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**Deliverable 3.4**

**Discussion Paper:**

**The use of (economic & social) values of Natural Capital and Ecosystem Services in national accounting**

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**Discussion Paper:**

**The use of (economic & social) values of NC/ES in national accounting:**

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# Developments of Natural Capital accounting

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## Introduction

### The concept of Natural Capital

Human economies are open systems that depend on a flow of renewable and non-renewable resources (e.g. timber, water, fossil fuels, minerals, biomass) and ecosystem services (e.g. provisioning, regulating and cultural services), which are provided by stocks of natural assets including ecosystems (MA, 2005; Kumar (ed.), 2010; ten Brink (ed.), 2011).

The increasing use of natural resources over the last decades resulted in unprecedented level of pollution in many areas of the world, in an increasing level of greenhouse gas emissions, in the depletion of renewable resources such as fish stocks and clean water, and the loss and degradation of biodiversity and ecosystems (ten Brink et al., 2011). Designing effective policies aimed at improving the environmental sustainability of modern economies requires measuring the availability and use of natural resources and the impact of the economy on ecosystems.

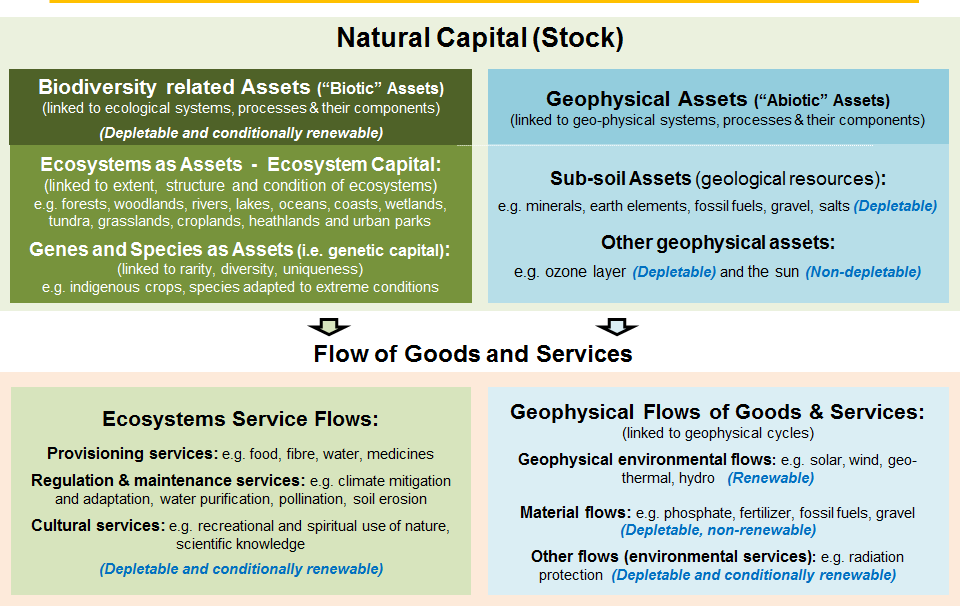
Natural Capital Accounting (NCA) provides a systematised approach to measure the stock of natural resources and the flows of resources and ecosystem services that underpin the functioning of the economy. Natural Capital (NC) is a term proposed by the economist E. F. Schumacher in 1973, as a metaphor to shed light on the role of nature in supporting the economy and human welfare. The concept builds on the idea of manufactured capital as one of the factors of production (together with land and labour), which was introduced by Adam Smith and David Ricardo in the eighteenth century.

The term “capital” refers to a stock of materials or information, which can generate a flow of goods and services that improve human wellbeing. Ekins (1992) defines four kinds of capital, i.e., manufactured, human, social[[1]](#footnote-1) and natural capital (see also Ekins et al., 2008), where the latter is constituted by the stock of natural assets that provide society with renewable and non-renewable resources (e.g., timber, water, fossil fuels, minerals) and a flow of ecosystem services. Costanza et al. (2014) draw attention to the interdependence among capital stocks, defining Natural Capital as “The natural environment and its biodiversity, which, in combination with the other three types of capital (social/cultural, human and built), provides ecosystem goods and services: the benefits human derive from ecosystems”. These capital stocks are in principle separately measurable, though in practice data are incomplete, and simplifying assumptions are necessary to derive simple measures at a national level for capital stocks that are in reality a combination of a vast array of complex elements.

According to the analytical framework developed in the context of the EU ‘Mapping and Assessment of Ecosystem and their Services’ initiative (European Commission, 2013b), Natural Capital includes stocks like sub-soil assets (geological resources) and abiotic flows like solar and wind energy. The Ecosystem Capital represents the biotic element of the Natural Capital and includes both ecosystems (which can be seen as stocks) and the flows of ecosystem services they provide to society (see Figure 1.1). This report will focus on the biotic components of Natural Capital, i.e., the ecosystems and the related ecosystem services.

However, it should be noted that the distinction between biotic and abiotic elements is not so clear-cut, as an ecosystem is “a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit” (United Nations,1992). For example, water is an abiotic element in itself, but ecosystems play a key role in its cycle, and also water is essential for nutrition and plays a key role in all ecosystems (Haines-Young and Potsschin, 2013; Russi et al., 2013). As another example, fossil fuels (an abiotic resource) were derived from the biological degradation of organic matter.

**Figure 1.1 The components of Natural Capital & associated flow of goods & services**



Source: own representation adapted from MAES analytic framework, European Commission (2013b), ten Brink, 2015

All four types of capital are needed to support human welfare. However, Natural Capital is arguably the most important one, as it is incorporated in all other forms of capital, and underpins them. Also, an important share of Natural Capital is non-substitutable with manufactured or other kinds of capital, and the manufactured, human and social capital would not be built without Natural Capital (Costanza et al., 1997). For example, minerals, metals and energy are needed to build the components of manufactured capital; human and social capitals are heavily dependent on the physical health of individuals, who in turn are dependent upon ecosystem services to maintain good health, including food, freshwater, timber and fibre and a wide range of regulating ecosystem services (e.g. water purification, nutrient cycling, protection from floods and other extreme events). In other words, the economy is embedded in the environment, and in order to be sustainable it needs to stay within its limits, both in terms of available resources and the capacity of the environment to absorb and process wastes.

The concept of Natural Capital is anthropocentric in nature, as it focuses on those aspects of nature that benefit humans, and makes no attempt to reflect the so-called ‘intrinsic value’ of nature or benefits to other species. Focusing only on benefits to society may lead to overlooking the non-anthropocentric benefits of nature conservation and to prioritising the protection of areas and environmental resources that are more directly used by humans over others with greater biological diversity. In fact, the concept of Natural Capital implies the existence of beneficiaries, and therefore a change in its value may be dependent on the population trends or on their perceptions and not necessarily on a change in the state of ecosystems or their flows. This implies that since the areas that are more pristine and rich in biodiversity tend to be located in less densely populated areas, the (monetary or non-monetary) valuation of ecosystem services cannot be taken as a measure of the quality of ecosystems. In addition, the Natural Capital approach may be seen as encouraging the commoditisation of nature (McCauley, 2006; Kosoy and Corbera, 2010; Mace, 2014).

Despite all these limitations, this concept can play an important political role in certain contexts, as it can help to shed light on the benefits that nature provides to human society; and consequently on the need for nature protection not only for moral reasons but also as a way to enhance human wellbeing and economy. As such, it can contribute to influence policy-making towards an improved environmental protection, besides acting as an environmental education tool for awareness building.

For all these reasons, the Natural Capital concept needs to be seen in conjunction with wider biodiversity and sustainability objectives: similarly, accounting needs to be used as a complementary tool to wider biodiversity and sustainability indicators. Furthermore, it is important to understand to what extent accounts do (or could) take into account different types of Natural Capital, changes in the quantity and state of the natural assets, and the flow of associated ecosystem services, so as to understand the meaning of the accounts and how to interpret the outputs. This is a moving target as guidance and methods develop, as new data becomes available, and as initiatives at national (and subnational), EU and global scale improve our practices, tools, understanding and results.

### Relevant initiatives for Natural Capital accounting at the global and European level

In recent years, there has been a growing interest in Natural Capital accounting, which is reflected by recent international, European and national initiatives and legislation.

At the international level, the Strategic Plan for Biological Diversity 2011-2020 includes the commitment to integrate biodiversity into national accounting (Aichi Target 2), and commitments to accounting are also included in various National Biodiversity Strategy and Action Plans (NBSAPs). Also, a communiqué was issued at the 2012 Rio+20 Conference, supported by the EU and 57 countries to encourage the development of Natural Capital accounting. In order to contribute to this process, the World Bank launched the Wealth Accounting and Valuation of Ecosystem Services (WAVES) Partnership, which aims to pilot methodological developments and experimentations with environmental accounts across the world[[2]](#footnote-2), building on The System of Environmental-Economic Accounting (SEEA) (see section 1.2 for details on SEEA). In addition, the CBD had developed guidance on Ecosystem Natural Capital Accounts (Weber 2014a), accounts have been developed for Mauritius (Weber 2014b), and a range of new initiatives are underway to support the development of accounts (e.g. TEEB initiative, supported by Norway), with plans to support NCA in Bhutan, Chile, Indonesia, Mauritius, Mexico, South Africa, and Vietnam[[3]](#footnote-3).

Finally, target 15.9 of the new Sustainable Development Goals for 2030 calls on signatories to “integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts”[[4]](#footnote-4) with a target date of 2020.

At the EU level, the first formal EU rules on environmental-economic accounting were established with Regulation 691/2011, which introduced the obligation for Member States to develop at least three kinds of accounts by 2013[[5]](#footnote-5): air emission accounts[[6]](#footnote-6) (in physical terms), accounts on environmental taxes[[7]](#footnote-7) (in monetary terms) and material flow accounts[[8]](#footnote-8) (in biophysical terms). The Regulation establishes that more modules can be added in the future[[9]](#footnote-9) to respond to key policy needs; following this, an amendment[[10]](#footnote-10) in 2014 added modules for environmental protection expenditures accounts, environmental goods and services sector accounts, and physical energy flow accounts.

The commitment to the development of physical and monetary environmental-economic accounts is also included in the 7th EU Environment Action Programme. In addition, the EU Biodiversity Strategy to 2020 requires Member States to map and assess the state of ecosystems and their services by 2014, and to assess their economic value and promote the integration of these values into accounting by 2020 (Target 2, Action 5). In order to meet these commitments, the initiative ‘Mapping and Assessment of Ecosystems and their Services’ (MAES), was established by the European Commission. MAES involves a consortium formed by the European Environment Agency (EEA), DG Environment and the Joint Research Centre (JRC), which work together with Member States to progress in the mapping, assessing and valuing of ecosystems and their services (see European Commission, 2013b, for the conceptual framework of the MAES process). It aims to contribute to the mapping and assessment of ecosystems and ecosystem services, in biophysical, and in a later stage possibly also monetary terms, by providing a coherent analytical framework to the EU and Member States, and includes a module on Natural Capital Accounting (see Chapter 2 for more details).

In addition, the EEA is currently developing experimental Ecosystem Capital Accounts (ECA), based on the available data at the European level. The ECA process does not aim to generate new data, but to integrate the available ones at the European level. In order to do so, all utilised data sets are transposed into a 1km2 grid across the entire area covered. The first experimental ECA will include land, organic carbon and water accounts.

Finally, other research projects are ongoing, including the inter-DG Knowledge innovation project on Accounting for Natural Capital and Ecosystem Services (KIP-INCA) [[11]](#footnote-11).

### Examples of Ecosystem Accounting in European countries

Ecosystem Accounting is still at an early, experimental, stage and only a few examples have been developed at the national level so far. However, there has been considerable progress since 2012 in Europe and globally. The UK in particular has developed work in conjunction with the Natural Capital Committee, an independent advisory body set up to advise the Government on the sustainable use of Natural Capital[[12]](#footnote-12). In addition, the UK Office for National Statistics, together with the Department for Environment, Food and Rural Affairs (Defra), has developed various Natural Capital Accounts[[13]](#footnote-13) including ecosystem accounts for woodlands and freshwater habitats, and “initial and partial” estimates of the aggregate monetary value of Natural Capital. Since 2013, the UK Office for National Statistics and Defra have published experimental accounts and methodologies of UK land use and land cover, woodland and freshwater ecosystems, and scoping studies for marine ecosystems and peatland[[14]](#footnote-14) (see section 2.3). France has regular forest accounts and is developing ecosystem accounts (EFESE), Portugal has been developing marine accounts and Germany is developing national accounts that build on the concept of landscape ecosystem capacity (e.g. for soil) and the Netherlands have developed a selected set of physical and monetary supply and use accounts for the Limburg Province for a selection, covering eight ecosystem services.

In addition, both UK and Spain have published National Ecosystem Assessments, which provide a snapshot of the ecosystems and the services they provide, both in biophysical and monetary terms.

## The system of environmental-economic accounting (SEEA)

The System of Environmental-Economic Accounting (SEEA) provides detailed methodological guidance on how to prepare environmental-economic accounts. The first version was published by the United Nations Statistics Commission (UNSC) in 1993, and it was recently subjected to a wide revision process, led by the UN Committee of Experts on Environmental-Economic Accounting (UNCEEA), a body consisting of countries and international agencies under the auspices of the UN Statistical Commission. The revised version includes three volumes, as summarised in Table 1.1.

SEEA-Central Framework (SEEA-CF) - Volume 1- includes the biotic and abiotic stock and flows that cross the boundaries between the environment and human economy. It also covers typologies of environmental-economic accounts that are not part of Natural Capital accounting, but can have a positive or negative impact on the Natural Capital, i.e., the environmental activity accounts, which include accounts for environmental protection expenditures, the environmental goods and services sector, environmental taxes and environmental subsidies. SEEA-CF provides standards for accounting that, when expressed in monetary terms, can be integrated into the System of National Accounts (SNA)[[15]](#footnote-15) (the international standard for national economic accounts).

SEEA-Experimental Ecosystem Accounting (SEEA-EEA) - Volume 2 - covers accounts of ecosystems and ecosystem services. This kind of accounts is still at an experimental level, and for this reason, SEEA-EEA does not provide an internationally agreed standard for Ecosystem Accounting, but only a discussion on the methodological options and challenges, and general guidance on how to structure and develop accounts. The accounts included in the SEEA-CF and SEEA-EEA are to a certain extent complementary, as accounts included in the former provide useful information to describe the pressures the economy exerts on ecosystems (e.g., through extraction of resources and releases of pollutants) and the latter can offer insight on the state of ecosystems that provide the natural resources recorded in the SEEA-CF accounts.

Volume 3, Applications and Extensions of SEEA, shows some applications of SEEA data for their use in policy making and research, such as the use of environmental indicators and the analysis of environmental taxes and subsidies. It also includes an overview of the methodologies that can be used with SEEA data, and in particular the Environmentally Extended Input-Output Tables, a discussion on the spatial disaggregation of SEEA data and an overview on possible extensions of the SEEA to cover specific sectors and topics.

**Table 1.1 The SEEA guidance manuals**

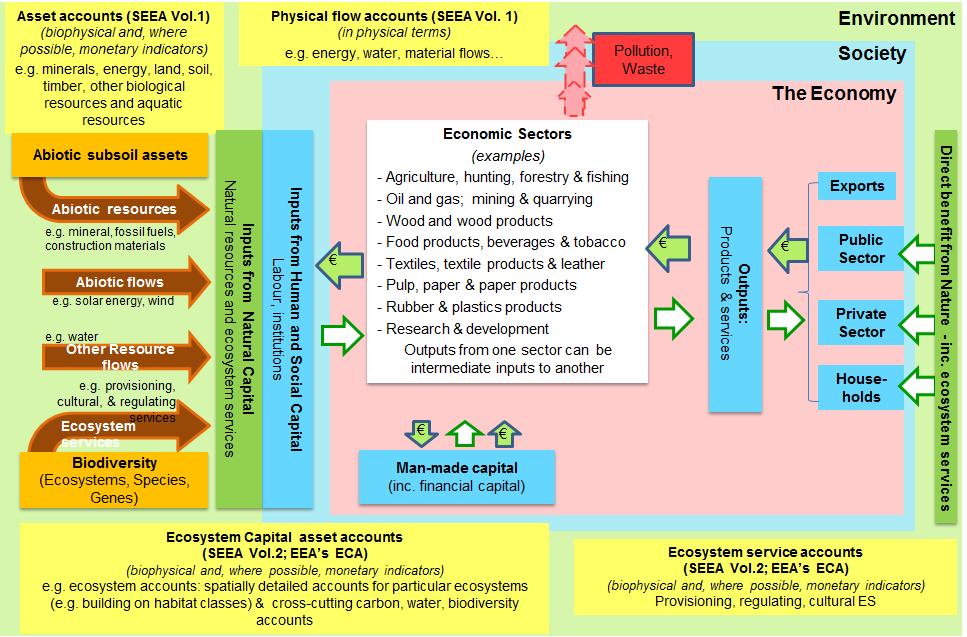
|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Publication** | **Year of publication** | **Scope** | **Standard** | **Possible integration into the SNA** | **Contents** |
| **Volume 1**  Central Framework (SEEA-CF) | 2012 | Stock of natural resources, flows of natural resources towards the economy, their contribution to the economy and the impacts of economic activities on them. | Yes | Yes | 1) Accounts of **flows** in physical terms for energy, water, material flows, air emissions, waste water and solid wastes.  2) Accounts of **assets** (in physical and monetary terms) for mineral and energy resources, land, soil resources, timber resources, aquatic resources, other biological resources and water resources.  3) **Environmental activity accounts** and related flows for environmental protection expenditures, the environmental goods and services sector, environmental taxes and environmental subsidies, in monetary terms.  4) **Combined physical and monetary accounts,** which provide the framework for the derivation of indicators such as resource efficiency and productivity. |
| **Volume 2**  Experimental Ecosystem Accounting (SEEA-EEA) | 2013 | The condition of ecosystems and the flows of ecosystem services. | No | No | 1) Accounting for **ecosystem services** in **physical terms.**  2) Accounting for **ecosystem assets** in **physical terms** (**carbon** and **biodiversity accounts** illustrated more in detail).  3) **Main challenges** and **methodological options** for the **monetary valuation** of ecosystems and ecosystem services. |
| **Volume 3**  Applications and Extensions of SEEA | 2014 | Guide to the use of SEEA-based data in decision making, policy review and formulation, analysis and research. It includes the most common applications of the SEEA and possible extensions. | No | No | 1) **Applications** of SEEA data, including the use of environmental indicators; the analysis of resource use and environmental intensity; the analysis of production, employment and expenditures relating to environmental activities; analysis of environmental taxes and environmental subsidies and similar transfers; analysis of environmental assets, net wealth, income and depletion of resources.  2) **Analytical techniques**: Environmentally Extended Input-Output tables (EE-IOT) and techniques for the analysis of input-output data (multiplier analysis; attribution of environmental pressures to final demand; decomposition analysis; computable general equilibrium analysis).  3) **Extensions of the SEEA**, including spatial disaggregation of SEEA data, extensions of SEEA to the household sector and to present environmental-economic accounts by theme (applied to the tourist sector as an example). |

Source: own elaboration, based on the SEEA guidance manuals

Interestingly, whereas the MAES initiative and the European Environment Agency use the term “Ecosystem Capital Accounts” to define accounts covering both ecosystems and ecosystem services, in the context of SEEA, the wording “Ecosystem Accounts” is adopted, in order to underline that SEEA-EEA covers not only assets, but also flows. This deliverable will adopt this convention.

Figure 1.2 provides a general overview of the different kinds of environmental-economic accounts and the role they can play in collecting and systematising the interactions between nature, society and the economy. The asset accounts included in the SEEA-CF measure the stock of certain components of Natural Capital (e.g. fossil fuels, minerals, timber, land) - generally in biophysical terms, but biophysical indicators can also be complemented by monetary information, if appropriate and where methodologies and data allow. The flow accounts included in SEEA-CF cover the flows of natural resources from the environment to the economy (i.e. inputs) as well as from the economy to nature (i.e. waste, water pollution and air pollution). SEEA-EEA accounts include both assets (ecosystem accounts) and physical and other flows into the economy (ecosystem services).

**Figure 1.2 Environmental-Economic accounts and Natural Capital**



Source: adapted by ten Brink from Russi and ten Brink, 2013

In principle, therefore, environmental accounting should be able to integrate a wide set of Natural Capital stocks as well as flow of ecosystem services. In practice, data availability, limitations or lack of agreement on methods means that only limited components of Natural Capital and ecosystem services are recorded in Natural Capital accounts, with only a subset of issues represented in monetary terms. This underlines again the need to see the results of accounts in perspective of what they integrate and how.

## Status of integration of Natural Capital and Ecosystem accounting in actual accounting practice

While Figure 1.2 provides a comprehensive overview of the different components of Natural Capital and ecosystem services, there exist constraints as regards the implementation of the concept. Some components of Natural Capital can be captured relatively well, as data is generally available and the accounting units are accessible to observation (even though the methods of measurement undergo constant improvement). Among these are for example water quantity, carbon stocks in vegetation and soils, fish resources, or the extent of ecosystems (mostly measured by land accounts). For other components of Natural Capital stocks, such a stock-taking appears possible in principle, but is constrained by data availability and an incomplete understanding of the natural biophysical and ecological processes underpinning the maintenance of Natural Capital and the production of ecosystem services. Once the data and natural scientific foundations are improved, such analyses will be possible, for example about the overall state of land ecosystems.

Similar considerations apply to capturing the flow of ecosystem services. Some services such as the production of fish or local recreational values of landscape can be assessed with existing data and methods. In some cases like the services provided by wild pollinators, this is possible today, but an improved data basis is needed.

However, some aspects of Natural Capital are very difficult to capture, due to the characteristics of some of the stocks and flows. Marine ecosystems and water quality are examples of Natural Capital stocks that are difficult to capture in an accounting framework. In some cases, available methods do not allow reliable estimates at all, such as the complexity of ecosystems or the pool of genes.

Table 1.2 provides an overview of the level of feasibility of different kinds of Natural Capital accounts

**Table 1.2 Feasibility of Economic Accounting for Natural Capital Stocks and Flows**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Not covered or not possible to cover** | **Less well covered and/or difficult to address by national accounts** | **Partially covered by national accounts and/or in principle possible over time** | **Currently well covered by national accounts** |
| **Ecosystems as stock** | Biodiversity of ecosystems, species and genes (in biophysical terms) – *too complex to integrate in accounts* | Marine ecosystem condition (in biophysical terms) | Terrestrial ecosystem condition- *via different ecosystem types and land cover data (in biophysical terms)* | Extent of most ecosystems in biophysical terms (land use by hectare) |
| Forest accounts in biophysical terms (timber stocks) |
| Water quality –*information* *exists in the River Basin Management Plans (in biophysical terms)* | Carbon in vegetation and soils in biophysical terms (tonnes) | Agricultural accounts in biophysical terms (land use by hectares) |
| Fish stock accounts (in biophysical and monetary terms) | Water stock accounts in biophysical terms (cubic metres) |
| **Flow of Ecosystem Services** | A range of supporting Ecosystem Services (in biophysical terms) – e.g. soil formation | Locally important regulating services such as water purification (in biophysical terms) - *some information exists in local studies, but not in accounts* | Contribution to crop production by wild pollinators (in biophysical and monetary terms) | Timber harvests in biophysical and monetary terms |
| Regulation of water flow and soil erosion mitigation (in biophysical terms) |
| Regulation services related to punctual events, e.g. natural hazards regulation (in monetary terms) - *as difficult to assess value of avoided impacts and which element relates to ES* | Tourism and recreation opportunities in terms of number of visits and in monetary terms | Agricultural production in biophysical and monetary terms |
| Fish landing in biophysical and monetary terms |

*Source: own elaboration.*

Brouwer et al. (2013) prepared a review of EU MS ecosystem service national assessments and found that most studies cover different kinds of provisioning, regulating, cultural and (in some cases) supporting ecosystem services, but only a small subset of them use monetary valuation methodologies to assess the ecosystem services. The study found that most provisioning services are or will be valued using market prices, and most regulating services using methodologies based on costs, where possible. Monetary valuation of cultural ecosystem services is much more complicated, because of methodological challenges, lack of data, lack of resources to conduct original valuation studies and also criticisms towards the use of monetary nonmarket valuation in some of the countries. However, the UK National Ecosystem Assessment Follow-on (2014) found that quantitative physical indicators of cultural ecosystem services can be developed using publicly available datasets.

## Challenges for the development of Ecosystem Accounts

Ecosystem Accounts are still at an early stage of development, and, as explained above, only a few pilot experiments have been developed so far. This is partly due to a range of challenges that still need to be addressed.

One important challenge regards **data availability**. For many ecosystems and ecosystem services, significant data gaps represent an obstacle to the development of reliable accounts. In some cases, data may be available at a different scale than the one required for accounting, and therefore models and approximations need to be used. Also, it should be taken into account that data on some key ecosystems and ecosystem services may be very location specific, and for this reason they need to be translated into indicators relevant at the scale at which the accounts are developed, through an aggregation and extrapolation process. In some cases, accounts are compiled on the basis of a mixture of empirical data and outcomes of modelling exercises and in these cases data obtained through modelling should be compared, if feasible, with measurements taken in situ, in order to verify their robustness and reliability. It is important to remember that not all ecosystem services can be covered in Ecosystem Accounts, due to lack of data and methodological difficulties.

Another challenge to be addressed is the development of a coherent and agreed-upon **conceptual framework, methodology and definitions**. SEEA-EEA represented an important step in this sense, but since Ecosystem Accounting is still at an early stage, Volume 2 does not provide standards. For some of the most controversial topics, as for example monetary valuation, SEEA-EEA only offers an overview of the available methodologies and alternative definitions. The need for the development of a common vision on concepts and definitions is even more needed since many different typologies of experts are needed to develop and discuss accounts, including statisticians, economists, ecologists and hydrologists.

The **monetary valuation** of ecosystem services faces multiple methodological challenges due to the fact that many ecosystem services are not transacted in the market and for this reason do not have market prices. For this reason, economists have proposed three categories of methodologies to be used for monetary valuation of ecosystem services (see White et al., 2011; Chapter 4 in ten Brink (ed.), 2011; Chapter 5 in Kumar P. (ed.), 2010; Brouwer et al., 2013; SEEA Central Framework, Chapter 5; OPERAs deliverable 3.2):

1. Methodologies based on **costs**, which use market prices to indirectly estimate the monetary value of ecosystem services. Examples include methodologies based on the avoided costs, such as the economic damage from floods by managing floodplains in a sustainable way; methodologies based on the replacement cost, such as the cost of mechanical purification of water, which is needed to replace natural water purification provided by healthy ecosystems; and methodologies based on the restoration costs, which are the cost of restoring a degraded ecosystem.
2. Methodologies based on **revealed preferences** estimate values based on the preferences of individuals, shown by their behaviour. Examples are the Travel Cost Method and the Hedonic Pricing Method.
3. Methodologies based on **stated preferences** such as Contingent Valuation and Choice Experiments use the preferences that are directly stated by people through surveys. They investigate people’s willingness to pay (WTP) for improved environmental conditions or their willingness to accept (WTA) compensation for a reduction in environmental quality.

Also, since monetary valuation studies are time and resource intensive, in many cases monetary values already calculated elsewhere for similar ecosystems are used. This procedure is called “**value (or benefit) transfer**” and needs to be carried out very cautiously because the provision of ecosystem services are often location-specific.

There is an on-going debate as to whether to use methodologies based on costs, which employ market prices to indirectly estimate the monetary value of ecosystem services (e.g., estimates of the avoided economic damages from floods ensured by sustainable floodplain management or estimates of avoided water pre-treatment costs for municipal drinking water provision) or methodologies based on revealed or stated preferences, based on for example on surveys that investigate people’s willingness to pay for improved environmental conditions (Brouwer *et al*., 2013). These two approaches give different information, as revealed and stated preferences methodologies are based on the measurement of changes in individual welfare, whereas accounts are based on the exchange value. This implies that only the first ones include the consumer surplus (i.e., the difference between the price consumers are willing to pay for a good or service and the market price) (see Chapter 3 for a discussion on this topic). In general, cost benefit analyses include the consumer surplus in the monetary valuation of environmental goods and services, but this is not coherent with the SNA approach, which is based on market prices. This point is currently debated among experts.

For example, Weber (2011) states that for environmental accounting monetary valuation should be carried out on the basis of restoration costs[[16]](#footnote-16) because he considers monetary valuation methodologies based on stated or revealed preferences as incompatible with environmental accounting, the reason being that they are based on subjective evaluations. On the contrary, there are also arguments that restoration and replacement costs should not be used as proxies for the economic value of ecosystem services because ecosystem service values should reflect the change in the stakeholders’ wellbeing due to a marginal change in the provision of ecosystem services, which is not dependent on what is arguably the exogenous cost of restoration. Moreover, restoration costs reflect technological ability rather than the value of an environmental asset: if a technology is developed that reduced restoration costs by 50%, it does not necessarily follow that the value of the asset has also been cut by half.

SEEA-EEA allows both categories of valuation methodologies to be used (i.e., the ones based on preferences and including the consumer surplus and the ones based on costs), but warns that if methodologies based on preferences are used, some adjustments need to be done (e.g. using shadow prices) (see SEEA-EEA, Chapter 5 for more details on this discussion).

A ‘third way’ option is provided by the concept of ‘simulated exchange values’ (Caparrós Gass and Campos Palacín 2009; Oviedo et al., 2010) which estimates the value of ecosystem services in terms of potential revenue if a market were to exist (see Chapter 3 for a discussion on advantages and weaknesses of this approach).

Other related issues of monetary valuation are whether and how to aggregate results obtained with different methodologies and how to scale up results obtained through valuations at the local level. In general, if different methodologies are used for monetary valuation (such as in the UK NEA), the outcome values of different ecosystem services may not be fully comparable (as they may measure different things) or additive.

Another problem related with monetary valuation based on stated or revealed preferences is the fact that people may not be aware of the ecosystem services they benefit from (typically in the case of regulating ecosystem services). For this reason, stated preference techniques should arguably only be used for end-services (though values for regulating services can be derived from valuation based on stated preferences for end-services, e.g. benefits of reduced flood risk can shed light on regulating services of flood control).

Also, the high costs related to data collection and processing usually represent an obstacle for monetary valuation to be used in Ecosystem Accounting. Furthermore, though experts agree on the principle of discounting and the formula to be used, they do not agree on how to derive the parameters (Arrow et al, 2013), and therefore do not agree on the discount rate to be used for the valuation of natural resources[[17]](#footnote-17).

Finally, **gaps in the scientific evidence base** regarding the key biophysical and ecological processes that replenish Natural Capital and generate ecosystem services remain a key challenge for environmental accounting.

In summary, many challenges as regards the use of monetary valuation in Ecosystem Accounting remain and they may explain why monetary valuation is not currently used in practice to inform policy making (Laurans et al. 2013) or to establish PES and other economic tools used for environmental management (Liu et al., 2010). For this reason it is important to manage expectations and find a balance between the demand for quick and easy indicators and for more detailed, time-intensive kind of accounts. It is also key to be transparent as to what accounts cover and clear on how to interpret the results.

# Ecosystem Accounting through biophysical indicators

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## Introduction

Ecosystem accounting can be carried out in biophysical terms and also, in principle, in monetary terms (see Chapters 1 and 3). This chapter summarises the guidance on Ecosystems Accounts provided by the System of Environmental-Economic Accounting (SEEA) process and the progress at the European and national level, based on the available published material, the results of the MESEU (Mapping of Ecosystems and their Services in the EU) workshop and the KIP-INCA meeting held in Brussels in July 2015 and April 2016, and a survey addressed to the relevant national bodies, which has been answered by experts from the UK, Germany, the Netherlands, Sweden and Spain.

## Ecosystem accounting in physical terms

As explained in Chapter 1, the System of Environmental-Economic Accounting (SEEA) is the result of an initiative lead by the United Nations Statistics Commission (UNSC) aiming at providing an internationally agreed and detailed methodological guidance to prepare Environmental and Ecosystem Accounts.

SEEA-Central Framework (SEEA-CF) represents a very detailed standard on Environmental-Economic Accounting, whereas SEEA-Experimental Ecosystem Accounting (SEEA-EEA) provides a general guidance on how to structure and develop Ecosystem Accounts, including an overview of the main methodological options and main challenges. A separate, more detailed SEEA manual was published in 2012 for Water Accounts, whereas SEEA-Energy and SEEA Agriculture, Forestry and Fishery (SEEA-AFF) are currently in preparation.

Both SEEA-CF and SEEA-EEA include biophysical indicators for ecosystems and ecosystem services. **SEEA-CF** covers accounts of assets (i.e. stocks) in physical and monetary terms for:

1. Mineral and energy resources
2. Land,
3. Soil resources,
4. Timber resources,
5. Aquatic resources,
6. Other biological resources and
7. Water resources.

And accounts of flows in physical terms for:

1. Energy,
2. Water,
3. Material flows,
4. Air emissions,
5. Waste water and
6. Solid wastes

**SEEA-EEA** covers accounting for ecosystem services and ecosystem assets in physical terms, and develops carbon and biodiversity accounts in more detail.

The accounts included in SEEA-CF and SEEA-EEA are to be seen as complementary, and together they can contribute to provide a picture of the state of the ecosystems and the flows of ecosystem services they provide. The accounts covered by SEEA-CF include information on key factors that influence ecosystems and ecosystem services, whereas SEEA-EEA focuses on describing more specifically the conditions of the ecosystems and the flows of ecosystem services they provide. For example, the variation recorded in the timber accounts over time, included in SEEA-CF, can provide an indirect indication of the state of forest ecosystems. And water accounts, also included in SEEA-CF, collect and systematise information on one of the most important elements that influences the state of ecosystems and the related flow of ecosystem services. In general, EEA-EEA looks at Natural Capital more holistically than SEEA-CF. For example, whereas the woodland accounts included in SEEA-CF cover the timber only, the SEEA-CF include a wide range of ecosystem services provided by forest areas.

Ecosystems Accounts in SEEA-EEA cover both **ecosystem assets** and the flow of **ecosystem services**. As regards the first ones, SEEA suggests that accounts are based on Basic Statistical Units, which are spatially detailed and determine the type of ecosystems and the extent of these ecosystem types, and should be used to build the biophysical models for ecosystem services. However, in practice other sources of information (such as sample surveys) are also used to complement them. For example, in the UK accounts are built combining data from the Land Cover Map, from the Countryside Survey, the National Forest Inventory and Agricultural Census sources. The use of multiple, non-integrated and (in some cases) sampled data sources can be problematic, but it avoids some major issues about the reliability of estimates at the local level and consistency with national estimates.

Ecosystem assets are measured in terms of **ecosystem extent** and **ecosystem condition**. In general, the **ecosystem extent** tend to be measured using data on land cover to distinguish between areas covered by different types of ecosystems (e.g. forests, wetlands, grasslands) and assess the changes therein[[18]](#footnote-18). However, for some ecosystems land cover data are not reliable and cannot distinguish ecosystem types. For this reason, integrated approaches tend to be used, covering both land cover and ecosystem functional units. For example, in the Netherlands a combination of land cover (for agricultural land), economic use (for paved areas) and specific regional functions (dune areas, river floodplains) is used.

**Ecosystem condition** is measured using a set of key characteristics of ecosystems like carbon, water, nutrient flows, vegetation, or proxies like, for example, the presence of key species, or potentially partial proxies in the form of designations such as Forest Stewardship Council (FSC) certificates, organic agriculture, high nature value (HNV) farmland. The former characteristics are measured through indicators that are then related to a reference condition, which in most cases refer to a target representing a good ecological status of a given ecosystem. When considered as a target, it refers to conditions allowing for the maintenance of the ecosystem health, the resilience of the system to natural disturbances, and the capacity for maintain ecosystem services

Each ecosystem can also be measured using different indicators of key characteristics (e.g. for water bodies, water flows, concentration of pollutants and changes in key fish species). For this reason, SEEA-EEA suggests to develop a number of **basic resource accounts[[19]](#footnote-19)** as a basis for the development of accounts on ecosystem conditions, including land accounts, carbon accounts, water accounts, soil and nutrient accounts, forest accounts and biodiversity accounts, many of which are covered in SEEA-CF (Chapter 5). For example, accounts of opening and closing stocks of water resources, timber resources and carbon and biodiversity can provide valuable information for ecosystem accounts. In particular, land accounts can play an important role as a basis to generate Ecosystems Accounts. For example, the European Environmental Agency is using the EU Corine Land Cover (CLC) database as a basis for its Simplified Ecosystem Capital Accounts (SECA). However, the basic resource accounts can only indirectly be used to assess ecosystem conditions by combining different relevant data on ecosystem characteristics.

As regards the flow of **ecosystem services**, they can be measured in physical terms using a variety of indicators and unit of measurements, depending on their physical characteristics and the service provided (e.g. tonnes of agricultural products, joules of bioenergy and cubic metres of water, tonnes of carbon stored in a forest, number of visitors in a protected area), as shown in Table 2.1.

**Table 2.1 Physical flows of ecosystem services for a specific area (e.g. an EAU**[[20]](#footnote-20)**, a National Park or a catchment area)**



Source: SEEA-EEA (2014)

In general, SEEA-EEA suggests special effort should be dedicated to the two areas of water and carbon accounting, as water and carbon are key characteristics of all ecosystems, and are able to provide a (very general) indication on the state of ecosystems and on several of the services they provide. As regards water accounts, this includes not only water quantity accounts (i.e. the provisioning service of fresh water) but also accounts covering other key ecosystem services (e.g. the regulating ecosystem service of water purification). As regards water quality accounts, there is still little standardisation on the choice of metrics to be used and the threshold levels to define quality classes and the measurement methodologies. For this reason, different countries tend to use different indicators, based on their specific problems and needs, but water quality accounts have not been developed yet in an integrated and systematic way (Russi and ten Brink, 2013).

The development of Ecosystems Accounts may require particular ecosystem assets and flows to be prioritised for inclusion and measurement, depending on data availability, political priorities and policy needs, characteristics of the area and methodological challenges related e.g. to scaling up and aggregating. This prioritisation exercise needs to be carried out with caution, because prioritising indicators with the highest data availability may result in a bias against the less analysed ecosystems, which may be characterised by a high level of biodiversity and provide valuable ecosystem services.

Ecosystems Accounts will benefit if developed in a **spatially explicit way** using, for example, geographic information systems (GIS). Geo-spatial analysis re-organises existing data according to standard geographical classifications, resulting in maps that visualise the state of ecosystems or the flows of ecosystem services they provide. Spatial accounts tend to require a large amount of data and a considerable amount of work, but they are a promising approach and have an important potential to be explored, both for analysis and for policy making (see Chapter 4). For example, they can be used to set priorities and to better identify environmental pressure points by seeing at a glance where intervention is mostly needed. This kind of approach can provide very valuable information because national averages can hide important differences in the level of stocks and flows in different locations, and the environmental importance of an ecosystem or an ecosystem service is closely related to its location. For this reason, information about the localisation of key ecosystems and ecosystem services can have high policy relevance. Also, spatial accounts can provide information on flows of ecosystem assets or services across different spatial areas, like for example carbon and water.

As explained by Schröter et al (2014), spatial models need to meet the following requirements in order to be used in ecosystem accounting: 1) they need to be based on measurable indicators that are representative for the ecosystem services to be modelled; 2) they need a high resolution that is sufficient to capture spatial variability of ecosystem services; 3) they need to ensure sufficient accuracy to be incorporated in an accounting framework. Many spatial models can be used for ecosystem accounting (see, for example, Schröter et al (2014), who reviewed 29 different models that are used in accounting exercises).

Spatial accounting for ecosystem services is still in the early development phase and many data are still not available in spatially explicit way (Heink et al., 2015). Moreover, many maps are still difficult to compare and combine (Jacobs et al 2015).

## Initiatives, processes and examples of ecosystem accounting in biophysical terms

### EU initiatives and processes

As explained in section 1.1, the EU Biodiversity Strategy (COM/2011/0244 final) established the commitment to map and assess the state of ecosystems and their services in all Member States by 2014 and to promote the uptake of their economic value into accounting and reporting systems at EU and national level by 2020 (Target 2, Action 5). In order to reach this aim, the EU Commission established the Mapping and Assessing Ecosystem Services process (MAES). MAES involves a consortium formed by the European Environment Agency (EEA), DG Environment and the Joint Research Centre (JRC), which work together with Member States to progress in the mapping, assessing and valuing of ecosystems and their services (see European Commission, 2013b, for the conceptual framework of the MAES process). In this context, the process of mapping and assessing the EU ecosystems and their conditions was led by the EEA and resulted in a collection of available data on pressures on ecosystems and ecosystem conditions, a European ecosystem map, a collection of information on habitats to be used to map the distribution of ecosystem types across Europe and, finally, a map of the ecosystem condition carried out by combining the ecosystem maps with environmental monitoring data (European Environment Agency, 2015)[[21]](#footnote-21).

The process of mapping and assessing the EU ecosystem services was led by JRC and resulted in a study on the trends in the ecosystem services in the EU based on 30 indicators, which were built using global and European land cover and land use datasets (JRC, 2015)[[22]](#footnote-22).

Finally, DG Environment established a three-year contract study called MESEU (Mapping of Ecosystems and their Services in the EU) to support the MAES process, using case-studies in the Member States and a survey on the status of MAES implementation in each MS[[23]](#footnote-23).

The DG RTD also funded the ESMERALDA project[[24]](#footnote-24) (enhancing ecosystem services mapping for policy and decision making), which builds on existing ecosystem services projects and databases (e.g. MAES, MESEU, OpenNESS, OPERAs, and national studies) to develop flexible mapping approaches which integrate biophysical, social and economic assessment techniques.

### National initiatives and processes

At the national level, only a few countries have completed and integrated mapping exercise of ecosystem services so far, including the UK and Spain (see Boxes 2.1 and 2.2). At a regional level, this has been carried out in Flanders (see Box 2.3). In France, a nation-wide appraisal of ecosystems and their services in underway

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| **Box 2.1 The UK National Ecosystem Assessment**  The UK National Ecosystem Assessment (UK NEA) was published in 2011 and covered terrestrial, freshwater and marine ecosystems of eight broad habitats, i.e. 1) Mountains, moorlands and heaths (18% of the UK’s land area); 2) Semi-natural grasslands (high diversity grassland, which comprises ≥ 1% of total land area); 3) Enclosed farmland (40% of land area); 4) Woodlands (12% of land area); 5) Freshwaters (open waters, wetlands and floodplains); 6) Urban (7% of the land area); 7) Coastal margins (0.6% of land area); 8) Marine (more than three and half times the land area)    The UK-NEA included a two years follow-on phase, which was finalised in 2014 and included work on economic valuation of ecosystem services, further analysis on cultural ecosystem services, research on future changes in ecosystems and the development of tools and other supporting materials. All reports produced by the UK-NEA process can be found in the UK-NEA webpage (<http://uknea.unep-wcmc.org>). |

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| **Box 1.2 The Spanish National Ecosystem Assessment**  The Spanish National Ecosystem Assessment (EME, from its name in Spanish: “Evaluación (de ecosistemas) del Milenio de España”) is an ambitious assessment exercise of the Spanish ecosystem services. It was structured following the categories proposed by the Millennium Ecosystem Services, i.e. provisioning, regulating, supporting and cultural ecosystem services. Table 2.2 shows the 22 ecosystems services covered by EME, which were assessed over 14 kinds of Spanish ecosystems: sclerophyllous scrub and forests; continental Mediterranean forests and scrub; Atlantic forests; Alpine forests; Mediterranean mountains; arid areas; ecosystems in the Canary Islands; agroecosystems; marine ecosystems; rivers and riparian areas; lakes and internal wetlands; aquifers; coastal ecosystems; urban ecosystems.  **Table 2.2 Ecosystem services included in the Spanish National Ecosystem Assessment**   |  |  |  | | --- | --- | --- | | **Provisioning ecosystem services** | **Regulating ecosystem services** | **Cultural ecosystem services** | | 1. Food | 8. Climate regulation | 16. Scientific knowledge | | 2. Fresh water | 9. Regulation of air quality | 17. Local ecological knowledge | | 3. Biotic primary resources | 10. Hydrological regulation | 18. Cultural identity and sense of belonging | | 4. Geological primary resources | 11. Erosion control | 19. Spiritual and religious enjoyment | | 5. Renewable energy | 12. Soil fertility | 20. Esthetical enjoyment of landscapes | | 6. Gene pool | 13. Regulation of natural perturbations | 21. Recreational activities and ecotourism | | 7. Natural medicine and active principles | 14. Biological control | 22. Environmental education | |  | 15. Pollination |  |   The analysis was performed using five case studies at different spatial scales: national scale, regional scale (Biscay region); ecosystem scale; river basin scale; detailed scale (case studies on Doñana natural park and transhumance in the Real Conquense glen).  The assessment was carried out using more than 400 indicators, aiming at evaluating the change in the human use of the ecosystem services and the change in their state, and covering the period between 1960 and 2010.  The results were used as a basis for the economic valuation of 12 ecosystem services, using market-based, stated preferences and participatory scenario methodologies.  The results of the EME process are uploaded in the dedicated webpage, <http://www.ecomilenio.es>. |

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| **Box 2.3 the Flanders Ecosystem Assessment**  Flanders, the northern region of the Belgian federal state, has seen a surge in ecosystem services projects and networks during the last 6 years (Segers *et al.* 2013), resulting in a ‘Flanders Regional Ecosystem Assessment’ (Flanders-REA, Stevens *et al.* 2015).  The technical report of Flanders REA was authored by an interdisciplinary team from different research institutes, agencies and administrations. Flanders REA consists of 16 ecosystem services chapters by specialist author teams, preceded by 10 overarching analysis chapters. Intensive editing framed the variety of ecosystem service types and author styles into a flexible yet comparable conceptual framework and provided a reporting structure geared towards regional policy-relevant research questions. All chapters, maps and reports are publicly available on [www.nara.be](http://www.nara.be).  **Table 2.3 Trends in ecosystem service supply and demand, supply-demand balance and state assessment for 16 ecosystem services in Flanders.**  Reporting on the state of ecosystem services was based on a transparent and traceable meta-review methodology of the ecosystem service reports, including quantification of reliability. Assessment of the state of an ecosystem service relates to four aspects: the trend in demand, the trend in supply, the balance between demand and supply and the impact of ecosystem services use on other services. This required capturing information from all available information sources (statements, model results, measurements data, expert judgments, arguments, case studies and maps) within the 16 ecosystem service chapters. Only a minority consists of validated quantitative models, and about 40% of the information sources underpinning the assessment are mapped data. The main data gaps are situated in the ecosystem function, drivers and governance aspects of the assessment (Figure 2.1). Data availability varies between components of the assessment framework (left panel), varies over different data types (as defined by Schägner et al. 2013, lower tight panel) and between mapped versus non-mapped data (upper right panel).  **Figure 2.1 Data sources and availability for the Flanders ecosystem account exercise**  Source: Jacobs et al., (2015) |

The ecosystem assessment exercises described in the previous section can be seen as a first step to develop Ecosystems Accounts. They both provide information that can feed into accounts, and, where accounts are developed in a spatially explicit way with sufficient resolution, could also provide a type of snapshot of results that accounts could develop. With regular updates this could also allow trends over time to be monitored.

The process of building Ecosystems Accounts is ongoing both at the EU and at the national level. At the EU level, the EEA is currently preparing Simplified Ecosystem Capital Accounts (SECA), which include four kinds of accounts, i.e. organic carbon accounts, which cover the carbon included in biomass and soil, water accounts, landscape/species accounts and land accounts. These accounts are being developed only in physical terms, because of the additional methodological challenges and uncertainties that a monetary accounts would imply (see Chapter 3). In the future, other accounts may be added, like for example fish accounts or nutrient accounts. SECA is being compiled with a spatial resolution of a 1km2 grid, based on available datasets and statistics at the EU level[[25]](#footnote-25).

Also, some EU countries have started developing different kinds of Ecosystems Accounts at the national level. For example, in the UK initial accounts for woodland and freshwaters have been published, together with a pilot study on peatlands, and planned work for coastal margins and farmland for the near future peatlands [see Box 2.4 and 2.5]. In Germany, water, carbon and forest accounts have been already developed[[26]](#footnote-26), and a set of ecosystem services indicators is being developed, which consider separately the supply and use of ecosystem services[[27]](#footnote-27). Also, in Sweden reports on water and forest statistics have been developed (see Statistic Sweden, 2001 and 2013). France is developing national-scale accounts for land cover, ecosystems, water and carbon.

In general, these accounts are not developed in a spatially explicit way because developing spatial explicit accounts at the national level implies the need for a high amount of detailed data and human resources. However, some first attempts to develop spatially explicit accounts at regional level have already being developed. For example, experimental spatial biophysical accounts were developed for the province of Limburg, in the Netherlands (see Box 2.6).

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| **Box 2.4 Ecosystem accounts for woodland in the UK**  In the UK, the Office for National Statistics published woodland ecosystem accounts based on a number of initial papers[[28]](#footnote-28) and some development work for Defra in 2015 (eftec, 2015a). They include: a physical account (condition and extent of the stocks), an account for ecosystem service flows, and a monetary account (presenting values for the stocks and flows). The elements of the eftec report concern:  1) Ecosystem Accounting Unit (EAU): accounts prepared for Great Britain, and (in greater detail due to better data) for the Public Forest Estate (PFE) in England;  2) Land cover/ecosystem service unit: woodland with a focus on – timber provision, carbon sequestration, recreation and water flow regulation;  3) Basic spatial unit: 1km2 either through detailed spatial units or through disaggregation of national/regional data.  For every ecosystem service considered here, a methodology in 5 steps has been implemented to create the different accounts:   1. Selection of ecosystem services (listed above); 2. Development of logic chain models to specify the productivity of the ecosystem and the provision of services (based on a review of evidence/literature about the link between ecosystem assets and the benefits for society); 3. Gathering of physical data for the physical stock account; 4. Gathering physical data and/or ecosystem service models for the physical flow account; 5. Identifying valuation evidence for the monetary stock and flow accounts.   Flows of timber production are far from constant for any given area, due to long forest production cycles. For accounting, the profile of flows over 20 years is based on “constant flow” assumption averaged over areas. In reality this service flow in the future will depend on economic and environmental conditions and woodland management, but full analysis of possibilities would be difficult to incorporate in accounting. An assumption has also been made about the age of harvested (between 40-60 and 80-120 years for conifers and broadleaves respectively). For more details on time horizon, see Chapter 3.  These assumptions meant that that the results at an aggregate (UK) level were not consistent with nationally available estimates. Hence, the estimates published by the Office for National Statistics are somewhat different to those developed at a spatially-disaggregated level. A number of other revisions to the methodological approach have also been made:  **Table 2.4 Physical account of ecosystem extent (stock) for UK woodland**   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | |  |  |  |  |  | *Thousand hectare* | | **Species type** | **Conifers** | | **Broadleaves** | | **Total** | | **Ownership** | **Public** | **Private** | **Public** | **Private** | | Opening stock as at 1 April 2014 | 742 | 866 | 129 | 1402 | 3,138 | | Additions to stock |  |  |  |  |  | | *Total additions to stock* | 0.3 | 2.3 | 0.1 | 7.6 | 10.3 | | Reductions in stock |  |  |  |  |  | | *Total reduction in stocks* |  |  |  |  |  | | Balancing item | 0.7 | 2.7 | -0.1 | 2.4 | 6.7 | |  |  |  |  |  |  | | Closing stock as at 31 March 2015 | 743 | 871 | 129 | 1412 | 3,155 |   Source: <http://www.ons.gov.uk/ons/rel/environmental/uk-environmental-accounts/2015/stb-environmental-accounts-2015.html#tab-Woodland-ecosystem-asset-and-services-accounts>  **Table 2.5 Physical account of ecosystem service provision (flow) for UK woodland**   |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | | Biomass for timber (million cubic metres overbark standing) |  |  |  |  |  |  |  |  |  |  | | *- Softwood removals* | *10.0* | *9.9* | *10.1* | *10.7* | *10.1* | *10.3* | *11.3* | *12.3* | *12.3* | *13.4* | | *- Hardwood removals* | *0.6* | *0.7* | *0.5* | *0.5* | *0.5* | *0.6* | *0.6* | *0.6* | *0.6* | *0.6* | | Total timber removals | 10.5 | 10.5 | 10.6 | 11.2 | 10.5 | 10.9 | 11.9 | 12.9 | 12.9 | 14.0 | |  |  |  |  |  |  |  |  |  |  |  | | Carbon sequestration (million tonnes carbon dioxide equivalent) | 18.2 | 18.3 | 18.1 | 18.0 | 17.8 | 17.6 | 17.7 | 17.6 | 16.6 | 16.9 | |  |  |  |  |  |  |  |  |  |  |  | | Recreation (million visits to woodland) |  |  |  |  |  | 482 | 495 | 544 | 542 | 574 |   Source: <http://www.ons.gov.uk/ons/rel/environmental/uk-environmental-accounts/2015/stb-environmental-accounts-2015.html#tab-Woodland-ecosystem-asset-and-services-accounts> |

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| **Box 2.5 Marine ecosystem accounts in the UK**  Building marine ecosystem accounts face several challenges such as the lack of good habitat maps, the mobility of the different species within the ecosystems/habitat, lack of data, and uncertainties about current and future ecosystem dynamics (such as fish stock recovery). In the UK, eftec developed a scoping study for Defra about how marine ecosystem accounts can be developed in the UK (eftec, 2015b). Again these include: a physical account (condition and extent of the stocks), an account for ecosystem service flows, and a monetary account (presenting values for the stocks and flows):  1) Ecosystem Accounting Unit: the spatial boundary is within the limits of the UK Exclusive Economic Zone (EEZ) and the mean high water mark (HWM), limits to estuaries on the coast and to the surface of the sea bed.  2) Land cover/ecosystem functional unit: Marine ecosystem with a focus on 3 ecosystem services (fish, carbon and recreation) to provide examples.  3) Basic spatial unit: variable, depending on the service (see tables below).  The development of these accounts generally follow the same steps as the spatially disaggregated woodland accounts, with logic chain models and the definition of marine metrics for each one of the considered ecosystem services, and assessment of physical data and ecosystem service models for the physical stock and flow accounts. However, they have been adapted to the specificities of the marine system and the lack of robust data. For example, the study explains that, in part because of international stock recovery plans, the landings (flow of fish) will vary. The accounts should thus not assume a constant flow, which would be inconsistent with current scientific assessments. Short-term, medium-term and long-term approaches have been proposed. For the short-term, the accounts should use data on pressures (for surface water, pelagic environment and benthic environments) instead of only using data on the spatial extent of marine characteristics, with steps to incorporate progress made on fish stock analysis, pressure analysis, and recreation. The medium-term approach would focus on the use of scientists’ stock assessment advice for ecosystem accounts, the carbon sequestration rate of saltmarsh, maerl and shellfish varying according to their condition, and the costs of different recreational visits/activities in different areas. Finally the long-term approach should focus on the link between ecosystem characteristics, their contribution to ecosystem service provision, and the impact of pressures on the ecosystem characteristics.  **Table 2.6 Physical account of ecosystem asset condition and extent (stock) at the end of an accounting period**    **Table 2.7 Physical account of ecosystem service provision (flow)** |

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| **Box 2.6 The physical accounts developed in the Netherlands**  In the Netherlands, spatial biophysical accounts have been developed for 2010 for the province of Limburg at three scales (Remme et al., 2014):  1) Ecosystem Accounting Unit: administrative boundaries of Limburg province  2) Land cover/ecosystem functional unit: pastures, cropland, forest, water, urban, infrastructure, heathland, other nature  3) Basic spatial unit: 25 x 25m  A specific spatial model was developed for every ecosystem service, using the ESRI ArcGIS 10 and Geospatial Modelling Environment software. The study covered the ecosystem services detailed in Table 2.9, presenting results in totals, mean/km/yr, and estimated standard deviations on the means.  **Table 2.8 Ecosystem services covered by the accounts developed for the province of Limburg (the Netherlands)**   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **Category** | **Service** | **Unit of measurement** | **Total per year for the area** | **Range across land cover/ecosystem functional units (LCEU\*) types of the means** | | | **Provisioning** | Crop production | 106 kg produce | 1,868 | t/ha/yr | 41.8 | | Fodder production | 106 kg dry matter (dm) | 784 | t / ha / yr | 10.9-12.0 | | Drinking water extraction | 103 m3 water | 26,995 | 103m3/ha /yr | 1.3-2.4 | | Hunting | kg meat | 34,193 | kg/km2/yr | 13-32 | | **Regulating** | Air quality regulation | 103 kg PM10 | 2,254 | kg/km2/yr | 0.5-2 | | Carbon sequestration | 103 kg carbon | 61,429 | 103 kg/ha/yr | 0-1.45 | | **Cultural** | Recreational cycling | 103 trips | 9,122 | Trips/ha/yr | 84-128 |   *Source: Remme et al., 2014*  \* The Land cover/ecosystem functional unit (LCEU) is defined in SEEA-EEA as an area satisfying a pre-determined set of factors relating to the characteristics and operation of an ecosystem (e.g. land cover type, water resources and soil type). A LCEU is to be broadly considered an ecosystem or biome, even though these concepts cannot always be defined in purely spatial terms.  The results were used to build monetary accounts, as related by Remme et al. (2015).  These figures have been recently updated to cover the year 2013 (see table below). This more recent work developed a new ecosystem units map (polygon map with a minimal width of 6m). The biophysical models were updated using this new ecosystem units map and monetary models were developed for all services except bicycle recreation.  **Table 2.9 Physical supply table for the Limbourg province (2013)**    Source: CBS (2015) |

## Interpreting the results

When interpreting the results of physical (and also monetary) indicators, it is very important to be aware of their scope, definition and required assumptions and hence their meaning and robustness, and therefore utility (i.e. for what are they fit-for-purpose) – see wider discussion on policy utility in Chapter 4. In general, ecosystems in better conditions will generate more ecosystem services than ecosystems in poor conditions, even though the link between ecosystem conditions and flows of ecosystem services is not straightforward.

For example, the way ecosystem services are defined and accounted for imply the existence of beneficiaries. For this reason, an increase or decrease in ecosystem services may depend on a variation in the number of beneficiaries and not on a change in the quantity or quality of the ecosystem services per se. As an example, the construction of a road in a forest or an increase in population near a natural area can result in an increase in the related ecosystem services, even though they may also mean a higher pressure over its ecosystems. Obviously, this does not apply to global ecosystem services such as typically carbon storage.

In general, since the areas more pristine and rich in biodiversity tend to be located in less densely populated areas, the actual flows of ecosystem services cannot be taken as a measure of the quality of ecosystems nor of the *potential* for the ecosystems to support services in future. For this reason, accounts of ecosystem services can be useful to compare similar areas or to monitor trends over time of a specific area, but cannot be used alone to prioritise conservation intervention across different areas. Their policy relevance can be increased if they are combined with accounts of ecosystem condition, in order to be able to provide a full picture. Also, it will be important to use also kind of indicators not exclusively based on the benefits provided by ecosystems to human societies, like for example biodiversity indicators (UNEP – WCMC, 2015) - even though of course biodiversity provide multiple benefits to humans too.

In addition, the aggregation process should be carried out very cautiously. Even if SEEA-EEA suggest not to aggregate ecosystem services across different types of Land Cover/Ecosystem Functional Units (LCEUs), it allows aggregation of the same type of LCEU across different regions of each country. However, the aggregation process may obscure regional differences, as the importance of ecosystem services is strictly related to the characteristics of each area. Also, aggregation needs to be carried out cautiously if information on the flow of ecosystem services is not measured in each area, but needs to be estimated on the basis of data from other sites and using scaling and transfer techniques to provide estimates for other areas. In general, both measurement in terms of simple indicators, and the subsequent aggregation of those indicators, inevitably imply a loss of information, and for this reason spatial accounts will represent an important development of biophysical accounts. On the other hand, the measurement and aggregation processes also transform information into more comprehensible, useable and comparable forms: spatial accounts will be better for certain purposes, but will not replace the need for aggregate accounts.

Accounting requires the use of methodologies to adjust the available data to the required scale and occasionally to develop estimates based on scaling and transfer methodologies. This results in the use of a range of assumptions, and in an inevitable degree of uncertainty. For this reason, it is very important to be aware of the level of uncertainty associated with the accounting exercise and also on the assumptions employed, in order to put the results of accounts in context and interpret them correctly.

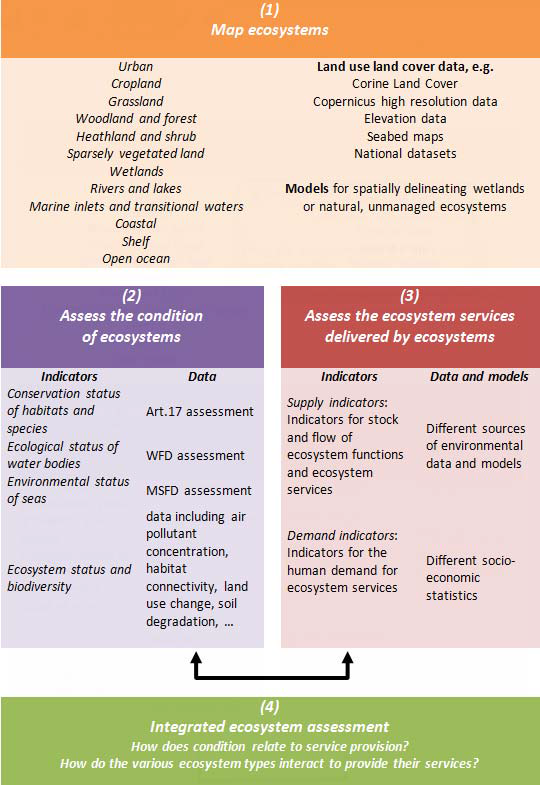
In general, Ecosystems Accounts can be useful to discuss policy priorities, for example by allowing trends of ecosystem services in different areas to be compared, or showing a decreasing trend in a specific area that needs to be addressed. They can also be useful to discuss trade-offs between alternative land uses. For example, a change in the ecosystem condition may increase the provision of certain ecosystem services (e.g. recreational ones and provisioning ones) at the expense of others (e.g. regulating ecosystem services). In many cases (but not always), an increase in provisioning services tends to be linked to an increased environmental impact, resulting in the decrease of other ecosystem services. In addition, Ecosystem Accounts can give an important indication on the trends in biodiversity at the level of ecosystems, by linking e.g. land use accounts to water and organic carbon accounts. Some promising potential in this direction is represented by the EU Earth observation programme Copernicus, which will provide vast amounts of accurate and easy-to-access satellite data on, among other areas, land management, the marine environment and climate change. The potential policy use of Ecosystem Accounts will be developed more in-depth in Chapter 4, whereas Chapter 3 will focus on the use of monetary valuation in the context of accounting.

## Future developments of ecosystem accounting

As explained above, the EU Biodiversity Strategy requires Member States to map and assess the condition of ecosystems and the flows of ecosystem services both in physical and monetary terms. In order to progress towards this objective, a number of initiatives are in place, including the MAES process, the MESEU study and the development of SECA by the EEA.

The mapping exercise of the MAES process will be used to develop accounts, as shown in Figure 2.1. According to the MAES roadmap, by 2016 biophysical ecosystem asset accounts will be ready at the EU level and in some Member States, accounts for ecosystem services will be prepared by 2018 and by 2020 accounts for ecosystems and ecosystems services will be developed in monetary terms. The final objective is to develop a data set at the EU level.

**Figure 2.2 A common assessment framework for ecosystems and ecosystem services**



Source: European Commission, 2014

As regards the SECA process, the data of the SECA land accounts are already accessible in the EEA webpage for the years covered by Corine[[29]](#footnote-29). A first time series of SECA carbon accounts was planned for the end of 2015, covering the years between 2000 and 2010, and an update including the years between 2000 and 2012 was scheduled for early 2016. As regards water (quantity) accounts, they are being developed at the EEA as part of SEEA water accounts and integration in SECA is scheduled for 2016. Finally, the EEA is developing specific indicators at macroscopic level and based on changes in the ‘ecosystem condition’, to be used to build landscape/species accounts, including the Net Landscape Ecosystem Potential (NLEP) for landscape structure, the indices of EU protected species (article 17 reporting) for biodiversity and some additional data layers on bird population trends and ecotones.

At the national level, different countries are in the process of developing Ecosystems Accounts and assessments of ecosystems and ecosystem services. For example, Germany is developing water, carbon and forest accounts (all in physical terms), and also studies on the steps needed to develop other kinds of physical and monetary Ecosystems Accounts, including the development of a set of indicators to assess ecosystem services at a national level. The Federal Agency for Nature Conservation (BfN) is leading this process, by focussing on specific topics like for example a monitory evaluation of erosion control in agricultural areas. UK has already published accounts for woodland and freshwaters, as well as land use and land cover stock accounts and scoping studies for marine ecosystems and peatland. Work is ongoing in the UK to develop enclosed farmland accounts, carbon accounts and cross-cutting service accounts for recreation and water-related regulatory services. The focus will be on national accounts in the future, as opposed to local accounts, and a project will start in the near future to check if local information can be used for national ecosystem accounts. In France an assessment of ecosystems and ecosystem services is currently being developed, aiming at being finalised by 2017 and covering six types of ecosystems (agro-ecosystems; forests; marine and coastal ecosystems; freshwater and wetlands; urban ecosystems and mountains and rocks). In addition, work on the monetary valuation of specific ecosystem services has been produced. In Finland there are plans to develop national accounting of 28 ecosystem services in the near future. In Norway research is going on to explore the potential of accounts for the Oslo region.

In general, developing accounts, and especially geographically explicit accounts, require a notable effort and consequently an investment from national or international bodies. For this reason, the degree to which accounts will be developed depends on the political will and the consequent availability of funding from national governments and EU bodies like Eurostat.

For example, in the Netherlands there are plans to develop accounts at the national level for a range of ecosystem services, including provisioning ecosystem services (crops, fodder, groundwater), regulating ecosystem services (carbon sequestration, air quality regulation, pollination, natural plague resistance) and cultural ecosystem services (amenity services, nature tourism, biking tourism). However, these accounts are going to be developed only if enough funding is secured.

In addition, developing accounts requires collaboration among different kinds of experts, including statisticians, ecologists and economists and the use of different sets of databases that are developed by different institutions and at different scales. For this reason, institutional collaboration among different bodies at the national and EU level is key, and needs to be promoted in order to cover data gaps, create synergies and improve the effectiveness of the process. The development of ecosystem accounts will proceed hand in hand with the development of biophysical assessments, mapping and data as well the development (or adaptation of existing) of valuation methodologies for accounting contexts, and the development of policy uses for accounting information. The next two chapters focus on these central aspects of the accounting research agenda.

# The use of monetary valuation for Natural Capital and Ecosystem Accounting

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## Introduction

Standard national accounts focus mostly on traded goods and services, with some important exceptions for which imputed values are used. This means that these accounts do not reflect several fundamental factors that underpin economic activity. In particular, depletion of resource stocks are ‘invisible’ to GDP accounts, and changes in non-traded Natural Capital and ecosystem services are not included. Environmental accounting and ecosystem accounting seek to address important parts of these shortcomings, by measuring the value of non-marketed natural services, and taking into account changes in the condition and value of Natural Capital stocks.

Physical accounts can be developed with little concern for issues of valuation or comparability with the SNA (see chapter 2). For monetary accounts, however, valuation is a central and contentious issue. Values can be defined and measured in different ways, and the appropriate choices will depend on the purpose of the assessment. A particularly important distinction is between exchange values and welfare values: while the valuation of non-market ecosystem goods and services is well established, there is a crucial inconsistency between the welfare-based values that are usually derived for use in CBA and the exchange values used according to the SNA principles that underpin ecosystem accounting – the exchange values can often be significantly lower than welfare-based values, as they do not take into account consumer surplus. Other relevant issues include the treatment of different spatial scales, assumptions about future flows and time horizons, and the distinction between realised and potential values. The need to develop and improve the application of valuation in ecosystem accounting is the subject of growing attention (see for example Pittini et al., 2013; Defra and ONS, 2014; Obst et al., 2014).

A crucial distinction must be made between valuing Natural Capital assets and valuing the flows of ecosystem service they generate. These are related, but not identical. In principle, the value of the capital asset can be calculated using the net present value of these flows, which could be derived by modelling the future supply of ecosystem services, valuing them using appropriate non-market valuation methods and finally, discounting them to present year currency. In practice, each of these steps is possible, but difficult. For instance, many Natural Capital stocks are managed over very long time scales (e.g. 150 year rotation for some timber stocks), but associated economic models have little relevance over these time scales. A further challenge is that many environmental valuation methods are appropriate for valuing particular quantities or levels of ecosystem services, such as a unit reduction in air or water pollutant concentrations, tonnes of timber, or a number of recreational visits. These can be considered ‘marginal’ values in that they are appropriate within a particular range of ecosystem service supply. Only in relatively rare cases is it appropriate to extrapolate these marginal values across large changes in the supply of ES (the notable exception is for valuing GHG flows). For instance, while Fiquepron et al (2013) show that on average 1 hectare of *new* woodland generates a savings of around €22 per year (in 2004 Euros) on French household water bills, it would be inappropriate to assume that 10,000ha of *existing* woodland already saves domestic users €220,000 per year. The point here is that valuing ecosystem services flows is not quite the same as valuing Natural Capital stocks, and economic methods are often better suited to valuing *marginal changes* in flows and in Natural Capital stocks than they are to valuing total flows and entire stocks. This is an important distinction when attempting to ‘relate the environment to national accounts’.

## Valuation principles for accounts

Non-market valuation is a well-established tool of environmental economics, with a rich theoretical background comprising several valuation methods, and an extensive literature of applied valuation work. OPERAs deliverable D3.2 covers the topic in some detail. Specifically for environmental and ecosystem accounting purposes, however, there is some disagreement over the appropriate methods and approaches that should be taken. In particular, this relates to the focus in the SNA, SEEA-CF and SEEA-EEA family on the use of exchange values, but there are also issues regarding time horizons, levels of accuracy required, dealing with future uncertainty and so on. These issues are discussed further in this paper.

National accounting is a method of collecting, organising and reporting desirable information on economic activity that is ultimately relevant for measuring trends and making decisions (Agarwala in preparation; Agarwala et al in preparation; Binner et al 2016). Here, the word “desirable” is key. National accounts and their constituent parts are not determined by economic theory, nor are they necessary fundamental components of a working economy (the UK’s industrial revolution took place before the modern era of GDP accounting). Crucially, they are not and were not intended to be a measure of human wellbeing (Agarwala et al 2014a; Coyle 2014). Rather, national accounts are human constructs, deliberately and strategically designed to tell specific stories over time. The body commissioning the accounts has considerable influence over what these stories might contain, and how the information might be used[[30]](#footnote-30). Apart from tradition, there is no fundamental reason that national accounting procedures cannot be amended to incorporate the value of Natural Capital, or indeed the value of the final ecosystem goods and services it generates.

It is important to recognise that developing valuation protocols for environmental and ecosystem accounting will inevitably involve compromise, with no single “right” answers. With this in mind, Pittini et al. (2013) identify some important principles for valuation of non-marketed goods and services for national accounting:

1. Accept that accounting frameworks will never capture **all** values for the natural environment. The point is rather to “expand the production and asset boundaries of the national accounts, starting with values that are as close as possible to the market and proceeding to include non-market values that probably still reflect direct and indirect use values”;
2. Accept that some loss of precision in value estimates may be acceptable, for the sake of greater inclusivity;
3. Accept that monetary valuation, whether through exchange or welfare values, cannot fully address sustainability concerns: there are inevitable challenges such as non-linearity, irreversibility and the limitations of marginal valuation that “point to the need for complementing monetary valuation and wealth accounting approaches with assessments of critical stocks, as well as to the importance of developing physical accounts and indicators”; and
4. Recognise, therefore, that monetary accounting depends upon and must be developed in parallel with physical accounting.

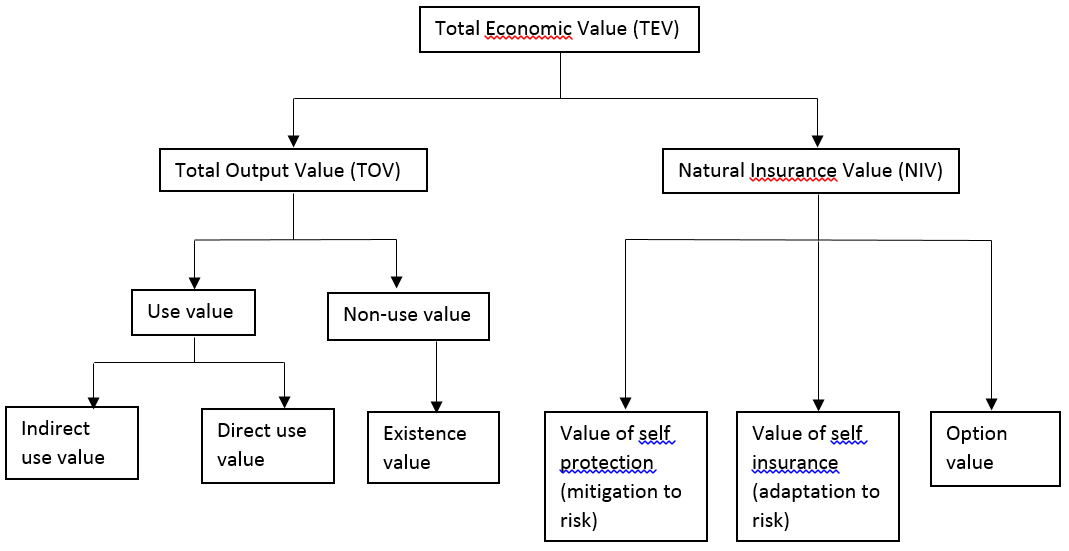
This in turn raises the questions as to whether a partial integration, the lack of precision and the limitations of exchange values and valuations, are acceptable limitations or not. This will also depend on how people interpret the results of accounts and use the results in decision making.

### Exchange and welfare values

In economics, the term ‘economic value’ generally refers to a measure of the contribution of a good or service to human welfare (Brouwer et al. 2013). Under the assumptions of economic theory, analysis of (changes in) ecosystem services aims to measure (changes in) ‘total economic value’ TEV), through estimates of (changes in) consumer and producer surpluses, or in some cases through proxies for these measures.

TEV is conventionally divided into use and non-use values for a good or service. Recent proposals (e.g. Pascual et al 2015) make space for ‘natural insurance value’ (NIV) as a component of TEV, with the more conventional components (use and non-use values) being classified as ‘total output value’ (TOV). Pascual et al further divide NIV into ‘self-protection’ (lowering the risk of a disturbance event) and ‘self-insurance’ (reducing the size of loss from an event).

**Figure 3.1 TEV including NIV (adapted from Pascual et al. 2015)**



This TEV framework for measuring surpluses is different from the notion of exchange value, defined as “the total value of income, production and expenditure as evidenced by transactions” (Brouwer et al. 2013) and measured as the product of market prices and quantities. Exchange values are used in economic impact assessment, generally adjusted for indirect and induced effects via the use of multipliers derived from input-output analysis.

The SNA uses exchange values, not welfare values, and the same basis is called for in ecosystem accounting (SEEA-EEA 2012). Exchange values are defined as the amounts of money that willing purchasers pay to acquire goods, services or assets from willing sellers. The exchanges should be made between independent parties on the basis of commercial considerations only, sometimes called “at arm’s length” (SNA 2008; 3.119). Formally, the

*“SNA does not attempt to determine the utility of the flows and stocks that come within its scope. Rather, it 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 (currency or transferable deposits).”* SNA (2008; p50 3.118).

This clearly states that exchange values do not capture the full benefits (utility) derived by the agents participating in a transaction. Thus, while walking in an open access woodland may entail an exchange value of €0, the benefits people derive from such walks may significantly exceed €0. Sen et al (2014) estimate that recreational users might be willing to pay as much as £3.59 per visit to forests and woodlands in the UK, on average, above any exchange value cost entailed in visiting the forest. This ‘consumer surplus’ is not included in exchange value, but is an important component of welfare value.

The focus in accounts on exchange values creates a challenge, since many ecosystem services and assets are not traded in markets and do not have observable exchange values. Similarly, in the SNA and the SEEA-CF 2012, the valuation of assets is limited to those assets over which property rights can be enforced, because it is the existence of property rights that generates the potential for a stream of economic benefits that in turn gives economic assets their exchange value. This is problematic in the context of ecosystem accounts, where ecosystem services are often provided without any transaction and with no clear property rights. Quantities can often be observed, but not prices: to include these flows in the accounts, prices or values will have to be imputed. However, there are precedents for using imputed values in the SNA, as discussed further below.

### Approaches to estimating exchange values

One option for ecosystem accounting purposes is to attempt to simulate exchange values – in other words, answer the question, what would willing purchasers pay to acquire ecosystem services and assets if they did in fact have to pay for them? To do this, we need to estimate the marginal WTP of consumers of the services involved.

In theory, if access to these services is not constrained, consumers faced with a zero price will use them up to the point at which their marginal WTP is equal to the marginal (opportunity) costs they incur in using the service. These costs will often be greater than zero, even if there is no direct market price; for example, people incur travel and time costs to enjoy outdoor recreation. These indirect costs form the basis of the revealed preference family of valuation techniques.

Day (2013) identifies three options for proceeding where no price can be observed:

1. Use a price of zero: this is a strict application of the SNA use of exchange values, valuing consumption of non-traded goods at zero;
2. Use a representative marginal price: create a model to estimate the price that would arise in a perfectly competitive market; or
3. Use representative discriminatory prices: select *any feasible set* of discriminatory prices that fall below the demand curve and pass through the observed quantity.

The first option of zero price maintains maximum compatibility with the SNA. It is implicitly widespread (i.e. for all non-traded goods and services that are not included in accounts), but defeats the object of ecosystem accounting, since it effectively excludes all non-marketed ecosystem services from the monetary (though not physical) accounts. Of particular concern is the idea that this could create perverse dynamic incentives (or interpretations) - moves to create markets in environmental goods and services would result in higher values recorded in accounts – even in cases in which aggregate welfare values fell due to some consumers being excluded by higher pricing.

Option 2 is the basis of the ‘simulated exchange value’ approach, and seems to be the most likely option for use in practice. The simulated exchange value aims to estimate the value of ecosystem services in terms of potential revenue in a hypothetical market (Oviedo et al. 2010). Practically, this requires estimating a demand and a supply curve for the ecosystem service in question and then making further assumptions on the price that would be charged by a profit-maximising resource manager under alternative market scenarios. The hypothetical revenue associated with this transaction, excluding the consumer surplus, is taken as a measure of value of the flow of ecosystem services.

This arguably represents a more consistent basis for including their value in national accounts alongside monetary transactions, and would avoid the perverse incentives noted above – though there could still be a temptation to move to ‘realise’ the flows recorded in the accounts, that concern is common to any inclusion of imputed values for ecosystem services. On the other hand, it introduces a logical inconsistency, since at any given price consumers would demand a lower quantity of the environmental service compared to when it is free at the point of use. This has the potential to add confusion between the monetary and physical accounts. Using the simulated price with the existing quantity would overstate the value of the service by valuing some units at a price above the maximum WTP. Using the simulated price with the simulated quantity would avoid this, but would then involve a fictitious quantity, which could be seen as introducing an inconsistency between the physical and monetary accounts.

This would be avoided by Option 3, using any feasible set of discriminatory prices - in effect, matching each unit of the service with a price that theoretically could exist under some possible market institution. But beyond that constraint, the choice of the price function is essentially arbitrary, which could be open to manipulation and could reduce comparability across different accounting exercises. Day (2013) proposes the use of the demand curve as a solution to the arbitrariness. This would also remove any confusion or inconsistency between values recorded in accounts, and surplus values used in welfare assessments and cost-benefit analysis. However there would be practical problems where marginal WTP is very high for first units of a service, as would be the case for essential services. And, by including all consumer surplus, this would drive a wedge between the treatment of marketed goods and services (valued at exchange values excluding consumer surplus) and non-marketed goods (valued at hypothetical exchange values where all surplus is captured in the exchange). This would skew comparison between marketed and non-marketed components and would likely be strongly resisted within the national accounting / statistics community, even if it were welcomed by environmental economists steeped in the welfare values and cost-benefit analysis traditions.

The fundamental point in the above is that exchange values are dependent on market institutions and structures and the definition of property rights, whereas welfare values are not. Where actual market prices is zero, we needs must estimate some imputed value if we are to include the flow in monetary accounts. Any price function meeting the conditions of option 3 above would be sufficient. The use of a single simulated exchange value would not meet these conditions, because the price would involve exclusion of consumers with lower WTPs. Nevertheless, the simulated exchange value may be favoured for its simplicity and its reasonable fit with the valuation basis of the SNA.

The above choices also raise questions of consistency and comparability across countries, the interests behind choices of methods (that may lead to divergent choices of approaches), and whether including certain values can be seen as sufficiently improving the representativeness and meaning of accounts to make the step worthwhile.

### Valuation methods for accounts

As previously noted, where markets exist there is relatively little trouble in deriving exchange value estimates for accounting purposes – market prices, seen as second-best proxies in the context of welfare valuation in the TEV framework, are ideally suited for accounting purposes. For non-market goods and services, however, most applied valuation studies are carried out in the context of cost-benefit analysis, or at any rate analysis of welfare changes using the ‘total economic value’ framework. Therefore most non-market valuation methods and applications developed in the field of environmental economics include consumer surplus, as discussed in OPERAs D3.2.

Unadjusted, therefore, these estimates are generally not directly applicable to the context of estimating exchange values for comparison with standard economic accounting estimates. However, there is considerable potential for using some of these methods to estimate exchange values, because the ‘true’ valuation methods (as opposed to the proxy-based methods), when applied in full, seek to estimate demand curves for environmental goods and services, thereby furnishing the core element of the simulated exchange value approach.

On the other hand, the literature on non-market valuation is thin for some important ecosystem services. Brouwer et al. (2013) reviewed EU national ecosystem assessments, and reported that while most studies cover several different kinds of provisioning, regulating, cultural and sometimes supporting services, relatively few services are assessed using non-market valuation techniques.

* Most provisioning services are valued using market prices. This is ideal for accounting purposes, and could also be extended to imputed values for certain provisioning services (e.g. wild food collection) where (a) there are market-equivalents for non-marketed provisioning services and (b) the services are significant enough to warrant inclusion.
* Regulating services are generally ‘valued’ using cost-based methods, notably the replacement cost approach. These are relatively easy to apply, but do not have any particular relationship with the TEV value of services (e.g. the costs to replace a service could exceed the maximum willingness to pay for it). However, where we can assume costs do not exceed maximum WTP, then the costs could be used as a simulated exchange value. The argument is that buyers who had to buy the service would be willing to do so at that price. Hence, cost-based methods may often give a reasonable estimate of (simulated) exchange value, whereas they would only be good estimates of welfare values by coincidence.
* ‘Cultural’ and supporting services are much less commonly valued in monetary terms. The main exception is recreation, which is relatively easy to observe/quantify in physical terms, and for which non-market valuation is quite common.

The suitability of valuation methods for accounting purposes is discussed further in **Table 3.1**.

**Table 3.1: The main valuation methods and their applicability to environmental and ecosystem accounts**

| **Family and methods** | **Description** | **Suitability for environmental and ecosystem accounts** |
| --- | --- | --- |
| **Market-based methods**:   * Market prices * Production functions * Resource rent (residual value approach) | Market prices are appropriate for exchange values. There may be a need to correct for taxes and subsidies, or to estimate how values change with quantity. | Actual market transactions should already be in the SNA. Where market prices exist for equivalent or similar goods or services, this is likely to be suitable for deriving estimates of imputed values. Where the value could rather be derived from considering a non-marketed service as part of a production function, this could be appropriate, but if the final output is itself marketed there is a risk of double-counting, depending on the boundaries of assessment, and the service might be better considered as intermediate consumption. |
| **Revealed preference**   * Travel cost * Hedonic pricing * Random utility model * Avertive behaviour | Methods based on values for environmental resources that are ‘revealed’ by behaviour in associated markets. | Applicable to non-marketed goods/ services that are part of marketed goods, or include marketed components (the ‘weak complementarity’ assumption). Fully applied, these methods seek to estimate demand curves (and therefore consumer surplus) but the demand curves could also be used in estimation of simulated exchange values. Potentially applicable to recreation, aesthetic values and also for mitigations e.g. to value role of natural services in screening noise, disagreeable views, air or water pollutants |
| **Stated preference**   * Contingent valuation * Choice experiments | Methods based on surveys in which people express preferences through responses to hypothetical payment questions or choices about alternative states of the world. | Applicable to all goods and services and capable of covering non-use as well as use values. Most applications seek surplus measures, but the methods could be used to estimate full demand curves and therefore any simulated exchange value. Double-counting is a risk, in particular due to embedding / part-whole bias. |
| **Cost-based techniques**   * Avoided costs * Replacement/ restoration costs | Proxies that do not assess economic value, but rather the costs that are avoided due to some ecosystem asset, or the costs that would be incurred to replace or restore the asset. | Many services could be treated using avoided or replacement cost techniques, for example flood regulation. Widely applicable to restoration of ecosystems, potentially where targets for conservation/restoration exist. Risk of double counting if these combined with values of services supported by the systems. Could be used as proxies for exchange values, if it is assumed that the estimated cost is one that would actually be incurred if necessary (i.e. the buyer would be willing to pay that price). |
| **Expenditure measures**   * Expenditures * Gross value added | Measure expenditure, not economic value: the bases of estimating regional economic impacts through input-output modelling and multipliers. | Actual expenditures will appear already in the SNA. The methods are used to assess the economic impact of recreation and tourism, but are not directly appropriate for valuing the ecosystem service. Could be used in studies of simulated exchange values. |

## 3.3 Extending valuation boundaries

To the extent that flows are traded, they are already included in the accounts, both through the SNA and in the SEEA-CF 2012. This includes, for example, trade in agricultural output, timber, and fish catches. Ecosystem accounts seek to develop a more holistic, ecosystem-based assessment. The accounts need to record changes in the status/condition of the assets that support service flows, as well as changes in flows.

However, although the existing SNA provides a framework for measuring and reporting activity within an economy that includes final environmental goods and services that are traded in markets, their contribution to the total value of output (formally, their value added) is not attributed to the environment, but is instead implicitly attributed to other factors of production (e.g. other capital and labour inputs). For instance, the value added from the agricultural sector depends on the combination of farm labour, farm machinery, and productive ecosystems. However, because current accounting practices do not recognize the environment as a factor of production, the value added that it generates is implicitly attributed elsewhere in the economy. This leaves two challenges:

1. How to account for non-market final environmental goods and services; and
2. Attributing value added from market-traded FEGS appropriately.

With respect to the first challenge, the simultaneous desires to (i) keep the definition and calculation of GDP the same, and (ii) to incorporate the value of FEGS within the GDP calculation, are incompatible. A central feature of the SNA is its production boundary, which sets out what does and does not ‘count’ as economic production, and therefore what is included and excluded from the national accounts. The SNA defines economic production 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.” (SNA 2008; p97, 6.24). It clearly states that natural processes “without any human involvement or direction [are] not production in an economic sense… the unmanaged growth of fish stocks in international water is not production, whereas the activity of fish farming is production.” (SNA 2008; p98. 6.24). Thus, many sources of FEGS are specifically excluded from the SNA and arguably conceptually distant from the natural capital and ecosystem services concepts.

This means that the production and asset boundaries of the SNA have to be *extended* for ecosystem accounting, to take account of feedbacks within and across ecosystems, because the consequences of resource use and economic activity can reach far beyond the immediate area and time. This gives rise to a number of issues in valuation.

In principle, the SNA can allow imputed prices for a whole range of non-marketed natural resource services, including private production/consumption of wood fuel, fishing, water abstraction, food production, and solar power. These could all fall within the production boundary of the SNA, but in practice they are generally omitted – both for practical reasons (lack of data) and because they are relatively minor compared to industrial sectors and are not directly relevant to monetary policy. However, in moving to environmental and especially ecosystem accounting, it becomes important to estimate exchange values for these goods and services.

The second challenge mentioned above refers to correctly attributing value added to an ‘environmental sector’ within the SNA. In principle, values already recorded in the SNA can be disaggregated to reflect the value added at various stages along the production process. Sectoral production functions describing how various sectors (e.g. forestry, agriculture, manufacturing, etc) actually utilise inputs could be developed to identify relative contributions to output (formally, the value added) from labour, capital and other inputs such as ecosystem services. These could then be used to add various ecosystems as lines in the value added sector of the input-output tables used to construct SNA accounts (Leontief 1970; Miller and Blair 2009). This would not affect the total value of GDP, but rather reattribute value from sectors that consume ecosystem services as inputs to an environmental sector that generates FEGS as outputs. Of course the process is not straightforward, and the primary challenge lies in identifying production functions that can adequately identify the share of value added that should be attributed to FEGS.

### Imputed values in the SNA

Not all productive services are considered to be within the “production boundary” of the SNA. For example, most services produced and consumed by households (such as housework, cooking, gardening, childcare, etc.) are not included, though when these services are directly paid for, for example through employing domestic staff, they do then fall within the production boundary and should be recorded. There are arguments for extending the production boundary in such cases, in order to give a fuller picture of productive activity and to avoid some anomalies. However being too comprehensive would reduce the usefulness of the accounts as an indicator of the market economy: “inclusion of all activity which is productive (in the economic sense) but which does not have a monetary value would swamp the monetary flows, obscure what is happening in the markets, and reduce the usefulness of National Accounts data for analysis” (ONS, 2014b).

Nevertheless, there are many cases in the SNA in which values are adjusted or imputed values in order to ‘correct’ for certain features of institutional structures, where important services are not fully traded in monetary transactions but are nevertheless included within the ‘production boundary’ of the SNA. Perhaps the most significant imputed transaction in the national accounts is the measurement of consumption of fixed capital (depreciation). Generally, these flows are internal to an institutional unit, so no actual monetary flows occur: accounts need to impute the value of these internal transactions in order to take account of these important changes in capital stocks.

Another imputed value concerns the services of financial intermediaries: “institutional units that incur liabilities on their own account for the purpose of acquiring financial assets by engaging in financial transactions on the market” (SNA 2008; 4.101), where there is a need to split interest payments and buy-sell price differentials into a real component and a charge for financial intermediation services (see Akritidis, 2007 and SNA 2008 for further details).

Imputed values are also widely used for health and education services. These can be market or non-market goods, depending on institutional structures, and to enhance comparability across accounts the SNA classifies non-marketed cases as ‘transfers in kind’ for which no counterpart flow or payment is received. The rule here is to value these flows at the market prices that would have been received if the resources had been sold in the market, i.e. to infer the value from market equivalents. If that information is lacking, the SNA suggests use of the value assigned by the donor as a rule of thumb for valuing transfers in kind (SNA 2008; 3.130).

It would of course be possible to carry out accounting using welfare-economic concepts of value rather than exchange values. However, for comparisons, this would require a re-estimation of SNA based accounting valuations from an exchange value concept to a welfare economic concept of value. This possibility is explored in approaches such as inclusive wealth accounting where the aim is to incorporate shadow prices for all assets, including ecosystems. In practice, the estimation of shadow prices is a challenging task and often market prices (based on exchange value concepts) are used as proxies. There are also problems associated with estimating total welfare values for essential goods and services (such as drinking water) since marginal values are very high for the first units supplied: welfare analysis is best suited to looking at marginal changes and can struggle to cope with large or total changes. Ecosystem accounts using exchange values avoid this problem, but it must be clearly understood that such accounts are not attempting welfare valuation and do not replace the need for CBA appraisal of policy changes.

The key point here is that current accounting practices mask important environmental-economic relationships, and that to address these omissions would require an expansion of the production boundary and a willingness to impute values for (notional) ecosystem service transactions. There are precedents for expanding the production boundary, as the GDP calculation is often adjusted to incorporate a broader set of economic activities. The most recent example is the inclusion of illegal drugs and prostitution, which together contribute between £7 and £11 billion to UK GDP, annually (ONS 2014). Such expansions face the same issues of how to accurately value economic transactions when they cannot be reliably observed in standard data collection exercises. In this way at least, drugs, prostitution and environmental accounting are alike: they all require an estimation of values that cannot be readily observed in market transaction data.

### Time horizons for asset valuation

The intent of asset accounts is to record the opening and closing stock of environmental assets and the different types of changes in the stock over an accounting period. Asset values can be measured in different ways, including:

* Values observed in markets (capitalised exchange values);
* Written down replacement cost (a cost-based valuation method that may or may not reflect the economic value of an asset); and
* Discounted value of future returns (i.e. summing a flow of either exchange-based values or welfare-based values over time).

The last involves estimating the present value of a stream of future flows of services. If the service flow is relatively straightforward to value – in particular, for the short term and if it is traded in a market – but the asset itself is not traded, this can be the most practical approach for ecosystem asset valuation. However, while in principle, assets should be valued over an ‘infinite’ time horizon, in practice, assumptions about flows over long horizons are likely to be extremely uncertain, and the impact of discounting means that distant years contribute relatively less to present values. Arguably the change in value between accounting periods is of greater interest than the absolute value (which would be higher for a longer asset life). Merely for consistency across accounts, any arbitrary time period could be used, but there also a need to be consistent within accounts, including with physical accounts. This may mean there are ‘natural’ periods that might be considered – for example, in forest accounts, a long enough horizon to account for a full production cycle.

### Actual vs potential flows

There is a distinction to be made between actual service flows and potential service flows. The difference can be very significant, due to three main situations:

* Spare capacity: services that could be economically valuable but that are not currently used fully or at all
* Changing condition: where deterioration or recovery of the ‘condition’ of a natural resource asset can cause large changes in future flows (or potential flows)
* Changing demand or preference conditions.

Generally, accounting frameworks prioritise the use of actual flows: see e.g. Defra and ONS (2014), principle 9.2. Valuation aims to assess the value of goods and services produced during an accounting period (for flow accounts) and at the present value of current and future goods and services (for asset accounts). The main rationale is that valuing actual flows is more consistent with general national accounting principles. This is generally true, and it will usually be appropriate to reflect this difference, noting for example that many regulating and cultural services will provide greater value where there are more people or businesses making use of the service.

On the other hand, there are situations in which a focus on actual flows could be misleading, in particular where flows are manifestly unsustainable, or otherwise likely to change for predictable reasons, and also in situations where the generation of benefits is highly variable or uncertain over time. For example, in forest accounts, a more representative picture of local ecosystem service flows may be derived by focusing on the annual increment rather than on the actual timber extraction, which follows very long term cycles. Similarly, for natural insurance values such as flood control or pest control, it may be more appropriate to value the potential service flow rather than actual damages avoided, which depend on variable conditions.

This also applies to calculating the asset values for accounting purposes. Ecosystems are also assets that may be capable of producing enhanced services in future – or that may be suffering unsustainable exploitation, leading to unavoidable decline in flows. In the SNA, consumption of fixed capital is tracked to account for some aspects of declining capital values. However depletion of non-produced assets (land, minerals etc.) is not accounted for.

One option is to take the position that accounts should not attempt to cover issues related to such complex and uncertain factors as ecological thresholds, non-linear ecological relationships, irreversible depletion of Natural Capital, and path-dependent functions. To assess these issues, other analytical tools and data would be needed. However, this could limit the usefulness of accounts, and potentially facilitate misinterpretation of accounting data. It would be possible to some extent to consider sustainability directly within environmental and ecosystem accounting, at least by attempting to account for future changes in service flows when estimating asset values.

Where current flows are sustainable, the constant flow assumption is relatively unproblematic. Although the assumption ignores any potential for enhanced future flows, this can be seen as a conservative position, and it is appropriate that any claim of increased future flows should be justified and evidenced.

When current flows may not be sustainable, for example due to over-harvesting or environmental pollution, however, the constant flow assumption could be dangerously wrong. A precautionary approach would require demonstration that a constant flow is a reasonable assumption. Where sustainability cannot be established, that begs the question of what future decline should be assumed. Dynamic models of ecosystems and service provision could help to account for possible changes and risks. Uncertainty in these models may be large, and almost certainly greater than that in measurement of current flows - but this does not mean that the assumption of constant future flows is less uncertain, or more justified. Given the current status of ongoing biodiversity loss, erosion of natural capital stocks and future pressures from climate change, demography and economic growth, it is likely that assuming current flows will be an over-estimate for many cases and hide important risks and costs to society.

## 3.4 Conclusions

Where markets exist, there is relatively little difficulty in using the exchange values in environmental and ecosystem accounts. Indeed in most cases these values will already be included in national income accounting. The extension to environmental and ecosystem accounts may involve different bundling and treatment of the values, and there may be issues associated with asset valuation, sustainability of future flows and uncertainty about future market conditions, but fundamentally the valuation issue for marketed goods and services is not a source of major concern for accounting.

Where problems arise is in the treatment of non-market goods and services. At present there is a lack of clarity as to the appropriate assumptions and adjustments that can be made with respect to the provision of ecosystem services and the estimation of exchange values. A strict interpretation of the exchange value criterion would see non-marketed goods included at zero value. However, there are notable precedents for non-traded values being included in the national accounts via imputed values (e.g. consumption of fixed capital, health, education, and intermediate financial services). It is also relevant that monetary transaction prices are not an unchanging feature of markets – they reflect the institutional setting through which the exchange takes place – and indeed this is recognised in the treatment of imputed prices in national accounts which ‘correct’ for specific features of institutional structures. Fundamentally, choices about what lies inside and outside the ‘production boundary’ of accounts reflect practical considerations and the uses to which the accounts will be put, rather than any theoretical necessity.

For some non-traded services, cost-based techniques (e.g. avoided cost, replacement/restoration cost) may be quite readily accepted as proxies for exchange values, if it is assumed that the estimated cost is one that buyers would actually be willing to pay if they had to. Care is needed to ensure that the use of cost-based proxies for ecosystem accounting purposes does not lead to confusion regarding values for use in welfare-based analyses, because where the cost of supplying a service has no relationship to the benefit derived from its consumption.

More generally, ‘true’ non-market valuation methods can be, and have been, applied to derive welfare measures for many environmental goods and services. These methods and evidence could be adapted to estimate part-estimates of exchange values (e.g. simulated exchange, or other ‘below-demand-curve’ functions). All options for imputing values for ecosystem goods and services involve introducing a fictitious exchange, so no individual option is ‘better’ from that perspective. A (monotonic) price function approach - passing through the current quantity and everywhere below the demand curve - would be logically consistent in representing one feasible market structure for efficient use of the service, but could be seen as arbitrary, as reducing comparability, and as confusing due to the use of different prices for different units.

The simulated exchange value has the advantage of providing a clear single price. It suffers from introducing a logical inconsistency (the single simulated price will often be inconsistent with the actual quantity), but perhaps this is of secondary concern. Obst (2013)[[31]](#footnote-31) reported that economists involved in the SEEA editorial process “felt that the simulated exchange value approach had not been sufficiently tested in the economic literature”, flagging this as an important area for research.

The main research agenda is clearly to develop and test approaches for imputing exchange values that are consistent with SNA principles and the way in which value is derived from natural assets with public good attributes. Existing non-market valuation methods appear to provide a ready starting point, with their use in deriving simulated exchange values a particularly promising avenue.

Research might also profitably explore the actual and likely uses of ecosystem accounts and how simulated values – both single prices and sets of discriminatory prices - would be interpreted and used by users and stakeholders. One area to address is the potential for confusion between welfare-based analyses (such as CBA for projects and investments) and the exchange value based accounts. How would stakeholders respond to having very different valuations for the same services and assets, underpinned by different conceptual bases with distinctions that are somewhat opaque to non-specialists? Is there a risk of damage to decision processes, or to the perceived relevance and robustness of valuation evidence, as a result of sending mixed signals about the value of ecosystem assets? Similarly, there could be confusion if multiple hierarchies of accounts (national ecosystem accounts, protected area accounts, corporate ecosystem accounts…) are constructed using different valuation assumptions.

The methods and evidence base are far from perfect, and data availability and gaps in understanding are a barrier to the development of reliable valuations and accounts in many cases. This applies both to the scientific understanding of ecosystem functions and the economic understanding of how humans benefit from them. Some modelling, transfer and approximation will likely be appropriate where relevant data exist at other locations or scales. But it can be argued that accounts do not necessarily have to be strictly accurate, so much as consistent across space and time. Specific values can be hard to interpret, but observing a significant change in those values over a period of years gives a clear signal that something important is happening which policy-makers should be concerned about. The main usefulness of accounting is for monitoring and tracking trends and changes (see Chapter 4). This does not mean that accuracy is of no concern, but it does suggest that the standards could be somewhat lower for accounting purposes, provided methods can be applied consistently over space and time. The overarching question that remains is, with the various assumptions, choices of values and methods, and issue coverage, whether the monetary accounts will live up to the expectations that some had of integrating natural capital and ecosystem services into GDP and representing their value to improve the evidence base for decision makers. In other words, will the problems noted above of exchange values, time scales as well as the only partial integration of natural capital stocks, degradation/appreciation of stocks and flows of good and services, undermine the potential added value of integration into monetary accounts? The “improved tool” may actually not be an improvement if people do not take into account the assumptions, fail to fully understand the meaning of the results and (accidentally) misuse them. This in turn leads to the question of what the account tools (and which aspects) are potentially useful for (see Chapter 5 on policy utility) and also needs to take into account questions as to what socio-cultural values the accounts can reflect (Chapter 4).

# Integrating Social Values into Natural Capital Accounting

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## Introduction

The inclusion of natural capital along with the other more conventional inputs into national accounts along with supplementary information on capital and labour inputs has the capacity to provide a more realistic representation of economic performance. Including changes in natural capital can demonstrate the contribution of the natural environment and the effect of environmental loss or degradation balance and, consequently, of the sustainability of economic development.

Currently, the SEEA represents the physical status of the environment and its ability to convert natural resources into other forms of capital at the prevailing time. The SEEA includes maintenance expenditure intended to protect natural capital. This expenditure is not, of course, representative of the value that society places on natural capital, but can be argued to reflect the weight that society places on an obligation to protect natural capital (Bartelmus, 2009). This type of expenditure or cost-based estimates of value is argued to be compatible with normal accounting conventions which depend on market or exchange values. Hitherto, Systems of National Accounts have avoided demand-side valuations based on consumer surplus estimates which are argued to be too variable from place to place or to depend on methodologies which cannot be applied with assured consistency. Instead, these methods have been presented in an accompanying volume of Experimental Ecosystem Accounts.

Peter Bartelmus (2009) argues that environmentally-adjusted measures of domestic product or environmentally adjusted capital formation are sufficient to take account of the environmental cost of economic development, whereas the inclusion of demand-side estimates would run the risk of accounting estimates “running wild”. The only limitation is that these measures adopt a weak sustainability perspective in presenting natural and man-made capital as ultimately being substitutes. Bartelmus acknowledges that an exception would occur with “irreplaceable” or critical natural capital.

By comparison, James Boyd (2009) argues that the inclusion of demand-side estimates of value, including consumer surplus, are essential if the true value of natural capital is to be represented. Most natural capital is consumed in the form of public goods and so has no exchange value. Although simulated exchange values can potentially be estimated on the basis of supply and demand, Boyd argues that only estimates of consumer surplus can reflect the condition of natural capital and that the correct approach to do so would be to value ecosystem services. However, he emphasises that only final ecosystem services values should be included so as to avoid double counting. In this respect, ecosystem service benefits would be more straightforward than a dependence on biophysical indicators of ecosystem health in that biology conventionally considers everything important and does not consent to the exclusion of intermediate processes.

Forests, for example, have a capacity to deliver important ecosystem services such as carbon sequestration that should be represented in SEEA. Similarly, wetlands have a role in the moderation of flooding. Without this natural capital, the economy would need to invest in artificial means of service delivery. This expenditure, most likely at a level greater than the maintenance of this natural capital, would be recorded in conventional national accounts. The inclusion of ecosystem services provides a measure of the effectiveness of the forests to sequester carbon or the ability of wetlands to provide for flood moderation and demonstrates changes in this effectiveness when recorded over time.

Chapter 3 discussed how revealed or stated preference methods can be used to provide evidence of the how the quality of these services may be change. Stated preference methods, in particular, have the capacity to capture a greater part of the full value of environmental resources as represented by the consumer surplus above the exchange value. This potentially makes them preferable for revealing changes in the quality of the resource that might arise from unsustainable use. Revealed and stated preference methods are also applicable to measurement of cultural ecosystem services, many of which are non-market in character and others of which are of existence or non-use value.

The chapter noted that, in principle, the SEEA accepts the use of revealed or stated preference. The problem has rather been finding methods to express values that are universally acceptable and of agreeing guidelines for the collection of such data based on common criteria. In the absence of ubiquitously acceptable standards, accounts have developed on the basis of exchange values. The chapter refers to Pettini et al. (2013) argument that we may have to accept the limitations of accounting, namely that national accounts cannot capture all values, cannot be entirely precise and cannot capture all sustainability concerns.

However, potentially, economic valuation can be used to refine national accounts by indicating the extent to which societal values exceed those reported in the accounts, how this discrepancy varies from place to place and over time, and whether natural capital assets are moving in a sustainable or less sustainable direction. A complementary role can be informed by indicators. Ecosystem service values can be quantified and developed into indicators. As a minimum, Boyd et al (2015) argue for the identification and development of biophysical indicators that can be easily understood by stakeholders and more routinely linked to economic values. They acknowledge that these values are typically location specific, dependent on the type of use, timing and subject to heterogeneity in use or preferences. If, however, the indicators themselves are universally acceptable, and understood, they can still be used to reveal the extent of this diversity. In this way, economic indicators can be used to complement a dependence on environmental accounting alone.

## Socio-cultural values

Socio-cultural values can provide a fuller picture of the importance that people attach to the environment and ecosystem services, not least because of their proximity to measures of well-being. In principle, neoclassical economics assumes that a diversity and plurality of values can be captured within Total Economic Value (TEV). Consequently, TEV includes option values and bequest values relevant to the future or to future generations. It includes altruistic values that arise from individual connections to the needs of others. It includes also non-use or existence values. It is assumed that each of these values can be represented within individual preferences and utility functions and that each value is well established and reasonably invariant to changes in context.

Other disciplines, including psychology, sociology and anthropology, allow for a greater fluidity of values, including for social influences and a more immediate role for context (Kumar and Kumar, 2008). They argue that economic preferences alone cannot represent all the values that people hold, including those that they attach to the environment or, for that matter, to what we have come to describe as ecosystem services.

Environmental entities often feature strongly in these values. Ethical values may extend to biocentric or ecocentric principles in which other species, or *Mother Earth*, are collectively endowed with autonomous values which presume moral or ethical obligations on human beings. In addition, as noted earlier, many environmental goods are also public goods which people experience or effect collectively and which could be degraded if their use is guided by individual utility motivations alone. This shared dependence necessitates consideration of the welfare of others if only for reasons of mutual assurance. It is often reinforced by reciprocal relationships or deontological principles, informed by cultural norms, social rules or common property institutions. These principles may be internalised to the individual as personal values, although the individual would be incapable of trading-off these principles with personal utility.

Such principles commonly evolve as a result of socio-ecological systems where there is an interdependence between human beings and the natural environment. This situation is most obvious in agrarian societies where sustainable livelihoods depend hugely on the capacity of natural systems to deliver food, fish or other materials. The natural systems may be primary environments that depend on the knowledge and restraint of human beings to harvest resources at a sustainable level. More typically, they are modified natural environments such as systems of cultivation or grazing where human beings are an input to continued sustainability.

The output of socio-ecological systems barely feature in conventional national accounts. Yields are lower than those which are produced in more capital intensive systems and do not involve any purchase or monetary exchange of inputs such as fertilisers. Rather they involve the preservation of natural capital and can support a secure living standard even though monetary incomes may be negligible and utility is satisfactory and well below any theoretical maximum.

Even in developed countries where livelihoods do not depend on socio-ecological systems, there is a very considerable body of literature to demonstrate our physical and emotional dependence on the natural environment and the irreplaceable contribution that it makes to our quality of life. Many values are argued to be incommensurable with personal utility considerations (Lo, 2011). Deontological principles feature to some extent and incommensurability may arise, for instance, from ethical positions towards other human beings or living things. There are also eudaimonistic values associated with aesthetic, emotional or other senses that are believed to contribute to the “good life” and which cannot be distilled into personal utility gains alone. These values can contribute to well-being without being reflected in national accounts. They may escape an economic valuation even if procedures are extended to value natural capital by these means.

## Subjective well-being

Just as national accounting conventions are moving towards the inclusion of a wider set of measures of performance in the form of natural and social capital, so too has our understanding of well-being progressed from a dependence on objective measures to the consideration of more multidimensional measures. Since the publication of Social Indicators Research (Bauer, 1966), well-being has been measured with an increasingly wider set of indicators. Economic indicators measure a person’s ability to select the goods and services that they desire, i.e. to satisfy preferences. The economic argument is that people select the best quality of life they can obtain commensurate with their resources and personal desires (Diener and Eunkook, 1997). By comparison, social indicators are based on normative ideals on what could be considered the good life. Examples of such include infant mortality levels, literacy, crime rates *and* the quality of the environment. Both economic and social indicators are objective measures. Neither set of indicators depends on the subjective experience of the individual, but rather on what society considers to represent quality of life. Rather, they form a ‘point of departure’ from which to evaluate life satisfaction as demonstrated by subjective indicators (Campbell et al., 1976)

Subjective well-being (SWB) records people’s perception of their satisfaction with their life, including their social or psychological needs as well as their material or physical needs. Perceptions of well-being involves an evaluation of one’s quality of life in relation to a set of personal values as well as the prevailing objective circumstances. The indicators which tend to be of most importance to people are those that are considered to be most relevant to an individual’s own personal situation (Pacione, 1982). Key indicators include personal health, public safety, social connectedness, family relationships, culture and identity, working conditions, sense of autonomy, personal security and levels of contentment (Fahey et al., 2003; Islam and Clarke, 2002)

Local contexts are very influential in this respect, particularly social relationships, but also the environment. This includes the environment’s ability to supply basic needs and survival by way of clean water, food, essential materials, protection and health. In the Maslow (1954) hierarchy of needs, these basic physiological, safety and security needs appear at the base of a pyramid. Once met, the person ascends through hierarchies of belonging, self-esteem and self-actualization in which emotional needs, productivity, autonomy, accomplishment emerge as important needs. Other researchers, for example Doyal and Gough (1991) or Max-Neef (1989, 1992) have taken a different perspective and environmental quality. For example, in the Human Scale Development Matrix (1991), there is no hierarchy of needs, but rather an inter-related system of needs. Indeed, needs analysis a long history in psychology informed by the writings of Sartre (1943), Marx (1848) and Fromm (1956).

Ecosystem services can be regarded as “needs satisfiers” (King et al., 2014). The Millennium Ecosystem Assessment (MEA, 2005) emphasised the connectivity between ecosystem services and dimensions of well-being. It demonstrated that the connection is not based only on consumption, but on supporting, provisioning, regulating and cultural ecosystem services provided by the ecosystem in its natural state. Their respective importance depends on the type and level of needs and benefits they help to fulfil. The challenge is to find indicators that can adequately describe cause and effect and which communicate the contribution of the environment to quality and way of life (King et al, 2014).

*Measuring socio-cultural values and subjective well-being*

Measures of subjective well-being have increasingly made use of participatory methods to allow people and communities to define for themselves the dimensions that are most relevant to their sense of well-being. Deliberative methods can be used within workshop settings to allow people to express their relationship with the environment and to learn of one another’s values. Participatory mapping (e.g. (Raymond et al., 2009) is useful both to demonstrate the location or key ecosystem services and to elaborate on people’s understanding of these services, inter-relations between them and, especially, the role of cultural ecosystem services which could be the more unfamiliar to outside observers. Both quantitative and qualitative measures are appropriate in this participatory work (Camfield, 2008), but must retain relevance and meaning to local stakeholders.

Various indices have emerged that use combinations of qualitative and quantitative data to map trends on quality of life. Of these, the Sustainable Livelihoods Framework (International Fund for Agricultural Development) specifically focuses on the role of ecosystem services and the implications for community resilience and capacity for adaptation to a changing environment. The benefits to human beings depend on a flow of ecosystem services and these provide opportunities to develop workable indicators of well-being. Participatory methods can provide valuable information on the benefits that people perceive from the environment, including the fulfilment of basic and intermediate needs, and to link these directly to the condition and sustainability of natural capital.

## Social values and national accounts

By their nature, national accounts require quantitative values to demonstrate economic performance. If these measures are to be at least a reasonably accurate they have to take into account the contribution of natural capital. Bartelmus (2009, 2015) believes that the contribution of the environment can be addressed by the inclusion of costs to account for depletion of natural resources or the maintenance of the natural capital stock. In his opinion the inclusion of demand-side estimates would introduce too much unreliable data and would be incompatible with conventional accounting methods and would degrade the pragmatic value of national accounts for governments. Boyd (2009) believes that a true account of the contribution of nature can only be achieved through the inclusion of ecosystem services values, specifically those relating to final benefits. To date, the SEEA has avoided the inclusion of demand-side estimates while acknowledging their merits in experimental accounts.

In principle, measures of the ecosystem services benefits can provide insight into the quality or level of these flows. Indicators can perform a service in this respect, particularly where they are most proximate to human welfare (Boyd et al., 2015). They can also, by transference, be used to measure the quality and status of the natural capital stock. Bartelmus (2009) acknowledges that the use of cost-based measures in national accounts cannot address the need to ensure the protection of irreplaceable natural capital.

Critical natural capital can sometimes be identified through biophysical indicators, but human beings also have a role in defining what is meant by critical natural capital and to what degree natural capital can be substituted by other forms of capital. A more widespread acknowledgement of socio-cultural values and an understanding of the factors that contribute to subjective quality of life can help to define what trade-offs are permissible and can clarify the true relative value given to other entries in the national accounts.

There is no guarantee that measurement of the flow of ecosystem services or ecosystem services benefits will provide an indication of the status of the natural capital stock. Ecosystem services flows may not respond in a discernible or predictable fashion to the depletion of the underlying stock of natural capital in a way that can be measured in accounting units. The use of participatory methods, particularly in socio-ecological contexts, can provide more information on changes in the quantity or quality of ecosystem services. At the very least, these methods provide greater insight into the value that is placed on natural capital, but they can also potentially provide information on the condition of critical natural capital. Thresholds may be present beyond which the ecosystem will no longer be able to meet human needs or might otherwise switch into an altogether new or novel state. Biophysical indicators are therefore needed that can relate to ecosystem services values which can be estimated by economic analysis or informed by social research. The location of environmental thresholds and the response of the ecosystem to change is often poorly understood using scientific criteria, but a greater awareness of the social implications can help to ensure that decisions based on the use of national accounts do not fail to take into account potentially irreversible impacts on critical natural capital.

# The policy use of ecosystem accounting

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## Introduction

As discussed in Chapter 2, the development of Ecosystem Accounts at the EU and national level is still at an experimental level. At the moment, the European Environment Agency is developing Simplified Ecosystem Capital Accounts (SECA), and a number of countries are starting to build different typologies of Ecosystem Accounts, including forest, water and carbon accounts (see Chapter 1 and 2).

The ambition behind this effort is to employ Ecosystem Accounts to collect and organise available raw data (and in some cases to create new data) in a systematic and coherent way, in order to provide information that is relevant for policy making and research. This process is still in an early stage for most types of Ecosystem Accounts. It will require a strong commitment over the next years to address the many methodological issues, to collect the necessary data, and to ensure that the accounts outputs are in a suitable form, in order for them to be useful as inputs into policy making processes.

This chapter discusses the actual and potential policy uses of Ecosystem Accounts, based on a literature review, engagement with expert groups and the answers to a questionnaire sent to national experts of different countries, including the UK, the Netherlands, Germany, Spain and Sweden.

## The different use of Ecosystem Accounts

The use of an Ecosystem Accounting framework defines the stock of ecosystems (ecosystem assets) and flows from ecosystems (ecosystem services) in relation to each other (as noted in Chapters 1 and 2), and also in relation to various other environmental, economic and social information – to the extent that these are linked in practice. Through the Accounts, ecosystems can be linked explicitly to economic and other human activity, both in terms of the services provided by ecosystems, and through the impacts that economic and other human activity have on ecosystems and their future capacity to support and supply services. Finally, Ecosystem Accounts can be useful to explore the potential trade-offs between the different mixes of ecosystem services that arise from different scenarios of future land use change.

Physical Ecosystem Accounts (as noted in Chapter 2) can provide useful information about the stock of resources (‘quantity’) and the physical condition of ecosystems (‘quality’), that in turn supports the provision of ecosystem services. They also give insights on changes in Natural Capital stock (e.g. degradation) and changes in service flows – all issues of policy interest. The physical accounts by their nature do not address issues of economic scarcity, human demand for services, and supply of labour and manufactured capital required to actualise ecosystem services: for this, monetary accounts are potentially useful (as explored in Chapter 3). Economic demand and scarcity are reflected through the prices that people are willing to pay in markets: higher demand or greater scarcity results in higher prices. The use of human and produced capital in ecosystem service production functions is represented through the payments to these factors of production

To the extent that monetary accounts can reflect ecosystem services (at the moment quite a partial coverage), they can highlight the different values arising from ecosystems as current flows, and in the future through the asset values, and help track changes in these values over time. They can also be used to estimate the economic costs related to losses of Natural Capital (i.e. a concept similar to Natural Capital depreciation) or the costs of maintaining natural capital such that the flow of services is not reduced over time. Where monetisation is possible, the result of monetary valuation of ecosystem services can be linked to other economic indicators, including e.g. job creation, added value provided by well-maintained ecosystems, and potentially the added value of sustainable practices (i.e. of sustainable tourism, fisheries, timber and agriculture).

Accounts can also be used to develop indicators to potentially support different phases of the policy cycle. This includes the diagnosis and prioritisation of environmental issues, the definition of objectives and associated targets, the design of policies for conservation and other sectors, and the monitoring and assessment of their impacts. Where there is actual potential for added value will depend on the accounts outputs and how these can respond to the specific needs and opportunities within distinct policy areas. By integrating data in a common framework, accounts can, for example, facilitate the assessment of trade-offs and synergies across policies, in particular where the accounts are based on spatially-explicit mapping.

There are many other potential areas of application, for example mapping and tracking information under the Water Framework Directive compliance, identifying areas of water stress, and informing the next round of River Basin Management Plans (see water section below). Extended analysis using accounts could also be useful in scenario planning exercises, as an alternative framework for presenting information. As an example, ecosystem accounts could be used to improve the management plans of the Natura 2000 network (developed after the EU Habitats Directive) which combine a good level of environmental protection with a certain degree of socioeconomic use. This could also be a good way to test the methodologies through different scales, as it could be applied at local (Site of Community Interest), regional (region or EU Member State) and, more widely, to a biogeographic region.

The usefulness of accounts for policy processes should grow over time as accounts become more robust and comprehensive, and also more familiar to policy makers. However, for the most part these uses remain hypothetical, and it remains to be seen how useful accounts prove to be in practice, in light of the uncertainties and methodological challenges (see Chapter 1, 2 and the conclusions of this chapter). Ongoing experimentation with accounts is starting to shed useful light on where accounts and which metrics and values (biophysical or monetary) offer added value and where limitations or indeed risks exist.

## The potential added value of Ecosystem Accounts to policy making

In principle, in the future Ecosystem Accounts may be useful at different levels of the policy-making process, from the European to the national and regional level. Their potential as a support tool for policy making will depend, among other factors, on the scale[[32]](#footnote-32) and the level of detail of the accounts, the type and precision of output indicators they produce and the type of issues they cover (e.g. land, water, carbon on the one hand, and links to spatially specific elements such as population centres and/or industrial installations on the other).

In general, the information collected in the Ecosystem Accounts seems to be more useful at a **higher level** (i.e. linked to objectives and targets such as carbon biomass targets, NNL objectives, as well as plans and programmes) and less at the level of specific instruments (like for example the establishment of Payment for Ecosystem Services or biodiversity offsetting programmes in specific locations), because the latter kind of instrument tend to require information at a much lower scale than the one that will be offered by ecosystem accounting. For example, the Simplified Ecosystem Capital Accounts (SECA) that are currently being developed by the European Environment Agency, adopt a grid of 1 km2, given the EU wide focus. Other accounts, especially regional and local ones can have significantly more precision and hence site specific utility.

That said, in some cases specific instruments could be directly linked to the higher level targets (e.g. carbon sequestration payments) and even for offsetting it is important to set the local details in the regional/national context which the accounts can provide. In other words, while the assessment of the level of service provided by a particular landowner would not be given by accounts, the level of payment could well be informed by broad-scale analysis. If e.g. accounts reveal a decline in provision/quality of a particular habitat type across a nation, that could be a signal for increasing conservation payments associated with that habitat type.

In general, Ecosystem Accounts seem more likely to play a role, when fully developed, in setting up, or monitoring performance against environmental objectives, targets and strategies to be used in **plans and programmes** (e.g. on land use change or on organic carbon stored in biomass), and also to assess their **impact**. This is particularly true for environmental issues that need to be addressed at a **global** level, like for example targets to be established for GHG emissions. For other environmental policy areas national targets set in quantitative terms at a national level have to be broken down to sub national or regional level according to the specific ecological and socio-economic conditions (e.g. national targets to reduce urban sprawl, or to extend natural floodplains for enhanced flood-mitigation). Another example of this is water policy, because specific targets on water availability and quality generally need to be set depending on the specific characteristics of each water body (i.e. good ecological status under the Water Framework Directive).

As regards biodiversity, which is highly local in terms of specific management interventions and specific performance, there may be benefits of regional/national aggregate data, which can show how national policies and measures are performing, especially where there are spatial considerations such as metapopulations, or where the service is providing suitable habitat rather than necessarily actual presence at any specific point in time (see biodiversity section). An example of this is the reporting of Art 17 of the Habitats Directive, done every 6 years, that could guide conservation policies for national, biogeographic, or even EU level.

In general, the potential in terms of policy-making will be more substantial when Ecosystem Accounts will be linked to spatial data – i.e. spatially defined accounts that are linked to other spatially important issues such as human population centres, thereby linking the supply of services (ecosystems) to the demand for them (human needs and preferences). This kind of development will need further research, methodological development and experimentations, but it is already seen as a promising direction and it is mentioned in the third volume of the SEEA revised version (section 4.2). More generally, spatial assessment and mapping of ecosystem services, and linking spatial land use models to human and economic models for spatially explicit valuation, is at the cutting edge of valuation research (see e.g. OPERAs task 4.4.2).

Debates on methodological and conceptual issues continue, alongside a range of experimentation at national and other levels. It is to be hoped that this process will result in the development of one or more coherent frameworks and sets of methodological guidance. Ecosystem Accounts will ideally ensure **comparability** across countries and over time. Comparability is particularly important when dealing with multi-country and cross-border environmental issues, like for example carbon storage in biomass and management of international river basins.

However, multiple levels or hierarchies of accounts, using different indicators and scales to meet different specific needs of assessment, monitoring, management and policy, can be useful for different policy areas. For example the size of basic accounting units may vary between national Ecosystem Accounts and protected area or corporate accounts (not covered in this article). Issues of scaling up and compatibility across different hierarchies of accounts are an important area for research and debate.

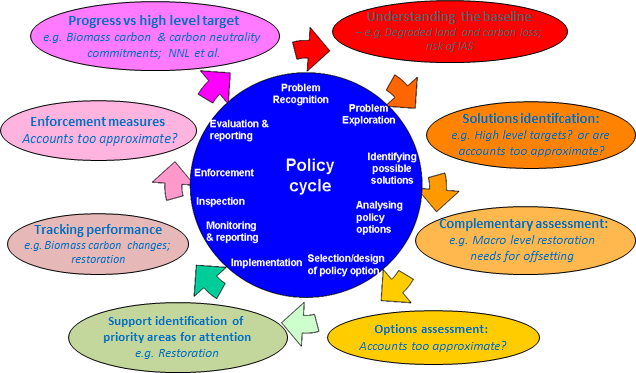
## The use of Ecosystem Accounts in the policy cycle

Policy making includes different phases and follows a cycle of understanding, action, reviews updating knowledge and further action (ten Brink et al., 2011):

* Problem recognition (e.g. endangered habitats, degradation, loss of ecosystem services; areas of soil loss and low biomass carbon; scale of potential risk of invasive alien species);
* Identification of solutions (e.g. management activities for favourable conservation status; potential restoration areas, if and where, suitable spatial definition);
* Assessing and identifying linkages between policy options (e.g. investment in protected areas, green infrastructure);
* The implementation process (e.g. restoration expenditure, subsidy reform, payment for ecosystem services); and,
* Ongoing monitoring and evaluation (e.g. status and trends and how this compares to objectives and targets, e.g. supporting insights on carbon neutrality ambitions, water storage and stress, soil erosion, contributions to NNL objectives and areas of net positive gain).

In some areas accounts seem to have a potential to contribute (see Figure 5.1 and discussions in sections below). In other areas questions can clearly be raised as to whether the tool will be able to offer sufficient detail to be fit for purpose and provide added value in those steps of the policy cycle. Current experimental accounts are likely to be too approximate (i.e. to large spatial resolution and accuracy) for a number of steps. However, this will evolve with the development of the tools, which in turn depends on experimentation and investment in resources.

**Figure 5.1 The potential utility of Ecosystem Accounts in the policy cycle: examples and questions**



Source: own elaboration, after ten Brink et al. (2011)

In principle, Ecosystem Accounts can be used to develop indicators that can support different phases of the policy processes aiming at improving the condition of the ecosystems and the provision of ecosystem services. These phases include the diagnosis and prioritisation of environmental problems to be tackled, the definition of objectives and targets, the design of sectorial policies and the assessment of their impacts.

In this respect, an added value of accounts over raw data that are not integrated in a common framework and data set is the capacity to support the analysis of trade-offs and synergies among policies, by enabling analysis of the links between different components of ecosystems and different datasets (e.g. between land use and organic carbon accounts). This is especially true if accounting is combined with spatial mapping.

In general, the answers to our questionnaire show that the accounts have not yet been used directly in policy making, because they are still in an early stage, but are being used to explore policy relevant questions. For example, in the UK they are classified as experimental statistics, meaning that they are not expected to be used directly in a policy context at the moment. However, the interviewees from the UK and the Netherlands underlined that the interest from several ministries in the development of Ecosystem Accounts is high. At the moment, the use that has been made of accounts can be defined as awareness raising, contributing to the first phase of the policy cycle, i.e. problem recognition/exploration. For example our UK interviewee said that the estimate of the total value of UK Natural Capital (Khan et al, 2014) has been widely quoted both inside and outside Government, and also the estimate that the asset value of UK woodland ecosystem recreation and carbon sequestration services is 19 times the value of timber provision has raised interest from within the Government, Including being used in recent speeches by the Secretary of State for the Environment.

As regards Spain, according to the answers to our questionnaire provided by the Spanish expert, the National Ecosystem Assessment has already been used in a number of occasions (see Box 5.1)[[33]](#footnote-33).

|  |
| --- |
| **Box 5.1 The contribution of the Spanish National Ecosystem Assessment to national plans, strategies and laws and international processes:**  The information collected and systematised in the Spanish National Ecosystem Assessment (The Spanish National Ecosystem Assessment (EME, from its name in Spanish: “Evaluación del Milenio de España”) – see Chapter 2 of this report - has contributed to a number of national and international policy processes by:   * Providing information for the implementation of the Spanish Strategic Plan for Biodiversity and Natural Heritage (2011-2017), and in particular helping to:   + Establish monitoring indicators of the main drivers of change in ecosystems.   + Promote coordinated projects to connect basic research and the development policies applied for biodiversity conservation.   + Promote studies addressing the economic valuation of biodiversity and conducting systematic reviews and analyses of available studies in Spain.   + Create lists of and mapping ecosystem services in Spain.   + Improve mechanisms for communication with society related to biodiversity.   + Promote the consideration of biodiversity and ecosystem services, including their economic value, in the design of the policies of the General State Administration.   + Encourage the consideration of biodiversity and ecosystem services, including social and economic values, in the activities of Spanish institutions.   + Develop environmental indicators related to human wellbeing in addition to the gross domestic product for incorporation into social and political debates. * Providing information for the implementation of Law on Natural Heritage and Biodiversity 42/2007 and Law for Sustainable Rural Development 45/2007. * Providing socio-ecological information on specific habitat types to establish Special Areas of Conservation in communities under Natura 2000, that has been used for the setting of both National Level and Site (of Community Interest) specific level Natura 2000 management plans. * Providing information for the development of the Water Framework Directive of the EU. * Providing information for the Spanish Endangered Habitats Catalogue developed as mandatory by the Spanish Law on Natural Heritage and Biodiversity 42/2007   EME also contributes to a number of international processes, including:   * The European Biodiversity Strategy (2020). Representatives of the Spanish NEA have been actively collaborating with the MAES Working Group to support the implementation of Action 5, which calls MS to map and assess the state of ecosystems and their services * Intergovernmental Platform on Biodiversity and Ecosystem Services: The work of the Spanish NEA has already been included in the “Assessment Catalogue” * Convention of Biological Diversity: The Spanish NEA provides up-to date information to progress in the assessment of ecosystems and biodiversity, and meet international goals. * Millennium Ecosystem Assessment Follow-Up. The Spanish NEA was approved as a new sub-global assessment in 2012 for the follow-up process, and has been in constant collaboration with the relative Sub-Global Assessment Network. * Habitats Directive *ad hoc* groups for establishing favorable reference values. Members of the Spanish NEA are involved in the elaboration of a new guidance to improve the reporting of the conservation status of habitats and species of community interest under the EU Habitats Directive.   Source: questionnaire carried out for this study |

## Ecosystem Accounts in the different policy areas

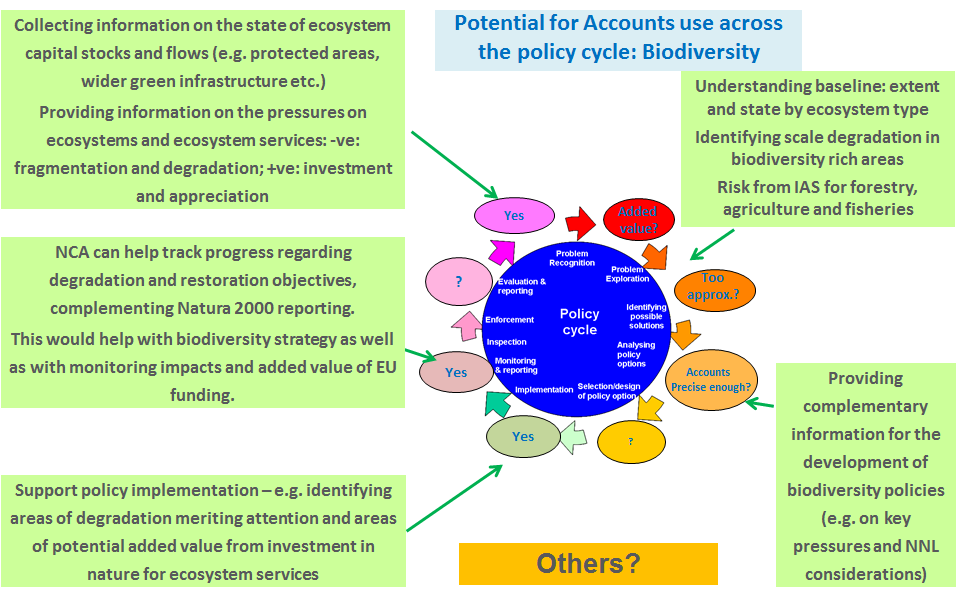
As discussed in Chapter 2, Ecosystem Accounts are as yet at an early development stage, and their present contribution to policy processes is still limited. As they progress and develop a robust and coherent set of data, they will potentially be able to support policy making in a range of areas. This chapter explores the potential use of Ecosystem Accounts in key environmental policy areas, which can help show both where likely utility will be, and where current experimentation on accounts can usefully focus. The experimentation will in turn improve the quality of accounting approaches and can lead to a wider set of areas being amenable to accounting as the tool matures.

### Biodiversity

The EU Biodiversity Strategy (COM(2011) 244 final) state that by 2050 the EU biodiversity and the ecosystem services it provides shall be protected, valued and appropriately restored. In order to reach this objective, Target 2 (Action 5) requires Member States to map and assess the state of ecosystems and their services in all Member States by 2014 and to carry out a monetary evaluation to integrate their value into accounting and reporting systems at EU and national level by 2020 (Target 2, Action 5). Ecosystem Accounts are therefore explicitly included, and as they develop they will play a key role in a number of stages of the policy cycle (see Figure 4.2).

Information on the physical state of ecosystems and the stocks of ecosystem assets are central to tracking targets associated with restoration of degraded ecosystems and halting the loss of biodiversity. Information on flows of ecosystem services and human activities impacting on ecosystems are important in identifying pressures on ecosystems. Ecosystem Accounts can track this information at a broad scale. This could be complementary to existing reporting at smaller scales, for example the reports on the Conservation Status as required the Habitats Directive’s art.17. This broader-scale assessment could potentially inform trade-offs across sites or priorities – for example, where degradation of coastal areas and other marine pressures are leading to ongoing loss of wading bird habitats, Ecosystem Accounts tracking the decline of the quantity and quality of intertidal habitats could be used to promote conversion of other, less-threatened habitats to intertidal through coastal realignment.

**Figure 5.2 Potential for Ecosystem Accounts for biodiversity policies**



Source: own elaboration

Ecosystem Accounts can prove useful for the problem recognition and problem exploration phase of biodiversity policies, by providing systematised and coherent data on the state of ecosystems and the flows of ecosystem. The support function of Ecosystem Accounts will be maximised when data will be made spatially-explicit, as in this way they will provide useful information on e.g. the ecosystem services provided by protected areas in order to support management strategies and evaluate their impacts. Ecosystem services can provide information on the pressures on ecosystems and on the related change in the provision of ecosystem services due to fragmentation and degradation, which will help to address them. Of course the information provided by Ecosystem Accounts will need to be complemented by more detailed information, as the scale and level of detail of Ecosystem Accounts will not be enough to support the decision-making process. However, Ecosystem Accounts can provide an overview of key processes and can give a first indication of priorities to address.

In general, Ecosystem Accounts may help to assess the key pressures on biodiversity, as they will allow to link information coming from different kinds of data, all in the same scale. For example, comparing land accounts and water accounts can help identify degraded areas and risks for key ecosystems (e.g. in wetland areas). Similarly, Ecosystem Accounts can help link information on changes in land use in areas with high biodiversity with other relevant variables (e.g. population, water use and availability, carbon storage and sequestration in biomass and soil).

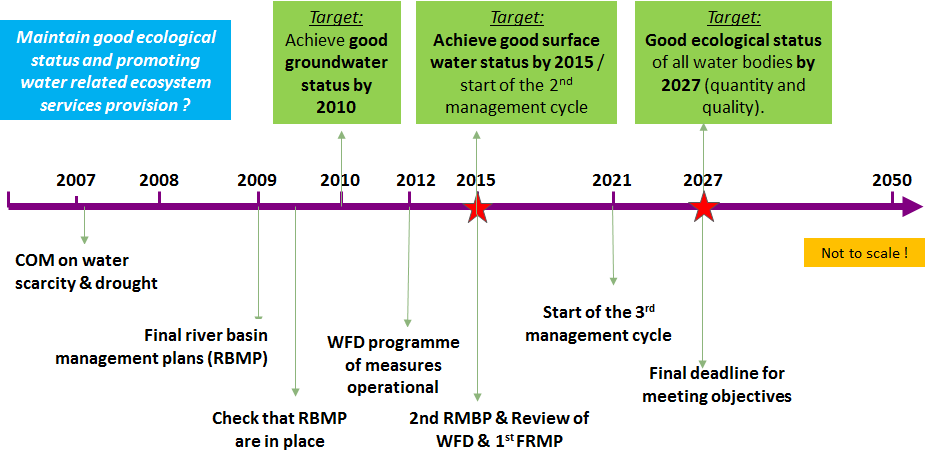
In addition, Ecosystem Accounts can provide an overview on the ecosystem services provided by areas rich in biodiversity, contributing to build up strong arguments to be used in the policy arena to defend their designation and management.

On a practical, operational, level, accounts could be useful tools within the context of Cohesion Policy (CP), where the proactive investment in Natural Capital is seen as supporting a range of policy objectives of the period 2014-2020 (see Hjerp et al., 2011), notably *Objective 6: Protecting the environment and promoting resource efficiency,* but also others such as *Objective 4: Shift towards a low-carbon economy in all sectors (see climate policy),* and *Objective 7: Promoting sustainable transport* (which includes green infrastructure investments, as well as routing choices*).*

### Water policy

In principle, Ecosystem Accounts can support the implementation of the main pieces of legislation on freshwater, i.e. the Water Framework Directive (2000/60/EC) (WFD) and the EU Floods Directive (2007/60/EC) (FD) and the Groundwater Directive (2006/118/EC) (see Figure 4.3 for key objectives and dates). All these Directives require detailed data on the quantity and quality of freshwater over time, which are already being collected at the water body level. The process of developing Ecosystem Accounts may potentially play a key role in this context, by integrating this kind of information in a coherent and wide assessment of ecosystem state and condition and ecosystem services, thereby supporting a more effective protection and management of freshwater.

**Figure 5.3 Water policy timeline: context for Ecosystem Accounts**



Source: own elaboration

In particular, the WFD requires river basin management authorities to prepare River Basin Management Plan (RBMPs), which include data to monitor the progress towards the achievement of a good ecological status, which is the objective of the Directive. The data collected in the RBMPs could also potentially be used to develop water accounts. Furthermore, synthesising information on water intake, water availability and water quality and exploring the links between water use and land cover will help to identify areas of water surplus & stress. With regards to specific targets, accounts could help support the development of River Basin Management Plans (RBMP). Furthermore, where sufficiently detailed, they may help with WFD legal requirements regarding detailed ecological flow objectives (by 2020), as they may help identify limits of abstraction that are consistent with the objectives. They could also help with the target of good status for groundwater and good ecological status/potential for surface waters (2027).

At the EU level, the Simplified Ecosystem Capital Accounts, which are being currently developed by the European Environment Agency, include water accounts. These accounts focus on water stocks and flows, whereas water quality accounts are not being developed yet in an integrated way at the national level (Russi and ten Brink, 2013).

In general, water accounts can help assess water demand, and give information on available water, exploitable water and water that is not exploitable because of ecological limitations. In addition, water accounts may help inform the application of the WFD, by collecting and summarising information on water intake at the sub-basin level.

Other kinds of accounts can support analysis and policy making for water policy. For example, land accounts can provide information on the link between forest areas and water availability and the link between water and cities (e.g. dependency of cities on upstream areas for water supply). This will be of interest to cities and regions. Within a European context there may be some policy links to Territorial Cohesion under the Cohesion Policy, given the importance of access to clean water for urban and rural populations.

Ecosystem Accounts may also contribute to the application of the WFD, providing a link between water and land use, e.g. to help define which wetlands are used as flood plains and to provide information on the ecosystem services related to flood management, by for example identifying the areas that allow water infiltration and reduce run-off. Finally, Ecosystem Accounts may help address the potential for water retention measures though water and land accounts integration.

In the future, Ecosystem Accounts could potentially cover quality elements, by e.g. providing information on the provision of ecosystem services like e.g. water purification, sediment treatment.

Challenges remain, in particular on developing integrated land-biomass-water accounts to provide (real world) indicators for the inter-linkages and hence prove added-value beyond existing indicator set. Also, it will be necessary to find resources for river basin management accounts and buy-in for these to become part of river basin management plans that integrate natural assets and ecosystem services

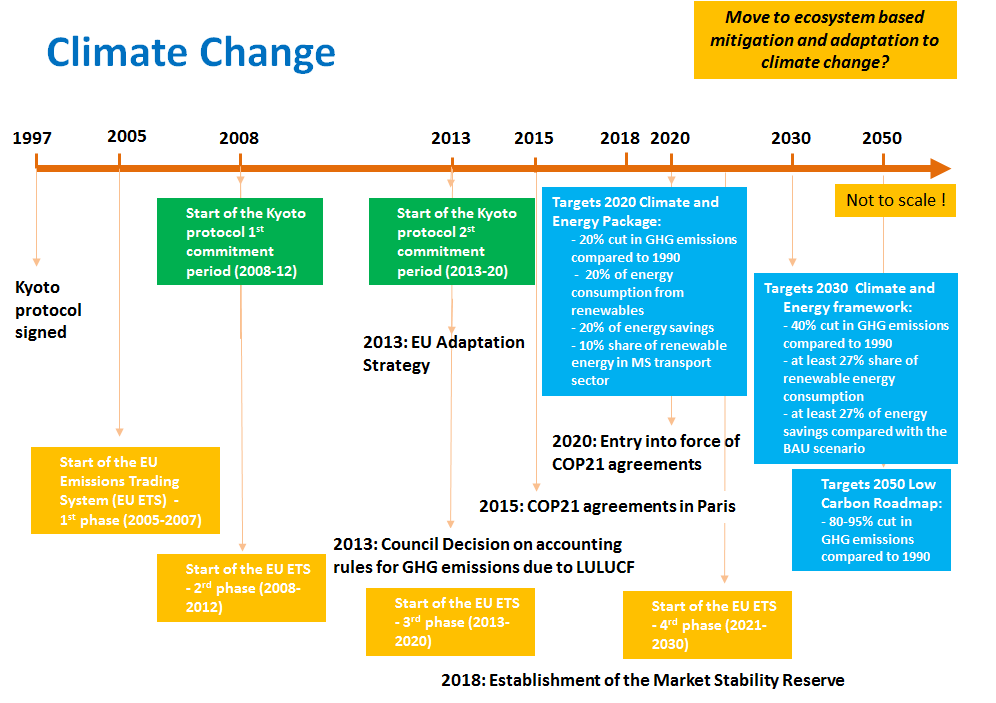
In principle, the accounts – had they been available on time - could also have helped with the Floods Directive (FD) and the identification of flood risk areas (2015), by helping identify which areas are at risk from flooding and priorities to address, e.g. linking water surpluses and proximity to population centres. However, given the target, the state of accounts and the existence of alternative measures (i.e. maps, indicators/monitoring, and hydrological monitoring), it is unclear whether and when accounts could offer higher added value than current tools.

### Climate: mitigation and adaptation

As regards climate change mitigation, Ecosystem Accounts can provide useful information on the carbon stored in biomass and soil, thereby helping monitoring the trends in carbon emissions due to changes in land use like for example deforestation, afforestation and increase or decrease of important carbon sinks like peatlands. Ecosystem Accounts can complement data collected by the United Nations Framework Convention on Climate Change (UNFCC) on Land Use, Land-Use Change and Forestry (LULUCF), and may help shed light on the links between changes in land use and carbon stored in biomass and soils. Changes in carbon storage and changes in soil fertility will also be a useful link to explore to help communicate the multiple benefits of certain agricultural practices that support soil carbon levels, avoid erosion and help with soil fertility levels.

Accounts can therefore help in monitoring progress of the carbon-biomass element to the overall targets of reducing GHG emissions over time (see Figure 4.4 for policy time line).

**Figure 5.4 Climate policy timeline: context for Ecosystem Accounts**

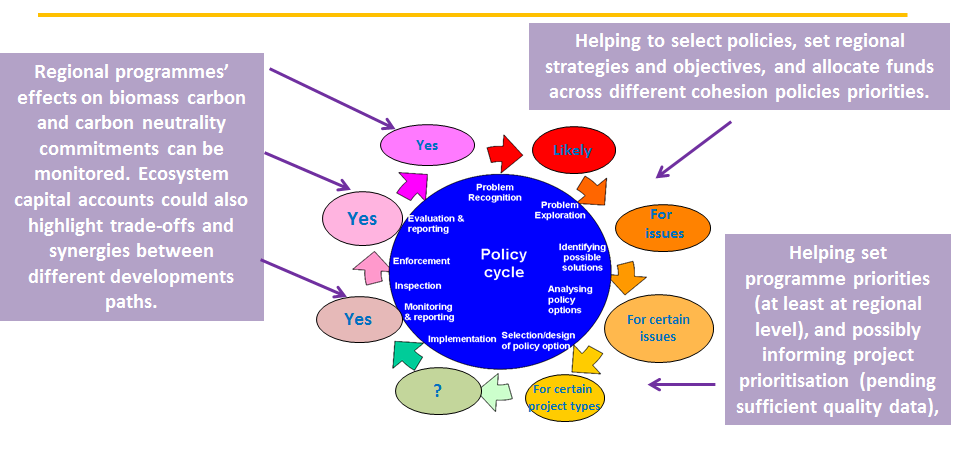


Source: own elaboration

Ecosystem Accounts can in principle also support adaptation policies, by collecting and systematising data on the ecosystems that prevent downstream and coastal flooding or droughts, and thereby supporting ecosystem-based adaptation policies. This will require an integration of other spatially critical elements in the accounts, notably location of population centres.

This will be of importance at the EU and national level, and also at regional levels. For example, commitments by regions to no net loss of carbon (as exist for emissions in some regions) could be expanded to net positive carbon sequestration by integration of positive fluxes of biomass carbon. This could support the Cohesion Policy[[34]](#footnote-34) in the development, monitoring and assessment of operational programmes, as well as in the prioritisation of large projects (see figure below on the policy cycle and accounts utility for cohesion policy and climate change).

**Figure 5.5 Potential for Ecosystem Accounts for climate change mitigation through Cohesion Policy**



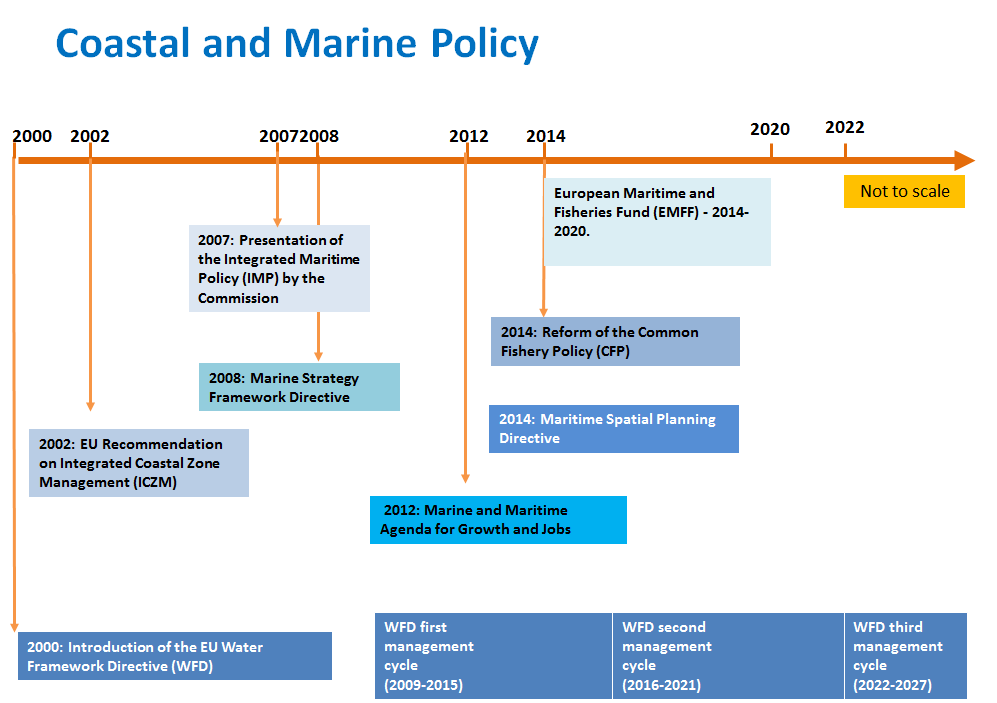
Source: own elaboration

In addition, accounts of biomass carbon could support the Common Agricultural Policy’s Regional Development Programmes, by providing information on the consequences of changes in land use on carbon emissions.

### Marine policy

The EU Marine Strategy Framework Directive (MSFD) requires Member States to achieve a good environmental status of their marine waters by 2020. In order to achieve these objectives, Member States should provide an assessment of the use of marine waters and develop action plans and explicit measures. Together with the MSFD, other policies on marine and coastal areas will require the collection and systematisation of data, including the Marine Spatial Planning Directive, the Integrated Maritime Policy and the Common Fishery Policy, and the Water framework Directive, which also have an impact on the status of marine ecosystems (see Figure 4.6).

**Figure 5.6 Coastal and marine policy timeline: context for Ecosystem Accounts**



Source: own elaboration

At the moment, not much information is available yet on the current status of marine waters, and in this context Ecosystem Accounts may provide a useful framework to organise and systematise relevant information on the condition of marine ecosystems and the ecosystem services they provide. They can also help analyse the link between the status of marine ecosystems and important stress factors like water and land use in coastal areas.

A scoping study on how to develop marine accounts has been recently prepared by eftec (2015b). Since scientific understanding that links habitats to the provision of ecosystem services in marine areas is uncertain and data on both quantity and quality of marine habitat characteristics are poor, the eftec scoping study suggests that in the short term accounts are developed using data on pressures, broken down into those related to surface water, the pelagic environment and the benthic environment. Monetary accounts could be developed using data on landings volumes and value from the previous year, while fisheries ecosystem stock accounts can be based on expected landings under ICES or other relevant stock predictions and harvesting rules. The long term ambition, however, is to develop an understanding of relationships among ecosystem characteristics, human pressures and fish provision, including parameterised food-web models, incorporating economic models that take into account fishing fleets’ behaviour in response to altered availability of fish species.

The research also flagged the importance of thresholds in marine environments and exploitation, though this also applies to other ecosystems. For fisheries, overfishing and stock collapse are common problems, making the constant flow assumption of accounts questionable for certain cases. As noted in Chapter 3 of this report, a precautionary approach would require demonstration that a constant flow is a reasonable assumption. Where sustainability cannot be established, that begs the question of what future decline should be assumed and indeed how to take non-linear losses into accounts. eftec (2015b) reports that the position taken in the SEEA is that accounting for thresholds does not fit in well within a model based on assessment of change over successive accounting periods, and conclude that further work is required on how to incorporate limits and thresholds into the accounts. Any interpretation of meaning of accounts will need to take into account what can and cannot be reflected in the accounts and how.

### Forestry policy

Forestry policy needs to be informed by biophysical indicators detailing information on the extension and types of forest cover, complemented by monetary information. The information should take into account the complexity and spatial variability of the impacts related to different land use choices. For example, planting forest over peat soils is likely to be detrimental in terms of carbon balance; planting forest near urban populations gives substantial recreational potential. However, policy making (and in particularly the CAP) typically fails to embrace this spatial complexity. Individual project appraisals may take account of some spatial factors, such as the location of a proposed investment with respect to human populations, but are less likely to take account of more complex interactions such as the availability of substitute sites or conservation network effects.

Spatial optimisation models such as TIM (Bateman et al 2014) seek to combine detailed land-use modelling with valuation of ecosystem services, taking account of spatial interactions across services and with human populations, and allowing exploration of different strategies and policies, including constrained optimisation of land-use choices with respect to welfare-based assessments of value for monetised services, and sustainability constraints on provision of non-monetised services.

Ecosystem Accounts will report aggregates of physical and monetary values based on data at the spatial scale used in the accounts. They will not, however, illustrate the local details of spatial trade-offs in the way that spatial optimisation models can. But they will track changes over time in the forest cover, and will provide a high-level overview by quantifying both in physical and monetary terms the provisioning and non-provisioning ecosystem services provided by forests, including carbon sequestration, protection from natural hazards, recreation and tourism opportunities. This kind of information will help raise awareness on the full range of benefits forests provide to human economy and wellbeing, and thereby support policies aiming at an improved protection of forest resources.

The intended uses of accounts will influence methodological decisions made in their construction. As discussed in eftec (2015a), where the purpose is national-level monitoring then the use of coarse aggregated indicators (at the national/regional scale) for service provision may be sufficient. If the wider application of accounts in establishing variation in the condition and the relative importance (value) of woodland stands (or other ecosystems) across the nation is of interest, then spatial disaggregated accounts will be required. For services which are spatially dependent, this may also have the added benefit of leading to improvements in the national estimates. If not information is available to develop spatially disaggregated forest accounts at the national level, in the short term forest accounts could focus on specific areas such as National Parks or catchment areas and use the accounts to help the management of all ecosystems included within the area, not just the woodland ecosystem on its own.

Spatially disaggregated accounts represent a conceptually consistent foundation for understanding ecosystem service provision, since both stocks of ecosystem assets and the provision of ecosystem services and associated economic benefits are not uniform over locations. Overall service provision is dependent on spatial variation in quality, quantity and spatial configuration of the ecosystems. Hence if Ecosystem Accounts are to be applied to inform decisions at lower ecosystem accounting units levels, then a bottom-up, spatially-explicit approach should be preferred over attempts to breakdown highly aggregated (national/regional) level reporting.

However, it is moot to what extent the benefits of these approaches should be ascribed to accounting itself, rather than to analysis that is conducted alongside or as part of the accounting exercise. For example, modelling and mapping ecosystem services can be used for spatially explicit prioritisation, targeting of habitat creation/restoration, and exploring synergies and trade-offs among different ecosystem services. Changes in the quantity of one habitat will lead to changes in others at a national level, and this will be reflected in the accounts, via changes in physical quantities, service flows, asset values and cross-cutting accounts (e.g. carbon balance sheet). But the policy insights and explicit recognition of trade-offs and synergies come from the spatially explicit modelling, rather than from accounts directly.

## Conclusions

Ecosystem Accounts can, in principle, shed light on the benefits society obtains from a sustainable use of ecosystems and their services, both in monetary and biophysical terms. More experimentation is needed on both physical and monetary accounts to understand their potential usefulness to policy markets. This experimentation will also help clarify data needs and methodological developments to help realise the potential of these tools.

At the current state of development, biophysical accounts are arguably more robust and more widely valuable for policy use than monetary accounts. Biophysical indicators are likely to be and remain intrinsically more robust than monetary accounts, as the latter are inevitably characterised by significant methodological challenges, uncertainties and related need for assumptions and data gaps. With a few exceptions (see further below), monetary accounting for actually informing policy should be avoided over the period to 2020 (the Aichi target deadline linking to environmental accounting) – as the economic values that can be integrated into accounts are at the moment (and likely to remain) quite few, not accurate for many ecosystem services, and lead to economic indicators of the importance of nature that will under-represent the multiple values of nature.

Some developments will be possible with monetary accounts as the tools, methods, and data develop (see road map for research), but even then it is fundamentally important to assess whether accounts are fit-for-purpose for each policy applications on a case by case basis and what complementary information is needed to ensure that the full picture is taken into accounts. For this reason it is important to have a careful assessment as to where it can offer added value, how the results need to be interpreted and what other complementary (or alternative) instruments are needed to ensure that there is sufficiently complete evidence base at hand for policy decisions. This creates an agenda for research and useful lessons for how monetary accounting can be developed to offer what type of added value for what issues.

In general, the multiple roles and rationales for the protection and management of nature need to be reflected via a range of complementary tools, with an understanding of the relevant merits of each tool. As an example, monetary accounts can provide evidence on the ecosystem services provided by a forest area in terms of natural hazard protection, recreation and carbon storage, as well as potentially the economic income derived from timber logging and sale. In this way, they can provide strong arguments in the policy debate in favour of the sustainable management of areas that provide valuable ecosystem services. However, they will need to be complemented both by biophysical indicators reflecting the ecosystem services provided by the forest and also by a range of biodiversity indicators (UNEP - WCMC (2015). A multidisciplinary and multicriteria approach is important in order to avoid a subset of services to drive policy considerations (e.g. as in the REDD+ debate, where experts criticise the use of an excessively carbon-driven instrument, which may lead to overlook other important ecosystem services). In addition, using biodiversity indicators together with those focussing on ecosystem services to societies is important in order not to incur in the risk of privileging areas that provide a large amount of ecosystem services (e.g. because they are located near intensively populated areas) over more remote areas with a potentially higher biodiversity importance.

### Accounts are one tool in a wider tool kit

As noted above there are a range of **potential benefits from the use of accounts** across **policy areas** and **policy cycle steps.** The **actual added value** will depend on the indicators that come out of accounts (type, granularity, robustness, real world-or modelled), how they fit the policy (cycle) needs and what other evidence bases and tools are available such as long time series indicators, maps, one-off ecosystem assessments, valuation and assessment tools, and models**.**

### Accounts are for primarily for trends, not snapshots

The primary usefulness of Ecosystem Accounts is likely to be in the trends that they reveal over time, rather than the specific values recorded at a given point in time (which can build on assessments). Related to this, it should be noted that, given uncertainties over measurement and valuation, the specific values in accounts can be hard to interpret. But observing a significant change in consistently-estimated values over a period of years can signal important issues and/or areas which should be of particular concern for policy-makers.

This is similar to the observation that Costanza et al’s (1997) attempt to value global ecosystem services produced numbers that were eye-catching but arguably of little or no direct policy relevance beyond raising awareness of the importance of nature for an audience that listened in particular to economic arguments. Likewise, the update (Costanza et al. 2014) produced numbers that, alone, were striking, but difficult to interpret. However, the latter analysis also revealed changes, and helpfully broke these down into components of physical changes and changes due to revised economic values for services, and this provided key insights into important trends.

### Accounts can support policy evaluations and project appraisals, but cannot replace it

In general, the observation of trends through Ecosystem Accounts or similar exercises only reveals that some intervention may be required – i.e. useful at problem exploration and identification stage and later in the policy cycle at the monitoring and reporting stage. Accounts do not directly address the question of what that intervention should be – i.e. which policy option could be an attractive solution. For this, policy and project appraisal methods are required in order to address the problems identified by accounting. Ideally, these methods should be applied in spatially-explicit ways, recognising the trade-offs across services and the dependence on location with respect to human populations. Accounting could therefore help indicate where appraisal is needed, but does not replace the need for project appraisal. These are complementary tools, not alternatives.

### Accounts as a tool for communication and debate

A major role of accounts is in processing and summarising a vast range of complex data into a smaller more comprehensible set of indicators that has the additional advantages of facilitating consistent comparisons over time and also enabling comparisons between economic activities and investments and ecosystem services and assets. At the same time, using accounts as a tool for communication and debate comes with risks attached. In particular, a focus on monetary comparisons may weaken attention to sustainability constraints, though emphasis on trends in the physical accounts could mitigate this risk. Secondly, accounts using exchange values will contain different flow and asset value estimates from social cost benefit analyses using welfare values. The latter are a better guide to the social desirability of policy decisions. Thirdly, the way ecosystem services are defined and accounted for imply the existence of beneficiaries, and therefore a change in the flow of ecosystem services may depend on a variation in the number of beneficiaries and not on a change in the quantity or quality of the ecosystem services.

### Where to develop and apply accounts also depends on policy needs – and a proof of utility will be needed for policy makers to continue to support Natural Capital and Ecosystem accounting

The development of accounts faces a range of barriers, including:

* **Financial.** Accounts cost resources – as they require considerable **data** and **method treatment** to ensure comparability of different data sets.
* **Timing and complexity** - raising concerns that it will take too long to get results given the complexity of accounts.
* **Methodological challenges –** for basic data comparability work (e.g. to get data into common geospatial units), modelling to complement real world data, calibration and for monetary valuation of the value of stocks, degradation, flow of services.
* **Policy** – policy makers and institutional processes may already be committed to alternative (but not necessarily better) methods for getting the evidence base (e.g. indicator sets); there may be scepticism that Ecosystem Accounts can deliver indicators that are robust (e.g. for many ecosystem services); and there may be concern that the accounts will deliver unhelpful messages if the results are not interpreted in the right context. As noted above, monetary valuation in the context of Ecosystem Accounts focus on “exchange values” and these are less than the welfare values calculated by economists. Furthermore, certain ecosystem services will be difficult to integrate in physical terms and/or impossible in monetary terms hence the final accounts results will underrepresent certain types of Natural Capital and ecosystem services. If the fuller values of nature may be underrepresented and if policy makers look only to accounts for “answers” then there are risks.
* **Acceptability** by different groups of stakeholders, notably NGOs, who may not be in favour of using an approach based on ecosystem services (as it is anthropocentric) and on monetary valuation for all the reasons explained above
* **Staffing, as accounts require long term commitment, which ties up staff**. The implication is that accounts should have policy relevance so as to ensure commitments by governments.

There is therefore a need to demonstrate a proof of utility of what accounts are being proposed to address. This is likely to be demonstrated in areas where there is:

* 1. **High policy need** - e.g. peatlands degradation/restoration and regional carbon balances – the link to biodiversity, climate and Cohesion policies can be important here. Vanguard European regions committed to climate and biodiversity could usefully seek Cohesion Policies funding support to develop accounts to inform their programmes and project selection.
  2. **Implementation needs** – e.g. river basin management plans and ecological flow objectives for WFD (by 2020), as accounts may help identify limits of abstraction that are consistent with the objectives, and also with the commitment to achieving good status for groundwater and good ecological status/potential for surface waters (by 2027).
  3. **Economic benefits of the evidence base** - e.g. using accounts to identify forest values at risk from invasive alien species (IAS), flood risk areas and costs, eutrophication areas and impacts on population areas (where mapping, modelling and accounting are combined).
  4. **Fewer competing info sources**, so that experimental accounts have a chance of real added value – e.g. marine areas, which are currently less well understood than terrestrial ecosystems.

Targeted application and experimentation will be essential to demonstrate the value of these tools and keep the commitment to the instrument real. Note that where something offers added value will be country and region specific and advice will be needed from statisticians, accountants and policy advisors in the field and country. The above discussions of potential utility across policy cycle steps for a range of policy areas should give a potential long list of areas where experimentation could be useful.

However, a policy utility driven progress on accounts in turn creates the risk that more effort will be put into certain issues than others, creating variable progress and a potential imbalance in coverage in the short term. While this may be inevitable, and experimentation is essential to catalyse progress, it underlines the importance of presenting results in context, interpreting them accordingly, and complementing them with other sources of information. Furthermore, it underlines the need to invest early on the wider linkage between the specific elements and accounts so that they have the potential to be linked in the future. Care is needed also to not focus on certain things now with the argument that other elements will be done later, as the political will to support accounts may wane over time, creating a risk that only a partial tool will be created, when the overarching benefit of accounts is its integration potential, comprehensiveness and linkages.

### Accounts are a work in progress

The policy utility of Ecosystem Accounts is expected to grow over time for different environmental policy fields, across the stages of the policy cycle and geographic scales. At the moment they are still at an experimental level, and mostly not yet ready to be directly used in the policy arena, even though there are already some examples of Ecosystem Accounts supporting policy processes (see for example the Spanish experience in Box 4.1).

According to a recent questionnaire targeting experts at the EU Member State level (Gocheva et al., 2014), difficulties in implementing a more rigorous approach beyond single pilot actions appear to be due both to the need of multidisciplinary scientific work and to the need for international alignment in adopting uniform and statistically correct procedures for data collection and reporting. Also, data availability is an issue, as most experts report a lack of data needed to develop accounts.

Over time, as more quantitative and more monetary data become available, the policy benefits will grow and involve different policy areas. In general, the potential use of accounts for policy making will depend on their data availability and quality, the spatial resolution (i.e. the level of detail they allow) and the time series that they cover (i.e. on to what extent they cover a period long enough to monitor trends over time).

A range of issues still need to be resolved – for example on the treatment of thresholds (ecological tipping points leading to social or economic tipping points), and a range of methodological challenges regarding monetary valuation still need to be addressed (e.g. the use of exchange vs. welfare values).

Arguably accounts will be mostly used in areas where there is high policy need (e.g. climate policy), where a policy instrument like the Water Framework Directive requires collecting a large amount of data over a long period of time and where they can provide new insights by integrating and connecting different factors (e.g. land use, biomass carbon, water, demography.).

### Accounts integrate across sectors and issues

One of the main added values of Ecosystem Accounts over existing indicators and data set is the opportunity to tackle integrated issues, and have a comprehensive view on key pressures and ongoing processes. For example, the integrated use of water, land and organic carbon accounts can provide relevant information on pressures on ecosystems and biodiversity and the link between water and land accounts can help identify areas with water stress. Furthermore, where they link to socio-economic indicators (e.g. population centres) in a spatially explicit manner, they can help explore key social-economic issues, such as access to nature by different social and economic groups, which in turn can help the wider debate on the health and social benefits of nature (see IEEP et al., 2016 forthcoming).Also, while monetary valuation can be useful to raise awareness on the multiple benefits provided by the sustainable management of environmental resources and to help argue for the protection of valuable ecosystems, it is necessary to be aware of its limits, due both to methodological challenges and data availability (see Chapter 3 for a full discussion on pros and cons of monetary accounts), as well as the risks of interpretation that arise from only a partial monetary representation.

All in all, Ecosystem Accounts have the potential to support a wide range of environmental policies. In order to make full use of their potential. It will be necessary to invest in experimental accounts, associated data gathering and promote interaction among different categories of experts, including statisticians, economists, ecologists, in order to progress in the development of common methodologies to allow integration of different set of data and comparability across geographical areas.

### A road map for developing Ecosystem Accounts

The added value of ecosystem accounts will depend on how much is invested in their development, what capacity is built up to ensure that they are understood and integrated into policy processes, and how the results are used, interpreted and complemented by other evidence base tools. Current experimentation, multi-stakeholder/experts discussions, data collection and treatment work, methods development and capacity building will each drive progress and increase the added value. Recommendations for the way forward include:

* **Focus on biophysical accounts to 2020** - as this offers significant added value to policy reflections - **while doing experimentation on monetary accounts** to get a better understanding on what can and cannot be said using these tools. This can usefully build on the MAES process and ESMERELDA project.
* **Selective experimentation on monetary accounts:** (a) where promising: carbon sequestration; depreciation of capital stock; (b) understand what is possible/not; (c) understand meaning & utility or results.
* **Support experimentation in areas where policy utility:** as it helps in obtaining resources and inputs into policy decision making as one tool/evidence base among others – e.g. water, landuse, biomass carbon, fish stock and ecosystem extent and condition + utility in CP to improve EU added value.
* **Integrate different accounts:** (e.g. land, organic carbon and water) – and where separate accounts, bear in mind the need for future integration. This can usefully build on the KIP INCA initiative (Knowledge Innovation Project on Integrated System for Natural Capital and Ecosystem Services Accounting in the EU).
* **Build capacity:** exchange of experiences among experts; discussion with policy-makers on needs; experimental accounts to inform methodological development; feasibility assessment of accounts for which not many data are available. **This can usefully build on the KIP-INCA initiative and ESMERELDA project as well as national work across the EU, WAVES work, London Group reflection and SEEA guidance and experimentation.**
* **Review role of monetary evaluation nearer 2020 target:** in light of insights to see to what extent monetary assessment and integration into SNA possible, useful, or desirable and how they can be complemented by other tools. Ensure that this review is by a mix of economists, statisticians, ecologists, and policy experts to ensure the multiple perspectives are integrated.

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1. Financial capital can be seen as part of social capital. [↑](#footnote-ref-1)
2. WAVES is funded by the European Commission, Denmark, France, Germany, Japan, the Netherlands, Norway, Switzerland, and the United Kingdom and it is being overseen by a steering committee. At the moment, the core WAVES countries - Botswana, Colombia, Costa Rica, Guatemala, Indonesia, Madagascar, the Philippines and Rwanda- are developing natural capital accounting. [↑](#footnote-ref-2)
3. https://www.wavespartnership.org/en [↑](#footnote-ref-3)
4. https://sustainabledevelopment.un.org/sdgs [↑](#footnote-ref-4)
5. However, Spain, France, Cyprus, Malta, Austria, Poland were granted partial or total derogations and were allowed to present the accounts up to two years after the 2013 deadline. [↑](#footnote-ref-5)
6. At least 14 different gases emitted by 64 industry groups and by households. [↑](#footnote-ref-6)
7. Including at least four tax types – on energy, transport (other than fuel), pollution, and resources – all broken down into 64 industry groups, households and non-residents who pay these taxes. [↑](#footnote-ref-7)
8. Material flow accounts for 50 material types showing domestic extraction, imports and exports. Then, Domestic Material Consumption = domestic extraction + imports – exports, for each type of material and in total. [↑](#footnote-ref-8)
9. This is possible every three years, and the next window of opportunity is December 2016. The potential candidates for the next batch of modules are 1) Environmentally Related Transfers (subsidies); Resource Use and Management Expenditure Accounts (RUMEA); Water flow accounts; Forest Accounts, through the development of Integrated Environmental and Economic Accounting for Forests (European Commission, 2013). [↑](#footnote-ref-9)
10. Regulation (EU) No 538/2014 of the European Parliament and of the Council of 16 April 2014 amending Regulation (EU) No 691/2011 on European environmental economic accounts  [↑](#footnote-ref-10)
11. [↑](#footnote-ref-11)
12. [↑](#footnote-ref-12)
13. http://www.ons.gov.uk/ons/taxonomy/index.html?nscl=Environmental+Satellite+Accounts [↑](#footnote-ref-13)
14. <http://www.ons.gov.uk/ons/rel/environmental/uk-environmental-accounts/2014/stb-stat-bulletin.html#tab-Experimental-natural-capital-accounts> [↑](#footnote-ref-14)
15. SNA accounts are the main source of information for internationally comparable economic aggregates and indicators such as Gross Domestic Production (GDP), economic growth rate and government deficit. [↑](#footnote-ref-15)
16. Restoration costs are the costs to restore an ecosystem to its original state before degradation. Complications arise in that restoration rarely gets the ecosystem back to the original state – i.e. ex post actual costs may not be a fully adequate measure. Similarly, assessing degradation costs for not restored areas poses significant methodological challenges as it require assumptions on how the restored ecosystem should be. An added complication is the choice of the re-introduced species, as if degradation has gone beyond the ecological tipping point restoration can be very expensive (or even de facto infinite in price in the case of extinct species). Finally, the cost of restoration is only a proxy of value and depending on the context can be an over-estimate or under-estimate. Each of these elements poses important challenges. [↑](#footnote-ref-16)
17. A discount rate is used to translate future benefits and costs into present values. The question of the discount rate, which attributes more relevance to costs and benefits in the present than to the ones in the future, has caused an animated debate among researchers, and the choice of a discount rate is one of the most disputed subjects of economic theory (see TEEB 2010 and 2011). [↑](#footnote-ref-17)
18. However, SEEA-EEA aims to move away from land cover as the only criterion for distinguishing ecosystem types. Integrated approaches are attempted, hence the original name coined in the SEEA EEA of land cover /ecosystem functional units. In order to represent the ecosystem extent, the Ecosystem Units map is used, which shows the type of ecosystems recognized, the extent of these ecosystem types, and forms the basis for all biophysical models for ecosystem services. The map determines the units and their size, and these units are then the row names in the supply and use tables. [↑](#footnote-ref-18)
19. To do: check with the next technical guidelines: (comment: these accounts will get a different name in the forthcoming technical guidelines) [↑](#footnote-ref-19)
20. EAU = Ecosystem Accounting Unit; LCEU= Land Cover/Ecosystem Functional Unit [↑](#footnote-ref-20)
21. The maps that have been produced are collected here <http://projects.eionet.europa.eu/eea-ecosystem-assessments/library/draft-ecosystem-map-europe>. [↑](#footnote-ref-21)
22. The study focuses only on terrestrial ecosystems, and not on marine ones. Also, the information on fresh water ecosystems only focuses on water provision but not on the other ecosystem services provided by water bodies. [↑](#footnote-ref-22)
23. More information on the case studies can be found in the following webpages <http://biodiversity.europa.eu/maes/maes-catalogue-of-case-studies> and <http://biodiversity.europa.eu/maes/maes-digital-atlas>. [↑](#footnote-ref-23)
24. http://www.esmeralda-project.eu/showpage.php?storyid=11754 [↑](#footnote-ref-24)
25. The most important data source for SECA is the Corine land cover database, which is used for the land accounts and as a basis for the other accounts. It covers the years 1990, 2000, 2006 and 2012. [↑](#footnote-ref-25)
26. A National Forest Inventory is developed in Germany by the Federal Ministry of Food and Agriculture (see <https://www.bundeswaldinventur.de>). Also, Seintsch and Weimar (2012) prepared a wood balance for the period between 2010 and 2012. Accounts for greenhouse gas emissions from land use change and forestry are developed by Umwelt Bundesampt, the Germany’s main environmental protection agency (see https://www.umweltbundesamt.de/daten/klimawandel/treibhausgas-emissionen-in-deutschland CO2-Bilanzen). Finally, data on water demand and supply for Germany can be found here, including an interactive map: <http://www.bmbf.wasserfluesse.de>). Regular statistical work on water supply and water use is provided by the Bundesanstalt für Gewässerkunde and the Statistical Office (use) (see <https://www.destatis.de/DE/Publikationen/Thematisch/UmweltstatistischeErhebungen/Wasserwirtschaft/WasserOeffentlich.html> and <https://www.destatis.de/DE/Publikationen/Thematisch/UmweltstatistischeErhebungen/Wasserwirtschaft/WasserAbwasserNichtoeffentlich.html;jsessionid=296D8C19770D8F6314F3ECC386E9032F.cae3>). A regularly repeated water accounting is not implemented, yet, but official information and data on both demand and supply sides are regularly provided on the following website of the Federal Environment Agency: https://www.umweltbundesamt.de/daten/wasser-als-ressource/wasserressourcen-ihre-nutzung. [↑](#footnote-ref-26)
27. Separating supply and use of ecosystem services is a way to help disentangle the multitude of factors affecting the provision of ecosystem services, and to separate human inputs from natural factors. It also allows to separate changes deriving from changes in the condition of ecosystems from changes in human demand. [↑](#footnote-ref-27)
28. See <http://www.ons.gov.uk/ons/rel/environmental/uk-environmental-accounts/2015/stb-environmental-accounts-2015.html#tab-Woodland-ecosystem-asset-and-services-accounts> [↑](#footnote-ref-28)
29. http://www.eea.europa.eu/data-and-maps/data/data-viewers/land-accounts [↑](#footnote-ref-29)
30. Historically, accounts were developed in order to assess the taxable wealth of a territory, and the information was used to determine the prospects for war. Indeed, military interests have provided a basis for compiling accounts since at least 1085, when William the Conqueror commissioned the Domesday Book (World Bank 2011) for precisely this reason. Nearly 600 years later, William Petty’s 1665 accounts for the King of England contained the following passage:

    “the Warr cannot well be sustain’d beyond the year 1698 upon the Foot it now stands, unlesse

    1. The Yearly Income of the Nation can be Increas’d.

    2. Or the Yearly Expence Diminish’d.

    3. Or a Forreign of Home Credit be Obtain’d or Establish’d.

    4. Or the Confederacy be Inlarg’d.

    5. Or the State of the Warr Alter’d.

    6. Or a General Excise, in effect Introduced.” (Bos 2008, p13 )

    By the 1930s, national accountants were firmly back on the war path as economists (including Nobel Laureates Simon Kuznets, James Meade and Richard Stone) were developing the basis of our current system of national accounts: initial estimates deducted government spending (e.g. on the military) from national income on the grounds that it represented a reduction in the resources available for consumption (Coyle 2014). It was only after US President Roosevelt, in preparation for the US entry into WWII demanded a set of accounts that showed military expenditure having a positive effect on the economy, that government spending was considered a contribution to gross domestic product (GDP) (Coyle 2014). Political influence over what is and is not included in the national accounts is not exclusively limited to military interests, however. For example, as recently as 2012 the Greek government, was declined loans from the International Monetary Fund and the European Central Bank because the country’s debt to GDP ratio was too high. In response, Greece’s national accountants amended their GDP calculation to incorporate estimates of the informal economy, effectively expanding GDP by approximately 25% and bringing the official debt to GDP ratio within acceptable limits for securing international loans.

    What William the Conqueror, President Roosevelt, the Greek debt crisis and the national accountants have in common is that the accounts they generate are and can be strategically designed to convey whatever information is desirable and deemed relevant for decision-making at the time. Historically, this has not included natural capital, nor has it included ecosystem services except where they have been traded in markets (e.g. timber, fish, agricultural produce). However, many of today’s big societal challenges relate to environmental sustainability, making the incorporation of ecosystem information within the accounting system at least timely and potentially useful, and perhaps long overdue and essential, though the latter point depends on what can be integrated, how it is integrated, what the results represent (and don’t represent), what they mean and how the results are used by policy makers. [↑](#footnote-ref-30)
31. Valuation for Natural Capital Accounting: A Seminar organised by the UK Department of Environment, Food & Rural Affairs and the UK Office for National Statistics, November 2013. [↑](#footnote-ref-31)
32. SEEA-EEA does not prescribe a specific scale for Ecosystem Accounts, but it proposes three kinds of units that can be used, depending on the purpose of accounts and resource availability: basic spatial units (BSU), land cover/ecosystem functional units (LCEU) and ecosystem accounting units (EAU). BSU is a small spatial area and is generally defined by overlaying a grid on a map. The squares of the grid (i.e. the BSUs) will be as small as possible, according to available information, landscape characteristics and also the policy or research needs. BSU can be aggregated to form LCEU or EAU. LCEU are areas satisfying a pre-determined set of factors related to the characteristics of an ecosystem (e.g. as regards land cover type, water resources, climate, altitude and soil type), and will have different dimensions according to the specific conditions in the areas covered by the accounts. Examples of LCEU are pastures and natural grassland; forest tree cover; open wetlands and inland water bodies. The definition of an EAU depends on the purpose of the analysis and reporting requirements, and thus on the administrative boundaries, large scale natural features, environmental management areas and similar. Examples of EAUs are national parks and river basins. [↑](#footnote-ref-32)
33. Assessments, while providing information that could input into accounts, are generally not accounts per se, because they provide a snapshot of the situation at a certain time, while accounts are updated regularly in order to allow to monitor trends. [↑](#footnote-ref-33)
34. Objective 4: Shift towards a low-carbon economy in all sectors; Objective 5: Promoting climate change adaptation, risk prevention. [↑](#footnote-ref-34)