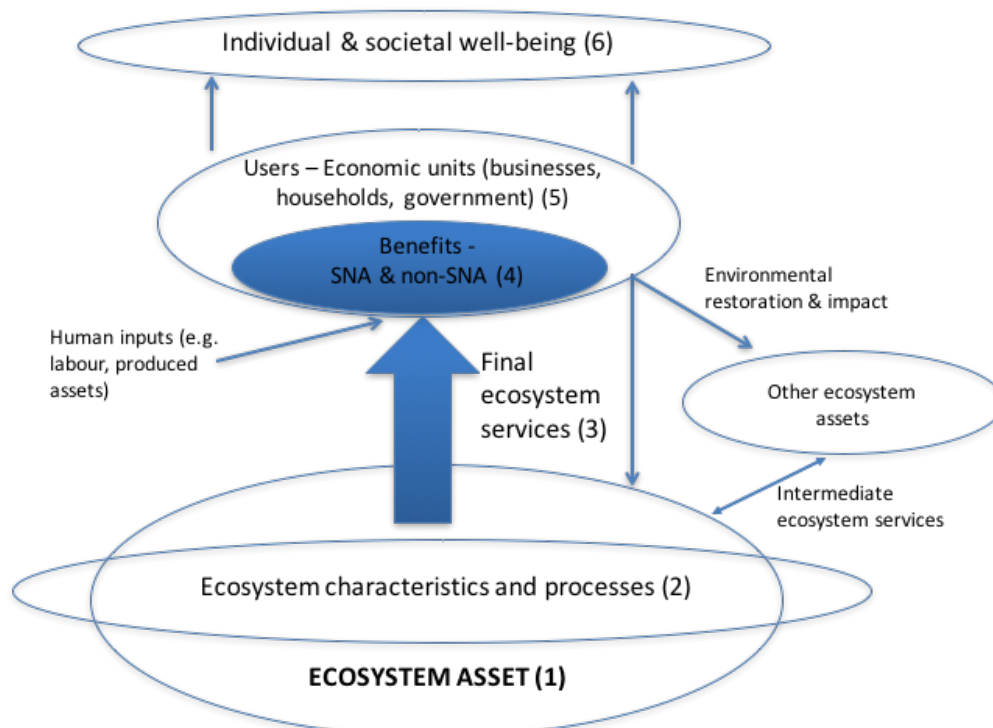
28. On the basis of the estimates of ecosystem services in monetary terms, the value of the underlying ecosystem assets can be estimated using net present value (NPV) techniques. Thus, the value of the asset can be estimated as the discounted stream of income arising from the supply of a basket of ecosystem services that is attributable to an asset. Ideally, observed market values would be used for ecosystem assets such as agricultural land. However, it is likely that those market values will not incorporate the full basket of ecosystem services supplied or will reflect values that are influenced by factors other than the supply of ecosystem services, e.g., potential alternative uses of land.

Summary of the key components

29. The key components of the ecosystem accounting framework as just introduced are set out schematically in Figure 1. The various parts of the figure display the following:

- At the bottom of the figure, the focus of the framework are the various biotic and abiotic components within an **ecosystem asset (1)** which is defined by a spatial area.
- Each ecosystem asset possesses a range of relevant **ecosystem characteristics and processes (2)** which together form the basis for the functioning of the ecosystem.²
- Each ecosystem asset supplies a basket of **final ecosystem services (3)** and intermediate ecosystem services.
- Final ecosystem services contribute to **benefits (4)** which may be SNA or non-SNA benefits.
- Since for each supply of ecosystem services there is a corresponding use, for final ecosystem services there is an associated **user (5)**, which is an economic unit (businesses, households or government units).
- Both SNA and non-SNA benefits contribute to **individual and societal well-being (6)**.

Figure 1: The ecosystem accounting framework



Source: Adapted from SEEA EEA (United Nations, European Commission, FAO, OECD and World Bank, 2014), figure 2.2.

² While each ecosystem asset is uniquely defined, ecosystem processes will generally operate both within and across individual ecosystem assets. Thus, while in figure 1 ecosystem assets are represented as discrete areas, the associated ecosystem processes are considered to be unbounded and can extend beyond the asset boundaries.

The set of ecosystem accounts

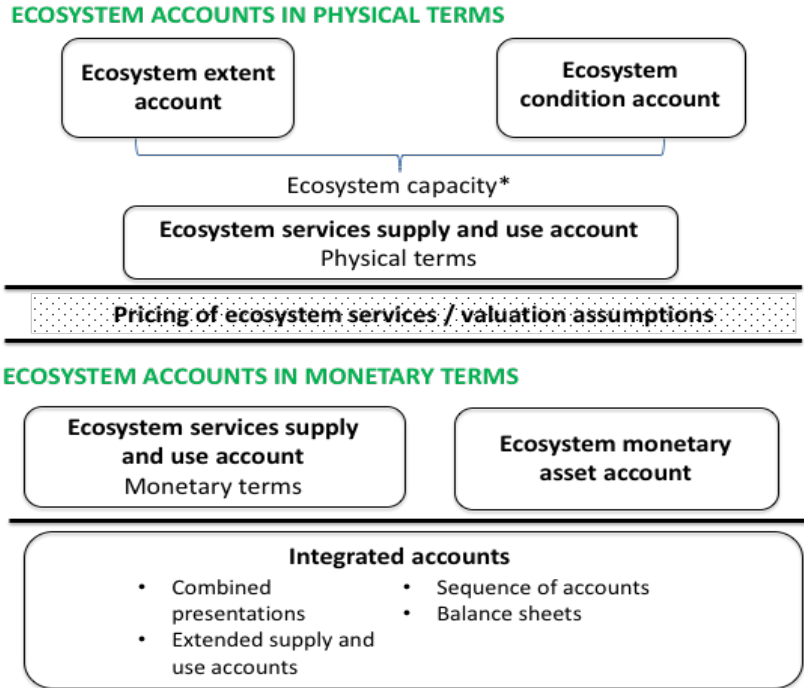
30. There are five core ecosystem accounts as listed in Table 1. These five accounts constitute an accounting system which presents a comprehensive and coherent view of ecosystems but there is not one single, all-encompassing ecosystem account. Each account has analytical merit in its own right and does not necessarily rely on other accounts. However, as for the SNA, there is additional analytical richness embodied in the connections among the accounts. Depending on the measurement pathway that is pursued, which in turn will be linked to the intended application of the accounting information, there will be a greater or lesser focus, in compilation, on the different accounts.

Table 1: The core ecosystem accounts

1	Ecosystem extent account – physical terms
2	Ecosystem condition account – physical terms
3	Ecosystem services supply and use account– physical terms
4	Ecosystem services supply and use account – monetary terms
5	Ecosystem monetary asset account – monetary terms

31. Since the accounting principles that underpin the accounts are derived from the SNA, data from the ecosystem accounts can be directly related to the set of economic accounts that encompass the measurement of GDP, national income and institutional sector accounts including balance sheets. Thus, accounts that integrate ecosystem and economic accounts, can be compiled, including associated aggregate measures of income and wealth, recognising that there are a range of accounting treatments that require further discussion before the exact description of the relevant accounting entries can be finalised. A key issue here is the definition and treatment of ecosystem degradation. The links between the accounts are shown in Figure 2. Note that ecosystem capacity is a linking concept between ecosystem assets (accounts for in terms of extent and condition) and ecosystem services. Its definition and treatment remain an area of ongoing discussion.

Figure 2: Connections between ecosystem accounts



32. Ecosystem assets have a range of biotic and abiotic components, for example, timber resources, water resources, land and soil resources, and are the locations in which environmental flows (e.g. water, energy, emissions, natural inputs) take place. These various environmental assets and flows are in scope of the environmental-economic accounting as described in the SEEA Central Framework. Compilation of relevant SEEA Central Framework accounts at the appropriate spatial scale, e.g. for catchments, can therefore provide information that contributes directly to the measurement of ecosystem assets and ecosystem services.

33. In addition, the SEEA EEA recognises *thematic accounts*. Thematic accounts are standalone accounts, or sets of accounts, on themes of specific policy relevance. Biodiversity and carbon are two high profile themes and accounting for these themes continues to develop. Other potential thematic accounts include accounting for protected areas, wetlands and forests.

3. Integrated accounting for the use of ecosystem services and ecosystem assets

Introduction

34. As noted before, accounting for the supply and use of services, or benefits, derived from ecosystem assets, and the accounting for the monetary value of stocks of ecosystem assets, including the recording of the various changes, among which the degradation of the relevant assets, that drive the developments in the values of the relevant stocks, require an extension of the production boundary and the asset boundary as currently applied in the international standards for compiling national accounts, the 2008 System of National Accounts (2008 SNA). Below, first issues around the extension of the current production boundary are discussed, with a focus on the similarities and differences between goods and services currently recorded in the system of national accounts and ecosystem services. Subsequently, the extension of the asset boundary with ecosystem assets will be discussed, again focusing on similarities and differences with the assets, which are recognised in the 2008 SNA.

Understanding the production boundary of the SNA

35. The 2008 SNA defines a general production boundary, and a more specific boundary to be applied in the actual compilation of national accounts. The general boundary is defined in § 6.24 as follows:

Economic production may be defined as an activity carried out under the control and responsibility of an institutional unit that uses inputs of labour, capital, and goods and services to produce outputs of goods or services. ... A purely natural process without any human involvement or direction is not production in an economic sense. For example, the unmanaged growth of fish stocks in international waters is not production, whereas the activity of fish farming is production.

36. According to this general production boundary, it is clear that a variety of goods and services, among which most prominently unpaid household activities, such as preparing meals, taking care of children and elderly, and cleaning, are part of production. However, the 2008 SNA prescribes a more restrictive boundary, with specific reference to unpaid household services. The production of goods within households, the main example of which relates to subsistence farming, should always be included, while the production of unpaid services is excluded with the exception of owner-occupied housing and the production of domestic and personal services by employing paid domestic staff.

37. The main reasons for the exclusion of the main part of unpaid household services produced within households are summarised in § 6.30:

..., the reluctance of national accountants to impute values for the outputs, incomes and expenditures associated with the production and consumption of services within households is explained by a combination of factors, namely the relative isolation and independence of these activities from markets, the extreme difficulty of making economically meaningful estimates of their values, and the adverse effects it would have on the usefulness of the accounts for policy purposes and the analysis of markets and market disequilibria.

38. Some may consider the argument regarding the problems of making meaningful estimates of unpaid household services slightly exaggerated, as at the same time national accounts also include estimates for substantial amounts of informal, hidden and illegal activities. More important are the concerns around the usefulness of the accounts and the analysis of markets. One could add that the inclusion of unpaid household activities also leads to a concept of household income that is likely considerably different from the perception that households have of their income at the micro-level.

39. Quite close to the concept of services provided by ecosystem assets, at least when it comes to provisioning services, concerns the recording of agricultural products. As these products are goods, the production of these products, including the gathering of berries or other uncultivated crops; forestry; wood-cutting and the collection of firewood; hunting and fishing are always considered as part the SNA production boundary.

40. However, the recording of these agricultural products will differ depending on the particular circumstances surrounding the relevant activity. As stated in § 6.136 of the 2008 SNA,

... the growth and regeneration of crops, trees, livestock or fish which are controlled by, managed by and under the responsibility of institutional units constitute a process of production in an economic sense.

Often, for example in the case of crops, the growth and harvesting take place in the same year, and the output value can be put on a par with the value of the harvested products. However, according to § 6.138 of the 2008 SNA,

... some plants and many animals take some years to reach maturity. In this case, the increase in their value is shown as output and treated as increases in fixed capital or inventories, depending on whether it concerns plant or animals that yield repeat products or not.

A good example regarding the latter distinction between fixed capital and inventories concerns fruit trees versus trees grown for one-off wood production. The growth of fruit trees is to be considered as gross fixed capital formation, and the use of these trees in the production of fruits is to be recorded as depreciation, while the growth of trees for wood production is to be recorded as positive changes in inventories, the felling of which is to be accounted for as negative changes in inventories.

41. An important criterion applied in the above is that the growth and regeneration process is *controlled by, managed by and under the responsibility of* an economic agent. If the above is not the case, and the growth relates to a purely natural process without any human involvement, in line with the definition of the SNA production boundary in § 6.24, the growth is not production in an economic sense. Examples relate to the unmanaged growth of fish stocks in international waters, the growth of trees in “uncultivated” forests. Only goods produced by catching the fish, felling the trees, or picking berries, etc. enter into the production boundary.

42. In respect of the above, it should be noted however that the 2008 SNA can be interpreted ambiguously. For example, in § 1.43, it is stated that

*... the natural growth of stocks of fish in the high seas **not subject to international quotas** (bold inserted by the authors) is not counted as production: the process is not managed by any institutional unit and the fish do not belong to any institutional unit.*

This can be interpreted as if the presence of international quotas can be regarded as a sufficient condition for the natural growth to be considered as part of the production boundary, while in the case of truly open access to fish in international waters only the catching of fish is entering the production boundary. The latter interpretation considering the presence, or not, of international quota, also makes one wonder about the recording of uncultivated forests, which are often under some form of control by the national government and cannot be used for e.g. wood production without an explicit permission provided by government.

Recording imputed output in the SNA

43. The above distinction may be less relevant for the recording of ecosystem services as such, but it matters when it comes to linking ownership of ecosystem assets to the benefits derived from them. It may also matter for the interpretation of the 2008 SNA and the SEEA Central Framework. Anyhow, it is clear that the inclusion of ecosystem services leads to an extension of the production boundary, as defined in the 2008 SNA³. But then again, that is the whole idea of accounting for ecosystems. However, to include ecosystem services in line with the main accounting principles, more conditions need to be met.

44. The latter can be illustrated by looking at other imputations of output in the SNA. The 2008 SNA includes imputations for production of goods and services for own final use, be it final consumption expenditure or gross fixed capital formation. As noted before, unpaid household services are not included here, with the major exception of owner occupied housing. Another imputation for output concerns the production of government services, where output is put on a par with the sum of costs for producing these services.

45. In all these cases, the producer coincides with the user. For each relevant economic agent, the imputation of the benefits in the form of additional output is equal to the imputation of the use of these benefits, as a consequence of which the imputations balance out, resulting in a zero impact on net lending/net borrowing. The latter is necessary to arrive at a consistent recording in which the budget identity from double entry bookkeeping, according to which the balance of current and capital transactions needs to be equal to the balance of financial transactions, is respected.

46. There is however one exception to this equality of output and use. Although in the case of government services, the use of the imputed services is first allocated to government by convention, there is an alternative recording in the 2008 SNA in which the individualised government services (health, education, etc.), as distinct from collective government services, are also allocated to the households benefiting from them. To arrive at a consistent recording, an additional recording of social transfers in kind, from government to households, is applied to balance the imputation of the reallocation of the use of the individualised government services to household consumption.

Allocations for ecosystem services

47. In the case of ecosystem services, the benefits and their uses are much more mixed. Looking at a forest, for example, some of the services may be related to provisioning services, such as the production of timber, while other services may be consumed by the public at large, in providing cultural services in the case of non-extractive recreation.

48. There are various solutions to this problem, which coincide directly with the question on how to account for the ecosystem assets from which these services are derived. The simplest solution is to

³ There is a discussion, however, on whether the natural growth of biological resources already accounts for provisioning services, and that the addition of the relevant ecosystem services, including their use, leads to double-counting. Here it is assumed that the ecosystem services are distinct from the natural growth, in the sense that the relevant services provide an input to the growth of biological resources.

allocate both the benefits and the uses to a separate sector, called “ecosystem”, thereby making a distinction between intermediate use for the part that is used in the production of goods and services, and final use for the part that is consumed by households. Another solution would be to partition the benefits (and the uses), and allocate them to the relevant economic agents, in line with their use.

49. In Table A6.1 of the SEEA 2012 EEA, two different models have been presented for the allocation of the benefits and uses of ecosystem services. According to Model A, the benefits are allocated to the separate sector “ecosystem”, while the uses have been attributed to the relevant economic agents, with an equivalent flow of transfers to off-set the use. In model B, the “ecosystem”-sector has been combined with the sector of the farmer who presumably owns the ecosystem (thereby cancelling out the output and intermediate consumption of the ecosystem services). Both models have their problems. Although in model A disposable income and saving is unaffected because of the off-setting flow of transfers, measures of sector level operating surplus and primary income are affected. The latter seems to be unjustified, as the use of the ecosystem services by the farmer does not involve a monetary payment that has an actual negative impact on his operating surplus. In model B, the simpler solution might have been to also allocate benefits to the households, in line with their final consumption of ecosystem services.

50. Another solution would be to consider the part of ecosystem services, which cannot be allocated to a specific group of economic agents, as a public good, and to allocate the output and use of them to government. This may work quite well in the case ownership of the underlying assets is less clear, and the benefits are used by the public at large, and not by a very specific group of economic agents. The use can subsequently be transferred to the households, enterprises and non-residents⁴ benefiting from these services, with an off-setting social transfer in kind. In the case of other services that can not be attributed to (groups of) individual units, they are “simply” considered as collective consumption.

51. The various types of ecosystem services may actually coincide with the different ways of recording in the above. Provisioning services could probably be attached to a specific group of economic agents (e.g. agriculture and fishing), while in the case cultural services such as those related to tourism and recreation one may prefer to apply the second way of recording. Regulating services, such as for example flood protection services have a clear resemblance with water protection services produced by government (e.g., dykes and water management), and similar to the latter services they could be recorded as collective consumption.

52. While the allocation of different ecosystem services to different beneficiaries has some appeal from the perspective of recording incomes and related flows, it may be more problematic from the perspective of recording assets since there is a single ecosystem asset in physical terms that will be subject to enhancement and degradation. The challenge is thus different from the partitioning of a single benefit stream, for example in the case of a joint venture.

53. Given the different options, proposals for the recording of ecosystem services in the sequence of accounts will be put forward later in this paper, after a more in-depth discussion of the accounting for ecosystem assets, including the costs of degradation of these assets.

Accounting for (the degradation of) ecosystem assets

54. In SEEA EEA, the (imputed) output of ecosystem services is directly linked to the underlying ecosystem assets from which these services are derived. As such, accounting for the benefits and uses

⁴ In the 2008 SNA, the imputation of such transfers, i.e. social transfers in kind, are limited to transfers to households. Having transfers to enterprises and non-residents would entail a considerable change to the recording, as it would also involve an imputation of final consumption by enterprises and, for the part allocated to non-residents, an imputation of exports. It should be noted however that there is also discussion of broadening such imputations for social transfers in kind benefiting non-resident households, and for free services provided by the digital economy.

of ecosystem services has a direct relationship with the recording of ecosystem assets, including the way in which degradation of ecosystem assets is accounted for. Looking at the asset boundary according to the 2008 SNA, an asset is defined, in § 3.5, as follows:

An asset is a store of value representing a benefit or series of benefits accruing to the economic owner by holding or using the entity over a period of time.

Central to this definition are that the entity, or asset, is being owned by an economic agent, and the entity represents a store of value for the owner.

55. In the system of national accounts, ownership is defined in terms of economic ownership, not legal ownership. As noted in § 3.26 of the 2008 SNA, economic ownership refers to

... the institutional unit entitled to claim the benefits associated with the use of the entity in question in the course of an economic activity by virtue of accepting the associated risks.

Usually legal and economic ownership coincide, but there are exceptions. One of those exceptions concerns financial lease, where the lessor is the legal owner, but the lessee takes all the risks and rewards related to the use of the asset in question. Public Private Partnerships (PPPs), for example in the case of developing and subsequently operating major infrastructural projects, may also lead to a disconnect between legal and economic ownership. However, for the more fundamental discussion in this section, this distinction is less relevant.

56. What is relevant for the discussion on broadening the asset boundary with ecosystem assets is what is being stated in § 3.22 of the 2008 SNA:

... sometimes government may claim legal ownership of an entity on behalf of the community at large. No entity that does not have a legal owner, either on an individual or collective basis, is recognized in the SNA.

57. In the case of ecosystem assets, legal ownership is often not the problem, apart from the high seas. Ecosystem assets are defined as spatial areas on the economic territory of a country, and one can thus assume that there usually is some kind of legal ownership, if only exercised by government in the case of public areas. More problematic is the economic ownership of these assets, which is very much related to the question of who claims the benefits and who runs the associated risks from these assets. Only when it comes to the valuation of these assets, which is directly linked to the (imputed) presence of benefits, one can observe a clear extension of the asset boundary as currently defined in the 2008 SNA.

58. So, all in all, from a purely technical point of view, the imputation of benefits through the production of ecosystem services leads to a recognition of ecosystem assets representing a store of value from which future benefits can be derived. However, this leads us back to the question of whose store of value, of who is the (economic) owner of these assets. A comparison with some of the assets that are currently recognised in the 2008 SNA may shed some more light on this issue. The answer to this question is also critical when it comes to the attribution of the costs related to the degradation of ecosystem assets.

59. Before describing some relevant SNA examples, it is relevant to note that determining, potentially by convention, the links between owner and asset may not fully resolve issues around the recording of degradation, at least not from a policy perspective. In addition, it is necessary to recognise that activities by the owner of one ecosystem may have detrimental effects on other ecosystems (and their owners). In this case, following a polluter pays principle, the degradation of the second ecosystem might be attributed to the income earned by the owner of the first ecosystem. This perspective on the allocation of degradation is common in economic discussions and was a key feature in the proposed treatments of costs associated with environmental degradation in the SEEA 1993. It will be necessary determine whether and how accounting principles and recording approaches can be best adapted to accommodate this reality.

Biological resources

60. The asset type which has the closest resemblance to ecosystem assets is what in the 2008 SNA is referred to as *biological resources*, i.e. *naturally occurring assets in the form of biota (trees, vegetation, animals, birds, fish, etc.* (§ 10.169 of the 2008 SNA). When these assets are taken place under the direct control, responsibility and management of institutional units, they are treated as *cultivated biological resources*, and the activity is treated as falling within the production boundary of the SNA. The assets therefore fall within the category of *produced assets*. § 10.169 of the 2008 SNA goes on with stating that:

The growth of animals, birds, fish, etc., living in the wild, or growth of uncultivated vegetation in forests, is not an economic process of production so that the resulting assets cannot be classed as produced assets. Nevertheless, when the forests or the animals, birds, fish, etc. are actually owned by institutional units and are a source of benefit to their owners, they constitute economic assets. When wild animals, birds, fish, etc. live in locations such that no institutional unit is able to exercise effective ownership rights over them they fall outside the asset boundary. Similarly, the forests or other vegetation growing in such regions are not counted as economic assets. On the other hand, fish stocks in the high seas which are subject to international agreement on how much may be caught by individual countries may be counted as falling within the asset boundary.

61. As stated before, the latter could be interpreted in such a way that vast areas of forests which are regulated in one way or another by governments, if only by controlling the cutting down of trees by way of granting permissions, are to be considered as produced assets.

62. In relation to fish stocks in open seas, § 17.334 of the 2008 SNA goes on stating the following:

Fishing quotas may be allocated in perpetuity or for extended periods to particular institutional units, for example, where fishing is an established way of life and there may be little alternative economic employment. In such circumstances the quotas may be transferable and if so, there may be a well developed market in them. Fishing quotas may therefore be considered as permits to use a natural resource that are transferable. They are thus assets in the SNA.

Whether or not such permissions are actually being granted, the limitation in the use of these stocks leads, from an economic perspective, to a resource rent, and thus to a monetary exchange value. In the case where the permission does not come for free, both the legal owner granting the permission and the economic owner who exploits the resources hold an economic asset in SNA-terms.

63. The latter obviously mainly relates to the provisioning services provided by an individual resource, i.e. the fish stocks. In the case of ecosystems, e.g. ocean environments, agricultural land and forests, other ecosystem services may be playing a role as well. It is important to note however that in the case there is completely free access to using the available resources and competitive markets, one may assume that the resource rent related to the provisioning services will be close to zero, and the value of the relevant assets will also fall down to zero. As noted before, the monetary exchange value will not give a fair representation of issues around the sustainability of the resources. In such situations the use of physical indicators may best allow consideration of these concerns, whereas one may also consider a supplementary valuation taking into account the sustainability of the resources.

Mineral and energy resources

64. Another asset type worth considering in respect of the above is mineral and energy resources. This class of non-produced assets has a clear ownership. The limitation in the exploitation of these resources, be it for economic reasons or because of technical capabilities, results in a resource rent which may or may not be shared between the legal owner and the exploiter of the reserves. In both

cases, biological resources as well as mineral and energy resources, the ownership, or the restrained use, and the resulting resource rent, also make it possible to allocate the costs of degradation or depletion to the owner/user of the resources. This economic agent clearly bears the related costs. This is much more difficult in the case there is no such thing as economic ownership, as a consequence of which the assets and the related costs of degradation cannot be allocated unambiguously.

Public assets of government

65. Before considering further the allocation of ecosystem assets and related costs of degradation, for which there is no clear ownership, it is good to also discuss some of the public assets of government. Some of the items that fall within the asset boundary of the 2008 SNA are also quite problematic in terms of economic ownership and valuation. This concerns, for example, public infrastructure and public R&D. In the former case, there may be clarity on the legal ownership of these assets, but given frequently occurring economic arrangements in which the roads are toll-free, the value of these assets on the market would be close to zero. Nonetheless, the valuation of the relevant assets in the system of national accounts is based on the current replacement costs of past investments, appropriately adjusted for the depreciation over time, while the benefits derived from these assets are, by convention, set equal to the depreciation costs and expenditures for maintenance, and allocated to government as part of collective consumption, although in reality they are being used by the people driving on the roads.

66. An even more problematic area, which still raises question whether or not it is appropriate to record them as assets, concerns public R&D. In this case, quite a substantial part of these assets relates to freely available and publicly accessible knowledge, which on the market would have no value at all. Yet, because they provide benefits for the community at large, they are considered as government assets by convention. Adding to this problem is the intangible nature of these assets, as opposed to public infrastructure whose physical presence makes it easier to look upon them as assets. Infrastructure also has the advantage of generating a market exchange value under changing economic arrangements, which is not the case for freely available knowledge.

67. The important conclusion to derive from this discussion is that in the current system of national accounts some public assets do not exhibit a clear ownership. Furthermore, in these and other cases, the benefits that can be derived from them may be imputed and not “proven” by market revenues, while the users of these benefits may only coincide with the imputations by convention. However, it should also be noted that in the case of public R&D, and also in the case of public infrastructure, balancing items such as net operating surplus, net disposable income and net saving are not affected by this way of recording, because the additional depreciation also leads to additional output. The latter is not the case for the costs of ecosystem degradation; see below.

Considerations and proposals for integrated accounting

68. From the above discussion, it will be clear that the ownership of ecosystem assets, and the related ownership of the costs of degradation, is central to the discussion on the consistency with and the integration into the system of national accounts. Where ownership is undisputed, for example in the case of provisioning services which benefit a specific economic agent, or group of agents, the benefits derived from the ecosystem asset and the use of these benefits can be attributed to the relevant industry or sector. The same holds for the relevant part, in this case the net present value of the provisioning services, of the ecosystem assets, and the (user) costs related to the degradation of the relevant assets. As stated before, one should realise however that the resource rent and the value of the ecosystem asset are strongly correlated with the ownership, or the exclusive use, of the asset. If there is completely open access to the asset, and the ownership becomes more blurred, the resource rent will be close to zero, as will be the exchange value of the asset and the costs of degradation.

69. The issue of ownership also becomes much more blurred in the case of regulating services and cultural services. When looking at regulating services, some of these services have a clear spatial, regional or national, component, such as, for example, the contributions of the ecosystem assets to flood protection or the lowering of local pollution. One could look upon this part of the ecosystem assets, including the related services, as the provision of a public good, similar to the investments in public infrastructure (e.g., investment in water defence structures). The same holds for many of the cultural services, although in these cases it may be easier to determine the beneficiaries of some of these services, such as in the case of recreation and tourism. More difficult to allocate are the services which benefit the world as a whole, the obvious example being carbon sequestration services.

70. From an accounting perspective, the most convenient solution for the above issue of allocating the relevant parts, i.e. those related to regulating and cultural services, of (the costs degradation of) the ecosystem assets is to account for them in a separate sector, “ecosystems”, which may or may not be consolidated with the public sector, or alternatively non-profit institutions serving households (NPISHs). The allocation of the use of the benefits derived from the ecosystem assets could then be done in the use of income accounts, with compensating transfers in kind, to avoid an impact on net lending/net borrowing. In the current system of national accounts, these re-allocations of the use of services is limited to transactions between government and households, but there is much to say in favour of extending this approach to especially non-residents⁵. In the case of, for example, carbon sequestration services, one would then observe, in accounting terms, a transfer from a country to the rest of the world.

71. However, the recording of the ownership of the ecosystem assets, and the related attribution of degradation costs, remains quite problematic. The costs of degradation feature as a component that negatively affects net saving, while in economic reality these costs are not internalised in an economic sense, as they do not involve a monetary payment, or they do not affect (the perception of) future income levels.

72. Another, more generic, issue with the proposals in the above concerns the splitting of the ecosystem assets, including the benefits and uses derived from them, and the costs of degradation. One may prefer an accounting for the whole asset. This would be consistent with the approaches described in the SEEA EEA for the delineation of ecosystem assets as spatial areas and the measurement of condition in ecological terms. Further, in terms of recording enhancement and degradation, this can only affect a single asset in physical terms and is generally associated with a single economic unit (e.g. restoration of ecosystems by farmers). However, as noted above, recording a single, unpartitioned asset in physical terms would have some disadvantages, such as the misalignment of benefits and uses, and an incorrect allocation of (the costs of degradation of) the ecosystem assets.

73. To support further discussion of alternative treatments, a possible complete sequence of accounts of the accounting proposals presented here is illustrated in Table 2 below. This table is a reconfiguration of Table A6.1 of the SEEA 2012 EEA. In the example, total ecosystem services amount to 110, of which provisioning services of 80 are used by agriculture, and 30 of other ecosystem services are used by the “public sector”. Degradation amounts to 15, distributed across provisioning services (10) and other services (5). In the example, it is assumed that the ecosystem services other than the provisioning services are consumed by domestic households, but one could easily attribute some of them to the rest of the world, with an equivalent change in the transfers.

74. It is anticipated that much further discussion on the pros and cons of alternative treatments will take place with the aim of balancing the application of standard national accounting approaches, the reality of multiple benefits to different beneficiaries from a single physical asset and the interpretation of the resulting accounting entries.

⁵ See the previous foot-note.

Accounting for liabilities related to the degradation of ecosystem assets

75. Proposals have also been made to account for the degradation of ecosystems through the recognition of a build-up of ecological debt, a debt of society towards nature; see e.g. Vanoli (2015). In short, Vanoli (2015) proposes to add the monetary value of (net) degradation of ecosystems as “unpaid ecological costs” to the final expenditure categories, thus arriving at final consumption and gross fixed capital formation at “total costs”. The unpaid costs would feed as a negative into saving, which would subsequently add to the increase of a new liability category, “ecological debt of the economy”. Table 3 provides an example of the way in which such an accounting for ecological debt would affect the standard national accounts, in addition to the inclusion of output and use of ecosystem services. In the table it is assumed that the degradation costs are equal to 15, as in Table 2, and that all these costs can be attributed to domestic final consumption.

76. Apart from the problems related to the estimation of this degradation, it may be a viable alternative recording, which may help to address some of the issues around the attribution of degradation costs, although – again – it may not align very well with the perception of consumers, as they are not directly confronted with the actual monetary payments, as a consequence of which they may not internalise the negative impact on their saving. In addition, it should be noted that this way of recording does not align very well with the accounting for the value of ecosystem assets, as in that case the degradation would be accounted twice, once as a decrease in the monetary value of the assets, and another time as an increase in ecological debt. Furthermore, one still will be confronted with difficulties in estimating the contributions of the various final expenditure categories to environmental degradation. On the other hand, recording the degradation of ecosystems in such a way would make the accounts very transparent in showing the externalities caused by economic expenditures.

Table 2: Simplified sequence of accounts for ecosystem accounting

	SNA 2008			Including ecosystem services			
	Farmers	Households	Total	Farmers	Households	Ecosystems (public sector)	Total
<i>Production and generation of income accounts</i>							
Output—products	200		200	200			200
Output—ecosystem services				80		30	110
Total output	200		200	280			310
Intermediate consumption—products	0		0	0			0
Intermediate consumption—ecosystem services				80			80
Gross value added	200		200	200		30	230
Less consumption of fixed capital	10		10	10			10
Less ecosystem degradation (non-SNA)				10		5	15
(Degradation-adjusted) net value added	190		190	180		25	205
Less compensation of employees	50		50	50			50
(Degradation-adjusted) net operating surplus	140		140	130		25	155
<i>Allocation/use of income accounts</i>							
(Degradation-adjusted) net operating surplus	140		140	130		25	155
Compensation of employees		50	50		50		50
Ecosystem transfers					30	-30	0
(Degradation-adjusted) disposable income	140	50	190	130	80	-5	205
Less final consumption—products		200	200		200		200
Less final consumption—ecosystem services (non-SNA)					30		30
(Degradation-adjusted) net saving	140	-150	-10	130	-150	-5	-25
<i>Capital account</i>							
(Degradation-adjusted) net saving	140	-150	-10	130	-150	-5	-25
Plus consumption of fixed capital	10		10	10			10
Plus ecosystem degradation (non-SNA)				10		5	15
Net Lending/Net Borrowing	150	-150	0	150	-150	0	0
<i>Financial accounts</i>							
Changes in cash	150	-150	0	150	-150	0	0
Net Lending/Net Borrowing	150	-150	0	150	-150	0	0
<i>Changes in balance sheets</i>							
Changes in fixed capital	-10		-10	-10			-10
Changes in ecosystems (non-SNA)				-10		-5	-15

Table 3: Simplified sequence of accounts for ecosystem accounting, including ecological debt

	SNA 2008			Including ecosystem services			
	Farmers	Households	Total	Farmers	Households	Ecosystems (public sector)	Total
<i>Production and generation of income accounts</i>							
Output—products	200		200	200			200
Output—ecosystem services				80		30	110
Total output	200		200	280			310
Intermediate consumption—products	0		0	0			0
Intermediate consumption—ecosystem services				80			80
Gross value added	200		200	200		30	230
Less consumption of fixed capital	10		10	10			10
Net value added	190		190	190			220
Less compensation of employees	50		50	50			50
Net operating surplus	140		140	140		30	170
<i>Allocation/use of income accounts</i>							
Net operating surplus	140		140	140		30	170
Compensation of employees		50	50		50		50
Ecosystem transfers					30	-30	0
Disposable income	140	50	190	140	80	0	220
Less final consumption—products		200	200		200		200
Less final consumption—ecosystem services (non-SNA)					30		30
Less unpaid ecological costs of degradation (non-SNA)					15		15
(Degradation-adjusted) net saving	140	-150	-10	140	-165	0	-25
<i>Capital account</i>							
(Degradation-adjusted) net saving	140	-150	-10	140	-165	0	-25
Plus consumption of fixed capital	10		10	10			10
Net Lending/Net Borrowing	150	-150	0	150	-165	0	-15
<i>Financial accounts</i>							
Changes in cash	150	-150	0	150	-150	0	0
Changes in ecological debt (non-SNA)					15		15
Net Lending/Net Borrowing	150	-150	0	150	-165	0	-15
<i>Changes in balance sheets</i>							
Changes in fixed capital	-10		-10	-10			-10
Changes in ecological debt (non-SNA)					15		15

4. Conclusions and research questions

77. A lot of progress has been made in accounting for ecosystems since the adoption of SEEA EEA in 2013. Notwithstanding its experimental nature, a large and growing community of statisticians, economists and ecologists is now looking at ways to move forward the conceptual framework for measuring and monitoring ecosystem assets and related services. The revision initially focused on four research areas and has now moved to drafting of the chapters of the revised SEEA EEA. The chapters are being drafted under the supervision of an extended Technical Committee serving as the Editorial Board, which operates under the auspices of the United Nations Committee of Experts on Environmental Economic Accounting (UNCEEA). The intention is to undertake a global consultation on the draft chapters in early 2020 and of the whole document in late 2020, with the aim to finalise the revised SEEA EEA by the end of 2020 for consideration by the United Nations Statistical Commission in March 2021.

78. It is important that the national accounts community also gets involved in the discussions leading up to the drafting of the various chapters, especially when it comes to the valuation of ecosystem assets; the valuation of the services, and benefits, that can be derived from these assets, including their allocation to sectors; and the valuation of degradation of ecosystem assets. Even more urgent is the involvement of national accountants when it comes to the alignment of the recording of ecosystems with the system of national accounts. In this respect, it is important to note that the national accounting community could particularly contribute to the draft chapters on valuation and alignment with national accounts in the first half of 2020.

79. The Advisory Expert Group (AEG) on National Accounts is requested to express their opinion on the following points:

- whether the current guidance of the 2008 SNA regarding the asset boundary is adequate when it comes to the delineation of natural resources, more specifically biological resources (see the discussion in paragraphs 41 – 42, and 58 – 61);
- whether the allocation of social transfers in kind should be extended beyond transactions between households and NPISHs to resident households, noting that this may also be relevant for more traditional services such as education and health (see paragraphs 50 and 68);
- the proposals around the valuation of ecosystem assets, related services and degradation, including the alignment of the accounting for these assets with the principles of national accounts;
- whether members of the AEG have proposals for alternative ways to account for ecosystem assets;
- how the AEG, and the national accounts community more generally, could/should be involved in the further process of drafting the new standards for ecosystem accounting, in particular when it comes to valuation and accounting for ecosystems in line with national accounts principles.

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