System of
Environmental
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Accounting

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

Chapter Draft prepared Global Consultation

Chapter 8: Principles of valuation for Ecosystem Accounting

May 2020

Opening note to the chapters on monetary valuation

In 2013, the United Nations Statistical Commission endorsed the System of Environmental-Economic Accounting Experimental Ecosystem Accounting (SEEA EEA) manual as the initial version of statistical framework on the integration of data on ecosystems and the economy. A process to revise the SEEA EEA began in 2017 with the aim of harmonizing and standardizing relevant definitions and concepts in the SEEA's approach to ecosystem accounting. In these chapters being prepared for consultation through the revision process, the central framing of the SEEA EEA in using national accounting principles to integrate ecosystem and economic data is retained, and is referred to generically as "ecosystem accounting".

Ecosystem accounting organizes data in a series of accounts. Three of the core ecosystem accounts organize biophysical and other data in quantitative terms, namely the ecosystem extent account, ecosystem condition account and ecosystem services supply and use account in physical terms. There are also two core ecosystem accounts that present data in monetary terms, the ecosystem services supply and use account in monetary terms and the ecosystem monetary asset account. The revised SEEA EEA will therefore also describe the integration of these ecosystem accounts in monetary terms with the sequence of institutional sector accounts, the balance sheets and the supply and use accounts of the System of National Accounts (SNA).

An important principle of ecosystem accounting is that both biophysical and monetary data are relevant in the description and assessment of the relationship between ecosystem and the economy. In this context, the three core accounts expressed in biophysical terms should be considered together with the monetary accounts as part of the broad discussion of the value of ecosystems given that the concept of value can be extended beyond those expressed in monetary terms. Chapter 2 "Overview of ecosystem accounting" will provide a more complete overview of the accounting framework and will also discuss the ways in which ecosystem accounts can support the discussion of different perspectives on value.

For those familiar with the SNA, the inclusion of this discussion early in the revised SEEA EEA is somewhat analogous to the discussion of the connection between national accounts and the measurement of welfare in the 2008 SNA, Chapter 1. For those familiar with the SEEA EEA revision process, the discussion on values planned for Chapter 2 will use findings from the revision discussion papers 2.1 and 5.1[1] which each considered these issues. From a global perspective, the discussion will use findings from different initiatives, including those concerning wealth accounting and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).[2]

Chapters 8 – 11 on "Monetary valuation and integrated accounting for ecosystem services and assets" are now being circulated for global consultation.

- Chapter 8 provides a summary of the core principles of monetary valuation that apply in the application of the national accounting concept of exchange value. These principles are articulated such that the available valuation techniques can be appropriately assessed in terms of their potential for use in ecosystem accounting.

- Chapter 9 describes the ecosystem services supply and use account in monetary terms and the various valuation techniques that can be applied to estimate the exchange value of ecosystem services.

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[1] These discussion papers are accessible via the SEEA EEA revision home page https://seea.un.org/content/seea-experimental-ecosystem-accounting-revision

[2] https://ipbes.net

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- Chapter 10 describes the ecosystem monetary asset account and approaches to the monetary valuation of ecosystem assets and changes in ecosystem assets such as ecosystem degradation.

- Chapter 11 discusses the integration of monetary values from ecosystem accounts with monetary values in the SNA sequence of accounts and balance sheets, including consideration of the ownership of ecosystem assets and the allocation of ecosystem degradation to economic units.

The focus of discussion of monetary valuation in these chapters is on the application of national accounts-based approaches to valuation. It is recognized that there are other approaches to monetary valuation of the environment that are commonly applied for reporting and decision-making purposes. An annex will be drafted for Chapter 8 describing the conceptual connections between the exchange value approach used in the SEEA and other monetary valuation concepts (an outline of this annex has been provided at the end of this version of Chapter 8). Further, an additional chapter will be drafted to provide an overview of complementary approaches to monetary valuation. The annex and the additional chapter will be circulated for consultation at a later date.

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Contents

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SECTION D: Monetary valuation and integrated accounting for ecosystem services and assets

8   Principles of monetary valuation for ecosystem accounting

8.1   The purpose and scope of monetary valuation for ecosystem accounting

8.1.1   *The purposes for monetary valuation in ecosystem accounting*

8.1   A number of motivations exist for the monetary valuation of ecosystem services and ecosystem assets depending on the purpose of analysis and the context for the use of valuations in monetary terms. The different motivations point to different requirements in terms of concepts, methods and assumptions. Monetary valuation can play a role in signalling the relative scarcity of ecosystem services and assets. Without market prices or some other form of economic valuation, there is no economic signal for scarcity and quality. Thus, data on monetary values can provide a signal to producers, consumers, and government, that supports more sustainable management and use of the environment. The common areas of focus of work in environmental economics, include the analysis of specific policy scenarios and alternative policy settings, the evaluation of specific projects, for example in cost-benefit analysis, and in the assessment of compensation and damage claims.

8.2   In ecosystem accounting, the motivation for monetary valuation using a common monetary unit or numeraire is to be able to make consistent comparisons of different ecosystem services and ecosystem assets in the context with standard measures from the national accounts of products and assets used in economic activity. Examples of these comparisons include comparing the values of environmental assets (including ecosystems) with other asset types (e.g. produced assets) as part of extended measures of national wealth, assessing the relative importance of ecosystem contributions to production in specific industries and their supply chains, evaluating the relative importance of ecosystem services that are not within the standard measures of economic production and consumption (e.g., air filtration), and deriving aggregates such as degradation adjusted measures of national income.

8.3   Within the general ambition of making explicit the relative importance of ecosystem services and assets, the data generated from a set of ecosystem accounts that covers multiple ecosystem services and multiple ecosystem assets will support public awareness of ecosystem related issues, the derivation of performance indicators, benchmarking the activity in industries and sectors, and undertaking general policy framing and analysis especially considering connections across environmental and economic policies. It is likely that more detailed and finer scale data and valuations are required for impact analysis of specific policy options, project evaluation and incentive design. Such detailed analysis can apply data from ecosystem accounts to support understanding of micro-macro linkages and the assessment of changes over time.

8.4   More broadly, it is expected that having monetary values for ecosystem services and assets that are consistent with the national accounts will facilitate and encourage the economic policy discourse to consider environmental factors and assist in mainstreaming discussion of biodiversity.

8.5   The monetary valuation of ecosystem services and ecosystem assets is challenging because they are not traded directly on markets in the same way as most other goods, services and assets and hence values expressed in monetary terms are not observable from market transactions. Further, as summarized in Chapter 2, monetary valuation raises a range of

ethical and cultural considerations which should be considered in interpreting values in monetary terms. While challenges exist, there are well established concepts and measurement techniques that can be used to estimate monetary values for use in ecosystem accounting.

8.6   In this context, this chapter outlines the core principles of monetary valuation used in ecosystem accounting in applying the national accounting concept of exchange value. These principles are articulated to provide a common basis for discussing and interpreting monetary values in ecosystem accounting and to allow the available valuation techniques to be appropriately applied.

8.1.2   The scope of monetary valuation for ecosystem accounting

8.7   Monetary valuation depends on two factors in an accounting context, namely (i) the definition and scope of goods, services and assets included; and (ii) the valuation concept that is used. In ecosystem accounting, measurement focuses on the exchange value of ecosystem services. ***Exchange values are values at which goods, services, labour or assets are in fact exchanged or else could be exchanged for cash*** (2008 SNA, 3.118). The valuation concept of exchange value is the same as applied in the SNA and is a concept that supports comparison and integration with national accounts estimates and a range of analytical and indicator applications as described above.

8.8   The majority of research and policy on environmentally related monetary valuation has been conducted with a focus on measuring changes in welfare. A commonly applied framework to assess the economic value of ecosystems is the Total Economic Value (TEV) framework (Pearce, 1992). Its aim is to describe the range of direct use (e.g. timber harvesting, recreation), indirect use (e.g. air filtration, water regulation) and non-use values (e.g. existence values of specific species) that are relevant in providing a comprehensive measure of economic welfare. Within this range of use and non-use values, it is usual to apply monetary valuation techniques that assess values of welfare and changes in welfare most commonly approximated using measures of consumer and producer surplus. Thus, for reasons of both scope and valuation concept, monetary valuation undertaken for the purpose of accounting will regularly differ from estimates of welfare values obtained in environmental economic studies.

8.9   While there are differences between monetary valuations responding to different analytical purposes, there are theoretical connections between exchange and welfare values. These are described in detail in Annex 8.1 to (i) support the understanding of account compilers in their use of non-market valuation techniques for ecosystem services; and (ii) build a common language among accountants and environmental economists. Importantly, because of the theoretical connections that exist, there is a clear potential for ecosystem accounting to provide the underlying, baseline information, including biophysical information, needed to derive welfare values and analyse changes in welfare.

8.2   Valuation concepts and principles for accounting

8.2.1   Defining exchange values for ecosystem accounting

8.10   In ecosystem accounting, the monetary valuation concept that is applied is exchange values as defined in the SNA. The 2008 SNA states that the SNA *"measures the current exchange value of the entries in the accounts in money terms, that is, the values at which goods, services, labour or assets are in fact exchanged or else could be exchanged for cash"* (2008 SNA, 3.118).

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Conceptually, exchange values reflect the multiplication of prices and quantities. The prices in this context are referred to as unit prices.

8.11   For the vast majority of entries in the national accounts, the concept of exchange values is measured using data from observed transactions involving market prices. Market prices *"are defined as amounts of money that willing buyers pay to acquire something from willing sellers"* (2008 SNA, 3.119)[3]. The use of observed market prices implies that the accounts embody information about the revealed preferences of the economic units involved.

8.12   Where market price-based transactions are not observable, imputations are required to estimate exchange values. Two primary methods of imputation are described in the SNA in relation to transactions in goods and services namely (i) market prices of similar or analogous items (adjusted for quality and other differences as required) (2008 SNA, 3.123); and (ii) where no appropriate market exists, prices may be derived by the amount that it would cost to produce them currently (2008 SNA, 3.135). Cost-based techniques are commonly applied in estimating the value of government supplied services including education, health and defence. In these cases, it can be assumed that the amount of expenditure reflects the revealed preferences of a country or community.

8.13   Assets are recorded at exchange values that apply at the balance sheet date, i.e. the beginning or end of the accounting period. The ideal source of exchange values for assets are unit prices and quantities observed in markets. Where there are no observable unit prices from markets, the SNA describes two approaches for imputing the exchange value of an asset. The first is the written down replacement cost approach which recognises that the value of an existing asset (most commonly relating to produced assets) at any given point in its life, is equal to *"the current acquisition price of an equivalent new asset less the accumulated depreciation"* (2008 SNA, 13.23).The second approach, which is of primary relevance for ecosystem accounting, entails using *"the discounted present value of expected future returns"* (2008 SNA, 3.137).

8.14   Observed market prices are defined in terms of actual exchanges without expectation that the market in which those exchanges take place satisfy a specific institutional arrangement or assumption. The 2008 SNA observes "*a market price should not necessarily be construed as equivalent to a free market price; that is, a market transaction should not be interpreted as occurring exclusively in a purely competitive market situation. In fact, a market transaction could take place in a monopolistic, monopsonistic, or any other market structure.*" (2008 SNA, 3.119). Given this, the general interpretation of exchange values in accounting is that they should reflect the current institutional context, i.e. the current market structures and associated legal or regulatory arrangements. Consequently, exchange values will likely reflect the presence of various market imperfections from the perspective of economic theory.

8.15   Entries in the accounts will usually be an aggregate value of multiple transactions in a specific good or service over an accounting period (e.g. all sales of bread in one year) or the aggregate value of multiple assets of a specific type at a balance sheet date (e.g. all registered trucks at 31 December). The accounting entries will therefore reflect the summation of exchange values for the set of relevant transactions or set of assets.

8.16   Accounting entries are recorded progressively over multiple accounting periods and balance sheet dates. In this way, time series of exchange values for various goods and services and types of assets will be compiled. All accounting entries are recorded at the respective points

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[3] The 2008 SNA notes a number of cases where actual exchange values do not represent market prices (e.g. in situations of transfer and concessional pricing (see para 3.131-3.134)).

in time at their nominal values – i.e. the exchange values applying at the time of the transaction or balance sheet entry.

8.2.2 Monetary valuation of ecosystem services

8.17 The monetary valuation of ecosystem services for ecosystem accounting involves using exchange values to reflect, in monetary terms, the contribution of ecosystems to benefits used in economic and other human activity. The challenge in practice is that ecosystem services are not generally exchanged directly in markets and therefore their exchange values cannot be observed. Therefore, the approach to monetary valuation rests on using valuation techniques to impute appropriate exchange values. This section provides the accounting context for valuing ecosystem services and Chapter 9, section 9.3, describes the valuation techniques that can be used to estimate exchange values.

8.18 From a national accounting perspective, flows of ecosystem services from ecosystem assets can be conceptualised in two ways. First, ecosystem assets are considered as complex and interacting producing units ("factories") who supply outputs of ecosystem services to various users. This view is consistent with the framing of measures of ecosystem extent and condition in which ecosystem assets are defined as ecological entities reflecting the definition of ecosystems from the Convention on Biological Diversity. Second, flows of ecosystem services are considered analogous to flows of capital services supplied by produced assets as described in SNA Chapter 20. These two perspectives are reconciled for the purposes of monetary valuation by treating the output of ecosystem assets as producing units as consisting solely of capital services. This treatment is possible by recognising ecosystem assets as distinct entities from any associated economic units who may own or manage the ecosystem (e.g. farmers, land managers). In national accounting terms, this implies that the output and the gross value added of ecosystem assets is equivalent, i.e. there is no intermediate consumption of goods and services or labour input.

8.19 Thus, ecosystem services should be valued for accounting purposes in a manner aligned with the valuation of capital services in the SNA. This value will be different from the rentals that would be charged following the definitions in the SNA (2008 SNA, 6.245). By way of example, the rentals paid by a tenant to a landlord will cover the capital services provided by the dwelling[4] as well as the direct operating costs (e.g. management and maintenance costs). Hence the output will be measured in terms of the rentals charged to the tenant and costs must be deducted in order to determine the value of the capital services, and equivalently the gross operating surplus. Analogously, in ecosystem accounting, ecosystem services are distinguished from the benefits to which they contribute, and hence the focus of valuation is on the contribution of the ecosystem asset and not on the valuation of the benefits.[5]

8.20 Consistent with considering ecosystem assets as distinct entities from economic units, the flows of ecosystem services are considered as transactions involving supply by ecosystem assets and use by economic units. For each transaction, a single exchange value can be envisaged and, since each transaction in a given ecosystem service may be undertaken in a different context, e.g. air filtration services supplied by different ecosystem assets, and with

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[4] These are commonly referred to as "user costs" and include both the consumption of fixed capital and the return on investment (opportunity cost) of the relevant asset.

[5] The selection of terms to convey the relevant concepts can be difficult. Here, the term benefits is used to reflect the concept of output (rentals) and is not intended to be considered in a context of a description of the outcomes or well-being associated with economic activity.

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different combinations of users, it may be the case that different exchange values apply for the same type of ecosystem service.

8.21   In applying national accounting principles to accounting for ecosystems, and particular in the context of the valuation of ecosystem services, it must be recognised that transactions in ecosystem services are not recorded in the SNA and, indeed, ecosystem services lie outside the production boundary that defines the scope of measured gross domestic product. In some cases, ecosystem services contribute to the production of SNA benefits, i.e. those goods and services within the production boundary of the SNA. In these cases, the values of ecosystem services are implicitly within exchange values recorded in the national accounts. Examples include ecosystem services, such as pollination, that contribute to agricultural output.

8.22   In other cases, ecosystem services contribute to non-SNA benefits, i.e. benefits received by economic units including households and governments that are not within the production boundary of the SNA. For example, air filtration services will contribute to cleaner air whose exchange value is not implicitly included in national accounts measures of output. In these cases, the relevant exchange values of the contribution of the ecosystem assets are estimated by estimating the value for which the ecosystem services would be exchanged if a market existed. There are a variety of valuation methods described in Chapter 9 that can be used to estimate exchange values following this framing.

8.2.3   Monetary valuation of ecosystem assets

8.23   In addition to recording exchange values of ecosystem services, ecosystem accounting incorporates recording the exchange values of ecosystem assets and associated changes in the value of ecosystem assets over an accounting period. These changes include ecosystem enhancement, ecosystem degradation, ecosystem conversions and revaluations. This section provides a framing for the valuation ecosystem assets in monetary terms for ecosystem accounting.

8.24   The ecosystem assets that are the focus of monetary valuation are delineated following the advice on spatial units and measurement of ecosystem extent as described in Chapters 3 and 4. To introduce the valuation principles, the focus is on a single ecosystem asset (EA) of a given ecosystem type (ET) (e.g. Cool temperate rainforests - IUCN Global Ecosystem Typology class T2.3). This EA is considered to supply a number of ecosystem services to different users (e.g. timber provisioning services, air filtration services, recreation related services).

8.25   For a given EA, the approach adopted for ecosystem accounting is to value ecosystem assets in monetary terms by aggregating the net present value (NPV) of expected future returns (of capital services) for each ecosystem service supplied by that EA. Application of the NPV approach requires (i) measuring the expected future returns for each ecosystem service; and (ii) applying a discount rate such that the future returns can be expressed in current period values.

8.26   To measure the expected future returns for an EA there are a number of considerations that need to be addressed. These include the scope of the returns (i.e. the range of ecosystem services to be included); the future patterns of flows in quantitative terms of each ecosystem service taking into consideration expected degradation and patterns of demand; the expected future unit prices for each ecosystem service; the expected institutional arrangements and the expected asset life. Together with the discount rate, all of these factors are combined to yield an estimated NPV for each ecosystem service at a given point in time. The NPV of the EA is equal to the sum of the NPV for each service. Chapter 10 provides additional details on these different factors.

SEEA

8.27   This approach assumes that the expected future returns for each ecosystem service are separable. The assumption of separability is considered in the sense of each ecosystem service being distinguishable and representing a distinct transaction between the ecosystem asset and the relevant user. Thus, the service of air filtration and the service of timber provisioning are both provided by forests but are assumed to be able to be measured distinctly, i.e. in a mutually exclusive manner. Consequently, the supply and use of each service and the future flows of each service can be recorded separately and aggregated as required. It is nonetheless recognised that since there are multiple services from a single ecosystem asset, determining the expected future flows for each service must involve consideration of the common supply context. Thus, factors influencing the future supply of one ecosystem service will be linked to the future supply of other ecosystem services. This framing is analogous to recognising that a hotel may provide separable outputs of both accommodation and meal services, each supplied using a common pool of produced assets and labour.

8.28   Chapter 10 describes how the expected future flows of each service may be considered jointly in the compilation process (including through the use of commonly classified data sets on ecosystem extent) to ensure that inherent contradictions in expectations are avoided, and that meaningful estimates of the aggregate value of an ecosystem asset and the changes in this value over time can be derived. Chapter 10 also provides definitions for the accounting entries associated with changes in the NPV of ecosystem assets. These accounting entries include ecosystem enhancement, ecosystem degradation, ecosystem conversions, other changes in the volume of ecosystem assets (including catastrophic losses) and revaluations.

8.29   While there are complexities in the measurement of ecosystem asset values in monetary terms, the underlying economic theory is consistent with that used in the measurement of the capital stock of produced assets as described in the SNA. Consequently, compilers familiar with the implementation of perpetual inventory models should recognise many of the requirements in relation to the valuation of ecosystem assets.

8.2.4   Volume and price measures

8.30   The analysis of nominal values can be of interest, for example, to understand the relative structure of consumption or production, or to compare levels of expenditure to budget and fiscal constraints. In addition, for analytical purposes, it is standard practice in national accounting to separate (or decompose) changes in exchange values recorded at two points in time into changes associated with price and those associated with changes in volumes, reflecting both changes in quantity and quality[6]. Following decomposition, the resulting time series that excludes the effects of price changes, i.e. a time series of changes in volumes, are commonly referred to as constant price measures. [7]

8.31   Since exchange values (and hence prices) for most individual ecosystem services are not observable, standard practices for estimating price and volume measures which rely on the use of price indexes cannot be applied. While other techniques might be considered, at this stage, it is not recommended that compilers aim to develop volume estimates of ecosystem services and ecosystem assets in a manner aligned with estimates in the national accounts.

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[6] The term volume is used in accounting since for many goods, services and assets, changes may be due to changes in quality, in addition to quantity and price. In accounting, volume reflects the combination of quantity and quality.

[7] The is an extensive literature on the theory and application of index numbers to accounting. The core elements are described in 2008 SNA Chapter 15.

SEEA

8.32   At the same time, since analysis is commonly undertaken using data with the price effects removed, it may be relevant to adjust the nominal values using a general measure of economy wide price change, such as the GDP deflator. The resulting estimates are commonly referred to as "real measures" in the national accounting literature.

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Annex 8.1: Exchange and welfare values in a national accounting context

<<***Note to reviewers***: *Through the revision process, a substantive amount of material has been developed to describe the connections between exchange and welfare values and hence place various approaches to the monetary valuation of environmental stocks and flows in a common context. While very good progress has been made on reaching an agreed framing from the perspectives of both national accountants and economists, a draft summarizing the relationship between these value perspectives has not been finalized at this stage.*

An outline has been drafted, shown below, to provide an overall sense of the coverage of the annex. Your comments on this outline will be welcome. Those wishing to familiarize themselves with the discussion are encouraged to read Discussion papers 5.1 and 5.2 and a short note by Caparros et al on this topic. These are all available on the SEEA EEA revision website.>>

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Draft Outline – May 2020

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1. Introduction
   a. Describe the motivation for connecting exchange values and welfare values in an ecosystem accounting context

2. Valuation of individual goods and services
   a. Valuation in economic theory
      i. Utility and income
      ii. Marginal costs and prices
      iii. WTP / WTA / revealed preferences
      iv. Consumer surplus and Hicksian variations
      v. Non-market pricing
      vi. Valuing externalities / Estimating shadow prices
   b. Valuation in accounting
      i. Transactions and exchange values
      ii. Measures of income and benefits
      iii. Volume and price measures and index number theory
   c. Connections between welfare and exchange values for individual goods and services
   d. Relevance of these connections in the context of valuing ecosystem services

3. Aggregate measures of income and wealth
   a. The scope of income in the SNA (production boundary, GDP, NDP)
   b. Linking the SNA production boundary and broader measures of welfare (e.g. Krutilla 1967, Weitzman 1976, treatment of defensive expenditures)
   c. Assumptions in using GDP to measure aggregate welfare

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d. Implications for the interpretation of ecosystem accounting aggregates

4. Measuring the value of assets and net wealth
    a. Valuing assets in the SNA
    b. Links and overlaps with wealth accounting principles
    c. Implications for the measurement and interpretation of ecosystem accounting asset values.

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