EU reference document on Natural Capital Accounting

Prepared as part of the EU *MAES* process

(Mapping and Assessment of Ecosystems and their Services)

Revised draft for consultation, 6 January 2015

Developed by the pilot study co-leads:

Jan-Erik Petersen, European Environment Agency, Copenhagen

Kremena Gocheva, Ministry of Environment and Waters, Bulgaria

With the support of:

Daniela Russi, Patrick ten Brink (IEEP)

Jan Cools, Daniela Mayes, Tony Zamparutti (Milieu Ltd)

Roy Haines-Young (Fabis Consulting)

Leo De Nocker (VITO)

Revision: 06/01/2015

Table of Contents

TABLE OF CONTENTS 1

EXECUTIVE SUMMARY 4

1 INTRODUCTION: PURPOSE AND SCOPE OF THE REFERENCE DOCUMENT 6

1.1 Why develop natural capital accounting? 6

1.2 The evolving policy context for natural capital accounts 7

1.3 Purpose and structure of this reference document 9

2 NATURAL CAPITAL AND HUMAN WELLBEING: THE CONCEPTUAL FRAMEWORK 10

2.1 What is natural capital? 10

2.2 An overview of available methodological guidance and tools 12

2.3 Summing up: 14

3 ACCOUNTING FOR NATURAL CAPITAL: METHODOLOGICAL FRAMEWORKS AND CHALLENGES 15

3.1 Introduction 15

3.2 Natural capital, accounting systems and decision-making 16

3.3 The System of Integrated Environmental and Economic Accounting (SEEA) 18

3.4 Physical natural capital accounts 21

3.5 Monetary accounts and valuation approaches 23

3.5.1 Monetary measurements in the SEEA-CF ***23***

3.5.2 Enlarging the scope to value ecosystem goods and services ***23***

3.5.3 Non-monetary valuation methods ***24***

3.6 Developing ecosystem accounts within an overall framework 25

3.7 Summing up: 27

4 THE ROLE OF NATURAL CAPITAL ACCOUNTS IN POLICY AND APPLICATION 28

4.1 Natural capital accounts in relation to the policy cycle 28

4.2 The information potential of natural capital accounts for key EU policy areas 29

4.2.1 Water Framework Directive and Floods Directive ***29***

4.2.2 Biodiversity strategy ***32***

4.2.3 Cohesion policy ***33***

4.3 Conclusions on potential policy applications 34

5 TAKING NATURAL CAPITAL ACCOUNTING FORWARD: CONCLUSIONS AND NEXT STEPS 36

5.1 The analytical promise of natural capital accounting approaches 36

5.2 Developing the conceptual focus 37

5.3 Laying the data foundation.....39

5.4 Establishing an effective organisational set-up.....41

5.5 Making accounts part of policy practice.....42

5.6 Conclusions and a draft roadmap for developing natural capital accounts in Europe.....43

REFERENCES.....46

ANNEXES: 50

Annex 1: Overview of definitions and terminology on natural capital accounting in various international and national guidance documents 50

Annex 2: Compilation of key terms relevant to natural capital accounting 52

Annex 3: Examples of accounting tables on components of natural capital 57

Annex 4: Overview of research and development questions for ecosystem accounting....59

Annex 5: Key outcomes of 2013 country survey on natural capital accounting.....62

EXECUTIVE SUMMARY

Purpose of this document

The main purpose of this document is to support EU Member States in developing their own natural capital accounting approaches. As it is developed in the context of a European process for the implementation of the EU Biodiversity Strategy to 2020 it focuses on developing accounts for ecosystems and their services.

The document builds on a review of existing methodological guidance and puts forward a draft roadmap for the further development of natural capital accounting in the European Union. As a reference document it sets out basic concepts and approaches of natural capital accounting, provides methodological synthesis, practical advice and compiles key reference sources and definitions.

Defining 'natural capital'

The concept of 'natural capital' aims to underline the role of nature in supporting the economy and human well-being. Natural capital is part of different types of capital which all play a role in societal and economic development. These also include manufactured capital, human capital and social capital all of which also draw on natural capital.

Natural capital comprises of the ecosystems and abiotic assets of the planet that provide people with exploitable resources, e.g. forests, solar radiation, water, fossil fuels and minerals. Its component 'ecosystem capital' generates a flow of benefits via ecosystem services, e.g. food, climate regulation and recreation.

The role of natural capital accounting

The global System of National Accounts (SNA) provides core economic indicators, e.g. GDP, that are useful for economic policy-making. However, to better understand the impact of our economic activities on the environment, it is important to develop complementary natural capital accounts. This would allow measuring the contribution of natural assets and associated service flows to our economy and well-being, and help monitor the changes in natural capital – that we ultimately depend upon.

Accounting systems are designed to bridge the gap between detailed environmental data and the information needed by the public and decision-makers to ensure long-term sustainability. They provide a structured framework for connecting economic activities to their environmental impact and for aggregating different measurements (of natural capital) across environmental issues and spatial scales. The objective of accounting can be limited to analysing bio-physical trends in a structured manner but many accounting approaches aim to support the valuation of natural capital (in monetary or non-monetary terms).

The development of environmental accounting

The UN's Rio Conference on Sustainable Development in 1992 called for the creation and use of integrated environmental and economic accounting methods. As a response, the UN System of Environmental-Economic Accounting (SEEA) provides a systematic framework to collect information on the state of natural capital. Its Central Framework (SEEA-CF) sets out an approach for environmental resource accounts to measure the stock and flows of abiotic resources and some biotic

resources. The experimental ecosystem account handbook (SEEA-EEA) provides methodological guidance for the measurement of ecosystem assets and services.

Other global initiatives also provide methodological guidance and support pilot projects in the area of natural capital accounting and valuation of ecosystem services. The most prominent among them are the TEEB process on '*The Economics of Ecosystems and Biodiversity'* (TEEB), the World Bank's '*Wealth Accounting and the valuation of ecosystem services'* (WAVES) project, and the CBD 'Quick Start Package' on '*Ecosystem Natural Capital Accounts'* (ENCA).

A range of work is underway in Europe. Through Regulation (EU) No 691/2011 on European environmental economic accounts (amended in 2014), the EU has established an overall legal framework for environmental accounting. A pilot project under the EU MAES process to support the implementation of targets in the EU biodiversity strategy has led to this reference document, which provides guidance on the ecosystem component of natural capital accounting. The European Environment Agency (EEA) is developing simplified ecosystem capital accounts for use at EU level. And many European countries are developing national approaches to account for (components of) natural capital, with several of them being quite advanced. In addition, EU research funding supports substantial projects on developing and/or implementing natural capital accounting methods.

Informing policy decisions via natural capital accounting

Natural capital accounting is a potentially useful tool for policy-makers from EU to regional level as it helps to understand the links between economic sectors and the environment at different spatial scales. This document reviews opportunities in key EU policy areas: water policy, biodiversity policy and Cohesion Policy.

The added-value of the approach depends on the maturity and quality of the accounts, the data they build on, and on other existing indicators and measurement tools already contributing to the evidence base for policy-making. Their relevance will grow as accounting systems and input data sets develop and practical experience is gathered in their implementation.

Taking natural capital accounting forward

Natural capital accounting enhances the knowledge base on natural resources and ecosystem assets and helps us to assess whether natural capital is managed within sustainable limits. A lot of progress has already been made on developing concepts and methodology. So the time is ripe for implementation and learning from experimentation. In parallel it is necessary to plan ahead and set strategic goals. For this purpose the concluding chapter proposes a draft roadmap for natural capital accounting in the EU which is organised under four main headings:

a) Developing a clear conceptual focus
b) Building a suitable common data platform
c) Establishing an effective organisational set-up
d) Making accounts part of policy practice

Work at EU and national level along these lines will help to build the conceptual and practical foundations for the ambitious natural capital accounting targets contained in the EU Biodiversity Strategy and 7th Environmental Action Programme of the European Union to be achieved.

EU reference document on Natural Capital Accounting

Prepared under the EU MAES process

Version 2.1 – for comment.

Please send feedback to: Jan-Erik.Petersen@eea.europa.eu

1 INTRODUCTION: PURPOSE AND SCOPE OF THE REFERENCE DOCUMENT

The world's ecosystems and abiotic resources are the foundation for human prosperity and well-being. This 'natural capital' includes biotic resources, e.g. fish and timber, and abiotic resources, e.g. minerals, wind and solar energy, and fossil fuels. Ecosystems and their services are important components of natural capital and provide food and medicine, regulate our climate and water cycles, and create a relaxing environment for recreation, amongst many other things.

For these reasons, it is important to be able to understand and measure natural capital in its many different dimensions. This allows us to appreciate the value of natural capital to society and the economy, and it provides us with crucial tools to address the growing degradation and scarcity of many components of natural capital.

Important EU policy documents, notably the EU Biodiversity Strategy to 2020 and the 7th EU Environmental Action Programme (7EAP), set goals for EU and Member State actions on natural capital accounting. The Aichi targets under the Convention on Biological Diversity (CBD) and the Natural Capital Declaration are examples of complementary international commitments.

Several international initiatives provide guidance relevant to natural capital accounting. These include: the *System of Environmental and Economic Accounts* (SEEA) – developed by the United Nations Statistics Commission, the CBD 'Quick Start Package', the World Bank *WAVES* project and the TEEB process on *The Economics of Ecosystems and Biodiversity*.

Based on a review of the existing methodological guidance, this document sets out basic concepts and approaches of natural capital accounting, provides methodological synthesis, practical advice and summarizes key references and definitions. The aim is to support EU Member States in developing their own natural capital accounting approaches, with a focus on ecosystem capital.

1.1 Why develop natural capital accounting?

Human prosperity and well-being depend on the integrity of natural systems and it is vital to understand how our actions impact on this natural capital resource. Information on how natural capital is being used, depleted or degraded is therefore essential to manage it sustainably. Accounting is an effective way of organising environmental (and other) information in a structured manner and is also the main tool used for reporting the wealth of nations. Hence the development of natural capital accounting is an important target in constructing the knowledge-base for better management of our natural environment.

Natural capital underpins the other capitals recognised as essential for economic and social prosperity, i.e. man-made, human and social capital, and provides humans with abiotic resources, such as solar radiation, minerals, fossil fuels, and a wide range of ecosystem services. The latter are defined as the contributions that ecosystems make to human well-being. Examples of ecosystem services are, e.g. fish, timber, the regulation of climate and water cycles, and attractive landscapes for recreation. Section 2.1 explains further the conceptual model of natural capital.

The development of Natural Capital Accounts can, over time, give insight into the state of natural capital and its recent and long-term trends. When combined with other information sources, e.g. agro-economic models, or input-output accounting, they can also increase our understanding of the drivers of degradation. This will help inform policy responses to reduce pressures, conserve and restore biodiversity and facilitate the integration of natural capital into other policies. For instance, accounting for the organic carbon stored in soils and vegetation on agricultural and forest land is potentially an important tool to further a better management of biomass carbon via global and national climate policies.

Natural capital accounts (NCA) are proposed to complement to the System of National Accounts (SNA), which produces economic indicators, e.g. Gross Domestic Product (GDP), that are widely used to guide public policy and private actions. Natural capital accounts will help to record the depletion or degradation of natural capital through pollution, resource extraction and ecosystem degradation, and provide a complete picture of our 'wealth' – both as nations and a global society.

Furthermore, Natural Capital Accounts provide information, on the role of nature in the economy, to decision-makers by describing the stocks of natural capital and the benefits that flow from them, in physical terms, and where appropriate, in monetary terms. This reference document describes how Natural Capital Accounts (NCA) can be developed and used to support sustainable management of natural capital, in particular its ecosystem component.

1.2 The evolving policy context for natural capital accounts

The concept of natural capital accounting and, more broadly, environmental accounting, has been discussed within international policy and statistical arenas for more than two decades. The first international statistical methodological guidance was the environmental-economic accounting standards (SEEA) – published by the United Nations Statistics Commission (UNSC) in 1993. A subsequent revision was finalised in 2012 as the System of Environmental-Economic Accounting Central Framework (United Nations *et al.*, 2014). Globally, this document is recognised as a statistical standard. The SEEA used the term 'environmental accounting' and established the principle that, while aspects of environmental accounts could be represented in monetary terms, information about our natural capital in physical terms, e.g. areas, volumes and counts, could be equally useful. An additional experimental framework, published in 2013, focuses on 'Experimental Ecosystem Accounting' (UN-SD, 2013) and thus integrates ecosystem aspects into the UN-SEEA approach.

The Rio+20 conference reaffirmed the importance of accounting for our natural wealth. Through its Natural Capital Declaration, it sought to encourage further development and implementation of the concept at global and national levels (UNEP, 2012). In addition to the on-going work of the UNSC, the challenge of developing and applying natural capital accounts has been taken up in the World Bank WAVES project (World Bank, 2012) which supports individual countries. To support implementation of the 2012 Aichi targets (CBD, 2012) under the global Convention on Biological Diversity (CBD), the

CBD secretariat has recently published a document on 'Ecosystem natural capital accounts: a quick-start package' (CBD, 2014).

The European Union (EU) and other European countries have long-supported international work on environmental accounting. EU legislation and policy strategies, for example, have also promoted the development of natural capital accounting. The first formal EU rules on environmental accounting were established with Regulation 691/2011 and amended in 2014 (Regulation N°538/2014). In total, six accounting modules are now subject to EU regulation: air emission accounts; accounts on environmental taxes and material flow accounts; energy accounts; environmental goods and services sector accounts; environmental protection expenditure accounts. The Regulation establishes that more accounting modules can be added in the future in response to key policy needs – the next window of opportunity is December 2016 and every three years thereafter.

The broad concept of natural capital accounting is also referred to in another two key EU policy documents: the EU Biodiversity Strategy to 2020 (European Commission, 2011) and the 7th EU Environmental Action Programme (7EAP) (European Commission, 2014). The EU Biodiversity Strategy to 2020 has set the following goals under Target 2, Action 5:

> *Member States, with the assistance of the Commission, will map and assess the state of ecosystems and their services in their national territory by 2014, assess the economic value of such services, and promote the integration of these values into accounting and reporting systems at EU and national level by 2020.*

The Biodiversity Strategy, therefore, contains a clear commitment to develop accounting approaches regarding the state of ecosystems and their services – including an assessment of their economic value. This is reinforced by the following text in the 7EAP:

> *The integration of the economic value of ecosystem services into accounting and reporting systems at EU and national level by 2020 will result in better management of the EU's natural capital.[…] Work to develop a system of environmental accounts, including physical and monetary accounts for natural capital and ecosystem services, will need to be stepped up.*

The 7EAP also includes the following commitment: *Developing and applying alternative indicators that complement and go beyond GDP to monitor how sustainable our progress is and continuing work to integrate economic indicators with environmental and social indicators, including natural capital accounting.*

To meet the commitments under the EU Biodiversity Strategy, the European Commission has established a joint process with Member States to support the *Mapping and Assessment of Ecosystems and their Services*, the so-called *MAES* Process. This initiative is designed to respond to the policy targets highlighted above – in particular, those established under the EU Biodiversity Strategy to 2020. The conceptual framework for the *MAES* process is described in the methodological guidance published by the European Commission (European Commission, 2013). This document complements previous work by providing reference and guidance on natural capital accounting, with a focus on ecosystem capital.

1.3 Purpose and structure of this reference document

A small working group, established under the EU *MAES* process, has reviewed the available methodological guidance on natural capital accounting in the context of the EU 2020 Biodiversity Strategy. This document is the outcome of that work and offers methodological references for work at Member State or EU level, in developing or improving natural capital accounting approaches.

Chapter 2 explores how to define 'natural capital' and other key terms in environmental economics, briefly reviews the methodological guidance available at international level, and discusses approaches for better management of natural capital. Developing an analytical framework defining the subject, scope and analytical questions is the first challenge.

Chapter 3 reviews the development of international environmental accounting standards, the logic of combining ordinary measures of national wealth with information on natural capital, and discusses physical and monetary accounting options. It concludes by presenting emerging accounting frameworks and principles in relation to natural capital.

Chapter 4 focuses on the use of accounting approaches for policy processes. Given that methods are evolving, many applications are still being explored and, thus, this section emphasises the potential of natural capital accounting to support key policy areas.

Chapter 5 concludes by discussing opportunities and challenges in developing natural capital accounting – covering the analytical strengths and limits of natural capital accounting as well as key factors in building a suitable data platform for future applications. It also proposes a draft roadmap for the further development of natural capital accounting systems in the EU towards 2020.

2 NATURAL CAPITAL AND HUMAN WELLBEING: THE CONCEPTUAL FRAMEWORK

Natural capital includes both abiotic and biotic assets. Abiotic components include sub-soil assets, e.g. fossil fuels and minerals, and geophysical cycles that generate abiotic services, e.g. solar and wind energy. The biotic components of natural capital represent the ecosystem capital, i.e. different types of ecosystems which provide flows of ecosystem services.

Accounting tools need to address different types of natural capital, different types of flows from the capital, and issues related to changes in capital stocks, i.e. whether these imply degradation, increase or simply change – all of which have different consequences on ecosystem service flows, and thus, their impacts and trade-offs have to be considered. This requires the development of clear concepts and accounting principles.

Several initiatives, at the international level, have provided methodological reference in that regard. In particular, the work of the UN Statistical Division on *Experimental Ecosystem Accounting*, the TEEB process on *The Economics of Ecosystems and Biodiversity* (TEEB), the World Bank initiative on *Wealth Accounting and the valuation of ecosystem services* (WAVES) and the recent CBD publication on *Ecosystem Natural Capital Accounting* (ENCA-QSP).

These reference documents, and other studies, provide insight into the relationship between human prosperity and well-being and the sustainable management of our natural capital. The latter not only depends on suitable accounts being available, but also on a good understanding of how different types of natural capital and derived-services need to be managed.

2.1 What is natural capital?

If natural capital accounting is a way of organising and presenting information about our natural capital, then an important first step is to be clear about the meaning of 'natural capital'. What, exactly, needs to be accounted?

The term 'natural capital' was proposed by David Pearce (Pearce, *et al.*, 1989), as a way to underline the role of nature in supporting the economy and human well-being. It is now recognised that human well-being depends on different types of resources or assets, which are categorised in relation to four broad types of capital. All of these capitals support the economy and human well-being (Pearce, *et al.*, 1989; Ekins, 1992; ten Brink, *et al.*, 2012):

- **Manufactured** or **'man-made' capital**: assets used to produce goods and services, such as machines, tools, buildings and infrastructure. Financial capital includes money and other financial assets, and is sometimes seen as a distinct additional category (Aronson, *et al.,* 2007).
- **Human capital:** assets in the forms of knowledge, education, motivation and work skills, mental and physical health.
- **Social capital:** includes social trust, norms and networks that facilitate social and intellectual interactions and solutions to common problems, e.g. neighbourhood associations, civic organisations and cooperatives, and the political and legal structures of a society.
- **Natural capital:** comprises of the ecosystems and abiotic assets of the planet that provide people with exploitable resources, e.g. solar radiation, fossil fuels and minerals, and generate a flow of benefits via ecosystem services, e.g. food, climate regulation and recreation.

While all four types of capital are needed to support human well-being, natural capital is arguably the most important one because it supports and underpins the other forms of capital. 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 are dependent upon ecosystem services to maintain good health. These services range from food, freshwater, timber and fibres, regulating ecosystem services, e.g. water purification, nutrient cycling, mitigation of floods, and benefits from open landscapes and urban parks that support recreation and well-being.

Natural capital: includes biotic and abiotic elements and comprises of all natural resources that human society draws upon. A sound analysis of ecosystem processes, combined with the general principles of environmental accounting, is the foundation for developing a natural capital accounting approach. Figure 2.1 illustrates the main components of natural capital as currently understood – this has been developed from the natural capital figure in the first EU *MAES* report on the 'Mapping and Assessment of Ecosystems and their Services' (European Commission, 2013).

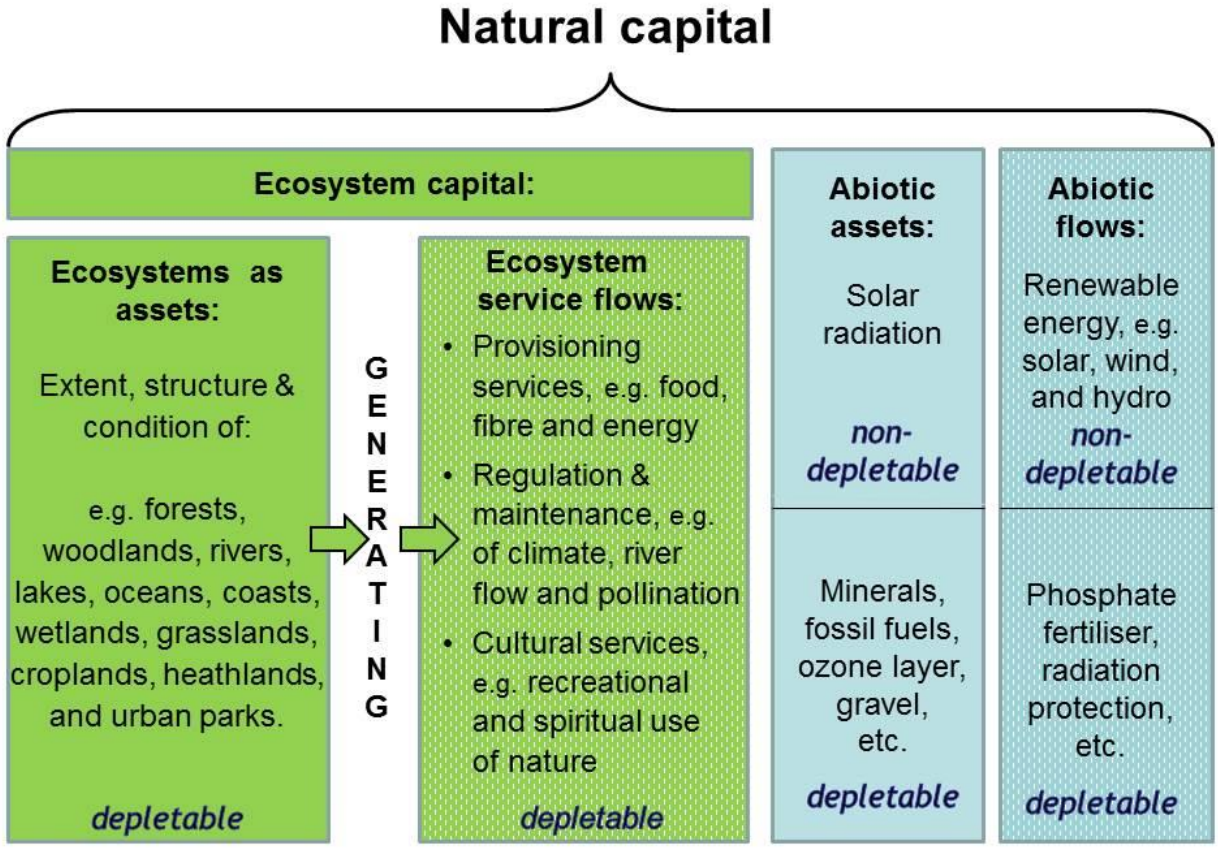


Figure 2.1 Components of natural capital

Figure 2.1 makes a distinction between ecosystem capital and abiotic resources. In reality, there is no clear-cut boundary between biotic and abiotic components. For example, water is an abiotic element and included under ecosystem capital as a living process playing a modulating role in its cycle, yet water plays a key role in all ecosystem processes (Russi, *et al.*, 2013; Haines-Young and Potschin, 2013). However, this distinction helps to identify and classify different types of natural capital which is important in the context of developing a natural capital accounting approach.

Another dimension in Figure 2.1 is the relationship between the concepts of 'assets' and 'flows'. According to standard economic theory, natural capital is the sum of the different physical assets of nature, e.g. mineral deposits or tons of biomass, and benefit flows would not really be part of natural 'capital'. However, for ecosystem capital in particular, the same natural processes govern ecosystem assets and ecosystem services, so it is often difficult to draw a line between the two. Secondly, in the context of monetary accounting the value of the asset stock is often derived from the flows it generates. Lastly, in many less-specialist discussions flows are considered as part of natural 'capital'. For all these reasons, Figure 2.1 shows ecosystem and abiotic assets and flows in the same colour but with different background shading.

The second key feature of assets and flows is their depletability. Some are, under current circumstances, unlimited, i.e. 'non-depletable' – for example, sun light and wind depend on solar radiation on which humans cannot influence. Most abiotic assets are, for obvious reasons, classified as 'depletable' because they do not renew themselves and their stock is, therefore, reduced over time by exploitation, e.g. fossil fuels and minerals. Ecosystems and associated service flows are also 'depletable' since over-exploitation can lead to the extinction of species or depletion, e.g. fish stocks. Outright habitat destruction, e.g. the conversion of forests or grassland to urban areas, ultimately destroys ecosystems and the regulation and maintenance, or other services, they generate. Ecosystem capital is particularly vulnerable because many species and habitats depend on specific conditions being maintained, and human society heavily exploits it via agriculture, forestry and other land uses. This part of natural capital can therefore be considered as a component for which society has a particular 'duty of care' – it is fragile, and human actions have already negatively impacted much of it.

EU targets under the Biodiversity Strategy to 2020 and the 7th Environmental Action Programme relate foremost to the ecosystem capital component of Figure 2.1. The focus in the EU *MAES* process on the implementation of these targets means that the discussion of natural capital accounting in this reference document relates mainly to ecosystem capital. As far as possible, it reviews accounting options for ecosystem assets as well as the related ecosystem service flows.

While ecosystem capital is fundamental to human well-being it must also be acknowledged that it is a highly 'people-centred' concept. This is because it focuses specifically on those aspects of nature that benefit humans, and does not directly reflect the intrinsic value of nature or other species. While many of these benefits can eventually be expressed in monetary terms decisions about natural capital may have important ethical, political and social dimensions. Information in the form of accounts that describe the way natural capital is used and provides (indirect) benefits can shed light on a range of important issues that surround people's relationship to nature and the benefits that ecosystems provide to human society.

2.2 An overview of available methodological guidance and tools

Similar to other analytical tasks, measuring and accounting natural capital and its associated service flows requires standardised terminology and methodology. Only with a common analytical approach can results from different regions and countries be summarised and compared. An aim of this reference document is to help develop such a common approach across the EU while recognising that work has not yet sufficiently advanced to suggest any single detailed common methodology for natural capital accounting in the EU. In addition, work at the UN level, in particular the System of

Environmental-Economic Accounting, provides very useful methodological standards and references that should be drawn upon.

Several international guidance documents are already available on the methodological approaches for measuring natural capital and/or ecosystem services. Nearly all documents propose a broad and holistic definition for natural capital to comprise of living (biotic) and non-living (abiotic) components. In the various concepts and definitions a distinction is often made between the stocks of ecosystem assets and the flows they generate for the benefit of the economy and livelihood. For a comprehensive overview of the list of definitions for natural capital or its equivalent terms see Annex 1 of this document.

The brief overview below of the purpose and focus of the various international initiatives is meant as an aide for choosing international guidance documents – depending on the purpose and methodological challenges of a given natural capital accounting exercise. Chapter 3 will go on to review in more detail selected methodological issues related to natural capital accounting, focusing on the UN system of environmental-economic accounting (UN-SEEA).

Focus of international guidance documents:

The System of Environmental-Economic Accounting (SEEA) provides guidance on environmental and ecosystem accounting and has been elaborated upon with expert support by the United Nations Statistical Division (UN-SD). The SEEA Central Framework (SEEA–CF, United Nations *et al*., 2014) covers biotic and abiotic environmental assets and environmental flows as standardized statistical global concepts. The SEEA document on experimental ecosystem accounting (SEEA-EEA, UN-SD, 2013) focuses on measuring and accounting ecosystem assets and services, and provides a framework for further development and experimentation.

The World Banks' Wealth Accounting and the valuation of ecosystem services (World Bank, 2012) initiative is a partnership that provides guidance to countries and a global platform for pilot studies on natural capital accounting. It closely follows the methodological approach laid out in both SEEA documents.

In 2014 UNEP produced a report entitled 'Towards a global map of natural capital: key ecosystem assets', (UNEP, 2014). As its name implies, it builds on SEEA-EEA guidance to produce a first map of key global ecosystem assets. The report provides a concise and well-written overview of key methodological issues and demonstrates how ecosystem assets can be mapped by ecosystem type at the global level.

The TEEB process has investigated 'The Economics of Ecosystems and Biodiversity' (ten Brink, 2011), and focuses on the ecosystem service flows of biotic ecosystem components, while recognizing the abiotic components as part of ecosystems. The TEEB has produced various reports on valuing ecosystem services using monetary valuation approaches, and providing guidance on involving stakeholders in such processes.

The Quick-Start Package on Ecosystem Natural Capital Accounts of the Convention on Biological Diversity (CBD, 2014) provides concrete guidance for countries who would like to develop ecosystem natural capital accounts. As a CBD document, it aims to support the implementation of the Aichi Biodiversity Target 2 on 'Integration of Biodiversity Values in National Accounting Systems' and it builds on the SEEA hand book on Experimental Ecosystem Accounts.

At the European level, the European Environment Agency (EEA) has suggested similar methodology in: 'An experimental framework for ecosystem capital accounting' (Weber, 2011).

An accounting framework for ecosystem services:

As recognized by most of the above documents, the question of measuring ecosystem services is an important challenge for natural capital accounting – which requires standardized methodology. Under the MAES process the CICES framework (Common International Classification of Ecosystem Services) has been adopted as the recommended methodological working proposal. The CICES classification also underpins the work of the European Environment Agency on ecosystem capital accounts and the SEEA handbook on experimental ecosystem accounting.

The development of CICES took the definition of 'ecosystem services' provided by the Millennium Ecosystem Assessment (MA, 2005) as a starting point and modified it to take account of recent research results and to reduce the risk of 'double counting'. The major groups of ecosystem services under CICES consist of three main types:

- provisioning services, e.g. biomass, water, fiber, crops and livestock;
- regulation and maintenance services, e.g. soil formation and composition, pest and disease control, climate regulation;
- cultural services, e.g. the spiritual and symbolic settings represented by ecosystems, landscapes and seascapes, and the physical interaction with them for recreation.

Further information on the development of CICES and the full CICES ecosystem service classification can be found under: www.cices.eu

2.3 Summing up:

The main purpose of this document is to support EU Member States in developing their own natural capital accounting approaches in response to EU policy targets.

This chapter proposes a revised definition of natural capital which includes ecosystem and abiotic elements. It introduces the concepts of 'assets' and 'flows' and how they relate to natural capital. Furthermore, it also discusses key characteristics of different natural capital components in relation to their 'depletability' and the resulting resource management implications.

The chapter also introduces key international methodological reference documents and the CICES classification of 'ecosystem services', all of which provide important methodological guidance to build upon. Chapter 3 develops several of these methodological aspects further.

Natural capital accounting enhances the knowledge base on the status of abiotic resources and ecosystem assets and helps us to understand whether natural capital is managed within sustainable limits. A lot of progress has already been made in developing concepts and methodology - now the time is ripe for implementation and learning from experimentation. In parallel it is necessary to plan ahead and set strategic goals. This document aims to support both types of processes at the national and the EU level.

3 ACCOUNTING FOR NATURAL CAPITAL: METHODOLOGICAL FRAMEWORKS AND CHALLENGES

The global System of National Accounts (SNA) provides core economic indicators, e.g. GDP, that are useful for economic policy-making. However, to better understand the impact of our economic activities on the environment it is important to develop complementary natural capital accounts. This would allow measurement of the contribution of natural assets and associated service flows to our economy and well-being and help monitor changes in the natural capital that we ultimately depend upon.

The UN System of Environmental-Economic Accounting (SEEA) provides a systematic framework to collect information on the state of natural capital. SEEA is a key approach, in particular as it is linked to the SNA. Its Central Framework (SEEA-CF) sets out an approach for environmental resource accounts to measure the stock and flows of abiotic resources and some biotic resources. The experimental ecosystem account handbook (SEEA-EEA) provides methodological guidance for the measurement of ecosystem assets and services.

Accounting systems hold the promise of bridging the gap between detailed environmental data and the information needed by the public and decision-makers for a better management of natural capital assets. A range of initiatives are developing approaches for the accounting of different types of natural capital. However, there are various methodological challenges, ranging from measuring components that are difficult to quantify (e.g. cultural services) to developing sufficiently accurate and complete physical accounts and to identifying suitable economic valuation approaches.

3.1 Introduction

This chapter reviews conceptual and methodological aspects of natural capital accounting. The starting point is a brief discussion of how the environment is integrated into current national accounting systems and decision-making. Then it discusses the system of integrated environmental and economic accounts (SEEA) and how this relates to natural capital accounting. This includes the development of physical asset accounts as well as a brief discussion of monetary valuation approaches. The chapter concludes with a review of general principles for constructing accounting frameworks.

Before going into the details of environmental accounting, it is necessary to reflect on how accounting systems deal with nature and the need to understand the 'ecosystem/economy boundary'. This concept arises from the utilitarian perspective that underpins environmental-economic accounting. Any accounting system divides whatever it measures into different categories, otherwise it could not function. So the purpose of environmental-economic accounting is not to analyse how nature functions in all its complexity, but to measure how humans benefit from nature, thereby helping to better manage natural capital at local, national of global scale.

The benefits that human society derives from exploiting abiotic capital, in the shape of e.g. minerals, gravel and fossil fuels, are fairly obvious - although the negative side effects of exploiting fossil resources also need to be accounted for. However, this becomes more complicated regarding the benefits derived from ecosystem capital. Ecosystem services are defined as the 'contributions that ecosystems make to human well-being'. So at what point do ecosystem assets or flows become 'contributions', and what does the term 'human well-being' actually mean? One concept that is used

frequently in this regard is the 'ecosystem/economy boundary'. This implies that only those parts of ecosystem assets or flows that have a direct or indirect utility for human society, i.e. increase our well-being, can be translated into measurable contributions. These are often called 'ecosystem benefits' - see Figure 3.1 for a representation of these concepts.

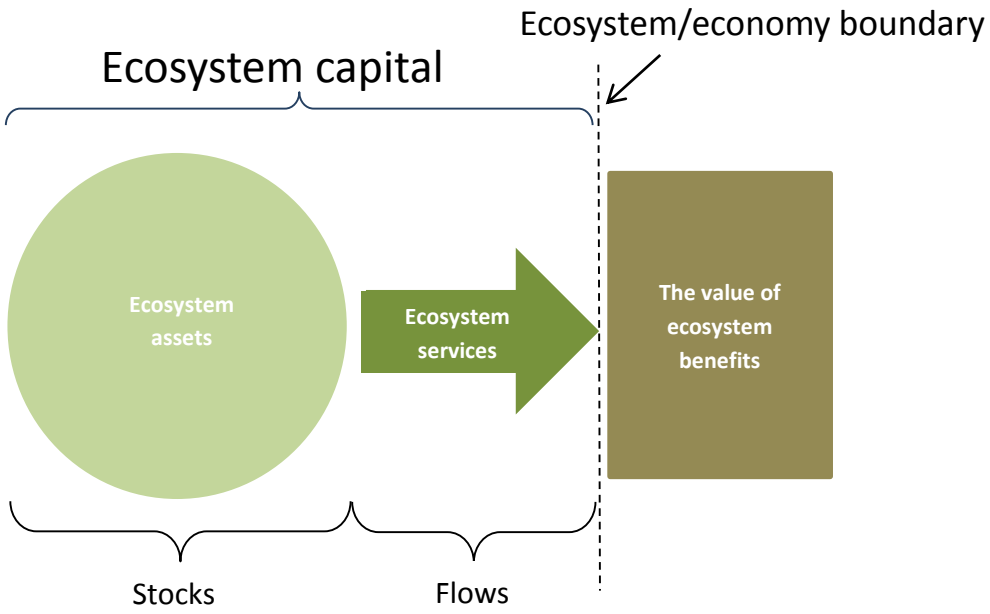


Figure 3.1 Natural Capital and ecosystem benefits

Based on UNEP (2014): Towards a global map of natural capital: key ecosystem assets.

Traditional accounting approaches only capture the economic value of products or services derived from nature on the right hand side of Figure 3.1. Natural capital accounting, however, aims to show how ecosystem assets and service flows are developing to give us an early warning system for managing ecosystem capital better.

3.2 Natural capital, accounting systems and decision-making

National Accounts and information on natural capital

The internationally-accepted and well-established System of National Accounts (SNA) provides a standard methodology for drawing-up national economic accounts. These accounts document the factors of production and consumption in the economy.

SNA accounts are the main source of information for internationally comparable indicators such as: Gross Domestic Production (GDP), value-added, national income, consumption, economic growth rate, or government deficit. SNA-derived indicators are used to track the economic performance of sectors and the flow of money between different sectors and households, salaries, purchases of goods and services, public and private investments and savings. The main point is that the accounts on which they are based represent an agreed way of synthesising information in consistent, meaningful and relevant ways so that comparisons can be made and decisions taken – relating to economic growth, employment or the reduction of government debt.

Despite the very real achievements and value of SNA accounts, they only include some components of natural capital, e.g. agricultural output or timber values. Most ecosystem services are not in the accounts because they provide public goods which do not generate market revenue and hence cannot be included in the SNA.

Human use of ecosystems and their services can lead to the depletion and degradation of natural capital. Where taken too far, this can lead to irreversible damage where a critical threshold is passed (Rockström *et al.*, 2009). This implies that negative side effects from exploiting natural capital, in all its forms, also need to be accounted for. For this reason, it is important that decision-making processes at the international, national, regional, local and business levels take into account not only economic performance, but also the role of nature in the economy. This means that economic accounts need to be complemented with environment-focused accounting approaches to ensure that public and private decision-makers consider natural capital in their planning processes.

If natural capital accounting is to have a positive impact on economic and environmental decision-making it needs to help fill in 'knowledge gaps' by providing a more complete picture of the interaction between economy and environment. There are two sides to this interaction: one is to improve the management of natural assets that provide public goods, the other is to avoid negative effects from economic activities that can damage natural capital, directly or indirectly.

Since the SNA only includes goods and services that are traded in markets, i.e. 'private' ones, complementary accounts are needed to help us understand what is going on – in particular, to the public goods and services provided by ecosystem capital. These include, above all, regulation and maintenance services as well as cultural services. Some of these are of global nature, e.g. climate regulation, which require global cooperation for critical underlying assets to survive into the future, e.g. rain forests. Others may provide benefits at regional or local level, for example forest stocks can help even-out water flow regimes within a water basin, as well as provide local opportunities for recreation. In this context, a better understanding of the spatial distribution of ecosystem assets can help to identify how inter-regional or cross-border flows of ecosystem services might mean that the benefits enjoyed in one country depend on the good management of natural capital stocks in another.

Economic growth derived from the over-use of different types of natural capital, e.g. fish stocks or forests, as well as the pollution of air and water via industrial activities, can lead to short-term economic benefits. However, in the long-term it does not really contribute to an increase in our total wealth if it destroys critical natural capital assets.

The issue of how to account and deal with the degradation of natural capital due to over-use, pollution or other factors is, therefore, another reason for natural capital accounting. This offers the possibility of estimating the 'ecological debt', that is transferred to other countries or future generations, by importing goods, over-exploiting ecosystems or exporting waste flows (Martinez-Alier, 2005, and Weber, 2012).

Accounting systems and the use of information in decision-making

Edens and Hein (2013) and van Dijk *et al.*, (2014) have reviewed current approaches to natural capital accounting and focused, specifically, on the issues arising from the goal of integrating ecosystem

services and natural capital into national accounts, and how to provide information to decision-makers. Figure 3.2, below, illustrates their thinking on the use of information in decision-making.

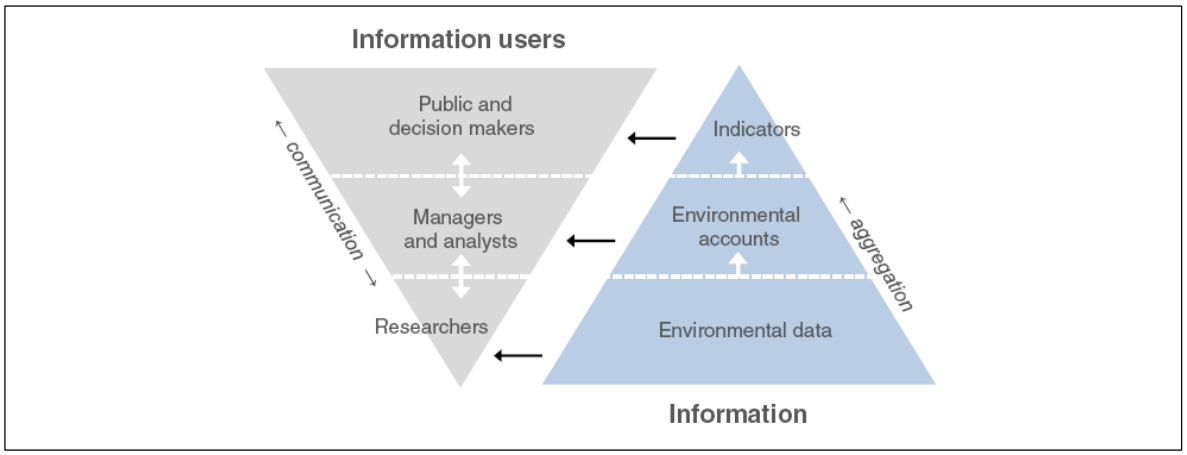


Figure 3.2: The role of natural capital or environmental accounts

(after van Dijk *et al.*, 2014)

Van Dijk *et al.* (2014), highlighted the particular dangers of ad hoc approaches to data collection and reporting. They suggested that a lack of standardisation and long-term perspectives will lead to increased costs – in terms of data sharing and coordination, and over-reliance on particular data sources that are easy to acquire even though they may not be entirely fit-for-purpose. These commentators see accounting systems as bridging the gap between underlying and comprehensive data infrastructures and the higher level indicators and metrics that decision-makers use for identifying policy priorities, and also as a means of communicating with the public (see Figure 3.2).
In designing such accounts, the accounting challenge is to find ways of aggregating data efficiently, without loss of information, and the presentation of them in ways that have meaning for managers and decision-makers working at different levels. The next section describes the main directions that this work is taking.

3.3 The System of Integrated Environmental and Economic Accounting (SEEA)

The need for complementary measurements and accounting, for both the economy and nature, has been the stimulus for the development of the System of Environmental-Economic Accounting (SEEA). The initiative is led by the United Nations Statistical Commission (UNSC), through the London Group on environmental accounting, which operates under the auspices of the UN Committee of Experts on Environmental-Economic Accounting (UNCEEA).

The SEEA is designed to provide a systematised framework to carry out natural capital accounting and the measurement of natural capital – in terms of the biotic and abiotic assets that compose it, their degradation or restoration as a result of interactions with the economy and society, and the flows of goods and services they provide.

Figure 3.3, below, presents an overview of where the different components of the SEEA seek to provide a fuller picture of the interactions between the economy and the environment and, hence, the way it extends the coverage of the SNA.

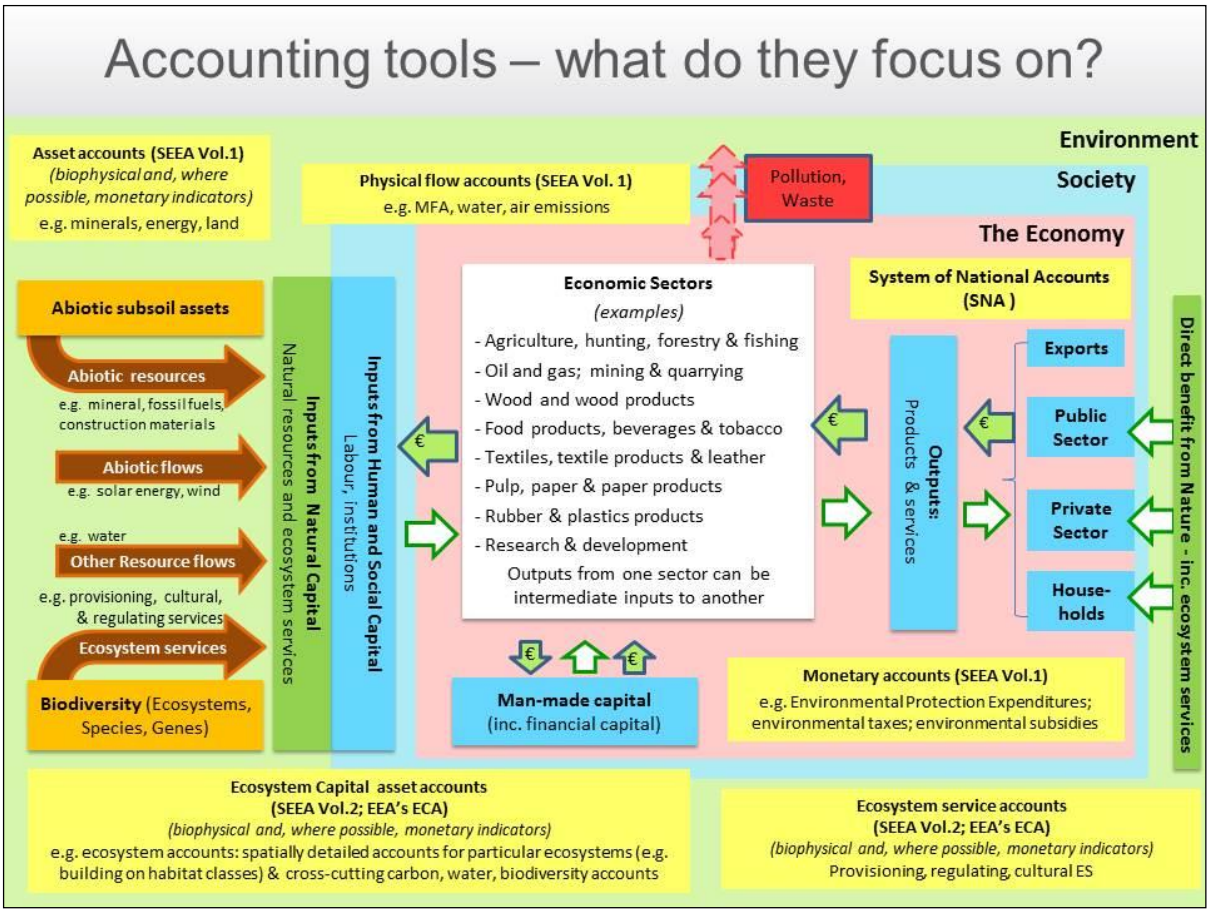


Figure 3.3: Overview of SEEA components extending the coverage of the SNA

Source: adapted by ten Brink, Mazza, Dekker and Russi from ten Brink *et al.*, 2011.

Conceptually, the SEEA provides a set of tables that are consistent and can be integrated with the SNA structure, classifications, definitions and accounting rules. In this way, an analysis of changes in the status of natural capital can be documented – with its contribution to the economy and the impacts of economic activities. The SEEA also provides detailed methodological guidance to prepare environmental-economic accounts on a wide range of issues. The approach is for each country to select the modules that it is interested in, according to their political priorities, resource availability and data accessibility. It should be noted that within the EU Regulation 691/2011 (amended in 2014) sets the frame for implementation of the different SEEA modules.

The most recent revision of the SEEA is described in a three volume set, which consists of:

- ***SEEA Central Framework*** (SEEA-CF): The environmental resource accounts which measure, in physical and monetary terms, the stock of natural resources and the flows that cross the boundary between economy and the environment and circulate within the economy.

  It focuses on the abiotic components of natural capital, e.g. minerals and energy, although it also includes some biotic components of natural capital, e.g. timber. It also includes material flow accounts (MFA) and waste, water and air emission accounts as well as environmental transfers, expenditures and environmental activities (see Table 3.1 below).

- ***The Experimental Ecosystem Accounts*** (SEEA-EEA): At present, this is a methodological guidance document rather than a formal statistical standard. It aims to show how to measure ecosystem components of natural capital, in terms of the state of ecosystems and their capacity

to provide ecosystem services, as well as estimates of the costs of protecting or repairing damage. The aim is to develop accounts for important natural capital stocks such as carbon, water and biodiversity, and ecosystem service flow accounts initially using quantitative physical metrics. Over time, these might become expressed in monetary terms – depending on methodological suitability.

- ***Extensions and applications of the accounts*** (SEEA - AE): Among other things, this volume describes examples of analytical and policy uses of natural capital accounts. It aims to be a guide to practitioners on the development and analytical use of environmental accounting approaches. See: http://unstats.un.org/unsd/envaccounting/ae_white_cover.pdf

Table 3.1 shows the different types of accounts that are included in the SEEA-CF and SEEA experimental ecosystem accounts and an example to illustrate their potential format is provided in Table 3.2 below. The different types of accounts will be explained in more detail in Sections 3.4 and 3.5 where the particular challenges that arise in their construction are identified.

Table 3.1 Component accounts of the SEEA

<table>
<tr><th colspan="2">SEEA Central Framework (SEEA-CF)</th><th colspan="2">SEEA experimental ecosystem accounts (SEEA-EEA)</th></tr>
<tr><th>Assets</th><th>Flows</th><th>Assets</th><th>Flows</th></tr>
<tr><td>In principle both physical and monetary accounts for:
• Mineral and energy resources
• Land
• Soil resources
• Timber resources
• Water resources
• Other biological resources</td><td>In principle both physical and monetary accounts for:
• Energy
• Water
• Material flows
• Air emissions
• Waste water
• Solid waste
Monetary accounts for:
• Environmental protection expenditure
• Environmental goods and services sector
• Environmental taxes and environmental subsidies</td><td>In principle both physical and monetary accounts for:
• Land accounts
• Carbon accounts
• Water accounts
• Soil and nutrient accounts
• Accounts for different types of ecosystems
• Biodiversity accounts</td><td>In principle both physical and monetary accounts for:
• Provisioning ecosystem services
• Regulation and maintenance ecosystem services
• Cultural ecosystem services</td></tr>
</table>

Table 3.2 Example of an accounting table

Basic form of an asset account
Opening stock of environmental assets
Additions to stock
Growth in stock
Discoveries of new stock
Upward reappraisals
Reclassifications
Total additions of stock
Reductions of stock
Extractions
Normal loss of stock
Catastrophic losses
Downward reappraisals
Reclassifications
Total reductions in stock
Revaluation of the stock
Closing stock of environmental assets

As a contribution to the international work that surrounds the development of the SEEA, and especially the work involving the issues in SEEA-EEA, the European Environment Agency is developing simplified ecosystem capital accounts (sECA). This initiative aims to build the first application of experimental ecosystem accounts, covering at the minimum biomass carbon, water quantity and land (use), based on the available data at European level.

3.4 Physical natural capital accounts

Ecosystem assets and the ecosystem service flows they generate are generally physical entities – so developing physical accounts expressed, using units such as areas, weights, volumes or counts, is the first logical step to take. Current approaches envisage physical accounts sitting usefully alongside economic information as a set of 'satellite accounts'. Subsequent valuation for policy purposes may include monetisation approaches, but not necessarily so.

The physical accounts form part of the SEEA Central Framework (SEEA-CF) and the Experimental Ecosystem Accounts (SEEA-EEA) measure both the stock assets and flows. The accounts included in the SEEA-CF collect information on:

- ***Physical assets*** represented by the available stock of natural resources and their changes due to extraction, new discoveries, natural growth, natural disasters and other reasons. They include asset accounts for mineral and energy, together with those for land and soil resources, timber resources, water resources, and accounts for other biological resources;
- ***Physical flows between the economy and the environment*** for inputs, e.g. energy accounts, water accounts, and material flow accounts, and outputs, e.g. air emission accounts, waste water accounts, and solid waste accounts.

In the context of the SEEA-EEA, ecosystems are regarded as assets and ecosystem services as the 'flows' of benefits that they provide to people. The SEEA-EEA defines ecosystem assets as *spatial areas containing a combination of biotic and abiotic components and other characteristics that* function together (SEEA-EEA, p. 23).

The SEEA-EEA, therefore, represents an important conceptual shift, compared to the approach of the SEEA-CF. The SEEA-CF considers assets more or less individually, e.g. in terms of energy resources, water, minerals, land, and timber. The SEEA-EEA sees environmental assets from a broader perspective – accounting aims to assess how different environmental assets interact as part of natural processes, in specific locations, in providing ecosystem services.

Thus the accounts in the SEEA-CF looks at the relationships between, for example, land cover, land use, carbon, biomass, and water provision. Differing from the SEEA-CF, the SEEA-EEA focusses only on biotic assets and the services which flow from those assets.

Most progress has been made so far in developing accounts for abiotic assets and the flows of benefits derived from them. In many instances, accounts are also available for ecosystem assets that provide marketable goods, e.g. forests. Future developments will extend the accounts to cover ecosystem services.

This requires a standardised approach which is provided by the Common International Classification of Ecosystem Services (CICES). CICES (see Table 3.3) now forms part of the SEEA-EEA.

Table 3.3 The CICES 4.3 classification of ecosystem services (first three levels)

Note: CICES is hierarchical in structure, and only the first three levels are shown in Table 3.3 (see www.CICES.eu)

Section	Division	Group
Provisioning	Nutrition	Biomass
		Water
	Materials	Biomass, Fibre
		Water
	Energy	Biomass-based energy sources
		Mechanical energy
Regulation & Maintenance	Mediation of waste, toxics and other nuisances	Mediation by biota
		Mediation by ecosystems
	Mediation of flows	Mass flows
		Liquid flows
		Gaseous / air flows
	Maintenance of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection
		Pest and disease control
		Soil formation and composition
		Water conditions
		Atmospheric composition and climate regulation
Cultural	Physical and intellectual interactions with ecosystems and land-/seascapes [environmental settings]	Physical and experiential interactions
		Intellectual and representational interactions
	Spiritual, symbolic and other interactions with ecosystems and land-/seascapes [environmental settings]	Spiritual and/or emblematic
		Other cultural outputs

The SEEA-EEA proposes to account for ecosystem assets by measuring the extent and condition of different ecosystems and their services. This requires geo-referenced data that at least provide a proxy distribution for the different types of ecosystem assets of interest. This approach provides scope for synergies, and a need for coordination, with the activities on mapping and assessment of ecosystems and their services as part of the wider EU *MAES* process.

3.5 Monetary accounts and valuation approaches

3.5.1 Monetary measurements in the SEEA-CF

Monetary accounts and associated indicators are included in both the SEEA-CF and the SEEA-EEA. The Central Framework contains a number of such monetary measurements, including:

- ***Environmental protection expenditure accounts (EPEA)***, covering expenditures on pollution prevention and abatement;
- ***Environmental goods and services sector accounts*** providing information on environmental goods and services such as waste and wastewater management and treatment services, and energy and water saving activities;
- ***Environmental taxes;***
- ***Environmental subsidies;***
- ***Water and waste water;***
- ***Energy accounts.***

While the SEEA-CF recognises that many aspects of the environment can be accounted for in physical and monetary terms, the scope of monetary valuation in the SEEA-CF is limited in scope since generally only assets that have a market price are included. Monetary accounting for those that lie outside any market is one of the challenges to be tackled in developing experimental ecosystem accounts.

3.5.2 Enlarging the scope to value ecosystem goods and services

To overcome the challenge of valuing ecosystem assets and services that are not traded in markets, and which therefore do not have a price, economists have proposed a number of different methodologies for the monetary valuation of ecosystem services, (White, *et al.*, 2011; ten Brink, (ed.), 2011; Pascual, *et al.*, 2010; Kumar, P., 2012; United Nations *et al.*, 2014). In this context it should be noted that the value of ecosystems, i.e. assets, can be approximated using the sustained flows of ecosystem services they provide. For example forests provide regulating ecosystem services, e.g. carbon storage, provisioning ecosystem services, e.g. timber, and cultural ecosystem services, e.g. recreational settings.

Analysis for the European Commission identifies three main methodologies (Brouwer, *et al.*, 2013):

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, e.g. economic damage from floods by managing floodplains in a sustainable way; replacement costs, e.g. the cost of mechanical purification of water which is needed to replace natural water purification provided by healthy ecosystems; restoration costs which calculate the cost of restoring a degraded ecosystem.

2) Methodologies based on ***revealed preferences*** that are estimated values based on the preferences of individuals – as shown by their behaviour, e.g. the Travel Cost Method and

Hedonic Pricing. The former can be used to estimate the value of a protected area through the amount of time and money people spend to visit it. The Hedonic Pricing Method uses the changes in the market value of goods that are directly related to the ecosystem services to be valued, e.g. differences in property prices can be used as indicators of the cultural ecosystem services provided by the landscape.

3) Methodologies based on ***stated preferences***, e.g. Contingent Valuation – which is based on 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.

Since monetary valuation studies are time and resource intensive, in many cases monetary values calculated elsewhere for similar ecosystems are used. This procedure is called value or benefit transfer and must be carried out with caution because the provision and the value of ecosystem services is often location-specific (Pascual, *et al.*, 2010; Brouwer, *et al.*, 2013, section 6.2.4.3; SEEA-EEA, section 5.6.3).

A review of national ecosystem service assessments across the EU Member States (Brouwer, *et al.*, 2013) found that most studies cover different kinds of provisioning, regulating, cultural and supporting ecosystem services, but only a small subset of them used monetary valuation in their assessments. In general, monetary valuation of ecosystem services is, therefore, still at a very early stage. The review found that most provisioning services are, or will be, valued using market prices. Most regulating services using methodologies based on costs, where possible. Monetary valuation of cultural ecosystem services, which are mainly valued using stated valuation methods, is much more complicated because of the methodological challenges, lack of data, lack of resources to conduct original valuation studies and criticisms towards the use of monetary non-market valuation in some countries.

If different methodologies are used for monetary valuation, then the values obtained for different ecosystem services are difficult to aggregate because they are not directly comparable. A particular issue is that market prices for goods should ideally not be conflated with economic values derived from methods such as 'willingness to pay'. This may pose a problem if monetary valuation is to be used for accounting purposes (Brouwer, *et al.*, 2013). Overall, there is not yet an agreed method for integrating monetary measurements across different types of accounts and considerable methodological challenges remain. Further national experimentation is crucial to identify potential ways forward.

3.5.3 Non-monetary valuation methods

Since monetary valuation is still at a very early stage, some studies used non-monetary valuation methods as an alternative to aggregate and weigh different ecosystem goods and services. The term 'non-monetary valuation' refers to a broad and heterogeneous collection of approaches and methods (Christie, *et al.*, 2012). Non-monetary valuation techniques do not translate the value of ecosystem services to money flows, but express their importance with relative ranks reflecting stakeholder perspectives. By avoiding reducing plural values into one single metric, these methods are able to grasp both tangible and intangible benefits derived from ecosystems (Chan, *et al.*, 2012).

It is important to note that preferences are often very contextual. Some issues may be overlooked, e.g. if only parameters are considered that have an economic value in the market place, as in the case

of some Payments for Ecosystem Service (PES) schemes. However, while non-monetary methods might offer a broad approach, they do not always mesh well with natural capital accounting principles and tend to be applied in more case-specific decision-making.

3.6 Developing ecosystem accounts within an overall framework

The review provided here suggests that while it is generally acknowledged that natural capital accounting is needed the ways to account for natural capital, i.e. the methodologies and principles needed to achieve this ambition, are still under development. A number or recent initiatives are, however, beginning to show the direction that practical applications are taking.

There are, for example, discussions between the UN-SD, UNEP, World Bank, and others, to develop guidance on ecosystem accounting that builds on the SEEA-EEA principles (Hein, 2014, pers. comm). One of issue being considered is which accounts should be part of the UN Ecosystem Accounting approach. A preliminary view is that they should include:

- ecosystem asset accounts, which describe in physical and monetary terms the stocks of ecosystem capital and their changes over time;
- ecosystem condition accounts, which describe the status or integrity of the ecosystem accounting units in some way, so that judgements about the extent of changes in the capacity of the assets to deliver ecosystem services can be made;
- ecosystem service flow accounts, which describe the outputs of services in both non-monetary and monetary terms;
- the supply-use account connecting suppliers and users, as classified by the classified by the International Standard Industrial Classification (ISIC);
- biodiversity accounts that record levels and changes in species composition.

Such a framework is consistent with those being suggested both in Australia and the UK, which also draw upon the foundation of the SEEA-CF and SEEA-EEA, and which seek to emphasis a more purpose-driven approach. The framework also emphasises that, while monetary accounts are useful, the development of physical accounts is perhaps more fundamental in the sense that it provides the foundation for the former. The emerging paradigm is perhaps best illustrated by the work in Australia (Bureau of Meteorology, 2013) which is based on a 'joint perspectives model' (Box 3.1). This is used to represent the core relationships between the economy, society, and environment. It envisages four nested systems: the physical earth system, the living system, the human cultural system, and the economic system – these collectively define the scope of any set of environmental accounts. The idea of nesting is used to emphasise the need to be able to used accounts to 'transfer value between places, times and entities' and, especially, to show how physical accounts for the earth and living systems can be relevant to social and monetary accounts at the level of cultural and economic systems.

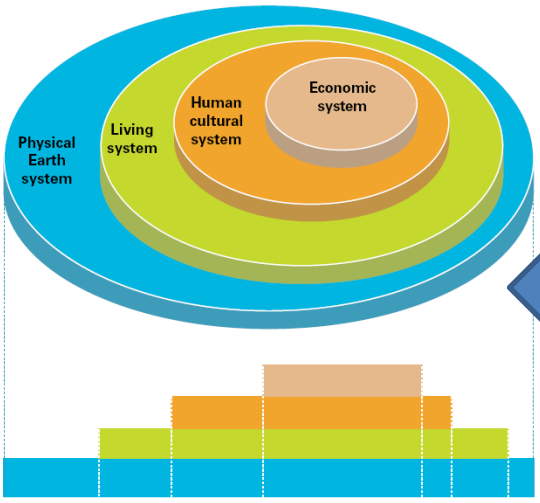
It is envisaged that for:

- **Physical and Living systems** accounts would be based on physical measures, and that those for natural capital would document ecosystem assets and flows, together with measures of their functions and processes, biodiversity, biocarbon cycle, water cycle. The accounts would primarily be defined spatially using classifications of land cover, habitat, ecosystems, or environmental assets;

- **Human cultural systems** relevant accounts would include those for ecosystem services that would document the benefits flowing directly to human cultural systems that are outside the economic system. The accounts would use indices of human well-being, suffering, and happiness, measured at the scales of individuals, groups, municipalities, communities, societies, and nations;
- **Economic systems** ecosystem service accounts would also be a key part, but here they would be measured in market-based values and captured in the SNA measured at the scale of individuals, households, businesses, enterprises, and nations etc.

Although the scope of the accounting framework suggested is very broad, the Australian work has gone on to provide a series of practical guidance documents, (Bureau of Meteorology, 2013), designed to help people understand the process of framing and using an environmental account.

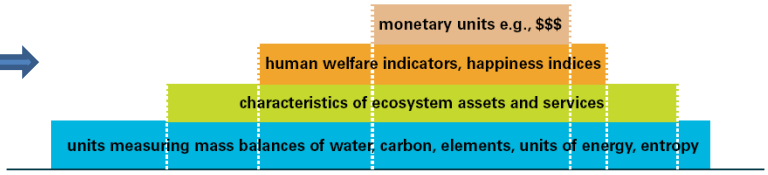
Box 3.1: The Joint Perspectives Model (after Bureau of Meteorology, 2013)



The Joint Perspectives Model is represented by a series of nested systems that include the physical earth system, the living system, the human cultural system and the economic system. These are represented in terms of the diagram left, and in the cross-sectional view, the vertical dotted lines delineate systems, while the coloured horizontal slices represent the different perspectives from which systems can be viewed.

Thus, while the economic system is generally viewed from the economic perspective, it can also be viewed from the physical Earth, living and human cultural system perspectives because it is, in turn, made of each of these systems. Similarly, the living system, which emerges from the physical Earth system, can also be understood from a physical perspective.

The nested system gives rise to the design of an integrated set of accounts linking physical and natural capital with human cultural and economic measures



The UK work (NCC, 2014) has also focussed on making practical advances in accounting methodologies by looking at specific purposes and needs – their principles currently focus on providing a framework for developing accounts for ecosystems and ecosystem services, rather than natural capital accounts, which is interpreted as being much broader in scope and encompassing elements relating to the SEEA Central Framework.

Thus sub-soil assets are not included within the scope of ecosystem accounts, along with accounts for the atmosphere, minerals and the oceans. However, in keeping with the SEEA it is envisaged that

development should be guided by such things as economic and policy relevance, the extent to which ecosystem services can be influenced by interventions, and the existence of adequate data and methods for quantifying and valuing the services.

The UK principles go on to describe assets accounts that document the stock, condition and other characteristics of an ecosystem unit, and ecosystem service accounts that document the flow of services, in non-monetary terms, for an accounting area. The service accounts describe both the supply and use of services, and like the Australian framework use land cover and habitats to disaggregate and report the information. It is also envisaged that accounts for biodiversity will be provided as part of the accounting exercise.

3.7 Summing up:

Natural capital accounting enhances the knowledge base on natural resources and ecosystem assets and helps us to assess whether natural capital is managed within sustainable limits. A lot of progress has already been made at international level in developing related environmental accounting concepts and methodology. This is particularly strong for physical accounts that aim to measure trends in the natural asset base as well as (ecosystem) service flows.

More work is clearly required with regard to economic valuation, both for monetary and non-monetary approaches. However, physical accounting approaches need in any case to be completed first as they provide a necessary platform on which to build economic valuation

A key conclusion to emerge from ongoing work is that future efforts to develop natural capital accounting should be targeted and purpose-driven. The need to focus efforts around specific needs and priorities is also emphasised in a recent CBD publication on 'ecosystem natural capital accounts', which provides a 'Quick-Start Package' designed to help implement the Aichi Biodiversity Target 2 on integrating biodiversity in national accounting systems.

Overall the foundation has been established for practical implementation and learning from experimentation at national and EU level. Such a process would benefit from further exchange between interested Member States and the development of an overarching strategy. In the context of the EU MAES process chapter 5 proposes a draft roadmap to strengthen momentum and capacity across Europe for taking natural capital accounting forward.

4 THE ROLE OF NATURAL CAPITAL ACCOUNTS IN POLICY AND APPLICATION

Natural capital accounting is a potentially useful tool for policy-makers across the policy cycle and also at different governance levels – from EU to national to regional level.

The added-value of the approach depends on the maturity and quality of the accounts, the data they contain, and on other existing indicators and measurement tools already contributing to the evidence base for policy-making. This will differ between accounts and policy areas, as well as across countries.

The potential policy benefits of natural capital accounts are discussed in relation to organic carbon, water and land use accounts for the policy areas related to biodiversity, water as well as for cohesion policy.

The policy utility of environmental accounting is expected to grow over time, both across the policy cycle areas, across more geographic scales, and for more policy areas. However, natural capital accounting will remain one among several sources of evidence for policy-making and monitoring.

4.1 Natural capital accounts in relation to the policy cycle

Since the publication of the Brundlandt report (1987) it has been argued that sustainable development requires the integration of economic, environmental and social goals. For such an integration to be successful one needs to establish a comprehensive and integrated information framework that can inform individual environmental and sectoral policy areas in a coherent manner.

The UN System of Environmental-Economic Accounting provides such a potential framework in relation to natural capital through a combination of SEEA-CF and SEEA-EEA. A draft implementation guide on the SEEA (UN-SD, 2014) proposes dividing issues, related to the environment-society interface, into four themes:

1) improving access to services and resources linked to policies that ensure households have access to appropriate, reliable and affordable resources, e.g. clean water, energy, food, land, materials, and waste treatment;
2) addressing the allocation of endowments of natural resources to meet the needs of current and future generations by managing supply and demand;
3) improving the state of the environment and reducing impacts, recognising that economic activities may harm the environment and including activities related to protecting and restoring natural capital for future generations;
4) mitigating risks and adapting to extreme events, referring to policies that aim to reduce harm to humans, ecosystems and the economy caused by extreme natural events and changing environmental patterns.

These themes link well to the concepts put forward in the 7th EAP under the heading 'Living well, within the limits of our planet'. The first three objectives of the 7th EAP are to

1) *protect, conserve and enhance the Union's natural capital;*
2) *turn the Union into a resource-efficient, green and competitive low-carbon economy;*
3) *safeguard the Union's citizens from environment-related pressures and risks to health and well-being.*

Whether one primarily reviews the four themes put forward in relation to the UN-SEEA, or 7th EAP objectives, it soon becomes clear that action, in many policy areas and individual policy instruments, are required to achieve the targets implicit in the above lists. Generating the knowledge-base that allows well-informed and focused development and implementation of policies to better protect and manage our natural capital, is a substantial task.

While not the only source of evidence for policy-making, natural capital accounts will offer crucial information in this context. What they offer as value-added, over other information sources, together with existing environmental data sets and indicators, is the potential for an integrated framework of environmental and economic data. If structured appropriately, such a framework allows cross-linkages to be made between different uses and components of natural capital, and to consider trade-offs in managing and exploiting this capital and the service flows it provides. The next section discusses these aspects in relation to EU policies for water, biodiversity and regional cohesion.

4.2 The information potential of natural capital accounts for key EU policy areas

4.2.1 Water Framework Directive and Floods Directive

The objective of the Water Framework Directive 2000/60/EC (WFD) is that all EU Member States should achieve good status for groundwater and good ecological status/potential for surface waters, i.e. rivers, lakes, transitional waters and coastal waters, by 2015 – although Member States have the possibility of requesting extensions to a later date. The concept of good ecological status refers to the quality of the biological community in water bodies as well as their hydro-morphological and chemical status.

Another important and closely linked directive for water management is the Floods Directive 2007/60/EC (FD), whose objective is to reduce and manage flood risk. This Directive requires the EU Member States to carry out a preliminary assessment to identify the most threatened river basins and coastal areas. For each of these areas, flood risk maps were to be prepared by 2013, and Flood Risk Management Plans are required by 2015.

Good management of water resources requires balancing supply and demand and understanding potential sources of pollution, or other impacts, on water bodies. For many river basins, there are long-running and detailed data sets on water extraction volumes and the use of water in different sectors, e.g. agriculture, industry and households. Different water uses can peak at different times of the year and water-use for irrigation often coincides with periods of low water flow during the summer months. This shows the particular importance of adequate temporal and spatial resolution when constructing water accounts.

The Directives, and other water management targets, set the context for developing accounts in this important policy area. Developing a comprehensive accounting system to address these needs would help to establish an integrated data and analytical platform to support key water management issues. Natural capital accounts could inform water policies by collecting and synthesising information on water abstraction and use, water availability, water quality, and its relationship to land and sectoral uses of water – complementing insights from SEEA Central Framework accounts.

One potential platform for the development of accounts in this thematic area is the WISE-WFD database, in particular the section on state of environment reporting. Information can be extracted in tabular format for a range of characteristics including the ecological status for each individual water

body, or the significant pressures affecting it. As part of River Basin Management planning and reporting, Member States are gathering a broad range of information on water conditions, providing a strong basis for natural capital accounts, such as the role of protected areas and their links with water availability, water quality and water productivity, and the links between forest areas and water productivity.

In the context of the Floods Directive, natural capital accounts may offer the opportunity for an integrated analysis of the link between water and land use. Box 4.1 below provides an example of a structured re-use of information, collected from water resource management, for developing natural capital accounting modules, and how eventually the system may provide the basis for reporting and monitoring policy effectiveness.

Box 4.1: Country insight - Bulgarian experience in information re-use

Support for integrated water management in Bulgaria is being implemented in a staged way. A common database model was created through a previous project in 2007 – *The Integrated Water Management in Republic of Bulgaria*. In 2009-2012, a joint project with the Norwegian Water Resources and Energy Directorate further developed the first six modules in a service-oriented geographic information system designed to cover all institutions responsible for water management. The system currently maintains the basic geo-information used for the development of the River Basin Management Plans and supports the effective management, monitoring and control of the permits under the Water Act and the IPPC permits, and will be extended with new financing.

The information it provides on the permitted water abstraction and discharge quantities is used by the National Statistical Institute (NSI) for securing the scope of statistical water observations and quality control. The system also gives information on the ecological taxes and fees modules of the national reporting under Regulation 691/2011. New functionalities will include, among others, the new Marine Strategy Framework Directive and nitrates modules, support for WFD reporting, and data integration with flood management systems. NSI experts are to be included in the stakeholder group defining the system's functions and outputs to ensure continued support for statistical reporting.

Data integration and re-use helps to eliminate major bottlenecks in reporting capacity – namely, the need to collect huge volumes of data from multiple economic operators, which would, otherwise, create new administrative burdens and severely strain the NSI's administrative capacity.

Table 4.1: Examples of potential policy applications of natural capital accounts

Water	Biodiversity	Cohesion Policy
Water Framework Directive (WFD): Good status for groundwater and good ecological status/potential for surface waters (2027). **Floods Directive (FD):** Flood risk areas (2015).	**Biodiversity Strategy to 2020:** Target 2, Action 5 & commitment to accounting. Supporting a range of other targets, including restoration and halting biodiversity loss.	**2014-2020 EU Cohesion Policy:** Thematic objectives related to: low-carbon economy; climate change adaptation, environmental protection, promotion of resource efficiency.
• WFD: Synthesising information on water abstraction/use, water availability and water quality and exploring the links between water quality/use and land use/cover. This can help identify priorities for River Basin Management Plans. • Establish data/trends on water flow in relation to ecological flow objectives. Note this requires very regular data collection on water flow volumes per river basin, e.g. monthly. • FD: identify priority needs and opportunities for Flood Risk Management Plans by linking data on forests and other natural water retention features with flood risk maps. • River basin NCA likely to be most useful. There is a growing body of existing water accounts work to build on. Existing indicators already fit-for-purpose in many areas but integration could provide additional benefits. ⇨ *NCA can help integrate information on the state and condition of water bodies and sectoral uses of water – this can support better management of river basins.*	• Collecting information on the state of natural capital stocks and flows and providing information on the pressures on ecosystems and ecosystem services – e.g. fragmentation and degradation. • Providing complementary information for the development of biodiversity policies (e.g. on key pressures). They complement Natura 2000 reporting in this regard. • NCA can help track progress regarding degradation and restoration objectives (not on the local scale, but regarding broad objectives at a larger scale). • Evidence from water, land use, and biomass-carbon accounts and the links between these and other component accounts. Current accounting approaches often do not cover biodiversity directly – if so, they need to be complemented by biodiversity indicators. ⇨ *NCA can provide info on state and pressures, monitor change in time (e.g. degradation and restoration) - this helps to develop an integrated analysis of key trends in, and pressures on, biodiversity.*	• Helping to select national strategies, set regional strategies and objectives, and allocate funds across different cohesion policy priorities. • Helping develop operational programmes, including priorities: natural capital accounts could highlight trade-offs and synergies between different development paths. • Helping to monitor and assess regional programme effects on biomass carbon and carbon neutrality commitments. • There are opportunities for using Cohesion Funding to invest in developing accounting systems. ⇨ *In summary: NCA assist in prioritisation, allocation of funding and the monitoring of achievement of programme objectives; reveal trade-offs and synergies (not only for Cohesion Policy).*

4.2.2 Biodiversity strategy

The European objectives for the protection and enhancement of biodiversity and ecosystem services are established by the EU Biodiversity Strategy to 2020 (COM (2011) 244 final), which states that, by 2020, the EU biodiversity and the ecosystem services it provides shall be protected, valued and appropriately restored. The EU Biodiversity Strategy sets, as an objective, to restore at least 15% of degraded ecosystems, and to ensure no net loss of ecosystem services by 2015. In addition, the Habitats Directive (92/43/EEC) and the Birds Directive (2009/147/EC) provide a framework for biodiversity protection.

A primary focus for natural capital accounting, in relation to the EU Biodiversity Strategy, is to support parts of Target 2, Action 5 – namely, the commitment to map and assess the state of ecosystems and their ecosystem services; to assess their economic value when possible; and to promote the integration of this information in EU and national reporting systems. Similarly, there is a need to integrate accounting into national biodiversity strategies and action plans – NBSAPs, (IEEP, 2013), called-for under the Strategic Plan for Biodiversity 2011-2020 and the corresponding Aichi Biodiversity Target 2 adopted at the 10th meeting of the Conference of the Parties to the CBD (COP 10) – where by 2020, at the latest, biodiversity values will have been integrated into national and local development, and poverty reduction strategies and planning processes will be incorporated into national accounting and reporting systems, as appropriate.

With appropriate scientific and methodological guidance, data gathered to construct the different types of tables included in natural capital accounts can support biodiversity policies by collecting information about the pressures on ecosystems. For example, water accounts and land accounts and their underlying data provide relevant information regarding key pressures on biodiversity. In the case of water, such accounts can provide trend information on minimum water flows during critical periods of the year, or help identify which water uses increase the most, to understand where best to reduce overall water demand.

Similarly, trend information at the interface between water and land accounts, and derived information on accessible water, can help identify wetland areas at risk of over-exploitation or degradation. This can be relevant for certain protected areas, e.g. wetlands, where either over-extraction or climatic effects threaten conservation objectives.

Natural capital accounting provides a useful analytical frame because it helps to link information, on changes in land cover, with information on other relevant variables, e.g. population trends, water use and availability and trends in land cover and use. Such an integrated framework can help inform policies to reduce pressures, help biodiversity proofing policies and programmes, and facilitate the integration of biodiversity into other policies (see section 4.2.3 on Cohesion Policy).

The complexity of biodiversity and the lack of monitoring data means that, currently, it can only be partially integrated and reflected in spatially-detailed accounts. Natural capital accounting, therefore, is only one tool, albeit one of potential growing utility, to support the objectives of biodiversity conservation and other biodiversity-related policies.

4.2.3 Cohesion policy

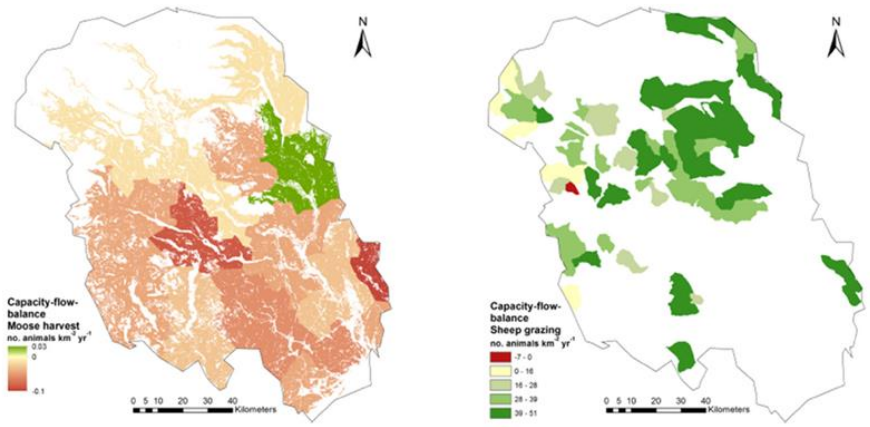
EU Cohesion Policy (CP) aims to reinforce economic, social and territorial unity by promoting sustainable regional development, creating opportunities for employment and increasing competitiveness. The mitigation of climate change is seen as a priority, with between 12–20% of the European Regional Development Fund (ERDF), in each Member State, allocated to promoting a low carbon economy over the period 2014-2020 (Hjerp *et al.*, 2011; Volkery *et al.*, 2012), and environmental protection, more generally, is also seen to be important. It is envisaged that CP will provide funds for preserving the environment and promoting resource efficiency through, for example, investment in biodiversity, the Natura 2000 network and nature-based solutions. Currently the bulk of environmental funding has, however, gone for infrastructure projects, such as wastewater treatment plants (IEEP and Milieu, 2013).

Given the broad range of concerns over Cohesion Policy, an integrated accounting approach is, therefore, likely to be especially useful at a number of the stages in the policy cycle, and may help broaden the range of measures that are implemented. Accounts could, for example, be developed to provide a framework under which benefits, trade-offs and synergies between different instruments can be evaluated – especially in relation to the assessment of the objectives of carbon neutrality and no net loss of biodiversity. They might also be useful in terms of documenting and recording the costs and benefits of restoration.

The development of natural capital accounts for Cohesion Policy will depend on the data sets available at country and regional scales, and the level of spatial disaggregation and representation that is possible. Two case studies illustrate that much can already be achieved. Such results can be used to identify priorities for environmental, and other spending, under Cohesion Policy, and also to monitor results.

Remme *et al.*, (2014), have shown how spatial biophysical accounting for multiple ecosystem services can be developed for the Limburg province in the Netherlands. The model-based analysis documented hunting, drinking water extraction, crop production, fodder production, air quality regulation, carbon sequestration and recreational cycling, as multiple spatial scales. The authors concluded that, while the work was focussed at the regional level, the methods could, in principle, be scaled up to the national scale, and be effective in helping decision-makers to understand the differences in flows of services between different land covers and localities. The complementary analysis made for Telemark county, Norway, by Schröter *et al.* (2014), illustrates how spatial accounts can be constructed to differentiate the capacity of ecosystems to supply services from the actual use of them (see Box 4.2).

Box 4.2 Modelled capacity flow relationships for two ecosystem services in Telemark county, Norway (after Schröter *et al.*, 2014)



These maps show the balance between the capacity of different land cover types to provide these services, measured as the recruitment or release rate of animals to the respective populations, and the rates of flow of the service, or supply, measured by the rates of removal through hunting or recapture.

4.3 Conclusions on potential policy applications

The policy relevance of natural capital accounting is clear from the targets in the EU Biodiversity Strategy to 2020, and the many references to natural capital in the 7th Environmental Action Programme of the EU. The previous section has discussed examples related to biodiversity, the EU Water Framework and Floods Directives and EU Cohesion Policy. These applications show opportunities for natural capital accounts to become an important information source in the medium term.

The main value-added of developing a natural capital accounting system is that it allows important cross-sectoral linkages to be identified and explored. Potentially-important linkages are found between issues, e.g. the water-land-carbon nexus; between data outputs and relevant administrative or functional regions, e.g. river basins and administrative units, such as NUTS II and III; between environmental and other sources of data, e.g. on city populations, protected areas, and infrastructure. These, and other linkages, maximise the potential to offer a coherent information basis to policy-making. Linking different sets of data to help explore synergies and trade-offs, associated with different policy options, is vital if better management of our natural capital is to be embedded more generally, in decision-making.

While these general considerations make a good case for natural capital accounting there is still substantial work to be done for it to achieve the policy influence it could have. This requires further development and a focused exploration of application options for natural capital accounts in policy debates and decisions. One potential approach here is to review the use of evidence in policy-making

during different stages of the policy cycle. A report for the UK government (DEFRA, 2010) suggests various entry points, including:

- identifying a problem or opportunity, e.g. use in business cases;
- assessing and setting policy priorities, e.g. informing strategic decisions, helping to optimise use of resources;
- improving policy development, e.g. providing the broader picture;
- identifying potential policy responses by issue or area;
- appraising policy options, e.g. use in impact assessments;
- improving policy or programme delivery, e.g. informing better resource management of delivery bodies; influencing behaviours by informing stakeholders through indicators.

Natural capital accounts are one type of such evidence with particular characteristics. Radermacher and Steurer (2014) have argued that it is essential to understand the stage or stages in the policy cycle where natural capital accounts would be used, because this will determine a number of key design requirements such as their accuracy and update frequency.

Physical asset accounts provide information on the state, trends and distribution of different types of natural capital and its monitoring function appears best-suited to informing early stages of the policy cycle, i.e. identifying problems or opportunities and setting priorities. For example, specific types of natural capital that show strong decline or growth, or help identify geographic areas that require particular attention in a natural capital perspective, can be highlighted.

Where accounting data includes information on the ownership of natural capital assets, it can also provide useful input to identifying potential policy responses, or improving programme delivery, by giving insight into the structure and type of economic agents that need to be influenced for certain policy goals to be reached.

The design of natural capital accounts influences their potential role in informing policy-making. This relates to spatial coverage, i.e. whether this covers an entire territory, certain regions, or specific types of ecosystems or other ecological units, and spatial resolution, i.e. coarse or detailed. For example, evidence on the role of ecosystems in national greenhouse gas reporting must cover the entire territory of a country and all (important) types of bio-carbon in vegetation, animals and soils. However, detailed information on carbon trends and carbon management options in biomass carbon 'hotspots', i.e. peat lands, can also inform potential policy responses and the appraisal of policy options, e.g. regarding a development proposal that would affect a particular peat land area. Further discussion of this issue can be found in a working paper for the Natural Capital Committee in the UK (NCC, 2014b).

Overall, it can be said that the requirements for natural capital accounts are likely to vary during different policy stages. Identifying these, and developing natural capital accounts with policy use in mind, will involve potential trade-offs between statistical measurability, scientific soundness and political relevance. Further development and practical use of such accounts at national level will help improve our understanding of the most promising policy applications for accounting frameworks.

Further insight into the wider relevance and use of natural capital accounting will also come through other European-funded work, such as OpenNESS and OPERAS. OpenNESS is considering policy

challenges related to competitiveness and regulatory frameworks. Both of these areas have been identified as key in understanding how ecosystem services and natural capital concepts can be operationalised, and sit alongside more traditional concerns relating to biodiversity, sustainable resource use and environmental restoration.

5 TAKING NATURAL CAPITAL ACCOUNTING FORWARD: CONCLUSIONS AND NEXT STEPS

Natural capital accounts have the potential to support and inform a wide range of sectoral and environmental policies. However, the degree to which they will be used for policy-making depends on the available data foundation, the robustness of methodological approaches, and on building sufficient knowledge and capacity to implement them in suitable detail.

This chapter reviews the key challenges that need to be tackled at national and EU levels in order to take natural capital accounting forward. There are four main headings under which the different challenges can be grouped:

1. Developing a clear conceptual focus
2. Building a suitable common data platform
3. Establishing an effective organisational set-up
4. Making accounts part of policy practice

Each of these points is discussed in a specific section that also suggests recommendations on priority tasks as appropriate. The chapter concludes by proposing a draft roadmap for developing natural capital accounting in the EU.

Substantial effort is required at EU and national level to build the conceptual and practical foundations for the ambitious natural capital accounting targets contained in the EU Biodiversity Strategy and 7th Environmental Action Programme of the European Union to be achieved.

5.1 The analytical promise of natural capital accounting approaches

This document has shown the progress achieved, so far, in developing a conceptual foundation for natural capital accounting. The UN System of environmental-economic accounting and the CBD Quick-Start Package, in particular, provide very useful methodological guidance for nearly all components of natural capital. This guidance now needs to be translated into the EU context – in particular, Action 5 of the EU Biodiversity Strategy to 2020. In that regard, the vision of natural capital accounts as one layer in an information pyramid, (see Figure 3.2), is important. It implies that there is a need to go beyond a technical understanding of what accounts are, how to construct them, and to analysis how this information will actually be used and integrated with other activities.

In the context of the MAES process, for example, a key focus has to be on the interaction between the compilation and structuring of data – for the purposes of ecosystem assessments and ecosystem accounting. While assessments seek to help decision-makers make judgements about the state of natural capital and the implications of long-term trends, accounts are more neutral as, in a sense, they

simply set out the basic evidence around which assessments can be built. Nevertheless, since both are concerned with similar issues and themes the two sets of activities can clearly benefit from each other.

The ecosystem assessments that are complete, or ongoing, in many Member States, represent an important step in establishing a data platform for subsequent accounting and valuation of ecosystem capital and ecosystem services. For that to work, assessments need to conform to accounting data standards regarding information on meta-data and the structuring of data sets.

Natural capital accounts have the potential to support and inform a wide range of sectoral and environmental policies. However, the degree to which they will be used for policy-making will depend on data availability and quality, robustness, and the level of disaggregation. Refining methodologies, investing in data, and extending the scope of current accounts, will improve the benefits of ecosystem capital accounting and the use of a natural capital concept in policy-making. Recognition of natural capital accounting use in current and future policy-making, should lead to further investment in the tools required to realise their potential.

This chapter reviews the key challenges that need to be tackled at national and EU levels in order to take natural capital accounting forward. There are four main headings under which the different challenges can be grouped:

1. Developing a clear conceptual focus
2. Building a suitable common data platform
3. Establishing an effective organisational set-up
4. Making accounts part of policy practice

The following sections tackle these issues one-by-one and provide recommendations on priority tasks, concluding with a draft roadmap for developing natural capital accounting in the EU.

5.2 Developing the conceptual focus

A report describing the Australian approach to environmental accounting (Bureau of Meteorology, 2013) emphasises the importance of understanding needs and contexts. In these guidelines it is suggested that it is important to recognise that accounts must be:

- purposeful and consequential for users who depend on the reported information;
- able to measure change in the issue of interest – via an accounting approach through time;
- organised to enable comparisons and crosschecks in an internally consistent manner;
- comparable with other relevant accounts so it can provide the basis for more detailed or aggregated analyses.

The Australian Government report also proposes an account-scoping process to help users work through the issues in a systematic way – this is set out in Figure 5.1 below.

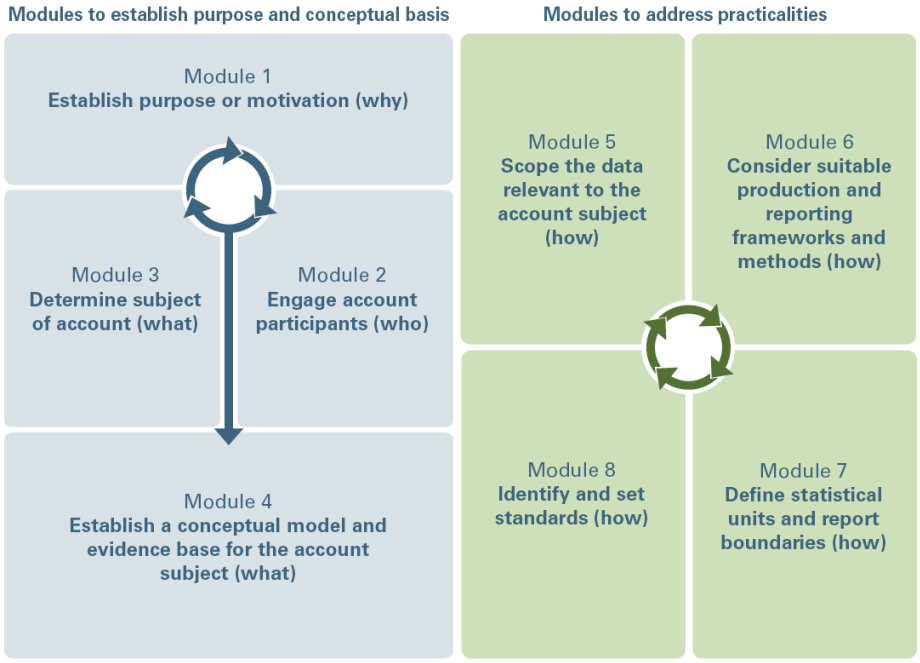


Figure 5.1: Methodology for framing an environmental account

Bureau of Meteorology (2013)

The steps described in Figure 5.1, offer a clear sequence for framing an environmental account that is also applicable to natural capital accounting – although, the individual steps need to be adjusted to the national or thematic context of the account to be developed. Given the diversity of socio-economic and bio-physical reality across Europe, it is not possible to derive specific recommendations from the framing methodology set out above. Nevertheless, the text below suggests some general considerations that would support comparability of accounting results between European countries.

The first choice to make in developing pilot natural capital accounts is:

1. whether these should focus on individual regions or policies; or
2. whether priority should be given to full territorial coverage for a few core components of natural capital.

Option 1 would be a better choice if the priority is to achieve comprehensive coverage of different types of natural capital assets and resulting ecosystem services, or if a link to economic accounts, e.g. in the agriculture sector, enables direct feedback on policy choices – for better management of natural capital affected by the policy in question.

Option 2 potentially provides the framework for better organisation and structure of data sets related to natural capital across the entire territory, and allows a comparison of natural capital trends between different geographic regions.

The current approach to natural capital accounting in the United Kingdom combines territorially focused approaches, e.g. for National Parks, with accounts for certain ecosystems that are the focus

of national policy debates, e.g. woodland. The guidance put forward in the CBD Quick-Start Package, on the other hand, suggests that developing an overall approach to natural capital accounts at national level could involve the creation of a set of 'core' or basic accounts that need to be established from the outset – with a set of 'functional' accounts developed from them. In this case, the core accounts are seen as the data infrastructure upon which more detailed and targeted accounts are developed for specific purposes.

Building on current experience at EU and national level, the following items are suggested as potential priorities in developing accounting approaches to describe natural capital in physical terms:

- ecosystem asset accounts describing physical stocks of ecosystem capital, e.g. land, water, carbon, and biodiversity, and their changes over time;
- ecosystem condition accounts, which describe the status or integrity of the ecosystem accounting units, with indicators representing the degradation/restoration of the assets;
- ecosystem service flow accounts that describe the outputs of services in physical terms and, would usefully be combined with tables of supplier and users.

Developing natural capital accounts in the context of the EU Biodiversity Strategy makes it useful and necessary to link to national and European ecosystem assessment processes and outcomes. Natural capital accounts and ecosystem assessment processes require an understanding of the status and benefits from ecosystems – but with different angles. Both rely on the same, or at least very similar data, and should therefore support each other. This implies that a review of the current outcomes and/or objectives of completed or ongoing ecosystem assessments is highly relevant to the framing of natural capital accounting approaches.

Reviewing the modules included in Figure 5.1, suggests that ecosystem assessments would be relevant to work under modules 1 to 5. This underlines, again, the mutually supportive relationship between these two important areas of work. It is therefore recommended to identify early in the planning stages of natural capital accounts the likely synergies between them.

5.3 Laying the data foundation

Good statistical data and other environmental information is the foundation of environmental analysis. Given the complexity of human interactions with ecosystems, the setting-up of natural and ecosystem capital accounts will therefore be a time and resource-intensive task. Success will depend on building a data foundation that is appropriate to the ecosystem processes to be studied, as well as being aligned to accounting practices at the same time. This requires understanding not only what kind of data are needed, but also how to integrate such data into structured data platforms that allow efficient queries and analysis.

Figure 5.2 sets out some important potential steps. Accounting systems only function if they build on clearly categorised, well-structured and comprehensive input data sets. Other aspects of data that are important for their analytical value are: sufficiently detailed spatial referencing and comparability across space and time.

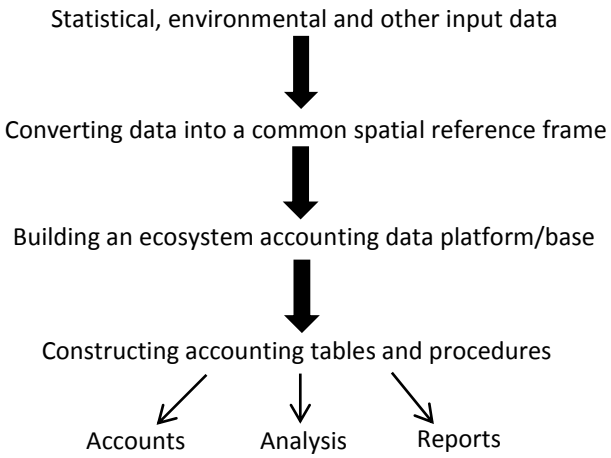


Figure 5.2: Possible future data organisation & analytical work flow

The work flow shown in Figure 5.2 suggests that the key task is to bring data together via a common spatial reference frame so that accounts and analysis can be developed for appropriate natural capital accounting units. These would most likely be significant biophysical units, such as water catchments or certain ecosystem types, but a geo-spatial reference frame would also allow reporting at different levels in the EU NUTS hierarchy of administrative regions.

Essentially the same approach would be applied whether starting from existing statistical data sources – where some kind of down-scaling to the basic accounting units might be required, or from primary or modelled data – where aggregation from finer-scale sources might be necessary.

In taking this approach forward, the first aspects to consider are the availability, suitability and use of different data sets for the kinds of analysis anticipated by the EU Member States and/or at European level. The potential contribution of natural capital accounts to policy-making depends on a range of factors including: input data, the tools used to explore the data, and the interconnections made between accounts. Key data aspects to consider in this regard are:

- Data suitability: does it cover the relevant issues, e.g. important natural capital assets or ecosystem service flows?
- Data source: are data derived from regular data collection exercises that will allow time series to be built – to show trends and possible projections?
- Data quality: are data being validated before publication; are uncertainty estimates possible; how much gap filling is required?
- Spatial resolution: is it at relevant scale to the issue, i.e. the biophysical system, or the political/other level at which management needs to be improved?
- Temporal resolution: are data updates sufficiently regular to allow analysis of critical periods, e.g. water flows during droughts, and to avoid long time-lags in reporting?
- Gap filling: where this is necessary, can proxies or other solutions be identified?
- Geo-spatial modelling: is it feasible to bring different data into a common reference frame, and are suitable models available for which data requirements are known?

Ecosystem accounting is informed by many different types of data, ranging from official statistics, environmental monitoring data and satellite observation data, to reporting under environmental

legislation. Given that the flows of natural capital are not limited to a particular scale, spatially-referenced natural capital accounting needs to allow for 'multi-scale' assessments, e.g. upstream-downstream considerations. The analysis of supply-and-demand for ecosystem services and, hence, the representation of natural capital stocks and the benefit flows that arise from them, hinges critically on the spatial integration of different sources of data.

Different types of natural capital assets and associated service flows, managers and users of natural capital assets, and the territorial focus of relevant policies, all exist or operate at various spatial scales. The ability to use a common spatial reference frame for 'multi-scale' assessments and analyses will therefore be an essential issue in the development of any natural capital accounting approach. Further information on useful approaches to organising and compiling information can be found in the CBD Quick-Start Package on Ecosystem Natural Capital Accounts and the draft Diagnostic Tool for the SEEA Central Framework proposed by the UN Statistical Division (UN-SD, 2014b).

5.4 Establishing an effective organisational set-up

The development of natural capital accounting requires not only a good data foundation, but also an effective organisational set-up, to be successful. Since related institutional structures and data flow organisation vary substantially across EU Member States, it is not appropriate to make concrete recommendations on the organisational structures required to develop and maintain natural capital accounts. As in other contexts, it will be essential to ensure clear organisational lead responsibilities and effective cooperation. This needs to cover the following dimensions:

- production and organisation of underpinning data;
- conceptual development and implementation of a natural capital accounting approach;
- involvement of institutional and economic stakeholders;
- facilitating the use of accounting results by policy and economic decision-makers;
- further development and analysis of accounts by engagement with the scientific community.

As part of its work on developing the System of Environmental-Economic Accounting, the UN Statistical Division has also reviewed implementation challenges at national level – including organisational aspects. Highly-relevant information to ensure effective organisational set-up for natural capital accounts can therefore be found in a draft SEEA Implementation Guide (UNSD, 2014).

Lastly, it is also important to learn from others that have already built up experience. In this regard, the UK provides a useful example of a central body with advisory and implementation responsibility for natural capital accounting in the form of the Natural Capital Committee (NCC).

The NCC was established, in 2012, as an independent advisory body to the Government and reports to the UK Economic Affairs Committee. The NCC's role is to:

- help the Government better understand how the state of the natural environment affects the performance of the economy and individual well-being;
- advise the Government on how to ensure England's 'natural wealth' is managed efficiently and sustainably, thereby unlocking opportunities for sustained prosperity and wellbeing.

The Committee consists of eight members from academia and business who collectively bring expertise and experience in ecology and environmental science, economics and business. The

Committee is supported by a full-time secretariat, based in the UK environment ministry (DEFRA). The NCC's work programme includes:

- producing an annual State of Natural Capital Report;
- working with DEFRA and the Office for National Statistics (ONS) to ensure the timely development of experimental natural capital national accounts, and to explore links with corporate natural capital accounting;
- working with land owners, businesses and accounting bodies, to encourage the uptake of corporate natural capital accounting;
- working with academics and Research Councils to identify research priorities that will improve future advice on managing the UK's natural assets.

Further details on the work of the Natural Capital Committee and its publications are available via its website: https://www.naturalcapitalcommittee.org/

5.5 Making accounts part of policy practice

Chapter 4 has discussed several policy areas where natural capital accounts can make an important contribution to the evidence base for policy-making. The potential usefulness of an accounting approach for developing analysis and advice for policy-makers has also become clear in other parts of this document. The main question therefore is how to go from theory to practice?

Examples of interesting and relevant policy applications are starting to emerge, such as the work in Norway on a 'nature index' (Box 5.1), which is being used to monitor whether or not Norway is succeeding in its aim of halting the loss of biodiversity. The tables that underpin the index describe the stock and change of species associated with the country's major ecosystems and are broadly consistent with accounting methods.

Box 5.1: Nature index, Norway

Under international agreements, Norway has undertaken to obtain an overview of the status and trends for biodiversity in its major ecosystems. The Norwegian Nature Index is intended to provide this, and to indicate whether or not Norway is succeeding in halting the loss of biodiversity.

The Nature Index is the most extensive compilation of information to-date on Norway's biodiversity. It measures the state of biodiversity in Norway's nine major ecosystems. A set of indicators has been chosen to represent biodiversity in each of these ecosystems.

More than 300 indicators were chosen from a variety of species groups for each ecosystem, to measure deviation from a reference state, which is intended to represent ecological sustainability. All indicators and the overall Nature Index have values between 1, i.e. for the reference state, and 0 for very poor state. The first edition of the Nature Index was published in 2010, and values were calculated for 1990 and 2000 as well as 2010 (NINA, 2014).

Further guidance on identifying practical policy uses for natural capital accounts is again available in the draft SEEA Implementation Guide, prepared by UNSD. Although basic information for thematic sectors such as land, carbon or water, is important in some policy contexts current experience suggests that the need to understand the synergies and trade-offs between different ecosystem services will become an increasingly important focus. Rarely are management or policy decisions

made about single environmental components; more usually it is necessary to understand the implications of interventions for bundles of services and to identify the potential winners and losers in societal terms.

Studies, such as the UK National Ecosystem Assessment (UKNEA), have shown that an understanding of the implications of different socio-ecological trajectories can usefully be achieved by looking at a range of ecosystem services and considering both market and non-market economic values in a spatial context using scenarios (Bateman *et al.*, 2013). This might be an additional type of approach to consider in terms of widening the interest of decision-makers in environmental accounts.

5.6 Conclusions and a draft roadmap for developing natural capital accounts in Europe

This document has made the case for natural capital accounting, and set out a number of technical and conceptual issues that need to be tackled in order to take the approach forward across Europe.

Natural capital accounts must fit the situation of the country for which they are developed – in terms of conceptual focus, data foundation and policy use. At the same time, it is important to identify a common frame for natural capital accounting in Europe so that national experience and insights can be effectively shared. The need to move towards standardised and robust accounting practices and agreed methods of reporting is an important goal. There has been considerable progress in the development of standards as a result of the work on integrated environmental-economic accounting (SEEA) by the United Nations Statistics Commission. The UN-SD handbook on experimental ecosystem accounting thus forms a crucial source of information, together with the CBD Quick-Start package on Ecosystem Natural Capital Accounts.

Accounting tools need to be able to address different types of natural capital stocks, different types of flows from the capital, and changes in capital. For public and private decision-makers to use natural capital accounting results it is furthermore important that the overall accounting approach also compiles information on the users and beneficiaries of natural capital assets and service flows.

The integration of economic values associated with, or derived from, natural capital into accounting systems remains a significant challenge and it is clear that further national experimentation is important. However, this review suggests that, while this ultimate step is desirable, physical accounts can make a significant contribution to decision-making in their own right. And without comprehensive and reliable physical accounts the valuation of natural capital, whether in monetary terms or otherwise, will not be credible. Hence this initial guidance focuses on physical accounting approaches.

To conclude and look forward, this section proposes a draft roadmap for natural capital accounting in the EU – see table 5.1 for a first proposal. The roadmap is organised under the four main headings that have also been discussed in this concluding chapter:

a) Developing a clear conceptual focus
b) Building a suitable common data platform
c) Establishing an effective organisational set-up
d) Making accounts part of policy practice

While 2020 is still some time away the methodological and operational foundations have to be laid now if the natural capital accounting targets contained in the EU Biodiversity Strategy are to be

achieved. To do that we can build on the substantial experience that has already been gathered in many countries in Europe and beyond.

Annex 4 provides an overview of important research and development questions to be tackled for improving accounting approaches on ecosystem capital (taken from SEEA-EEA). Further conceptual and practical development is probably best achieved via concrete implementation projects at local, national and EU level. It is hoped that this reference document can support such work. Feedback on the document is welcome and will help to improve future iterations of this guidance.

Table 5.1: Draft roadmap for natural capital accounting in the EU

Activity	Short term (~2016)	Medium term (~2020)	Long term
Developing concept and focus of natural capital accounts	• Agree scope, design and content of priority accounts at national scale but allow for (later) convergence at EU level • Review opportunities for developing priority accounts in concert with national ecosystem assessment exercises so as to identify where synergies can be achieved • Develop first practical applications of EU level priority accounts building on national and EU level data sets	• Review and agree structure of priority accounts on the basis of operational performance and identify extensions (functional accounts) for ecosystem services. • Standards for the classification of ecosystem services and beneficiaries fully established. • Identify and implement functional or thematic accounts at national level, including integration with economic and social accounting were appropriate.	• Standards for fully integrated natural capital accounting agreed and used • NCAs regularly used to document changes instate and value of natural capital • NCA firmly established as an assessment tool at MS and EU levels
Building a suitable common data platform	• For priority accounts, identify missing or incomplete data at national scales and report on coverage collection methods, quality, and ownership of relevant sources • Review protocols for integration of data/accounts at national level as well as at EU scale • Agree strategy for establishing a common data platform to support priority accounts within the EU	• Data platforms for the operational implementation of priority accounts at MS level are functional • Integrated data infrastructure established for priority accounts at EU level • Methods for building and using multi-scale NCA established	• Data platform support for fully integrated NCA completed and stable at both national and EU level • National and EU level data sets are available in shared spatial reference frame
Establishing an effective organisational set-up	• Review EU coordination process on NCA in the context of the MAES process and establish links to on-gong MAES mapping activities with identification of shared outputs • Develop capacity at national level and share experience between MS based on their specific interests • Develop road maps for NCA at MS level • Review and develop practical options to support MS needs at the EU level	• Network of practitioners established and knowledge transfer/exchange mechanisms fully in place. • Institutional support for NCA at MS level in place • Well-functioning coordination group and minimum accounting capacity established at EU level	• NCA is recognised as part of standard professional practice and suitable training and exchange programmes are well-funded and functioning • Institutional set-up for NCA is fully mainstreamed and well-resourced
Making accounts part of policy practice	• Work with policy makers at national level to identify how NCA can support implementation and monitoring of key targets of related sectoral and environmental policies • Develop a roadmap for integrating the outcome of natural capital accounting into policy monitoring and evaluation approaches at EU level	• Operational application of NCA in context of identified priority sectoral and environmental policies established • Portfolio of policy applications for priority and functional accounts is available for training and capacity building	• NCA is an established tool for policy monitoring and evaluation • Integrated NCA allow thorough analysis of policy cross-linkages, synergies and trade-offs

REFERENCES

Aronson, J., S. J. Milton & J. Blignaut, Eds., (2007). Restoring Natural Capital: Science, Business and Practice. Island Press, Washington, D.C.

Bateman, I., *et al.*, (2013). Bridging Ecosystem Services into Economic Decision-Making: Land Use in the United Kingdom, Science, 5 July 2013, Vol. 341, no. 6141, pp. 45-50.

Brundlandt, G. H. (1987). Report of the World Commission on Environment and Development: Our Common Future. Accessed on 27/11/2014 at: http://www.un-documents.net/our-common-future.pdf

Bureau of Meteorology (2013). Guide to environmental accounting in Australia, Environmental Information Programme Publication Series no. 3, Bureau of Meteorology, Canberra, Australia,122pp. Last viewed on 27/11/2014 at: http://www.cbd.int/financial/values/australia-accountingguide.pdf

Brouwer, R., Brander L., Kuik, O., Papyrakis, E. and Bateman, I., (2013). A synthesis of approaches to assess and value ecosystem services in the EU in the context of TEEB. Last viewed on 27/11/2014 at: http://ec.europa.eu/environment/nature/biodiversity/economics/pdf/EU%20Valuation.pdf.

CBD (2012). Aichi Biodiversity Targets, Convention of Biological Diversity, last viewed on 27/11/2014 at: http://www.cbd.int/sp/targets/

CBD (2014). CBD Technical Series No. 77. Ecosystem Natural Capital Accounts: A Quick-start Package for implementing Aichi Biodiversity Target 2 on Integration of Biodiversity Values in National Accounting Systems in the context of the SEEA Experimental Ecosystem Accounts, last viewed on 27/11/2014 at: http://www.cbd.int/doc/publications/cbd-ts-77-en.pdf.

Chan, K.M.A., Guerry, A.D., Balvanera, P., *et al.* (2012). Where are Cultural and Social in Ecosystem Services? A Framework for Constructive Engagement. BioScience 62(8): 744-756.

Christie, M., Fazey, I., Cooper, R., Hyde, T. and Kenter, J.O., (2012). An evaluation of monetary and non-monetary techniques for assessing the importance of biodiversity and ecosystem services to people in countries with developing economies. Ecological Economics 83: 67-78.

DEFRA, (2010). IHPR for Defra: Assessing the impact of evidence on policy (2010), last viewed on 27/11/2014 at: http://archive.defra.gov.uk/corporate/docs/policy/evidence-policy-report.pdf

Edens, B. and L. Hein, (2013). Towards a consistent approach for ecosystem accounting. Ecological Economics 90: 41-52.

Ekins, P., (1992). 'A four-capital model of wealth creation', in P. Ekins and M. Max-Neef (Eds), Real-Life Economics: Understanding Wealth Creation, Routledge, London and New York, pp. 147-155.

European Commission (2011). Our life insurance, our natural capital: an EU biodiversity strategy to 2020. COM(2011) 244, last viewed on 27/11/2014 at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0244:FIN:EN:PDF.

European Commission (2013). Mapping and Assessment of Ecosystems and their Services. An analytical framework for ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020. Technical Report –2013–067.

European Commission (2014). General Union Environment Action Programme to 2020: Living well, within the limits of our planet. Conclusions on setting the framework for a Seventh EU Environment

Action Programme. Accessed on 27 November 2014 at: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013D1386&from=EN

Haines-Young, R. and Potschin, M., (2013). Common Classification of Ecosystem Services (CICES): Consultation on Version 4, August-December 2012. Report to the European Environment Agency. http://cices.eu/wp-content/uploads/2012/07/CICES-V43_Revised-Final_Report_29012013.pdf; accessed on 7 January 2014.

Hein, Lars (2014): personal communication, 21 October 2014.

Hjerp, P., K. Medarova-Bergstrom, F. Cachia, D. Evers, M. Grubbe, P. Hausemer, P. Kalinka, M. Kettunen, J. Medhurst, G. Peterlongo, I. Skinner and P. Brink, (2011). Cohesion Policy and Sustainable Development. Report for DG Regio. http://ec.europa.eu/regional_policy/information/studies/index_en.cfm.

IEEP (2013). Incorporating biodiversity and ecosystem service values into NBSAPS: Guidance to support NBSAP practitioners. A joint UNEP-WCMC and IEEP project at: http://www.ieep.eu/assets/1200/Guidance_doc_A4_FINAL.pdf.

IEEP and Milieu (2013). The Guide to Multi-Benefit Cohesion Policy Investments in Nature and Green Infrastructure. By Peter Hjerp, Patrick ten Brink, Keti Medarova-Bergstrom, Leonardo Mazza, and Marianne Kettunen of IEEP, together with Jennifer McGuinn, Paola Banfi and Guillermo Hernández of Milieu. A Report for the European Commission. Brussels. http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/guide_multi_benefit_nature.pdf

Kumar, P., (Ed.), (2012). The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations. Routledge.

MA (Millennium Ecosystem Assessment), (2005): http://www.maweb.org/en/index.aspx.

Martinez-Alier, J., (2005). The Environmentalism of the Poor: A Study of Ecological Conflicts and Valuation. New Delhi. Oxford University Press.

NCC (Natural Capital Committee), 2014. Second State of Natural Capital Report. Accessed on 10 December 2014 at: https://www.naturalcapitalcommittee.org/state-of-natural-capital-reports.html

NCC (Natural Capital Committee), 2014b. Towards a Framework for Defining and Measuring Changes in Natural Capital. Accessed on 27/11/2014 at: https://nebula.wsimg.com/efc0de70bf88dea33ef3fe26747f7b76?AccessKeyId=68F83A8E994328D64D3D&disposition=0&alloworigin=1

NINA, (2014). The Norwegian Nature Index at: http://www.nina.no/ninaenglish/TheNorwegianNatureIndex.aspx.

Pascual, U., Gómez-Baggethun, E., Brander, L., Martín-López, B., Muradian, R., and Verma, M., (2010). The economics of valuing ecosystem services and biodiversity. In: TEEB (2010). The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations, (Ed: P. Kumar). Earthscan, London.

Pearce, D. W., and Turner, K., (1990). Economics of natural resources and the environment. Baltimore: Johns Hopkins University Press.

Pearce, D. W., Markandya, A., and Barbier, E., (1989). Blueprint for a Green Economy. Earthscan, London.

Radermacher and Steurer (2014). Do we need natural capital accounts, and if so, which ones? Last accessed on 27/11/2014 at: http://www.oecd.org/statistics/measuring-economic-social-progress/Radermacher.pdf.

Regulation No. 691/2011 of the European Parliament and of the Council of 6 July 2011 on European environmental economic accounts at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:192:0001:0016:EN:PDF.

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 at: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014R0538&qid=1416217604983.

Remme, R.,P., Schröter, M., Hein, L., (2014). Developing spatial biophysical scales for multiple ecosystem services. Ecosystem services 10: 6-18.

Rockström J., Steffen W., Noone K., Persson A., Chapin III F.S., Lambin E.F. (2009). A safe operating space for humanity. Nature 461: 472-5.

Russi, D., ten Brink, P., Farmer, A., Badura, T., Coates, D., Förster, J., Kumar, R. and Davidson, N., (2013). The Economics of Ecosystems and Biodiversity for Water and Wetlands. IEEP, London and Brussels. Ramsar Secretariat, Gland.

Schröter, M., *et al.*, (2014). Accounting for capacity and flow of ecosystem services: A conceptual model and a case study for Telemark, Norway. Ecological Indicators 36: 539-55.

ten Brink, (Ed.), (2011). The Economics of Ecosystems and Biodiversity (TEEB) in National and International Policy-Making. Earthscan, London and Washington.

ten Brink, P., Armstrong, J., Kettunen, M., Rayment, M., Ruhweza, A., Shine, C., Vakrou, A., and Wittmer, H., (2011). The Global Biodiversity Crisis and related Policy Challenge. In: The Economics of Ecosystems and Biodiversity (TEEB) in National and International Policy-Making. An output of TEEB. (Ed) Patrick ten Brink, IEEP. Earthscan, London.

ten Brink, P., Gantioler, S., Gundimeda, H., Sukhdev, P., Tucker, G., and Weber, J. L., (2011). Strengthening indicators and accounting systems for natural capital. In: The Economics of Ecosystems and Biodiversity (TEEB) in National and International Policy-Making. An output of TEEB. (Ed) Patrick ten Brink, IEEP. Earthscan, London.

ten Brink, P., Mazza, L., Badura, T., Kettunen, M. and Withana, S., (2012). Nature and its Role in the Transition to a Green Economy. An output of TEEB. Accessed on 27 November 2014: http://www.teebweb.org/wp-content/uploads/2012/10/Green-Economy-Report.pdf

UNEP (2012). Natural Capital Declaration at: http://www.naturalcapitaldeclaration.org/the-declaration/#.

UNEP (2014). Towards a global map of natural capital. United Nations Environment Programme - World Conservation Monitoring Centre at: http://www.unep-wcmc.org/news/towards-a-global-map-of-natural-capital.

United Nations, European Union, Food and Agriculture Organization of the United Nations, International Monetary Fund, Organisation for Economic Co-operation and Development, The World Bank, (2014). System of Environmental-Economic Accounting 2012: Central Framework. Last viewed on 27/11/2014 at: http://unstats.un.org/unsd/envaccounting/seeaRev/SEEA_CF_Final_en.pdf.

United Nations Statistical Division (UN-SD), (2013). System of Environmental-Economic Accounting 2012 - Experimental Ecosystem Accounting. White cover publication. Last viewed on 27/11/2014 at: http://unstats.un.org/unsd/envaccounting/eea_white_cover.pdf

UN-SD (2014b). SEEA Implementation Guide [draft]. Ninth Meeting of the UN Committee of Experts on Environmental-Economic Accounting, New York, 25-27 June 2014 at**:** http://unstats.un.org/unsd/envaccounting/ceea/meetings/ninth_meeting/UNCEEA-9-6d.pdf.

United Nations Statistical Division (UN-SD), (2014c). System of Environmental-Economic Accounting 2012 – Applications and Extensions. White cover publication. Last viewed on 05/01/2015 at: http://unstats.un.org/unsd/envaccounting/ae_white_cover.pdf

van Dijk, A., *et al.*, (2014). Environmental reporting and accounting in Australia: Progress, prospects and research priorities. Science of the Total Environment 473-474: 338-349.

Volkery, A., Withana, S., Fedrigo, D., Baldock, D., (2012). Towards a 7th Environment Action Programme: Priorities and action needs. IEEP Policy Paper. September 2012. http://www.ieep.eu/assets/986/Priorities_and_action_needs_of_the_7EAP_-_IEEP_policy_paper.pdf.

World Bank, (2012). Moving beyond GDP: How to factor natural capital into economic decision-making. Washington, DC. Accessed on 27 November 2014 at: www.wavespartnership.org/waves/sites/waves/files/images/Moving_Beyond_GDP.pdf.

Weber, J. L., (2011). An experimental framework for ecosystem capital accounting in Europe. Technical Report No 13/2011. European Environment Agency, Copenhagen.

Weber J. L., (2012). Recording Ecological Debts in the National Accounts: Possibilities Open by the Development of Ecosystem Capital Accounts. Paper submitted for presentation at the XII Biennial International Society for Ecological Economics (ISEE) Conference, 16-19 June 2012, Rio de Janeiro.

ANNEXES:

Annex 1: Overview of definitions and terminology on natural capital accounting in various international and national guidance documents

Document	Definition	Source
System of Integrated Environmental and Economic Accounting (SEEA)	The SEEA has used several definitions The glossary in the **SEEA Handbook (2000)** has the following definition: **Natural capital**: natural assets in their role of providing natural resource inputs and environmental services for economic production and human well-being. In the SEEA central framework **(SEEA-CF)** (2014), the term 'capital' in general and 'environmental assets' is used. There is no use of the term 'natural capital', 'environmental capital' or 'ecosystem capital'. The SEEA-CF glossary defines '**environmental assets**' as the naturally occurring living and non-living components of the Earth, together constituting the biophysical environment, which may provide benefits to humanity. The SEEA experimental ecosystem accounting **(SEEA-EEA)** report (2013) gives a definition for "ecosystem assets" and "environmental assets" Definitions are not explicitly given for Natural Capital *"Ecosystem assets"* are spatial areas containing a combination of biotic and abiotic components and other characteristics that function together "*Environmental assets*" are the naturally occurring living and non-living components of the Earth, together constituting the bio-physical environment, which may provide benefits to humanity. The SEEA-EEA glossary specifically states that "Ecosystem or ecological capital" is not explicitly defined in SEEA Experimental Ecosystem Accounting. Instead the term "ecosystem assets" is employed to refer to the individual spatial areas that are the focus of measurement.	Handbook of National Accounting: Integrated environmental and economic accounting: an operational manual. United Nations, 2000. SEEA-CF (2012) http://unstats.un.org/unsd/envaccounting/pubs.asp SEEA-EEA (2013) http://unstats.un.org/unsd/envaccounting/eea_white_cover.pdf
MAES	Natural capital is defined as the stock of natural assets that provide society with renewable and non-renewable resources and a flow of ecosystem services, the latter being the benefits that ecosystems provide to people. It includes abiotic assets, e.g. fossil fuels, minerals, metals, and biotic assets, e.g. ecosystems that provide a flow of ecosystem services. The biotic component of natural capital is defined as ecosystem capital (European Commission, 2013).	http://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/MAESWorkingPaper2013.pdf
OECD Glossary of statistical terms	Natural capital are natural assets in their role of providing natural resource inputs and environmental services for economic production	http://stats.oecd.org/glossary/detail.asp?ID=1730
WAVES (World Bank)	WAVES does not give a precise definition, but rather gives an explanation of what natural capital is. Natural capital includes, first of all, the resources that are easily recognised and measured, such as minerals and energy, forest timber, agricultural land, fisheries and water. It also includes ecosystems producing services that are often 'invisible' to most people such as air and water filtration, flood protection, carbon storage, pollination for crops, and habitat for fisheries and wildlife. These values are not readily captured in markets, so their contribution to the	https://www.wavespartnership.org/en/frequently-asked-questions-natural-capital-accounting-nca

Document	Definition	Source
	economy and people's livelihoods is unknown – often, these services are taken for granted and, thus, the cost of losing them is also unknown.	
TEEB	TEEB refers to the MAES definition, i.e. natural capital is defined as the stock of natural assets that provide society with renewable and non-renewable resources and a flow of ecosystem services, the latter being the benefits that ecosystems provide to people. It includes abiotic assets, e.g. fossil fuels, minerals, metals, and biotic assets, e.g. ecosystems that provide a flow of ecosystem services. The biotic component of natural capital is defined as ecosystem capital (European Commission, 2013).	http://www.teebweb.org/wp-content/uploads/2014/01/TEEB_-NaturalCapitalAccounting-andwaterQualityBriefingnote_20131.pdf
UNEP	*Towards a global map of natural capital (2014)* Natural capital comprises both ecosystem assets, such as fresh water, and natural resources, such as fossil fuel deposits. The report claims to have a definition that is equivalent to the SEEA. *Global Environment Outlook (GEO-5, 2012)* Natural capital includes land, minerals and fossil fuels, solar energy, water, living organisms, and the services provided by the interactions of all these elements in ecological systems	http://www.unep-wcmc.org/news/towards-a-global-map-of-natural-capital
Convention on Biological Diversity (CBD) – Quick Start Package	The Quick-Start Package does not give a definition of Natural capital. It provides a concise overview of existing definitions	http://www.cbd.int/doc/publications/cbd-ts-77-en.pdf
Natural Capital Committee, UK	Various definitions have been proposed by the Natural Capital Committee, on the website and in the 1st (2013) and 2nd (2014) state of natural capital report . These are: *Definition on their website:* Natural capital is our 'stock' of waters, land, air, species, minerals and oceans. This stock underpins our economy by producing value for people, both directly and indirectly. Goods provided by natural capital include clean air and water, food, energy, wildlife, recreation and protection from hazards. *Definition in 1st State of the Natural Capital report (2013)* Natural capital refers to the elements of nature that produce value or benefits to people (directly and indirectly), such as the stock of forests, rivers, land, minerals and oceans, as well as the natural processes and functions that underpin their operation. *Definition in 2nd State of the Natural Capital report (2014)* Natural capital refers to the elements of nature that produce value to people, such as the stock of forests, water, land, minerals and oceans. These benefit us in many ways, by providing us with food, clean air, wildlife, energy, wood, recreation and protection from hazards.	http://www.naturalcapitalcommittee.org/natural-capital.html

Annex 2: Compilation of key terms relevant to natural capital accounting

This annex provides an explanation of some concepts and definitions for key terms relevant to natural capital accounting with a particular focus on the ecosystem component.

Definition and use of terms relevant to natural capital accounting varies slightly between international processes and research communities. Rather than add new or slightly modified definitions this section draws mainly on the work developed by the United Nations Statistical Commission on experimental ecosystem accounting (SEEA – EEA) via an expert group and with support from the London Group on Environmental Accounting. Further work in this regard will be considered when revising this first draft.

Selection of terms from the glossary of the UN publication on SEEA–EEA (Experimental Ecosystem Accounting):

Biodiversity: "Biodiversity is the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part, this includes diversity within species, between species and ecosystems." (Convention on Biological Diversity (2003). Article 2, Use of Terms).

Generally, in SEEA Experimental Ecosystem Accounting, the measurement of biodiversity is focused on the assessment of diversity of species, although changes in the diversity of ecosystems are also an important output from the measurement of changes in ecosystem extent and condition.

Ecosystems: "Ecosystems are a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit." (Convention on Biological Diversity (2003). Article 2, Use of Terms).

Ecosystems may be identified at different spatial scales and are commonly nested and overlapped. Consequently, for accounting purposes, ecosystem assets are defined through the delineation of specific and mutually exclusive spatial areas.

Ecosystem assets: Ecosystem assets are spatial areas containing a combination of biotic and abiotic components and other characteristics that function together.

Depending on the analysis being conducted, an ecosystem asset may be defined as containing a specific combination of ecosystem characteristics, e.g. a tropical rain forest represented by an LCEU, or it may contain areas that contain a variety of combinations of ecosystem characteristics, e.g. a river basin containing wetlands, agriculture and settlements represented by an EAU.

Ecosystem assets should be distinguished:

(a) from the various individual components, e.g. plants, animals, soil and water bodies, that are contained within a spatial area;
(b) from other ecosystem characteristics, e.g., biodiversity and resilience.

In different contexts and discussions, each of these components and other characteristics may be considered assets in their own right. For example, in the SEEA Central Framework many individual

components are considered individual environmental assets. However, for ecosystem accounting purposes, the focus is on the functioning system as the asset.

The term “ecosystem assets”, rather than “ecosystem capital” has been adopted since the word “assets” is more aligned with the terminology employed by the SNA and also conveys better the intention for ecosystem accounting to encompass measurement in both monetary and physical terms. In general, however, the terms “ecosystem assets” and “ecosystem capital” may be considered synonymous.

Ecosystem or ecological capital: Ecosystem or ecological capital is not explicitly defined in SEEA Experimental Ecosystem Accounting. Instead the term “ecosystem assets” is employed to refer to the individual spatial areas that are the focus of measurement. In many discussions, the term “ecosystem capital” may be considered to relate to a broader concept of the stock that provides a foundation for future well-being, together with human capital, produced/man-made capital and social capital.

These various types of capital are regularly brought together in models of sustainable development and wealth accounting. While there is no difference between the application of the terms “capital” and “assets” in SEEA Experimental Ecosystem Accounting and their use in other contexts, e.g. wealth accounting, some care is needed to understand the potentially different measurement scopes of these types of capital/assets. Specific considerations concern the treatment of mineral and energy resources and the distinction between natural and cultivated biological resources.

Ecosystem capacity: The concept of ecosystem capacity is not defined from a measurement perspective in SEEA Experimental Ecosystem Accounting, but it is linked to the general model of ecosystem assets and ecosystem services that is described.

In general terms, the concept of ecosystem capacity refers to the ability of a given ecosystem asset to generate a set of ecosystem services in a sustainable way into the future. While this general concept is very relevant to ecosystem assessment, definitive measurement of ecosystem capacity requires the selection of a particular basket of ecosystem services and in this regard measures of ecosystem capacity are more likely to relate to consideration of a range of alternative ecosystem use scenarios than to a single basket of ecosystem services.

Ecosystem characteristics: Ecosystem characteristics relate to the ongoing operation of the ecosystem and its location. Key characteristics of the operation of an ecosystem are its structure, composition, processes and functions. Key characteristics of the location of an ecosystem are its extent, configuration, landscape forms, and climate and associated seasonal patterns. Ecosystem characteristics also relate strongly to biodiversity at a number of levels.

There is no classification of ecosystem characteristics since, while each characteristic may be distinct, they are commonly overlapping. In some situations, the use of the generic term “characteristics” may seem to be more usefully replaced with terms such as “components” or “aspects”. However, in describing the broader concept of an ecosystem, the use of the term characteristics is intended to be able to encompass all of the various perspectives taken to describe an ecosystem.

Ecosystem condition: Ecosystem condition reflects the overall quality of an ecosystem asset, in terms of its characteristics.

Measures of ecosystem condition are generally combined with measures of ecosystem extent to provide an overall measure of the state of an ecosystem asset. Ecosystem condition also underpins the capacity of an ecosystem asset to generate ecosystem services and hence changes in ecosystem condition will impact on expected ecosystem service flows.

Ecosystem services: Ecosystem services are the contributions of ecosystems to benefits used in economic and other human activity.

The definition of ecosystem services in SEEA Experimental Ecosystem Accounting involves distinctions between the:

(i) ecosystem services;
(ii) benefits to which they contribute;
(iii) well-being which is ultimately affected.

Ecosystem services should also be distinguished from the ecosystem characteristics, and the functions and processes of ecosystem assets.

Ecosystem services are defined only when a contribution to a benefit is established. Consequently, the definition of ecosystem services excludes the set of flows commonly referred to as supporting or intermediate services. These flows include intra- and inter-ecosystem flows and the role of ecosystem characteristics that are reflected in ecosystem processes.

A range of terms is used to refer to the concept of ecosystem services defined here. Most common are the terms “ecosystem goods and services” and “final ecosystem services”. These two terms highlight particular aspects of the definition above. The first recognises that ecosystem services include flows of tangible items, e.g. timber and fish, in addition to intangible services. The second recognises that only those ecosystem services that contribute to a benefit, i.e. final outputs of the ecosystem, are within scope.

Ecosystem services as defined in SEEA Experimental Ecosystem Accounting exclude abiotic services and do not encompass the complete set of flows from the environment. A complete set of flows from the environment may be reflected in the term “environmental goods and services”.

Three main types of ecosystem services are described: provisioning services, regulating services and cultural services. The Common International Classification for Ecosystem Services (CICES) is an interim classification for ecosystem services – but adopted as working standard at UN and EU level.

Environmental assets: Environmental assets are the naturally occurring living and non-living components of the Earth and they constitute the bio-physical environment which may provide benefits to humanity.

This definition of environmental assets is intended to be broad and encompassing. As explained in the SEEA Central Framework, the measurement of environmental assets can be considered from two perspectives. First, from the perspective of individual components, i.e. individual environmental

assets that provide materials and space to all economic activities, e.g. land, soil, water, timber, aquatic, mineral and energy resources. Second, environmental assets can be considered from the perspective of ecosystems. However, the scope of environmental assets is not the same as ecosystem assets since it includes mineral and energy resources which are excluded from the scope of ecosystem assets.

Also, the scope of environmental assets is broader than natural resources as it includes produced assets such as cultivated crops and plants – including timber and orchards, livestock, and fish in aquaculture facilities.

In the SEEA Central Framework, the measurement scope of environmental assets is broader in physical terms than in monetary terms as the boundary, in monetary terms, is limited to those assets that have an economic value in monetary terms following the market valuation principles of the SNA.

Expected ecosystem service flow: Expected ecosystem service flow is an aggregate measure of future ecosystem service flows from an ecosystem asset for a given 'basket' of ecosystem services.

In general terms, the measure of expected ecosystem service flows is an assessment of the capacity of an ecosystem asset to generate ecosystem services in the future. However, the focus is on the generation of specific, expected combinations of ecosystem services – which may not be produced on a sustainable basis. The measure is not necessarily reflective of sustainable or optimal scenarios of future ecosystem asset use. At the same time, the expectations of future ecosystem service flows must be informed by likely changes in ecosystem condition – noting that the relationship between condition and ecosystem service flow is likely to be complex and non-linear.

Inter-ecosystem flows: Inter-ecosystem flows are flows between ecosystem assets that reflect ongoing ecosystem processes. An example is the flow of water between ecosystem assets via rivers.

These flows may relate directly or indirectly to flows of ecosystem services. Most commonly, inter-ecosystem flows relate to the flows considered as supporting or intermediate services.

Intra-ecosystem flows: Intra-ecosystem flows are flows within ecosystem assets that reflect ongoing ecosystem processes, e.g. nutrient cycling.

These flows may relate directly or indirectly to flows of ecosystem services. Most commonly, intra-ecosystem flows relate to the flows considered supporting or intermediate services.

Natural capital: Natural capital is described as the elements of nature that directly, or indirectly, produce value for people – including ecosystems, species, freshwater, land, minerals, air and oceans, as well as natural processes and functions.

The term natural capital is not defined in SEEA Experimental Ecosystem Accounting. Commonly, natural capital is used to refer to all types of environmental assets as defined in the SEEA Central Framework. Used in this way natural capital has a broader scope than ecosystem assets as defined in SEEA Experimental Ecosystem Accounting since it includes mineral and energy resources.

Generally, natural capital incorporates broad notions of the set of services from ecosystems in line with the accounting for ecosystem assets described in SEEA Experimental Ecosystem Accounting. In

this regard, although aligned in bio-physical terms, natural capital may be considered a broader measure than the measures of environmental assets that are described in the SEEA Central Framework which are limited to consideration of material/SNA benefits.

Natural resources: Natural resources include all natural biological resources, including timber and aquatic resources, mineral and energy resources, soil resources, and water resources.

In the SEEA, unlike the SNA, natural resources exclude land which is considered a distinct type of environmental asset.

Following the SNA, natural resources are defined in the SEEA to include only non-produced environmental assets, i.e. they are not considered to have come into existence as outputs of processes that fall within the production boundary of the SNA. A distinction is thus made between “natural” and “cultivated” environmental assets.

Annex 3: Examples of accounting tables on components of natural capital

Ecosystem Capital Accounts: Land Cover Account for coastal zones in 26 countries in Europe, 1990 – 2006:

Area in km²

Corine Land Cover types	1	2A	2B	3A	3B	3C	4	5	
	Artificial surfaces	**Arable land & permanent crops**	**Pastures & mosaic farmland**	**Forests and transitional woodland shrub**	**Natural grassland, heathland, sclerophylous vegetation**	**Open space with little or no vegetation**	**Wetlands**	**Water bodies**	**Total**
Opening Stock (Land cover 1990)	**26,384**	**91,210**	**78,219**	**70,953**	**40,482**	**8,867**	**26,425**	**43,330**	**385,870**
Consumption of land cover	**465**	**2,197**	**3,172**	**5,700**	**1,397**	**516**	**461**	**168**	**14,075**
Urban land management	324	8	9	5	1	0		3	349
Urban residential sprawl		525	917	182	116	15	4	8	1,767
Sprawl of economic sites and infrastructures	32	569	527	284	203	43	13	67	1,739
Agriculture internal conversions		854	1,218						2,071
Conversion from other land to agriculture	41		107	237	128	118	29	3	664
Withdrawal of farming		216	358						573
Forests creation and management	24			4,786	753	166	303	0	6,032
Water bodies creation and management	6	13	31	16	6		0	1	73
Changes due to natural and multiple causes	37	13	7	190	190	173	111	85	807
Formation of land cover	**3,854**	**1,697**	**1,154**	**6,029**	**716**	**283**	**187**	**155**	**14,075**
Urban land management	349								349
Urban residential sprawl	1,767								1,767

Sprawl of economic sites and infrastructures	1,739								1,739
Agriculture internal conversions		1,366	706						2,071
Conversion from other land to agriculture		332	332						664
Withdrawal of farming			116	250	185	4	18	0	573
Forests creation and management				5,778	211	43			6,032
Water bodies creation and management						1		72	73
Changes due to natural and multiple causes				1	320	234	169	82	807
Net formation of Land cover (formation - consumption)	**3,390**	**-500**	**-2,018**	**329**	**-681**	**-233**	**-274**	**-13**	**0**
Net formation as % of initial year	12.8%	-0.5%	-2.6%	0.5%	-1.7%	-2.6%	-1.0%	0.0%	
Average net formation rate	0.8%	0.0%	-0.2%	0.0%	-0.1%	-0.2%	-0.1%	0.0%	
Total turnover in land cover (formation+consumption)	**4,319**	**3,895**	**4,326**	**11,729**	**2,113**	**799**	**647**	**323**	**28,151**
Turnover as % change of initial year	16.4%	4.3%	5.5%	16.5%	5.2%	9.0%	2.4%	0.7%	7.3%
No change	**176,328**	**1,329,217**	**925,947**	**1,174,897**	**312,517**	**173,227**	**53,513**	**91,363**	**4,237,008**
Continuity of land cover as % no change of initial year	668.3%	1457.3%	1183.8%	1655.9%	772.0%	1953.6%	202.5%	210.9%	1098.0%
Closing stock (land cover 2006)	**29,773**	**90,710**	**76,201**	**71,281**	**39,801**	**8,634**	**26,152**	**43,318**	**385,870**

Annex 4: Overview of research and development questions for ecosystem accounting

The SEEA handbook on Experimental Ecosystem Accounting (SEEA-EEA) provides a broad conceptual framework for ecosystem accounting (UNSD, 2013). However, notwithstanding the important steps that have been taken, a number of conceptual and practical issues remain to be addressed. To advance ecosystem accounting, work is required to research the conceptual issues that remain to be elaborated or are the subject of discussion.

In addition, testing of the conceptual framework will provide valuable inputs in the ongoing development of concepts, methods and classifications on ecosystem accounting. Considering the multidisciplinary nature of ecosystem accounting, the advancement of the research agenda as well as the testing of SEEA-EEA will require engagement across disciplines and organizations.

The research agenda presented in this annex provides a general overview of the main issues to be addressed and has been taken from the SEEA-EEA handbook. The issues presented have been organized according to broad research areas. These areas reflect the general nature of the focus of the intended work but all issues are closely interconnected and need to be addressed in a coordinated fashion, taking into account initiatives underway in countries and by international agencies.

Areas of research

Three areas of research are proposed – each of these are explained below:

- physical ecosystem accounting;
- monetary ecosystem accounting;
- communication and dissemination.

Physical ecosystem accounting

This area of research aims to advance understanding of the classifications, concepts and data sources required for the physical measurement of ecosystem services and ecosystem condition and the application of these measures into accounts in physical terms. Some of this work relates to the research agenda for the SEEA Central Framework, including for example topics such as land use and land cover classifications, accounting for soil resources and the measurement of depletion of biological resources. A combined approach to these topics would be desirable.

This area of research encompasses work on:

- Delineating spatial units following the broad conceptual model outlined in SEEA Experimental Ecosystem Accounting. This should initially focus on spatial units for terrestrial areas (including rivers, lakes and other inland waters) and extend to units for marine areas and the atmosphere.
- Developing the classification of spatial units, in particular Land Cover Ecosystem functional Units (LCEU).
- Identifying possible geospatial sources of information such as remote sensing data and other “big data” sources for ecosystem accounting.
- Investigating techniques for linking data related to ecosystem measurement to geo-referenced social and economic data. This multi-dimensional geo-referencing may be considered in the delineation of spatial units for ecosystems.
- Identifying the main ecosystem services and relevant indicators of service flow for each type of ecosystem (e.g. forests, agricultural land etc.) including understanding measurement of the supply, demand and distribution of ecosystem services and the associated benefits. This work should consider the appropriateness of the proposed classification of ecosystem services (CICES) and the general measurement boundaries discussed regarding ecosystem services.

- Identifying the main ecosystem characteristics for the measurement of ecosystem condition and relevant indicators of condition for each type of ecosystem (e.g. forests, wetlands etc.). This work should consider the links to spatial units delineation.
- Considering the links between expected flows of ecosystem services and measures of ecosystem condition and extent, including assessment of relevant models and the connections to issues such as resilience and thresholds. This work should also advance understanding of ecosystem degradation in physical terms.
- Investigating different approaches to determining reference conditions for the assessment of ecosystem condition based on practical experience in countries.
- Developing specific topics of research on measures related to biodiversity and carbon in the context of ecosystem accounting.
- Examining aggregation methods for both ecosystem services and ecosystem condition indicators, to derive measures across and within ecosystems. In conjunction, methods of downscaling and upscaling information should be investigated.
- Examining the treatment of the so called ecosystem disservices in the ecosystem accounting such as pests and diseases.
- Assessment of data quality and the accreditation of data sources, particularly scientific and modelled data.

Monetary ecosystem accounting

This area of work focuses on the pricing and valuation of ecosystem services and ecosystem assets and the possible augmentation of the standard economic accounts of the SNA using these valuations. Valuation of water has been included in the research agenda of the SEEA Central Framework and would benefit from being discussed also in the context of ecosystem accounting.

This area of work encompasses work on:

- Clarifying the alternative ecosystem service pricing techniques and their relevance to determining (i) prices for ecosystem services connected to market goods and services; and (ii) prices for ecosystem services connected to non-market goods and services. The choice of underlying assumptions for ecosystem accounting purposes (covering both economic and social approaches to valuation), and the general feasibility for implementation (including any requirements for information in physical terms) should be identified.
- Applying information from emerging environmental markets, including Payments for Ecosystem Services (PES) to the valuation of ecosystem services and ecosystem assets.
- Identifying ecosystem related transactions and expenditures within the standard economic accounts and aligning these transactions with measurement of ecosystems in physical terms.
- Determining methods for the valuation of ecosystem assets, ecosystem degradation as well as possible derivation of degradation-adjusted macro-economic aggregates.
- Developing the sequence of accounts by institutional sector that incorporate flows relating to ecosystem services and ecosystem assets. This work should distinguish between flows already within scope of the standard economic accounts and extensions to standard measurement boundaries. Also, the work should consider options for the attribution of ecosystem degradation to institutional sector and industry.
- Investigating extended national balance sheets including consideration of overlaps between the valuation of individual environmental assets (especially land) and ecosystem assets. Links should be drawn to alternative measures of wealth. Links should also be considered to the recording of entries in the capital account and connections between flows related to ecosystem enhancement and land improvement.

Communication and dissemination

This area of work focuses on communicating the results of ecosystem accounting. This work should encompass:

- Developing combined presentations that show ecosystem accounting information against data from the SEEA Central Framework, the SNA and other sources.
- Proposing ecosystem accounting tables, dashboards, headline and composite indicators, maps and other communication tools.
- Illustrating the range of uses of ecosystem accounting information including, but not limited to the analysis of trade-offs - for example between alternative land uses.

Annex 5: Key outcomes of 2013 country survey on natural capital accounting

National practice: overview

This section builds on the results of a survey among EEA member countries on national activities on natural capital accounting, as well as an associated workshop in Copenhagen in June 2013. Material from that workshop, and the twelve country responses received, are available under: http://biodiversity.europa.eu/ecosystem-assessments/events-1/eureca-meetings/natural-capital-accounting-2013/

The questionnaire covered the following main topics:

a) Concept of, and approach to, natural capital accounting (questions 1a – 1c);

b) Valuation of natural capital (questions 2a – 2c);

c) Organisation and process at national level (questions 3a – 3d);

d) Actions planned to 2020 (questions 4a – 4d).

The main outcomes for each topic are presented in table 5.1 and briefly reviewed below.

The results show a substantial diversity of activities across countries, with some responses indicating that natural capital accounting is still in its early stages at national level. Each respondent country has its strong and weak points in different areas. Equally diverse are the responses regarding future action to be taken until 2020 – which is not surprising, since related concepts and methodologies are still being consolidated – this document being an example of such an exercise.

Table A5.1: Overview of country responses to survey on NCA (status November 2013)

Country group	Approach to NCA	Work on valuation	Organisation & process	Actions by 2020
Significant progress to date	BG, CZ, DE, NO, PL, SE, UK *Included: countries reporting either a national system of NCA (ready or under development), or specific national legislation concerning ecosystem services (BG and PL for forestry)*	DE, FI, UK *Included: countries reporting (fully or partially) both questions 2a (integration of ESS values in accounting) or 2b (taking into account depreciation/appreciation of natural capital*	DE, FI, NO, SE, UK *Included: countries with a legally formalised/officially designated inter-institutional process*	***Key messages, needs & plans:*** AT: - Understanding of NCA varies a lot between countries; - Quality of natural capital is important BG: - Monetary valuation may derive less funding for countries with rich biodiversity but small GDP; - Simplify reporting for business (Directive 2003/34/EC), inter alia by maximum data reuse; - Lots of methodological work ahead – exchange of best practices is key. CZ: Missing demand for natural capital accounts slows down their adoption DE: - Insufficient spatial detail of land use maps for high value ecosystems
Some progress to date	AT, FI, LV, PT *Included: countries reporting national or local research and/or pilot projects including other initiatives (such as TEEB, NAMEA)*	BG, CZ, EE, NO, SE *Included: countries reporting (fully or partially) at least one of questions 2a or 2b being addressed institutionally, and not merely in research or single projects*	BG, PL *Included: countries reporting cooperation on national accounts between national statistics and other competent bodies on ad-hoc or project basis*	

Country group	Approach to NCA	Work on valuation	Organisation & process	Actions by 2020
Work at the beginning or some responses missing	EE *Included: countries reporting only the minimum EU legal requirements*	LV, PL, PT, SE *Included: countries reporting none of questions 2a or 2b.* *Note: Poland reports the water permits regime under question 2a but does not specify the manner in which they are used to estimate the value of ESS and which ESS are targeted*	CZ , EE, LV, PT *Included: countries reporting single-institution (statistic institute) implementing NCA, or project not directly managed by national env. administration*	- Need for valid methods on flood damage prevention EE: Need for data gap analysis FI: - Use ES approach to develop sustainable alternative to GDP - Systems model of ES processes and derived ESS - Fully interlinked economic model on I/O in "foodweb" NO: Need for good biodiversity indicators in key areas PL: Value of protected species and habitats is not accounted for, need for EU methodology PT: Need for cooperation between academics and statistical office SE: - Need for international data to measure the impact of Swedish consumption on countries exporting to Sweden - Specific research: ○ Added social data to accounting systems ○ Hazardous chemicals indicators

Note: Not all countries have responded to all questions. This might have led countries missing in certain columns or misplacement of countries for some categories.

Ad a): The concept of, and approach to, natural capital accounting varies across the countries that responded. Most reported a diverse set of activities that can be grouped under natural capital accounting but were not initially devised to respond to that agenda. The focus, or inspiration, of ongoing work is often current EU policy processes – whether it is the EU Regulation on environmental accounting, or the objectives on ecosystem assessment at national and EU level set out in the EU biodiversity strategy. Lack of concrete policy demand for natural capital accounting is visible in some responses, and specifically noted as problem by the Czech Republic.

No country has yet reported covering, in its national efforts, all of the identified ecosystem services on its territory. The most advanced countries have started by assessing some of ecosystem services (ESS) and have ongoing national projects to increase the number of services covered. National approaches to assessing ecosystems (ES) and ESS, in some countries – notably the UK, have developed a number of ESS accounts for certain ecosystems. Individual countries use the data from existing NCA accounts both for statistical and reporting needs, e.g. Germany reports the use of NCA for Target 5 efforts, national biodiversity strategies, and the WFD reporting.

Ad b) Work on the valuation of natural capital is generally in its infancy, with only Germany, Finland and the UK reporting dedicated activities. The majority of countries cover some of the NCA components, notably provisioning services and abiotic factors as per Regulation 691/2007. However, beyond these basics, country practice, research and policy priorities vary widely. The same holds true for the needs in guidance and cooperation. The policy demand for NCA information seems to be an

important driving force – even in countries without a formal NCA process, e.g. FI and SE. However, in countries with a more limited formal process for developing NCA, such as CZ or PT, the weaker policy demand seems to account for limiting ESS related work to academia.

Ad c): There is a notable difference in the organisational approach to NCA across the countries consulted. Depending on the level of backing and institutional set-up, the NCA process ranges from being mostly statistics-driven, i.e. in AT and FI, to dedicated national processes, i.e. in UK, DE, and NO. A shared challenge for many countries, however, is the placement of NCA in the national decision-making process. Most countries have institutional processes – either formalised or *ad hoc*. Not surprisingly, there is correlation between the involvement of diverse institutions in a formal process and the progress in covering various aspects of ESS valuation and integration into national accounts.

Ad d): In 2013 only some countries had mapped out actions for the coming years to 2020, which reflect the challenge of dealing with this new policy area, as well as the resource constraints that most countries are facing in the current economic situation. Other respondents simply stated that there is no formal NCA process – even if ESS research is being conducted by research bodies, e.g. in EE, PT and FI.

This annex lists additional issues identified by the country survey on implementing natural capital accounting at national level. The following additional points were identified when reviewing the twelve available country responses (status November 2013):

- The implementation of the resident principle when compiling accounts related to NCA;
- cross-border NCA of ecosystem services with cross-border impact, e.g. carbon sequestration, services whose value may be integrated in the income from international tourism;
- the use of other data , e.g. WISE data, quality and quantity monitoring data for waters, in NCA related to ESS;
- using the NCA related to ESS and especially their monetary valuation, in other policies, e.g. in RBMP under the WFD, activities under MSFD, NATURA 2000 reporting, for agricultural and fisheries needs;
- integration of ESS considerations in cost-benefit analysis performed for major projects in relevant sectors, e.g. wastewater treatment under Directive 91/271/EEC); and/or other means of considering limited social affordability under multiple legislation efforts;
- re-use of data to ensure maximal leverage with minimal funding, especially in Member States, e.g. Bulgaria, that are rich on biodiversity but hardly pressed to afford funding for its protection. Such reuse may be fostered, for example, by better use of common platforms, e.g. EEA, JRC data, WISE, improved implementation of INSPIRE across legislative implementation;
- ensuring data consistency and avoiding double counting between policies when accounting for NCA and/or between NCA statistics and other mandatory national reporting;
- achieving best value for money in spending that covers multiple policies and across relevant funding sources – some EU funding programmes are currently under preparation

for the 2014-2020 programming periods, and other donors outside the EU provide additional funding;

- handling small but valuable ecosystems in less detailed land use sets;
- socially responsible ESS related research including also cross-border transfer of ESS;
- quality assessment of ESS.