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## **System of Environmental-Economic Accounting 2012 - Experimental Ecosystem Accounting Revision**

### **Chapter Draft prepared Global Consultation**

#### **Chapter 11: Integrated and extended accounting for ecosystem services and assets**

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*Disclaimer:*

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## **SECTION D: Valuation and integrated accounting for ecosystem services and assets**

### **11 Integrated and extended accounting for ecosystem services and assets**

#### **11.1 Introduction**

- 11.1 A key purpose behind ecosystem accounting is the integration of information on ecosystems with measures of economic activity. The integration of ecosystem and economic data supports a richer discussion of the connection between ecosystems and people, underpins the development of indicators showing the relationship such as the contribution of ecosystem services to measures of economic production and allows the derivation of adjusted national accounting aggregates such as degradation adjusted measures of GDP.
- 11.2 The discussion of combining ecosystem accounting data with standard economic data such as from the national accounts is increasingly relevant as countries, both nationally and multi-nationally, are recognizing the losses of some ecosystem services and are developing policy instruments to mitigate and reverse this trend. Where new property rights are established and new transactions arise, there is an overlap between the aim of adjusting for environmental concerns and the inclusion of these transactions in the existing framework of the SNA. Thus, for example, the treatment of payments for tradable emission permits is an important issue for the SNA as there are actual transactions that must be recorded. To the extent that ecosystem services are “internalized” in the SNA, there is need to understand the changing measurement boundary.
- 11.3 Historically, the approaches to integrating ecosystem-related information with the national accounts have focused on the valuation of degradation and the appropriate recording of this “cost of capital” in the accounts of different sectors. This is characteristic of the previous approaches outlined by national accountants (see, e.g., Harrison, 1993; Vanoli, 1995; Nordhaus & Kokkelenberg, 1999). As explained in the SEEA EEA 2012 and the recent literature (e.g., Edens and Hein, 2013; Obst, Hein and Edens, 2016), the emergence and application of the concept of ecosystem services has enabled a reconceptualization of integration with the national accounts. This new basis for integration underpins much of the discussion in this chapter.
- 11.4 A complete integration of ecosystem data with economic data is a process involving many steps. These include the delineation of spatial areas, identifying and measuring the supply and use of ecosystem services and the monetary valuation of ecosystem services and assets. Data and accounts compiled for each of these steps are relevant in their own right but take on greater meaning when considered in a fully integrated accounting context that requires a coherent picture to be conveyed. Thus, the objective of integration provides a purpose and rationale for the selection and structuring of the ecosystem information.
- 11.5 This chapter describes the various ways in which ecosystem and economic data can be integrated with the standard accounts of the SNA to demonstrate the links between the economy and the environment and to compare trends over time. Integration is considered with respect to three types of accounts: the supply and use accounts, national balance sheets and the sequence of institutional sector accounts. All of these accounts are labelled as extensions to the SNA accounts. Thus, in concept, the aim is to use the data recorded in the core ecosystem accounts, to extend the relevant SNA accounts. For the institutional sector accounts the question of ownership of ecosystem assets is a key area of focus since it affects

the ways in which ecosystem related transactions are recorded and the allocation of ecosystem assets and degradation to economic units.

## 11.2 Extended supply and use accounts

- 11.6 Standard supply and use accounts (SUA) (also commonly referred to as supply and use tables) are accounts which show the relationships between economic units (households, business, governments) in terms of flows of goods and services. Each type of good or service is recorded as supplied by an economic unit and used by another, either for final consumption, intermediate consumption, investment or export. Inherent in the design of an SUA is the ability to record supply chains through the economic system by showing the gross output and intermediate inputs and how these are netted in each economic unit to derive measures of value added. SUA are commonly used to support the compilation of measures of GDP as they force a complete reconciliation between the supply and demand for goods and services and hence among the three different measures of GDP. To meet this purpose, the scope of goods and services included in a standard SUA is limited to the production boundary of the SNA.
- 11.7 Compiling extended SUA involves combining the ecosystem services SUA in monetary terms described in Chapter 9 with the standard SUA from the SNA as just described. Extended SUA thus require explicit consideration of the measurement boundaries between the economy and the ecosystem to ensure an appropriate structure for the accounts and that recorded data do not imply double counting. Extended SUA thus present the data on the supply and use of ecosystem services as extensions to the standard SUA compiled following the SNA.
- 11.8 The compilation of extended SUA can provide a powerful analytical tool. They support
- showing the contribution of ecosystem services to the output and value added of different industries and the economy as a whole
  - understanding the main users of ecosystem services and the relative contribution of ecosystem services to household and government final consumption expenditure
  - describing ecosystem services as inputs to economic supply chains and understanding the ecosystem service dependent industries
  - integration of ecosystem services data into analytical and modelling tools that use SUA data as primary data sources, for example input-output models and computable general equilibrium models.
- 11.9 There are two key aspects to consider in extending the SNA SUA to incorporate ecosystem services. First, since ecosystem accounting implies an extension to the standard production boundary, the set of goods and services within scope of the extended SUA will be broader and hence the dimensions of the SUA must increase. This would usually be carried out through the addition of new rows (each additional row representing an additional ecosystem service).<sup>1</sup>
- 11.10 The accounting requirement is to ensure that the ecosystem services are distinguished clearly from the goods and services (products) that are already recorded within the standard SUA. For the products to which ecosystem services are direct inputs (i.e. SNA benefits), ecosystem services are recorded as intermediate consumption of the associated user of the ecosystem

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<sup>1</sup> SUA do not need to be square matrices – i.e. where the number of goods and services is equal to the number of supplying industries. The standard input-output matrix algebra that underpins input-output analysis has been adapted to allow standard, non-square, SUA data to be used in I-O analysis and this can be applied in the case of extended SUA. Note that the resulting I-O tables are square matrices.

service. For example, the ecosystem service of timber biomass provisioning is recorded as additional intermediate consumption of forestry units.

- 11.11 For ecosystem services that contribute to non-SNA benefits, there are no associated products with which to connect and it is sufficient to record the supply of the relevant ecosystem service (e.g. air filtration services) and the use of that service by the relevant economic unit following the advice in Chapter 6.
- 11.12 It is possible to design an extended SUA that incorporates intermediate services supplied by ecosystems. For example, where pollination services are of relevance, an additional row might be added to recognize these flows as inputs to the generation of associated final ecosystem services, e.g. biomass accumulation of crops. However, the general recommendation is that the extension of SUA should be limited to final ecosystem services. This reflects (a) that if intermediate services supplied by ecosystems were added to the extended SUA, then there would be an increase in the complexity of the table; and (b) that from an economy-wide production perspective, any recorded intermediate services would net out in accounting terms and their effect would be embodied in the final ecosystem services. The analysis of intermediate services is best undertaken in the context of the ecosystem services SUA described in chapters 7 and 9.
- 11.13 The second key aspect of the extended SUA entails the requirement that columns be added to reflect the source of the supply of ecosystem services. Thus, ecosystem assets (grouped by ecosystem type) are treated as additional producing units alongside the current set of industries (agriculture, manufacturing, etc.). Given that an extended SUA would generally be compiled at national level (or for a large administrative region), it might be sufficient to introduce just one additional column to cover the production of all ecosystem services by all ecosystem assets. In this case, detail on the source of ecosystem services would be available in the underlying ecosystem services SUA. To demonstrate the steps involved in these extensions a simple example is presented in Annex 11.1.
- 11.14 Table 11.1 below shows an extended SUA incorporating a selected set of product groups and using the list of ecosystem services from the ecosystem services SUA from chapter 9. Note that after including additional rows for ecosystem services and additional columns for ecosystem assets, the extended SUA is completed by incorporating the standard value added entries for industries and for ecosystem assets. Where ecosystem services are inputs to SNA benefits this will have the effect of partitioning the operating surplus of the using industry (e.g. agriculture or forestry) such that the contribution of ecosystem services is deducted from that industry and shown as output and operating surplus of the relevant ecosystem asset.
- 11.15 Extended SUA are different from environmentally-extended input-output tables (EE-IOT).<sup>2</sup> EE-IOT can readily incorporate flows of individual ecosystem services following the same methods that would be applied to incorporate flows of GHG emissions, water use or flows of solid waste. However, in an EE-IOT there is no inherent change or extension in the production boundary as is applied in the extended SUA and as a result there is no inherent extension of supply chains that record the links between the economy and ecosystems. In concept, extended SUA embody a nested systems perspective in which the economic system is shown as seamlessly connected with the underpinning ecosystems.

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<sup>2</sup> The connection between EE-IOT and the SEEA Central Framework accounts is described in the SEEA Applications and Extensions.



## 11.3 Extended balance sheets

### 11.3.1 Introduction

- 11.16 Ecosystem accounting data can be used to augment the economic accounts of the SNA through the compilation of extended balance sheets. Extended balance sheets allow the comparison and integration of the values of ecosystem assets with values of produced assets, financial assets (and liabilities), and other assets.
- 11.17 The development of extended balance sheets aligns closely with the general intent in the compilation of wealth accounts as has been driven forward by the World Bank<sup>3</sup> and UN Environment Program<sup>4</sup>. In general terms there is a common desire to extend valuation of natural capital to incorporate a wide range of ecosystem services beyond those that are incorporated in the valuation of natural resources. Where the outputs of wealth accounting apply exchange value concepts in the valuation of different capitals, the values from the ecosystem monetary asset account included in the extended balance sheet described here will be appropriate. Note that wealth accounts will generally also include measures of human capital (and in some cases social capital) in addition to produced and natural capital.
- 11.18 Extended balance sheets encompassing monetary values of ecosystem assets can be applied in a number of contexts. These include understanding the changing composition of wealth, identifying imbalances in stocks of wealth, for example where balances of particular asset classes are very low, providing a basis for assessing sustainability of flows from particular asset classes, and analyzing productivity and return on investment.
- 11.19 One concern regarding extensions made to balance sheets containing the monetary values of economic and ecosystem assets is that by presenting the different assets side by side it may be interpreted as meaning that economic assets are substitutable for ecosystem assets. In theory, estimates of all asset prices should take into account the extent to which there are developing shortages in the availability of certain “critical” resources, where the effect should be that asset prices reflected in the accounts rise over time, and the relative value of these assets becomes much higher. In this sense, an extended balance sheet framing is also able to support discussion and identification of those assets, particularly environmental ones, that are essential and hence are not substitutable, i.e. in the framing of the concepts of strong sustainability and critical natural capital.
- 11.20 However, in practice, since the future trends in the availability of various assets and their interactions cannot be perfectly anticipated, the extent to which shortages and imbalances will be reflected in estimated asset prices will be more limited than ideal. Thus, when interpreting extended balance sheets, it remains fundamental to also consider the biophysical and quantitative aspects and associated thresholds for all assets.
- 11.21 Compiling extended balance sheets involves integrating values of the opening and closing stock of ecosystem assets as described in Chapter 10 with SNA balance sheet values described in SNA Chapter 13. In some cases, there may be significant overlap between the scope of economic assets and the scope of ecosystem assets, for example with regard to biological resources and land. To avoid a double counting of asset values, clear treatments of different assets is required. These treatments are discussed in sub-section 11.3.3.

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<sup>3</sup> See the World Bank Changing Wealth of Nations project and related outputs <https://www.worldbank.org/en/news/infographic/2018/01/30/the-changing-wealth-of-nations>

<sup>4</sup> See the UNEP Inclusive Wealth <https://www.unenvironment.org/resources/report/inclusive-wealth-report-2018>

### 11.3.2 *Structure of an extended balance sheet*

- 11.22 The structure of an extended balance sheet may follow a number of pathways depending on the type of analysis of wealth being undertaken. An extension of the SNA balance sheet would require that the values of ecosystem assets over and above those currently recorded as natural resources be included as categories of other natural resources. Such an extension may also require making a distinction between produced and non-produced assets.
- 11.23 The approach adopted here is to distinguish a high-level asset class of environmental assets following the definition in the SEEA Central Framework, and to describe the next tier of asset classes around ecosystem types, making connections to SNA asset classes as appropriate. In an extended balance sheet, environmental assets are then shown alongside produced assets and non-produced assets (both excluding environmental assets), financial assets, financial liabilities and net worth.
- 11.24 The extended balance sheet in Table 11.2 presents this approach. Environmental assets are classified into a number of classes starting from the separation of the biophysical environment into the four higher order realms following the framing of the IUCN Global Ecosystem Typology. Within each realm it is possible to breakdown the classes further into, for example, biomes or ecosystem functional groups, as described in Chapter 3. In addition to the four realms in the current IUCN GET, the set of environmental assets includes deep geological systems and atmospheric systems. Further, in the terrestrial realm an exception is made concerning urban areas (IUCN T4.7 Urban and infrastructure lands). Urban areas are separately identified since it is recognized that the value of land in those areas, in terms of the provision of space, will be the most significant share of the total monetary value.
- 11.25 For each realm, the total monetary value including all ecosystem services is recorded, thus reflecting an aggregation of the monetary values compiled in the ecosystem monetary asset account. Further, for each realm “of which” entries are included which highlight the relevant portion of that value which is currently recorded as an economic asset following the SNA. While in many contexts this framing wherein the value of the economic asset is a sub-set of the value of a corresponding environmental asset (e.g. timber resources as a sub-set of the value of forest ecosystems), there is a range of boundary cases. These borderline cases are considered below and conventions are described to support comparable measurement.

**Table 11.2: Structure of an extended balance sheet for non-financial assets**

Asset class			Monetary value	
			Opening value	Closing value
<b>Produced assets</b>	Fixed assets	Dwellings		
		Other buildings and structures		
		Machinery and equipment		
		Weapons systems		
		Intellectual property products		
	Inventories*			
	Valuables			
<b>Environmental assets</b>	Terrestrial ecosystems (excl urban areas)			
		Of which: Timber resources		
		Of which: Cultivated biological resources – non-timber, non-aquatic*		
	Land (as provision of space)	Of which: Land under buildings		
	Freshwater ecosystems			
		Of which: Water resources*		
		Of which: Freshwater aquatic biological resources		
	Marine ecosystems			
		Of which: Marine aquatic biological resources		
	Subterranean ecosystems			
	Deep geological systems			
		of which: Mineral and energy resources*		
	Atmospheric systems			
		of which: Radio spectrum		
<b>Other non-produced assets</b>	Contracts, leases and licenses*			
	Goodwill and marketing assets			
<b>Financial assets</b>				
<b>Financial liabilities</b>				
<b>Net worth</b>				

Note to the table:

\* These entries are boundary cases for which specific measurement conventions apply as discussed in section 11.3.3.

### 11.3.3 *Aligning ecosystem asset values with the values of economic assets*

11.26 As highlighted in the previous sub-section, there are a number of potential overlaps between the SEEA measurement scope for ecosystem assets and the SNA measurement scope of economic assets. To articulate the overlaps and differences the appropriate starting point is the definition of economic assets in the SNA. The SEEA Central Framework (section 5.2.3) provides a useful overview from an environmental-economic accounting perspective. It notes that,

*“In the Central Framework, consistent with the SNA, the scope of valuation is limited to the benefits that accrue to economic owners. An economic owner is the institutional unit entitled to claim the benefits associated with the use of an asset in the source of an economic activity by virtue of accepting the associated risks. Further, following the SNA, an asset is a store of value representing a benefits or series of benefits accruing to the economic owner by holding or using the entity over a period of time.” (SEEA Central Framework 5.32)*

11.27 At an aggregate level, for example for a country, where the aim is to convey information about the total stock of assets and their value, the inclusion of assets in an extended balance sheet without clear attribution of economic ownership is possible. In effect, the aggregate measures in this situation assume attribution of the environmental assets to the country of reference. In turn this implies that establishing a total value for environmental assets requires primarily that a set of economic benefits is identified. The focus in aligning the scope of valuation for various asset classes is thus on aligning the extended set of economic benefits with the relevant asset classes. Issues concerning the ownership of ecosystem assets are considered in sub-section 11.3.4.

11.28 The definition of economic benefits in the SNA is potentially broad in concept, since they *“reflect a gain or positive utility arising from economic production, consumption or accumulation” (2008 SNA, 3.19)*. However, in practice, the scope of the SNA with respect to economic benefits from environmental assets is limited to those:

*“(i) in the form of operating surplus from the sale of natural resources and cultivated biological resources; (ii) in the form of rent earned on permitting the use or extraction of an environmental asset; or (iii) in the form of net receipts (i.e. excluding transaction costs) when an environmental asset (e.g. land) is sold.” (SEEA Central Framework 5.33).*

11.29 In ecosystem accounting, a broader set of economic benefits is recognised, referred to as ecosystem services. The inclusion of ecosystem services increases the value of environmental assets relative to the SNA and hence extends the balance sheet relative to the scope of the SNA.

11.30 To clarify the nature of the extensions to the balance sheet due to considerations about the scope of economic benefits, the treatment of a range of economic assets in the context of extended balance sheets incorporating ecosystem assets are described in the following paragraphs. It is noted that in practice, since few countries compile full balance sheets of non-produced assets, the following considerations may be most relevant in developing such accounts in the first instance or in refining initial estimates.

11.31 Treatment of biological resources. In general terms, the value of all natural (non-cultivated) and cultivated biological resources will be included in scope of both ecosystem assets and economic assets. The values considered in this context are limited to those biological resources that provide inputs to agriculture, forestry and fisheries production, including household production on own account, and hence will be reflected in relevant measures of operating surplus and biomass provisioning services.

- 11.32 For cultivated timber resources (i.e. plantation timber) the value of the resources will be recorded as produced assets in the SNA but will be classified under inventories as distinct from fixed assets. The valuation of these resources date will align with the value of associated provisioning services and hence can be combined with the value of natural timber resources as an 'of which' item under terrestrial ecosystems.
- 11.33 For other cultivated biological resources related to agriculture there is a range of types to be considered including annual crops, plantation crops, livestock for slaughter and livestock for breeding and ongoing production (e.g. dairy cows, sheep for wool). The value for all of these assets, whether treated as inventories or fixed assets, is included in the scope of environmental assets as defined in SEEA Central Framework. However, this value will not reflect the value of ecosystem services, for example the value of livestock will be greater than the value of the associated contribution of the ecosystem service to the growth of livestock. This situation also applies for cultivated aquatic resources (e.g. aquaculture). By convention, these additional values beyond the value of ecosystem services should be recorded against the total value of terrestrial ecosystems (or freshwater and marine ecosystems in the case of cultivated aquatic resources) and included in the relevant 'of which' entry.
- 11.34 The value of natural biological resources including timber, fish and wild animals should be recorded against the relevant ecosystem type and identified as an 'of which' entry.
- 11.35 Treatment of mineral and energy resources. These natural resources are defined in the SEEA Central Framework but are not considered a part of ecosystem assets since the benefits they provide are not the result of ecosystem processes. They are recorded in the extended balance sheet under environmental assets – geological systems.
- 11.36 Special consideration is required of peat resources which may be used as a form of fossil fuel (and hence may be considered a part of mineral and energy resources), but which also are a widely distributed type of ecosystem that can provide a range of ecosystem services. In particular, peat soils are a very significant store of carbon. It is recommended that the value of peat resources that pertains to their use as an energy source be included under geological systems. The value of other uses of peat resources should be included as part of terrestrial ecosystems.
- 11.37 Treatment of energy from renewable sources. Renewable sources of energy (such as wind and solar sources) cannot be exhausted in a manner akin to fossil energy resources and neither are they regenerated as is the case with biological resources. Thus, in an accounting sense, there is no physical stock of renewable sources of energy that can be used up or sold.
- 11.38 Consistent with the advice of the SEEA Central Framework, the monetary value associated with the ongoing capture of energy from wind and solar sources is considered to be embedded in the values of the associated area, reflecting the specific characteristics of the location in which the renewable energy is captured. In the extended balance sheet, by convention, the value of location (including both terrestrial and marine locations) that is linked to the capture of wind and solar energy should be included in the value of land (as provision of space).
- 11.39 For energy generated from hydropower sources, the monetary value associated with the capture of energy is also considered to be embedded in the values of the surrounding area that will incorporate water resources and land formations. In the extended balance sheet, by convention, the value of the location that is linked to hydropower should be included in the value of land (as provision of space).
- 11.40 For energy generated from geothermal resources, relevant values should be included under deep geological systems.

- 11.41 Treatment of inland water resources (i.e. excluding marine ecosystems). Valuation of water resources is recognized in the SNA in cases where *“surface and groundwater resources used for extraction to the extent that their scarcity leads to the enforcement of ownership or use rights, market valuation and some measure of economic control”* (2008 SNA 10.184) It is recommended that this value should be recorded as additional to the value of ecosystem services of freshwater ecosystems.
- 11.42 Some groundwater resources may be considered within scope of ecosystem assets depending on their location and nature of connection to surface water and other ecosystems. Other groundwater resources will be considered outside of the scope of ecosystem assets. By convention, the value of all ecosystem services and abiotic flows from all groundwater resources should be attributed to the value of freshwater ecosystems although a separate identification of specific groundwater resources may be appropriate in some cases (e.g. aquifers not in direct connection with ecosystems).
- 11.43 Treatment of land. A key function of land is to provide space. Land, and the space it represents, define the locations within which economic and other activity is undertaken and within which assets are situated. This role of land is a fundamental input to economic activity and can have significant value.
- 11.44 However, the provision of space is not considered as an ecosystem service and consequently the value of ecosystem assets, particularly for terrestrial ecosystems, should exclude the value of provision of space. Thus, depending on the location and ecosystem type, the total value may be greater than the value of the aggregated ecosystem services. At the extreme will be values of urban ecosystems for which the value of the provision of space will likely be the predominant aspect of total value compared to the value of ecosystem services. It is likely that for agricultural land the distinction will be less evident, i.e. the value of provisioning ecosystem services is likely to be closer to the total market value of the land as recorded in the SNA. In this case however, note that the value of the ecosystem asset may be larger, through the inclusion of the value of non-provisioning services (e.g. water regulation) provided by agricultural land but not recognized in the market value of land. For areas of government-owned or public land, it is likely that no value is recorded following the SNA and in this case the value associated with the relevant ecosystem assets will reflect the total value of the area.
- 11.45 In the extended balance sheet, the approach taken is to record the aggregated value of ecosystem services following the advice in Chapter 10 against the relevant ecosystem type and then where relevant, record the value of land in terms of the provision of space as a separate asset class. In a number of cases, most notably for urban ecosystems and agricultural land, it will be necessary to partition the value of land as recorded in the SNA to extract that component of value that is attributable to ecosystem services (e.g. in relation to amenity services embodied in land values).
- 11.46 Treatment of the atmosphere and high seas: The scope of ecosystem assets excludes the atmosphere, and for national level accounting purposes, marine areas beyond the exclusive economic zone would also be outside the ecosystem accounting area that defines the scope of the accounts. The values of these environmental assets will therefore not be captured in the value of ecosystem assets. SNA values relevant to these environmental assets include the radio spectrum and fish stocks on the high seas over which ownership rights may exist. The value of the radio spectrum should be included under atmospheric systems in Table 11.2 and the value of fish stocks on the high seas that satisfy the definition of economic assets in the SNA should be included under marine ecosystems.
- 11.47 Treatment of permits and licenses to use natural resources. In the SNA the value of permits and licenses associated with the use of natural resources, including for example resource

leases and transferable quotas, is recorded separately from the value of the underlying resource. In recording this value separately, the total value of the natural resource is considered to be partitioned with the value of the permit or license reducing the value of the resource that is recorded as part of natural resources. In the extended balance sheet, by convention, the total value of the natural resource is recorded as part of environmental assets and, if required, the value of the associated permit or license, should be recorded as an 'of which' item.

#### **11.4 Assigning economic ownership and allocation of degradation and enhancement**

*<<Note to reviewers: Some reviewers will be aware that there has been a long discussion of potential approaches to assigning ownership in the context of ecosystem assets and various "models" have been proposed. The following two sections, 11.4 and 11.5, reflect the choice of one of those models to underpin the structure of the sequence of institutional sector accounts. A discussion on the different models and options can be found in SEEA EEA revision process Discussion paper 5.3 available on the SEEA EEA revision website.>>*

##### *11.4.1 Considerations in assigning economic ownership*

- 11.48 The compilation of the core ecosystem accounts in biophysical and monetary terms does not require a statement or assumption concerning the ownership of ecosystem assets. This is important since it highlights that accounting for ecosystem assets, their services and their links to the economy can be undertaken from the perspective of ecosystems being distinct ecological entities, irrespective of the associated legal or economic arrangements. This neutrality with respect to ownership enables the set of core ecosystem accounts to support a wide range of decision-making contexts.
- 11.49 This perspective on ecosystem assets is consistent with the wider definition of environmental assets from the SEEA Central Framework in which these assets are defined with respect to the components of the biophysical environment and the potential delivery of benefits (SEEA Central Framework, 2.17). This differs from the definition of assets in the SNA which requires both economic ownership and a future flow of benefits (2008 SNA, 10.8).
- 11.50 Nonetheless, understanding the legal and economic ownership context of ecosystem assets is of high relevance in developing and enacting policy with respect to ecosystem management and use, since determination of ownership will commonly be needed to enact policy. There is thus a clear policy relevance in cross-classifying data from the core ecosystem accounts with data on legal and economic ownership. For example, data from ecosystem extent accounts may be cross-classified with data from cadastres to assess the connections between different ecosystem types and the types of economic units that manage them. Undertaking this type of work spatially is likely to also be of significant benefit in applying the results from the ecosystem accounts.
- 11.51 From a national accounting perspective, full integration of the core ecosystem accounts with the accounts of the SNA requires a treatment or appropriate convention to be determined such that transactions between ecosystem assets and economic units can be consistently recorded. In particular, the income, distribution of income, capital and financial accounts of the SNA are structured by institutional sectors and sub-sectors, including corporations, households and general government. Thus, to support integration with the institutional sector

accounts and also to underpin derivation of degradation adjusted measures of income and saving, ecosystem assets must be assigned to an institutional sector.

#### 11.4.2 *The institutional sector for ecosystem assets*

- 11.52 In the national accounts, the discussion and determination of ownership distinguishes between legal and economic ownership. The SNA defines the legal owner as “*the institutional unit entitled in law and sustainable under the law to claim the benefits associated with the entities*” (2008 SNA, 10.5) Entities include goods and services, financial assets, natural resources, etc. The economic owner is “*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*” (2008 SNA, 10.5).
- 11.53 Further, all buildings and structures and almost all land and marine areas with the economic territory of a country are deemed, by convention, to be owned by economic units that are considered resident in that territory.<sup>5</sup> Where a non-resident unit is the legal owner, a notional resident unit is created which is considered to own the relevant asset, and the non-resident unit then holds a financial asset equal to the value of the notional resident unit. The implication of this treatment is that all ecosystem assets are considered resident units. This treatment underpins the recording of flows between ecosystem assets and units resident in the rest of the world including with respect to imports and exports of ecosystem services but also concerning the attribution of value in a balance sheet context.
- 11.54 In many cases the legal and economic owner are the same but there are a range of situations in which there may be a lack of clarity. Such situations include government ownership of entities, such as public roads, national parks, natural resources, situations involving financial leases and assets built under private finance initiatives.
- 11.55 Using these national accounting principles of ownership, and solely for the purpose of integrating ecosystem accounts data with the standard sector accounts of the SNA, it is considered appropriate to partition the ownership of ecosystem assets using a focus on the users of different types of ecosystem services. Thus, where an ecosystem asset supplies ecosystem services that contribute to SNA benefits (i.e. primarily provisioning services), that part of the value of the asset will be considered to be owned by the sector that uses those ecosystem services. Most commonly, this will be the legal and economic owner of the ecosystem asset who is using the ecosystem for private returns; e.g. in agriculture and forestry.
- 11.56 At the same time, where an ecosystem asset supplies ecosystem services that contribute to non-SNA benefits (i.e. primarily regulating and maintenance services and cultural services), that part of the value of the asset will be considered to be owned by a new sub-sector of general government titled the “ecosystem trustee”. In this treatment, the ecosystem trustee is considered the supplier of those ecosystem services.
- 11.57 In the situation where an ecosystem asset does not contribute to non-SNA benefits, the treatment will align with the assignment of ownership of the relevant area in the SNA. Further, where an ecosystem asset does not contribute to SNA benefits, e.g., public land such as national parks, the ecosystem trustee is assigned complete ownership. Generally, where some private ownership of land and other areas exists, there will be some partitioning of

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<sup>5</sup> A small exception applies to the treatment of land and buildings of foreign governments such as embassies which are treated as outside the economic territory of a country. This matter is not considered material to the development of integrated environmental-economic accounts and hence is not considered further here. As required the treatments in the 2008 SNA should be applied.

ownership recognising that most of these ecosystem assets will contribute to both SNA and non-SNA benefits.

#### *11.4.3 Allocation of degradation and enhancement to economic units*

- 11.58 Chapter 10 described approaches to the valuation of ecosystem degradation and enhancement in the context of the ecosystem monetary asset account. In that account the focus of measurement is on degradation and enhancement for individual ecosystem assets and ecosystem types within an EAA.
- 11.59 When integrating ecosystem accounts with economic accounts the allocation of ecosystem degradation and enhancement to economic units is required. For both degradation and enhancement this allocation is directly related to the approach applied to the assigning of ownership as explained above. Thus, ecosystem degradation and enhancement of an ecosystem asset is partitioned and recorded in the accounts of either the economic unit that receives the SNA benefits or the new ecosystem trustee sector in relation to contributions to non-SNA benefits.
- 11.60 For integrated economic accounting in the SEEA, a costs borne approach for recording ecosystem degradation is followed meaning that the cost of capital is attributed to the economic unit who is assigned ownership of the asset. This is consistent with general accounting practice. An alternative is to allocate degradation on the basis of costs caused (polluter pays) by determining the appropriate “source” economic unit. This may be challenging, for example due to factors of distance (i.e., when impacts of causing economic units are felt in distant ecosystems) and time (i.e., when the impacts become evident well after the causing activity occurred). Nonetheless, it is recognized that there is likely to be substantial policy interest in providing estimates of an allocation of degradation that is attributable to causing or polluting economic units. Chapter 12 includes discussion of the presentation of such complementary estimates. It is noted that the aggregate measure of degradation from the ecosystem accounts is not affected by the choice of allocation approach.

### **11.5 Integrated sequence of institutional sector accounts**

#### *11.5.1 Introduction*

- 11.61 Ecosystem accounting data can be used to augment the economic accounts of the SNA through the compilation of an extended sequence of accounts for institutional sectors. The extended sequence of accounts shows how entries for the values of ecosystem services, and changes in ecosystem assets (including ecosystem degradation and enhancement) can be combined with standard measures of production, income and consumption and associated accounting aggregates such as saving and net lending.
- 11.62 One of the main functions of the sequence of accounts is to demonstrate the linkages among incomes, investment and balance sheets. In this regard, a key feature of the standard SNA sequence of accounts is the attribution of consumption of fixed capital (depreciation) to economic activities and institutional sectors as a cost against income. The equivalent outcome from an extended sequence of accounts is the attribution of ecosystem degradation as a cost against the income of institutional sectors. Thus, the extended sequence of accounts describes the relevant accounting entries for the derivation of adjusted measures of value-added, domestic product, national income and net worth. Section 11.5.3 describes adjusted income measures.

### 11.5.2 *Structure of the extended sequence of accounts*

- 11.63 The design of an extended sequence of accounts reflects the ownership structure described in section 11.4. The extension thus requires the inclusion of the ecosystem trustee as a new sub-sector within the general government sector.
- 11.64 This extended sequence of accounts is shown in Table 11.3 where a simple example is used to show the different accounting entries. The example shows a simple economy consisting of a farm that produces wheat (with an output value of 200). The wheat is purchased and consumed by households. The cropland used by the farmer provides a mix of ecosystem services (gross ecosystem services supply of 110) of which 80 are used by the farmer as input to wheat production (i.e., crop provisioning services as inputs to SNA benefits) and 30 are air filtration services which are inputs to the non-SNA benefit of cleaner air. For simplicity, all production of the farmer (200) is recorded as final consumption of households and no other production, intermediate consumption or final consumption is recorded. Furthermore, it is assumed that compensation of employees is 50, and that the consumption of fixed capital of a tractor by the farmer is 10.
- 11.65 For the purpose of comparison, the accounting entries that follow the recording principles of the SNA are also shown. In this case, no transactions in ecosystem services are recorded as this activity lies outside the production boundary. Following the SNA, the economy in this example has a value added (gross domestic product) of 200 and the farmer has a net saving of 140.
- 11.66 Following the partitioned ownership approach described in section 11.4, the ecosystem asset is partitioned such that flows of ecosystem services are shown (i) as supplied by farmers in the case of the crop provisioning services (thus increasing the measure of gross output of the farmer) and (ii) as supplied by the ecosystem trustee in the case of air filtration services. The crop provisioning services are immediately deducted in the accounts of the farmer as intermediate consumption.
- 11.67 The use of the air filtration services is shown in two steps. In the allocation/use of accounts an ecosystem services transfer in kind is recorded as payable by the ecosystem trustee and receivable by the subsequent recipient. In this example, the final recipient of air filtration services is the household sector but in other cases multiple recipients may be recorded. In a second step, the use of the ecosystem services is shown as the final consumption of the household sector.

**Table 11.3: Models for including ecosystem services in the sequence of accounts (excluding financial account and change in balance sheet entries)**

		SNA treatment			Extended sequence of accounts			
		Sector		Total	Sector			Total
		Farmer	Household		Farmer	Household	Ecosystem trustee	
<b>Production and generation of income account</b>								
Output	Products (wheat)	200		200	200			200
	Ecosystem services (crop provisioning)				80			80
	Ecosystem services (air filtration)						30	30
<b>Total output</b>		200		200	280		30	310
Intermediate consumption	Products	0		0	0			0
	Ecosystem services (crop provisioning)				80		0	80
<b>Gross value added</b>		200		200	200		30	230
less Consumption of fixed capital (produced assets)		10		10	10		0	10
less Ecosystem degradation					10		5	15
<b>Degradation adjusted net value added</b>		190		190	180		25	205
less Compensation of employees		50		50	50		0	50
<b>Degradation adjusted net operating surplus</b>		140		140	130		25	155
<b>Allocation / Use of income accounts</b>								
<b>Degradation adjusted net operating surplus</b>		140		140	130		25	155
plus Compensation of employees			50	50		50		50
Ecosystem service transfer in kind payable							30	30
Ecosystem services transfer in kind receivable						30		30
<b>Degradation adjusted disposable income</b>		140	50	190	130	80	-5	205
less Final consumption	Products (wheat)		200	200		200		200
	Ecosystem services (air filtration)					30		30
<b>Degradation adjusted net saving</b>		140	-150	-10	130	-150	-5	-25
<b>Capital account</b>								
<b>Degradation adjusted net saving</b>		140	-150	-10	130	-150	-5	-25
plus Consumption of fixed capital (produced assets)		10		10	10			10
plus Ecosystem degradation					10		5	15
<b>Net lending/borrowing</b>		150	-150	0	150	-150	0	0

### 11.5.3 Adjusted income aggregates

11.68 A key focus in the development of the extended sequence of accounts is the derivation of various measures of economic activity including valued added, operating surplus, disposable income and net saving which take into account the cost of ecosystem degradation. Table 11.3 shows how these measures are derived and the relationships between them. Importantly, to retain accounting consistency, in addition to deducting measures of ecosystem degradation it is necessary that the income measures themselves are extended to incorporate the generation and use of ecosystem services (i.e. the flows that are not captured within the standard SNA production boundary).

11.69 The discussion of adjusting measures of GDP and other SNA aggregates for environmental factors is however much broader than the degradation adjusted measures just described. Some considerations on the theoretical relationship between national accounts and welfare are relevant as discussed in Annex 8.1. There is a range of approaches to measurement coverage and valuation that lead to the derivation of a variety of alternative and complementary measures of the environment-economy relationship. Chapter 12 provides an overview of the approaches and the relationship to the measures described in the core ecosystem accounts and in the extended accounts presented in this chapter.

## Annex 11.1: Example of an extended supply and use account

Table 11.4 shows a small, stylized series of SUA using timber production as an example. Part A of the table presents the standard SUA recording of timber production for furniture purchased by households, i.e., no ecosystem services are recorded. It shows the production of logged timber by the forestry industry (50 units), the use of that timber by the manufacturing industry and the ultimate sale of the furniture to households of 80 units. Total value added of 80 is recorded equal to both the sum of the value added for forestry and manufacturing and the total household final consumption expenditure.<sup>6</sup>

Part B extends this recording to include the flow of provisioning services (30 units) from the ecosystem asset (a forest) which is recorded as an input to the forestry industry. There is thus an additional row and an additional column in the SUA relative to the standard SUA in Part A. The main effect of this extension is to partition the value added of the forestry industry between the industry (previously 50, now 20) and the ecosystem asset (now 30, equal to the supply of ecosystem services). Overall value added through the inclusion of the ecosystem asset remains unchanged however (at 80 currency units) even though the total supply for all units has increased by 30. This reflects the extension of the production boundary and demonstrates how the accounting framework deals with the challenge of double counting.

Part C introduces a second ecosystem service, air filtration, which is supplied by the same ecosystem asset (i.e. the forest). In this case a second additional row is required but no additional columns. In this third case total supply is further increased (by 15 units), but in this case, total value added also rises (to 95 units) because the additional production is not an input to existing products. Rather the supply of air filtration services is recorded as an increase in the final consumption of households.

An important result of integrating the flows of ecosystem services in the extended SUA is that it becomes clear how the commonly discussed topic of double counting can be managed. Quite commonly, there is concern that integrating ecosystem services with the national accounts will result in double counting (in terms of the impacts on value added and GDP), if the final ecosystem services that contribute to SNA benefits are recorded. The gross basis of recording – i.e. recording both supply and use of ecosystem services - that is used in Table 11.1 is the most transparent means of dealing with double counting.

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<sup>6</sup> The recording presented here ignores all other inputs and potentially relevant flows (e.g., labour costs, retail margins, taxes, etc).

**Table 11.4: Stylised example of an extended SUA**

	Ecosystem asset (forest)	Forestry industry	Manufacturing industry	Households final demand	Total
<b>PART A: Standard SUA</b>					
Supply					
Logged timber		50			50
Furniture			80		80
Use					
Logged timber			50		50
Furniture				80	80
Value added (supply less use)		50	30		80
<b>PART B: Extended SUA (SNA benefits)</b>					
Supply					
Ecosystem service – growth in timber	30				30
Logged timber		50			50
Furniture			80		80
Use					
Ecosystem service – growth in timber		30			30
Logged timber			50		50
Furniture				80	80
Value added (supply less use)	30	20	30		80
<b>PART C: Extended SUA (non-SNA benefits)</b>					
Supply					
Ecosystem service – growth in timber	30				30
Ecosystem service – air filtration	15				15
Logged timber		50			50
Furniture			80		80
Use					
Ecosystem service – growth in timber		30			30
Ecosystem service – air filtration				15	15
Logged timber			50		50
Furniture				80	80
Value added	45	20	30		95

Source: Obst, Hein and Edens, (2016).

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