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Accounting treatments when integrating ecosystem accounts in the SNA

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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. Since there remained no clearly preferred pathway for accounting in this area, rather than incorporating proposals with respect to degradation in the SEEA Central Framework, a separate volume was developed, SEEA Experimental Ecosystem Accounting (SEEA EEA). The SEEA EEA describes a comprehensive approach to accounting for ecosystems that encompasses accounting for degradation.

4. The intent of ecosystem accounting is 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. This necessitates an extension of both the SNA production and asset boundaries, in order to recognize ecosystems as assets providing ecosystem services that yield two type of benefits: those already included in the SNA (called SNA benefits), and those that are not yet recognized in the SNA (called non-SNA benefits).

5. The objective of this issue paper is to describe a range of options for integrating ecosystem services and ecosystem assets (and the degradation of thereof) within the so-called SNA sequence of accounts, i.e. the comprehensive set of national accounts. The first SEEA EEA completed in 2013 already included possible accounting treatments (so-called Model A and Model B), but in the context

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

of the SEEA EEA revision process additional options have emerged that are detailed in this issue paper.

6. The outline of this paper is as follows. In section 2, a brief overview is provided of the SNA sequence of accounts for those not familiar with all the details of the System of the National Accounts. Section 3 focuses on how ecosystem services may be integrated within the production and income accounts. Section 4 discusses the accounting treatment of degradation costs. Section 5 discusses the possible introduction of liabilities in the accounts concerning environmental degradation and associated costs. A central issue throughout the paper is the issue of economic ownership, which for natural resources and ecosystems more widely is less straightforward than for produced assets.

7. The ambition in this paper 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 for the revised SEEA EEA. 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 contributes more effectively to the important discussion of sustainable development.

2. Summary of the SNA sequence of accounts

8. Before discussing the accounting treatment of ecosystem services, assets and degradation, it is important to outline some of the key accounts, concepts, definitions and accounting rules from the System of National Accounts (SNA). The SNA is a set of interrelated accounts or economic statistical statements, each one providing an aggregated portrait of economic activity during a given period. Each account differs from the others by considering a different aspect of the economy, such as production, generation and distribution of income, use of income, capital formation, financing, and wealth accumulation.

9. Because these accounts all use a common set of definitions, concepts and classifications, and are explicitly related to each other, they form an integrated system. As a result, the economic information occurring from the "system" is coherent. At a high level the "system" records the change in wealth from one period to another by recording the transactions and other economic flows that occur during an accounting period. The complete list of accounts is shown in Table 1.

Table 1. Elements of the sequence of accounts and their balancing items.

Account	Key Activity	Balancing item
Current accounts		
1. Production account	Production	Gross value added
2. *Generation of income account*	Income accruing to the factors of production	Gross operating surplus and mixed income
3. *Allocation of primary income account*	Income accruing to the owners of the factors of production	Balance of primary income
4. *Secondary distribution of income account*	Re-distribution of income	Disposable income
5. *Use of disposable income account*	Use of income via consumption or saving	Saving
4a. *Redistribution of income in kind account*		Adjusted disposable income
4b. *Use of adjusted disposable income account*		Saving
Accumulation accounts		

5. *Capital account*	Capital transfers and investments in non-financial assets	Net borrowing or lending
6. *Financial account*	Investments in financial assets and borrowing	Net borrowing or lending
7. *Other changes in the volume of assets account*	Other economic flows	
8. *Revaluation account*	Other economic flows	
9. Balance Sheet Account	Stocks of assets and liabilities	Net worth

10. Each account within the SNA has the same structure. One "side" of the account is used to record increases (+) in value and the other "side" of the account is used to record reductions (-) in value. The difference between the increases and reductions is referred to as the balancing item.

11. Production, income and wealth (as reflected in the value of the stock of assets) play a prominent role in the sequence of accounts. Production is an activity carried out by an institutional unit using capital, labour and intermediate inputs. Income represents the payments to the factors of production that were used in the production process or primary incomes that accrue to owners of financial assets. Wealth aggregated across all sectors is represented by assets that are owned and used repeatedly in the production process for more than one year, or that otherwise generate a series of benefits for an economic owner (e.g. interest and dividend flows).

12. The 'first' account in the SNA sequence of accounts is the production account, that describes the outputs of production as well as the various inputs required. The production account is based upon the SNA definition of production which is defined as *"an activity, carried out under the responsibility, control and management of an institutional unit, that uses inputs of labour, capital, and goods and services to produce outputs of goods and services"* (SNA 2008, § 6.2). Value added is the balancing item of the production account. Valued added can be measured either gross or net, that is, before or after deducting consumption of fixed capital (i.e. depreciation).

13. The 'second' account is referred to as the generation of income account. The generation of income account shows, for sectors and industries, how the income generated through production is distributed to the factors of production. In general terms it records the payments to capital and labour. The payment to labour is referred to as compensation of employees and the payment to capital (the assets used in the production of the goods and services) is referred to as gross operating surplus (or gross mixed income when the payment to labour and capital cannot be distinguished one from the other).

14. Gross operating surplus is further divided into two components. One component is referred to as consumption of fixed capital. When non-financial assets are used to produce goods and services, part of the life of the asset is consumed or used up during the accounting period. From one perspective, consumption of this capital, which is restricted to produced capital, can be seen as the decline in the value of the stock of non-financial assets owned and used by a producer as a result of physical deterioration, normal obsolescence or normal accidental damage. Consumption of fixed capital can also be viewed from an income perspective. It can be seen as representing the income that needs to be set aside to replenish that part of the asset that was 'used up' in the production process. Consumption of fixed capital is valued at replacement cost – or the cost to the institutional unit to replace the capital it consumed at today's prices. The remainder (the difference between gross operating surplus and consumption of fixed capital) is referred to as net operating surplus. This represents the return to owners of capital (of all types) after accounting for the income required to replenish the fixed capital stock.

15. At this point it is good to pause and discuss the implications of these entries when accounting for ecosystems. Ecosystems are not produced and consequently, their degradation is not covered in the measurement of consumption of fixed capital. "***Consumption of fixed capital does not, therefore cover the depletion or degradation of natural assets such as land, [ecosystems], mineral or other deposits, coal, oil or natural gas or contracts, leases and licences***" (SNA 2008, § 6.241). The complication with ecosystems, and indeed other non-produced assets, is that institutional units can and often do 'use' the capital (ecosystems) 'free' of charge. Because they are able to use the ecosystem free of charge, there is no "payment" recorded in the SNA (either explicitly or implicitly) that reflects the capital cost with respect to the use of ecosystems.

16. The 'third' set of accounts in the SNA records income flows and how they are being distributed, and how the income has been used (**the *allocation of primary income account, the redistribution of income account, the use of income account*.** These accounts are used to record the 'transfer' or allocation of income from the institutional unit using (financial) capital to the institutional unit owning (financial) capital, how these income flows are redistributed between institutional units by means of the payments and receipts of current transfers (e.g. taxes, social benefits, etc.). The purpose of the use of income account is to describe how households, government units and non-profit institutions serving households (NPISHs) allocate their disposable income between final consumption and saving.

17. The complication associated with ecosystem accounting is that, even if we are able to attribute some of the gross operating surplus to ecosystems, it is not clear where (which institutional sector) the income should be transferred. This is why the issue of the ownership of ecosystem assets is critically important.

18. The "fourth" set of accounts are the accumulation accounts which concern changes in the assets of an economy. There are four accounts commencing with the **capital account** which records the financial resources or funds available, and the uses of the funds, for the net purchase of non-financial assets. When the sources of funds are greater than the use of funds, the sector is a net lender and when the sources of funds is less than the use of funds the sector is a net borrower. The resources come from three main sources, current period net saving, consumption of fixed capital (noted earlier) and net capital transfers received. The consumption of fixed capital can be viewed as the funds or income the firm (sector) needed to set aside to maintain its capital stock.

19. The recording in these accounts is well established provided we are not including the role that ecosystems play in the production of goods and services. If we consider that ecosystems are an asset and that during the production process the ecosystems are 'used up' (i.e. there is degradation), then some income should be set aside to allow for the restoration and regeneration of the ecosystem. The key challenge, which is discussed in Section 4 of this paper, is what value should be placed on the degradation of the ecosystem and to which sector should it be allocated.

20. In addition to transactions in non-financial assets (recorded in the capital account) and transactions in financial assets (recorded in the **financial accounts**), changes in assets are also recorded in the **revaluation account** and the ***other change in the volume of asset account***. The latter account is used to record changes in wealth that are not due to transactions or revaluations, but are the result of other economic flows. For example, if a building is destroyed in a fire, there is a loss in value but it is not due to a transaction (including depreciation) or revaluation. The other change in the volume of asset account is used to record the appearance of an asset, the disappearance of an asset or the change in the value of an asset this is not due to a transaction or a revaluation. Again, this is particularly important for ecosystems which are often impacted (positively or negatively) by such events. If an ecosystem is destroyed by a fire or impacted by a flood then the loss in wealth would be recorded in this account. The revaluation account is reserved for recording changes in asset values over an accounting period that are due solely to the effect of changing asset prices.

21. Finally, as noted earlier, the stock of assets at the opening and closing of the accounting period are recorded in the ***balance sheet account***. Assets are classified as either produced assets or non-produced assets and are recorded at market prices. The balance sheet account records the stock of non-financial assets, financial assets and liabilities and the resulting net worth both for the economy as a whole and for each resident institutional sector (households, non-profit institutions serving households, financial corporations, non-financial corporations, general governments). Non-financial assets are further broken out into produced non-financial assets and non-produced non-financial assets. Produced non-financial assets (such as machinery and buildings) enter the system via the ***production account***. Changes in non-produced assets such as land are recorded via the ***other change in the volume of asset account***. Like land, ecosystems themselves are considered non-produced assets in the SNA.

22. Non-financial assets are recorded in the accounts for the sector of the economic owner rather than the sector of the legal owner. Both the market price valuation principle and the ownership principle pose problems for ecosystem accounting. First, ecosystems are not sold on the market and therefore determining an appropriate valuation requires consideration of non-market values. Second, many benefits from ecosystem asset can be considered public goods and hence the link between benefits and economic owners is likely to be unclear. Having said that, the SNA can provide a framework for the recording of ecosystem assets as well as the degradation of ecosystem assets, which occur as a result of the production of goods and services and other economic activities. Using the national accounts framework would make the information coherent with the other parts of the System of National Accounts.

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

Introduction

23. 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). In this section, 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. In section 4, 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

24. 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.

25. 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.

26. 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.*

27. 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.

28. 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.

29. 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.

30. 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.

31. 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

32. 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 SNA[2]. 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.

33. 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.

34. 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.

35. 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

[2] 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.

reallocation of the use of the individualised government services to household consumption. This exception as we will see now, lies at the heart of all options for integrating ecosystem services in the sequence of accounts.

Allocations for ecosystem services

36. 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.

37. 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. Let's illustrate this by looking at the example of a simple economy (as presented in the SEEA EEA Table A6.1) consisting of a farm that produces crops (with an output value of 200), which are being purchased and consumed by households. Assume now that the cropland used by the farmer provides a mix of ecosystem services (total output 110) of which 80 are used by the farmer (e.g., crop provisoning services) and 30 are ecosystem services leading to non-SNA benefits (e.g. air filtration services to local communities). All SNA production of the farmer (200) is recorded as final consumption of households. For simplicity, no other production, intermediate consumption or final consumption is recorded. Furthermore, assume that compensation of employees (i.e., wages) is 50, and that depreciation of the fixed capital (i.e. consumption of fixed capital) used by the farmer (e.g., a tractor) is 10. According to the SNA, no production or consumption of ecosystem services is recorded, as this output lies outside the production boundary. Hence, following the SNA the economy has a GDP of 200 and the farmer has a net saving of 140.

38. 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 ecosystem services are allocated to a separate (and additional to the SNA) sector "ecosystems", while the uses are attributed to the using economic agents, and an equivalent flow of transfers is recorded (in a new row called ecosystem transfers) to off-set the use in terms of the impact on net saving (as mentioned in paragraph 35 above). The entries for Model A are aligned with the recording in the ecosystem services supply and use table in which the ecosystem services are being supplied by the various Ecosystem Types (ETs) (e.g., farmland). In model B, the ecosystem asset is integrated into the sector accounts of the farmer, who owns the ecosystem (thereby cancelling out the entries for the output, and the intermediate consumption of the ecosystem services used by the farmer).

39. Both models have their advantages and disadvantages. Although in model A disposable income and saving for the farmer is unaffected (i.e., both are 140) because of the off-setting flow of transfers, measures of sector level operating surplus and primary income are affected. This is not ideal, 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, and we would create a difference with actual monetary flows. The difficulty with model B, is that the crop provisioning service used by the farmer is not made visible. Model A and model B also differ in their treatment of degradation cost, as will be discussed in Section 4.

Table 2. Models for including ecosystem services in the sequence of accounts

	SNA 2008			Model A				Model B			Model C			
	Farmer	Household	Total	Farmer	Household	Ecosystems (public sector)	Total	Farmer	Household	Total	Farmer	Household	Ecosystems (public sector)	Total
Production and generation of income accounts														
Output—products	200		200	200			200	200		200	200			200
Output—ecosystem services						110	110	30		30	80		30	110
Total output	200		200	200		110	310	230		230	280			310
Intermediate consumption—products	0		0	0			0	0		0	0			0
Intermediate consumption—ecosystem services				80			80	0		0	80			80
Gross value added	200		200	120		110	230	230		230	200		30	230
Less consumption of fixed capital (SNA)	10		10	10			10	10		10	10			10
Less ecosystem degradation (non-SNA)						15	15	15		15	10		5	15
(Degradation-adjusted) net value added	190		190	110		95	205	205		205	180		25	205
Less compensation of employees—SNA	50		50	50			50	50		50	50			50
(Degradation-adjusted) net operating surplus	**140**		**140**	**60**		**95**	**155**	**155**		**155**	**130**		**25**	**155**
Allocation/use of income accounts														
(Degradation-adjusted) net operating surplus	140		140	60		95	155	155		155	130		25	155
Compensation of employees		50	50		50		50		50	50		50		50
Ecosystem transfers				80	30	-110	0	-30	30	30		30	-30	0
(Degradation-adjusted) disposable income	140	50	140	140	80	-15	205	125	80	205	130	80	-5	205
Less final consumption—products		200	200		200		200		200	200		200		200
Less final consumption—ecosystem services (non-SNA)					30		30		30	30		30		30
(Degradation-adjusted) net saving	**140**	**-150**	**-10**	**140**	**-150**	**-15**	**-25**	**125**	**-150**	**-25**	**130**	**-150**	**-5**	**-25**

Green: additional rows and columns compared to 2008 SNA sequence of accounts.

40. An alternative solution, depicted in Table 2 (see also the Annex for the full sequence of accounts) as Model C, is to introduce different recordings based on the nature of the various types of ecosystem services (provisioning services, regulating services and cultural services). Provisioning services are often used in the same area as they are supplied and can be considered as private benefits (think of the farmer owning his land, benefiting from crop provision service). Regulating services (e.g., air filtration) often have a public goods character, and the the location of the beneficiaries (e.g., households benefiting from clean air) is usally different from the area where the biophysical process (e.g., the actual filtration of particles by vegetation) takes place. 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.

41. Concretely, Model C would impute the value of the supply of provisioning service as additional output to the farmer, which would be intermediately consumed by the farmer, leaving its grosss value added similar to the 2008 SNA recording, but having made the value of the relevant ecosystem service visible. The value of the regulating service (of 30 in our example) would receive the same treatment as in Model A, including the use of an ecosystem transfer.

42. While the recoding of ecosystem services based on the nature of the service has appeal from the perspective of recording incomes and related flows, it would introduce, similar to the application of Model B, a difference with the current setup of the physical supply and use tables (PSUTs), which still show the crop provisioning service as being supplied by the Ecosystem Type (e.g. cropland and used by the farmer). More problematic from the perspective of recording assets is that there is a single ecosystem asset in physical terms that will be subject to enhancement and degradation, the benefits and monetary value of which will be partitioned. The challenge is thus different from the partitioning of a single benefit stream, for example in the case of a joint venture. We will therefore now turn to the accounting for ecosystem assets and their degradation.

4. Integrated accounting for ecosystem assets and their degradation

Introduction

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

44. 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.

45. 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*.

46. 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.

47. 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.

48. Before describing some relevant SNA examples, it is relevant to note that determining, potentially by convention, the links between an (economic) owner and an 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 to determine whether and how accounting principles and recording approaches can be best adapted to accommodate this reality.

Biological resources

49. 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.

As stated before, the latter could be interpreted in such as 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.

50. 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.

51. The latter obviously mainly relates to the provisioning services provided by an individual resource, in this case the fish stocks. In the case of ecosystems, such 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. The monetary exchange value will therefore 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, wheras one may also consider a supplementary valuation taking into account the sustainability of the resources.

Mineral and energy resources

52. 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

53. Before considering further the allocation of ecosystem assets and related costs of degradation, for which there is no clear ownership, it is also good to discuss some of the public assets of government. Some of the items that fall within the asset boundary of the 2008 SNA can also be 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.

54. 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 (e.g. research done by universities, the results of which are not patented and pulished in scientific articles). 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.

55. 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 receivers of the benefits by convention. In this respect, 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 the 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.

Options for accounting for assets and degradation

56. 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. Our example assumes that we have been able to assess that the cost of degradation (see issue paper 5.4 on the proposed definition of this) are 15.

57. As described in the SEEA EEA (Annex A6) in standard capital accounting practice, e.g. for the consumption of fixed capital, the costs associated with the use of produced assets, is deducted from the income of the user of the asset. The logic of this deduction is clear, given that there is only one economic unit that supplies and receives the capital service and there is only one capital service for each asset. However, in ecosystem accounting, the relationships between economic units and ecosystems are more complex. Consequently, as discussed above, alternative approaches to the allocation of ecosystem degradation to economic units must be considered.

58. In Model A, the full amount of ecosystem degradation is attributed to the new ecosystem sector. The rationale of this recording is that the ecosystem is considered the sole supplier of ecosystem services and, as a producing unit, must incur the full impact (called in the 1993 SEEA the '**cost borne'**) of declines in the capital base. In this framing, the amount of ecosystem services can be seen as the return to wealth of the ecosystem sector. A decline in wealth as a result of degradation would therefore lead to a decreased income flow.

59. Model B adopts a more integrated view of the relationship between ecosystems and economic units. The key difference lies in the fact that adjustments for ecosystem degradation are made to the income of the producer rather than to the imputed income of the ecosystem. Thus, ecosystem degradation is attributed directly to a standard economic unit. However, this model requires the assumption that a specific institutional unit manages the ecosystem and is therefore responsible for the generation of ecosystem services as well as any degradation caused.

60. There is also another possibility for the attribution ofdegradation costs which is to follow the so-called "polluter pays principle" (or what was called in the SEEA 1993 the '**cost caused**'). Suppose the degradation is caused not by the farmer but by a neighboring factory, whose pollution degrades

the cropland, affecting the farmer. According to the polluter pays principle, these degradation costs should be costed to the income of the factory owner, hence signaling a lower net value added

61. In Model C, the logic would be to partition the ecosystem asset, based on who benefits from the asset. 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.[3] In our example, this is why in Model C the degradation costs of 15 are being **split**: 10 is being charged to the farmer, and 5 to the ecosystem sector. Model C effectively follows a cost borne approach.

62. A disadvantage of splitting the asset as in Model C is that one would 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. Also, more gerenally with the holistic approach of the SEEA EEA in looking at ecosystems as assets rather than at the individual environmental assets (e.g., standing timber, mushrooms etc.). 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).

63. More generally, whichever solution we choose, the recording of the ownership of the ecosystem assets, and the related attribution of degradation costs, will remain quite problematic, as 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.

Table 3. Degradation transfer example

	Degradation transfer				
	Factory	Farmer	Household	Ecosystems (public sector)	Total
Production and generation of income accounts					
Output—products	100	200			300
Output—ecosystem services		80		30	110
Total output	100	280			310
Intermediate consumption—products		0			0
Intermediate consumption—ecosystem services		80			80
Gross value added	100	200		30	330
Less consumption of fixed capital (SNA)	20	10			30
Less ecosystem degradation (non-SNA)	15				15
(Degradation-adjusted) net value added	65	190		30	285
Less compensation of employees—SNA	20	50			70
(Degradation-adjusted) net operating surplus	**40**	**140**		**30**	**210**
Allocation/use of income accounts					
(Degradation-adjusted) net operating surplus	40	140		30	210
Compensation of employees	10		50		60
Ecosystem transfers			30	-30	0
Degradation transfer	15	-10		-5	0
(Degradation-adjusted) disposable income	45	130	80	-5	205
Less final consumption—products			300		300
Less final consumption—ecosystem services (non-SNA)			30		30
(Degradation-adjusted) net saving	**45**	**130**	**-250**	**-5**	**-80**

[3] 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.

64. It would be technically possible to include both cost caused and cost borne presentations in the sequence of accounts by allocating degradation on the basis of cost caused in the production account, and by transferring degradation costs between sectors in the distribution of income account through an additional row (degradation transfers) in the sequence of accounts (see Table 3). This would have the advantage that in the capital account and balance sheet we end with the capital value underpinning the supply of services being allocated to the economic owner reflecting costs borne, while measures of production are on a costs caused basis.

In Table 3 an additional economic activity – a factory with output 100 - has been added for illustarive purposes. The 15 degardation costs are charged in the production account to the factory reducing its net value added and operating surplus. The degradation transfer transfers these costs to the activities being impacted by the degradation (in this case following Model C recording).

5. Accounting for liabilities

65. 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". Model D shown in Table 4 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.

Table 4: Unpaid ecological costs

	Model D			
	Farmer	Household	Ecosystems (public sector)	Total
Production and generation of income accounts				
Output—products	200			200
Output—ecosystem services	80		30	110
Total output	280			310
Intermediate consumption—products	0			0
Intermediate consumption—ecosystem services	80			80
Gross value added	200		30	230
Less consumption of fixed capital (SNA)	10			10
Less ecosystem degradation (non-SNA)				
(Degradation-adjusted) net value added	190		30	220
Less compensation of employees—SNA	50			50
(Degradation-adjusted) net operating surplus	**140**		**30**	**170**
Allocation/use of income accounts				
(Degradation-adjusted) net operating surplus	140		30	170
Compensation of employees		50		50
Ecosystem transfers		30	-30	0
Degradation transfer				
(Degradation-adjusted) disposable income	140	80	0	220
Less final consumption—products		200		200
Less final consumption—ecosystem services (non-SNA)		30		30
Less final cosumption - unpaid ecological costs		15		15
(Degradation-adjusted) net saving	**140**	**-165**	**0**	**-25**

66. 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 also 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.

67. A variation of the above proposal would be to differentiate between degradation costs for which an economic owner can be identified, and those costs for which one cannot, as there is no underlying asset. Examples of the latter concern the atmosphere and fisheries in the high seas. Such degradation costs could be recorded as unpaid ecological costs, hereby avoiding the issue of double counting, as such assets would not be on any balance sheet to begin with.

6. Conclusions and research questions

68. This paper has shown various options for the recording of ecosystem services, including related services and costs of degradation, in the sequence of accounts. In addition to Model A and B that were part of the SEEA EEA, an alternative Model C has been put forward that would split the ownership of ecosystem assets based on who benefits from the respective ecosystem services that it provides. The advantage it has compared to Model B is that it makes ecosystem services explicitly contributing to SNA benefits visible. Another advantage it has over Model A and B is that it leaves national accounts entries for operating surplus and saving intact, as both supply and use of ecosytem services are always introduced within the same institutional sector. The main drawbacks with Model C are:

- it requires to partition the ecosystem asset according to services provided, which may be perceived to go against the definition of ecosystems in the SEEA EEA;
- it may introduce an inconsistency with the PSUT that record flows of ecosystem services from ecosystem types to sectors (this is the appeal of Model A);
- it may have implications for the condition account, that would need to record changes in condition viz-a-viz individual ecosystem services, rather than ecosystem assets as a whole (in order to estimate the degradation costs one needs to have information for each ecosystem service; however, as shown in issue paper 5.4, this is more a presentational issue than a foundational problem.

69. Model C favors the costs borne approach over the costs caused or polluter pays principle, which may be seen by some as a disadvantage. It is however possible to show both approaches by introducing a so-called degradation transfer in the sequence of accounts. Further discussion is also required on the treatment of liabilities and the links to recording degradation and negative externalities. These issues are considered further in Discussion Papers 5.4 and 5.5.

Tabel A1. Full sequence of accounts for the proposed Model A, B and C, and unpaid ecological costs

	SNA 2008			Model A				Model B			Model C				Model D			
	Farmer	Household	Total	Farmer	Household	Ecosystems (public sector)	Total	Farmer	Household	Total	Farmer	Household	Ecosystems (public sector)	Total	Farmer	Household	Ecosystems (public sector)	Total
Production and generation of income accounts																		
Output—products	200		200	200			200	200		200	200			200	200			200
Output—ecosystem services						110	110	30		30	80		30	110	80		30	110
Total output	200		200	200		110	310	230		230	280			310	280			310
Intermediate consumption—products	0		0	0			0	0		0	0			0	0			0
Intermediate consumption—ecosystem services				80			80	0		0	80			80	80			80
Gross value added	200		200	120		110	230	230		230	200		30	230	200		30	230
Less consumption of fixed capital (SNA)	10		10	10			10	10		10	10			10	10			10
Less ecosystem degradation (non-SNA)						15	15	15		15	10		5	15				
(Degradation-adjusted) net value added	190		190	110		95	205	205		205	180		25	205	190		30	220
Less compensation of employees—SNA	50		50	50			50	50		50	50			50	50			50
(Degradation-adjusted) net operating surplus	**140**		**140**	**60**		**95**	**155**	**155**		**155**	**130**		**25**	**155**	**140**		**30**	**170**
Allocation/use of income accounts																		
(Degradation-adjusted) net operating surplus	140		140	60		95	155	155		155	130		25	155	140		30	170
Compensation of employees		50	50		50		50		50	50		50		50		50		50
Ecosystem transfers				80	30	-110	0	-30	30	30		30	-30	0		30	-30	0
Degradation transfer																		
(Degradation-adjusted) disposable income	140	50	140	140	80	-15	205	125	80	205	130	80	-5	205	140	80	0	220
Less final consumption—products		200	200		200		200		200	200		200		200		200		200
Less final consumption—ecosystem services (non-SNA)					30		30		30	30		30		30		30		30
Less final cosumption - unpaid ecological costs																15		15
(Degradation-adjusted) net saving	**140**	**-150**	**-10**	**140**	**-150**	**-15**	**-25**	**125**	**-150**	**-25**	**130**	**-150**	**-5**	**-25**	**140**	**-165**	**0**	**-25**
Capital account																		
(Degradation-adjusted) net saving	140	-150	-10	140	-150	-15	-25	125	-150	-25	130	-150	-5	-25	140	-165	0	-25
Plus consumption of fixed capital (SNA)	10		10	10			10	10		10	10			10	10			10
Plus ecosystem degradation (non-SNA)			10			15	15	15		15	10		5	15			0	
Net Lending/Net Borrowing	**150**	**-150**	**0**	**150**	**-150**	**0**	**0**	**150**	**-150**	**0**	**150**	**-150**	**0**	**0**	**150**	**-165**	**0**	**-15**
Financial account																		
Changes in cash	**150**	**-150**	**0**	**150**	**-150**	**0**	**0**	**150**	**-150**	**0**	**150**	**-150**	**0**	**0**	**150**	**-150**	**0**	**0**
Chnages in ecological debt (non-SNA)																**15**		**15**
Net Lending/Net Borrowing	**150**	**-150**	**0**	**150**	**-150**	**0**	**0**	**150**	**-150**	**0**	**150**	**-150**	**0**	**0**	**150**	**-165**	**0**	**-15**
Changes in balance sheets																		
Changes in fixed capital (SNA)	-10		-10	-10			-10	-10		-10	-10			-10	-10			-10
Changes in ecosystems (non-SNA)			-10			-15	-15	-15		-15	-10		-5	-15				
Changes in ecological debt (non-SNA)																15		15

Green: additional rows and columns compared to 2008 SNA sequence of accounts

References

Eftec, RSPB, PWC (2015) Developing Corporate Natural Capital Accounts, Final report for the UK Natural Capital Committee

European Commission et al (2003) Handbook on National Accounting: Integrated environmental-economic accounting 2003

Evison, W (2018) Presentation to the Bonn SEEA EEA Revision workshop on the valuation of ecosystem assets and their services. Available at: https://www.fresh-thoughts.eu/userfiles/file/bfn_ppts/3_Will%20Evison_CNCA_v26_4.pdf

Fenichel, Abbot, Seong Do Yun (2018) "The nature of natural capital and ecosystem income", in *Handbook on Environmental Economics*

Kervinio, Y (2018) Presentation to the Bonn SEEA EEA Revision workshop on the valuation of ecosystem assets and their services. Available at: https://www.fresh-thoughts.eu/userfiles/file/bfn_ppts/4_20180425-KERVINIO_ecological_debt_V3.pdf

Ogilvy et al (2018) Accounting for liabilities related to ecosystem degradation, *Ecosystem Health and Sustainability*, 4:11. 261-276

Schweppe-Kraft, B & B. Ekinci (2019) "Exchange values, consumer surplus, avoided cost and ecological liabilities – A real income compatible "green-box" would strengthen policy relevance of ecosystem accounting". In Proceedings of *Expert meeting on ecosystem valuation in the context of natural capital accounting*

UN (1993) Handbook on National Accounting: Integrated environmental-economic accounting, interim version

UN et al (2014a) SEEA Central Framework

UN et al (2014b) SEEA Experimental Ecosystem Accounting

UN Statistics Division (2017) Technical Recommendations in support of the implementation of the SEEA EEA, white cover edition

Vanoli A. (2015) National accounting and consideration of the natural heritage. In: Fabert, B. P. (Coordinator): Nature and the Wealth of Nations. La Revue du CGDD, December 2015, Commissariat Général au Développement Durable) (English version)