THE FINNISH ENVIRONMENT 1en | 2015

NATURAL RESOURCES

# Towards A Sustainable and Genuinely Green Economy. The value and social significance of ecosystem services in Finland (TEEB for Finland)

**Synthesis and roadmap**

**Jukka-Pekka Jäppinen and Janne Heliölä (eds.)**

MINISTRY OF THE ENVIRONMENT

THE FINNISH ENVIRONMENT 1en | 2015

# Towards A Sustainable and Genuinely Green Economy. The value and social significance of ecosystem services in Finland (TEEB for Finland)

**Synthesis and roadmap**

**Jukka-Pekka Jäppinen and Janne Heliölä (eds.)**

Helsinki 2015

MINISTRY OF THE ENVIRONMENT

Ympäristöministeriö
Miljöministeriet
Ministry of the Environment

THE FINNISH ENVIRONMENT 1en | 2015
Ministry of the Environment
Department of the Natural Environment

Page layout: Marianne Laune
Cover photo: Image bank of the Environmental Administration / Jutta Kuure

The publication is available on the internet:
www.ym.fi/julkaisut

Edita Prima Oy, Helsinki 2015

ISBN 978-952-11-4339-7 (nid.)
ISBN 978-952-11-4376-2 (PDF)
ISSN 1238-7312 (pain.)
ISSN 1796-1637 (verkkoj.)

NORDIC ENVIRONMENTAL LABEL
4041 0002
Printed matter

# FOREWORD

Natural capital constitutes the foundation for human well-being and is a key asset for economic prosperity. Nature provides a range of goods and services, commonly referred to as ecosystem services, whose economic value for many reasons has thus far been invisible and therefore a major cause of their undervaluation and mismanagement. The international study on *The Economics of Ecosystems and Biodiversity* – known as TEEB – raised the level of knowledge in this regard and emphasized the need to both incorporate natural capital into standard national accounting and develop indicators integrating biodiversity and economic considerations more consistently.

The Convention on Biological Diversity's (CBD) Strategic Plan for Biodiversity 2011–2020 and its 20 Aichi Biodiversity Targets are the major tools for integrating ecosystem services and related biodiversity into the development work on national and regional levels, through updating of existing national biodiversity strategies and action plans. Finland has adopted the revised National Biodiversity Strategy (2012) and Action Plan (2013) in line with the CBD decisions agreed in Nagoya 2010.

The EU Biodiversity Strategy 2020 aims at protecting biodiversity for its intrinsic value and refers to the maintenance of ecosystems and their services and contributes, among other things, to the EU's sustainable growth objectives and to the mitigation of and adaptation to climate change, while promoting the economy and social cohesion and safeguarding the EU's cultural heritage.

TEEB assessments have shown that there is still scattered understanding of the economic and social importance of ecosystem services and related biodiversity. However, these assessments are providing an approach that can help decision-makers recognize and capture the values of natural capital. The TEEB Nordic study (2013) concluded that a range of ecosystem services are of high socio-economic significance for the Nordic countries, either based on their market value or an estimated value for the broader public. The main challenge is to integrate the values of natural capital into sectoral policies and decision-making.

The TEEB for Finland study[1], carried out in 2013–2014, provides, among other things, preliminary estimates on the economic importance of some key ecosystem services in Finland. The main focus is on so far under-recognized regulating and cultural services, but not forgetting traditional provisioning services, the value of which has traditionally been recognised due to their vital importance for the Finnish economy and society. TEEB for Finland also describes the main drivers and future trends affecting the provision of ecosystem services; gives suggestions for ecosystem service indicators; and describes as an example the spatial assessment and mapping of ecosystem services and green infrastructure in the Helsinki–Uusimaa region. Further, the study also considers possible elements for improving the regulatory and management system that could enable securing the future provisioning of ecosystem services and their foundation – the biological diversity of Finland. TEEB for Finland includes a scoping assessment on natural capital accounting and a review of the relationship between ecosystem services and a green economy.

[1] Towards a Sustainable and Genuinely Green Economy – The Value and Social Significance of Ecosystem Services in Finland (TEEB Finland).

Finland has been at the forefront in working with environmental indicators, accountings and models. It was therefore easy for us to continue the work and examine what the economics of ecosystems and biodiversity encompass, including the lessons learnt in a Finnish context. A comprehensive set of national ecosystem service indicators are currently being developed with a view to monitoring and indicating the status and value of these services. These indicators play a key role in enhancing the integration of natural capital into the Finnish national accounting systems. Consequently, the future work on natural capital accounting in Finland is foreseen to focus on more closely aligning the ongoing work on indicators with the existing framework of national and environmental-economic accounts.

Ecosystem services are an integral part of a number of economic sectors relevant to a green economy in Finland, namely, the forest sector, water, tourism, agriculture and food sector, game and fisheries, and renewable energy. In addition, ecosystem services are perceived as an integral part of growing green economy sectors such as life and health style business, cosmetics and pharmaceuticals.

The integration of a whole range of ecosystem services into a green economy helps to ensure that the green economy is both environmentally and socially sustainable. However, in order to achieve the synergies between the management of ecosystem services and related biodiversity, they need to be secured in both investment and management decisions in a holistic way. Marked-based measures also complement the existing arsenal of measures and provide ways to achieve the aim of ecosystem services and their underlying objectives of biodiversity conservation.

We can also perceive the links between biodiversity and human health and well-being. Considering ecosystem services in policy-making can improve natural resource and land use planning, save financial costs, boost innovative enterprises and other job-creating actions, and enhance sustainable livelihoods nationally, regionally and globally.

I sincerely hope that this TEEB for Finland study will encourage many other countries to launch new findings in the field of ecosystem services and human well-being. I also hope that scientific expertise on biodiversity and that of different stakeholders will steadfastly take account of biodiversity and ecosystem services in decision-making processes. The future of our planet and our societies depends on it.

Sanni Grahn-Laasonen
Minister of the Environment,
Finland

**Referencing the publication**: Jäppinen, J.-P. & Heliölä, J. (eds.) 2015: Towards a sustainable and genuinely green economy. The value and social significance of ecosystem services in Finland (TEEB for Finland). Synthesis and roadmap. The Finnish Environment 1en/2015. The Finnish Ministry of Environment, Helsinki. 144 p.

**Suggested reference for separate section**: Borgström, S. & Similä, J. 2015: Integration of ecosystem services into decision making. In: Jäppinen, J.-P. & Heliölä, J. (eds.), Towards a sustainable and genuinely green economy. The value and social significance of ecosystem services in Finland (TEEB for Finland). Synthesis and roadmap. The Finnish Environment 1en/2015. The Finnish Ministry of Environment, Helsinki. p. 73–80.

**List of participating authors:**

**MTT Agrifood Research Finland**
Heini Ahtiainen
Janne Artell
Tuija Lankia
Eija Pouta

**Finnish Environment Institute (SYKE)**
Anni Ahokumpu
Katriina Alhola
Riina Antikainen
Ari-Pekka Auvinen
Martin Forsius
Vuokko Heikinheimo
Janne Heliölä
Maria Holmberg
Pekka Itkonen
Jukka-Pekka Jäppinen
Vladimir Kekez
Leena Kopperoinen
Laura Mononen
Edouardo Olazabál
Petteri Vihervaara
Arto Viinikka
Ieva Vyliaudaite

**Institute for European Environmental Policy (IEEP)**
Patrick ten Brink
Marianne Kettunen
Daniela Russi

**Pellervo Economic Research PTT**
Paula Horne
Matleena Kniivilä
Anna-Kaisa Kosenius

**University of Eastern Finland**
Suvi Borgström

**University of Helsinki**
Dalia D'Amato
Kaisa Hauru

**University of Lapland**
Jukka Similä

## CONTENTS

YHA-Kuvapankki / Pirjo Ferin

# 1 Introduction: The TEEB for Finland study

**Jukka-Pekka Jäppinen and Marianne Kettunen**

The Millennium Ecosystem Assessment (MA 2005) and Global Biodiversity Outlook reports under the Convention on Biological Diversity (CBD) are an essential basis for assessments of the global state of biological diversity, ecosystems and the services they provide. According to these assessments, the global natural systems, which are the basis for the world economy, livelihoods and human well-being, are in danger of collapse if mankind does not rapidly start to conserve and use sustainably biological diversity which is the foundation of all life on Earth and the ecosystem services (ES) that it provides[1]. Major threats to biodiversity are: transformation and loss of ecosystems, overuse of natural resources, pollution, alien invasive species and climate change. Synergies between the factors causing degradation of the state of the environment and the availability of ES are worsening the situation further, as is the burden of population growth and unsustainable production and consumption.

In Finland, agriculture and forestry, production of energy, the taking of ground materials, mining, and urban and industrial construction are causing pressure on the ecosystems and their ability to produce essential services for people. The assessment of the state of ecosystem services and their social significance, and also the development of sustainable policy and steering mechanisms for the management of ES are of utmost importance for the overall assets of society, for instance, for the development of optimal land use and responsible management of natural resources and the bio-economy. Resolving the intertwined climate, energy, environmental and natural resource questions demands diversified knowledge and know-how, as well as cross-sectoral and holistic policies and planning.

Provisioning, regulating, supporting or maintenance, and cultural services of the natural environment are commonly included under the concept of ecosystem services (MA 2005, Kumar 2010, UK NEA 2011, see also www.cices.eu). Provisioning services and their material benefits for society have traditionally been considered adequately in decision-making, and generally an economic value for provisioning services in different markets has been formed. For instance, food, timber, clean water and other products from forests, mires and freshwater ecosystems, such as forest berries and mushrooms, game, and fish, have monetary market prices, which can be used while evaluating their importance to the national economy. Furthermore, detailed knowledge and decision-making support systems for the management of provisioning services and land use have been developed.

The values of regulating services (e.g. containing floods, nutrients and water, as well as the binding of carbon and purification of air) or cultural services, such as recreation, landscapes, the Finnish national heritage, and identity, have been variously identified. Even when regulating and cultural services are qualitatively identified, for instance, by establishing the recreational use of green spaces as a goal, they are not generally evaluated using financial or other scales.

When developing the management and valuation of ecosystem services important for people and society, as well as in every associated communication, one should emphasize, more than is being done currently, the socially beneficial regulating and cultural services behind and alongside the provisioning services, not to mention the supporting or maintenance services that enable ecosystems to function. As the connections between ecosystems and their different services are in danger of remaining unidentified, because of, for example, sectoral and administrative

[1] "The Global Biodiversity Outlook-3 had warned that all major pressures on biodiversity were increasing, and that some ecosystems were being pushed towards critical thresholds or tipping points. If these thresholds were passed, there was a real risk of dramatic loss of biodiversity and degradation of a broad range of services on which people depend for their livelihoods and well-being. The poor would suffer the earliest and most severe impacts, but ultimately all societies and economies would be affected" (Secretariat of the Convention of Biological Diversity 2014).

boundaries, investigations into ecosystem services must transcend not only administrative, but also ecosystem boundaries (Primmer & Furman 2012). Nature conservation, land use and natural resources policies should encourage a new kind of thinking whereby ecosystems and their multi-objective conservation, management and sustainable use are scrutinized with a longer-term perspective to secure ecologically, socially and economically sustainable development, while combining the views of individual administrative and livelihood sectors with the help of the ecosystem approach of the Convention on Biological Diversity.

1.1

## Ecosystem service assessments – policy and objectives at EU and national level

The European Union's Biodiversity Strategy 2020 *Our life insurance, our natural capital: an EU biodiversity strategy to 2020* (European Commission 2011) demands that the "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" (Target 2, Action 5; see Figure 1.1).

To initiate the work on mapping and assessment of ecosystem services, a Working Group for the Mapping and Assessment of Ecosystems and their Services (MAES), with nominated experts from all EU Member States, was set up by the European Commission (DG Environment) in March 2012. The group also involves a number of stakeholders and scientists. MAES assists and strives to standardize the ecosystem assessments of Member States (European Commission 2013a, see //biodiversity.europa.eu/maes). Finland has also participated in the MAES process. The European Commission (DG ENV and the Joint Research Centre) together with the European Environment Agency (EEA) are supporting Member States in carrying out the mapping work.

The target year for mapping and assessment to be completed was set as 2014, but this goal was not reached. Ecosystem service mapping is already taking place in the majority of the EU member states, but it is not being uniformly developed and EU-based guidance (e.g. a common approach) is needed (MAES 2014). Assistance is also needed in order to harness the broad range of ecosystem service mapping and assessment approaches currently available or under development (see Martínez-Harms & Balvanera 2012, Egoh et al. 2012 or Crossman et al. 2013a for respective reviews). The Horizon 2020 project ESMERALDA – *Enhancing Ecosystem Services Mapping for Policy and Decision Making* – will start supporting the implementation of Action 5 in the Member States, and through this their national biodiversity strategies from 2015 onwards. As the MAES working group is key to the implementation of Action 5, ESMERALDA will work closely with it.

Based on related ongoing activities in Europe (such as MAES, OpenNESS, OPERAs, MESEU, BEST, MEA, TEEB, national studies; e.g. in MAES 2014, TEEB 2011, MA 2005) and close relations with the international network of ecosystem service scientists and practitioners, known as Ecosystem Services Partnership (ESP), ESMERALDA will enhance ecosystem service mapping and assessment by developing a flexible, tiered mapping approach integrating biophysical, social and economic valuation techniques. This flexible methodology will provide a means to deliver pan-European, national and regional mapping and assessment of ecosystem services by transmitting experiences during an active process of dialogue and co-creation of knowledge. The composition of the ESMERALDA consortium (44% university partners, 16% from scientific academies or elsewhere in academia, 28% from state or other superior organizations, 12% from SMEs) supports the transfer of scientific contributions from an academic level to various fields of application at state organization and private company levels. Finland is represented in the consortium of 25 partner institutions from all over Europe.

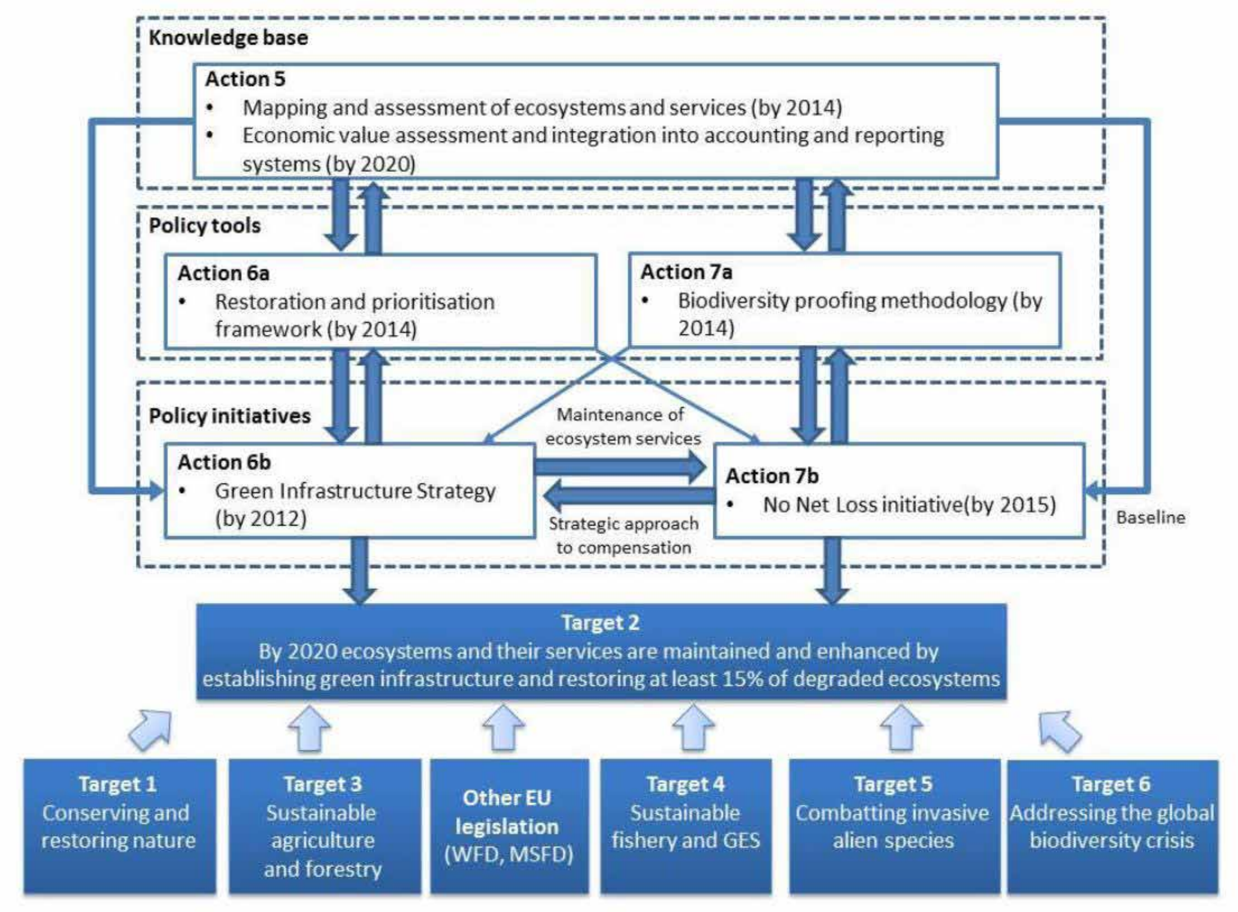



**Figure 1.1.** The importance of Action 5 in relation to other supporting Actions under Target 2 and to other Targets of the EU Biodiversity Strategy (European Commission 2013a).

The obligations of the EU Biodiversity Strategy 2020, as well as international decisions at the global level (Rio+20, CBD), are generating a need to create a national monitoring system for the state of biodiversity and ecosystem services on the basis of indicators. There is also a need to integrate biodiversity and ecosystem service indicators as part of a national weighing of sustainable development and well-being. The need to assess the economic significance of biodiversity and ecosystem services has been recognized in the Finnish Government's programme (2011) and, as a consequence, the above-mentioned developing needs are incorporated into the National Strategy and Action Plan[2] for the Conservation and Sustainable Use of Biodiversity in Finland (NBSAP) 2013–2020, Saving Nature for People[3] (Ministry of the Environment 2012, 2013a). The Finnish NBSAP is executing the global Aichi Targets (2010) approved under the Convention on Biological Diversity, in which both the European Union and Finland have been engaged.

[2] Actions 39 and 41.

[3] http://www.ym.fi/en-US/Nature/Biodiversity/Strategy_and_action_plan_for_biodiversity

1.2

## Assessment of ecosystem services and natural capital

The economic benefits of ecosystem services and the expenditures for the national economy resulting from the degradation of biodiversity and ecosystems have been assessed globally in the Economics of Ecosystems and Biodiversity (TEEB) study (Sukhdev et al. 2010, Kumar 2010, ten Brink 2011), and also in regional studies (e.g. TEEB Nordic, Kettunen et al. 2013, TEEB Arctic 2014, ongoing), national studies (e.g. TEEB assessment of TEEB 'inspired' studies for India, Germany, the Netherlands, Norway and Sweden), and thematic studies (e.g. TEEB for Business Brazil). In addition to these, national ecosystem assessments (i.e. as a follow-up to the Millennium Ecosystem Assessment rather than TEEB) on a European level have been carried out, for example, by the United Kingdom (UK National Ecosystem Assessment 2009–2011), Spain and Portugal.

With regard to natural capital, the UN Statistics Division (UNSD) is developing experimental standards for ecosystem capital accounting in the context of the revision of its System of Environmental-Economic Accounting (SEEA) handbook (European Commission 2013b). Methodological developments are supported by the European Environment Agency (EEA), and Eurostat, which is representing the European Commission in the EEA Drafting Group. The RIO+20 meeting saw the launch of a natural capital declaration with the objective of getting such accounts integrated into annual business reports. The World Bank (WB) has launched the 50:50 initiative to gather political support for natural capital accounting on a national level, and it is piloting methodological developments in developing countries through the Wealth Accounting and Valuation of Ecosystem Services (WAVES) Partnership, which has been supported, amongst other donors, by the UK, France, Germany and the EU. Natural capital accounts on a national level are seen as being based on coarse-aggregated indicators, but to be meaningful these statistics should reflect the state of ecosystems in the territory concerned (European Commission 2013b).

Under the EU's 7th research framework programme, the 'Operationalisation of Natural Capital and Ecosystem Services' (OpenNESS) and 'Operational Potential of Ecosystem Research Applications' projects, led by SYKE and the University of Edinburgh (respectively) and implemented through multiple partners, aim to translate the concepts of Natural Capital and Ecosystem Services into operational frameworks and instruments that provide tested, practical and tailored solutions for integrating ecosystem services into land, water and urban management and decision-making. These projects examine how the concepts link to, and support, wider EU economic, social and environmental policy initiatives, and also scrutinize the potential and limitations of the concepts of ecosystem services and natural capital (European Commission 2013c; see also: www.opennessproject.eu http://www.openness-project.euand //operas-project.eu).

1.3

## Ecosystem services and natural capital in the Nordic countries and Finland

1.3.1

### Outcomes of TEEB Nordic

The TEEB Nordic project, carried out in the context of the Finnish Presidency of the Nordic Council of Ministers (NCM), assessed the socio-economic importance of ecosystem services in the Nordic countries (Kettunen et al. 2013). This assessment played a key role in setting the scene for TEEB Finland, including assessing the state of play as regards ecosystem service information in Finland and identifying a range of areas with recommendations for future action.

In general, while provisioning services provided by agriculture, forestry and fisheries still remain essential in all Nordic countries, a number of other regionally important ecosystem services can also be identified. These include reindeer herding (especially in the north), wood-based bioenergy, non-timber forest products such as berries, mushrooms and game, and recreation and tourism. In addition to this, there seem to be a range of existing and novel possibilities related to different bio-innovations (the so-called bio-economy). Given the areal coverage of forests in the region, it is not surprising that the mitigation of climate change (i.e. carbon storage and sequestration) is among one of the most significant – or at least most frequently discussed – regulating services provided by Nordic ecosystems. In addition to this, the importance of water purification, as seen with the eutrophication of the Baltic Sea, and pollination are often highlighted.

In terms of information available, TEEB Nordic revealed that existing biophysical and socio-eco-

nomic data on Nordic ecosystem services – including Finnish ecosystem services – is limited. The information on biophysical status and trends consists mainly of information on stocks, flows or indirect socio-economic proxies (i.e. the use of and/or demand for services). With the exception of provisioning services, most of the information available is based on individual case studies with very little data available at national and regional levels. Available data on the socio-economic value of Nordic ecosystem services consists mainly of information on the quantity and market value of stocks. In addition to this, some studies could be found that reflect the appreciation and public value of ecosystem services (i.e. people's willingness to pay for the improvement of services), including water purification and recreation. Important concrete information gaps identified included, for example, a lack of estimates reflecting broader cultural and landscape values and a lack of data on nature's role in maintaining regulating services and human health. With the exception of provisioning services, most of the information available is based on individual case studies with very little data available at national and regional levels. Finally, no national or regional assessment focusing on the socio-economic role of the ecosystem processes and functions supporting the maintenance of services could be identified.

Despite the significant gaps in the existing knowledge base, it seemed evident that a range of ecosystem services are of high socio-economic significance for the Nordic countries, either based on their market value or estimated value for the broader public. Natural capital (biodiversity, ecosystems and related services) also underpins socio-economic well-being in the Nordic countries. On the other hand, based on the existing evidence, it is also clear that several of these ecosystem services including, for example, marine fisheries, water purification and pollination, have been seriously degraded and several others, such as carbon storage, are facing serious risks. Additionally, rather alarmingly, the information available does not yet allow any conclusions to be drawn on the status of and trends in the majority of services, including processes and functions supporting their maintenance.

The outcomes of TEEB Nordic emphasized that the first step towards the development of a comprehensive national framework for ecosystem and ecosystem services assessment and the integration of the value of ecosystem services into national policies and decision-making processes is to identify and develop a common set of indicators to assess and monitor the status, trends and socio-economic value of ecosystem services. As highlighted above, there are significant gaps in the information available on the biophysical status of ecosystem services. Furthermore, there is a fundamental need to develop new and/or improve existing indicators in order to appropriately assess nature's long-term ability to supply services. In particular, appropriate indicators for many regulating services, both in biophysical and socio-economic terms, are largely still missing. More data is available for the socio-economic value of ecosystem services (especially provisioning services). However, even this data is mainly based on case studies and is inconsistent. Consequently, the development of ecosystem services indicators – both biophysical and socio-economic alike – was seen as one of the key actions required in the Nordic countries for the future. These needs have been picked up and addressed in the context of TEEB for Finland, where national indicator development and the mapping and valuation of ecosystem services on a regional level are key focal areas (see Sections 3–5).

Building on the assessment and monitoring of ecosystem services, TEEB Nordic acknowledged that in order to be truly sustainable, economic systems need to build a more comprehensive appreciation and understanding of the value of natural capital. This was seen as requiring the development of natural capital accounts that improve the evidence base on the stocks of natural capital, integrate ecosystem services into existing national and/or regional accounting systems and, in due course, take into account gains and losses in the stocks and flow of services. A number of Nordic studies were identified exploring the possibilities for and implications of integrating the broader values of natural capital into regional and national accounts. These studies indicate that conventional accounts underestimate nature-related wealth and potential sustainable development based on natural capital. Building on this conclusion, TEEB for Finland further explored the future opportunities and possible directions for developing national capital accounting in Finland (see Section 7).

Finally, to complement 'greener' and more sustainable accounting systems, TEEB Nordic identified a range of complementary approaches towards a transition to a green economy. In addition to avoiding, reducing and restoring environmental damage and conserving nature (i.e. business as usual approaches) more active approaches towards the management of natural capital can be adopted. These include, for example, pro-active investment in natural capital and nature-based risk management via restoration, conservation and improved ecosystem management practices, including restoration of ecosystems for water management, carbon

storage and other co-benefits, and implementation of protected area networks. For example, there is an increasing evidence base to suggest that restoration of wetlands can bring significant benefits to both people and biodiversity. Other focal areas identified included securing the implementation of a comprehensive regulatory baseline, continued reform of harmful subsidies, making increased use of opportunities (including earmarking) for funding investment in natural capital (e.g. management of protected areas and restoration of ecosystems) and exploring innovative solutions for eco-efficiency and decoupling of the economy from resources (e.g. via nature-based innovations). Building on these Nordic insights, a range of opportunities related to a green economy and the uptake of more innovative policy measures for ecosystem services (e.g. PES and habitat banking) have been explored in the context of TEEB for Finland, supported by an assessment of the regulatory baseline to secure the provisioning of services (see Sections 6–7).

### 1.3.2 Current knowledge base on ecosystem services in Finland

In Finland, researchers have already carried out or are in the process of implementing several ecosystem service research and development projects. They have examined and scrutinized, among other things, the concept, identification and visualization of ecosystem services, and their socio-economic and ecological valuation, commercialization, applications for decision-making and the relationships between ecosystem services and biodiversity.

Research and development projects for the enhancement of the management of ecosystem services have included the ERGO project, which categorized and clarified the concept of ecosystem services (Ratamäki et al. 2011); the ERGO II project (Primmer & Furman 2012, Primmer et al. 2012), which considered the application of ecosystem services to decision-making; the PROPAPS project (Hyytiäinen & Ollikainen 2012), which scrutinized the ecosystems of the Baltic Sea and the values of their services; the SuoEko project (2010–2013), which considered the identification and valuation of ecosystem services of mires and peatlands (Silvennoinen 2012); the Green infra project, which examines the identification and mapping of green and blue infrastructure at the ecosystem level and its steering mechanisms; and the FESSI project, which develops ecosystem service indicators (Mononen et al. 2014). In the EKONET project, which was led by the Pellervo Economic Research, for example, the willingness of forest owners to produce different ecosystem services in their forests was examined (Kniivilä et al. 2011, Rämö et al. 2013). The ESPAT project, led by the University of Eastern Finland, has clarified the economic values and applications of the provisioning services of forest, agriculture, mire and inland water ecosystems[4] (Saastamoinen et al. 2014). The ecosystem services of Finland have also been surveyed in the PRESS project (Maes et al. 2012), which mapped European ecosystem services.

While the above-mentioned investigations have improved the understanding of ecosystem services, it is evident that a more holistic synthesis and comprehensive national analysis is required, focusing on the identification of the actors shaping the state of ecosystems, as well as an analysis of different ecosystem services and their mutual values and relationships. We must also gather information on the actors utilizing ecosystem services and possible steering mechanisms that are affecting their decisions. The cross-cutting goal of TEEB for Finland has been to produce and increase this type of information and know-how.

To create a natural resource policy that is integrated, more rational and cost-effective, as well as compatible with sustainable development, one must 'green' the national accounting systems and measuring of gross domestic product (GDP), which are being used as a basis for decision-making. Finland is committed, as a Member State of the European Union, to enhance the incorporation of natural values (incl. biodiversity and ecosystem services) into national accounting and reporting systems until 2020, as mentioned earlier. This is a general binding obligation for each Member State. However, at the moment in Finland, there is no official process that would foster the achievement of this goal.

### 1.3.3 TEEB for Finland

#### Objectives

'Towards A Sustainable and Genuinely Green Economy – The Value and Social Significance of Ecosystem Services in Finland (National Assessment of the Economics of Ecosystem Services in Finland, TEEB for Finland) – Synthesis and Roadmap', has been a pioneering project that has aimed to initiate a systematic national process for the integration of ecosystem services (natural values, i.e. natural capital) into all levels of decision-making. The main goal of TEEB for Finland (2013–2014) has

[4] http://www.nessling.fi/fi/tutkimushankkeet/rahoitetut_hankkeet/synteesi_ekosysteemipalveluista_2012/

been to support the Finnish Ministry of the Environment and other national decision-makers in the identification of the value and social significance of ecosystem services and propose methods to assess their current state and future trends.

The goal of TEEB for Finland was also to provide some preliminary estimates on the economic importance of some key services, especially those so far under-recognized, for example, regulating and cultural services, while not forgetting traditional provisioning services important for Finnish society. The aim of the project was also to consider possible elements for the renewal of the regulatory system (e.g. legislation, payment for ecosystem services (PES), habitat banking) that could secure the provisioning of ecosystem services and their foundation, the biological diversity of Finland.

Building on the insights above, TEEB for Finland wanted also to analyze the opportunities for improving the governance of ecosystem services, including exploring how ecosystem services can support the development of a green economy in Finland (e.g. the policy mix needed). The goal of TEEB for Finland was also to explore possibilities for integrating the value of ecosystem services into the national accounting system of Finland (Natural Capital Accounting, NCA). As the values of provisioning services have already been integrated into the national accounting system, the focus of TEEB for Finland has been on other categories of ecosystem services (see Section 7.2).

The aim of TEEB for Finland has also been to produce information for the implementation of the Finnish National Biodiversity Strategy and Action Plan (NBSAP) 2013–2020 'Saving Nature for People'. TEEB for Finland has also produced information and knowledge for the reporting of national actions connected to the CBD and the EU's Biodiversity Strategy 2020 and their obligations regarding ecosystem services and natural capital.

### Expected results

The expected outcomes were:

- Ecosystem-based lists of the most important ecosystem services and their indicators in Finland
- The biophysical state and trends of ecosystem services (incl. pressures) in Finland
- Case studies on the socio-economic importance and value of ecosystem services
- Recommendations for future policy responses (e.g. policy mixes needed to address ecosystem services; the potential role of green infrastructure and payment for ecosystem services (PES) schemes in Finland; the role of ecosystem services in green economy and the integration of ecosystem services into National Capital Accounting)
- A policy brief for decision-makers (in Finnish)
- A main report for the international audience (in English)
- Scientific publications (e.g. on ES indicators; application of the GreenFrame method in land use planning; and the role of ecosystem services in developing green economy)

### Results

TEEB for Finland produced an assessment of the current state and future trends of ecosystem services, and their value and social significance, and also the role of and possibilities for promoting a green economy in Finland. The project also produced examples of ecosystem service mapping suitable for land use planning (application of the GreenFrame method in the visualization of ecosystem services) and examples of national ecosystem service indicators.

TEEB for Finland also produced insights and recommendations for a better integration of ecosystem services into essential policy processes in Finland. The recommendations also include insights for different steering mechanisms for better safeguarding of natural capital (including ecosystem services). There are also recommendations for research needs.

TEEB for Finland contains a 'Scoping assessment on policy options and recommendations for Natural Capital Accounting in Finland', prepared by IEEP and SYKE (see Section 7.2). The assessment is an investigation of the possibilities for integrating natural capital (including ecosystem services) into the national accounting systems (Natural Capital Accounting, NCA vs. Ecosystem Accounting). This investigation utilized the ongoing European and Nordic studies (e.g. the Ecosystem Capital Accounts for Europe project of the European Environment Agency (EEA) and the Natural Capital in a Nordic Context project of the Nordic Council of Ministries) and expert interviews (e.g. Statistics Finland). The preliminary results of the scoping assessment were presented (11.11.2014) to the Ad Hoc Group of the Nordic Council of Ministers that works for the development of more comprehensive well-being indicators.

Under the framework of TEEB for Finland, a case study 'Potential for the uptake of Payments for Ecosystem Services (PES) in Finland - Feasibility assessment related to water purification and water regulation' was also carried out (D'Amato &

Kettunen 2014). Moreover, Pellervo Economic Research PTT produced an estimation of the benefits, disadvantages and applicability of habitat banking mechanisms in Finland (Kniivilä et al. 2014a).

### Structure, implementation and cooperation

The results were produced mainly on the basis of existing knowledge and through six interconnected project components. Each component was led by responsible researchers:

- **Component 1.** An overview of the state and future trends of ecosystem services in Finland (including ecosystem service indicators) (Petteri Vihervaara, Ari-Pekka Auvinen & Martin Forsius)
- **Component 2.** Identification and visualization of ecosystem service production areas (Leena Kopperoinen & Pekka Itkonen)
- **Component 3.** The social significance and economic value of ecosystem services in Finland (Eija Pouta)
- **Component 4.** Ecosystem services in society and policy (Suvi Borgström & Jukka Similä)
- **Component 5.** The role and possibilities of ecosystem services in promoting green economy (Riina Antikainen, Katriina Alhola & Marianne Kettunen)
- **Component 6.** Summary of conclusions and recommendations (Jukka-Pekka Jäppinen & Janne Heliölä).

TEEB for Finland was implemented through a compact cooperation with the development of ecosystem service indicators for Finland project (FESSI, led by SYKE) and the Green infra project (a pilot for the Green infrastructure of Finland, led by SYKE). The results of TEEB Nordic (Identification of ecosystem services in the Nordic countries, led by Finland) were also included. Special attention was paid to the regulating, support or maintenance, and cultural services, which have not attracted major scientific interest in Finland compared to the provisioning services. It was deemed that the identification and valuation of these services would reveal new information that could support the protection, management and sustainable use of ecosystem services that are important for the production and continuation of these services.

TEEB for Finland utilized the results of ecosystem-based expert groups of FESSI and stakeholder workshops organized under TEEB for Finland or its sub-projects. Researchers from universities and state research institutes, ministries and other government bodies, private companies and other actors of society participated in the expert groups and workshops. The representatives of other interest groups and NGOs were also invited. The project has also initiated bilateral meetings with essential stakeholders and actors (e.g. the Central Union of Agricultural Producers and Forest Owners MTK; forest industries; and Statistics Finland). The preliminary results of TEEB for Finland were also presented (4.11.2014) to the Environment Committee of the Finnish Parliament in a two-hour open-access hearing.

The implementation of TEEB for Finland was joined to the TEEB Global Network, coordinated by the United Nations Environment Programme (TEEB Office, UNEP, Geneva, Switzerland, Ms. Jasmine Hundorf, 8.1.2013). In addition to this, TEEB for Finland received international support from a workshop and discussions with an expert from UNEP's World Conservation Monitoring Centre (Programme Officer, Dr. Claire Brown, UNEP-WCMC, Helsinki 12–13.5.2014).

TEEB for Finland also benefited from the parallel discussions and preliminary outcomes of professional seminar series on *Nature for Health and Well-Being in Finland* (Jäppinen et al. 2014, forthcoming), led jointly by the Finnish Forest Research Institute and the Finnish Environment Institute, and financed by the Finnish Cultural Foundation.

The TEEB for Finland study was coordinated by the Finnish Environment Institute (SYKE) and carried out jointly with Agrifood Research Finland (MTT), the Institute for European Environmental Policy (IEEP) and Pellervo Economic Research PTT. The project, which lasted almost two years (2013–2014), was financed by the Finnish Ministry of the Environment. SYKE was responsible for the ecologic and socio-economic expertise on ecosystem services, MTT mainly for the valuation of ecosystem services and IEEP for engaging an international knowledge base (TEEB Global, TEEB Nordic) and for implementing a scoping assessment of natural capital accounting. On the views related to a green economy, all participants worked in joint cooperation.

During the implementation of TEEB for Finland, the steering group of the project, led by the Ministry of the Environment (chair, Ms Marina von Weissenberg), assembled five times.

# 2 TEEB for Finland: approach, methods, concepts and definitions

2.1

## Approach, methods and essential definitions

The conceptual framework and basis for the implementation of TEEB for Finland have been adopted from the international TEEB country study models, the EU's Mapping and Assessment of Ecosystems and their Services (MAES) project and the EU's Biodiversity Strategy 2020 (Section 1.3.3; see also Figures 1.1, 2.1.1 and 2.1.2).

The need for knowledge of ecosystem services has risen quite dramatically in recent years due to, for instance, the quest for a green economy. At the same time, classification frameworks of ecosystem services have already been under development for quite some years (Haines-Young & Potschin 2010a). The most widely used classification system, the Common International Classification for the Ecosystem Services (CICES), is supported by the EEA and has become the backbone of the European Commission's work on ecosystem services (e.g. Maes et al. 2012, 2013). Another often used way to classify ecosystem services is the so-called Cascade model (Haines-Young & Potschin 2010b). The Cascade model puts focus on the interdependent processes involved in ecosystem service delivery and makes an important connection between the biophysical and societal realms of the phenomenon. On the biophysical side, ecosystem structures and functions are identified as prerequisites for the delivery of ecosystem services. On the societal side, concrete social, economic and health benefits can be identified and, in the end, valued in appropriate ways.

Despite well-established frameworks, ecosystem service classifications have not been implemented comprehensively on a national scale. In TEEB studies both biophysical and socio-economic indicators have been described, but rather unsystematically, based on data that are easily available. Indicators have also been split into supply and demand types, as well as projected spatially explicitly on maps. These can offer rough estimates of, for instance, areas of delivery potential and overconsumption (Burkhard et al. 2012). The availability of data limits the development of spatially-explicit and reliable indicators for most ecosystem services (Vihervaara et al. 2012, Tolvanen et al. 2014). This often results in the use of proxies, that is, using the nearest available information on the question studied which still can be linked to the original target.

2.2

## Indicators for ecosystem services and the assessment of their trend

**Petteri Vihervaara, Ari-Pekka Auvinen, Laura Mononen, Anni Ahokumpu, Maria Holmberg and Martin Forsius**

Quantification and monitoring of ecosystem services are necessary for the sustainable use of natural resources and processes. We need to be sure that we are not over utilizing critical natural processes and crossing thresholds after which the provisioning of associated ecosystem services is compromised – permanently, in the worst case.

Reliable spatio-temporal data that show the development of different aspects of ecosystem services – such as delivery potential or harvest – are a prerequisite for informed decision-making. Long-term monitoring data gives us a perspective on the changing nature of both ecosystem service provision and the benefits that we gain from nature's free services. Today's drivers and pressures affecting ecosystem services include societal development, climate change and land use. As their joint effects vary depending on local circumstances, adaptation to changes in ecosystem service provision would benefit from knowledge of the related cascading processes.

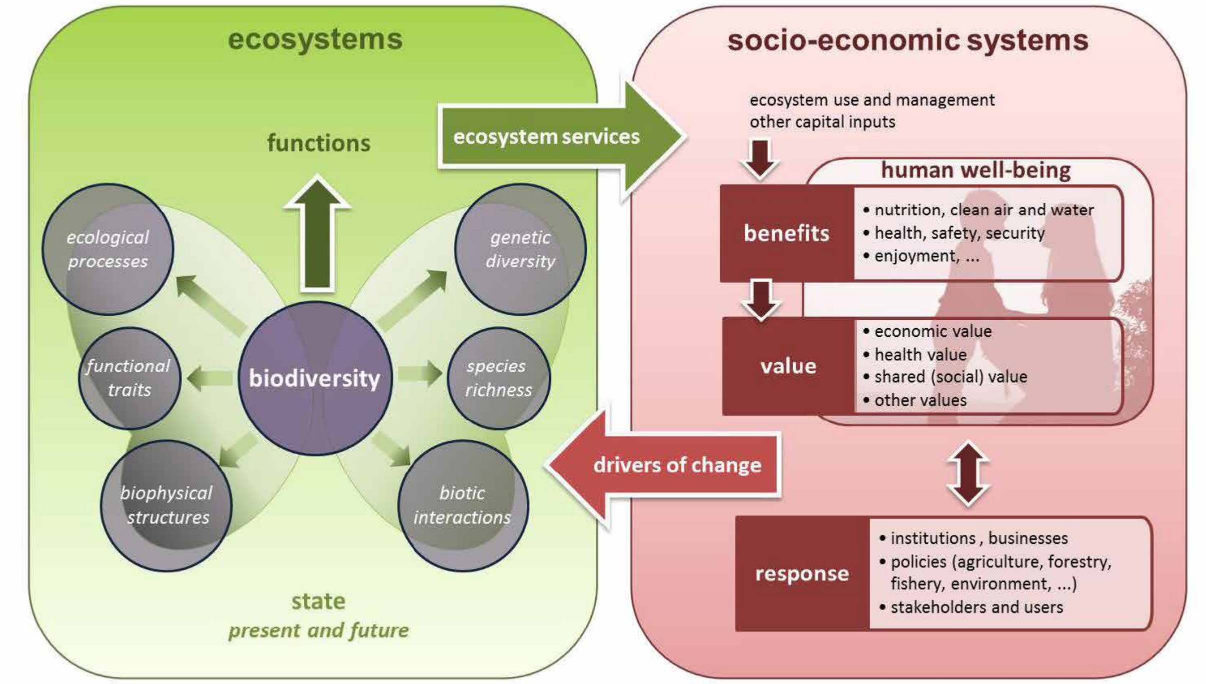



**Figure 2.1.1.** Conceptual framework for EU-wide ecosystem assessments (European Commission 2013a).

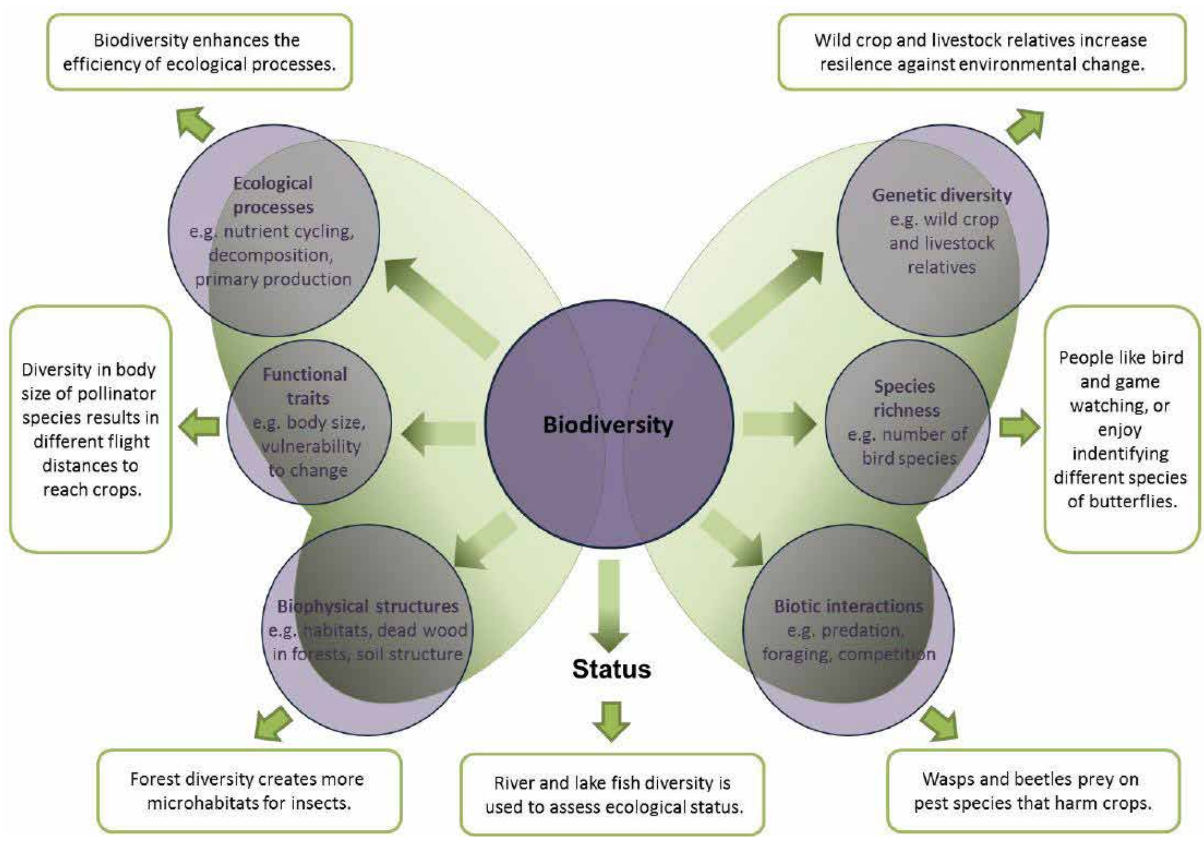



**Figure 2.1.2**. The multi-faceted role of biodiversity in supporting the delivery of ecosystem services and assessing the status of ecosystems. Biodiversity has multiple roles in relation to the delivery of ecosystem services and represents therefore a central component of the framework depicted in Figure 2.1.1 (European Commission 2013a).

In the TEEB for Finland study the CICES classification systems and the conceptual Cascade model were merged and applied systematically to the national ES indicator framework to get an overall view of the status and trends of the main ecosystem services in Finland. The results and details of this process are described in Section 3, and their implementation is discussed in Section 8.1.

2.3

## Defining concepts related to the mapping of ecosystem services

**Leena Kopperoinen and Pekka Itkonen**

### Green infrastructure

Green infrastructure (often referred to as GI) is the network of natural and semi-natural areas, features and green spaces in rural and urban, terrestrial, freshwater, coastal and marine areas, which together enhance ecosystem health and resilience, contribute to biodiversity conservation and benefit human populations through the maintenance and enhancement of ecosystem services (Naumann et al. 2011). In addition to this, it is seen as a conceptual tool for developing a strategically planned network of the above-mentioned components, specifically designed and managed to deliver a wide range of ecosystem services (European Commission 2013d). With regard to usually single-purpose grey infrastructure, green infrastructure offers many benefits at the same time, that is, it is multifunctional.

### What is the mapping of ecosystem services?

The mapping of ecosystem services refers to spatially explicit identification, analyses and visualization of sites providing ecosystem services, as well as the sites where there is demand for ecosystem services. A multitude of mapping methods are available, and a common starting point for any mapping effort is the availability of spatial datasets representing qualities and characteristics of biophysical features of the environment, spatially located socio-economic data on, for example, population, and spatially explicit data on actual demand for ecosystem services. Based on various spatial data, and often together with some kind of expert knowledge, the variance in ecosystem service provision potential, capacity, supply and demand is assessed. As a consequence, maps on ecosystem service hotspots, trade-off, flows, and so on are produced. These can be used, for example, in land use planning, impact assessment, decision-making, and research.

### Ecosystem service provision potential, potential supply, supply and sustainable supply

Ecosystem service provision potential means the perceived potential of an area to produce ecosystem services (Kopperoinen et al. 2014). The closely related concept of potential supply of ecosystem services, on the other hand, has been used as a synonym for the hypothetical maximum yield of selected ecosystem services. The phrase supply of ecosystem services has been used to refer to the quantified actual used set of ecosystem services (Burkhard et al. 2012) or to actual provision which means that part of ecosystem service provision which is or can be made use of (Kopperoinen et al. 2014). All the above-mentioned concepts have to be separated from the sustainable supply of ecosystem services, which is that amount of ecosystem services that can be utilized sustainably, not exceeding the limits that would lead to deterioration of the ecosystem and a diminished flow of benefits.

### Demand and potential demand for ecosystem services

Demand for ecosystem services has been defined as the sum of all ecosystem goods and services currently consumed or used in a particular area over a given time period (Burkhard et al. 2012). From the point of view of the expected or required level of ecosystem service delivery, demand can be defined according to environmental standards. Expected demand is then the minimum amount of produced ecosystem services to reach those standards (Baró et al., manuscript). This definition applies to non-transferrable ecosystem services, such as urban temperature regulation, which cannot be outsourced. We can also assess potential demand which is estimated based on, for example, the number of people living within a certain distance of areas producing ecosystem services, such as in the case of recreation.

### Flow of ecosystem services

The flow of ecosystem services has been defined as the transmission of a service from ecosystems to people (Bagstad et al. 2013). It includes both spatial and temporal aspects of the flow, as well as a quantified or estimated amount of services accruing for beneficiaries.

2.4
## Valuation of ecosystem services

**Heini Ahtiainen, Janne Artell, Eija Pouta and Tuija Lankia**

The valuation of ecosystem services is an important tool for understanding their significance for human well-being. As the concept of ecosystem services is anthropocentric – it emphasizes the benefits humans obtain from nature – it is essential to base the measure of the magnitude of their benefits on human perceptions. Values measure the importance of these benefits. The value of ES can be measured with qualitative, quantitative or monetary approaches, which all have their advantages (Sections 4.1 and 5). Monetary (i.e. economic) valuation allows value estimates to be compared with the costs of securing ecosystem services, which is useful information for decision-making. As most ES have no markets and, subsequently, no prices, monetary measures of values are determined by asking people directly or by observing people's behavior, which can reveal the economic value of ecosystem services.

To support decision-making, ecosystem services are valued to assess the socio-economic benefits (or losses) resulting from changes in the status of ecosystems and their biodiversity. This valuation approach entails the valuation of marginal changes in the flow of ecosystem services instead of total values. Estimating the total values of ecosystem services is typically neither useful nor advisable (Brouwer et al. 2013). As an example, the total value of ecosystem services fundamental to human well-being is arguably infinite.

A clear understanding of the interactions between ecosystem services and the goods and benefits they produce is necessary in valuation as it helps to prevent double-counting of values. Double-counting occurs when underlying (intermediate) ecosystem services that contribute to final service benefits are valued separately, and the values are aggregated to obtain estimates of ecosystem value (Turner et al. 2010). For example, in many cases whilst regulating services do not contribute to human welfare directly, they play an important part in the production of final services. Thus, their values are already embodied in the values of final services. Proper use of valuation estimates requires the recognition of the spatial distribution of ES and benefits. People tend to value ES that exists close to them more than those further away. Similarly, the fewer the substitutes, the higher the values are (Bateman 2009).

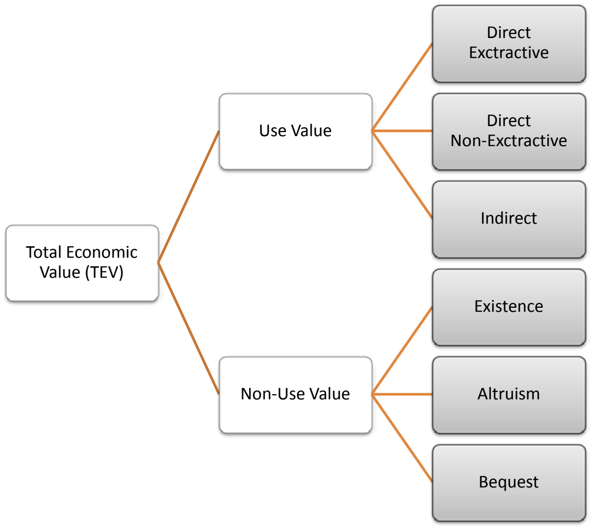



**Figure 2.4.1**. Classification of total economic value to its constituents.

Economic values can be divided into two main categories (Figure 2.4.1.), use values and non-use values. Use values represent values that people enjoy from direct use of ES. Outdoor recreation in its many forms is an example of use values. Use values can be divided further into direct uses that can be extractive (e.g. fishing, hunting, and berry and mushroom picking) or non-extractive (e.g. nature walks, boating and photography). Indirect use values include enjoying nature documentaries and photography or natural products collected by others. Non-use values are placed on the knowledge of well-functioning ecosystems (existence value), and the availability of ES for others in the current generation (altruism) or for future generations (bequest value). Use values are generally linked to provisioning (e.g. food) and cultural (e.g. recreation) ES, while non-use values fall in the category of cultural ES.

2.5
## Concept of green economy

**Riina Antikainen, Katriina Alhola and Marianne Kettunen**

Extensive exploitation of ecosystems and increased amounts of emissions into air and discharges to water and soil have led to significant environmental problems in many areas. Additionally, our society is facing other, often conflicting challenges such as economic recession leading to loss of jobs. As an answer to these multiple challenges, the concepts of a green economy and green growth have been

introduced by organizations such as UNEP (2011) and OECD (2011). Several definitions have been used for both green economy and green growth, but their general content is similar. For example, UNEP defines green economy as one that results in "improved human well-being and social equity, while significantly reducing environmental risks and scarcities" (UNEP 2011). The transition to green economy produces various benefits, but, simultaneously the transition is a long-term challenge and requires actions and significant technological, behavioral and system changes at all levels of society, including citizens, private companies, public sector and decision-makers.

Green economy builds on safeguarding the functional capacity of ecosystems, thus supporting their protection and sustainable use. At the same time, in a green economy society also remains dependent on ecosystem services, many of which are available free of charge (ten Brink et al. 2012). As in the current economic system these services do not have a market price and as a consequence they are often overexploited (e.g. excess withdrawal of water or deterioration of a certain environmental component of an ecosystem). For a more sustainable economic system, environmental externalities should be taken into account more extensively. Environmental externalities refer to the uncompensated environmental effects of production and consumption that affect consumer utility and enterprise costs outside the market mechanism. If environmental externalities and ecosystem services were taken into account from the life-cycle perspective, many of the green economy solutions that are currently considered too expensive would actually become profitable. In addition to this, early actions to mitigate environmental challenges often outweigh the costs of delayed action, as, for example, with climate change (Stern 2006).

Maintaining the 'free of charge' ecosystem services could also play a significant role in fighting poverty and supporting people with low incomes. For example, in India it has been estimated that if vital ecosystem services such as water availability, soil fertility and wild foods were lost for the poor, it would cost US$ 120 per capita to replace this lost livelihood (Secretariat of the Convention on Biological Diversity 2010). This sum equals roughly 10 per cent of India's GDP per capita (World Bank 2014). While it is therefore important to acknowledge the welfare importance of non-market ecosystem services, the valuation and monetization of these services should not lead to their commodification and marketization as this could lead to the deterioration of the well-being of some interest groups.

Valuation of ecosystem services has resulted in increasing attention and interest in the idea that investments in environmental technologies and sustaining biodiversity produce more benefits than costs (e.g. TEEB 2011, ten Brink et al. 2011). Many enterprises are also seeing this and investments in environmental issues are regarded more as an opportunity than mere costs. For example, the World Business Council for Sustainable Development (WBCSD) has given guidelines for corporate ecosystem valuation to improve corporate decision-making (WBCSD 2011). According to the WBCSD "the ability to factor ecosystem values into business decision making is becoming an ever-more pressing need because there is increasing evidence that the ongoing ecosystem degradation has a material impact on companies – undermining their performance, profits, license to operate and access to new markets, but simultaneously, new opportunities are emerging that are linked in some way to restoring and managing ecosystems". However, "moving from the ecosystem services concept to action remains a challenge, due to relatively little corporate testing and sharing of effective approaches and tools" (BSR 2013).

Currently, there is no agreement on an analytical framework or a set of indicators to monitor green growth or green economy, although many of the various definitions that are currently used by international organizations have a lot in common (GGKP 2013). However, three types of benefits can be identified – environmental, economic and social. These cover a range of topics, including climate change mitigation, improving resource efficiency, reducing fossil fuel dependency, atmospheric and water emissions and the loss of biodiversity; improving economic growth, productivity and competitiveness, and accelerated innovation, through correcting market failures due to lack of knowledge; reducing environmentally induced health problems and risks, commodity price volatility, and economic crises; increased resilience to natural disasters; job creation and poverty reduction; improved regional equality and improved access to environmental services and amenities (e.g. modern energy, water, sanitation and health care).

## Green economy vs. Bioeconomy

Global challenges and the call for green economies have drawn new attention to the use of forests and other biomass in the form of a so-called bioeconomy. To answer this call, the Finnish government has recently launched its bioeconomy strategy (Finnish Bioeconomy Strategy 2014). In the strategy, bioeconomy refers to an economy in

which renewable natural resources are used to provide food, energy, products and services. Bioeconomy can be seen as a part of green economy, but they are not synonyms: a bioeconomy focuses on products and services based on renewable resources whereas green economy also encompasses aspects related to broader environmental and socio-economic sustainability, also covering the use of non-renewable materials. The Finnish national strategy aims at promoting economic development and creation of new jobs, but also at combating the degradation of ecosystems. The newly launched plan to build a bio-product mill in the town of Äänekoski has been presented as an example of the new bioeconomy. The realization of the plan would, however, increase the annual use of fiber wood in Finland by 10 per cent. The bio-product mill concept can, in the future, produce new types of bio-products including biomaterials, chemicals and energy products, in addition to more traditional forest products.

2.6

## Scoping assessment on natural capital accounting

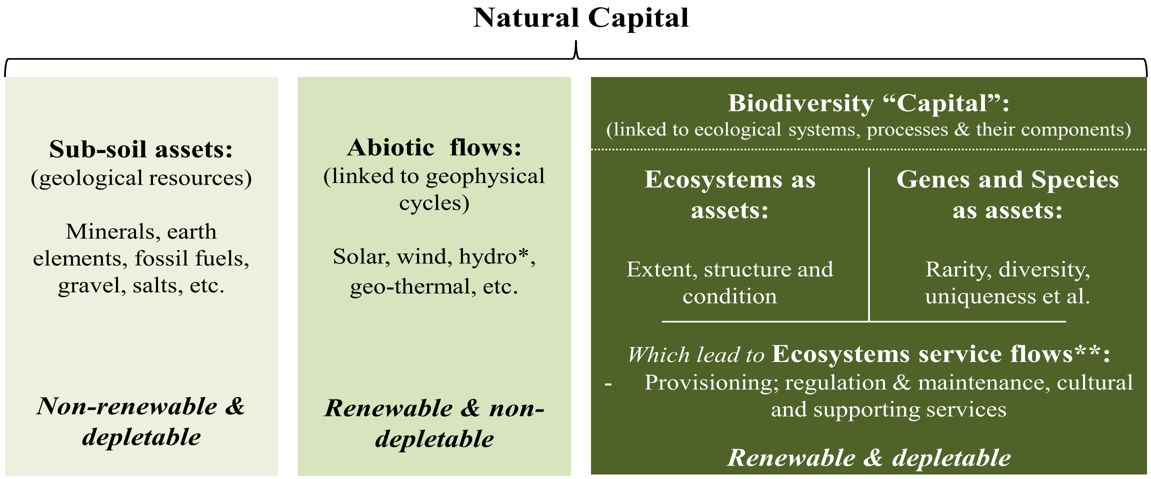
**Marianne Kettunen, Patrick ten Brink and Daniela Russi**

Natural capital (NC) is a term used to capture and highlight the role of nature in supporting the economy and human welfare (Pearce et al. 1989). According to the analytical framework developed in the context of the EU 'Mapping and Assessment of Ecosystem and their Services' initiative (European Commission 2013a), natural capital includes subsoil assets (geological resources), abiotic flows like solar and wind energy and ecosystem capital (EC), which represents the biotic element of the natural capital and includes both ecosystems and the flows of ecosystem services they provide to society (see Figure 2.6.1).

As with the concept of ecosystem services, the concept of natural capital is anthropocentric focusing on those aspects of nature that benefit humans. Consequently, the concept of natural capital does not directly reflect the intrinsic value of nature nor does it encompass benefits provided by different habitats and species to other species (ten Brink & Russi 2014). From the perspective of biodiversity conservation, the main purpose of this concept is to help to shed light on the benefits that nature provides to human society and consequently on the need for nature protection – not only for moral reasons – but also as a way to enhance human well-being and economy. As such, the concept of natural capital, in particular when fully capturing the elements of ecosystem capital, can contribute to a shift towards more sustainable and biodiversity-friendly policy-making while also acting as an environmental education tool for awareness building.

National Accounts is the statistical system that systematically describes a country's national economy and underpins the estimation of GDP. The accounts present the gross domestic product and gross national income that reflect the state and development of a national economy. The underlying problem from the perspective of the sustainable use of natural resources and natural capital is that the full contribution of natural capital – especially the ecosystem capital – to maintaining economic well-being and underpinning the functioning of different economic sectors is not factored into the national accounting systems (SNA).

A range of policy initiatives have been initiated to improve the integration of natural capital into the accounting frameworks, at both global and EU levels.The objective of the "Ecosystem services and Natural Capital Accounting (NCA)" component of TEEB for Finland was to outline the concept of natural capital accounting and discuss its possible future application and development in Finland (see Section 7.2). This brief scoping assessment was based on a review of current literature, including, in particular, the on-going pioneering work in Europe (e.g. ten Brink & Russi 2014, Russi & ten Brink 2013, European Commission 2013a, ten Brink et al. 2012, EEA 2011) and global guidance on accounts – the System of Environmental-Economic Accounting (SEEA) led by the United Nation's Committee of Experts on Environmental-Economic Accounting (UNCEEA). Furthermore, the outcomes and recommendations were supported by a review by national experts from Statistics Finland.




* Hydro strictly speaking also related to biotic components, with related ecosystem services of water storage, purification and regulation.

** The total future value of ecosystem service flows is a representation of value of the capital stock, and known as "capitalisation", but is not a capital as such.

**Figure 2.6.1.** The components of Natural Capital, highlighting the role of biodiversity (ten Brink's own illustration, building on the MAES analytical framework, European Commission 2013a).


YHA-Kuvapankki / Aarno Torvinen

# 3 An overview of the state and future trends of ecosystem services in Finland

3.1

## Main drivers affecting the provision of ecosystem services in Finland

**Leena Kopperoinen and Janne Heliölä**

A driver is any natural or human-induced factor that directly or indirectly causes a change in an ecosystem or in its ability to produce services that are essential for human well-being. While a direct driver influences ecosystem processes, an indirect driver operates more diffusely, by altering one or more direct drivers. Although it has been taken into consideration that changes in ecosystem services are almost always caused by multiple, interacting drivers (such as population and income growth interacting with technological advances that lead to climate change), here the drivers identified are assigned to only one group of drivers (Nelson et al. 2005).

Two recent reports, The State of the Environment in Finland 2013 (Putkuri et al. 2013) and Socio-economic importance of ecosystem services in the Nordic Countries (Kettunen et al. 2012) have assessed the current drivers affecting the state of biodiversity and ecosystem services in Finland and its neighboring countries. The most important drivers are presented in Table 3.1.1, grouped according to the classification in the Millennium Ecosystem Assessment (Nelson et al. 2005).

3.2

## The development of ecosystem service indicators

**Petteri Vihervaara, Ari-Pekka Auvinen, Laura Mononen, Anni Ahokumpu, Martin Forsius, Maria Holmberg and Ieva Vyliaudaite**

Finland's ecosystem service indicator framework has been developed to present the most nationally important ecosystem services from four different angles by utilizing the Cascade model (Mononen et al. 2014). The identification of the most important ecosystem services was made following the CICES classification version 4.3 (http://cices.eu) and by utilizing the expertise of six ecosystem-specific expert groups (http://www.biodiversity.fi/en/about/expert-groups). The indicators were also discussed in a wide-based stakeholder workshop in March 2014. The basic division into provisioning, regulating and maintenance, and cultural services is seen on the website – www.biodiversity.fi/ecosystemservices – where the set of 112 ecosystem service indicators are published and updated.

The Cascade model was applied to create four different indicators for all ecosystem services chosen. The indicators cover different stages of the ecosystem service flow: 1) structures and 2) ecosystem functions required for the provision of ecosystem services, as well as 3) benefits and 4) values arising from them (Haines-Young & Potschin 2010b, Tolvanen et al. 2014). Suitable indicators were defined according to ecosystem service divisions. For provisioning services (10 in total), structure indicators are described as area of habitat or population of organisms necessary for the provision of the ecosystem service. Function indicators focus on productivity and take into account human inputs that enhance it (e.g. feeding, fertilizers and management). Benefit indicators represent the proportion of the total yield utilized. Value indicators for

**Table 3.1.1**. The main drivers affecting ecosystem services in Finland.

| Direct drivers | Indirect drivers |
|---|---|
| **Land use changes**<br>• Forests: large-scale timber production continues, but with new more sustainable management<br>• Mires: drainage for timber production, arable use or peat production<br>• Agriculture: more intensive use of arable areas vs. abandonment of semi-natural grasslands<br>• Urban areas: densification of infrastructure<br><br>**Climate change**<br>• Rising average temperatures and rainfall<br>• Decreasing snow cover<br>• More frequent storms and floods<br>• Accelerating rates of decomposition and nutrient cycling<br><br>**Nutrient loading in water bodies**<br>• More efficient nutrient use in agriculture<br>• Effective cleaning of sewage waters<br>• Leaching of nutrients from forestry and peat production<br><br>**Invasive species**<br>• Increasing number of alien species due to climate change and human translocations<br>• Arrival of new plant and animal diseases | **Demographic drivers**<br>• Growing population in larger cities vs. abandonment of rural areas<br><br>**Economic drivers: consumption, production, and globalization**<br>• High and increasing energy consumption<br>• Diminishing the use of non-renewable energy sources<br>• Increased production of bioenergy<br>• Decreased amount of municipal waste placed in landfills<br>• Increasing tourism and nature-based recreation<br><br>**Sociopolitical drivers**<br>• Targets for reducing greenhouse gas emissions<br>• Targets for the conservation and sustainable use of biodiversity and natural resources<br>• Reduced eutrophication of inland waters by improving water quality standards of EU Water Framework Directive<br>• Moving towards environmentally targeted taxation<br>• EU environmental legislation, financial support and policies to environmentally sustainable practices<br><br>**Cultural and religious drivers**<br>• Rising popularity of voluntary nature conservation<br>• Rising popularity of both local and ethical food production<br><br>**Science and technology**<br>• Possible reduction in carbon dioxide emissions due to advancing technologies<br>• Increasing importance of environmental business and biotechnological innovations (Cleantech) |

provisioning services are divided into four value categories: 1) economic, 2) social, 3) health, and 4) intrinsic value. These are reported in the order of their perceived importance according to the results of a stakeholder survey that was conducted in March 2014.

For regulating and maintenance services (12 in total), structure indicators represent the habitat qualities or species assemblages that enable the optimal flow of ecosystem services. In this case, the focus is even more on the quality aspects of ecosystems than in the case of provisioning services, as there have been fundamental human-induced changes in the functioning of many natural ecosystems. Indicators for ecosystem functioning are described typically as units per area per time and attempt to assess how well the desired ecosystem processes are functioning. Benefit indicators deliver information on the improved quality of an ecosystem which is of benefit to humans. Value indicators focus, most often, on the avoided costs of damage prevention and repair.

The approach in cultural service indicators (6 in total) emphasizes the preferences of people. Structural indicators focus on the qualities of ecosystems that people define as desirable. Furthermore, attention is paid to accessibility to nature and its elements. All cultural services have the same indicator as the function indicator: natural events and phenology. This expresses the seasonal or long-term natural variability in the environment that attracts people or captures their imagination. The benefits of cultural services are typically measured as number of visits, times used or work(s) produced reflecting the intensity at which people use nature for nourishment, inspiration, and so on. The values of cultural services are measured in a similar fashion, with the values of provisioning services utilizing all four value categories (economic, social, health and intrinsic). Due to their close links to culture, social values are often emphasized in the case of cultural ecosystem services.

3.3

## The state of ecosystem services: an overview

**Petteri Vihervaara, Ari-Pekka Auvinen, Laura Mononen, Anni Ahokumpu, Martin Forsius, Maria Holmberg and Ieva Vyliaudaite**

This section provides an overview of Finland's most important ecosystem services. All ecosystems services selected for indicator development will be briefly introduced by means of their four cascading indicators. This overview will follow the standard division into provisioning, regulating and maintenance, and cultural services. Connections between ecosystem services and Finland's main habitat types will be given. As the development of indicator content is still underway, a few examples of different types of indicators will be provided rather than a comprehensive account of the data available. For a fuller and up-to-date picture of Finland's ecosystem services, the reader is advised to refer to www.biodiversity.fi/ecosystemservices where all indicators are published as soon as they become available.

3.3.1

### Provisioning services

**Table 3.3.1**. The ten most important provisioning services in Finland and their associated indicators.

| | 1. Structure | 2. Function | 3. Benefit | 4. Value |
|---|---|---|---|---|
| Berries and mushrooms | Berry and mushroom habitats (forests, mires) | Average annual yield (total kg/A or kg/ha per A) | Harvested yield (harvest entering markets + domestic use) | Sales of berries and mushrooms, value of domestic use, health impacts of the use of berries and mushrooms |
| Game | Game habitats (forests, mires, farmlands, alpine habitats) | Game population, reproduction rate, wildlife richness | Game bag | Economic value of game bag, social, health values and intrinsic cultural values related to hunting |
| Reindeer | Reindeer pastures (alpine habitats, forests, mires) | Number of reindeer, birth rate, additional feeding | Culled reindeer | Sales of reindeer meat, employment in reindeer husbandry, intrinsic cultural values related to reindeer herding |
| Wood | Managed forests (forests, mires) | Growing stock increment, effect of management | Roundwood removals | Economic value of roundwood trade, employment in forestry |
| Clean water | Aquifers, pristine mires and other wetlands, undisturbed soils (forests, mires, inland waters, farmlands, urban areas) | State of surface water and groundwater, capacity to clean water | Use of raw water | Economic value of domestic, irrigation and process use, health impacts of clean water, social values related to the availability of clean water |
| Bioenergy | Types of forest used for bioenergy harvesting, area under bioenergy crops (forests, mires, farmlands) | Annual growth of biomass, sustainability of biomass harvesting (stumps, cutting residue) | Harvest, energy content | Value of produced energy, employment |
| Fish and crayfish | State of surface waters, stream connectivity (Baltic Sea, inland waters) | Population dynamics of commercially used fish and crayfish | Total catch (commercial and domestic) | Value of commercial and domestic/ recreational catch, employment, health impacts of the use of fish and crayfish, intrinsic cultural values related to fishing |
| Crops | Area under crop cultivation (farmlands) | Nutrient dynamics, yield per ha, use of fertilizers and pesticides (organic vs. conventional) | Harvest | Agricultural income, employment, values related to agricultural landscapes |
| Reared animals | Number of animals, area of pastures | Nutrient and energy uptake, productivity (organic vs. conventional) | Animal products | Agricultural income, employment, values related to agricultural landscapes |
| Genetic material | Number of varieties | Genetic variance, evolution | Breeding and discovery potential, benefit gained from utilizing genetic variance thus far (increased yield per ha etc.) | Intrinsic value of genetic variance and evolution, economic value of modified organisms |

Nationally important ecosystem services were identified in expert group meetings (http://www.biodiversity.fi/en/about/expert-groups), and altogether the 28 most important ecosystem services were chosen for the indicator work. The ten most important provisioning services selected include many natural resources that have been historically very important for Finland's development (Table 3.3.1). In the latter half of the 20th century the Finnish economy relied heavily on provisioning services such as roundwood and agricultural products (mainly cultivated crops, meat and dairy products). The role of the forest sector was particularly considerable in the nation's post-war development with sayings such as "Finland stands on wooden legs" not being far off the point. Fishing continued to be an important source of livelihood and employment.

During the past two to three decades there have been far-reaching changes with respect to the relative significance of several provisioning services. For example, between 1975 and 2011 the forest sector's share of Finland's GDP decreased from 9.5% to 4.3% and the agriculture's share from 5.6% to 1.0% (Figure 3.3.1 A). The number of professional fishermen fell by more than 50% between 1980 and 2010 (Ministry of Agriculture and Forestry 2010).

This is not to say that these economic sectors have not continued to be important, but rather that other sectors of the economy have grown more in relative significance and thus these provisioning services are not as vital to the economy as they used to be. Forest industry products continue to constitute a large portion of Finland's exports and the country is primarily self-sufficient in terms of agricultural products. The total value of exported forest products remained quite stable between 1996 and 2012 and the share of forest industry products of total exports now lies at 20% (Figure 3.3.1 B). The most important crops cultivated in Finland are cereals, potato, sugar beet, turnip rape and rape, and the most commonly reared animals include poultry, pigs and cattle (TIKE 2014).

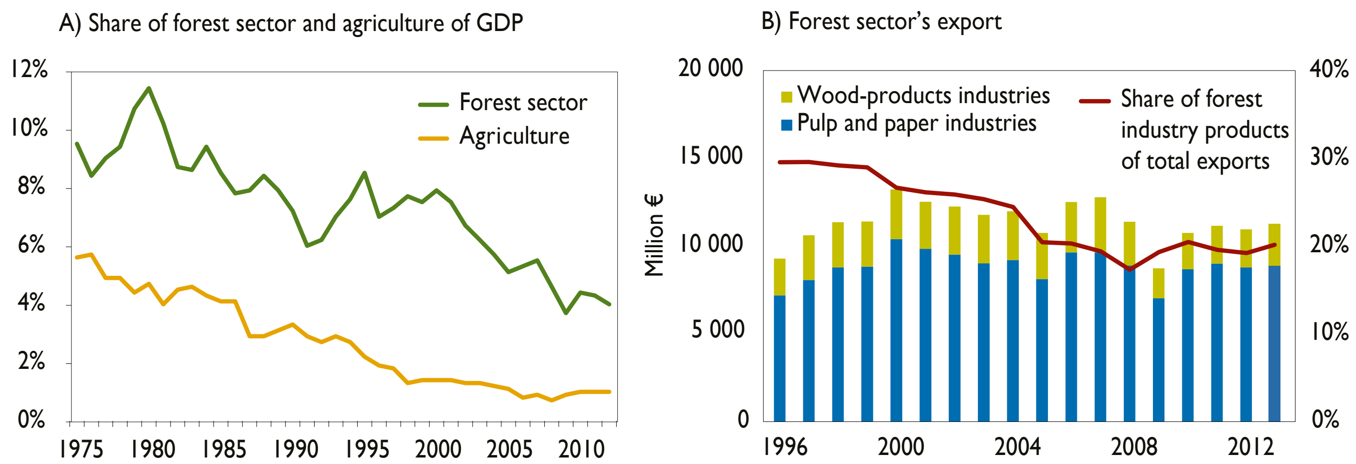



**Figure 3.3.1**. The forest sector's and agriculture's share of Finland's Gross Domestic Product 1975–2010 (A) and the value of exports from the forest industries and forest industry products' share of the total exports 1996–2013 (B) (OSF 2014a; Finnish Customs 2014).

At the level of the whole economy, the direct economic importance of other provisioning services such as reindeer, game, natural berries and mushrooms is small and has mainly declined over the long term; however, these can still be locally important. Nowadays picking berries and hunting game also contain an important recreational dimension, as securing a good catch is often less vital than the time spent in nature looking for one.

A special group in terms of dependency on provisioning services is the indigenous Sámi people, for whose culture and livelihoods natural resources such as reindeer, game and fish continue to play a major role. Most Sámi living in the Sámi Homeland in northern Lapland are either reindeer herders or have close family ties to reindeer herding. The reindeer management area covers one third of the total land area of Finland (Kumpula et al. 2000). In addition to its social value, reindeer herding produces meat and other related products and acts an essential background for tourism in Lapland.

One provisioning service with a contrary trend is the use of biomass for energy production. The majority of the biomass used for this purpose in Finland consists of wood. Because of climate targets, there has been a dramatic increase especially in the use of forest chips for electricity and heat production since the turn of the millennium (Figure 3.3.2 A). At the moment, wood fuels cover 23% of the total energy consumption (Figure 3.3.2 B). Peat is used mainly for heat generation. Its share of the total energy consumption is 5%. The future role of peat-based energy is heavily debated due its negative impacts on biodiversity, water quality and climate change.

Other major provisioning services in Finland are clean water and genetic material. Water as a provisioning service is used directly in domestic households and industrial processes, and for irrigation. The good quality of surface and ground waters is pivotal in a country where many systems rely on the ubiquitous and ample provision of water. Genetic material is preserved in native breeds, gardens and gene banks, but also by maintaining species diversity in the wild. A national program for preserving plant genetic resources was established in 2003 and a program for preserving farm animal genetic resources in 2004 (Ministry of Agriculture and Forestry 2003, 2004). The genetic diversity of forests is preserved in special gene reserve forests (65 km2 in 2013) and ex-situ gene reserve collections (Metla 2013a-b). A wide pool of genetic material enhances breeding possibilities, capacity for coping with future challenges and the discovery of potential new nutrition sources, chemicals and medicines.

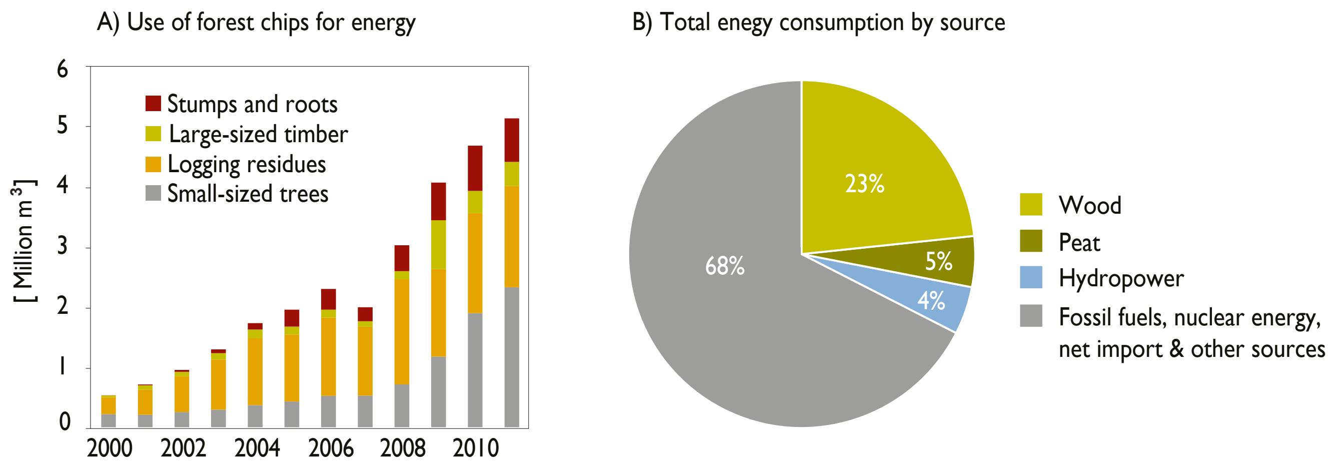



**Figure 3.3.2**. Use of forest chips for energy production 2000–2012 in heating and power plants (A) and total energy consumption by source in 2012 (B). Wood chips provide approximately one fifth of the total energy generated by the burning of wood fuels. The most important source of wood-based energy is forest industry waste and by-products (Metla 2001–2013; OSF 2014b).

3.3.2

## Regulating and maintenance services

**Table 3.3.2**. The twelve most important regulating and maintenance services in Finland and their associated indicators.

| | 1. Structure | 2. Function | 3. Benefit | 4. Value |
|---|---|---|---|---|
| Water retention | Undrained habitats, vegetation type and cover (forest, mires, inland waters, farmlands, urban areas) | Detention time (per habitat type, natural vs. modified) | Flow control (natural levelling of flow) | Avoided costs of flood prevention and damage repair |
| Water filtration | Undisturbed habitats, vegetation type and cover, aquifers (forest, mires, inland waters, farmlands) | Groundwater production (recharge rate, mm/ha/A) | Groundwater and surface water quality | Health impacts, economic value of groundwater stock and high quality surface water |
| Climate regulation | Carbon-storing habitats (forest, mires, Baltic Sea, inland waters) | Carbon balance, sequestration rate | Climate regulation, stable climate | Avoided costs of negative climate impacts, intrinsic value of stable climate |
| Nitrogen uptake | Nitrogen-fixing vegetation (forests, farmlands) | Nitrogen fixation rate | Improvement of nutrient balance and soil quality | Avoided costs of fertilizer use |
| Erosion control | Vegetation type and cover: nontilled farmland, undrained habitats, unprepared forest soils (forests, mires, farmlands) | Particle retention rate | Avoided erosion, improved water quality | Avoided costs of fertilizer use, economic value of high quality surface water |
| Soil quality | Functional diversity of soil organisms (farmlands) | Cycling of substances | Soil quality | Avoided costs of soil improvement, economic value of increased harvest |
| Nutrient retention | Vegetation type and cover: nontilled farmland, buffer strips, undrained habitats, unprepared forest soils (forests, mires, farmlands) | Nutrient retention rate | Improved water and soil quality | Economic, social, health and intrinsic value of clean water, avoided costs of fertilizer use and water protection measures |
| Mediation of waste and toxins | Ecosystem, soil organisms | Decomposition, mediation or storage of waste by biological, biochemical or biophysical processes | Improvement of water and soil quality | Economic, social, health and intrinsic value of clean soil and water, avoided costs of waste management |
| Nursery habitats | Area and state of nursery habitats (Bladderwrack communities, mire edges etc.) | Shelter and nutrition (measured as reproduction success) | Viable populations | Avoided costs of stock replenishment and other management measures |
| Pollination | Pollinator nesting and foraging habitats (area + quality) | Pollination | Increase in yield | Economic value of improved yield |
| Air quality | Urban green infrastructure | Retention of small particles | Improved air quality | Health values of clean air, avoided medical costs |
| Noise reduction | Vegetation in urban areas | Acoustic absorption | Reduced noise level | Health values of reduced-noise environment, avoided medical costs |

Twelve regulating and maintenance services were identified for Finland (Table 3.3.2). Some of these are related to ecosystem structures (e.g. water filtering wetlands) while others are more functional (e.g. pollination). Taken as a whole, provisioning services are often unremarkable background processes that go unnoticed until there is something wrong with them. For example, erosion control normally only becomes manifest after the removal of natural vegetation has had undesired impacts.

Many fundamental ecosystem functions providing regulating and maintenance services are brought about by micro-organisms and vegetation. In the Finnish context these include climate regulation through the carbon cycle, nitrogen fixation, soil quality and mediation of waste and toxins. Vegetation also plays a major role in many processes related to the cycling of water (water retention and filtration, erosion control).

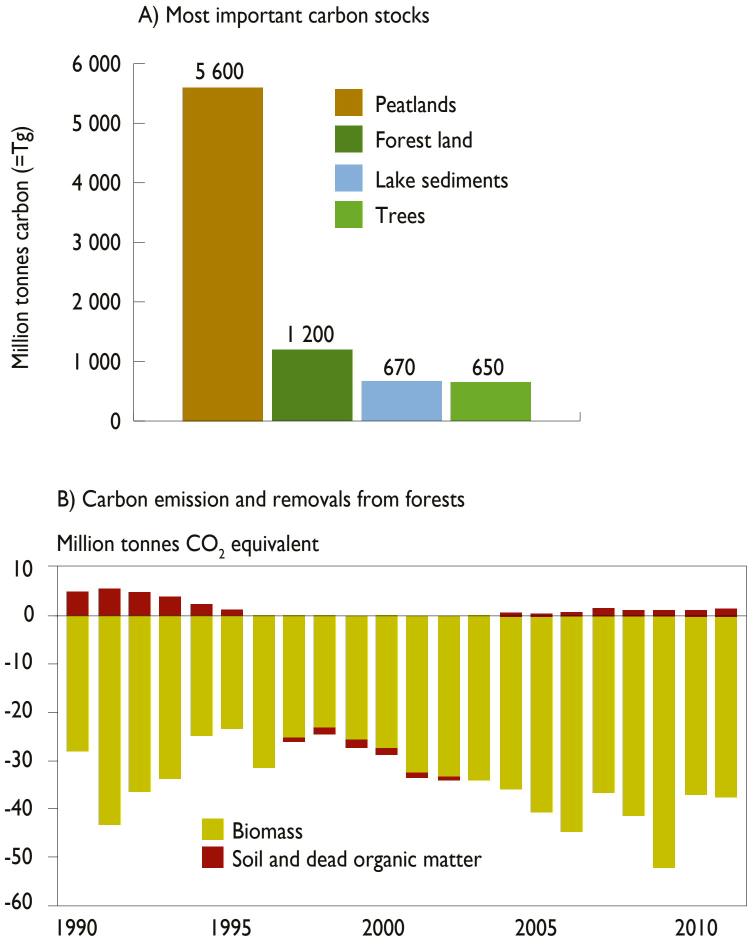



**Figure 3.3.3**. The most important carbon stocks in Finland (A) and greenhouse gas emission and removals from the forest carbon stock 1990–2011 (B). Negative values indicate removals, and positive values indicate emissions. (Kauppi et al. 1997, Liski & Kauppi 2000, Liski & Westman 1997, Minkkinen 1999, Pajunen 2004, Virtanen et al. 2003, Metla 2012).

Together forests and mires (peatlands) cover 74% of Finland's land surface. Both of these contain a large carbon stock (Figure 3.3.3). Finnish mires have accumulated 5,600 million tonnes of carbon as peat during their 10,000 year long history since the latest ice age. Forest land contains the second largest stock at 1,200 million tonnes of carbon. This stock, which consists of slowly decomposing forest litter and dead trees, is quite stable. The 650 million tonnes of carbon stored in living trees is in a much more dynamic state.

Nitrogen fixing crops are used frequently to improve the quality of the soil in farmlands. The most common nitrogen fixing plants are *Fabaceae* and *Trifolium*. About 3% of the nitrogen input in Finnish agricultural soils originates from biological nitrogen fixation. This equals 8,800 tonnes of nitrogen annually. (Antikainen et al. 2005). Furthermore, nitrogen fixing bacteria in the root nodules of alders (*Alnus*) play an important role in early stages of forest succession by increasing nitrogen levels in their environment and thus increasing the productivity of the whole ecosystem (cf. Compton et al. 2003).

Soil quality is a result of the broad functional diversity of the soil organisms. One particularly important group affecting soil properties is earthworms (*Oligochaeta*). Their species-wise distributions and abundances have been studied in Finland with the aim of developing more environmental friendly cultivation techniques such as direct seeding (Nuutinen et al. 2007). Mediation of waste and toxins is also dependent on the function of microorganisms. These microorganisms neutralize or remove hazardous substances from contaminated land and groundwater, for example. Effective techniques have been developed, for example, for the removal of polycyclic aromatic hydrocarbons (PAHs) by fungi and bacteria from contaminated soils (Winquist et al. 2014).

Water-related ecosystem services have an essential role in Finland. About 5.4 million m$^3$ of groundwater is generated in Finland every day (SYKE 2013). Areas of eskers and terminal moraines with sorted coarse-grained soils have the largest high-quality groundwater deposits. Most of the 3,800 groundwater deposits suitable for use as water supplies have been assessed as good in quality. About 350 deposits were considered to be at risk and 98 had bad water quality in 2013 (SYKE 2014). Water retention, erosion control and nutrient retention can be seen as different aspects of the same phenomenon. Water is retained by lakes, ponds, natural wetlands and mires as well as in soil and vegetation. Running water is the main cause of erosion in Finland. Structures such as wetlands, forest with unprepared soils and certain agricultural lands such as untilled field verges play a key role in erosion control. These structures are also important in nutrient retention thus improving the quality of both water and soil.

Nursery habitats provide shelter and nutrition for juvenile animals and ensure viable populations of many species that are economically important. In Finland the most important nursery habitats include bladderwrack (*Fucus vesiculosus*) and common eelgrass (*Zostera marina*) meadows for many fish species, wooded mires for many forest grouse species and spawning rivers for salmon. There are only two salmon spawning rivers left in Finland, Tornionjoki and Simojoki. During the recent decade the number of smolts has increased considerably, particularly in Tornionjoki (Figure 3.3.4).

Pollination by living organisms is an integral ecosystem service function. Effective pollination leads to larger yields (Hoehn et al. 2008, Maes et al. 2012) and is especially important for the production of some crops such as rape, as well as many cultivated fruits and berries (TIKE 2014). Air quality and noise reduction are enhanced by vegetation in urban areas. Plants retain particles that originate from exhaust gases, street dust and forest fires, for example, and thus improve the air quality. The leaves of trees and scrubs, on the other hand, absorb sound waves and mitigate the negative health impacts of urban noise.

Comprehensive knowledge on most regulating and maintenance services is missing for the time being. Several ongoing research projects aim at filling in some of these knowledge gaps, these are for example CLIMES (Impacts of climate change on multiple ecosystem services), YASSO (Soil carbon model) and ES-LUPPI (The relationships of biotopes, habitat structure and habitat quality to the provision of ecosystem services) by the Finnish Environment Institute.

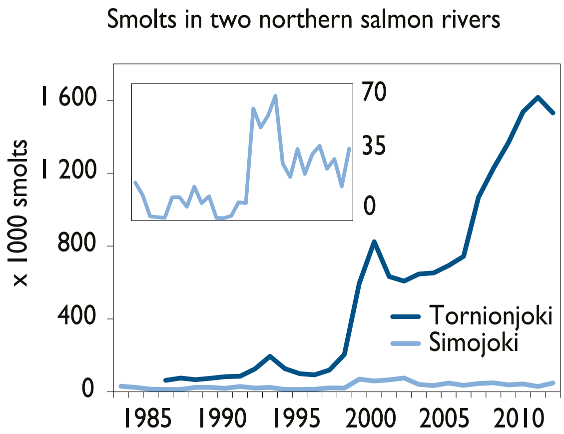



**Figure 3.3.4**. Number of smolts in two salmon rivers in northern Finland 1983–2012. (RKTL 2013 & 2014c).

3.3.3

## Cultural services

Cultural ecosystem services are nonmaterial benefits that humans derive from nature. Their role is becoming increasingly important due to many societal developments, including urbanization and the increase of material welfare. Urban people seek well-being and refreshment from nature, and increasing numbers have the means to do so. In some cases the cultural significance alone of a certain activity related to utilizing provisioning services can outweigh its original purpose. It can be argued that in the cases of hunting, non-professional fishing and berry and mushroom picking, for example, the recreational and health benefits related to the activity are often more important than the economic value of the game bag, fish catch or berry harvest, respectively.

The six most important cultural services were listed for Finland (Table 3.3.3). Recreation has grown in popularity in Finland during the past decades. According to the Finnish Forest Research Institute nearly all Finns (96%) report taking part in outdoor activities. On average, these are pursued two to three times a week resulting in a total of 170 outdoor recreation events per year. During a ten year period from 2000 to 2010, the proportion of older people (65 to 74 years) in particular engaging in outdoors activities increased. More than half of the population walk, swim and cycle in nature, pick wild berries as well as spend time on the beach and at holiday cottages (Figure 3.3.5 A). The fastest growing forms of outdoor activity include Nordic walking, running, recreational forest management and bird watching. Recreation in nature has been

**Table 3.3.3**. The six most important cultural services in Finland and their associated indicators.

| | 1. Structure | 2. Function | 3. Benefit | 4. Value |
|---|---|---|---|---|
| Recreation | Preferred natural areas, accessibility | Natural events, phenology | Recreation, experience | Health (incl. avoided medical costs, economic values (invested time etc.), social values |
| Nature-based tourism | Preferred natural areas, accessibility | Natural events, phenology | Employment, recreation, experience | Tourism revenue, employment |
| Nature-related heritage | Cultural heritage in natural landscapes | Natural events, phenology | Cultural continuity | Social values, intrinsic value |
| Landscape | Valuable/preferred landscapes | Natural events, phenology | Aesthetic experience | Social value (identity, aesthetics), economic value (marketing value), intrinsic value |
| Arts and popular culture | Emblematic species and landscapes | Natural events, phenology | Aesthetic experience, recreation | Social value (identity, aesthetics), economic value (marketing value), intrinsic value |
| Science and education | Areas of particular interest | Natural events, phenology | Source of knowledge | Social value (knowledge, sustainability), intrinsic value, economic value (innovation), health |

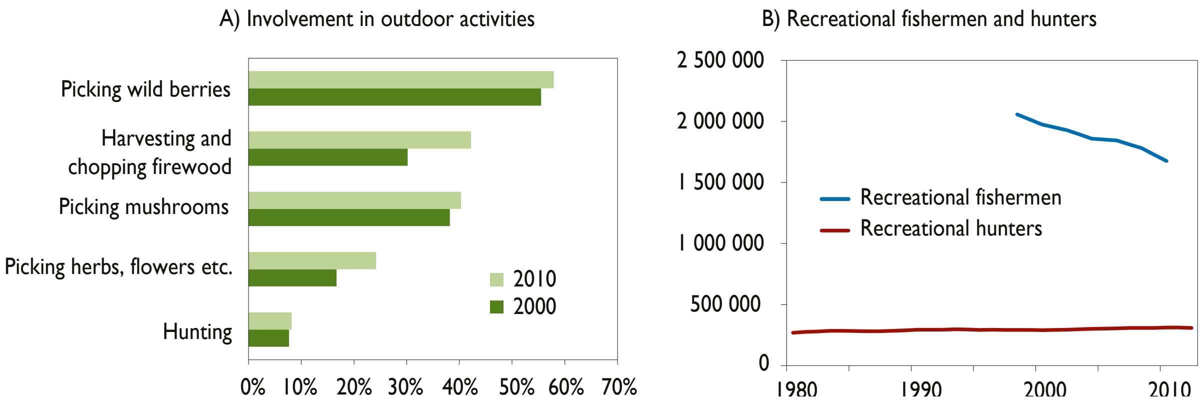



**Figure 3.3.5**. Involvement of the adult population (15–74 years old) in outdoor activities (A) and number of recreational fishermen and hunters in Finland (B). The numbers of fishermen and hunters are based on survey and paid game management fees, respectively (Metla 2000, 2010; RKTL 2014a-b).

studied for its effects in enhancing physical and mental health by alleviating stress, fatigue and allergies, decreasing heart rate and blood pressure, and improving physical condition and the ability to focus attention (Hanski et al. 2012, Karjalainen et al. 2010, Korpela et al. 2011).

Besides picking berries and collecting mushrooms – the two nature-related activities which involve nearly half the population – recreational fishing and hunting are also popular among Finns (Figure 3.3.5 B). On the basis of survey data, the number of people engaging in recreational fishing has been decreasing, but remains, nevertheless, quite high. More than 30% report fishing at least once a year. On the contrary, the number of hunters has been increasing quite steadily for the past decades and amounts to more than 300,000 Finns at the moment.

The most popular destinations for nature-based tourism in Finland are national parks and Lapland (Tyrväinen & Tuulentie 2007). Statistics collected by Metsähallitus Natural Heritage Services (NHS) show an increase in visits to national parks (Figure 3.3.6). Besides the positive health impacts and the invaluable spiritual experiences, national parks also bring considerable economic benefits to the surrounding area. Studies conducted by Metsähallitus NHS and the Finnish Forest Research Institute reveal that, on average, one euro spent on the recreation infrastructure in a national park returns to the local economy tenfold in the form of increased demand for accommodation and outdoor activity services, for example. The total local economic and employment impacts of visitors' spending for the 37 national parks of Finland were 110 million euros and 1,412 person years in 2012 (Huhtala et al. 2010).

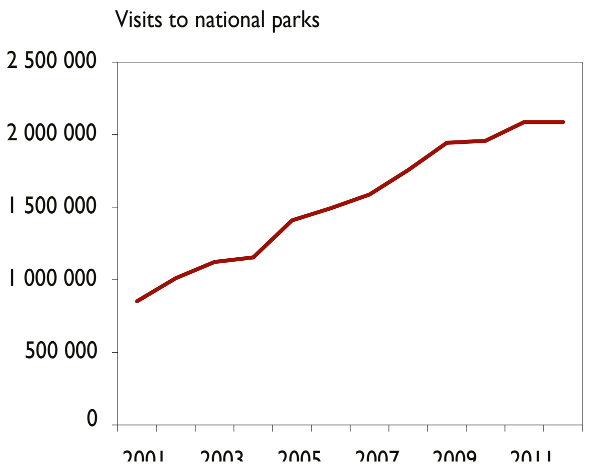



**Figure 3.3.6**. Total number of visits to the 37 national parks of Finland (Metsähallitus NHS 2013).

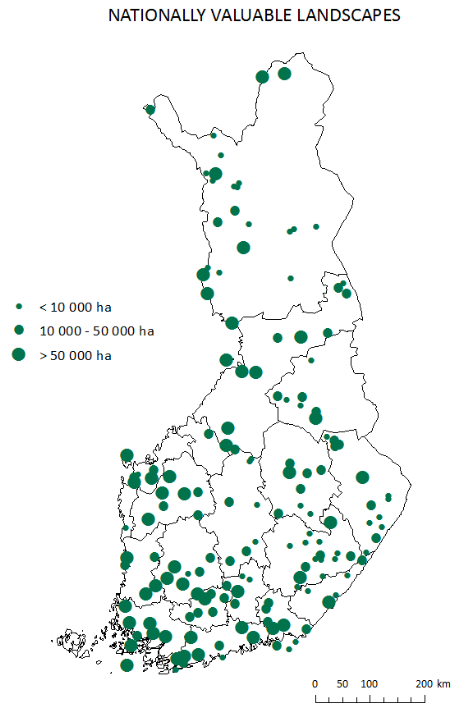



**Figure 3.3.7**. 156 nationally valuable landscapes in Finland (Ministry of the Environment 2014a).

Nature-related heritage is an elemental part of Finnish culture. Practicing natural religion continued alongside Christianity in some parts of Finland until the beginning of the 20th century and it is still present in vocabulary, expressions and extensive folklore. There are many sacred places left in Finnish nature such as seita (e.g. unusual rock formations, large rocks or trees), sacrificial stones, lakes (saivá) and springs or other sacred natural areas such as fells and groves. Many of these are conserved by the state.

Landscapes were an important element of developing national identity at the end of the 19th century and these ideas still determine Finland and Finns to some extent. In the 1990s 156 nationally valuable landscapes were identified in Finland (Ministry of the Environment 2014a) and this listing is currently under review (Figure 3.3.7; www.maaseutumaisemat.fi). Landscapes are considered central to maintaining cultural history, providing aesthetic experiences and promoting tourism, for example.

Cultural ecosystem services lie at the heart of Saami culture and identity. Because of the nomadic lifestyle and use of decomposable materials such as wood, little of the cultural heritage of the Saami people exists as durable built structures. Instead, the Saami culture relates strongly to the natural landscape. This is manifested, for example, in the rich terminology and knowledge that relates to nature. Despite the wide dispersal of the Saami people – 60% of the 10,000 Saami living in Finland now live outside their Homeland – cultural ties to the landscapes of northern Lapland remain strong even among those living elsewhere. Practices and traditions related to species, habitats and landscapes remain a key question for the continuation and development of Saami culture.

Arts had an important role in the development of national identity as well, and landscapes and nature were constantly portrayed in paintings, compositions and poetry at the turn of the 19th and 20th century. Nature also nowadays plays a significant role in contemporary visual arts, as demonstrated by many Finnish artists engaging in environmental and land art for example, as well as in popular culture, ranging from schlager songs to reproduced household imagery.

Finns have a long tradition of ecological research and monitoring both in the form of professional academic research as well as amateur interest in species and habitats. One outcome of this is the latest Red List of Finnish species 2010 which is among the most inclusive red lists in the world (Rassi et al. 2010). The fields of bioengineering, biochemistry and medicine are built upon this heritage and aim to develop new innovations to support the needs of a healthier and more sustainable society.

Most of the cultural ecosystem services are abstract. It is often very difficult or even impossible to draft quantifiable indicators for benefits such as knowledge, cultural continuity or aesthetic experience. On the other hand, concrete indicators of cultural ecosystem services can be developed based on data on visits to recreational areas, the number and location of cultural heritage sites in natural landscapes or employment and revenue derived from nature-based tourism.

3.3.4

### Indicators on the value of ecosystem services

While assigning values to ecosystem services, social, health and intrinsic values of cultural services are often over-run by economic values. Indeed, it would be tempting to measure the value of all ecosystem services in purely monetary terms as this would allow for more straightforward comparison and integration of ecosystem services into national accounting systems. The use of monetary units to compare ecosystem services' impact on the economy is a valid approach; however, it should not be the only way to compare different ES as putting a price tag on some services is not always appropriate from the viewpoint of sustainable use of the ES. It is notable that the simplicity of valuing varies greatly between ES categories; the valuation of provisioning services is more straightforward than for regulating and cultural services where the actual benefits are not concrete (see also Section 5).

A stakeholder group presenting different sectors and organizations such as forestry, agriculture, tourism, conservation, social issues, NGOs, administration and research were asked to assess the importance of the four value types of different ecosystem services. Value types were divided into the following categories: economic (ES improving the economy), social (ES improving society e.g. employment, outdoor activity), health (ES improving human health) and intrinsic values (ES' value of existence).

According to the results, economic value was the preferred measure for 22 out of the total of 28 ES. This preference was particularly pronounced in the case of five ES's: wood, crops, reared animals, water retention and nature-based tourism. Understandably, those ES for which markets and economic valuation systems already exists, were seen best measured in economic terms. Most of these are provisioning services. Genetic material was an interesting exception among them – most respondents stressed the intrinsic value of genetic material as much as its economic significance. In general, regulating services also received quite high scores for economic valuing. This may be slightly surprising as no markets exist for most of them.

Social value was the most preferred way of measuring three ES: nature-related heritage, landscape, and science and education. However, the social values related to two provisioning services were seen as almost equally important as their economic value. The social significance of hunting (game), particularly elk, is considerable as is the significance of reindeer husbandry for the continuation of the indigenous Saami culture. Two ES, air quality and noise reduction, received the highest scores of preference for health values.

The measuring of the ecosystem service values is often difficult but some new research results are available on the subject, such as national parks' employment effect on local municipalities (social value). There is also a growing field of environment-related health research in Finland. The Finnish Environment Institute and the Finnish Forest Research Institute started a seminar series in 2013 to review the connections between ecosystem services and human health (Jäppinen et al. 2014). The objectives of this review are to define the ecosystem services that influence both physical and mental aspects of health and to understand more profoundly the links between them. Furthermore, the review is expected to be of help e.g. in future land use planning, if the health benefits springing from ecosystem services can be taken into account. Some other projects cover research into the interrelationship between environmental biodiversity, human microbiota and allergies, or health impacts of the green environment in urban parks in Helsinki, for example.

3.4

## Evaluating future trends in ecosystem services

**Petteri Vihervaara, Ari-Pekka Auvinen, Laura Mononen, Anni Ahokumpu, Martin Forsius, Maria Holmberg and Ieva Vyliaudaite**

The future provision of ecosystem services depends on the temporal development of the factors driving the changes in crucial ecosystem processes. One of the key drivers of change in Finland are climate warming and societal response in the form of forest and agriculture management strategies directed towards mitigation and adaptation options (Forsius et al. 2013, Holmberg et al. 2015). Global climate change is characterized by the warming of the high-latitude areas, which has also been observed in Finland (Jylhä et al. 2014). Changes in seasonal patterns as well as in the frequency and intensity of episodes are also projected. These changes are affecting ecosystem structures and spatial patterns, driving changes in species distributions and numerous processes in both terrestrial and aquatic ecosystems.

Dynamic process models as well as statistical models can be utilized to study time series of observations of ecosystem variables, while process based models are in most cases preferred for studying the impact of future changes in the temporal

drivers, i.e. scenario analysis. Other quantitative methods to assess ES include element mass balance calculations to quantify retention processes. Crossman et al. (2013b) call for new integrated assessment models that include biophysical and socio-economic drivers of land use change and ES supply and demand impacts. A key scientific question is the development of dynamic models of ES coupled with biogeochemical cycles for scenario analysis in a changing environment (see also Lehtoranta et al. 2014). In policy, the management of multiple ES is a crucial challenge (Fu et al. 2013).

Forsius et al. (2013) evaluated the impacts of climate change on several key ecosystem services in Finland using data from intensively studied research sites. The results clearly indicated not only complex interactions between the different ecosystem processes but also trade-offs between the ecosystem services. Climate change was predicted to have both positive and negative effects on key ecosystem services in the Finnish context, the results being sector-specific and scenario-specific. Provisioning services such as food and timber production would largely benefit from increasing temperatures and prolongation of the growing season in the cool Finnish conditions (with, for example, estimated increases in growth rates of trees up to 80% and the introduction of a wider selection of crops), although increasing occurrence of factors such as fungal diseases and insect outbreaks were estimated as causing increasing risks. On the other hand, climate change was predicted as posing a major threat to several endangered and valuable species, water and air quality, and tourism services dependent on present climate conditions. Goal conflicts between maximizing service production and meeting environmental quality objectives were also identified.

The efforts to develop integrated modelling systems for ES evaluation for Finnish conditions are continuing. Holmberg et al. (2015) introduce a virtual laboratory for ecosystem services (ESLab) and report its pilot application in southern Finland, and Vihervaara et al. (2015) have demonstrated how biodiversity variables can be integrated in it. Recent development of the Essential Biodiversity Variables (EBVs) has been a promising approach to integrate remote sensing data of land-cover changes with large biological data sets, which is also a prerequisite of trade-off and scenario analysis (Pereira et al. 2013). The concept orders to allow integration of global monitoring systems for ecosystems and biodiversity (GEOBON), directly supporting IPBES information needs. ESLab is a research environment for ecosystem services, which allows sharing open data and methods used. ESLab is being developed in order to illustrate the comprehensive societal consequences of multiple decisions (e.g. concerning land use, fertilization or harvesting) in a changing environment (climate, deposition). ESLab provides ecosystem service indicators at different landscape scales: habitats, catchments and municipalities, and shares the results via a service that utilizes machine readable interfaces. ESLab and other similar kind of applications can be further developed to estimate delivery of multiple ES under varying future scenarios.

# 4 Mapping the value of ecosystem services

4.1

## International experiences and mapping approaches in ecosystem service valuation

**Leena Kopperoinen, Pekka Itkonen and Vladimir Kekez**

The mapping and assessment of ecosystems and their services are at the core of the EU Biodiversity Strategy to 2020. Action 5 of the Strategy claims that the Member States of the EU map and assess the state of ecosystems and their services, as well as assess the economic value of such services and further, promote the integration of these values into accounting and reporting systems at EU and national level (European Commission, 2011). The results of this should support the maintenance and restoration of ecosystems and ecosystem services. The *Working Group on Mapping and Assessment on Ecosystems and their Services* (MAES), set up within the Common Implementation Framework of the Biodiversity 2020 Strategy, has opened up the utility of mapping as follows (Maes et al. 2013):

> "Maps are useful for spatially explicit prioritisation and problem identification, especially in relation to synergies and trade-offs among different ecosystem services, and between ecosystem services and biodiversity. Further, maps can be used as a communication tool to initiate discussions with stakeholders, visualizing the locations where valuable ecosystem services are produced or used and explaining the relevance of ecosystem services to the public in their territory. Maps can […] contribute to the planning and management of biodiversity protection areas and implicitly of their ecosystem services at sub-national level. However, the mentioned purposes will not be attempted through the sole mapping exercise, but rather through the combination of digital mapping with the assessment of the supply of ecosystem services related to their demand (including the spatial interactions between them).
>
> […] mapping can assist decision makers in identifying priority areas, and relevant policy measures, including the improvement of the targeting of measures and in demonstrating or evaluating their benefits in relation to costs (e.g. impact assessment) via spatially explicit reporting obligations […]."

Although the mapping of ecosystem services in each Member State of the EU is still under way, research on such mapping methodologies in different contexts has flourished over fifteen years already; even longer if we count also those mapping studies where the concept of ecosystem services has not been mentioned as such.

'Valuation' has often been referred to as a synonym for 'economic valuation' or 'monetary valuation'. However, 'value' should be understood more broadly, as the 'importance' of something (see also Section 5). Consequently, valuation is about understanding the worth or importance of something and can be defined as the act of assessing, appraising or measuring value, as value attribution, or as framing valuation (how and what to value, who values) (Dendoncker et al. 2013). (Gómez-Baggethun et al. 2014)

Ecosystem service valuation can refer to a variety of values, which can be grouped into three main categories: ecological, sociocultural, and monetary values (Table 4.1.1). A wide range of mapping techniques can be used to analyze and visualize this multitude of different values.

Mapping *ecological values* often works on the basis of quantitative modelling, semi-quantitative mixed methods or purely qualitative expert judgments (Figure 4.1.1). *Sociocultural values* are commonly mapped using deliberative methods or qualitative methods, such as public participatory GIS (PPGIS), interviews or focus groups. Ecological and sociocultural valuation mapping methods can be grouped under the common title of non-monetary valuation.

*Monetary values* are derived when ecological or sociocultural values are monetized, for example, by calculating the market price of food produced from fields, avoided costs of repairing flood damages that would occur without natural flood protection, or willingness to pay for aesthetic views next to one's home. Spatially explicit mapping of monetary values of ecosystem services is based on assigning monetary values to an ecologically and/or socio-culturally mapped supply of ecosystem services. Some common methods for carrying out this are reviewed in Section 4.1.2.

It is also possible to present the results of methodologically more elaborate, but spatially less detailed valuation studies in thematic maps. However, this approach differs from the valuation mapping described here in the sense that the areas providing the ecosystem services (i.e. the service providing units) cannot be distinguished from the thematic maps. A more comprehensive insight on the economic valuation methods is provided in Section 5.

4.1.1

## Non-monetary valuation mapping of ecosystem services

Non-monetary valuation mapping is about spatially-explicit analysis and visualization of ecological and sociocultural values (see Table. 4.1.1). Using non-monetary methods helps to achieve a more complete picture of the human well-being brought about by the ecosystem services, including material, physical, social, and spiritual aspects. This gives visibility to both the tangible and intangible contribution provided by nature to society. Information on sociocultural, ethical and spiritual values should complement monetary values in the decision-making process to capture the 'true' or total value of an ecosystem service or a bundle of services (de Groot et al. 2010). In an ideal case, mapping of ecological and sociocultural values leads to joint learning outcomes where stakeholders achieve a better understanding of ecosystem functions and ecosystem services. This also results in the stakeholders comprehending their own and others' arguments better, which is important in reconciling conflicting views (Kopperoinen et al. 2014).

There is a multiplicity of methods for mapping ecological and sociocultural non-monetary values. The methods can be classified into three categories: quantitative, qualitative and deliberative methods (Figure 4.1.1). However, there are many mixed methods that combine characteristics of more than one category.

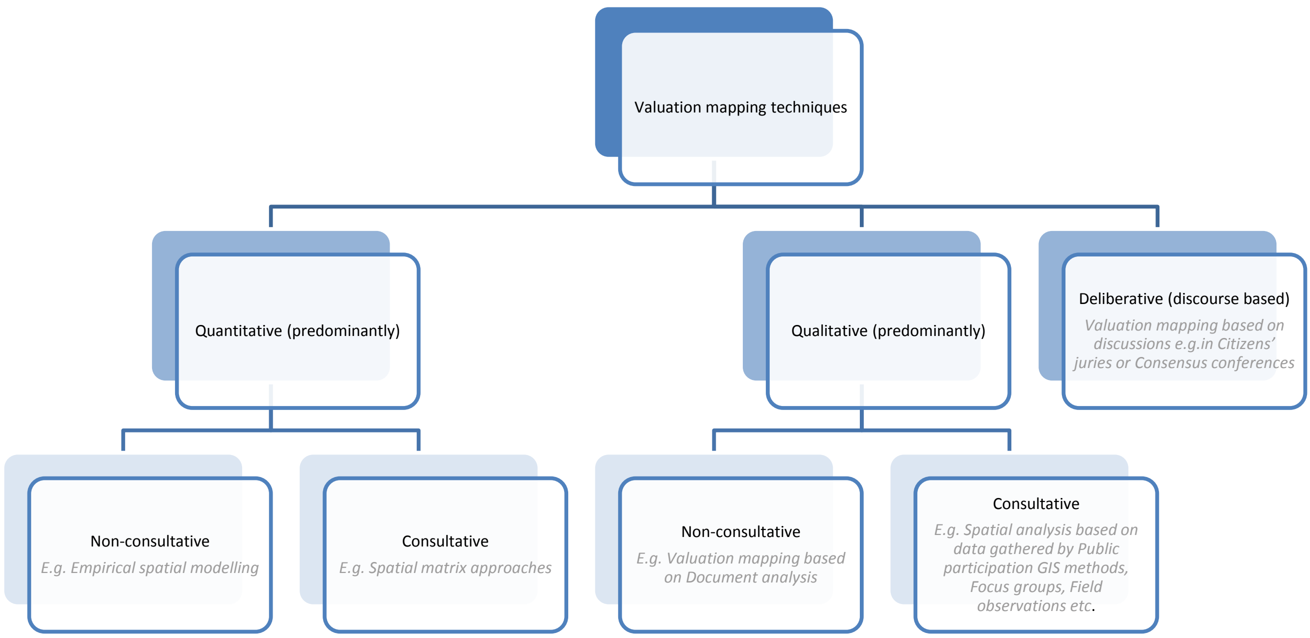



**Figure 4.1.1**. Valuation mapping techniques according to methodological similarities. It has to be noted that valuation mapping techniques may comprise both quantitative and qualitative features and the examples given are indicative. (Graph inspired by Kelemen et al. 2014: 2.).

**Table 4.1.1**. Characteristics of ecological, sociocultural, and monetary values of ecosystem services (ES) (cf. Section 2.4).

| Ecological (supply of ES) | Sociocultural (demand of ES) | Monetary |
|---|---|---|
| ***1 Importance of a given ecosystem***<br>• In sustaining human and non-human life<br>  o *Objectively important*<br>• In satisfying physiological human needs of society, e.g.<br>  o *Food*<br>  o *Freshwater*<br>  o *Air purification*<br>  o *Water regulation*<br>• In ensuring the maintenance of other ES that are essential for satisfying other fundamental human needs, e.g.<br>  o *Affection*<br>  o *Identity*<br>  o *Leisure*<br>  o *Creativity*<br><br>***2 Ecosystem functions, processes and components***<br>Integrity of regulating and habitat functions of an ecosystem<br>• Ecosystem parameters<br>  o *Complexity*<br>  o *Diversity*<br>  o *Rarity*<br>  o *Stability*<br>Integrity of service-providing units<br>• Component populations<br>• Communities<br>• Functional groups<br>• Abiotic components<br>• Habitat type<br><br>***3 Insurance value***<br><br>• Ecosystem resilience<br>  o *Self-repairing capacity of ecosystems*<br>• Maintenance of critical amounts of ecological infrastructure and key service-providing units<br>• Precautionary conservation of stocks<br>• Setting of safe minimum standards<br><br>***4 Biophysical measures as values***<br>• Need to be put in relation to some attribution of societal importance<br>• Conversion of biophysical indicators into constructed scales | ***1 Non-material, experiential values***<br>• People obtain through<br>  o *Spiritual enrichment*<br>  o *Cognitive development*<br>  o *Reflection*<br>  o *Recreation*<br>  o *Aesthetic experience*<br>• Created in the mind of ES beneficiaries<br>• The value depends on who is the observer<br><br>***2 Material, moral, spiritual, aesthetic, therapeutic values***<br><br>***3 Emotional, affective and symbolic values***<br><br>***4 Artistic, educational, scientific values***<br><br>***5 Place value***<br><br>***6 Heritage value***<br><br>***7 Sense of community***<br><br>***8 Social cohesion*** | ***1 Use values***<br>Conscious use and enjoyment of ES<br>• Direct use<br>  o *Extractive / Consumptive – provisioning ES*<br>  o *Non-extractive / Non-consumptive – cultural ES*<br>• Indirect use<br>  o *Regulating ES*<br>• Option values<br>  o *Potential future direct and indirect uses of ES*<br><br>***2 Non-use values***<br>Satisfaction from the knowledge that BD and ES are maintained and that other people have or will have access to them<br>• Existence values<br>• Altruist values (intra-generational equity)<br>• Bequest values (inter-generational equity) |

*Source:* Compiled based on Gómez-Baggethun et al. 2014.

*Ecological values* often refer to ecosystem functions, processes and components, which can be mapped by using a variety of *biophysical mapping* methods, for example. Ideally, these methods are based on quantitative assessments. When empirical quantitative data is scarce or unavailable, proxy or surrogate data, and/or expert and stakeholder judgments may also be relied on. Surrogates should be analyzed carefully and treated with caution in order to avoid faulty conclusions. For example, rich biodiversity or high level of supply of one ecosystem service does not necessarily indicate high supply of all ecosystem services (Egoh et al. 2008). However, using for example an area of different forest types as spatial surrogates for mapping the variation in wild berry production can produce plausible results (Maes et al. 2014).

If biophysical measures are used as a basis for valuation mapping, they need to be related to some type of societal importance as well as converted into constructed scales of importance for a particular purpose (Gómez-Baggethun et al. 2014). Examples of such valuation mapping methods comprise for example supply, demand, and budgets of ecosystem service provision based on score matrices of land use and land cover classes (e.g. Burkhard et al. 2009, Burkhard et al. 2012) or of biotope classes (Vihervaara et al. 2012). Instead of just one spatial dataset like land cover, a wide variety of spatial datasets can be deployed along with scientific expert and local stakeholder scorings for assessing spatial variation in the provision potential of ecosystem services over the landscape. The GreenFrame method using this approach is presented as an example of non-monetary valuation mapping methods in Section 4.2 (Kopperoinen et al. 2014).

Ecological valuation mapping can also be based on (predominantly) quantitative biophysical models, which valuate the ecosystems, for example, based on their capacity to regulate local climate or sequestrate carbon (e.g. Bastian et al. 2012), with several examples in Kareiva et al. (2011)).

In *sociocultural valuation mapping*, the focus is on the importance, preferences, needs or demands on nature, expressed by people or groups of people, and the plural values (i.e. valuing something for several reasons), through a variety of qualitative and quantitative measures (Chan et al. 2012). The diversity of sociocultural valuation methodologies is presented in Figure 4.1.1. When a spatial extent is added to these valuation methodologies, they are also often referred to as demand mapping. Sociocultural values are difficult – or impossible – to map based on biophysical parameters only. Acknowledging this problem, participatory mapping methodologies and, for example, photo-based methods have been developed to capture the values (Milcu et al. 2013).

Participatory mapping methods (including PPGIS: public participatory GIS) comprise Internet-based surveys, interviews, surveys, focus groups, citizens' juries, community or group process mapping, and modelling from participatory mapping of landscape values (Brown, 2013, Kyttä & Kahila 2011, Kyttä et al. 2013, Kelemen et al. 2014). These methods provide systematic identification and measurement of values based on local ecological knowledge and people's experiential values, which are seen critical in developing place-based solutions to societal problems such as biodiversity loss, and in supporting robust and adaptive socioecological systems and expanding public participation and community consultation (Raymond et al. 2009, Brown 2013).

Some examples of sociocultural valuation mapping tools that are publicly available are listed below.

- Tools for collecting citizen knowledge for bringing together resident insight and planning expertise, for example Maptionnaire (http://maptionnaire.com/en/) and Harava (https://www.eharava.fi/en/).
- SolVES model (Social Values for Ecosystem Services) (http://solves.cr.usgs.gov/) provides functionality to assess, map, and quantify social values such as aesthetics, biodiversity and recreation by deriving social value maps of a 10-point Value Index from a combination of spatial and non-spatial responses to stakeholder attitude and preference surveys. It also calculates metrics characterizing the underlying environment, such as average distance to water and dominant land cover. (Sherrouse & Semmens 2012)

*Integrated valuation* represents the idea of appreciating plural values, which can however be difficult to compare with each other or cannot be measured using commensurable metrics. In integrated valuation these various values – ecological, sociocultural and monetary – are integrated in a consistent way to support decision-making (Gómez-Baggethun et al. 2014). Trade-offs and conflicts as well as power relations between values are presented. This requires inter-disciplinarity, trans-disciplinarity and methodological pluralism (Norgaard 1989).

4.1.2

## Monetary valuation mapping of ecosystem services

Monetary valuation of ecosystem services aims to shed light on the economic value of functioning ecosystem services – or the other way around – the costs of the degradation of ecosystems and their services. Difficulties in incorporating the economic value of ecosystem services into decision-making may result in decisions that are suboptimal in the long term – not only ecologically, but also economically. Mapping the monetary values of ecosystem services means an examination of how values vary across geographical areas. In order to do that, monetary values need to be assigned to mapped ecosystem service provisions based on some kind of biophysical assessment. Schägner et al. (2013) carried out a review of monetary valuation mapping studies and classified the studies based on the type of the ecosystem service supply mapping method and the type of the valuation method.

The methodologies used for mapping the value of ecosystem service supply were divided into five main categories:

(1) One-dimensional proxies for ecosystem services, such as land use and land cover.
(2) Non-validated models based on likely causal combinations of explanatory variables, of which there are no real world observations but the basis is researchers' assumptions.
(3) Validated models calibrated based on primary or secondary data on ecosystem service supply.
(4) Maps based on representative data from at least one real world observation to quantify ecosystem service supply.
(5) Implicit modelling of ecosystem service supply using a monetary value transfer function.

Methodologies for distributing values to mapped ecosystem service supply across the study area were grouped as follows:

(1) Unit values: a constant value per unit for ecosystem services.
(2) Adjusted unit values: values are adjusted according to simple variables, such as population density, income levels or consumer price index.
(3) Value functions: values base on functions using multiple spatial variables.
(4) Meta-analytic value function transfers: values base on functions estimated through statistical regression analysis of the results of primary valuation studies.

A synthesis of the combinations of the methodology used for assessing ecosystem service supply and the methodology for valuation in the mapping studies reviewed is presented in Table 4.1.2. We grouped the mapped and valued ecosystem services according to sections of the CICES classification (www.cices.eu) and separated biodiversity related studies. As can be seen from the table, using unit values is the most common value mapping methodology and its most common counterpart in assessing ecosystem service supply is using proxies. The choice of ecosystem service valuation mapping methodology is dependent on the policy context or scientific purpose (as it defines the accuracy and precision required), scale, availability and quality of data, and amount of resources and time. Although the simplest combination, proxies together with unit values, might produce error prone results (Eigenbrod et al. 2010), they can be completely appropriate for, for example, quickly proceeding land use planning processes, when applied correctly. The more complicated the methodologies for mapping ecosystem service supply and valuing it, the more attention should be paid to the interpretation and communication of the results to the users.

**Table 4.1.2.** The number of studies using different ecosystem service valuation mapping methodologies and the ecosystem services mapped classified according to CICES v.4.3 (modified from Schägner et al. 2013).

| Methodology | | Valuation methodologies: Unit values | | Adjusted unit values | | Value functions | | Meta-analytic value functions | |
|---|---|---|---|---|---|---|---|---|---|
| *ES mapping methodologies* | *BD, ES sections* | Mapped ES | ∑ | Mapped ES | ∑ | Mapped ES | ∑ | Mapped ES | ∑ |
| Proxies | Biodiversity | B:22 | 22 | | | | | B: 3 | 3 |
| | Provisioning services | AP: 14, F: 1, FO: 6, Hun: 1, RM: 18, T: 4, WS: 19 | 26 | Non-T: 1, T: 1 | 1 | | | F: 1, HUN: 1; WS: 2 | 2 |
| | Regulation and maintenance services | BC: 17, DP: 19, E: 19, GHG: 23, GR: 16, MC: 1, NC: 18, P: 17, SF: 18, WR: 19, WT: 18 | 26 | | | | | RM: 1; DP: 2; WT: 2 | 2 |
| | Cultural ecosystem services | CUL: 20, R: 21 | 23 | CUL: 1, R: 1 | 2 | CUL: 1, R: 2 | 2 | CUL: 1, R: 1, | 2 |
| Non-validated models | Biodiversity | B:2 | 2 | | | | | | |
| | Provisioning services | AP: 3, RM: 5, T:1, WS: 1 | 8 | | | AP: 1, T: 1 | 2 | | |
| | Regulation and maintenance services | DP: 1, E: 3, GHG: 7, GR: 2, NC: 4, SF: 2, WR: 5, WT: 2 | 9 | | | | | | |
| | Cultural ecosystem services | CUL: 1, R: 5 | 5 | CUL: 1 | 1 | R: 1 | 1 | | |
| Validated models | Biodiversity | B: 1 | 1 | | | | | | |
| | Provisioning services | AP: 2, F: 2, Hun: 1 | 5 | | | AP: 3, T: 2 | 3 | | |
| | Regulation and maintenance services | GHG: 7, GR: 1, E: 2, MC: 1, NC: 1, WR: 4, WT: 3 | 13 | WT: 1 | 1 | DP:1 | 1 | | |
| | Cultural ecosystem services | R: 3 | 3 | | | R: 4 | 4 | R: 1 | 1 |
| Representative data | Biodiversity | B:1 | 1 | | | | | | |
| | Provisioning services | AP: 3, F: 2, Non-T: 1, RM:1, WS: 1 | 7 | | | AP: 1 | 1 | | |
| | Regulation and maintenance services | GHG: 1 | 1 | | | | | | |
| | Cultural ecosystem services | R: 2 | 2 | R: 1 | 1 | | | | |
| Implicit modeling | Biodiversity | Not applicable | | Not applicable | | | | | |
| | Provisioning services | | | | | AP: 1 | 1 | | |
| | Regulation and maintenance services | | | | | DP: 1 | 1 | | |
| | Cultural ecosystem services | | | | | CUL: 3, R: 2 | 3 | CUL: 1, R: 2 | 2 |

ES abbreviations: **AP**: agricultural production, **B**: biodiversity, **BC**: biological control, **CUL**: cultural (including amenity), **DP**: disturbance prevention (including storm protection, flood protection and avalanche protection), **E**: erosion control, **F**: fisheries, **FO**: food production, **GHG**: greenhouse gasses regulation, **GR**: gas regulation (atmospheric chemical composition), **Hun**: hunting, **MC**: microclimate regulation, **NC**: nutrient cycling, **Non-T**: non-timber forest products, **P**: pollination, **R**: recreation, **RM**: raw material, **SF**: soil formation, **T**: timber, **WR**: water regulation, **WS**: water supply, **WT**: waste treatment (including soil, air and water quality)

∑ represents the number of studies in which a specific combination of mapping and valuation methodologies was used to valuate various ES (grouped here in sections as listed in CICES v4.3, www.cices.eu, 2013)

It should be noted that the aspect of demand for ecosystem services integrated with supply is missing from the valuation mapping methodologies presented above. The demand strongly affects the value of ecosystem services because it complicates the generalization of value over space. For example, the accessibility of areas changes the value of similar types of biophysical areas. A place that has great natural assets but is far away from users and reachable only with difficulty does not have the same value as a similar place in a favorable location. Cultural and personal differences in appreciation of various ecosystems and ecosystem services make valuation mapping even more intractable. This is reflected in the low number of studies dedicated to mapping the value of cultural ecosystem services (Table 4.1.2).

To allow for easier use of monetary valuation mapping, several tools or toolkits have been developed. A few of them are presented below as an example.

- The **InVest toolset** (http://www.naturalcapitalproject.org/InVEST.html) including sixteen distinct models suited to terrestrial, freshwater, and marine ecosystems is probably the most well-known toolkit. InVEST is designed to help decision makers to assess quantified trade-offs associated with alternative management choices and to identify areas where investment in natural capital can enhance human development and conservation.
- **ARIES modelling platform** (Artificial Intelligence for Ecosystem Services) (http://www.ariesonline.org/about/approach.html) maps the potential provision of ecosystem services (sources), their users (use), and biophysical features that can deplete service flows (sinks) using ecological process models or Bayesian models. Agent-based flow algorithms are used to map actual service flow from ecosystems to people. ARIES offers several approaches for economic valuation of ecosystem services. After computing values for a set of ecosystem services of interest, multiple services can be paired with priority weightings stated by the user, in a multiple criteria analysis that will yield maps of concordance of the computed flows of ecosystem services with the levels of provision desired by the user. Such maps can be considered an 'abstract' quantification of relative value. Alternatively, ES flow information can be used to build a transfer function to translate previously assessed economic values for specific benefits into estimated valuation portfolios. The transfer function operates on the aggregated values retrieved from the Ecosystem Services Database with the help of a neural network classification algorithm that identifies the most likely candidates based on ecological and economic similarities between source and destination areas.
- **TESSA toolkit** (Toolkit for Ecosystem Service Site-based Assessment) http://www.birdlife.org/worldwide/science/assessing-ecosystem-services-tessa) provides guidance on low-cost methods for evaluating the benefits people receive from nature at particular sites in order to generate information that can be used to influence decision-making (Peh et al. 2013). The toolkit helps users to select appropriate methods according to the site characteristics through decision trees. Over 50 methods are available for assessing ecosystem services in TESSA. With these it is possible to valuate an 'alternative state', to compare with the current site state and estimate the impact of potential or actual ecosystem service changes. Examples are given on how to derive a value (quantitative, qualitative) for each service, including the difference in value between two site states. The toolkit offers guidance on assessing how benefits are spread across local, national and global communities and advice on disaggregating values at the local level into measures that reveal potential inequities in the costs borne and benefits received.
- **i-Tree** (Tools for Assessing and Managing Community Forest) (https://www.itreetools.org/about.php) is a software suite from the USDA Forest Service that provides urban forestry analysis and benefits assessment tools. i-Tree tools help communities of all sizes to strengthen their urban forest management and advocacy efforts by quantifying the structure of community trees and the environmental services that trees provide. i-Tree offers six different analysis tools to quantify urban forest structure, environmental effects, values to communities, quantify the monetary value, simulate the effects of changes within a watershed on stream flow and water quality, model the effects of planting scenarios on future benefits, amongst other things.

Monetary valuation mapping is seen to be beneficial in creation of policy applications, like green accounting, land use policy evaluation, resource allocation, and payments for ecosystem services (Schägner et al. 2013).

4.2

# Case: Mapping green infrastructure and ecosystem services in the Helsinki-Uusimaa Region

**Pekka Itkonen, Leena Kopperoinen, Arto Viinikka, Eduardo Olazábal and Vuokko Heikinheimo**

The Uusimaa Regional Council is currently preparing Regional Plan 4 for the Helsinki-Uusimaa Region, which complements the previous regional land use plans. The goal of the plan is to ensure the competitiveness of the region while not exceeding the limits of sustainable development. Regional Plan 4 concentrates on five particular themes, namely green infrastructure, business and innovation, logistics, wind energy and cultural heritage. This regional case study on the green infrastructure and ecosystem services in the Helsinki-Uusimaa Region was implemented in cooperation with the Uusimaa Regional Council, and the results are utilized in the planning of the green infrastructure theme of Regional Plan 4.

The region consists of 26 municipalities with a total of 1.6 million inhabitants. The 1.1 million inhabitants of the capital region alone (Helsinki, Espoo, Kauniainen and Vantaa) make up 20% of Finland's total population (Statistics Finland, 2014). In addition to this, the Helsinki-Uusimaa Region is among the fastest growing regions in Europe. Thus, there is constant pressure to densify the urban structure and convert new areas for residential purposes. In order to ensure the goals of sustainable development, safeguarding biodiversity and sustaining vital ecosystem services, green infrastructure must be integrated in land use planning and decision-making at all levels.

4.2.1

## Mapping the potential supply of ecosystem services

In order to assess the regional Green Infrastructure (GI), the potential supply of ecosystem services (ES) was analyzed using the GreenFrame methodology developed by SYKE (Kopperoinen et al. 2014). GreenFrame is an integrated approach to study the variation in the ES supply within a study region, making use of a wide variety of spatial data and expert knowledge. Instead of quantifying the actual stocks and flows of ecosystem services, the aim is to valuate areas based on their potential to support the supply of various ES. Spatial data is usually scarce on regulating and maintenance services and intangible services, such as cultural ecosystem services. GreenFrame provides an approach to infer this information from related thematic data based on assessments from experts and local and regional actors. Qualitative assessments can be complemented with existing quantitative spatial data from the study area. Quantitative data is more often available for tangible provisioning services, such as timber volume.

In the first phase, the potential supply of 23 ecosystem services was analyzed (Table 4.2.1). Each ES was first assessed individually using the data themes listed in Appendix 1. The data themes were pre-processed into a compatible format and overlaid in GIS. The weighting of each theme in the assessment of each ES was determined by expert evaluation (for the method, see Kopperoinen et al. 2014). The expert scores used are listed in Appendix 2 and Appendix 3. The supply potential for provisioning services P3 and P4 was complemented using quantitative data on groundwater formation. Provisioning services P5 and P6 were analyzed using quantitative data on timber volumes and estimated biomass potential (Table 4.2.2).

**Table 4.2.1**. The potential supply of 23 ecosystem service groups in total was analyzed. The classification is adapted from the Common International Classification of Ecosystem Services (CICES v. 4.3, http://cices.eu).

| ES SECTION | ES GROUP CODE | ES GROUP |
|---|---|---|
| P: Provisioning | P1 | Agricultural and aquaculture products |
| | P2 | Wild plants, animals and their outputs |
| | P3 | Surface and ground water for drinking |
| | P4 | Surface and ground water for non-drinking purposes |
| | P5 | Materials from plants, algae and animals and genetic materials from all biota |
| | P6 | Biomass-based energy sources |
| R: Regulating and maintenance | R1 | Mediation of waste and toxics |
| | R2 | Mediation of smell/noise/visual impacts |
| | R3 | Mass stabilization and control of erosion rates, buffering and attenuation of mass flows |
| | R4 | Hydrological cycle and flood protection |
| | R5 | Mediation of air flows |
| | R6 | Pollination and seed dispersal |
| | R7 | Maintenance of nursery populations and habitats, gene pool protection |
| | R8 | Pest and disease control |
| | R9 | Soil formation and composition |
| | R10 | Maintenance of chemical condition of waters |
| | R11 | Global climate regulation |
| | R12 | Micro and regional climate regulation |
| C: Cultural | C1 | Recreational use of nature |
| | C2 | Nature as a site and subject matter for research and of education |
| | C3 | Aesthetics and cultural heritage |
| | C4 | Spiritual, sacred, symbolic or emblematic meanings of nature |
| | C5 | Existence and bequest values of nature |

**Table 4.2.2**. The quantitative datasets used in assessing the supply potential of provisioning services.

| ES GROUP | THEME | DATA | SOURCE |
|---|---|---|---|
| P3, P4 | Groundwater formation | Groundwater areas | © SYKE, Centre for Economic Development, Transport and the Environment |
| P5 | Timber volume | BalBic-data | © Forestry Development Centre TAPIO 2013<br>© Finnish Forest Research Institute METLA 2013 |
| P6 | Forest bioenergy potential | BalBic-data | © Forestry Development Centre TAPIO 2013<br>© Finnish Forest Research Institute METLA 2013 |

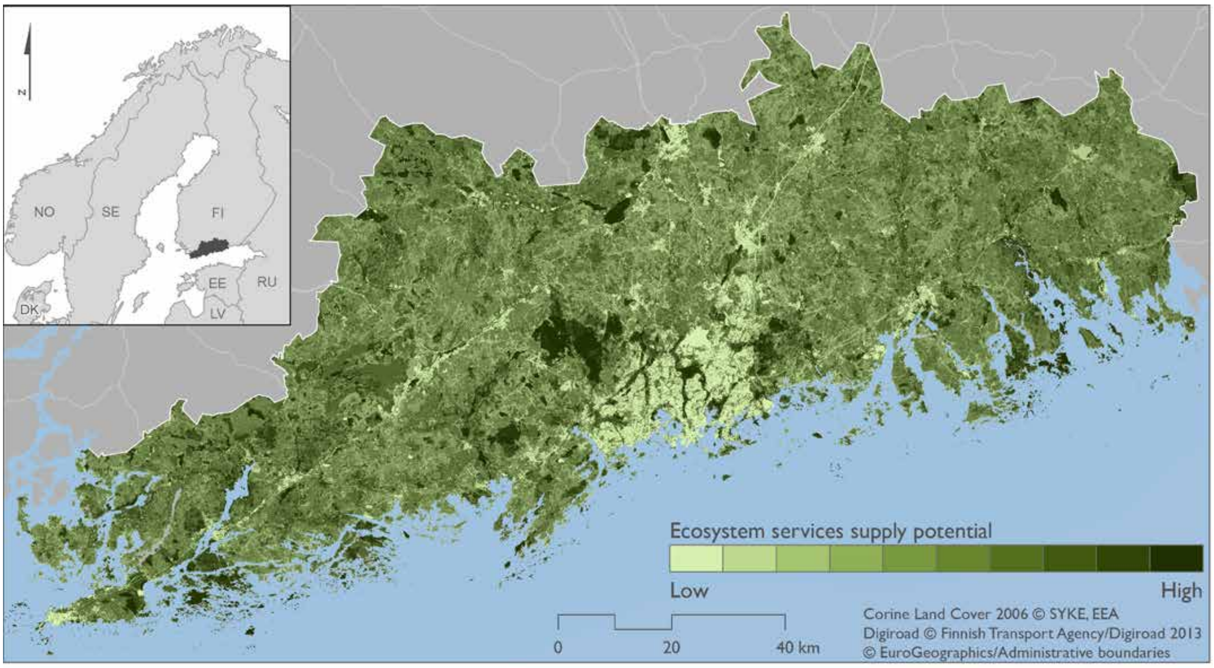



**Figure 4.2.1**. The ecosystem services supply potential in the Helsinki-Uusimaa region.

As outputs of these analyses, 23 raster layers of the supply potential of different ES groups were created. These 23 layers were normalized to a common scale and combined to form composite layers of each of the three ES sections (provisioning services, regulating and maintenance services, cultural ecosystem services). Finally, these composite layers were normalized again and combined into a final synthesis layer, where all three ES sections were included and ranked as equally important. Moreover, each individual ES group within an ES section composite was included and ranked as equally important (Figure 4.2.1).

4.2.2

## An approach to identify key areas of regional green infrastructure

The core of the regional green infrastructure consists of a network of protected areas and other areas with high nature and biodiversity values (European Environment Agency 2014). Not only do these areas sustain biodiversity, but they also provide many other important ecosystem services of local, regional and national importance (e.g. water purification). However, there are also large areas providing ecosystem services outside the protected areas. These multifunctional areas need to be recognized and taken into account in decision-making and land use planning. Unfortunately, there is no way to unambiguously determine which areas belong to green infrastructure and which areas do not – the examination is always context and scale-dependent. In this case, in order to create an overall picture of the most important areas of the regional green infrastructure, the following approach was used.

As the aim was to provide meaningful information to the process of regional land use planning, the process involved interaction with the regional planners and stakeholders. The regional council has brought together wide groups of stakeholders and experts for each of the forthcoming regional plan's themes. The expert group on regional green infrastructure was consulted and gave feedback at several stages.

1. First, the core network of valuable areas of nature was identified. It included:

- Nationally designated protected areas on state owned and private land
- National parks
- Nature reserves
- Nature conservation program areas *(National Old Growth Forest Programmes, the National Esker Conservation Programme, the National Herb-Rich Forest Conservation Programme, the National Conservation Programme of Bird Wetlands, development programme for national parks and strict nature reserves, the National Shore Conservation Programme, the National Mire Conservation Programme)*
- Existing conservation areas in the current regional plan

- The Natura 2000 network
- Important Bird Areas (IBA)
- Designated national urban parks
- Regionally important bird areas in the former Uusimaa region
- Regionally valuable nature environments in the former Eastern Uusimaa region

2. The GreenFrame analyses of ES supply potential were used to identify the areas with highest ES supply potential outside the network of protected areas and other valuable areas of nature. Instead of examining the supply potential of all ES listed in Table 4.2.2, these analyses concentrated on the most relevant and important ES from the perspective of regional land use planning in the Helsinki-Uusimaa region. Having discussed their information needs, the regional planners selected the following 10 ES:

| | |
|---|---|
| P1 | Agricultural and aquaculture products |
| P3 | Surface and ground water for drinking |
| P5 | Materials from plants, algae and animals and genetic materials from all biota |
| P6 | Biomass-based energy sources |
| R4 | Hydrological cycle and flood protection |
| R7 | Maintenance of nursery populations and habitats, gene pool protection |
| R11 | Global climate regulation |
| C1 | Recreational use of nature |
| C3 | Aesthetics and cultural heritage |
| C5 | Existence and bequest values of nature |

The best 20% of the landscape, having the highest supply potential for the selected ES, was included.

3. Those core areas of nature and connecting corridors that were not included in the first two steps were included. These are areas that support the connectivity of the network and provide habitats less susceptible to disturbance and edge effects. The identification of core areas of nature and connecting corridors was carried out based on land cover classifications. The following land cover classes were extracted from the Finnish national CORINE Land Cover raster (2006): forests, woodlands, pastures, peat bogs, bare rock, inland marshes, terrestrial salt marshes and rivers. Touching pixels of these classes were merged to form uniform areas. Core areas of nature were those parts of the extraction that remained after the removal of a 100 meter-wide edge zone from each separate area. Corridors that physically interconnect at least two core areas were also included. The core areas and corridors were identified using Morphological Spatial Pattern Analysis (Soille & Vogt 2009). Connectivity beyond the administrative borders of the region was taken into account to prevent arbitrary edge effects from affecting the results of the analysis.

4. After combining these three components, separate patches of less than 10 hectares were removed, except those belonging to the core network of valuable areas of nature. This was carried out for the sake of visual clarity and to focus on the most important targets with regional significance (Figure 4.2.2). The small areas should not be neglected in municipal land use planning, however, but their significance in the municipal green infrastructure should be assessed when preparing local master plans and local detailed plans.

The planners and the stakeholders were asked to comment on the outcome and to assess whether the approach was able to identify relevant targets. They were also asked to use their expertise in pinpointing areas of the regional green infrastructure that require improvement and/or areas that have special importance. The approach was criticized for not being able to identify the diverse mosaic of patches of forests and agricultural areas. These areas provide diverse habitats for many species and allow species movement between larger continuous habitats. Therefore, a complementary analysis of the ecological permeability of the landscape was carried out using the Finnish national CORINE Land Cover raster (2006). The impedance i.e. difficulty of movement through different land cover classes was scored based on expert discussions (Appendix 4). The permeability of different patches of land in a certain area is not only affected by the characteristics of the patch itself, but also by the characteristics of the surrounding areas. Hence, the CORILIS spatial smoothing technique (Peifer 2009) was applied to also take into account land cover of the surrounding areas of each cell in the land cover raster. The impact of the surrounding pixels decreases as a function of distance within a selected radius. As the choice of radius affects the result, two radii were used: 250 m and 1 000 m (Figures 4.2.3 and 4.2.4).

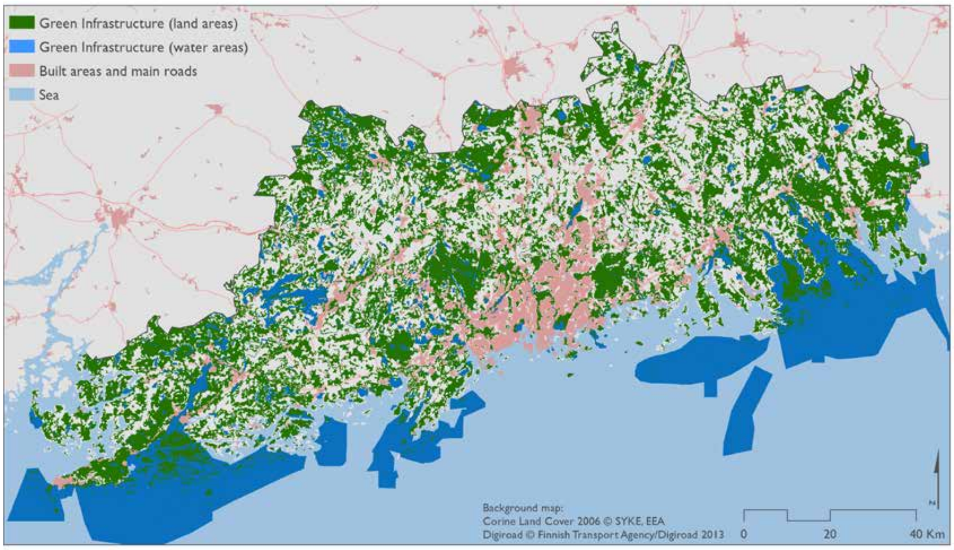



**Figure 4.2.2**. The key areas of the regional green infrastructure in the Helsinki-Uusimaa Region.

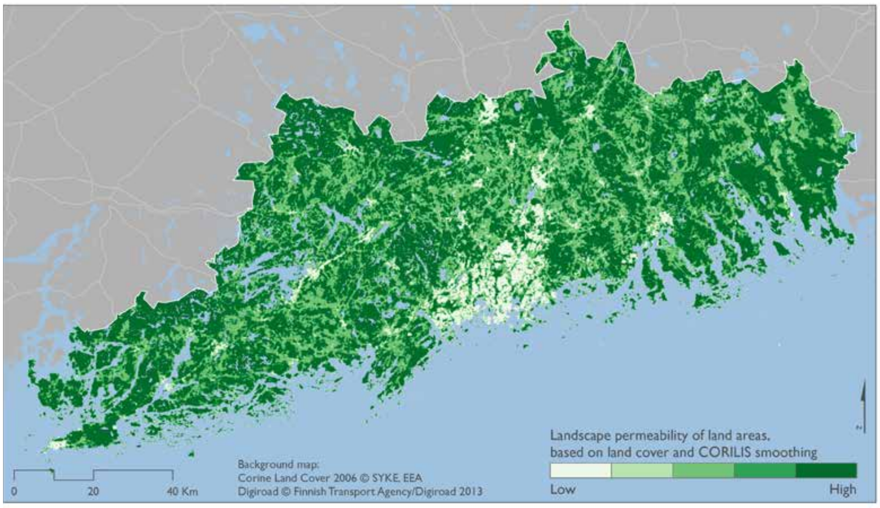



**Figure 4.2.3**. The landscape permeability of land areas in the Helsinki-Uusimaa Region. The analysis is based on impedance values given for the land cover within a radius of 250 meters.

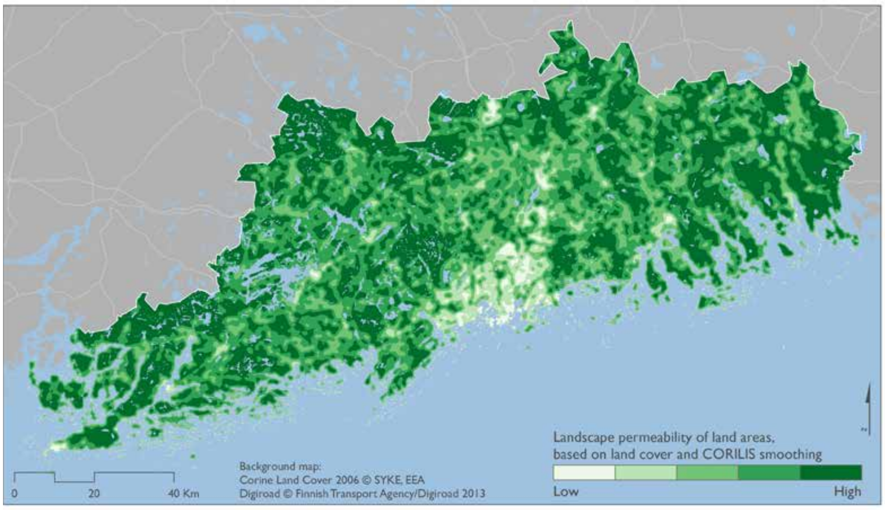



**Figure 4.2.4**. The landscape permeability of land areas in the Helsinki-Uusimaa Region. The analysis is based on impedance values given for the land cover within a radius of 1000 meters.

4.2.3

## Mapping the demand for ecosystem services using Public Participatory GIS

After assessing the potential supply of ES, the demand was also assessed. Spatial analyses of the demand within the region were not feasible for all ecosystem services, because the service flows from service providing units (e.g. a forest patch) to the actual beneficiaries may be very complicated and largely determined by factors other than the location of the population. Therefore, the spatial analyses focused solely on the demand for cultural ecosystem services. Cultural ecosystem services are immaterial and experiential, and their benefits are not in fact restricted to a single location – the beneficiaries can take the health benefits of recreation, or the pleasant experience of admiring scenic beauty, for example, with them. However, these immaterial services need to be consumed at a distinct location – the recreational activities and admiring impressive scenery require a physical setting.

An online Public Participatory GIS (PPGIS) survey was carried out to examine the region's inhabitants' perceptions of cultural ecosystem services. The survey was titled *"The meanings of nature for the people of Uusimaa"*. It was open for eight weeks, and targeted at all residents of Uusimaa, regardless of their background. The respondents were asked to pinpoint targets on a map for the following themes:

- Good places or routes for recreation
- Good places to learn from nature
- Very scenic places
- Good vantage points
- Places where history and cultural heritage combine in a way that adds to the value of the place
- Regionally symbolic places
- Places with a unique identity that people attach meanings to and where they can feel attached to their environment (sense of place)
- Relaxing/revivifying places
- Places where people can experience holiness
- Places with intrinsic value, to be preserved for future generations.

These themes cover the whole variety of cultural ecosystem services. The respondents were allowed to mark places that are not necessarily pristine nature, but nature did have to be present in these places and affect their experience. In fact, in addition to the actual demand, these markings also represent the actual supply of cultural ecosystem services – the respondents marked locations where they already have consumed these ecosystem services. Altogether 5,043 point markers were marked by a total of 555 respondents (Figure 4.2.5).

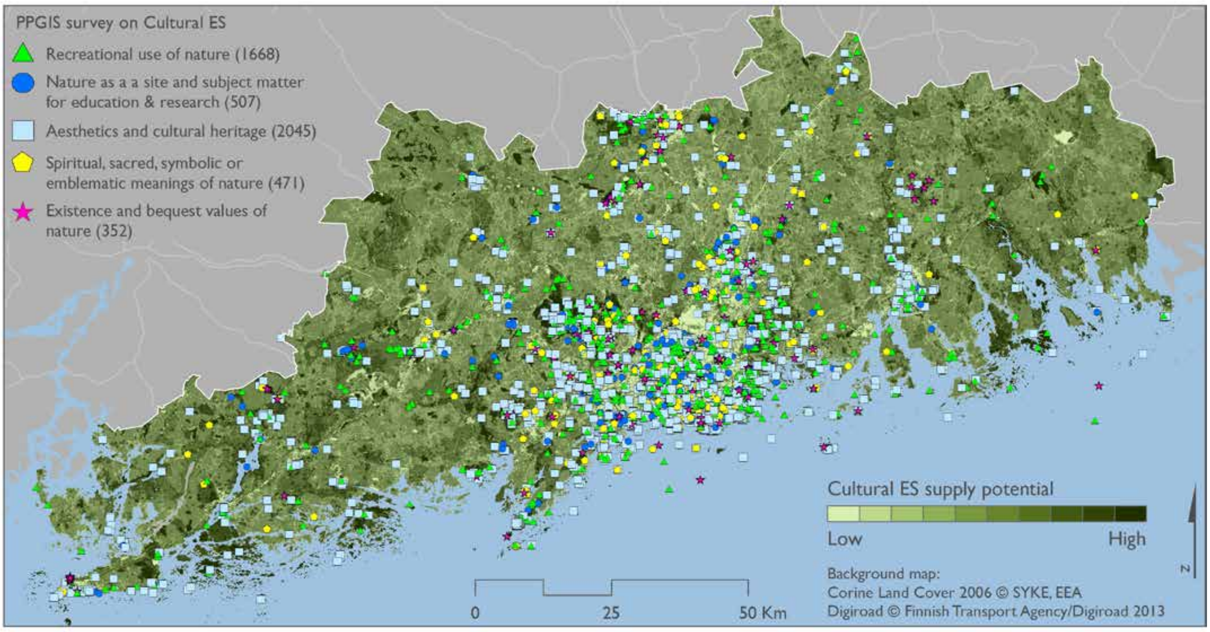



**Figure 4.2.5**. The places marked by the respondents of the PPGIS survey "The meanings of nature for the people of Uusimaa", displayed on top of GreenFrame analysis of cultural ecosystem services supply potential. 5,043 point markers were placed, covering all cultural ecosystem services.

The sample of the respondents was not fully representative of the demography of the region, but the survey results can be used as a source of supplementary information in collaborative land use planning. The clusters of point markers constitute hot spots – locations to which many respondents attached several different meanings (Figure 4.2.6). A regional plan is a relevant planning instrument for cultural ES, as many recreational areas, cultural heritage landscapes and aesthetically valuable sites, for example, have regional importance and these themes are already covered separately in valid regional plans.

4.2.4

## Mapping the demand for ecosystem services using accessibility analysis

In addition to the PPGIS survey, another approach was also taken in order to analyze the potential demand for cultural ecosystem services – the calculation of the number of residents that can access each location in the region in a given time via the transport network. As population data, a 250 meter grid was used, containing the population of each grid cell (© SYKE/YKR). The estimates of the travel time between pairs of population grid cells were calculated using road network data (STK 2013 / © ESRI Finland, Finnish Transport Agency / Digiroad 2013). The estimates of travel time for each road segment take into account different road types and the slowing effect of traffic in city centers (Figure 4.2.7).

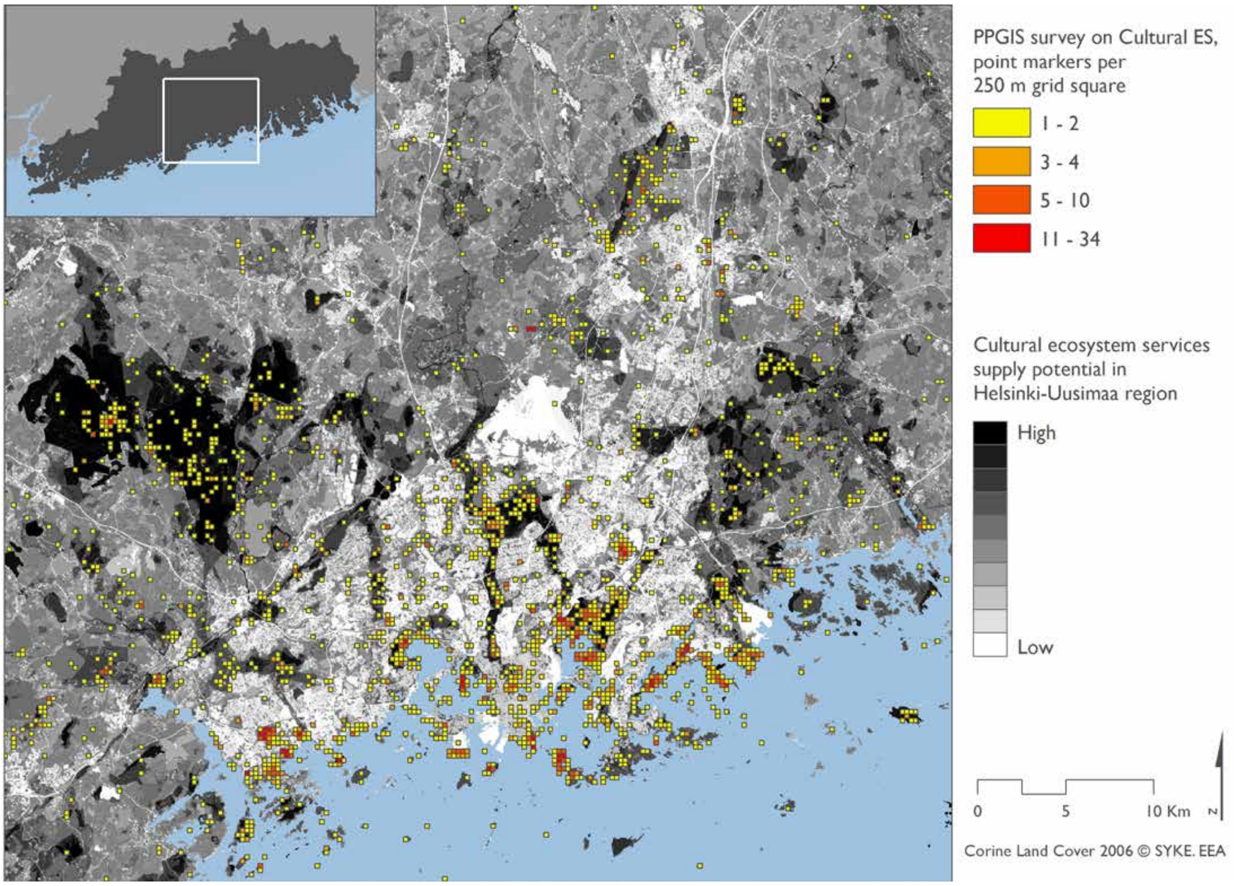



**Figure 4.2.6**. The point markers of the PPGIS survey aggregated in 250 m grid cells. Red cells indicate hot spots of cultural ecosystem services identified by the respondents. The variation of cultural ecosystem services supply potential is displayed in the background.

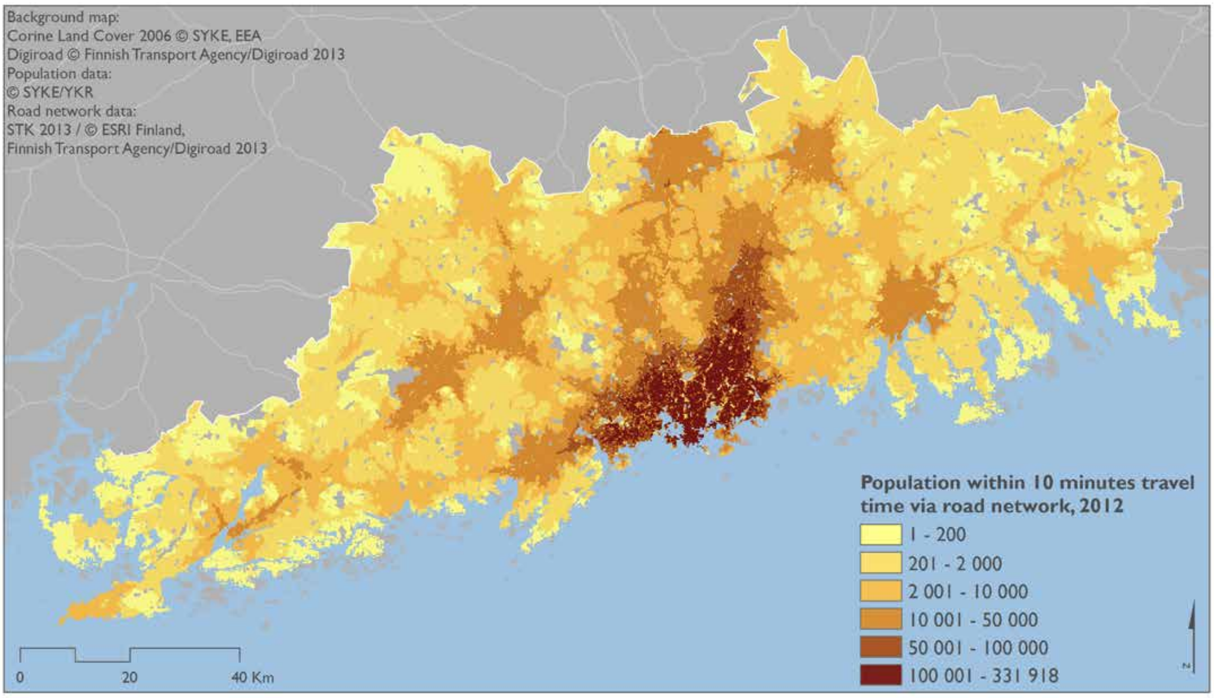



**Figure 4.2.7**. The population within 10 minutes travel time via the road network in Helsinki-Uusimaa region. The estimate is based on population data (SYKE/YKR) and road network data (STK 2013 / © ESRI Finland, Finnish Transport Agency / Digiroad 2013).

4.2.5

## Relating the supply and the demand of ecosystem services

Although different areas may be equally good in terms of accessibility, their attractiveness and capability for supplying different ES may vary. Therefore, it is useful to compare the estimates of the potential demand together with the supply potential of cultural ES in each grid cell of the region (Figure 4.2.8). This allows, inter alia, the recognition of locations where high demand for ES meets high supply, or on the other hand, low supply of ES, for example. In the context of land use planning, it is valuable to identify both types of areas. Despite the densified urban structure and the trend towards the expansion of urban areas, there are still areas with high ES supply potential in the core of the capital region. These areas are subject to high demand because of their central location and good accessibility not just by road but also by public transport.

It must be kept in mind that these accessibility estimates represent the potential demand for the cultural ES based on the population density and accessibility of different areas – not the actual visits. Some locations, such as national parks, draw visitors from much larger areas than just their surroundings. When available, data on the admissions to national parks and the use of other recreational areas are useful in assessing their actual demand. However, as it is not possible to monitor the use of all areas providing cultural ES, mapping the potential demand is necessary when assessing the whole region.

4.2.6

## Impacts of expected population growth on green infrastructure in the Helsinki-Uusimaa Region

A growing population, changes in urban structure, climate change, and diminishing natural resources, to name but a few, challenge the future development of the Helsinki-Uusimaa Region and have an impact on the ecosystem service provision potential. Drivers affecting ecosystem services may influence nature's capability to provide food, materials, and energy, processes regulating the state of the environment, as well as opportunities for and quality of nature-based recreation and other experiential benefits provided by nature.

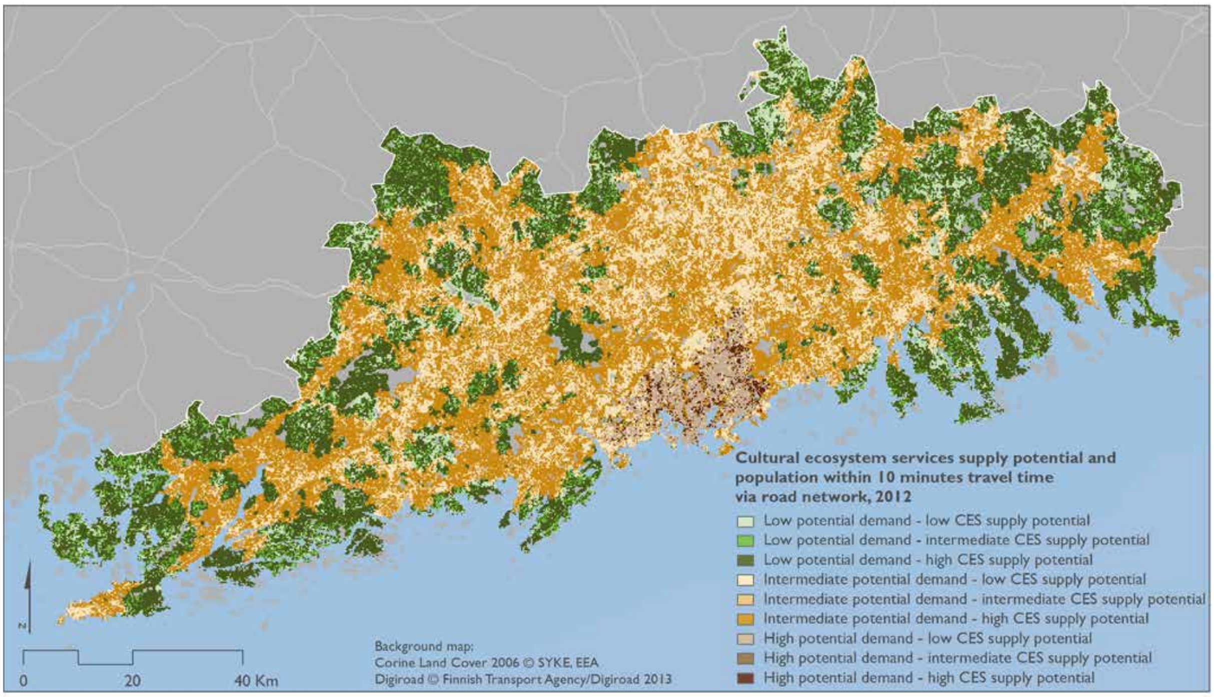



**Figure 4.2.8**. Cultural ecosystem service supply potential in relation to the potential demand.

Constantly increasing population and land use change could be named as the top drivers of change in the Helsinki-Uusimaa Region. The Helsinki Metropolitan Area is one of the fastest growing urban regions in the whole of Europe, which causes many indirect impacts on the ecosystems by spreading built-up areas and increasing the use of natural resources for building, livelihoods, energy consumption, and recreation. To prevent further urban sprawl and to mitigate climate change by increasing the eco-efficiency of cities, densification of urban structure is encouraged. This has a twofold impact on the green infrastructure: areas providing ecosystem services diminish and the number of potential users grows. Paradoxically, prospects for using nature-based solutions for climate change adaptation deteriorate.

To visualize the impacts of population growth on green infrastructure and thus on the ecosystem service provision potential, we carried out spatial analyses. The current situation and the anticipated future change in the population pressure were assessed by calculating the number of people residing in the immediate surroundings of the key areas of the regional green infrastructure. In addition to the current distribution of population, a scenario of the situation in 2035 was also examined, based on the 2035 population scenario data from the Uusimaa Regional Council which predicts a growth of 300,000 new inhabitants and 132,000 new jobs compared to 2006 (Figure 4.2.9). The possible land use conversions that might change the distribution of the regional green infrastructure are not taken into account because the outline of the new regional land use plan is still in progress. It is possible that some valuable green infrastructure areas will decrease in size or even be lost due to expansion of urban areas, which would result in even greater demand for the ecosystem services provided by the remaining areas of green infrastructure.

The visualized population pressure on the key areas of the green infrastructure aroused interest and lively discussion when presented to the expert group on green infrastructure supporting the regional land use planning process. These kinds of maps illustrate clearly the need to take good care of green and blue infrastructure areas both in planning and management, if we are to sustain the flow of benefits they provide for communities.

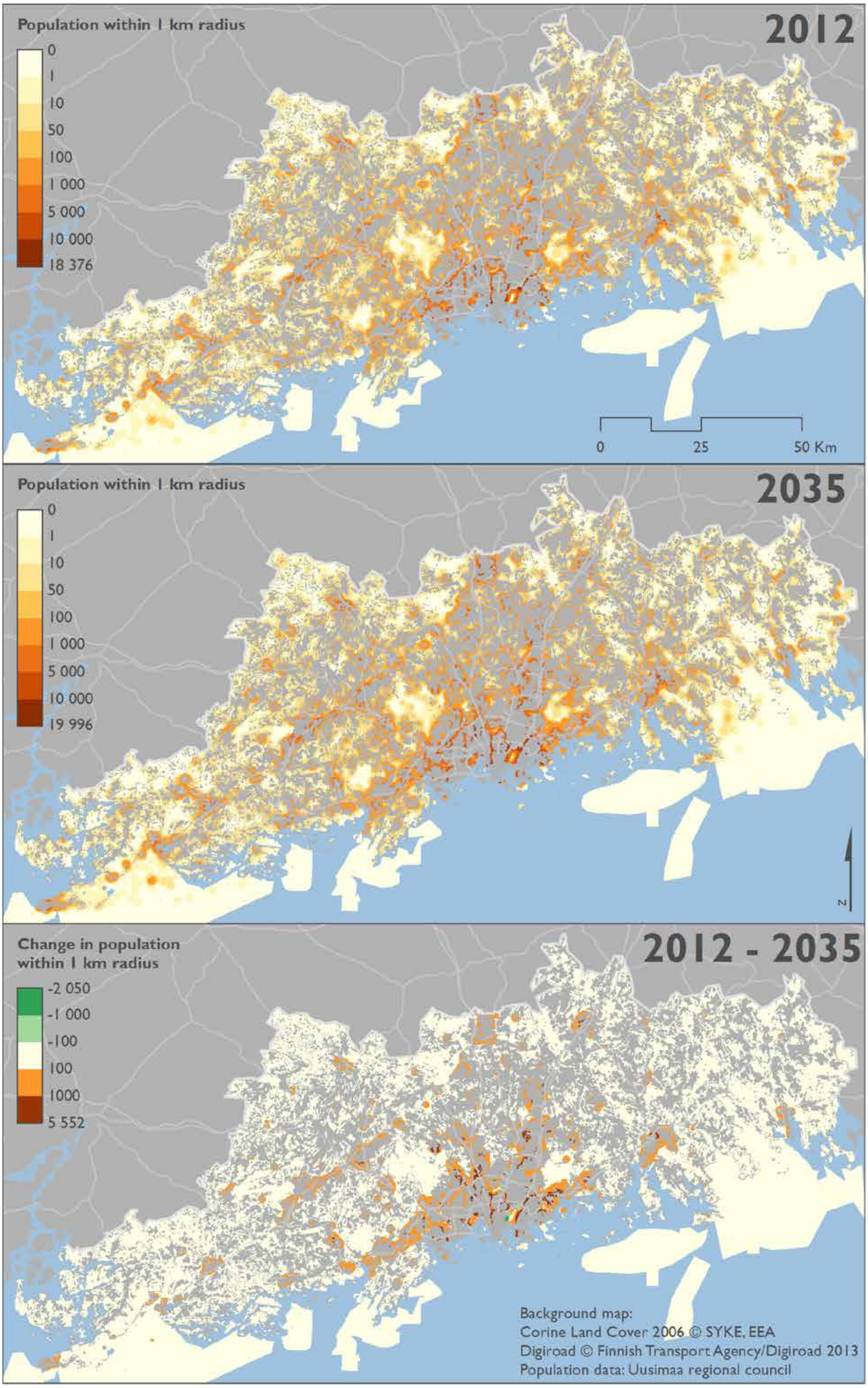



**Figure 4.2.9**. Current situation (2012, top), future scenario (2035, center), and the anticipated change (2012–2035, bottom) of the immediate population pressure on the key areas of regional green infrastructure (Population data source: Uusimaa Regional Council).

# 5 Social significance and economic value of ecosystem services in Finland

5.1

## Approaches for assessing the social significance and economic value of ecosystem services

**Janne Artell**

Decision-making processes always involve value judgments, whether made at the level of an individual, industry or the whole society. In the case of ecosystem services (ES) in particular, the recognition and quantification of the values of these services is important. The social significance of ES is often underestimated as little direct information of their values is conveyed to decision-making processes. Direct voting on decisions that affect ES would provide immediate and accurate signals of social significance, but, in most cases, such direct approaches are infeasible due to the related costs and time constraints. Even if ES were traded in the markets, prices would not fully indicate their social significance, as markets may omit ES attributes and market prices may be distorted through intervening taxation, subsidies and other regulation. Thus, other measures of social significance and economic value are required to support decision-making.

How can understanding ES values then help decision makers in practice? One answer is environmental cost-benefit analysis – a commensurate comparison between the benefits and costs of a project. Being commensurate means that costs and benefits are both expressed using the same measure, i.e. money. In addition to enabling comparisons, estimated values can be used to set prices for the use of ES. These prices may be, for example, admission prices to natural parks and fishing license fees, taxes on polluting activities, or subsidies to actions promoting ES provision. Furthermore, the decision maker may benefit from understanding the underlying factors of values. For example, forest recreation values can differ between commercial and natural forests, and they can cater to different audiences. Finally, valuation provides a good way to incorporate the larger public voice into decision-making.

This section focuses mainly on the monetary (i.e. economic) valuation of ES. More information on qualitative and quantitative valuation mapping approaches can be found in Section 4.

### Valuation methods fall into two main categories

There are a number of methods used to estimate ES values held by the public. A common factor is that they estimate the demand for the ES valued, and thus the change in welfare from changes in the provision or quality of the ES. Economic valuation methods can be used to estimate the monetary value of ES. The most popular methods of non-market valuation estimating benefits can be divided into two main categories – revealed preference methods (RP) and stated preference methods (SP) (Barton et al. 2012). In addition to these, there are methods that rely on market prices or cost information to produce value estimates.

### Values through revealed preferences

Revealed preference methods use actual consumption decisions of consumers in markets that are closely connected to the demand for the ES under assessment (Flores 2003). In some cases markets with price information for the ES already exist, e.g. fishing license prices for a particular area. In these cases the value of the ES is represented by the gains by both fishermen and the supplier of permits that can be estimated by market analysis of fishing licenses (King et al. 2000).

In cases where market prices do not exist, connections between the ES and markets of closely related goods can be used for valuation. For example, to enjoy recreation in nature one must travel to a recreational site. Travelling presents the market

with real prices in the form of travel costs. The travel cost method (TC) can be used to estimate use values for a single site or multiple sites over a period of time by estimating a demand function and consequentially the value of recreational trips (e.g. Vesterinen et al. 2010). In the case of multiple sites, the method also allows for comparison of whether site-specific demand is dependent on the quality of the ES, thus providing benefit estimates for improved ES quality. Another example of using market information is found in property markets, where nearby ES may influence property selling or rental prices. The hedonic property pricing method (HP) assumes property prices are established based on bundles of attributes (e.g. number of rooms, size of the lot, location, and status of the ES in the neighborhood) that, while not priced separately, have statistically discernible effects on prices (e.g. Artell 2014). The strength of the RP methods is that they are tied to real behavior. Real behavior data does not, however, allow for the valuation of cases which have not already been realized. Furthermore, as the RP methods cannot assess non-use related values, the estimates capture only a part of the total economic value.

## Values through elicited preferences in hypothetical markets

Stated preference methods, on the other hand, use hypothetical, but realistic scenarios of ES development to elicit information directly from the public in the form of surveys. Survey respondents are presented with detailed descriptions of possible changes in the provision or quality of the ES being valued, and then are asked directly about their willingness to pay (WTP) for that change to occur. Two main approaches for asking such questions are the contingent valuation method (CV) and the choice experiment method (CE). In the contingent valuation method the survey respondents are presented clearly defined scenarios (including information on the extent and time scale of the change) of the ES change and subsequently asked how much they would at most be willing to pay (considering their budgetary constraints) for that change (e.g. Ahtiainen et al. 2014). The CE, on the other hand, originates from market good studies, separating the change in the ES into one or more attributes and quality levels (e.g. Kosenius 2013). The respondent is then presented with multiple sets of different alternatives that include different combinations of levels for each ES attribute and some monetary payment. When choosing the best alternative from the choice sets, the respondents subtly reveal their preferences for the different ES attributes and their levels in monetary terms too. Thus in general, the CE makes it possible to separate ES values by relevant attributes and quality levels. In comparison, the CV studies are simpler to analyze, but are most suited to cases where there are a limited number of clearly defined scenarios to value. What the CE loses in more time-consuming analysis it gains in its ability to estimate the relative importance of different ES or their attributes.

## Cross-over methods on actual and hypothetical market behavior

There are also methods that combine RP and SP approaches, of which the contingent behavior method (CB) is the most prominent example. The contingent behavior method can join, for example, TC and CV methods so that in a survey people are asked about their current travel frequencies and costs to a site but also their likely travel frequencies to that same site after the ES has changed according to a set scenario (e.g. Whitehead et al. 2000, Whitehead 2005). Such methodological cross-overs offer the possibility of estimated ES values being anchored to real behavioral patterns, and at the same time allowing for the valuation of changes in ES provision and quality.

## Production function and cost-based valuation approaches

There are also methods that rely on market prices to value ES. The reliance on prices alone does not fully represent human preferences and may thus produce a conservative or otherwise biased estimate of values (Barton et al. 2012). The production function is used to value ES that are providing inputs for production processes. In essence, the method has two parts, where first the extent of the ES impact on production (e.g. water for agricultural production) is identified. Then the value of the change in the provision of the ES can be estimated through its effect to the output produced (Barton et al. 2012). Furthermore, it is possible to assess ES value through surrogate costs, be it through costs of replacing or renewing the ES, protection or substitute costs or avoidance costs in the case of environmental hazards (King et al. 2000, Barton et al. 2012). An example of a replacement cost-based value of natural migratory fish cycle in rivers can be estimated through restocking costs and lost revenue for power firms due to fishway construction and upkeep. This case is clearly dependent on the market prices for stocked fish and electricity prices, without a direct link to human preferences and thus the actual demand of the valued ES.

## Categorizing preference eliciting valuation methods

Figure 5.1.1 categorizes the methods that can be used to measure consumer preferences through data collection methods, through direct contact with people whose values are being elicited, or indirectly observing their behavior through statistics and the types of market data used in the methods. In the top left corner of Figure 5.1.1 is public voting, which is a direct elicitation of public opinion in a real-world context. The RP methods (TC and HP) fall into the category of indirectly observing real market behavior, while the SP methods (CV, CE and CB) use direct elicitation of values in hypothetical markets. Indirect observation of behavior in hypothetical markets is not possible unless, for example the results of a prior study eliciting behavior in hypothetical markets can be verified later (ex-post) with real-world behavioral data.

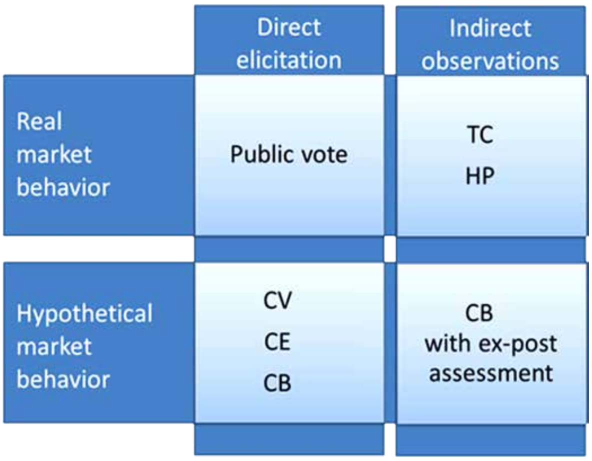



**Figure 5.1.1.** Preference-eliciting valuation methods classified by observation methods and behavior studied.

## Using existing studies from valuation repositories

There are often pressures to produce ES values in a short time. This increases the demand for methods that use existing primary valuation studies to estimate ES values in other contexts. There are a number of methods – value and function transfers and meta-analysis (Rosenberger & Loomis 2003, Barton et al. 2012) – for benefits transfer, where the accuracy of the methods is crucially dependent on the similarity of cases under comparison. The magnitudes of errors in transferring values between similar studies have ranged from errors of a few per cent to large, even 300% errors in estimates (Barton et al. 2012). To ease benefits transfer, and help in validating and comparing valuation study results, there are repositories collecting summary data from ES valuation studies across the globe. The largest of these is the Environmental Valuation Reference Inventory (www.evri.ca) originally developed by Environment Canada, and now also in use in United States, Mexico, France, Great Britain, New Zealand and Australia. The inventory holds information from over 4,000 valuation studies, classifying and reviewing each entry with a common structure to ease comparison and value transfers. The inventory holds 41 valuation studies undertaken in Finland up to 2008[5]. After the year 2008, a number of new valuation studies have been published in both peer reviewed publications and grey literature. While we have identified a number of recent valuation studies in this report, there is no definitive knowledge of the number of Finnish studies published since 2008, or, more importantly, there are no full records of the results of these studies held in a repository to help decision makers[6]. As the number of valuation studies increases over time, it will be important to maintain the knowledge of these studies, be it in a national or an international repository.

[5] These were entered to the inventory as a part of a one-time funding from the Nordic Council of Ministers to develop a Nordic Environmental Valuation Database (NEVD). The NEVD database has not been updated since. Some Finnish valuation studies have been entered to EVRI later.

[6] See Kosenius et al. (2013) for a list of recent valuation studies for Finnish ecosystem services.

5.2

## The weight of the most important provisioning services in the national economy

**Paula Horne**

Land use usually takes place either to construct infrastructure – roads, residential areas, airports, among others – or to produce some provisioning ecosystem services more efficiently. The main material constituents for basic human well-being – shelter, energy, food – were traditionally provided by ecosystem services, and in many cultures they still are, not least in Finland. In order to provide these provisioning ecosystem services more intensively and economically, land use changes have taken place, which have altered the landscape and the combination of joint production of ecosystem services. The prevalence of land use changes e.g. in forests, has varied depending on the era. The change has typically been to turn forest to arable land or arable land to forest (e.g. Saastamoinen et al. 2013). A forest ecosystem in its natural state provides game, berries, mushrooms and extractive goods such as wild honey for nutrition. With a growing human population these did not suffice for long. Forests were turned into fields and grazing land to multiply the production of food, and similarly, commercial forests are managed to produce timber and energy wood more intensively. Additionally, marshlands have been drained for forestry land.

When we consider the importance of provisioning services in the national economy, we should not only look at their value when extracted from the ecosystem. The intensified production of provisioning ecosystem services typically first serves the purpose of fulfilling the basic needs of human well-being. After that they provide the potential for trading in order to gain some other required goods or services. The provisioning ecosystem services – as well as other ecosystem services – serve many aspects of human well-being directly, but to keep abreast of them society requires other, man-made services such as health care, education and entertainment, or value added products such as means of transportation, newspapers and pacemakers. The processing of provisioning ecosystem services creates upstream industry which produces value-added products suitable for trading and export.

Economically, the most important provisioning ecosystem services are agricultural produce, timber, fish and game, other extractive forest products, and water. Their value-added summed up to less than three per cent of the total gross domestic product in 2013. Their share of GDP has been diminishing as other industries – especially the service sector – are growing.

The weight of provisioning ecosystem services lies not only in their direct value. The whole value chain linked to provisioning ecosystem services should be looked at. Together with the upstream industry their share increases to over ten per cent of GDP. For example, in the 2000s the forest sector provided €6–10 billion to the national economy, about 4–8% of the total. Forestry and forest based industries employ about three per cent of annual working units. A major part of the forest industry products are exported to foreign countries, which improves Finland's trade balance. The forest industry provides about 20% of Finland's export earnings (Metla 2013c). The tax revenues accruing from the sector to the state economy are needed to cover welfare services such as health care and education spending.

On the top of that, the upstream industry has brought about indirect effects in the whole value chain. Many industries have started to investigate the role of ecosystem services in their value chain and there is on-going research on the topic (e.g. Shantiko et al. 2013).

National TEEB projects have attempted to capture the value of ecosystem services for economies (Brouwer et al. 2013). Valuation of non-market ecosystem services poses a challenge that has been partly faced by different valuation methods (e.g. Kosenius el al. 2014). However even the importance of provisioning ecosystem services has not yet been fully covered. There are efforts to improve the accounting of natural capital in the national economy. The framework for the System of Environmental-Economic Accounting (SEEA) was developed in 2012 by the United Nations (Autio et al. 2013). In Finland, Environmental Account Statistics describe the interactions of natural resources and human activities, such as economy-wide material flows or public sector environmental protection expenditure, however they do not cover all provisioning, let alone all ecosystem services (Statistics Finland 2014) (for more on natural capital accounting, see Section 7.2).

5.3

# Case: Value of recreational services provided by ecosystems in Finland

**Tuija Lankia**

5.3.1

## Valuing recreational ecosystem services

Valuation of recreation as an ecosystem service is complicated in the sense that recreation in natural areas also requires conventional goods and services in addition to the services provided by ecosystems. In the Millennium Ecosystem Assessment (2005), recreation is considered as an ecosystem service, but some authors (e.g. Boyd & Banzhaf 2007, Fisher et al. 2009) understand recreation as a benefit produced using ecosystem services as inputs. This definition recognizes that ecosystems provide the surroundings and aesthetic landscape for recreation, but often conventional goods and services such as park facilities, accommodation and equipment are also needed to facilitate the recreation experience. Consequently, the whole value of recreation should not be assigned to ecosystem services, but the contribution of ecosystem services to the economic value of recreational use of the environment should be identified (Bateman et al. 2011). However, the share of the economic value accounted for by the ecosystem services may not be easily identifiable and the focus of studies has been on the value of recreational visits as a whole including both ecosystem services and other facilities.

The economic impacts of nature tourism can be evaluated based on the consumption expenditure of tourists, tourism revenues and the employment impact of tourism. In Finland, a tourism satellite account statistical system recommended by the European Union is employed to describe the economic impacts. In 2012, a total of €13 billion was spent on tourism in Finland, and tourism composed 2.7% of the gross domestic product (Ministry of Employment and the Economy 2014). Although nature tourism has been estimated as making up a quarter of tourism's value added (Parviainen & Västilä 2011), it is very difficult to isolate the contribution of ecosystem services to the economic impacts of tourism. Furthermore, actual expenditure, revenues and gross domestic product do not reveal the economic value of outdoor recreation in Finland, where recreational services are characterized by common right of access to land and waterways, no matter who owns the land (Ministry of the Environment 2013b). Therefore, recreation has no market price that could be used to estimate its value, but economic valuation methods for non-market goods are needed. Both revealed and stated preferences methods can be used, but most commonly recreational benefits are assessed with the travel cost method which reveals the value of recreational services by examining how much individuals are prepared to pay to travel to enjoy recreational services provided by ecosystems. Studies focusing on the value of recreational use of ecosystems in Finland are listed in Appendix 5.

5.3.2

## Recreational use of natural areas in Finland

Information on the recreational use of natural areas in Finland has been collected extensively in two national outdoor recreation inventories (LVVI), conducted in 1998–2000 and 2009–2010 by the Finnish Forest Research Institute (Metla). According to the latest study LVVI2, almost every Finn (96%) participates in outdoor recreation annually (Sievänen & Neuvonen 2011). On average, a Finn participates in close-to-home outdoor recreation 156 times a year. Almost half (42%) of Finnish outdoor recreationists make outings more than three times a week and approximately one third (31%) exercise outdoors on a daily basis. Walking and jogging are the most popular outdoor recreational activities, followed by walking a dog, being outdoors with children, cycling and skiing.

Almost half (46%) of the outdoor recreational visits takes place within walking distance from home, which emphasizes the importance of recreational services in the vicinity of residential areas. Approximately two thirds of the visits are to municipal areas, 9% in holiday cottages and 6% in state owned areas. The majority (90%) of the outdoor recreational visits are made to forest areas and routes, a third to areas with water systems and a fifth to both agricultural areas and natural areas with fells or high hills. Parks are essential to people living in urban areas, as about half of the outdoor recreation visits in municipalities with 25,000–99,999 inhabitants and about 60% in towns with over 100,000 inhabitants take place in areas with grass and plants.

National parks and holiday cottages and their surroundings are popular destinations for nature trips including overnight stays. Of the Finnish population, 43% makes at least one nature trip a year. On average, Finns make 8 nature trips per year. A third of nature trips are to holiday cottages and a fifth to state owned areas. The rest of the trips are made to privately owned areas and municipal lands. The majority of the nature trips are to Northern Finland, and to the central and eastern parts of

the country, where holiday cottages are concentrated. The most common outdoor recreation activities during nature trips are spending time at a holiday cottage (15% of all nature trips), cross-country skiing (10%), hiking (9%), fishing (6%), boating (5%) and down-hill skiing (5%).

Foreign tourists also utilize recreational ecosystem services in Finland. According to Border interview survey 2008 (Statistics Finland 2009), a third of all foreign tourists, and 97% of those who visited Lapland, participate in nature activities.

### 5.3.3 Estimates of the economic value of recreational ecosystem services

Lankia et al. (2015) utilized the second national outdoor recreation demand inventory (LVVI2) to estimate the value of recreational services and the subsequent spatial distribution in Finland. The travel cost method was applied for the valuation of the visits, which was done separately for each region and three different area types: 1) areas used for recreation based on everyman's right, regardless of who owns the lands, 2) state-owned recreation and nature conservation areas such as national parks, and 3) holiday cottages and their surroundings.

The economic value of a close-to-home recreation visit to areas used based on everyman's rights and to state owned recreational areas was estimated to vary between €2 and €7. The value of a close-to-home recreation visit to a holiday cottage was found to be considerable higher, €5–97. The large difference is probably caused by a longer average distance from home to a holiday cottage than to other outdoor recreation opportunities near to a person's primary residence.

In previous studies, Huhtala & Pouta (2008) used the first national outdoor recreation survey carried out in 1997–2000 (LVVI1) to examine the benefits of recreational opportunities in stated-owned national parks and hiking areas. They evaluated the respondents' willingness to pay (WTP) for the same range of recreation services as is currently provided by the government free of charge to be on average FIM 128 (€19) per year, and the median WTP was FIM 62 (€8) per year. By dividing the estimates by the average number of visits for the users (7.08), the mean willingness to pay per visit becomes €3 and median €1. Ovaskainen et al. (2012) estimated the value of a trip to the Teijo hiking area to vary between €23 and €59 depending on the travel cost variable. In 2001, Tyrväinen (2001) estimated the recreational value of urban forest areas in Salo to be approximately €5–13 and in Joensuu €7–9 per person per month.

According to Lankia et al. (2015), the value of a nature trip including an overnight stay to state owned nature conservation areas and areas used based on everyman's right, ranges between €29 and €105. The value of a trip to a holiday cottage varied between regions, from €105 to €252. In a previous study, Huhtala & Lankia (2012) estimated the value of a holiday cottage trip to be €100–200.

In addition to the per trip values, Lankia et al. (2015) also estimated aggregate values of both close-to-home recreational and nature trips in Finland. The aggregate values were calculated by multiplying the estimated per trip values by the total number of trips obtained from the LVVI2-data. The aggregate annual value of close-to-home recreation was estimated to be €2.6 billion and of nature trips €0.3 billion. Figures 5.3.1 and 5.3.2 illustrate the distribution of the aggregate values among different regions in Finland.

The aggregate value of close-to-home recreation (Figure 5.3.1) follows the population distribution, the value being highest in the most populated region, Uusimaa.

The aggregate value of nature trips (Figure 5.3.2) follows the number of trips, the value being highest in Lapland, where the unique nature and tourism centers attract visitors. In addition to this, the importance of the Lake District in the central and eastern parts of country shows in the map.

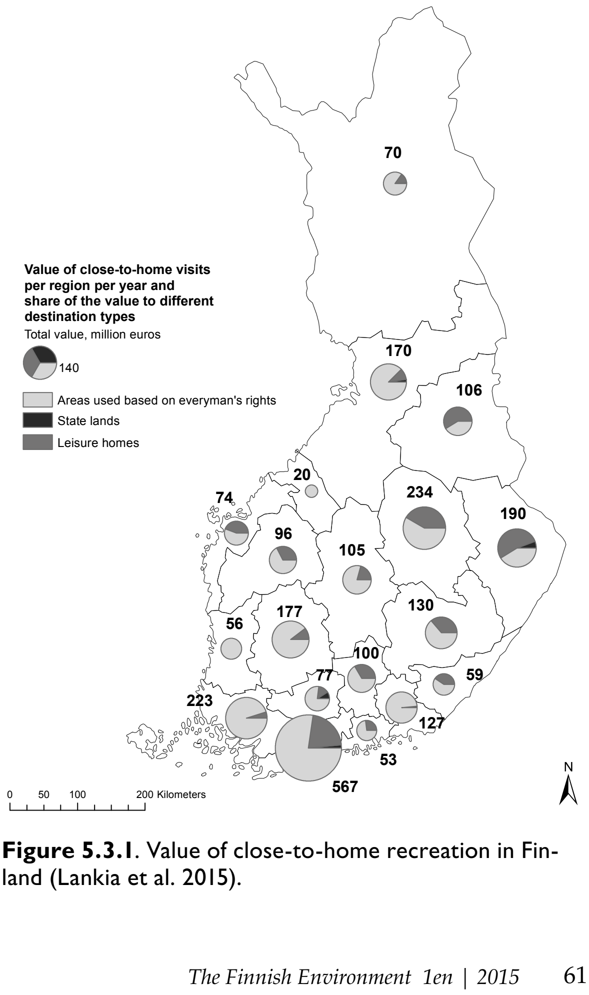



**Figure 5.3.1**. Value of close-to-home recreation in Finland (Lankia et al. 2015).

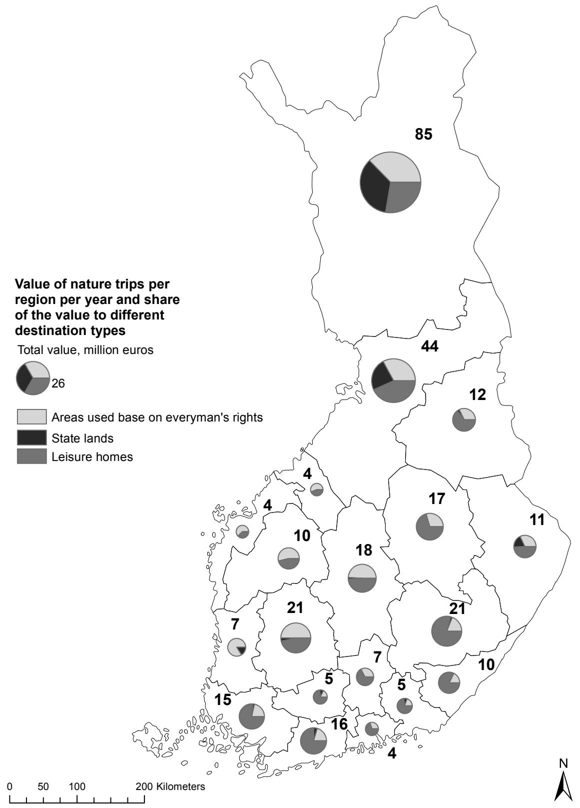



**Figure 5.3.2**. Value of nature trips in Finland (Lankia et al. 2015).

5.3.4
## Effect of different ecosystem characteristics on recreational value

To determine the welfare effects of various management policies influencing outdoor recreational opportunities, studies on the relationship between the characteristics of ecosystems and the value of recreation services are needed. In a study by Lankia et al. (2015) correlation analysis was used to examine the importance of the regional population, the number of visits and trips, and the supply of ecosystems as the drivers of regional recreational values. The value of close-to-home recreation was significantly correlated only with the population and the number of holiday cottages. As for nature trips, the aggregate value correlated most strongly with the total number of trips to a region. It also correlated with a trip's value, presence of other natural land areas like fells, and the share of state owned recreation and nature conservation areas. However, since the spatial scale was coarse, it did not allow closer examination of the relationship between different ecosystem characteristics and the value of recreational services.

Most commonly the effects of different ecosystem and landscape characteristics on the recreational value of ecosystems in Finland have been studied with choice experiments. According to studies related to forest ecosystem characteristics and recreational benefits, Finnish recreationists appreciate rich biodiversity and landscapes without remarkable visible traces of intensive forestry, such as clear cuts. Hence, the value of recreational services could be increased by improving biodiversity and managing recreational areas (Tyrväinen et al. 2013, Juutinen et al. 2011, Lankia et al. 2014, Horne et al. 2005.) According to Tyrväinen et al. (2013) visitors to Ruka-Kuusamo were willing to pay €12.27 more per one week visit for an improvement in landscape quality so that there would be no visible traces of intensive forestry operations on the sides of routes, and €10.82 more for a slight improvement in the landscape quality so that traces of intensive forestry operations are visible on 10% of the side of routes. In a study on citizens' willingness to contribute to the management of recreational quality on private lands (Lankia et al. 2014) 66.5% of the respondents found forest clear-cuts undesirable, however, only 9% of them were willing to pay for postponing the clear-cuts.

The visitors to the Ruka-Kuusamo area would claim a compensation of €36.83 per a one week stay for a decrease in biodiversity resulting in 10% of species in the area becoming extinct. Furthermore, at Oulanka national park visitors would claim a compensation of €12.20 per visit for biodiversity loss resulting in 15 species becoming extinct in the park (Juutinen et al. 2011). Furthermore, they were willing to pay €6.73 per visit for a 10% increase in population of endangered species in the park. However, Lankia et al. (2014) reported that Finnish outdoor recreationists found removing dead wood and decayed wood, which are crucial for forest biodiversity (Siitonen 2001), almost equally often desirable as undesirable, indicating heterogeneous preferences for biodiversity and recreation among Finns.

With regard to agricultural lands, Pouta & Ovaskainen (2006) studied how agricultural land affects outdoor recreational activity and value in Finland, and Grammatikopoulou et al. (2012) Finns' preferences for agricultural landscape improvements in Southern Finland. Pouta and Ovaskainen (2006) found that people in Finland have a lower preference for agricultural areas as recreational environments in comparison to other ecosystems. Respectively, the value of a nature trip including overnight stay was found to be somewhat lower (€51) than the value of a trip to other

kind of destinations (€57). The presence of agricultural land had only a minor effect on the value of a close-to-home recreation trip. According to Grammatikopoulou et al. (2012), Finns appreciate most agricultural lands with grazing animals and renovated production buildings, and were willing to pay on average €82.52 per person per year for the presence of grazing cattle and horses, and €35.78 for renovated production buildings in an agricultural area.

In addition to changes in value per visit, the frequency of outdoor recreation influences the aggregate benefits of recreational services. For example, climate change will probably affect cross country-skiing activities in Southern Finland as snow cover will become less probable and the winter season shorter in the future (Ruosteenoja et al. 2005). Pouta et al. (2009) found that climate change will decrease the participation rate in skiing from the current 40% by 36% in the long term and the average skiing days per skier from the current 18 days by 39%. The effect was found to be strongest for participation of older women living in urban areas and people with lower economic status. Participation rates and days spent partaking in other snow-based recreation activities like downhill skiing and snowmobiling are also expected to decline due to climate change (Sievänen et al. 2005).

However, according to IPCC (2014), the overall economic impact of climate change on outdoor recreation will probably be limited, because people tend to change their recreational activities rather than the amount of time and money spent on recreation. Thus, people will, for example, compensate for the reduced skiing with outdoor recreation activities better suited to changed climate conditions. The economic impact on tourism may be more considerable, as tourists might adapt to the climate change by changing also their trip destination, with climate and weather being important determinants for their choice. It has been hypothesized that in Europe climate change could shift the emphasis of tourism from the southern locations towards more northern areas (Amelung et al. 2007, Hamilton & Tol 2007). However, it may also be the case that the total number of international tourists would fall, as tourists from the northwestern Europe would prefer to spend the holiday in their home country (Hamilton & Tol 2007).

5.4

## Case: Value of surface waters and groundwater in Finland

**Heini Ahtiainen**

Both marine and freshwater habitats provide a wide range of ecosystem services that affect human well-being. Provisioning services include water for direct use (e.g. irrigation and drinking water), power generation (e.g. hydropower), fish and shellfish stocks (food), and other plant and animal-based materials. Examples of regulating services are climate regulation, waste disposal and dilution, and flood and storm protection. Supporting services of surface waters include resilience, nutrient cycling, biogeochemical cycling, wild species diversity and habitats, and genetic diversity. Water ecosystems also provide many cultural ecosystem services, including tourism and recreational opportunities, aesthetic properties and landscapes, inspiration, cultural heritage, mental and physical health benefits, existence values of plants, animals and habitats, and education and research opportunities.

The state of water ecosystems affects the provision of many ecosystem services and, in turn, the benefits people obtain from them. For example, algal blooms caused by eutrophication may hinder or even prevent the recreational use of a water body.

The value of some provisioning ecosystem services can be inferred from market behavior and prices. For example, the volume and value of the provision of fish and shellfish for consumption can be based on catch landings and market prices. The price of tap water can be used as a proxy for the value of water for direct use, and energy prices can be used as a proxy for the value of energy production. This section focuses in particular on cultural ecosystem services, which are difficult to value as their value cannot be seen in markets or prices. Therefore, revealed and stated preference valuation methods have been used to estimate their value.

In Finland, marine and freshwater ecosystems have been one of the focus areas of environmental valuation (see Appendix 6). There are several studies of water-related cultural ecosystem services, including water recreation, aesthetic values and non-use (existence) values. The main emphasis has been on valuing changes in the eutrophication status of waters, and water recreation. In addition to these, water restoration and management, water quality in general, the effects of oil spills and preserving endangered species have been studied. There are only a few studies on the value of ecosystem services provided by groundwater.

5.4.1

## Water recreation and recreational fishing

The extent of water recreation in Finland has been studied as a part of the Finnish national outdoor recreation demand inventory (LVVI), a comprehensive survey measuring outdoor recreation in Finland (Sievänen & Neuvonen 2011). Of water recreation activities, the study measured the participation rates for and the frequency of swimming (including diving and snorkeling), fishing, boating (including canoeing), water sports (such as surfing, water-skiing, water scootering), and being on the beach. All water recreation activities are common in Finland. Swimming is a one of the most popular recreational activities in Finland, as two-thirds (70%) of the population swim in lakes, rivers and seas. The average person goes swimming over 20 times a year. Around 44% of the population takes part in fishing, especially angling. Almost half (49%) of the Finnish population participates in boating and around 2% in other water sports. Being on the beach is among the most popular activities, as around 65% of people spend time on the beach viewing landscapes, having a picnic and sunbathing.

The value of water recreation has been estimated in three studies (Lankia & Pouta 2012, Luoto 1998, Vesterinen et al. 2010). These studies, most of them using the travel cost method, have estimated the value of one water recreation visit or day, and also assessed how this value would change if water quality changed. The value estimates for water recreation are in the range of €6–20 per visit.

Separate studies have been conducted on the value of recreational fishing (NAO 2007, Parkkila 2005, Parkkila et al. 2011, Toivonen et al. 2004, Valkeajärvi & Salo 2000). These studies have used the travel cost and contingent valuation method, and either estimated the value of recreational fishing per trip or the value of improved fishing possibilities. The estimated annual values of recreational fishing are in the range of €80–180 per person, while improved fishing conditions are valued at €25–55 per person per year.

5.4.2

## Value of reduced eutrophication

There are several studies that have valued the benefits of reduced eutrophication for the general public. The eutrophication studies have all used stated preference methods (contingent valuation and choice experiment) to value cultural ecosystem services, including recreational, aesthetic and existence values. The majority of the studies conducted have focused on the marine environment (Ahtiainen et al. 2014, Gustafsson & Stage 2004, Kosenius 2004, Kosenius 2010), but there are also studies on the value of improved eutrophication status in a single lake (Ahtiainen 2008, Lehtoranta 2013, Mäntymaa 1993). Eutrophication reduction has been typically described in terms of algal bloom occurrence, water turbidity, fish species composition and some other indicators describing the condition of the ecosystem.

Marine studies have either included the entire Baltic Sea (Ahtiainen et al. 2014) or focused on a specific area in the Baltic Sea, for example the Gulf of Finland (Kosenius 2004, Kosenius 2010) and the sea around the Åland Islands (Gustafsson & Stage 2004). These studies have found an average annual willingness to pay in the range of €25–600 per person or household. The wide range of value estimates stems from differences in study settings, the change in eutrophication and valuation methods.

Studies focusing on a single lake have been conducted for Lakes Hiidenvesi, Oulujärvi and Vesijärvi (Ahtiainen 2008, Lehtoranta 2013, Mäntymaa 1993). The study populations have been residents and cottage owners in the nearby areas. Results of these studies suggest that the annual benefits to the local population range from €10 to €165 per household.

### 5.4.3
## Water restoration and water quality

The benefits of stream restoration according to the Helsinki Small Water Action Plan have been studied using the contingent valuation method (Lehtoranta et al. 2012). The proposed actions entailed restoring the streams to close to their natural state, which would reduce flooding, increase biodiversity and improve the aesthetic properties and recreational opportunities. Households of the City of Helsinki's average willingness to pay for the management and restoration of streams was approximately €8–16 per year.

Artell (2014) has studied the value of improved water quality using hedonic pricing and sales information for holiday cottage lots that have not been built on. This approach reveals the difference in prices of lots that have different quality. The findings indicated that holiday cottage lots that have excellent water quality were 20% more expensive compared to lots with satisfactory water quality. With average prices, this translates into approximately €9,000 per lot. Lots with good water quality were, in turn, about 9% (€4500) more expensive than lots with satisfactory quality.

### 5.4.4
## Other studies

There is only one study focusing on the benefits of reducing the damages from possible future oil spills (Ahtiainen 2007). The study estimated the benefits from improved oil spill response capacity in the Gulf of Finland, which would reduce harm to the ecosystem and well as the recreational use of the coast. The estimated benefits were €28 per person as a lump sum.

Studies focusing on endangered species are to date rare in Finland, but there is one on the benefits of protecting the Saimaa ringed seal (Moisseinen 1997). Both the general population and the local population were asked their willingness to pay for the protection of the Saimaa ringed seal in a contingent valuation setting. The willingness to pay (as a one-time payment) varied between population groups, being €14 per household for those living close to Lake Saimaa and €36–60 per household for the national population.

Huhtala & Lankia (2012) have estimated the recreational benefits from trips to second homes (i.e. holiday cottages) using the travel cost method. They found that the recreational value is approximately €170–205 per trip, and that the presence of algae that prevent water recreation and lack of beach decrease the value substantially.

The value of marine ecosystem attributes, namely the amount of healthy vegetation, preservation of pristine environments and the size of fish stocks has been studied in the Finnish-Swedish archipelago with the choice experiment method (Kosenius & Ollikainen 2012). The results indicated that the values for increasing the amount of healthy vegetation were €40–69 per person, protecting pristine areas about €70 per person and increasing the size of fish stocks €37–53 per person as a one-time payment.

### 5.4.5
## Groundwater

Finland has ample resources of groundwater, as there are around 6,000 classified groundwater areas (Kitti 2013). Groundwater is the most common source of water for household consumption (Mäenpää & Tolonen 2011). In addition to providing water for direct use in municipal, agricultural and industrial purposes, groundwater participates in many ecosystem functions and thus contributes to the provision of many ecosystem services (National Research Council 1997, Murray et al. 2006, Kitti 2013).

The price of tap water can be used as a proxy for estimating the value of groundwater for municipal use. It is also possible to estimate the costs of replacing groundwater with other water sources, and use these costs as a measure of the value of groundwater. These approaches provide estimates for the total value of groundwater, and do not give insights into the change in values of the quality or quantity of groundwater change. For agricultural and industrial uses, it is possible to assess the contribution of ground water to the value of production (National Research Council 1997).

There are very few valuation studies of groundwater in Finland (see review by Kitti 2013). Based on the costs of illness, Jääskeläinen (1997) assessed the costs of three water-related epidemics in the 2000's. The costs ranged between €20,000 and €26,000 depending on the extent of the epidemic and the costs included in the assessment. There are also estimates of the costs of cleaning and restoring groundwater reserves (Penttinen 2001, Kivimäki et al. 2009) and reducing the risk of groundwater contamination (Ojajärvi et al. 2003, Hölttä 2008, Salminen et al. 2010).

The only valuation study of groundwater was conducted in Rokua esker in Northern Finland (Koundouri et al. 2012). The purpose was to estimate the benefits of different water management attributes, including recreation and the value of ground and surface water quantity. The value of improved recreation possibilities was estimated at €10–12 per household and increased water quantity at €13–26 per household.

5.5

# Citizens' evaluation of the importance of ecosystem services

**Eija Pouta and Kaisa Hauru**

The values of ecosystem services provided by various ecosystems have not been systematically studied in monetary terms using the whole range of ecosystems services. For many ecosystems, the value of provisioning services can be calculated in monetary terms based on market prices, but the values for regulating and cultural services in particular are missing. As monetary measures of values are not available, here we present the results of studies measuring citizens' perceptions of the importance of various ecosystem services in three types of ecosystems: agricultural environments, urban forests and peatlands.

5.5.1

## Agricultural ecosystems

As a part of a wider landscape study (Pouta et al. 2014), MTT studied Finnish citizens' perceptions of ecosystem services provided by agricultural landscapes and their importance. The data were collected in April 2012 by randomly sampling 3,016 individuals from the Internet panel of a private survey company, Taloustutkimus. After a pilot survey of 100 people, 800 people completed the final survey, which resulted in a response rate of 27%. The data were for the most part representative of the general population.

The survey focused on various ecosystem services citizens may experience from agricultural landscapes. Respondents were presented with a typical Southern Finnish agricultural landscape that also contained forest stripes, and asked about the extent of ecosystem services they perceived the landscape produces.

Respondents found food production to be the most important ecosystem service of agricultural landscapes (Figure 5.5.1). Cultural services were also considered highly important. Of the cultural services, the three most important ecosystem services were landscape, recreation and the strengthening of humans' place attachment. Ecosystems' ability to promote local culture was also considered significant. In addition to this, several regulating and supporting services, such as pollination and improving air quality, were evaluated as relevant. The survey data also revealed the difficulty the general public had in evaluating regulating services, as the number of "don't know" responses was considerably higher for regulating services than for cultural or provisioning services.

The perceptions of the produced ecosystem services correlated significantly, implying that those respondents who considered the production of cultural services to be extensive also perceived a high level of provisioning and regulating services from agricultural ecosystems. High perceived levels of regulating and provisioning services were strongly correlated. The respondents' perceptions of high level of ecosystem services were positively associated with the female gender, middle age, and living in rural areas particularly in parts of the country other than the Helsinki-Uusimaa region.

5.5.2

## Urban forests

Ecosystem services in nearby forests as perceived by residents were studied by Hauru, Eskelinen Yli-Pelkonen, Kuoppamäki and Setälä in the City of Lahti, Finland. A postal survey was sent to local residents in the Kiveriö residential area in February 2013. To get the idea of important ecosystem services in the area, the residents were also asked what purposes they use their nearby forests for. Residents (n = 197) recognized several benefits both for themselves and for society in general. Benefits mentioned were *a posteriori* classified into categories.

Benefits (number of mentions) that the residents felt their nearby forests (i.e. forests situated within a close distance to their homes; 82 m on average) provide for *themselves* were: psychological restoration such as relaxation (n = 74), recreational benefits such as physical exercise and dog walking (n = 52), values related to existence of nature (including connection to nature, n = 36), aesthetic experiences such as beauty, sounds and odors (n = 35), forest products (n = 31), environmental regulation (n = 31), education (n = 26), positive feelings (n = 26) and amenity values such as coziness and living comfort (n = 13).

Benefits that the residents felt their nearby forests provide for *society* in general were similar to those at the personal level: recreational experiences (n = 60), increase in aesthetic quality (n = 47), psychological restoration (n = 36), environmental regulation (n = 29), existence of nature, e.g. biodiversity, birds and vegetation (n = 23), forest products (n = 22), education (n = 13) and monetary benefits such as increased demand for the area (n = 10).

Only a few disadvantages were mentioned and those were mostly related to human behavior, e.g. dog feces, fear of violence and falling trees.

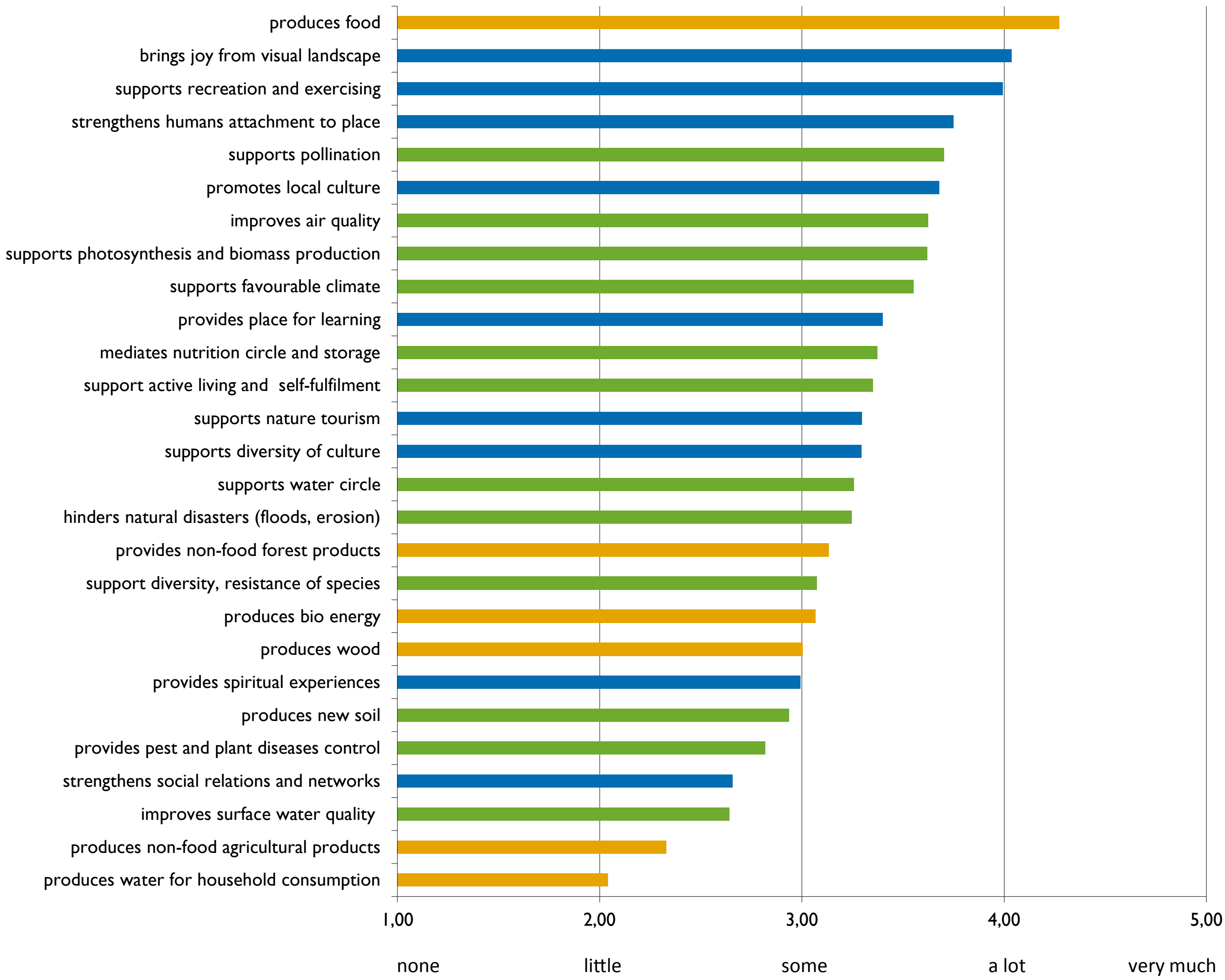



**Figure 5.5.1**. Citizens' evaluations of the ecosystem services produced by the agriculture landscape. The respondents were shown a photograph of typical South Finnish agricultural landscape with forest stripes.

It was also found that residents used their nearby forests for many purposes both in the summer and in the winter. The most frequently mentioned purpose of use was physical exercise (ca. 70% of the respondents chose this alternative both in summer and in winter). Enjoying the beauty of nature (ca. 50% mentioned this), observing nature (ca. 36%) and different purposes related to psychological restoration and getting away from everyday routines were often mentioned (ca. 40% mentioned a benefit related to psychological restoration).

All in all nearby forests (i.e. forests that are located within walking distance from a person's home) provide many benefits to local residents, most of which are 'cultural', i.e. immaterial or experiential in nature. This means that nearby urban forests that may not be economically or ecologically the 'highest quality' compared to e.g. rural pristine or silvicultural forests, are highly valuable for local residents because they offer easily accessible places to get away from everyday stress, to experience aesthetic pleasure, to do physical exercises, to educate children, to get in contact with nature and many other benefits.

**Table 5.5.1**. The perceived ecosystem services from peatlands in Lieksa, North Karelia, based on Silvennoinen (2012). Dark blue: mentioned by respondents, light blue: pointed out from the list of ecosystem services.

| Main category of ES | Ecosystem service | Natural peatland | | Drained peatland | |
|---|---|---|---|---|---|
| | | Local | General | Local | General |
| Provisioning services | Berries and mushrooms | | | | |
| | Game | | | | |
| | Timber | | | | |
| Cultural services | Recreation | | | | |
| | Landscape experience | | | | |
| | Existence values of biodiversity | | | | |
| | Learning, teaching, research | | | | |
| Regulating and maintenance services | Climate control | | | | |
| | Water fluctuation control | | | | |
| | Habitat services | | | | |

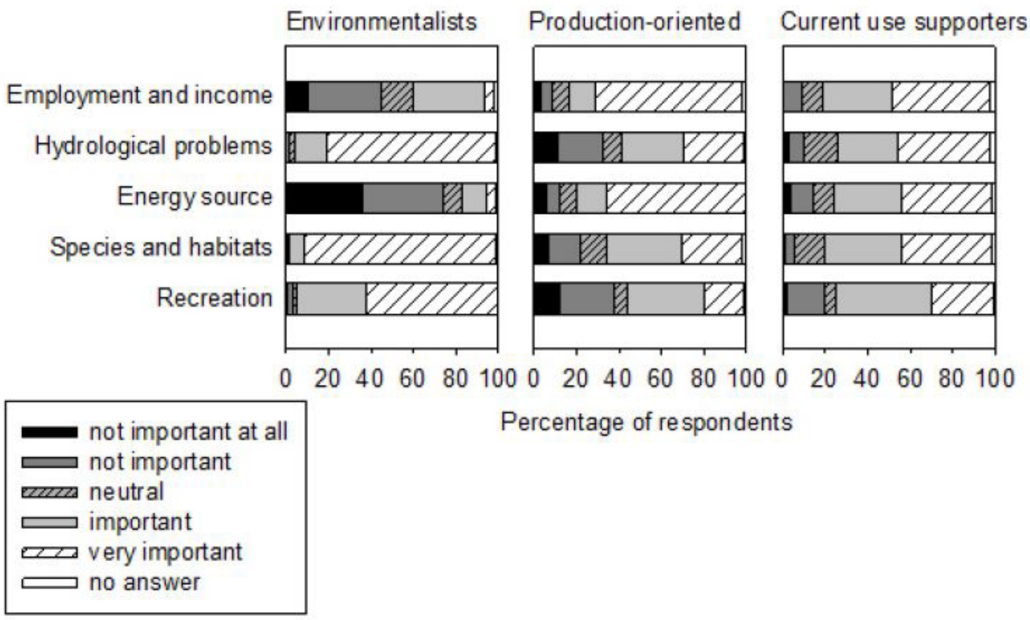



**Figure 5.5.2**. Different individuals perceive the importance of ecosystem services from peatlands very differently (Tolvanen et al. 2012).

5.5.3

### Peatlands

There are no comprehensive studies on Finnish people's perceptions of ecosystem services from peatlands. Silvennoinen (2012), however, presents results concerning two peatland areas in North Karelia. The study did not aim to value the ecosystem services in monetary terms, but allowed qualitative assessment of their importance. In the interviews local people (23) identified the ecosystem services they perceive from either a natural or a drained peatland area in Lieksa. The results also provide people's perceptions of the services obtained on social level. Table 5.5.1 summarizes the results. The natural peatland provided cultural services in particular, such as recreation, but concerning provisioning services, berries and mushrooms were also important. Regulating services, identified from the list provided for respondents, related to water fluctuation control and climate control. Whilst the drained peatland offered mainly provisioning services, it did also provide a recreational environment.

Individuals can perceive the importance of ecosystem services very differently. The heterogeneity of the importance of various ecosystems services from peatlands is illustrated in Tolvanen et al. (2012) (Figure 5.5.2). Their study identified three different citizen groups. Environmentalists emphasized hydrological regulation, maintenance of habitats, and recreation. Production-oriented individuals perceived particularly the income from provisioning services as important. They also considered peatlands an important energy source. The perceptions of the third group lie between the two other groups.

5.6

## Expert opinions on the priorities in ecosystem management

**Eija Pouta, Heini Ahtiainen, Janne Artell and Tuija Lankia**

At present, scientific studies do not offer value estimates for the various ecosystem services and changes in their provision. One approach to obtain information on the relative importance of various ecosystem services or information on priorities for ecosystem management alternatives are workshops eliciting expert and stakeholder opinions (e.g. Milcu et al. 2013). Here, with information obtained from an expert workshop, we aim to identify those ecosystem services that are affected either negatively or positively by environmental changes, and measure the expert opinion on the strength of the effect of the environmental changes on ecosystem services. The experts were also asked to allocate public funds to secure ecosystem services affected by environmental changes and thus to indicate the importance of ecosystem services. The information collected in the workshop can also be used to identify the most important topics for future valuation studies.

TEEB for Finland workshop of 27 experts and stakeholders was organized on 18th March 2014. The experts and stakeholders represented research organizations, environmental and natural resource administration, extension organizations, natural resources related firms and interest groups. Before the workshop, we identified the environmental changes that are considered most severe at present (Putkuri et al. 2013). These environmental changes can also be assumed to threaten ecosystem services and thus they are potential targets for public policies aiming to prevent loss in ecosystem services. The environmental changes that were selected were climate change, land use changes, nutrient leaching to surface waters (later eutrophication) and the use of chemical and other harmful substances (later chemicalization). In the workshop, the experts stated their perceptions of the direction and strength by which each environmental change would affect the ecosystem services. The presentation of the ecosystem services was based on the CICES classification. The participants were asked "How strongly and in which direction do you think environmental changes will affect the following ecosystem services in Finland within the next 30 years?"

**Table 5.6.1**. Expert allocation of 100 points to support ecosystem services undergoing environmental changes.

| Environmental change – ecosystem service pairs | Average of allocated input (scale 0-100) |
|---|---|
| Eutrophication: ability to maintain the chemical condition of waters | 18 |
| Climate change: global climate regulation | 14 |
| Land use change: maintenance of populations, habitats and gene pool protection | 14 |
| Climate change: hydrological cycles and flood protection | 13 |
| Chemicalization: ability to maintain the chemical conditions of water | 12 |
| Land use change: recreational use of nature | 12 |
| Climate change: pest and disease control | 12 |
| Eutrophication: recreational use of nature | 9 |
| Climate change: control of erosion | 9 |

The most positive effects of environmental changes were related to provisioning services. Climate change in particular was considered to have a positive impact on food, wood and fiber and bioenergy production. Land use changes and eutrophication were also considered to support bioenergy production.

The most negative effects of environmental changes on ecosystem services were targeted at regulating and cultural services. Land use changes and chemicalization were seen as decreasing the supply of ecosystem services in general. However, the effects of climate change were the most widely dispersed, involving both the most negative and the most positive estimates. Climate change was perceived as having a negative effect especially on hydrological cycles and flood protection, global climate regulation, pest and disease control and control of erosion. Land use changes were considered to have a negative effect particularly on the recreational use of nature and maintenance of populations, habitats and gene pool protection. Eutrophication of waters was perceived as decreasing the ecosystems' ability to maintain the chemical condition of waters and also as reducing the possibilities for recreation in nature. Chemicalization of the environment was professed as disturbing the ecosystems' ability to maintain the chemical conditions of waters.

The next question provided information on how the experts would allocate public funds between a set of ecosystem services under environmental changes. These results can also be interpreted as information on the relative value the experts and stakeholders place on these services and the environmental changes affecting them. Participants were shown the previously identified nine ecosystem services that were considered to be deteriorating the most due to environmental changes. They were asked the following question: "How should the input to support the ecosystem services be allocated, if you think about the welfare effects of ecosystem services for people?" The experts were asked to allocate 100 points to the environmental change – ecosystems service pairs. The means of the allocations that ranged from 0 to 100 points are presented in Table 5.6.1.

The results showed that the experts emphasized the importance of supporting the quality of water ecosystems, as on average over half of the inputs were allocated to water ecosystem services. 27% of the total inputs were directed towards two effects of eutrophication: the maintenance of the chemical conditions of waters and the recreational use of nature. Two other climate change effects were related to water ecosystems, i.e. supporting the hydrological cycles and erosion control, comprising 22% of the total available input to support ecosystem services. Furthermore, the effect of chemicalization on water ecosystems ability to maintain water conditions received 12% of the allocated input.

The effect of land use changes on the maintenance of biodiversity and recreation received 26% of the input to support ecosystem services overall. Although regulating services are intermediate and do not provide final benefits to people, they were emphasized in the allocation. Preventing the effects of climate change on regulating services in particular collected a high level of support. Of the total input, 48% was allocated to regulating services controlling global climate, hydrological cycles and floods, pests and diseases, and erosion.

Previous valuation studies have shown that the recreation benefits of reducing eutrophication (one-meter increase in sight depth) were valued at around €30.6–92.4 million in Finland (Vesterinen et al. 2010). This provides a benchmark of the magnitude of the benefits of reducing the harmful effects of environmental changes. As shown in Table 5.6.1, several other environmental threats were of greater importance than the eutrophication effects on recreation in stakeholder and expert judgments. However, a majority of these regulating ecosystem services that were evaluated as highly important by experts and stakeholders were intermediate services. As intermediate services do not affect human well-being directly, it is important to identify their contribution to the provision of final ecosystem services and thus benefits. Although the discussions in the workshop revealed some difficulties in stakeholders' and experts' understanding of regulating services for, the results still emphasized the need to take regulating services into account more rigorously in the valuation of ecosystem services.


YHA-Kuvapankki / Milla Popova

# 6 Ecosystem services in society and policy

6.1

## Integration of ecosystem services into decision-making

**Suvi Borgström and Jukka Similä**

Mapping, measuring and valuing ecosystem services is important for ecosystem service governance, but the research alone doesn't directly lead to the increased use of this knowledge in decision-making (Primmer & Furman 2012). In order to ensure that the available knowledge on ecosystem services is actually taken into account, regulation is needed. In addition to this, channels through which decision-makers can access this knowledge on ecosystem services need to be in place.

However, the operationalization of new scientific concepts such as ecosystem services does not always require the promulgation of new legislation. A tremendous amount of incremental regulatory reform can be accomplished through creative interpretation of existing norms and effective utilization of the implementation mechanisms under contemporary legislation. (Ruhl 2011)

Having said this, there are also factors limiting the possibilities for taking new knowledge into account in decision-making affecting the rights and responsibilities of individuals. The general aim of the legal system is to provide stability and security regarding expectations, and thus general principles such as the principle of protecting legitimate expectations, the requirements for precision in the law defining the rights and obligations of individuals etc. limit the possibilities for adopting new approaches.

In some cases the strict legal norms may directly prohibit the utilization of the new scientific knowledge and concepts such as ecosystem services. However, in most of the cases laws do not directly authorize or ban integration of new scientific concepts in decision-making. In these cases the challenge is to find those provisions that can reasonably be interpreted in a way that provides possibilities to implement the new concept.

In Finland there are already numerous regulatory instruments including direct regulations (e.g. species and habitats protection instruments in the Nature Conservation Act (1096/1996)), economic instruments (e.g. the METSO-programme for forestry) and planning instruments (e.g. land use planning and water management plans), introduced to steer economic and other actors in protecting biological diversity and environment. All of these are relevant for securing provisioning of ecosystem services as well. However, most of these regulations were not introduced with ecosystem services in mind, and thus they may either fail to take into account knowledge of ecosystem services or act as actual barriers for their consideration. Thus it is important that the present regulation models are carefully re-evaluated. (Ruhl & Salzman 2007)

On one hand, the situation can be improved to some extent without major legislative changes through providing information on how ecosystem services can be taken into consideration within the framework of existing regulations on decision-making. Effective implementation of existing environmental regulations is also often considered important in this regard (Mertens et al. 2012). On the other hand, some changes to regulations may be needed in order to remove barriers. Furthermore, new instruments that integrate the value of ecosystem services into economic system could be introduced.

Below, the aspects that are important in assessing and developing regulatory frameworks for integrating ecosystem services into decision-making are discussed. Based on these aspects remarks are made on the current regulatory system. The aim is not to carry out a thorough review of the very comprehensive set of regulations that currently apply, but rather to highlight some possibilities and limitations of the current regulatory frameworks based on previous research (see especially Similä et al. forthcoming, Borgström & Kistenkas 2014, Borgström, forthcoming). In addition to this, needs for developing the knowledge systems providing content for decision-making will be discussed.

6.1.1

### Assessing and developing a regulatory system for ecosystem services

As ecosystems are only partially non-rivalrous, meaning that focusing on the production of single service may lead to a decrease in the production of other services, regulation is needed to manage the potential trade-offs between ecosystem services. Ensuring that ecosystems continue to provide numerous services for the benefit of society requires regulating those activities that drive rivalry. How to best manage rivalry is highly dependent on the nature of user groups (current and future generations and non-humans) and the recourse characteristics such as the renewal rate of the recourse (Frischmann 2013, Borgström & Kistenkas 2014). Depending on the circumstances, in some cases directing land use towards specific areas or regulatory activities to minimize the negative impacts on ecosystems are adequate measures, but in other cases conserving areas or restoration measures may be needed. In our opinion, any legal system securing effectively production of ecosystem services should include legal mechanisms for all these functions (directing the placement of activities, regulatory activities to minimize the negative impacts on ecosystems, protecting areas and places of special importance for ecosystem services, restoration). (Similä et al. forthcoming)

What makes the task of securing the provision of ecosystem services even more difficult is the uncertainty caused by the nature of ecosystems as highly complex, constantly changing systems. As changes are natural in ecosystems, it is apparent that their services cannot be secured through eliminating changes. Instead, the focus of ecosystem management should be on enhancing and supporting ecosystem resilience. Resilience is the capacity of a system to withstand internal and/or external change and yet remain with the same regime (Holling 1973, 1996). Resilient ecosystem is capable of sustaining ecosystem functions essential for production of ecosystem services. As scientists have concluded, ecosystem resilience cannot be sustained by preserving single species and specific tracks of land. Instead, the ecosystem functions should be preserved by protecting biodiversity "everywhere" (Folke et al. 2004). Folke et al. consider that, in order to conserve ecosystem resilience, it is necessary to identify the major social and economic forces that are currently driving the loss of functional diversity, and to create incentives to redirect those forces. In this regard reform of subsidies may be needed as currently some economic sectors, such as energy, transportation and agriculture are subsidized in a manner that is harmful for the environment (Hyyrynen 2013).

In addition, protecting ecosystem functions requires regulatory framework that allows consideration of different spatial scales, since neither ecosystems nor the services they deliver follow administrative or sectoral boundaries. This calls for coordination between different instruments and strategic planning to support single decision-making procedures. (Borgström et al. forthcoming)

Further, conservation institutions that apply adaptive governance and adaptive management techniques have been seen as important for achieving ecosystem resilience. Adaptive governance enhances an institution's capability to deal flexibly with new situations, thus preparing managers for uncertainty and surprise. In order to enhance adaptive governance, environmental laws need to be flexible enough to allow consideration of local conditions, experimenting and learning (Arnold & Gunderson 2013, Camacho 2009, Cosens 2010, Green et al. 2011, Ruhl & Salzman 2013, Ruhl 2012). However, while some scholars have delineated the benefits of a regulatory system with flexible norms, and with decentralized and redundant regulatory authority, various weaknesses have also been identified. These include the failure to address broadly dispersed issues such as global climate change, and potential incentives for regulatory inattention as well as problems with legal security and enforceability. Thus, regulatory flexibility and fragmentation of decision-making needs to be balanced with adequate coordination of decision-making, robust monitoring and feedback systems (Buzbee 2005).

The key findings of this section are summarized in Table 6.1.1.

**Table 6.1.1**. The key issues to be addressed in assessing and developing regulation to secure the provisioning of ecosystem services.

- Coverage and coherence: do the regulations cover all sectors and activities affecting land use and use of water resources and include tools for all measures needed to protect ecosystem services? Does the regulatory system work for enhancing ecosystem functions and services in a robust manner across all sectors?
- Accommodating diverging interests: do the regulations allow consideration of a variety of ecosystem services, equally balancing economic, social as well as ecological benefits?
- Coordination between instruments: do the instruments function well together and does the regulation provide tools for landscape level management?
- Capacity to support adaptive management: Does the regulatory system provide mechanisms that leave flexibility in local decision-making and require robust monitoring? Does it include adequate feedback systems and allow for adaptation of decision-making?

6.1.2

## Remarks on the potentiality and pitfalls of the current regulatory system

### Coverage and coherence

With the exception of the Act on the Remediation of Certain Environmental Damages (383/2009) the concept of ecosystem services is not made explicit in the Finnish legislation. However, there are a variety of instruments (regulatory, economic, planning) in place, which are relevant for ecosystem services. The Finnish regulatory machinery provides opportunities, in principle, to conserve whatever habitat types the authorities consider worth protecting, and most activities that could potentially change these environments are regulated in some way or another. With regard to the placement of activities and regulation of them, the regulatory network seems to cover all major activities and hence provide some kinds of tools for directing detrimental activities away from valuable areas. However, some small activities, such as pulling cords, fall outside the permitting procedure, and they can be carried out without any environmental control.

In Finland particularly valuable habitat types are protected through the Nature Conservation Act (1096/1996), the Water Act (587/2011), the Act on Wilderness Areas (62/1991), the Forest Act (1093/1996), and the Rapids Conservation Act (35/1987). Some of these habitat types are directly protected by law, while others require a separate administrative decision in order to have legal effects. In addition to these 'traditional' nature conservation instruments, the voluntary protection of certain forest habitats is possible under the Forest Biodiversity Protection Programme for Southern Finland (METSO). However, these mechanisms have not been created with ecosystem services in mind, and thus they are unlikely to be adequate for the protection of ecosystem services. For instance, mechanisms to protect a habitat have been criticized for covering only small fractions of land and only a part of the habitats in need of protection (Raunio et al. 2010). In addition the criteria for the selection of a site and the management provisions may fail to allow for consideration of ecosystem services, as they tend to focus on special natural values. In addition to this, the existing legal mechanisms for area protection are inadequate for securing connectivity between protected areas, which is important for the provisioning of many ecosystem services. (Similä et al., forthcoming)

If we look at the four groups of concrete measures that contribute towards securing the provisioning of ecosystem services (directing the placement of activities, regulating activities to minimize the environmental harm, conserving places of special importance and restoration measures) the main institutional deficiency relates to restoration (Borgström, forthcoming).

The legal basis for restoration measures in Finland can mainly be derived from the EU's Nature Conservation Directives, the Water Framework Di-

rective and the Marine Strategy Directive. While the lack of specific legal obligations for restoration has been viewed as a failing of the Habitats Directive, the legal obligation for restoration can be derived from the Directive through interpreting the provisions in the light of conservation objectives. The obligation regarding the restoration of ecosystems can be derived from Articles 6(1) and 6(2) of the Habitats Directive, which require member states to establish the necessary conservation measures corresponding to the ecological requirements of the natural habitat types in Annex I and the species in Annex II present on the sites. The same Articles also require the member states to take appropriate steps to avoid the deterioration of natural habitats and the habitats of species in the special conservation areas (Trouwborst 2011).

The same applies to Finnish nature conservation legislation; there are now explicit requirements for ecosystem restoration. However, as restoration measures are essential for achieving the objectives of the EU and national nature conservation legislation, though largely unregulated, ecological restoration is a commonly used nature conservation practice in state-owned protected areas. (Metsähallitus 2014)

Regarding inland waters and marine environments, the provisions under the Water Framework Directive and the Marine Strategy Directive, which are implemented by the Water Management Act in Finland, set clearer obligations to conduct restoration measures, in comparison with the Habitats and Birds Directives. This is due in particular to the time limits set to achieve the targets of the Directives. However, in Finland these obligations are not entirely reflected in restoration practice as, according the National Biodiversity Strategy, the financing for restoration measures is inadequate and in order to meet the conservation targets and the legal obligation to achieve the good status of water bodies and favorable conservation status of the species and habitats as required according to EU law, financing should be significantly increased (Ministry of Environment 2013).

The responsibility for ecosystem restoration in Finland is largely left to public bodies and is highly dependent on the availability of public finance. Finnish law does not allow obligations to be placed on landowners forcing them to take active measures to restore habitats, except when this obligation is a permit condition of natural resources use. There are only a few legal obligations which require the restoration of changed habitats (e.g. after extraction of soil or mineral resources). There is no general mechanism that can cover situations where the need to restore habits is based on the cumulative effects of various kinds of possible small activities. (Similä et al. forthcoming)

Thus in general, restoration requires either voluntary action based on negotiation, or economic instruments compensating for the economic loss, that activities carried out for the public good may cause. The key instrument for financing biodiversity conservation measures in Finland is the METSO programme. However, it covers only forest areas and provides limited possibilities for funding restoration projects. Furthermore, the strict provisions on species and habitat conservation may even serve to curtail voluntary restoration measures as landowners may instead be incentivized to prevent the settling of protected species in order to avoid strict land use restrictions in the future. (Schoukens et al. 2010)

While in general the Finnish regulatory system covers all the sectors and activities relevant for securing the provisioning of ecosystem services, the coherence of the system is questionable (Similä et al., forthcoming). It seems that not all regulations work towards protection of ecosystems, but rather some may have negative effect on them. Currently, there are a variety of economic tools that do not function in a coherent manner to protect and secure provisioning of ecosystem services. Hyyrynen (2013) has identified several state subsidies that are harmful for the environment. According to Hyyrynen, most of the significant subsidies that are harmful for the environment are given in the energy sector, for transportation and for agriculture in Finland. These subsidies also have direct or indirect negative effects on ecosystem services. Often these subsidies enhance the use of non-renewable resources or they enhance production of one group of ecosystem services (provisioning services) at the expense of others. Thus, removing these kinds of subsidies and/or redirecting them to support measures that enhance or preserve ecosystem resilience would significantly enhance the efficiency of the regulatory system for securing provisioning of ecosystem services.

In the case of forestry in Finland, another evaluation by the Finnish Association for Nature Conservation (SLL) provided a more negative view of the industry's environmental impacts than Hyyrynen (2013). This NGO report (SLL 2014) recommended that the government suspend subsidies for constructing forest roads, trenching and forest renewal.

## Accommodating diverging interests

To a large extent the laws regulating nature conservation and the use of natural resources tend to focus on specific natural values and provide adequate protection only to those values. For instance, a relatively new act regulating mining (the Mining Act 621/2011) has been slated for allowing economic interests to override social and environmental values, as it only gives due consideration to significant environmental values or significant negative effects on local livelihoods etc. In addition to this, as mentioned above, economic tools are often intended to enhance production of a single ecosystem service (such as food production), with negative effects on others.

On the other hand there are flexible norms in use which leave a lot of discretion to decision-makers and allow, in principle, for consideration of wider environmental values and balancing of interests. For instance, land use planning provides a flexible mechanism to take into account ecosystem services and accommodate diverging interests. However, without clear legal obligations to weight and balance the social, economic and environmental benefits, decision makers may continue to use these flexible norms to override one of the benefits in favor of another one. Thus, finding the right balance between regulatory flexibility and enforceability is important.

## Coordination between instruments

The current environmental governance system in Finland consists of a broad, but fragmented set of instruments (Similä et al. forthcoming). While regulatory fragmentation as such cannot be regarded as a negative phenomenon, it becomes problematic if coordination between instruments and information sharing between authorities is not adequate. The sector specific governance systems and single decision-making procedures often restrict consideration to only the particular activity and area in question. They fail to provide means to plan conservation of wider landscapes and to consider joint effects. Furthermore, the regulatory fragmentation runs the risk of regulatory inattention. (Camacho 2010)

To improve the coordination of decision-making, there has been a trend towards more integrated environmental regulation in Finland. For instance, an increased use of planning instruments such as management plans under the water framework Directive can been seen as part of a development towards a more integrative regulatory system. These plans have their legal effect through provisions that require authorities to "take into account" or "give due consideration" to them in decision-making based on other legislation.

However, there is still work to be done to enhance coordination between instruments in Finland. For instance, the link between the planning law, which is a key planning instrument relevant for ecosystem services, and instruments regulating various activities is either completely lacking or weak. According to the Land Use and Building Act (§3), the land use objectives and plans must be taken into account, as separately prescribed, when planning and deciding on use of the environment on the basis of other legislation. Detailed regulations – and defining the crucial permit conditions – occur under other laws, which do not always require that planning decisions are taken into account.

Furthermore, the Water Management Act seems to provide a better link between planning and decision-making based on other laws, as it requires authorities to give due consideration in their operations to the water resources management plans as appropriate (Water management Act §21). The effectiveness of management plans, however depends on how authorities "give due consideration" to the plans in their operations, especially in granting permits for operations.  Without deeper legal analysis and material on the matter it is difficult to say much about the legal effects of the plans on single decision-making processes such as decisions on environmental permits. (Kauppila 2011)

The Act on Environmental Impact Assessment has also been criticized for a lack of effectiveness in final decision-making (Pölönen 2014). However, the latest amendment to the Directive on Environmental Impact Assessment aims to improve the situation in this regard. A new article (8a) was introduced to require competent authorities to include some items substantiating the decision in the development consent decision itself.

## Capacity to support adaptive management

A prerequisite for adaptive management is an effective monitoring system. In Finland there are a huge number of monitoring programmes and data banks which are in some way or another relevant for the understanding of the state of and changes to ecosystems. However, there is no sufficient data concerning ecosystem services and the mechanisms affecting the provision of those services available for decision-makers. Nevertheless, a new combination of existing sources of information may provide opportunities to develop the information basis for ecosystem services policy (Similä et al., forthcoming).

While continuous and robust monitoring is important for ecosystem management, it is inadequate for making sure that this knowledge is reflected in decision-making. Thus mechanisms to ensure that decisions on conservation measures, plans, programs, legislation and administrative decisions are revised according to knowledge gained. When it comes to the mechanisms to respond to new knowledge gained on ecosystem services through monitoring or other means, our analysis indicates that there are various approaches in use aiming to increase the adaptive capacity of regulations. To begin with, in a small country like Finland, even environmental laws are often revised; two thirds of environmental laws and regulations are less than 10 years old and one third less than 5 years old. Regulatory impact assessment is obligatory for all new laws and either strategic impacts assessment or environmental impact assessment is compulsory for all major policy and administrative decisions. This system provides a basis for the integration of ecosystem services into legislation. In connection with the review of laws affecting the use of land and water, the government should continuously make sure that the sustainable use of ecosystem services is secured.

The existing regulatory framework also includes mechanisms that allow for consideration of new knowledge, even without changes in legislation. For instance, the plans under the planning laws are frequently updated. Furthermore, permit decisions regulating activities need to be renewed after a period of time, and conditions for subsidies are regularly revised. Modern laws governing the regulation of activities and projects, even make it possible to initiate a process aiming to change permit conditions before the regular revision is due, if something unforeseeable happen, or new knowledge is gained. However, the problem lies in the fact that the adaptive capacity of regulations is not harnessed for securing the production of ecosystem services. The legal requirements for the renewal of permits or changing them before regular revisions do not make any special reference to potential limiting of ecosystem services providing grounds for authorities to change permit conditions based on new knowledge on harmful effects of activities on ecosystem functions.

6.1.3

### Assessing and developing knowledge systems

Scientific knowledge on identifying, mapping and valuing ecosystem services is developing fast, but those ultimately governing ecosystem services often continue to base their decisions on traditional knowledge of production, segregated to specific habitats, ecosystems, geographical areas and sectors, while an ecosystem service approach would require integration of multiple knowledge sources. (Primmer & Furman 2012)

In order to assess the potential and pitfalls of the current knowledge systems and the knowledge base of the decision-makers on ecosystem services, the TEEB for Finland sent a questionnaire to 100 representatives from the public authorities, research institutions, and non-governmental organizations. The questionnaire was sent to the Ministries of the Environment, Agriculture and Forestry, Employment and the Economy, Centres for Economic Development, Transport and the Environment (ELY Centres), Regional state administrative agencies, representatives from Regional Councils and municipalities. The questionnaire was also sent to Regional Forest Centers, Metsähallitus (Finnish Forest and Parks Service), Forestry Development Centre Tapio (TAPIO), Finnish Environment Institute (SYKE), Finnish Forest Research Institute (Metla), GTK (Geological Survey of Finland) and SLL (The Finnish Association for Nature Conservation). In the questionnaire, we first asked respondents to identify the knowledge systems they use in their work. Secondly, in order to assess the potential and pitfalls of the current systems we asked whether the knowledge systems used are sector, habitat, ecosystem or geographically specific, and whether the sector specific nature of the knowledge systems hinders the possibilities for taking into account ecosystem services in the decision-making. Furthermore, we asked whether the knowledge systems are readily available, and what may limit availability. We also asked whether information in different knowledge systems is easily integrated and applied in decision-making and if these knowledge systems provide a sufficient overall picture of ecosystem services relevant for decision-making. The possibilities for integrating new knowledge on ecosystem services into existing knowledge systems, was also asked about.

Thirdly, we aimed to assess the relationship between regulation and knowledge systems by asking whether the knowledge available on the value (social, economic, ecological), spatial distribution and the state and development trends of ecosystem services can be used in decision-making. Furthermore, we asked respondents to identify barriers or limitations to using the knowledge. Finally we asked for recommendations to improve the situation through changes to knowledge systems, legislation and policy instruments.

We gained 21 responses, representing the Finnish Environment Institute (SYKE); the Ministry of the Environment; the Ministry of Employment and the Economy; Centres for Economic Development, Transport and the Environment (ELY Centres); Regional State Administrative Agencies; Regional Councils; municipalities; Metsähallitus (Finnish Forest and Parks Service); Forestry Development Centre Tapio (TAPIO); Finnish Environment Institute (SYKE); Forest Research Institute (Metla); GTK (Geological Survey of Finland); and SLL (The Finnish Association for Nature Conservation).

It is not surprising that that the knowledge systems used proved to be sector specific. However, it was not expected that only 8 out of 21 respondents agreed that the sector specificity of the knowledge systems hinders the possibilities for taking into account ecosystem services in their work. Half of the respondents agreed that it is difficult to integrate knowledge from different sources and apply it. The majority also responded that they do not get adequate information on ecosystem services from the current systems. 10 out of 20 respondents also stated that knowledge systems are not readily available.

According to the respondents, the majority of the valuable databases have been made available. One respondent commented that it is sometimes difficult to get GIS-based data on the land use plans. Further legislation, especially on the protection of privacy information was often seen as a barrier for access to relevant data. This was seen as problematic especially in the context of forest information. It was also commented that sometimes concerns regarding commercial secrets are used to block the access to relevant data. For instance, private peat-extracting companies do not give information on the quality of peat for use as a basis for decision-making on environmental permits. In addition to this, information on the appearance of endangered species is not always available due to legislation. Practical difficulties in using knowledge systems were also identified as a problem. According to some respondents there is often not sufficient guidance for using different knowledge systems. Furthermore, it was stated that knowledge is scattered between different actors and obtaining access rights is not a clear or smooth process.

When asked about the possibilities for using knowledge on the value of ecosystem services in decision-making, only 4 out of 20 respondents agreed that they could use information on the economic value of ecosystem services and only 3 agreed that they could use knowledge on the social value of ecosystem services in decision-making. However, 9 out of 20 respondents agreed that they could use knowledge on the ecological value of ecosystem services and knowledge on the state and trends of ecosystem services in decision-making. Finally, 11 out of 20 respondents agreed they could use knowledge on the distribution of ecosystem services in decision-making.

Legislation was seen as a barrier, limiting the possibilities for using knowledge on ecosystem services in decision-making. It was commented that neither the Environmental Protection Act nor the Water Act allows for consideration of ecosystem services in permit decisions. The following laws were seen as the most important when developing legislation in this regard:

- Land use and Building Act
- Forest Act
- Act on Financing Sustainable Use of Forests
- Nature Conservation Act
- Environmental Protection Act
- Water Act
- Water Management Act
- Legislation regulating agriculture sector
- Act on Forest information system
- Fishing Act

In particular, a lack of IT-skills, time and resources in using the knowledge were seen as barriers for using the knowledge available on ecosystem services.

Respondents also gave recommendations for developing knowledge systems, legislation and economic tools. These recommendations, taken directly from the questionnaire, are listed in boxes below.

Recommendations gained from the TEEB for Finland questionnaire on developing knowledge systems, legislation and economic tools

**Recommendations for developing knowledge systems:**

- Financing consistent analysis covering the whole country, providing open access to the results and providing metadata and documentation in a transparent manner
- Developing and enhancing education for decision makers to improve the knowledge base on ecosystem services
- Areas providing the most valuable ecosystem services should be integrated into the environmental administration GIS database
- Knowledge on ecosystem services should be in an open portal and the development of ecosystem service indicators should be transparent
- Accessibility and user friendliness, utilization of existing well-functioning systems: for instance "Maanmittauslaitoksen paikkatietoikkuna" (a web service called "GIS window" provided by the National land Survey of Finland)
- Increasing open access to databases
- Opening up the use of sector specific databases and knowledge systems between different public authorities
- Developing monetary valuation of ecosystem services
- More knowledge is needed on the values, trade-offs and synergies as well as ecological processes producing ecosystem services
- Introducing one easily accessible knowledge system
- Utilizing existing knowledge systems to a feasible extent
- Information and data produced should be available and easily accessible for everyone
- Knowledge systems should enable a holistic view without dependence/connection to sector-specific interests
- Developing open access internet based GIS-systems
- Information should be processed to help with decision-making: in addition to knowledge on the location of species etc. information on their value should also be available
- Adequate time and education for introducing new knowledge systems is needed.

**Recommendations for developing legislation:**

- The Land use and Building Act: An obligation to take into account ecosystem services in land use planning
- The Environmental Protection Act: A provision that would prevent deterioration of important ecosystem services
- Developing legislation to prevent the spread of invasive alien species
- Taking into account ecosystem services when revising legislation
- Developing legislation based on the principle of open information
- Decreasing regulation: utilizing a bottom-up approach
- Legislation should be developed to create a framework for utilizing ecosystem services at a sustainable level
- Focus on supportive legislation rather than command and control based regulation.

**Recommendations for developing economic tools:**

- Development of compensation instruments through experimentation
- Developing taxation (for instance lower tax levels for ecologically friendly food products)
- Incorporating measures to prevent invasive alien species in subsidy systems
- Developing policy instruments to decrease consumption
- Developing voluntary based instruments
- Removing/reducing environmentally harmful subsidies
- Developing taxation from income tax towards consumption based taxation; tax for transportation in order to support local production
- Re-directing existing subsidies (for instance changing the Act on Financing Sustainable Forestry in order to diversify the measures that are eligible for financing)
- Focus more on taxation than subsidization.

6.2

# Case: Payments for ecosystem services (PES)

**Dalia D'Amato and Marianne Kettunen**

6.2.1

## PES as a policy instrument for ecosystem services

Ecosystems' functions underpin ecosystem services. These functions are the necessary inputs that maintain ecosystems' production systems, regulatory processes and cultural attributes. However, the socio-economic 'invisibility' of ecosystem services (ES), especially in terms of market value, has led to undervaluation and mismanagement of ecosystems and their many benefits. In the absence of an economic incentive for maintaining ecosystem services, landowners will be likely to ignore them, leading to socially and even economically sub-optimal land use decisions.

Payments for ecosystem services (PES) compensate individuals or communities for undertaking actions that maintain or increase the provision of ecosystem services such as water purification, flood mitigation and carbon sequestration. PES schemes have thus gained attention as a policy solution complementary to the historical command and control forms of intervention to promote environmental conservation. Key principles for the success of economic instruments like PES, are cost-effectiveness and additionality. In other words, PES needs to deliver demonstrated and measurable additional environmental benefits which would not be already provided otherwise or be less costly to provide in an alternative way (see Box 1.).

### BOX 1. Examples of existing PES schemes in the Netherlands and Sweden

For the construction of buffer strips between ditches and crops in Noord-Brabant, in the Netherlands, landowners were paid €0.35–0.70 per meter of buffer strip. Payments were financed by the water boards in Brabant and by the province from the Investment Budget for Rural Areas scheme. As a result, the drift of pesticides declined by 90%. Avoided costs for artificial treatment of water were estimated at €2.20 and €8.50 per kilogram of nitrogen and phosphorous respectively. This management option would also beneficial for biodiversity and habitat protection, pollination and soil fertility. It contributes to the aesthetic and landscape value and attracts interest and tourism (TEEB for Business – The Netherlands 2012).

In Lysekil Municipality, Sweden, a payment mechanism was set up between 2005 and 2011 whereby the local waste water plant pays mussel farmers to remove nutrients from coastal waters. Payments are based on the content of nitrogen and phosphorous in the mussels harvested. About 3,500 tonnes of blue mussels per year helped remove 100% of the nitrogen emissions of the waste water treatment plant, while the minimum requirements for the plant are 70% removal of nitrogen. The mussels also capture phosphorus and organic material. The estimated savings for the municipality, compared to using a traditional technique, are €100,000 per year. Mussels are then used as seafood for human consumption (Lindahl & Kollberg 2008, Zandersen et al. 2009).

6.2.2

## PES as a part of sustainable water management in Finland

Water purification and water regulation are key ecosystem services, underpinning socio-economic well-being in Finland and, in general, in the Nordic countries. Forests, wetlands, lakes, rivers and coastal waters play an important role in the hydrological cycle, contributing to water provision (water storage and recharge), regulation (retention and distribution of flows) and purification (removal of nutrients, heavy metals, suspended sediments, pathogens). Water quality and quantity also support the provisioning of several other ecosystem services. They link to food provision, human health and safety, soil fertility, recreational opportunities, aesthetic and cultural values, for example by preventing and mitigating flood events, controlling the spread of waterborne diseases and water pollution, providing clean water for recreational activities and supporting biodiversity.

The biggest challenges regarding the management of water-based ecosystem services in Finland are the reduction of agricultural and forestry loads; the reduction of domestic wastewater in areas outside sewerage networks; the mitigation of flood risks in rivers, lakes and coastal areas; groundwater protection; water body restoration and mitigation of harmful impacts of hydrological engineering and water level regulation (Maunula 2012). These issues are likely to grow in importance as climate change impacts hydrological cycles. In managing water resources, a mix of regulatory and economic tools can be used at different spatial scales and

governance levels. The different instruments can interact together creating positive synergies. While regulation helps to secure a safe minimum standard for biodiversity conservation and ecosystem service provision, economic instruments, such as PES, can complement the regulative baseline by producing additional environmental benefits. Despite some conceptual and technical limitations, PES schemes can offer a direct, and possibly more equitable, solution for achieving environmental outcomes.

### Developing policy coordination among existing and potential instruments

The EU-wide agri-environmental payments are often considered as a type of large scale, public funded PES scheme. Agri-environmental payments in Finland cover more than 90% of agricultural areas and already comprise a high share of water protection measures. Despite great effort, agri-environmental payments have not achieved the set targets so far (Berninger et al. 2011). The main difference in comparison to pure PES is that agri-environmental payments are conditional on land-use changes and management actions, rather than ecological targets indicating ecosystem services provision such as measurements of nitrogen balance in a field parcel. The recommendations for improving the effectiveness of agri-environmental schemes include introducing – when possible – outcome-based payments and targeting environmentally sensitive or the most ecologically valuable areas (OECD 2010). In the future, such improved agri-environment schemes could function as a kind of the national/regional 'bottom-line' public PES scheme for sustainable water management, with the possibility of being 'topped up' by smaller scale schemes (public or private).

Excluding agri-environmental payments, there are no PES schemes for water purification and regulation services in Finland. However, the potential for developing PES-type measures does exist. At a regional scale, river basin management plans under the Water Framework Directive hold potential as a framework to implement PES schemes. As highlighted by previous studies, synergies between the Common Agricultural Policy (CAP) and the Water Framework Directive (WFD) can contribute to achieving common goals by improving economic and administrative efficiency and by increasing public participation, bringing together relevant actors and preventing conflicts among different stakeholders (Ecologic 2006, summary in Box 2.).

### BOX 2. Linking the implementation of the Water Framework Directive and Common Agricultural Policy

The development of a proper water pricing system in the agricultural context, recommended by the WFD, is influenced by CAP policies and their effect on farmers' decisions. According to a study in 2006 (Ecologic 2006), some of the CAP incentives work against the cost recovery aspects of sustainable water pricing. On the other hand, however, the CAP payments can soften the social and economic hardships resulting from WFD implementation. Consequently, the development of a proper water pricing system in the agricultural context needs an understanding of CAP payments and their effect on farmers' decisions.

In order to achieve this, the study emphasized that good coordination is needed among responsible authorities planning rural development and those responsible for river basin management plans, as well as cooperation regarding control and monitoring of water quality, quantity and hydro-morphological aspects (e.g. shared databases).

Finally, the study identified public participation as a key factor for a successful implementation of the CAP and WFD: the involvement of relevant stakeholders, such as farmers, water suppliers and nature conservation groups, can lead to measures beneficial for all parties, minimizing potential conflicts. Measures and initiatives to foster co-operation and participation need to be carefully adapted to the governance level they are intended to address.

At a local level and regional level, several instruments could be adopted to develop – or to complement – PES schemes. These include municipal water and storm-water fees, one-off investments, the LIFE+ programs and schemes financed by private companies.

Water bills (water supply and wastewater fees) can be used to create ear-marked payments targeting landowners that maintain the desired management practices or achieve certain environmental targets. In Italy, for example, a payment scheme was developed by Romagna Acque S.p.A., a public company owning and managing all the drinkable water resources of the Romagna region. The company used part of the revenues deriving from the water tariff payments (1–3%) to compensate landowners in the catchment areas, helping them to cover the costs related to changes in management practices. This PES scheme achieved positive im-

pacts on the environment and reduced the water company's costs for water purification, while the landowners increased or maintained their annual forest revenue (Pettenella et al. 2012).

In Finland, about 20–30 % of the municipal costs of water are due to the purification of drinking water and the treatment of sewage. Sourcing from nearby high-quality water bodies lowers the cost of the water supply and purification. Municipalities paying higher water fees for water purification (e.g. Kärstämäki, Levi, Naantali) could be interested in integrating ecosystem-based solutions, if this results in an abatement of the costs of artificial water purification.

Stormwater or rainfall taxes exist in a number of northern EU Member States. In Sweden, Denmark and Germany storm-water fees works as disincentives to establish impervious surfaces, or as incentives (reduction in taxation) to implement solutions to control storm-water (Mattheiss et al. 2010). Revenues collected from the fee could be used to finance ecosystem services payment schemes.

One-off investments secure conservation and enhancement of ecosystem services through land acquisition or restoration, rather than through systematic payments to landowners. Instead of a business transaction where a buyer and a provider are identified and a market for ES is created, the above-mentioned initiatives arise in the context of a virtuous action, sometimes coordinated by a mixture of public and private bodies, acting as an investor on behalf of the whole community.

Finnish cases of one-off investments include initiatives and measures such as restoration of water bodies, construction or protection of wetlands, creation of green infrastructures and buffer zones, all aimed at enhancing a bundle of ecosystem services. For example, creation of wetlands or other buffer zones can be develop to support water regulation, water purification, habitat and biodiversity protection and cultural and landscape values in urban areas. Even though one-off investment initiatives are not PES schemes, they can be important elements in supporting such schemes, bringing together different stakeholders and testing the feasibility of new measures and actions to implement the ecosystem services approach in land management. They create a good substrate for ecosystem services thinking and can be considered a potential 'incubator' of PES schemes. In Finland these initiatives have been shown to receive strong support from local communities and local public entities and private stakeholders, where the participatory process is a key component for success.

LIFE+ projects have been used in other countries to develop workable solutions, which can feed into policy development, often by establishing best practice or guidelines (Grieber 2009). In Finland, the LIFE+ project 'Urban Oases' aims at implementing constructed wetlands and other natural water systems intended to create additional regulating and cultural services mitigation. Measures eligible for LIFE+ funding could be used to compensate land owners for virtuous management practices. Even though LIFE+ is not intended for payments in the long term, it can create opportunities to develop new methodologies, improve existing management measures and bring together stakeholders, securing PES sustainability through a participatory approach.

The most common and well known private PES schemes in western countries are those in which companies bottling water or producing other beverages participate. Private PES schemes have been set up by the companies Vittel, Henniez and Bionade in France, Switzerland and Germany respectively (Hirsch et al. 2011).

Due to its high-quality freshwater, Finland has the lowest bottled water consumption level of European countries. Market niches exist, for example, in those areas in the country where water is contaminated or low quality. Bottled water is also required in specific situations such as during traveling and for consumption in restaurants, bars etc. Finnish bottled water is also shipped to be sold abroad, even though in this case the ecological burden of transporting bottled water internationally needs to be considered. Maintaining the already excellent water quality for national and international markets could be a sensible investment for water companies both for economic reasons and in terms of public image. In addition to this, a clean supply of water is necessary for the production of all sorts of beverages, such as milk, juices, soft drinks beer and cider, which are very popular in Finland. Wastewater, on the other hand, is one of the most significant waste products of brewery operations. This creates some space, in theory, for two PES scenarios, with the companies paying the landowners for delivering at source good quality water or for having the wastewater purified in a sustainable and more cost-effective way. This may also provide new opportunities for agricultural entrepreneurship.

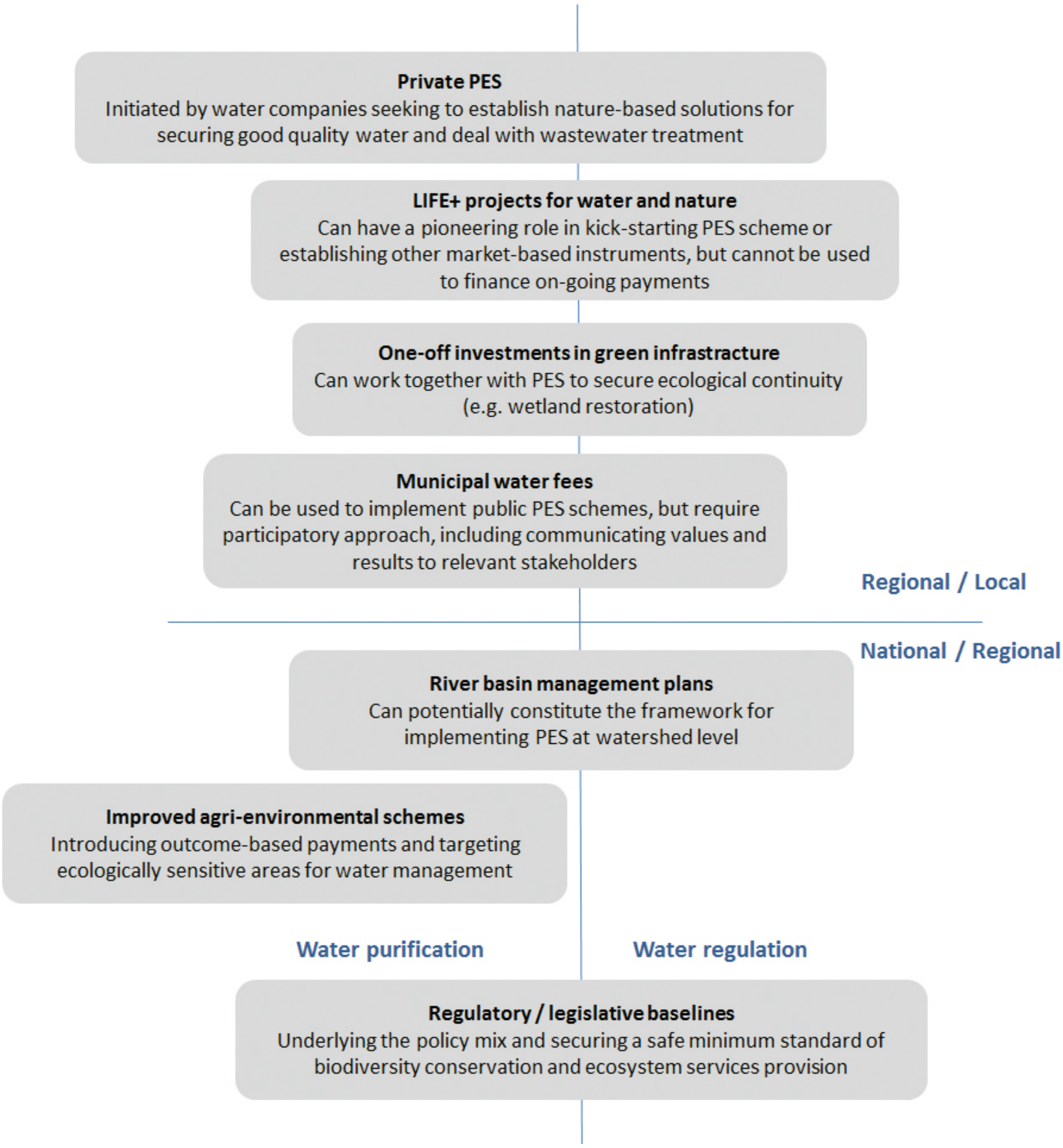



**Figure 6.2.1**. A possible framework for the protection and management of water resources in Finland, including a mix of existing and potential new tools. Such a framework is recommended for forming the basis for implementation of PES schemes.

### Spatial coordination for ecological and economic effectiveness

In addition to creating a mix of instruments where PES can work efficiently (Figure 6.2.1), there is a need to implement this 'policymix' in a spatial context. Spatially targeted payments, complemented by other instruments such as one-off investments, can be developed to secure an ecological continuum across public and private borders, resulting in economic and ecological efficiency (Prager et al. 2012, Wünscher et al. 2008). This approach is necessary for an integrated and holistic management of water resources, as recommended by the Water Framework Directive, amongst others. There are opportunities at different spatial scales (upstream-downstream locations) and governance levels (local, regional, national) for implementing locally attuned nature-based measures (Figure 6.2.2).

Sustainable forest and agriculture practices – set aside forests or peatland restoration, creation of buffer zones between ditches and crops – can contribute to the regulation of the water flow and soil erosion, contributing to water storage and improving water quality. Wastewater from urban or industrial provenience can be treated by natural and constructed wetlands. Agri-environmental schemes could be regionally targeted toward areas representing the heaviest sources of agricultural nitrogen loads, or toward the most environmentally sensitive or valuable areas. It has also been hypothesized that agri-environmental schemes could be extended to support mussel farming enterprises to remove nutrients from coastal waters, the same way as support is paid to agricultural farmers for operations that reduce nutrient leakage from their farmland (Lindahl & Kollberg 2009). The removal of nitrogen in coastal waters could be a solution to complement the management of the nutrient load at the source. Localized activities such as artificial reefs or mussel farming can potentially contribute to the enhancement of the natural self-purification capacity of the environment. This solution might be suitable in the south-western coastal areas of Finland, which are intense sources of pollution and where inland ecosystems have limited capacity to assimilate nutrients.

Mussel farming as a method of nutrient removal is a relatively new development. Implementation costs for mussel farming show a large variation (€0.1–1.1 billion per year) depending on production, sales options, and formulation of nutrient load targets for the Baltic Sea. An evaluation of mussel farming as a cleaning device under the HELCOM Baltic Sea Action Plan revealed that mussel farming could decrease total abatement costs by approximately 5% (Gren et al. 2009). While further research is crucial to the development of a strong PES market, there is also a need to investigate market demand for the mussels produced (Smith et al. 2013). Technical challenges might be related to cold weather and the mussels' survival rate, as well as to infrastructure damage caused by ice (Box 3.).

### BOX 3. Lessons learnt from mussel farming in Lysekil, Sweden

**Technical challenges**

Mussel farming works best where there are some currents which bring the food (phytoplankton) in sufficient quantities to the mussel farm. However, mussel growth in Finland is very much limited by climate conditions, and this is of course a challenge. It is absolutely necessary to be able to lower the mussel farms to below the surface during winter in order to escape the ice, and especially ice drift. The farming equipment should be cost-effective, which means little maintenance and simple to harvest. The logistics after harvest and taking care of the harvested biomass are also of great importance.

**Business plan**

What Lysekil municipality paid for N-harvest was not enough to run the farming economically. The company was also dependent on selling the mussels as seafood, mainly on the European market. When this failed, the company went bankrupt. Thus, an accurate business plan is crucial to establish a sustainable business. Most likely the payment for harvesting N and P using mussel farming must cover all the costs, including transport to the mussel meal plant, biogas production plant or compost/fertilizer company, etc.

Lindahl, Odd – verbal communication.

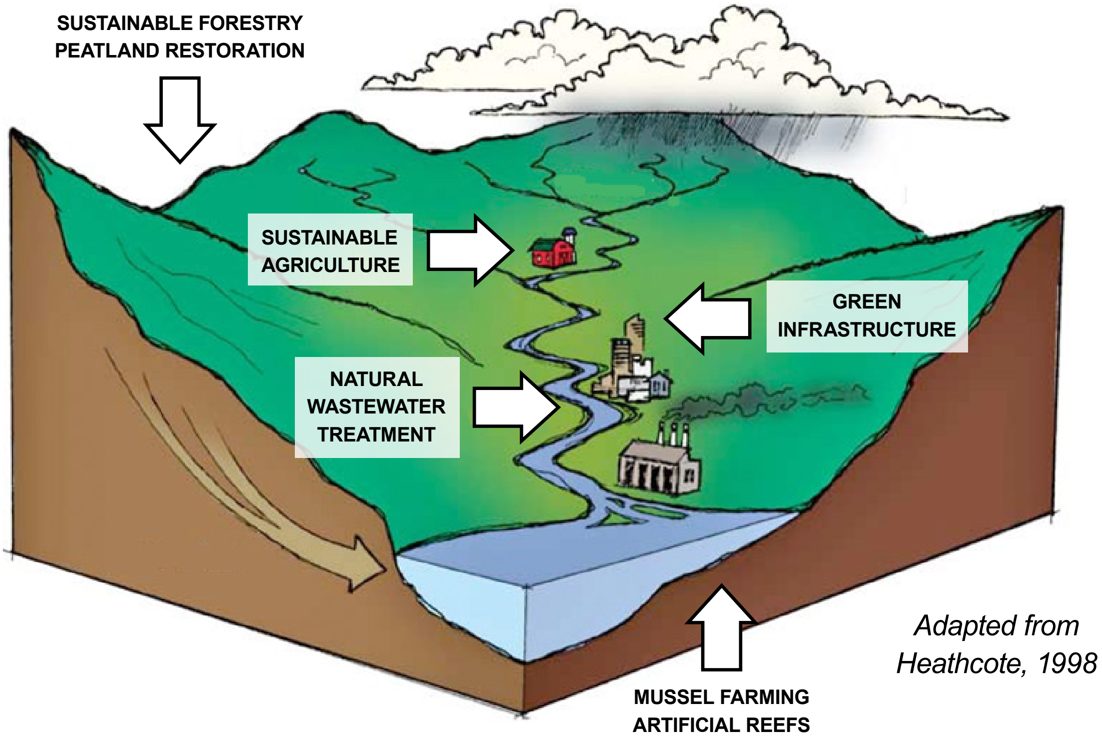



**Figure 6.2.2**. Spatial illustration of opportunities for sustainable water management at a watershed level, supported by the implementation of PES schemes.

6.2.3

## Opportunities for and barriers to the uptake of PES schemes in Finland

Several factors can potentially enable – or on the other hand hamper – implementation of PES schemes in Finland at different levels. Understanding of the biophysical components and processes underpinning water regulation and purification is still fragmented. Furthermore, the socio-economic value of these services is still not fully recognized by society and institutions. Ecological and monetary valuation methods to assess the value of ecosystem services are imperfect and cannot fully capture the real value of assets. A sensible problem to be addressed is how to measure or demonstrate additionality and cost-efficiency of payments i.e. whether the PES scheme is actually delivering additional environmental benefit and is cost-efficient compared to other solutions. Further ecological and economic information is needed. The development of ecosystem services indicators – both biophysical and socio-economic alike – is seen as one of the key actions required (Kettunen et al. 2012). The socio-cultural context and implementation and coordination of relevant policy framework are also factors likely to affect the feasibility of PES schemes. Synergies between the policy framework and national legislation need to be assessed further.

### Improving the understanding of biophysical processes and socio-economic value of water purification and water regulation

The biophysical status and trends of natural systems can be an indication of their capacity to deliver ecosystem services. While the status of ecosystems (cover area, vulnerability) in Finland is relatively well known, there is a need to further investigate the components and mechanisms of ecological functions delivering water-related services and how changes in land use and climate change are likely to impact on these functions. Examples of ecological functions underpinning water purification and regulation are the pollution retention capacity or the water storage capacity of ecosystems such as forests, wetlands, inland and coastal waters. For example, nitrogen retention can be used as an indicator for water purification. Relatively advanced models are currently available to map nitrogen fluxes (Box 4.).

### BOX 4. Nitrogen fluxes in Finland: sources and sinks

Lepistö et al. (2006) analyzed the nitrogen export and retention capacity in 30 river basins in Finland. The estimated total export from river basins in Finland was 119,000 tonnes of nitrogen per year for the period 1993 to 1998. This estimation includes nitrogen export from different land use types, nitrogen inputs from atmospheric deposition and point sources. The study highlighted that the nitrogen export is higher in south-west Finland. The retention capacity of the system is weaker in small coastal river basins. In coastal areas in south-west Finland, these two phenomena overlap, resulting in a considerable nitrogen load from anthropic sources and a weak retention capacity of the natural system.

The ability of healthy watersheds to moderate water flows and purify water supplies for consumption and other uses is reflected by very tangible social and economic considerations. Water quality and quantity affects human health and security and economic sectors such as fishery, recreation and tourism. Qualitative and quantitative information on the importance of water purification and regulation in Finland is available both for the current situation and in terms of future changes (e.g. climate change). Examples are the areas and populations at risk of droughts or flooding, the water consumption needs and the available freshwater sources. Regarding the monetary value of water-based services, while a number of case studies and local examples can be identified, national and regional level data is often lacking. Water fees can be used to partially approximate the value of water purification, while the monetary value of water regulating services could be estimated as the costs and damages caused for example by flood events (Box 5.).

### BOX 5. Flood protection in Finland

In the ´Extreme Flood Project´, the Regional Environmental Centres made flood damage estimates for almost 400 risk areas in all Finland. According to these estimates, the sum of damage costs of extreme floods occurring in all risk areas of the country would be around €550 million. However, the probability of such extremes occurring everywhere in the country during a single year is extremely low. Broken down according to various human activities, 52% of the damage could be expected to be caused to buildings, 20% to industry, 17% to agriculture, 6% to roads and bridges, 3% to forestry and 2% to public services (Silander et al. 2006).

### Understanding the socio-cultural context

Public perception of payments for ecosystem services and landowners' willingness to engage in PES schemes are pivotal factors in the success of PES implementation. Studies regarding public willingness to pay for ecosystem services (Box 6.) show that Finnish people are concerned about the quality of environment and are willing to support environmental measures dedicated to restoring or protecting ecosystems and their services. If user-based PESs are to be established i.e. via water bills or other taxes, transparency and a participatory approach are important components for success.

Land owners interests and values in managing their land and willingness to engage in payments for ecosystem services can be described and predicted through surveys and models (Layton & Siikamäki 2009). Existing studies show that farmers and forest owners are interested in ecosystem services production, but not inclined to make long term commitments. In particular, forest owners fear losing autonomy and lack trust in authorities. In addition to this, fragmented and fast-changing forest ownership can make it difficult to identify and engage land owners in long-term PES schemes.

#### BOX 6. Helsinki citizens' willingness to pay for restoration measures in streams and small waters

Barton et al. (2012) assessed public interest in a fictional restoration project involving streams and small waters in Helsinki. Restoration measures would deliver additional benefits in terms of soil erosion control, flood and storm protection, aesthetic and recreational values and maintenance of biological diversity and wilderness values. Citizens' willingness to pay was estimated at €1.4 million per year for the five year period of the fictional restoration project.

6.3

## Case: Habitat banking

**Matleena Kniivilä, Anna-Kaisa Kosenius and Paula Horne**

6.3.1

### What are ecological compensation and habitat banking?

One possible solution for achieving no net loss of biodiversity is a wider use of compensation mechanisms. In Finland legislation requires avoidance and minimization of losses to nature. In large-scale projects possible measures aiming for avoidance and minimization are examined through the environmental impact assessment (EIA) process. The legislation does not, however, enable the use of ecological compensation in permit procedures. Requirements for compensation are included in only a few statutes.

Habitat banking is one of the compensation mechanisms used to achieve compensation for ecological losses caused by development projects (e.g. construction of infrastructure). Several European countries use some compensation mechanisms, but habitat banking is widely used only in Germany as well as outside Europe, e.g. in the USA and Australia. This section is the summary of Kniivilä et al. (2014a, see also Kniivilä et al. 2014b), which examines the applicability of habitat banking in Finland, assesses the most essential aspects from the Finnish perspective and the pros and cons of the mechanism and compensation in general, along with recommendations for the future actions.

Ecological compensation must be considered in the context of the 'mitigation hierarchy'. This means that compensation should be preceded by prevention and mitigation of negative impacts and used only as a final measure to compensate for the remaining negative impacts, if proceeding with the development project is considered necessary. The key aim is to ensure that the overall state of biodiversity remains unchanged or improves. As the term 'compensation' is used somewhat vaguely and does not always include the idea of no net loss, the term biodiversity offsetting is often used instead. Biodiversity offsets are formalized arrangements for delivering compensation in terms of ecological values to increase biodiversity values or at least to achieve no net loss (ICF GHK 2013). The key principle in compensation is that there are 'no go areas', i.e. areas the nature values of which are so valuable that they have to be kept intact (see e.g. OECD 2013, ICMM IUCN 2012).

The Business and Biodiversity Offsets Programme (BBOP) has created a guide to best practices for the establishers of biodiversity offsets (BBOP 2009a-b, BBOP 2012). The criteria have been created in co-operation with significant number of international organizations, governments and private companies. BBOP defines biodiversity offsets as follows:

"Biodiversity offsets are measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from development plans or projects after appropriate prevention and mitigation measures have been taken. The goal of biodiversity offsets is to achieve no net loss and preferably a net gain of biodiversity on the ground with respect to species composition, habitat structure, ecosystem function and people's use and cultural values associated with biodiversity." (ICMM IUCN 2012, BBOP 2012).

Offsetting mainly takes the form of measures to restore, rehabilitate, create or preserve habitats (Commissariat général…. 2012). In many countries several of these measures are used and the choice of the measure depends on the circumstances. Three mechanisms used to implement compensation are (e.g. OECD 2013):

1) One-off approach: once adverse impacts have been evaluated, the biodiversity offset is carried out by the developer or by a subcontractor.
2) In-lieu arrangement: a government agency stipulates a fee that a developer has to pay to a third party, to compensate for residual biodiversity impacts.
3) Habitat banking / Biobanking, etc.: once adverse impacts are evaluated, the developer can purchase offsets directly from an already existing public or private habitat bank. The price of the credits is often determined on the market.

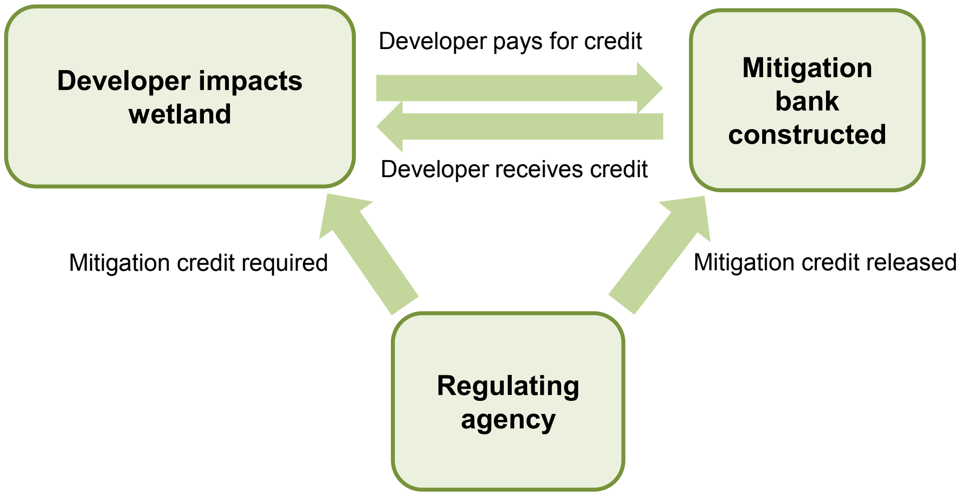



**Figure 6.3.1**. Wetland mitigation bank structure (Source: Hook & Shadle 2013).

6.3.2

## Habitat banking in practice: The USA as an example

Two compensation programs exist in the USA: conservation banking and wetland banking. Wetland banking is based on the Clean Water Act of 1972. The use of conservation banking began in the mid-1990s. In both mechanisms developers whose actions are causing damage to nature are obliged by law to compensate for the damage. This can be done by buying credits from habitat banks (conservation or wetland banks), for example.

Habitat banks are sites where resources (e.g. a certain habitat type or species) are restored, established and/or preserved (for perpetuity). The aim is to provide compensatory mitigation for the impacts of development projects that lead to biodiversity loss elsewhere. The habitat bank sells credits to developers who are obligated to provide compensation (Figure 6.3.1). The price of credits is often determined by supply and demand. The seller of the credits is the owner of land with biodiversity values (e.g. a private landowner, companies, the state) and credits are bought by the developers (e.g. companies, the state) whose activities harm valuable features of nature. The authorities define the rules of habitat banking, monitor implementation and define the type, number and release of credits.

The unit of trading is normally a given acreage of strictly defined habitat. Sometimes, instead of acreage, the unit can be e.g. a nesting pair of an endangered bird species or a combination of the size of the area and species composition. For wetlands, functional value of the area and its size are of major importance (www.ecosystemmarketplace.com). In conservation banking credits are normally sold only after it can be proved that conservation has been successful. Thus, the mere realization of the conservation measures is not enough. This was not required in all agreements before.

The prices of credits sold, varies depending on the characteristics of the habitat, costs of restoration and demand. At the beginning of the 2000s the highest prices per hectare were already hundreds of thousands of US dollars (Bishop et al. 2008). The cheapest prices were at the same time about thousand US dollars per hectare (Bishop et al. 2008). According to the Ecosystem Marketplace portal the average price of wetland credits in 2008 was about US$30,000 per hectare. Prices vary between states and wetland types.

6.3.3

## Pros and cons of habitat banking

The use of ecological compensation has increased in Europe during the last few years. The aim has been that degraded biodiversity could be compensated for with new, high-value areas. In practice, however, the outcome has not always been successful (Quickley & Harper 2005a, 2005b, Moilanen et al. 2009, Walker et al. 2009, Maron et al. 2012). One reason for these failures has been criteria for compensation that are too simple, both in terms of habitat replaced and time needed (e.g. Overton et al. 2013). There have also been flaws in practical implementation and monitoring.

Bekessy et al. (2010) consider the time-lag related to restoration and the risks of failure, for example, to be problematic. In addition to this,

some compensation mechanisms allow the use of sites which are already threatened and thus do not necessarily bring any additional ecological value to conservation network as compensation areas. Bekessy et al. (2010), however, consider the use of ecological compensation as reasonable when it can be proved that the compensation area has reached the biodiversity level required. According to McKenney & Kiesecker (2010) mechanisms should be developed so that it is possible to evaluate the additional ecological value compensation areas are providing, the likelihood of reaching the ecological targets and the time needed to create new ecological values.

If habitat banking is used as a compensation mechanism, it is important to assess the economic factors which impact on land-owners' and entrepreneurs' interest in the mechanisms and to their willingness to create and use habitat banks. If landowners make their decisions based on economic grounds, the net income from habitat banking should be higher than the net income from an alternative land use, e.g. forestry. Habitat banking as an economic activity includes risks related to ecological failures, regulation and time perspective (no certainty on demand and markets), for example, with all of these impacting on expected net income.

From society's point of view a significant factor is the consistency of habitat banking with the 'Polluter pays' principle. Furthermore, by using habitat banking, markets are created for non-market goods – biodiversity and ecosystem services. The creation of economic value for these goods should lead to more optimal use of resources from society's point of view. Similarly, private landowners would benefit if they provide public goods on their property.

The use of compensation mechanisms includes ecological and economic risks and the researchers' conclusions on the applicability of the mechanism are not unambiguous. However, if implementation is carried out using good practices, the use of the mechanism will lead to no net loss of biodiversity or net gain in biodiversity compared to a situation with no compensation demanded.

6.3.4

### Applicability to Finland

#### Factors supporting the implementation of the mechanism in Finland:

+ Finland is a stable society with well-functioning institutes. This is a prerequisite for the success of habitat banking. Strict criteria, involvement of different parties and monitoring of activities are prerequisites for functioning of the mechanism.
+ Habitat banking might be an interesting activity for Metsähallitus (the organization governing state-owned commercial forests and nature protection areas) as the organization is already carrying out restoration activities. Habitat banking could also be an additional financing source for Metsähallitus.
+ Furthermore, several Finnish companies find the No Net Loss principle interesting and relevant to their activities.
+ Private forest owners could find habitat banking interesting as there are already positive experiences of the voluntary forest biodiversity conservation program METSO.
+ There is a significant amount of experience of restoration activities in Finland.
+ The ecological knowledge and information needed for measuring sufficient compensation are readily available in Finland.

#### Challenges and restricting factors:

- It can be challenging to find compensation sites which are ecologically valuable and located close enough to development sites.
- There may not be enough voluntary demand. Changes in legislation might be needed.
- No certainty of sufficient demand and supply to guarantee economic viability.
- Development of the actual trading mechanism will take years.
- Development of ecological values in restoration sites will take a long time.
- Private forest holdings in Finland are small. However, co-operation between forest owners would partly solve this problem.
- The role of the state should be assessed. Could the state act as a seller and buyer of nature values and on the other hand also as a regulator of the mechanism? What would be the role of those restoration projects which are already under way?

6.3.5

### Conclusions and policy recommendations for Finland

If ecological compensation is to be used in Finland, compensation should be an option only if avoidance and minimization of loss are not enough to eliminate the problem, and carrying out the development project is still considered essential from society's point of view.

As in Natura 2000 areas, the requirement for compensation could also be considered in other conservation areas where nature values are weakened. Ecological compensation could also be an option if biodiversity of existing conservation area is indirectly weakened e.g. because of a development project. This could include the impacts of large-scale projects like mining and major road construction. Furthermore, the mechanism could be used in peat production by requiring ecological compensation for the use of peatlands in purely or nearly natural states.

If the aim is to halt biodiversity degradation in accordance with the EU's 'No Net Loss' target, the requirement for compensation should also include other sites of specific ecological importance even if they are located outside conservation areas (e.g. habitats conserved by the Nature Conservation Act). It should be explicitly determined which nature values are considered exceptionally valuable and thus meeting requirements for compensation, so that the requirement for compensation would not lead to heavy bureaucracy and/or the hindering and stagnating of conventional development.

The use of compensation would inevitably cause costs. If the mechanism is used in Finland, the developers causing the loss should be obliged, as far as is possible and reasonable, to bear the costs. This would also encourage developers to seek alternative solutions to compensation (avoidance, minimization). This would also be in line with the EIA process.

The habitat banking mechanism is a market-based mechanism, but regulation is needed to support it. Use of habitat banking would encourage landowners to voluntarily produce ecosystem services of social importance and it increases landowners' possibilities to make choices between different production lines. The use of habitat banking might be a way to move forward from the METSO programme and partially closer to market-based methods in nature conservation. Compensation mechanisms could also partially act as a financing mechanism for METSO.

The use of habitat banking is possible only if landowners/entrepreneurs find the mechanism interesting. The level of interest is dependent on many issues, e.g. clarity of the mechanism, the stability and predictability of regulation, the level of demand and expected earnings, risks, and the availability of financing.

In addition to the supply, it would also be important also assess the level of demand for habitat banking. On what grounds would the developers causing losses be willing to take part in habitat banking? Is voluntary demand enough from society's point of view or is obligatory compensation needed? Which of the compensation mechanisms or other mechanisms are considered important from society's viewpoint and what is the role of habitat banking in different mechanisms? In infrastructure projects the buyer of natural values would typically be the government. In more business oriented cases buyers would be private companies. In particular for companies working in international environments it is important that potential new practices in Finland are in line with international practices. Even if habitat banking is a market-based mechanism, strong involvement from the government is also needed. There are risks related to regulation, which would impact on the success of habitat banking.

As restoration can fail due to ecological risks, for example, the mechanism should be used in habitats where the likelihood of success is high. Habitat banking could also be combined with the production of other ecosystem services, e.g. carbon sequestration or production of clean water. By producing several ecosystem services instead of one, habitat banking would most likely be more effective.

Habitat banking is one the mechanisms which could be used to prevent or slow down the degradation of biodiversity in Finland. However, the application of the mechanism should be carefully defined and restricted so that the compensation demand would not lead to the hindering of ordinary economic activity.

A careful and relatively long-lasting piloting phase is required before the possible implementation of the mechanism in Finland. The use of the mechanism should be piloted in many habitats, such as forests, peatlands, and traditional rural biotopes. Traditional biotopes, which can be developed in a relatively short time, and already partially restored mires serve as a potential supply pool for habitat banking sites, as well as forest sites offered to the METSO conservation programme but not yet accepted due to budget limits.

The interest of sellers and restrictions they set should be assessed. Similarly, the needs and interest of buyers should be examined. Possible buyers in the pilot phase could be those companies which are already now carrying out compensation in their own activities, for example. Furthermore, in the pilot phase a special emphasis should be placed on the verification of the impacts of actions and assessing the impacts on the costs for public authorities.

YHA-Kuvapankki / Pirjo Ferin

# 7 The role and possibilities of ecosystem services in promoting green economy

7.1

## Ecosystem services as part of green economy

**Riina Antikainen, Katriina Alhola and Marianne Kettunen**

The links between ecosystems services and green economy are evident. The objective of this section is to discuss the role and possibilities of ecosystem services in promoting green economy in Finland. Our aim is to identify the most important economic and business sectors in Finland utilizing and benefiting from ecosystem services. Additionally, we present four sector-specific cases to exemplify the benefits and disadvantages caused to ecosystem services by some economic sectors. Our approach is one of life cycle thinking. Moreover, we discuss new business potential related to ecosystem services. The section is based on a more thorough analysis of the topic presented in Antikainen et al. (2014, manuscript).

This review was based on literature along with cases and examples from other countries and various business sectors. We used four economic sectors as examples to systematically demonstrate the interlinkages and interdependencies between ecosystem services, economic sectors and green economy. These sectors were the forestry sector, mining, water supply and management and tourism. They were selected because they are either currently significant in terms of the national economy and use of natural resources in Finland, or will be considered to be more important in the future.

To identify and structurize the connections between ecosystem services and economic sectors, a conceptual assessment framework was developed (Figure 7.1.1). Ecosystem services facilitate business activities in different sectors by providing resources for the sector, but on the other hand, an economic sector also affects ecosystem services either by causing them to deteriorate or improving their state. Identification of the connections and interlinkages between ecosystem services and economic sectors provides more understanding on questions such as: What are the most important ecosystem services that the long-term sustainability of selected sectors depends on (directly or indirectly)? What kinds of green economy benefits can the selected sectors bring through sustainable use of ecosystem services? How could the economic sector improve its business performance by integrating ecosystem service and green economy components in its operations, and what kind of implications would this have on sustainable use and management of ES? This information and understanding then can be used to find topics that need more thorough consideration and research, and to support decision-making in both private and public sectors. The use of the conceptual assessment framework is exemplified in the case of the forest sector (Figure 7.1.1).

Results are also presented from the TEEB for Finland stakeholder workshop held on 18.3.2014, where the relationship between green economy and ecosystem services in Finland, both now and in the future, was discussed.

7.1.1

### Green economy in selected sectors in Finland: forestry, water supply and management, tourism, and mining

#### Forest sector

Forests form an important part of Finnish nature as they cover over 70% of the country's land surface. Forestry and the forest industry have long been significant economic sectors providing employment in rural areas. Many Finnish towns were originally created around sawmills. Even though in recent years the production of Finnish forest industries has decreased, the sector's share of Finland's industrial production was still about 18% in 2012 (Suomen virallinen tilasto 2012). Forest industries also have a significant role in Finnish foreign trade. In 2012, forest industry products, mainly products from the pulp and paper industries, represented

19% of the total Finnish exports of goods. On the other hand, the proportion of wood procurement made up of imported wood in the Finnish forest industries has been around 17%, sometimes even nearer to 30% (Metla 2013c).

From the economic perspective, the most substantial ecosystem services produced by Finnish forests include the provisioning services of materials from plants (wood) and bioenergy. In addition to this, forests also widely maintain other ecosystem services benefiting forest industries either directly or indirectly by affecting to the growth of forests. These regulating and maintenance services impact on the hydrological cycle and flood protection, pest and disease control and soil formation and composition. If any of these ecosystem services were to not exist, material production for the industry would be halted or significantly reduced.

In addition to the dependency of the forest industry on forests, forest ecosystems provide many ecosystem services to other sectors, including tourism and recreation, the food sector (wild plants, berries, mushrooms, fish and game animals) and the chemical and pharmaceutical industry (e.g. Jäppinen et al. 2014), for example. Multiple uses of forests is customary even in commercial forests. While providing raw-materials, the forests can be simultaneously utilized for e.g. recreation and ecosystem services are still maintained, if the forests are managed according to the green economy principles.

While the forest industries are strongly dependent on and benefit from ecosystem services, the forestry and forest industry also have a major impact on all ecosystems services provided by forests. Evidently, it affects the wood material provisioning, but also other services, such as the hydrological cycle and climate regulation (Figure 7.1.1). In the case of some ecosystem services, the current impact can be positive: Finnish timber reserves are growing as the annual average increment of the current growing stock (104 million $m^3$) exceeds the drain (68 million $m^3$). In addition to timber provisioning, this is significant in terms of global climate regulation, as the increasing wood biomass binds carbon from the atmosphere. On the other hand, forestry practices can cause local deterioration of water quality, for example. Moreover, forests are home to the majority of the threatened species in Finland. Many species with economic value, such as game animals also suffer from the forestry practices, for example due to fragmentation.

The transition to bioeconomy, aiming at using renewable natural resources to replace fossil resources as much as possible (see definition in Section 2.5) and implementation of several new large scale bio-product plants could lead to increased demand for wood in Finland. This, in turn, could lead to the intensification of existing forest practices within the region and/or acquisition of further areas for forestry, resulting in negative impacts on both biodiversity, e.gl. for saprophytic species (Antikainen et al. 2007) and ecosystem services such as water retention. It is important that these effects are also considered sufficiently in such a large project. Besides timber products and pulp and paper, the bioeconomy also leans strongly on using biomass for innovative products such as pharmaceuticals, functional foods, enzymes and replacing fossil materials and minerals in plastics, fabrics and construction materials, for example.

A key question in the transition to bioeconomy in Finland is how the ecosystem services and multiple uses of forests are maintained simultaneously. Currently in Finland biotic materials including wood, plants and animals compose about ten per cent of the total material requirement of the country (Statistics Finland 2014). Event though not all non-renewable resources can be replaced with renewable alternatives, the transition places great pressure on the multiple ecosystem services the forests provide. On the other hand, a sustainable forestry and forest industry with proactive integration of ecosystem services into the sector can produce many green economy environmental benefits, including climate change mitigation, a reduction in fossil fuel dependency, as well as socio-economic benefits such as potential improvements in economic growth, productivity and competitiveness, accelerated innovation, and thus job creation and poverty reduction.

### Water supply and management

In Finland, the fresh and drinking water supply is generally regulated and managed by dedicated companies within municipalities. The role of these companies is to both ensure that a sufficient amount of water is available and also to guarantee the quality of the water supply. These companies form an important economic sector at regional and local levels, especially in the context of cities and broader urban areas.

The supply of drinking water – both in terms of quantity and quality – is underpinned by a range of ecosystem services. Naturally, the availability of water builds on the provisioning of surface and ground water (i.e. water provisioning). Importantly, however, this water provisioning is directly linked to ecosystems' ability to maintain hydrological cycles and 'capture' and store water, while at the same time mitigating the risk of surface run-off and flooding. Indirectly these beneficial functional services build on other ecological attributes such as

availability of good-quality, permeable soil and the existence of vegetation cover to prevent soil erosion. Furthermore, ecosystems play an integral role in maintaining the chemical conditions of water and capturing waste and toxins, thereby also maintaining the quality of water. On the other hand, the functioning of the fresh and drinking water sector can have impacts on a range of different ecosystem services. In particular, almost all ecosystems' beneficial regulating processes (indirectly) build on the availability of water. Cultural ecosystem services depend directly on the quality of ecosystems and a range of dedicated characteristics that are affected by water availability (species diversity, ecosystem structure, aesthetic characteristics, etc.)

In terms of green economy, a range of economic sectors and society as a whole are dependent on the availability of fresh and drinking water. Furthermore, a range of sectors such as agriculture and tourism strongly depend on the maintenance of other ecosystem services potentially affected by water extraction and consumption. However, the dependencies of water – and other – economic sectors on ecosystems' ability to maintain water quality and availability are not reflected in water prices in Finland. In general, however, water bills (water supply and wastewater fees) could integrate aspects of ecosystem services. For example, as highlighted in Section 6.2 of this report, water bills could be used create ear-marked payments (payments for ecosystem services – PES) targeting landowners who maintain desired management practices or achieve certain environmental targets related to the maintenance of water-related ecosystem services (D'Amato & Kettunen, 2014, Pettenella et al. 2012). In Finland, about 20–30% of the municipal costs of water are due to the purification of drinking water and the treatment of sewage. Sourcing from nearby high-quality water bodies lowers the cost of water supply and purification. Municipalities paying higher water fees for water purification could be interested in integrating ecosystem-based solutions into their water management policies, if this results in an abatement of the costs of artificial water purification. Stormwater or rainfall taxes exist in a number of northern EU Member States. In Sweden, Denmark and Germany stormwater fees work as disincentives to establishing impervious surfaces, or as incentives (reduction to taxation) to implement solutions to control storm-water (Mattheiss et al. 2010). Revenues collected from the fee could be used to finance water-related PES schemes. Such PES schemes could be considered as forming a part of a green economy, given they aim to capture the value of well-functioning ecosystems in regulating water quality and quantity and integrating this value into economic signals, including directing payments to people keeping ecosystems in good and functioning condition.

Currently, only 2% of the groundwater resources important to and suitable for water supply purposes in Finland are classified as low quality, and approximately 500 (of around 6,000) groundwater areas are at significant risk from human activity (EEA 2010; Ympäristö 2011). However, ground and surface water protection is still considered one of the biggest current challenges related to management of water-related ecosystem services in Finland (Maunula 2012). These challenges are likely to grow in importance, as climate change is likely to induce changes in hydrology, nutrient load and thermal properties of water bodies (Forsius et al. 2013). Flooding patterns are likely to be altered and extreme events are expected to become more common, while annual variation in floods may also increase (Veijalainen et al. 2010, Marttila et al. 2005). These predicted challenges to the fresh and drinking water supply sector mean that the integration of wider, ecosystem services related considerations into the functioning of the sector are of high importance in the future.

### Tourism

Tourism and recreation in nature are extremely popular in Finland (Kettunen et al. 2012) and – not surprisingly – the tourism and recreation sector is one of the growing industries in Finland, currently representing 2.3% of the country's GDP (Matkailun toimialaraportti 2011). In terms of ecosystem services, the tourism and recreation sector builds on the easy access to nature and the enjoyment and different values people associate with nature. Consequently, the sector is directly dependent on the availability and maintenance of cultural services. The sector also relies heavily on the availability of resources related to catering for and the safety of visitors, including the provisioning of (local) food, availability of fresh water and mitigation of any possible natural disasters. Both the cultural and provisioning services underpinning the tourism and recreation sector are directly or indirectly linked to ecosystems' ability to maintain their beneficial regulatory functions, such as the maintenance of hydrological cycles and water quality (see 4.2.3 above). Furthermore, visitors' enjoyment is linked to the aesthetic features and environmental quality of an area, which in turn builds on, among other things, the abundance of insect-pollinated flowers, the regulation of pest and disease outbreaks, and water resources maintaining the vegetation cover.

Tourism and recreation can have impacts on a range of different ecosystem services. If not sustain-

ably managed, tourism and recreation can directly lead to the degradation of ecosystems: high visitor numbers can increase erosion, cause disturbance to species, and lead to littering and overconsumption of water resources. These ecosystem impacts have further negative effects on the quality and future availability of cultural services, diminishing the natural beauty and people's enjoyment of areas. Increased visitor numbers can also affect the spiritual and cultural values people – especially locals – associate with a place. Finally, the tourism industry is known to contribute to the global carbon emissions, thus indirectly affecting the global climate regulation.

In terms of green economy, the tourism and recreation industry is clearly a growing area in Finland, and regionally it is already a significant source of livelihood in Finland. By 2020, the tourism industry is expected to offer 50,000 new jobs in Finland (OSKE 2013). At the moment, the financial benefits from the tourism trade are mainly enjoyed by restaurant and accommodation services, with some benefits also flowing to amusement parks, ski resorts, programme services, festivals and other cultural services, and camping sites (Finland's Tourism Strategy for 2020). Beautiful nature is indeed the most common reason for choosing Finland as destination for leisure trip, although not a dominating reason. Other reasons, such as new experiences and amusements and having fun are also often mentioned by visitors. (Ilola & Aho 2003).

From the national and local economic perspective, developing inbound tourism to Finland is the most efficient method of increasing the income generated by tourism. The key development objectives within the tourism sector in Finland include strengthening tourism clusters and networks, supporting the growth and development of enterprises, and improving the infrastructure of travel destinations and tourism areas (Finland's Tourism Strategy to 2020). As regards tourism industry trends, sustainable travelling has been recognized as one of the main trends globally. Tourism is sustainable when it "takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment and host communities" (UNWTO 2005). At present, climate change, untouched and clean nature and landscape-related values are focuses among travelers (Finland's Tourism Strategy to 2020). For example, 46% of German travelers consider sustainability in travelling very important. In addition to environmental awareness, there are trends such as 'Mindfulness' and 'Traditional treatments' that are gaining interest globally, but which have not yet appeared in Finland to a large extent. These new trends utilize services provided by nature's ecosystems and they often focus on improving mental and physical well-being in terms of decelerating, controlling stress, and 'earthing', for example walking on the ground with bare feet. In Finland these kind of old treatments include for example peat treatments (SMAL 2013).

### Mining

Finland's geographical conditions, i.e. bedrock and soil provide a basis for mining operations as they form a foundation for the extraction of metals and minerals. The development of the mining industry is seen as a major opportunity for Finland in terms of creating competitiveness and local socio-economic benefits, while responding to the increased global demand for raw materials. The Ministry of Employment and the Economy has launched an action plan which aims at making the country a leader in the sustainable extractive industry (Ministry of Employment and the Economy 2013a). In 2013, there were 12 metal ore mines operating in the country; and industrial minerals were extracted from over 30 mines (GTK 2014, Ministry of Employment and the Economy 2013b). In addition to this, hundreds of new soil extraction permits have been issued in recent years.

With the exception of supplies of fresh water for mining processes, the mining industry is not directly dependent on ecosystem services (Bishop 2010) but it has many significant direct or indirect impacts on ecosystem services. These impacts occur during the mining life cycle, i.e. in the exploration phase, construction of the site, roads and other infrastructure that provide access to distant areas, extractions and processing of metals and minerals, and mine closure (Kauppila et al. 2011).

Major impacts may be felt by provisioning services and regulating services in exploration and construction due to the removal of overlying habitats and the geological features of quarries and their construction areas. This may cause changes to the ecosystem's ability to provide resources, e.g. availability and quality of wild berries, mushrooms, medicinal plants, fish, fresh water and wood or timber. In addition to this, large cuttings of timber will have an effect on global climate regulation in terms of losses of carbon storage in the logging timber stage and years ahead.

The extractions and processing phases (including waste handling) may cause environmental and health impacts including emissions of greenhouse gases, dust and small particles; pollution to water; and noise (smell and visual impact are also possible). If the risk of emissions of heavy metals or chemical leaks and tailings, such as cyanide or sulfides to soil and water is realized, surface and

groundwater pollution, and soil and landscape contamination may occur on a large scale causing serious degradation and permanent damage to the environment in terms of losing the possibility to use water for drinking and non-drinking purposes.

Mining operations also have an impact on cultural ecosystems services, i.e. losses of recreational fishing and refreshing activities. Especially in Finland, the quarries located close to inland waters that may serve as a source for professional fishers, farmers and recreational use of nature as many people have their holiday cottages nearby. According to studies, the mere location of a quarry near to the property would cause a continuous hindrance to the owners in terms of 5% decreases in the prices of properties located between 5 and 20 km from the mining site (see Hietala et al. 2014). However, in the case of a severe accident, the environmental, economic and social losses would be much higher.

The impacts on ecosystem services can continue years after the closure of the mine, including for example, losses of carbon storage, death of flora and fauna, exposure to water and soil erosion. Abandoned mines may pose serious environmental risks especially if the after-treatment of the mine and areas affected by the mining operation are ignored.

It is commonly argued that mining industry makes a positive contribution to the national economy and increases local social-economic well-being in terms of creating jobs, generating income and taxes, and stimulating investments in education, health care and overall infrastructure, for example. But from the ecosystem service point of view, this all comes with certain costs to society. Besides the economic and social benefits in the nearby area, the mining may cause economic and social hindrances to other areas or even to other sectors. For example, the planned metal quarry to be located in Kuusamo, close to a natural park and the Ruka holiday resort, would cause an 11.5% decrease to the annual net revenue. The impact on employment in the tourism sector in those areas would be a 14.5% decrease within a year. If the quarry is opened as planned, this would cause €82.7 million losses in salary revenues in the tourism sector and a €15.9 million decrease in tax revenues. (Hietala et al. 2014). However, the impacts of the mining industry on other sectors vary regionally and the benefits and hindrances should be assessed on a case by case basis. (see Hietala et al. 2014).

Despite the global climate regulation impact, these external costs of environmental hindrances will be realized mostly locally and it will be primarily people living nearby who are on the receiving end. A serious environmental accident, such as the one that happened at Talvivaara mine in 2012, could evidently outweigh economic benefits. Thus an assessment of the mining industry as one of the potential growth sectors in the light of green economy is critical. Mining operations always have an impact on ecosystem services even though mining can be considered 'sustainable' or 'green' if the operations do not cause severe degradation to the ecosystem or will not reduce the possibilities of future generations to use the ecosystem services. In addition to this, the external costs caused to ecosystems should be covered by the company's income in order to also be sustainable from a social point of view.

Recognizing future trends worldwide, the terms "urban mining" and "landfill mining" are seen potential as creating new market opportunities and jobs, and accelerating the recycling of valuable metals such as cobalt, titanium, platinum and gold, which are needed especially in the development of "high tech" products. Both terms refer to processes through which the compounds and materials are recovered from products, buildings and infrastructure that have reached their end of life. In landfill mining the valuable materials including non-renewable materials have been discarded over the years. Sometimes urban mining is even seen as an alternative to the extraction of resources from geological deposits ("primary mining") as secondary materials are accumulating in large amounts as waste especially in urban settlements (World Resource Forum 2012). Projects that assess the landfill and urban mining potential have been carried out worldwide. However, in Finland they have so far indicated relatively low share of recyclable materials (see for example Kaartinen et al. 2013).

7.1.2

### Stakeholders' understanding of green economy and ecosystem services in Finland

In the TEEB for Finland workshop (18.3.2014), the main findings of the earlier literature review were presented. The stakeholders presented their understanding and views on the state of and links between a green economy and ecosystem services in Finland. The participants considered many economic sectors as central to green economy in Finland. They also felt that some sectors, such as mining and peat extraction, cannot be included in green economy, even if they are implemented with high environmental standards. The most important sectors identified were:

- the forest sector
- the agriculture and food sector
- game and fisheries

- tourism, including adventure tourism and use of nature for recreation and well-being; also including neighboring recreational areas
- renewable energy
- cosmetics, pharmaceuticals and nutritional additives from nature
- pure water
- the textile industry
- consultation and communication.

However, the division into "traditional" economic sectors was considered to be old-fashioned, and not likely to produce any new business ideas or innovations. Thus, it was expected that in the future the boundaries between the traditional business sectors are likely to weaken and dissolve. The paradigm change needed to support the transition to green economy requires traditional sectors to be viewed more widely. For example, the forest sector is traditionally considered as providing raw materials mainly for wood products and paper, but in the future, new business opportunities for the forest sector are likely to arise from natural cosmetics and pharmaceuticals, from the food sector (wild berries, mushrooms, medicinal plants, game, nutritional additives) and tourism, for example. Integrated production serving many business branches will be increasingly important in the future and thus greening the economy will also grow in importance. Natural products can also be based on cultivated or semi-cultivated materials, in which case they would no longer fit into the traditional division of agricultural or forestry products. Another potential example would be linking tourism with forestry; these two businesses can occur simultaneously in the same place.

In addition to multiple economic sectors, different types of actors were also seen as important in promoting green economy in Finnish society. Key actors identified included decision makers, companies (e.g. large business chains, logistics chains), consumers, and various intermediaries and trendsetters, such as bloggers.

In the future, it was predicted that the intangible services provided by the ecosystems will grow in importance. For example, the attractiveness of Finland as a country, where one can find silence, can create significant new business opportunities for utilizing forests in health and nature tourism (see Jäppinen et al. 2014).

Green economy can also bring opportunities in the global allocation of sustainability responsibilities. The use of advanced and clean Finnish technology can help to decrease emissions in developing countries. However, there is a risk of green washing, and therefore the promotion of a truly green economy should be based on measured and verified data and facts about the development. In the future, the current understanding that GDP reflects well-being will not be enough, and the benefits and disadvantages of different actions should be identified more widely on the basis of life cycle thinking.

Several challenges can slow the transition to green economy. These include for example the different values and views of actors, regulation, harmful subsidies, and restrictions for business, such as the high costs of patenting processes and difficulties in getting risk financing for new innovations and development work. More specifically, the structure of retail markets in Finland was considered as complicating the promotion of green economy. Other structural challenges mentioned included excessive sector-specificity (silos) and competition between the different ministries. As green economy is largely dependent on the use of biomass, the Finnish everyman's rights will play a central role in the transition to a green economy, especially in the future. Everyman's rights refer to the right of everyone in Finland to enjoy outdoor pursuits regardless of who owns or occupies an area, and they are pivotal in enabling tourism and the use of nature's products such as berries and mushrooms. On the other hand, the fragmentation of land ownership can restrict this process.

Even though the workshop participants identified several possibilities and examples for green economy in Finland, they felt that the concept was still poorly structured. In many comments it was used as a synonym for a more narrowed concept of bioeconomy. Instead, green economy should be considered a dynamic concept; as society develops and becomes greener, the level required in terms of sustainability should be raised even higher.

7.1.3

### Conclusions and policy recommendations for Finland

Our assessment and the stakeholder workshop clearly showed that ecosystem services are an integral part of a number of economic sectors relevant to green economy in Finland, namely the forest sector, water, tourism, the agriculture and food sector, game and fisheries, and renewable energy. In addition to this, ecosystem services are perceived as an integral part of growing green economy sectors such as the textile industry, life and health style business (LOHAS), cosmetics and pharmaceuticals.

Green economy is a wide concept and it is not – and should not be perceived as – just focusing on the innovation of new 'green' products or cli-

mate change mitigation. Integration of the understanding of a whole range of ecosystem services into green economy helps to ensure that the green economy is both environmentally and socially sustainable and truly 'green', i.e. also brings benefits in terms of biodiversity. However, in order to achieve this, synergies between the management of ecosystem services and biodiversity need to be secured in concrete investment and management decisions, i.e. focusing on the management of a single ecosystem service only – such as maximizing biomass production for renewable energy or enhancing carbon sequestration through intensive timber monocultures – can also negatively impact upon biodiversity conservation.

Green economy cuts through various policy sectors, thus policy coherence is needed in order to provide consistent regulation and guidance for private companies and other stakeholders. The promotion of green economy needs wide collaboration between different stakeholders and policy sectors. Consequently, ecosystem services need to be taken into consideration systematically when greening these sectors in the future. Ecosystem services need to be more systematically integrated into policy level strategies and recommendations, especially in bioeconomy strategy.

The connections between ecosystem services and green economy identified in the context of this assessment can be systematically assessed and conceptualized through the framework presented in Figure 7.1.1. This illustrative framework systematically highlights the interlinkages between an economic sector and ecosystem services, including both interdependencies and impacts. The use of such a systematic assessment and illustration can be a helpful aid in decision-making, highlighting a) how ecosystem services facilitate business activities in different sectors by providing resources for the sector and b) how the economic sector also affects the ecosystem services either by causing them to deteriorate them or improving their state. If the sector utilizes ecosystem services in sustainable manner – based on an understanding on their interdependency and possible impacts on ecosystem services – it may produce green economy benefits

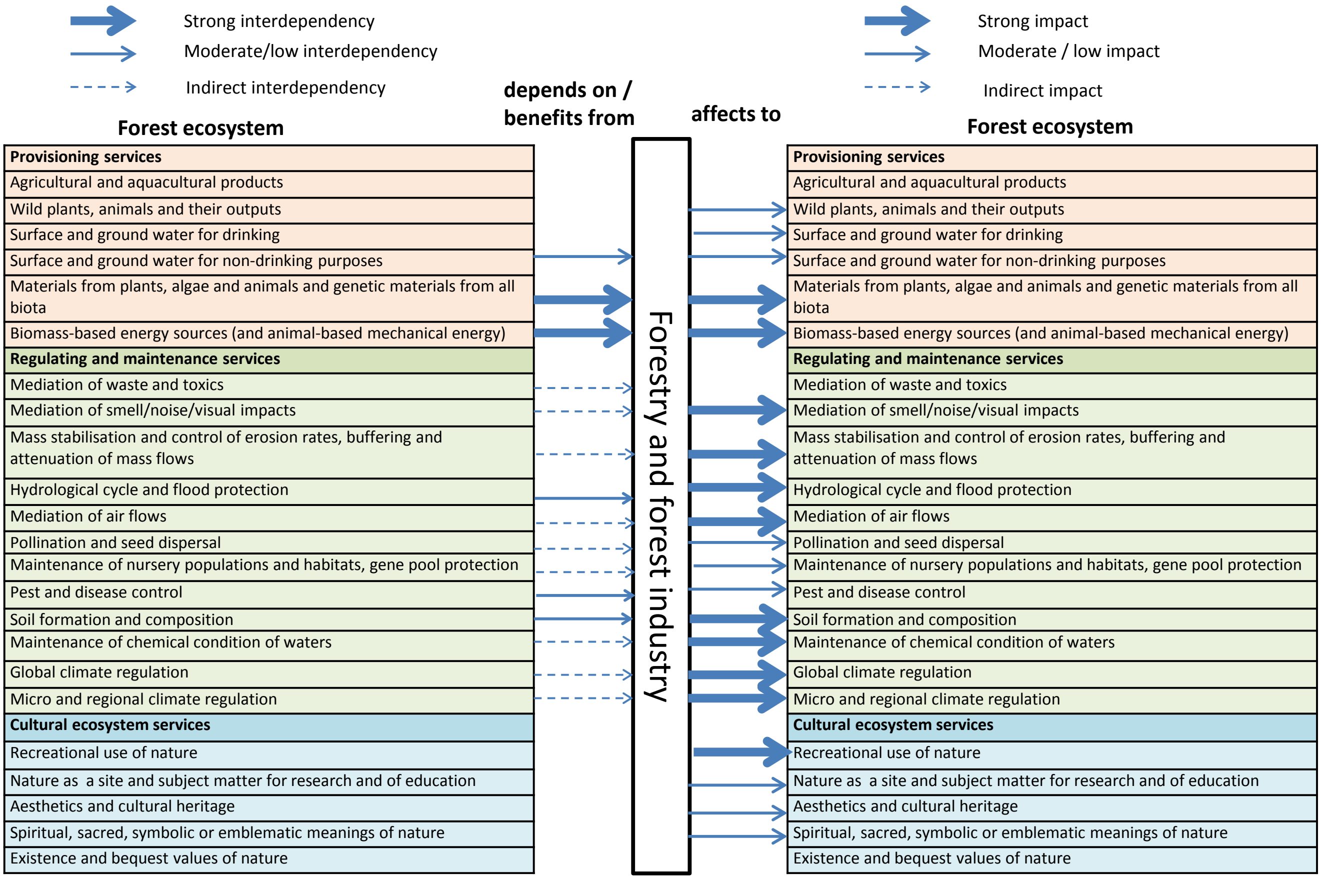



**Figure 7.1.1**. Example of a systematic assessment and illustration of interlinkages between an economic sector and ecosystem services: interlinkages between ecosystem services and the forestry and forest industry.

for society. By understanding the full spectrum of dependencies and impacts on ecosystem services such a systematic assessment can also help to identify links between different sectors, for example highlighting the impacts of the water and forest sectors on tourism. Consequently, it is recommended that systematic ecosystem services assessments – as illustrated in Figure 7.1.1 – would be an integral part of the 'greener' decision and policy making within different economic sectors in the future.

At a company level tools supporting the integration of ecosystem services into companies' sustainability management systems and product/service chains already exist, e.g. the World Business Council on Sustainable Development's (WBCSD) guidelines for ecosystem service review and ecosystem services valuation. Similar tools could also be developed to be applied at the level of national and regional sectoral policy.

Recommendations concerning the economic sectors:

- Finnish forests provide a large variety of raw materials and intangible services for many economic sectors. In addition to wood and biofuel for forest and energy sectors, forests provide berries and game for the food sector and nature for tourism, for example, as well as many regulating and maintenance services that are also vital for humans and the economy. Therefore, sustainable forest management is one of the key prerequisites for a Finnish green economy.

- Water supply and management is another area that is crucial for different economic sectors. New concepts such as payments to ecosystem services (PES) (as outlined in more detail in Section 6.2) could be helpful in improving water quality and giving an economic incentive for different actors to act in that way.

- Mining can be a regionally important economic sector bringing socio-economic benefits. However, according to the green economy criteria, the mining sector is not considered to be a green economy sector. Although operations can be carried out according to green mining principles, it can have significant impacts on other green economy sectors at a regional level. Mining areas should be located far from tourism and natural resorts.

- Tourism is a growing sector and clearly dependent on ecosystem services. In order to maintain Finnish nature in a way that is attractive to tourists and to support this green economy with high potential, ecosystems must be utilized sustainably.

7.2

## Ecosystem services and Natural Capital Accounting (NCA)

**Marianne Kettunen, Patrick ten Brink and Daniela Russi**

7.2.1

### Concept and purpose of natural capital

Natural capital (NC) is a term used to capture and highlight the role of nature in supporting the economy and human welfare (Pearce et al. 1989). The term capital itself refers to a stock of materials or information, which can generate a flow of goods and services that improve human well-being. In general, four kinds of capital are identified: manufactured, human, social and natural capital (Ekins 1992, Ekins 2008) where the latter is formed of the stock of natural assets that provide society with renewable and non-renewable resources (e.g. timber, water, fossil fuels, minerals) and a flow of ecosystem services.

According to the analytical framework developed in the context of the EU 'Mapping and Assessment of Ecosystem and their Services' initiative (European Commission 2013a), natural capital includes sub-soil assets (geological resources), abiotic flows like solar and wind energy, and ecosystem capital (EC), which represents the biotic element of the natural capital and includes both ecosystems and the flows of ecosystem services they provide to society (see Figure 2.6.1). Naturally, the distinction between the biotic and abiotic elements of an ecosystem is not always such a clear-cut (ten Brink & Russi 2014). For example, water is an abiotic element in itself but since ecosystems both depend on and play a key role in its cycle, water is often considered a part of ecosystem capital. In the context of biodiversity policy, the term natural capital is nowadays often used in particular to refer to the biotic components of natural capital, i.e. the ecosystem capital and the related ecosystem services (ten Brink et al. 2012). All four types of capital are needed to support human welfare. However, natural capital can arguably be considered the most important one as it is embedded in all other forms of capital, underpinning them (ten Brink et al. 2012, ten Brink & Russi 2014). Furthermore, an important share of natural capital is non-substitutable with manufactured or other kinds of capital (Costanza et al. 1997). For example, human and social capital are heavily dependent on the physical health of individuals, who in turn are dependent upon ecosystem services to maintain good health, including food, freshwater, timber and fiber and a wide range of regulating ecosystem services (e.g. water purifi-

cation, nutrient cycling, protection from floods and other extreme events).

As with the concept of ecosystem services, the concept of natural capital is anthropocentric, focusing on those aspects of nature that benefit humans. Consequently, the concept of natural capital does not directly reflect the intrinsic value of nature nor does it encompass benefits provided by different habitats and species to other species (ten Brink & Russi 2014). From the perspective of biodiversity conservation, the main purpose of this concept is to help to shed light on the benefits that nature provides to human society and consequently on the need for nature protection – not only for moral reasons – but also as a way to enhance human well-being and the economy. As such, the concept of natural capital, in particular when fully capturing the elements of ecosystem capital, can contribute to a shift towards a more sustainable and biodiversity-friendly policy-making, while also acting as an environmental education tool for building awareness.

The concept also has risks, as focusing only on the benefits to society and the economy could be seen as encouraging commoditization of nature (McCauley 2006, Kosoy & Corbera 2010) and in certain contexts it may lead to prioritization of the protection of areas that are more directly used by humans over others with higher biodiversity value. For this reason, the natural capital concept must be seen in conjunction with wider biodiversity objectives and accounting must be used as a complementary tool to wider biodiversity indicators (ten Brink & Russi 2014).

7.2.2

## The concept and purpose of natural capital accounting

National Accounts is the statistical system that systematically describes a country's national economy and underpins the estimation of GDP. The accounts present the gross domestic product and gross national income which reflect the state and development of a national economy. The accounts include, for example, data on the national economic output, employment and income, use of income and capital formation, described by transaction and/or sector. Information on economic output, employment and capital formation are presented by transaction and sector, whereas data on consumption are presented by purpose and durability categories. Furthermore, supply and use tables – and the input-output tables based on them – describe in detail product flows in the national economy. Finally, the National Accounts can be supported by so called Satellite Accounts. Satellite Accounts provide a framework for more focused and detailed statistics on a certain aspect of economic and social life in the context of national accounts. Satellite accounts can exist, for example, for culture and tourism. Environmental-economic accounts (SEEA) are nowadays very seldom called Satellite Accounts, because they have become a much larger and more independent statistical system.

The underlying problem from the perspective of the sustainable use of nature and natural capital is that the full contribution of natural capital – especially ecosystem capital - to maintaining economic well-being and underpinning the functioning of different economic sectors is not factored into the national accounting system (SNA). This poor representation of natural capital is considered one of the key limitations of national accounts and the GDP. For example, while timber resources are counted in national accounts, the other services of forests, such as carbon sequestration and water retention and purification, are not included.

A range of policy initiatives have been initiated to improve the integration of natural capital into the accounting frameworks, both at global and EU level (Box 7.). The so called environmental-economic accounts form the overall framework for integrating environmental assets into the accounting, whereas ecosystem capital accounts (by EEA/MAES) or ecosystem accounts (SEEA-EEA) refer to the accounts specifically covering ecosystems and ecosystem services. In general, these two accounting systems consist of dedicated information for assets and flows. Assets accounts measure the stock of natural capital (e.g. fossil fuels, minerals, timber and land). Flow accounts cover the flows of natural resources from the environment to the economy (i.e. inputs) as well as from the economy to nature (i.e. waste, water pollution and air pollution). The two accounting systems are to a certain extent complementary. Environmental-economic accounts provide information on the state of assets across all ecosystems (e.g. water, timber and land accounts) and the flow of these assets into the economy. Ecosystem (capital) accounts offer insight into the overall state of the ecosystems providing these assets, including spatially-detailed and ecosystem-specific information on the assets, information on the broader set of ecosystem services and their flow into the socio-economic systems (e.g. regulating ecosystem services that, among other things, underpin the provisioning of assets) (see also Section 7.1 above). Figure 7.2.1 by Russi & ten Brink (2013) provides a general overview of the different kinds of environmental-economic / ecosystem (capital) accounts and the role they can play in collecting and systematizing interactions between nature, society and the economy.

Finally, indicators reflecting the availability and quality of assets and flows form the basis of both environmental-economic and ecosystem (capital) accounts. Both assets and flows are commonly accounted for in biophysical (i.e. quantity of timber, amount of water stored or purified, amount of carbon captured or stored) terms but they can also be complemented by monetary information, if appropriate and where methodologies and data allow (ten Brink & Russi 2014). Understandably, for many ecosystems and ecosystem services data gaps represent the key obstacle to their integration into the accounting frameworks and to the development of reliable accounts. For example, data may be available at a different scale to the one required for accounting, leading to the need for models and approximations (e.g. local and regional data versus national application) (ten Brink & Russi 2014). Similarly, data on some key ecosystems and ecosystem services may be very location specific and, in order to be used, this data needs to be translated into indicators relevant at the scale at which the accounts are developed.

### BOX 7. The key developments towards the uptake of ecosystem services in natural capital accounting

The System for Environmental and Economic Accounts Central Framework (SEEA-CF – volume 1), adopted by the UN Statistical Commission in 2012, provides an internationally-agreed method for asset accounts – which can be in physical and monetary terms – for mineral and energy resources, land, soil resources, timber resources, aquatic resources, other biological resources and water resources. In short, the SEEA-CF provides standards for environment related accounting that - when expressed in monetary terms – can be integrated into the System of National Accounts (SNA), i.e. the international standard for national economic accounts. (System of Environmental-Economic Accounting, 2012)

Of even greater relevance to ecosystem services is the Experimental Ecosystem Accounting (SEEA-EEA – volume 2). The SEEA-EEA aims to measure the ecosystem conditions – with a particular focus on carbon and biodiversity – and the flows of ecosystem services into the economy and other human activities. This kind of accounting is still at an experimental stage and for this reason SEEA-EEA does not provide an internationally agreed standard for Ecosystem Accounting, but only a discussion on the methodological options and challenges, and general guidance on how to structure and develop accounts. (System of Environmental-Economic Accounting. Experimental Ecosystem Accounting 2012)

At EU level, the EU Regulation for European environmental economic accounts (EU Regulation 2014) introduced the obligation for Member States to develop at least three kinds of accounts by 2013: air emission accounts[7], accounts on environmental taxes[8] and material flow accounts[9]. The Regulation establishes that more modules can be added in the future to respond to key policy needs. This can create a legislative basis for developing natural capital accounts at EU level. The next window of opportunity for additional accounting modules is December 2016. The potential candidates for the next batch of modules are 1) Environmentally Related Transfers (subsidies); Resource Use and Management Expenditure Accounts (RUMEA); Water flow accounts; and Forest Accounts, through the development of Integrated Environmental and Economic Accounting for Forests (European Commission 2013c).

The EU Biodiversity Strategy to 2020 requires Member States to map and assess the state of ecosystems and their services by 2014, and to assess their economic value and promote the integration of these values into accounting by 2020. In order to meet these commitments, the initiative 'Mapping and Assessment of Ecosystems and their Services' (MAES), was established by the European Commission, with support of Member States, the EU Joint Research Centre (JRC) and the European Environment Agency (EEA) (European Commission 2013b). It aims to contribute to the mapping and assessment of ecosystems and ecosystem services in biophysical – and at a later stage possibly also monetary – terms by providing a coherent analytical framework for the EU and Member States. MAES also includes a module on natural capital accounting.

The EEA is currently developing experimental Ecosystem Capital Accounts (ECA), based on the data available at the European level. The ECA process does not aim to generate new data, but to integrate the available data at the European level. In order to do so, all data sets utilized are transposed into a 1 km$^2$ grid across the entire area covered. The first experimental ECA will include land, organic carbon and water accounts. (European Environment Agency 2011)

Source: synthesis based on by Russi & ten Brink (2013) and ten Brink & Russi (2014).

[7] At least 14 different gases emitted by 64 industry groups and by households.

[8] Including at least four tax types – on energy, transport (other than fuel), pollution, and resources – all broken down into 64 industry groups, households and non-residents who pay these taxes.

[9] Material flow accounts for 50 material types showing domestic extraction, imports and exports. Then, Domestic Material Consumption = domestic extraction + imports – exports, for each type of material and in total.

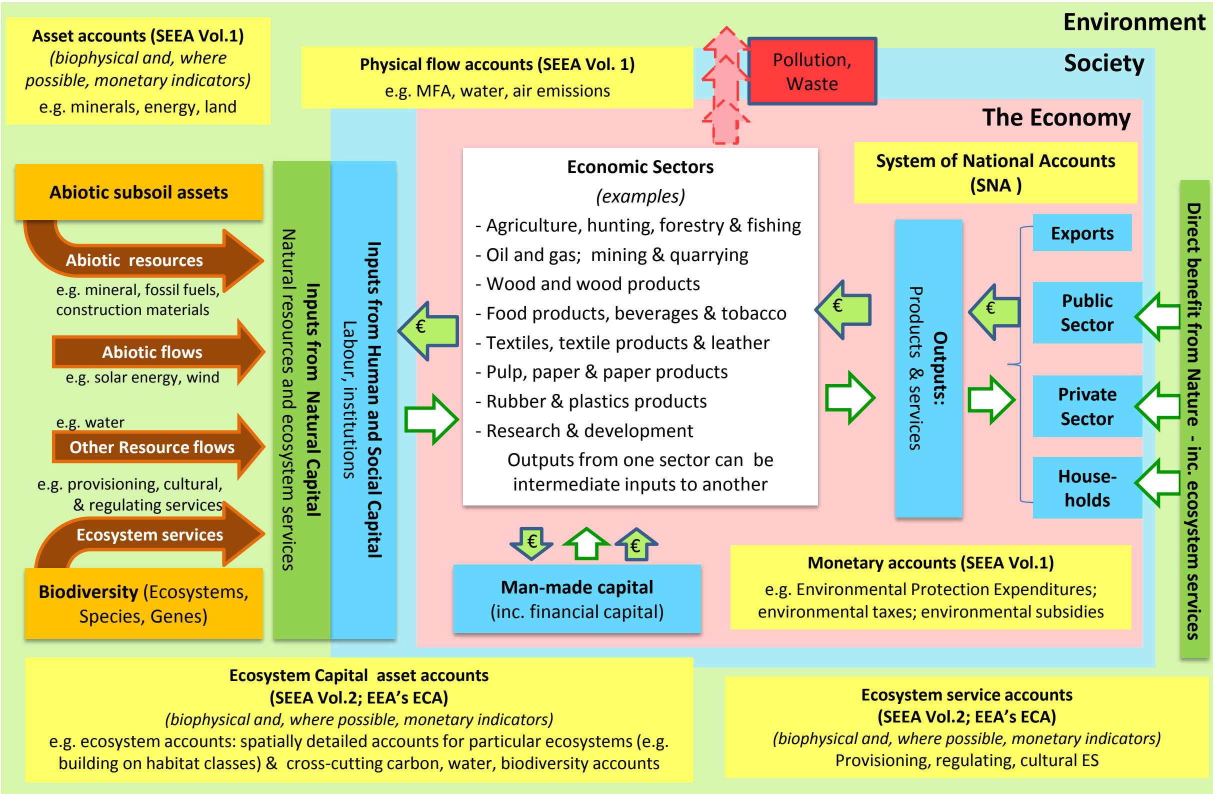



**Figure 7.2.1.** Environmental Economic Accounts and Natural and Ecosystem Capital (Russi & ten Brink 2013).

Building on the above, the general existing accounting framework itself should be able to allow for integration of a wide set of natural capital types as well as the flow of ecosystem services. While the accounting frameworks themselves provide flexibility for the integration of ecosystem service aspects, the lack of reliable and/or suitable ecosystem services indicators form the key barrier to the mainstreaming of ecosystem services information into the accounting systems (ten Brink & Russi 2014). Consequently, in practice there is currently only partial integration of natural capital and ecosystem services into accounts, with only a subset of issues represented in monetary terms.

In general, if successful and comprehensive, natural capital accounting – building on environmental-economic and ecosystem (capital) accounts – has the potential to help countries and regions to improve their understanding of the true contribution of nature to economic growth while balancing trade-offs and creating synergies between different economic sectors and between economic development and broader well-being (ten Brink & Russi 2014). Such broader accounting frameworks are predicted to form a basis for the development of a truly sustainable green economy that builds on the broader understanding of a country's or area's natural assets and their value (Kettunen et al. 2012, ten Brink et al. 2012, see also Section 7.1 above). The added value of accounts over 'raw' indicator data is that the former is integrated into a common national statistical framework supporting decision-making and discussion on trade-offs and synergies among policies (ten Brink & Russi 2014). Ecosystem (capital) accounts can also enable the analysis of links between different components of ecosystems and different datasets (e.g. between land use and organic carbon accounts), which will help to shed light on trade-offs and synergies among policy and economic sectors.

7.2.3

## Existing relevant initiatives in Finland and their status

The CBD Strategic Plan for Biological Diversity 2011–2020 includes commitment to integrate biodiversity into national accounting (Aichi Target 2), and commitments to accounting are also included in the Finnish National Biodiversity Strategy and Action Plan (NBSAP) 2013–2020. Finland is also committed, as a Member State of EU, to enhancing the incorporation of natural values (incl. biodiversity and ecosystem services) into national accounting and reporting systems by 2020. At the moment, there are no official dedicated processes

underway supporting the achievement of this goal. However, a number of relevant initiatives that can form a basis for broadening the natural capital accounting framework for Finland to include aspects of ecosystem services have been identified below.

### Sustainable development and well-being indicators

Finland has identified a range of official indicators that aim to reflect the sustainability and overall well-being of the nation. While several of these indicators provide information on the status of the natural environment and ecosystems, only a few of them are directly related to the availability and flow of ecosystem services (Table 7.2.1). The existing indicators most directly related to ecosystem services and natural capital include indicators for provisioning services, namely timber/wood, fish, crop, biofuels, and plants and wild animals. With the exception of timber – for which both the increment and drain is assessed – these asset indicators mainly capture the annual use of resources, with no reflection on how sustainable the flow of these resources is in the longer run. In addition to this, a dedicated indicator exists for the value of recreation, captured as annual visitor numbers to the national parks and related flow of income to regional economies.

Reflecting the current knowledge on how ecosystem services and natural capital underpin sustainable development and well-being, a number of key ecosystem services indicators are missing from the current national set of indicators. In terms of food and water security it would be useful to know, for example, the status and trends of the pollinator 'stock' and projected sustainability of the fish stocks. In the context of the Baltic Sea, information on the capacity of coastal (wetland) ecosystems to act as buffers against nutrient leakage into the sea would complement the current indicators measuring water quality. From the perspective of mitigating climate change, information on carbon storage and sequestration capacity would be important.

### Relevant existing accounting systems

On the basis of the EU Regulation, Finland has adopted a number of environmental-economic accounts. Economy-wide material flow accounts describe in units of mass (tonnes) the volume of materials extracted, transferred or transformed from nature. These accounts provide an overall picture of the used material flows into the economy. This information about material flow volume and its ratio to other National Accounts aggregates describes the material dependency of the national economy and the pressures economic activities impose on the environment. The information of the material flow accounts can be used to 'interpret' the GDP in the light of the volume of materials required to generate it. National statistics in the context of the SEEA framework are also provided regarding environmental and energy taxes, air emissions and the economic role of environmental goods and services sector. The latter refers to production based on environmental pollution prevention or saving natural resources and the data describe business activities involving the environment practiced in Finland.

The Finnish National Accounts are also complemented by a number of satellite accounts, some of which are of interest from the perspective of ecosystem services and natural capital. Finland has developed dedicated satellite accounting systems for tourism and culture (Statistics Finland 2014). The Tourism Satellite Account – TSA provides statistical information on the role of tourism in Finland's national economy. While the National Accounts include tourism as one of the economic sectors, TSA provides additional, more detailed information supplementing and adding clarity to the national accounts. It includes information, for example, on consumption of inbound and domestic tourism, output and income formation of the tourism industry, internal tourism supply and demand by product, employment in tourism and physical indicators of tourism (Table 7.2.2). Similarly, the Culture Satellite Accounts is a statistical system which aims at describing the contribution of culture to the economy (Statistics Finland 2014). There is no internationally agreed method for producing culture satellites, but the culture satellite compiled in Finland largely follows the same internationally accepted methods that are used in the TSA. The Culture Satellite Accounts describe the role of culture as part of Finland's national economy, complementing the National Accounts. The culture satellite produces data on culture's share of output, GDP and employed persons, as well as on private and public consumption expenditure directed at culture.

**Table 7.2.1**. Current biodiversity and ecosystem services related indicators identified as part of the sustainable development and well-being indicators in Finland (Source: www.findicator.fi).

| Indicator | Current use | Focus | Source |
|---|---|---|---|
| Status of threatened species | Sustainable development (nature) | Biodiversity | www.biodiversity.fi |
| Status of bird populations: forest birds, mire birds, farmland birds | Sustainable development (nature) | Biodiversity<br>Inexplicit/unquantifiable links to game assets | www.biodiversity.fi |
| Status of the Baltic sea: chlorophyll a concentration, frequency of algal blooms, visibility depth source | Sustainable development (nature) | Environmental quality<br>Some inexplicit/unquantifiable links to ecosystems' ability to retain nutrients (water purification / waste retention) | www.biodiversity.fi |
| Recreation | Sustainable development (nature) | Ecosystem service<br>Recreation: the value of recreation, expressed as number of visits to national parks and related regional revenue streams | Metsähallitus |
| Awareness: attitudes towards biodiversity | Sustainable development (nature) | Biodiversity<br>The value of general importance people place on biodiversity as an underlining factor for well-being, source of food, fuel and medicine, economic growth, and mitigating climate change. | The European Commission |
| Blue-green algal situation in inland waters | Well-being | Environmental quality<br>Some inexplicit/unquantifiable links to ecosystems' ability to retain nutrients (water purification / waste retention) | The Finnish Environment Institute SYKE |
| Blue-green algal situation in the Finnish marine areas | Well-being | Environmental quality<br>Some inexplicit/unquantifiable links to ecosystems ability to retain nutrients (water purification / waste retention) | The Finnish Environment Institute SYKE |
| Generation of municipal waste | Well-being | Resource use<br>No links to ecosystem services | Statistics Finland |
| Total consumption of natural resources (inc. TMR and GDP): plants and wild animals, wood, minerals, soil materials, manufactured imports | Sustainable development (resource wise economy) | Resource use<br>Plants and wild animals and wood as assets | Statistics Finland |
| Renewable energy as a proportion of final energy consumption / Share of renewable energy in energy consumption | Sustainable development (resource wise economy and carbon neutral society) | Resource use<br>Fiber as a bioenergy asset, water as a renewable energy asset | Statistics Finland |
| Increment and drain of growing stock of timber reserves | Sustainable development (resource wise economy) | Resource use<br>Fiber (timber) as asset | Finnish Forest Research Institute (Metla) |
| Greenhouse gas emissions | Sustainable development (carbon neutral society) | Carbon balance<br>Carbon emission as an output from the economy, required to be sequestered. | Statistics Finland |
| Fishery catch | Environment and natural resources | Resource use<br>Fish as an asset | Finnish Game and Fisheries Research Institute |
| Grain crop | Environment and natural resources | Resource use<br>Crops as an asset | Tike, Information Centre of the Ministry of Agriculture and Forestry |

Furthermore, one of the most relevant existing national accounting systems in Finland from the perspective of ecosystem services and natural capital is Forest Accounts. While not identified as a dedicated satellite account, forest accounts describe changes in the resources and flows of wood material, as well as their values in the national economy thus complementing the forest sector related information within the accounting framework (Statistics Finland 2014). Besides wood resources, the accounts also cover other benefits with known volumes of monetary values derived from forests, linked to timber extraction and use, as well as data relating to the environmental load of the forest industry (e.g. suspended solids, biological oxygen demand, nitrogen and phosphorus emissions, etc.) The following information, building on the relevant indicators (e.g. the ones also used in the context of sustainable development, above) is captured by the accounts: annual data on forests, wood and flows of wood material in the national economy; data on wood resources and their use (Table 7.2.3), including increment and drain of the growing stock; tying up of wood material in end products; use of other forest products; and data on volumes and values by industry and commodity. What is not covered, however, are the attributes contributing to the ability of forest ecosystems to maintain sustainable production, such as rate of soil erosion, soil quality, etc.

Finally, national statistics are also provided on hydrological resources and fisheries. The information on hydrological sources is compiled and published in the form of monthly hydrological observations and conditions in Finland (Environment 2014). The statistics include tables and diagrams presenting daily or monthly means of hydrological variables during the year. Summaries are presented for a number of variables including, for example, water level, discharge, runoff from small basins, areal precipitation, regional water equivalent of snow, evaporation, the temperature of surface water, groundwater level, snow depth and soil frost depth. Descriptions of the methods of observing or computing the variables are also included. While not framed as accounts as such, the information on the hydrological resources provides important information about the availability and flow of the water resources at the national level. However, information about the water quality is not integrated into these statistics on the hydrological resources, i.e. they do not seem to make direct connections with the indicators for sustainable development (above). As regards fisheries, the available statistical information includes data on the volume and values of commercial fishing. There are no official statistics on the available fish resources (i.e. actual stock and population levels in Finnish waters, maximum sustainable yields and ecosystem carrying capacity) reflecting the availability of resources in the ecosystems and, consequently, the sustainability of fishing activities.

**Table 7.2.2**. Example of data provided by the Tourism Satellite Accounts: tourism demand in 2007. Source: Statistics Finland http://193.166.171.75/database/StatFin/kan/matp/matp_en.asp

| Tourism demand and supply by Indicator | Year 2007 |
|---|---|
| Inbound tourism demand total, EUR million | 3,126 |
| Inbound tourism demand total, share of total tourism demand % | 29 |
| Domestic leisure tourism demand total, EUR million | 5,500 |
| Domestic leisure tourism demand total, share of total tourism demand % | 50 |
| Other domestic tourism demand (compensated business trips, own free-time residences), EUR million | 2,332 |
| Other domestic tourism demand (compensated business trips, own free-time residences), share of total tourism demand % | 21 |
| **Total tourism demand in Finland, EUR million** | **10,958** |

**Table 7.2.3**. Example of data provided by the Forest Accounts: use balance (2012) (Statistics Finland http://www.tilasto-keskus.fi/til/mettp/2012/mettp_2012_2013-12-18_tau_001_en.html).

| | Round wood | Fuel wood | Forest chips | Residues from ind. | Sawn wood | Wood-based panels | Mechanical pulp | Chemical pulp | Paper and board | Waste liquors | Recycled paper |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | *1,000 cubic meters* | | | | | | *1,000 tonnes* | | | | |
| **Basic supply** | | | | | | | | | | | |
| Fellings | 51,026 | 6,174 | 8,292 | | | | | | | | |
| Import | 6,168 | 95 | | 3,781 | 460 | 395 | 6 | 492 | 459 | | 50 |
| Production and other supply | | | | 16,810 | 9,440 | 1,200 | 3,409 | 6,826 | 10,694 | 12,370 | 704 |
| Export | 750 | 88 | | 487 | 6,451 | 929 | 228 | 2,483 | 9,932 | | 160 |
| **Total supply** | **56,444** | **6,181** | **8,292** | **20,104** | **3,449** | **666** | **3,187** | **4,835** | **1,221** | **12,370** | **594** |
| **Forest industry use** | | | | | | | | | | | |
| Sawing and planing | | | | | | | | | | | |
| - as raw material | 21,197 | | | | | | | | | | |
| - production | | | | 11,330 | 9,440 | | | | | | |
| Wood-based panels | | | | | | | | | | | |
| - as raw material | 2,630 | | | 167 | | | | | | | |
| - production | | | | 2,140 | | 1,200 | | | | | |
| Mec. pulp prod. | | | | | | | | | | | |
| - as raw material | 6,742 | | | 1,714 | | | | | | | |
| - production | | | | 480 | | | 3,409 | | | | |
| Chem. pulp prod. | | | | | | | | | | | |
| - as raw material | 28,028 | | | 8,194 | | | | | | | |
| - production | | | | 2,860 | | | | 6,826 | | 12,370 | |
| Paper, board prod. | | | | | | | | | | | |
| - as raw material | | | | | | | 3,187 | 4,835 | | | 567 |
| - production | | | | | | | | | 10,694 | | |
| **Total use as raw material in forest industry** | **58,597** | | | **10,075** | | | **3,187** | **4,835** | | | **567** |
| **Other use** | | | | | | | | | | | |
| Power plants as fuel | | 95 | 7 621 | 9,340 | | | | | | 11,758 | |
| Small-size dwelling as fuel | | 5,363 | 671 | | | | | | | | |
| Other industries and changes in inventories, as raw material | -2,153 | 723 | | 689 | 3,450 | 665 | | | 1,221 | 612 | |
| **Other use total** | **-2,153** | **6,181** | **8,292** | **10,029** | **3,450** | **665** | | | **1,221** | **12,370** | **27** |

7.2.4

### Conclusions and recommendations for Finland

There are important political commitments to environmental economic accounting, including the EU Biodiversity Strategy 2020 (Action 5: promote integration of values in accounting by 2020) and the CBD Strategic Plan for Biodiversity 2011–2020 (Target 2, signed in Nagoya Japan in 2010). These political commitments remain in the heart of the EU: the recent Environment Council conclusion (October 2014) called on both the Commission and Member States to step up their efforts in developing a system of valuation of EU natural capital, including contributing to the development of environmental accounts [10]. On a national level, both the Finnish Biodiversity Strategy and Finnish Bioeconomy Strategy (see 2.3 above) identify the development of a framework for natural capital accounting as one of the key future actions.

As outlined in Section 3 of this report, a comprehensive set of national ecosystem service indicators is currently being developed with a view to monitoring and indicating the status and value of these services. These indicators play a key role in enhancing the integration of natural capital into the Finnish national accounting systems. Consequently, future work on natural capital accounting in Finland is predicted to focus on more closely aligning the ongoing work on indicators with the existing framework national and environmental-economic accounts, leading to the development of ecosystem (capital) accounts in Finland (see also Mazza et al. 2013). This should be carried out within the general framework currently being developed under the EU-wide MAES initiative.

Given the challenges with indicators, the appropriate policy approach to developing natural capital accounting should be to identify a number of key ecosystem services for which the indicators and accounting can be developed within a short time frame, supported by plans for more detailed and time-intensive accounts in the future (ten Brink & Russi 2014). Therefore, the key immediate next step in Finland would be to identify a number of ecosystem services and related indicators that could support the development of a pioneering set of ecosystem accounts. Building on the existing statistical frameworks for forestry, water resources and tourism, it appears sensible to focus on exploring how these frameworks could take on board broader information on forest, water and recreation related ecosystem services.

[10] Council Conclusion on Greening the European semester and the Europe 2020 Strategy – Mid-term review (28. October 2014)

The existing forest accounts could be expanded to include dedicated information on carbon, provided by the anticipated ecosystem indicators for carbon storing-habitats, carbon balance and carbon stocks and sequestration (e.g. related value). Furthermore, information related to the quality of forest ecosystems – also directly linked to the ability of forest ecosystems to support timber production – such as soil quality, soil carbon, nitrogen fixation and erosion control could be included to complement current information solely focused on the available and used timber. Such information could be used to create a picture of the overall quality and the level of degradation of forest ecosystems. Finally, the forest accounts could also be expanded to acknowledge other economically important forest-related ecosystem services such as provisioning of wild berries, tourism and food resources for reindeer herding (lichen) in Lapland.

As regards water, the existing information on water resources and quality – supported by future information on water retention and infiltration capacity – could be combined and used to create a dedicated system for water accounts. First and foremost, it seems important to integrate the existing data on water resource statistics with the information on the water quality. These two sets of complementary data currently seem disconnected, missing opportunities for joint national level analysis and conclusions. The anticipated indicators for water retention and water filtration (e.g. aquifers and undrained habitats, water retention potential, flood and flow control, ground water production) can function as key elements in bringing together information on water quantity and quality, while revealing the capacity of ecosystems for maintaining these attributes.

Similarly to the above, the existing national information on fisheries – complemented by information on fisheries resources – could be used to develop dedicated national accounts for fisheries. However, information and indicators on the current status of fish stocks might still require further research and development. Given the importance of recreational fishing in Finland (see Kettunen et al. 2012), these accounts would need to include information both on commercial and recreational fisheries.

The existing Tourism Satellite Accounts (TSA) could be expanded to include a dedicated element focusing on nature-based tourism, building on the set of ecosystem service indicators currently being developed this purpose (e.g. high nature value areas, employment and tourism revenue). Ideally, the future TSA system would be able to both specify the significant role nature plays in creating domestic

and international tourism flows and also provide information on the quality of nature this economic sector heavily relies on (see also Section 7.1 above).

The development of monetary accounts for ecosystem services does not seem to be an immediate a priority and there are no immediate plans to attempt to adjust the GDP to take into account ecosystem degradation and loss of associated capacity to deliver ecosystem services (Mazza et al. 2013). The latter is not currently seen as practical or feasible, due to the lack of robust empirical base and international standards. However, in the longer run the possibilities for such monetary accounts – when relevant and feasible – could be considered. Also in the longer run, ecosystem accounts are considered to be at their most useful for decision-making when linked to spatial data. This kind of development will need further research, methodological development and experimentations, but it is already seen as a promising direction and it is mentioned in the third volume of the SEEA revised version.

Finally, even the most comprehensive accounts cannot fully capture issues related to the irreversible depletion or erosion of natural resources, ecosystems and ecosystem services (ecological limits and thresholds, nonlinearity) (Harris & Khan 2013). Consequently, it is crucial that transparency as regards to what accounts can or cannot cover is kept in mind when developing the accounts in the future.

There are major efforts underway for developing guidance (UNSTAT's SEEA as well as very recent CBD guidance document Weber (2014)), as well as commitments to experimentation with accounts (NCA within the MAES process in Europe, and international experimentation within the WAVES[11] initiative led by the World Bank). Finnish engagement with environmental-economic accounting should therefore both be able to benefit from growing body of experience, as well as, contribute practice and insights to support the global commitments to improve governance, and both meet, biodiversity targets as well as address sectoral, and other policy concerns in a growing range of areas.

[11] WAVES (Wealth Accounting and the Valuation of Ecosystem Services) is a global partnership that aims to promote sustainable development by ensuring that natural resources are mainstreamed in development planning. It promotes the development of environmental economic accounting according to the guidelines provided by the System of Environmental-Economic Accounting (SEEA). WAVES is funded by the European Commission, Denmark, France, Germany, Japan, the Netherlands, Norway, Switzerland, and the United Kingdom and it is being overseen by a steering committee. At the moment, the core WAVES countries – Botswana, Colombia, Costa Rica, Guatemala, Indonesia, Madagascar, the Philippines and Rwanda – are developing natural capital accounting. Source: http://www.wavespartnership.org

YHA-Kuvapankki / Pekka Luukkola

# 8 Summary of conclusions and policy recommendations

**All researchers**

8.1

## Summary of conclusions

The assessment of the value of ecosystem services and related biodiversity brings benefits for the development of sustainable use of natural resources by demonstrating the societal benefits of biodiversity, for instance, through Green and Blue Growth, human health and well-being, and nature-based solutions. It also helps to set priorities for future policy actions, through identifying and integrating the importance and the true value of ecosystem services and related biodiversity into decision-making processes. Additionally, it enables revealing the mutual and interlinked supply of ecosystem services and their effect on human well-being and economy. Considering the value of ecosystem services can enable a more holistic natural resource and land-use planning procedure, save financial costs, boost new enterprises and other job-creating actions, enhance the quality of life and secure sustainable livelihoods nationally, regionally and globally.

Recently, the Finnish government has reviewed the policies for the government's natural resources report *Intelligent and Responsible Natural Resources Economy*, to the Finnish Parliament. The vision and objective of this new policy frame is to enhance cross-sectoral policies in a way that improves the possibilities of Finland becoming a path setter for sustainable natural resources economy in 2050. The assessment of ecosystem services and related biodiversity is an integral part of activities in this renewed policy frame, and the results of TEEB for Finland are in harmony and supportive with this policy.

8.1.1

### Assessing ecosystem services – developing and adapting indicators for green economy

Developing indicators for ecosystem services is essential for several reasons. In drafting them we are immediately faced with some fundamental questions: What are the most important ecosystem services in Finland? How can we measure their state and significance? Are there any clear trends related to specific ecosystem services? Furthermore, indicator development forces us to think about ways of connecting data on ecosystem qualities and processes to the societal benefits that arise from their utilization. The question of how to measure the values of ecosystem services emerges.

All these questions have been tackled within our national effort to create a collection of ecosystem service indicators for Finland. Despite fast development in ecosystem service research and monitoring, few examples, if any, of such national indicator collections exist anywhere in the world. Therefore, it has been a challenging task to create a framework for an indicator set, which is, at the same time, both suitably comprehensive and succinct. The proposed Finnish indicator collection is based on a combination of the international CICES classification of ecosystem service types and the Cascade model, which has been developed to make the flow of ecosystem services from ecosystem structures and functions to the benefits and associated values that humans gain from them visible.

Expert and stakeholder consultations were organized to discuss the list of the most important ecosystem services in Finland. At the moment, 28 services in total have been selected: 10 provisioning, 12 regulating and 6 cultural services. Four indicators will be drafted for each indicator group: one each on structure, function, benefit and value. All ecosystem services will be linked to the eco-

systems that are most closely associated with their provision. Work on creating indicator content is currently underway. It is obvious that there are many information gaps, most notably regarding some regulating and cultural services. All indicators will be published online (www.biodiversity.fi/ecosystemservices) as they are created. More expert and stakeholder consultations will be held as the work progresses.

Based on the work that has been done so far, a few preliminary conclusions can be drawn. Trends related to many provisioning services have been relatively stable over the last two decades as regards harvests and other types of utilized yields. However, as the economy has simultaneously grown in other areas, the relative significance of the forestry, agriculture and fishery sectors, for example, has decreased. Relative to other areas of the economy these are no longer as vital as they used to be. There are also increasing recreational values related to many provisioning services. For instance, fishing and hunting are now often regarded as forms of recreation rather than means of securing nutrition or earning a living.

Knowledge regarding many regulating services is lacking. However, many such ecosystem processes are now encouragingly under investigation. The role of the carbon cycle and associated climate regulation has become the most discussed and, perhaps, critical of all regulating services as human induced climate change advances. Contrary to most other regulating services, markets for carbon emissions and sequestration are already developing. Many regulating services have been traditionally taken for granted. Their role in sustaining the human economy only becomes visible when these processes are disturbed. In Finland, there are some critical questions related to the flow and retention of water, nutrient dynamics and reproduction of important species, for example.

Cultural ecosystem services are also receiving more attention. Questions related to recreation in nature and beneficial impacts of nature on human health and well-being in particular are being studied intensively. Some studies show that, in some cases at least, the recreational and health benefits already outweigh the benefits of traditional forest management, for example. Information on some cultural services is more problematic to present in indicator format as there is very little quantitative or indeed any systematically collected information on the significance of nature in Finnish arts and popular culture, for instance.

One area that requires further investigation is the trade-offs between the utilization of different ecosystem services. The ecosystem indicator framework offers an opportunity to further these kinds of analyses as well.

The Aichi Targets of the CBD, EU's Biodiversity Strategy 2020 and so called "Fitness check" of Nature Directives ((Bird and Habitat Directives) require analysis of existing biodiversity, habitat and ecosystem service data, and continuous development of scientific methods and policy actions. Combatting these challenges needs more research and development e.g. on the mapping and assessment of ecosystems and their services on EU Member State level.

There are still several other scientific needs to be resolved while working for the establishment of a sound and workable indicator framework. For example, regional spatially explicit sustainability indicators supporting MAES work need to be developed. Sectoral indicators regarding regulating and cultural services which would support sustainable agriculture and forestry, and water-related livelihoods and well-being should be developed and tested. A set of Essential Biodiversity Variables (EBVs) suitable for Finnish conditions, should be developed in order to allow integration into global monitoring systems for ecosystems and biodiversity (GEOBON), directly supporting the information needs of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). Model systems can allow evaluating the spatio-temporal development of risks and the vulnerabilities of key ecosystem services. This would be especially important for studying extreme climate change scenarios – both the direct environmental impacts, but also, for instance, the impacts of the societal response-actions such as increasing bioenergy production on biodiversity and ecosystem services.

In general, developing the knowledge on ecosystem services supporting green economy requires investments to research. A targeted, multidisciplinary research programme, for instance, could support the integration of ecosystem service concepts with resource efficiency and sustainable economic systems. Launching of such research programme should be promoted for national funding organisations.

8.1.2

### Mapping the value of ecosystem services for land use planning

To be able to deploy the ecosystem based approach in practical planning and decision-making the information gaps related to ecosystem service provision and demand must be filled actively. Spatially explicit mapping provides a concrete and powerful method for making ecosystem services visible. Mapping the value of ecosystem services helps in particular in defining the most important areas for safeguarding the flow of vital services to society. A wealth of valuation mapping methods, are available for various needs, depending on the available data. Therefore, in land use and natural resource related planning and decision-making, the spatial variation in both, a) the potential and the sustainable capacity of green and blue areas (known as green infrastructure) to provide ecosystem services, as well as b) the social and societal demand for them (the beneficiaries) should be assessed. This should be done early enough in the planning or policy development process to allow time for sufficient analysis and attaining reliable results. Gathering and processing data, collaboration with stakeholders and the final analysis requires allocation of enough resources and thus funding, which needs to be taken into account.

Regulating and cultural ecosystem services require particular attention, because they remain more easily unrecognized in the planning process. Participatory GIS methods are recommended for collecting experiential data about the meanings and significance of places offering people various cultural ecosystem services, such as recreational opportunities, learning about nature, aesthetic values, spiritual experiences or a sense of place. Participatory planning is especially important when it comes to ecosystem services, as they are an essential constituent of the daily living environment. Integrating local people in land use planning allows their views and values to be taken into account properly in the planning process, often resulting in less contested final plans.

The key areas of green infrastructure comprise valuable areas of nature as the backbone, which are supplemented by areas with the highest ecosystem service provision potential and areas that are especially important for people. To ensure a coherent and connected green infrastructure, green and blue corridors, so called stepping stones and the landscape permeability, should be taken into account as well. The key areas identified, must then be considered in land use planning, and the functionality of their ecosystems, maintained or enhanced by land use decisions. This involves giving them an actual legitimate status in land use plans. In regional plans, key areas of green infrastructure identified, based on natural values and hotpots of ecosystem services, should be marked also in the so called 'white areas' where there is no allocated land use otherwise.

8.1.3

### Valuation of ecosystem services

Valuation studies of ecosystem services can support decision-making by uncovering the benefits ecosystems provide to society and the determinants of ecosystem service values. Valuation can depend on qualitative descriptions, quantitative measures or monetary estimates. Monetary value estimates can be used in cost-benefit analyses of environmental projects and in impact assessments.

The review of case studies on the value of ecosystem services presented in this report has revealed the economic importance of recreation in nature, marine and freshwater ecosystems, agricultural environments, urban forests and peatlands. In addition to these studies of the general public, a workshop of stakeholders and experts provided information on how they rank and assess different ecosystem services.

Recreation is a highly important ecosystem service in Finland. Values of close-to-home recreation visits have been estimated to be in the range of €2–13 per visit, and value estimates of overnight trips (such as visits to holiday cottages) vary between €29 and €252 per trip. The total annual value of close-to-home recreation and overnight nature trips in Finland has been estimated at around €2.9 billion. The total value of recreation is considerable when taken into account that it is mostly obtained by using everyman's right on forests, water areas and agricultural landscapes that are actively used for the production of other ecosystem services, such as timber and food.

According to studies on the effects of ecosystem and landscape characteristics on the value of outdoor recreation, the value of recreation ecosystem services could be increased further by enhancing biodiversity and avoiding remarkable visible traces of intensive forestry, such as clear-cuts, in recreational areas. With respect to agricultural land, Finnish recreationists appear to appreciate landscapes with grazing animals and renovated production buildings. The value of a close-to-home recreational visit to an agricultural area is at the same level as the value of visits to other types of natural areas. Agricultural lands are not, however,

as appealing as nature trip destinations as other kinds of natural areas.

In addition to recreation, marine and freshwater ecosystems have also been a focus area of ecosystem valuation in Finland. There are several studies on water-related cultural ecosystem services, including water recreation, aesthetic values and non-use (existence) values. The main emphasis has been on valuing changes in the eutrophication status of waters, and water recreation. These studies indicate that significant value is placed on improvements in the state of surface waters in Finland, showing the importance of both water recreation and the existence of well-functioning water ecosystems. For example, the value of water recreation has been estimated at €6–20 per visit. As the number of studies available is large, there are possibilities to use these to support decision-making related to water resources. However, there are only a few studies on the value of ecosystem services provided by groundwater, which is an interesting avenue for further research.

Studies measuring citizens' perceptions of ecosystem services in agricultural environments, urban forests and peatlands provide information on the relative importance of various ecosystem services. Based on these three studies, the general public emphasizes cultural ecosystem services in particular, for example the recreational use of nature and its many benefits. The studies, however, do not provide a deeper understanding of the links between cultural ecosystem services, which is an interesting topic for future studies. For example, recreation benefits can be a prerequisite for experiencing several other cultural ecosystem services. The studies also reveal the difficulties in understanding the concept of regulating services, which is natural as regulating services relate in many cases to the ecosystem functions that underlie the final services used by people.

The workshop with stakeholders and experts focused on the changes in ecosystem services caused by environmental changes: climate change, eutrophication, land use changes and chemicalization. The results showed that the experts emphasize in particular securing ecosystem services provided by water quality that may be affected by eutrophication, climate change and chemicalization. Supporting biodiversity and recreation under the pressure of land use changes was also considered important. The stakeholders and experts stressed securing regulating services, and in particular preventing the negative effects of climate change on these. The results of the workshop highlighted the importance of understanding the connections between various ecosystem services and considering also the regulating services in valuation.

As resources for research are scarce, making the most of existing ecosystem service valuation results is important. In Finland, there are dozens of studies that have estimated monetary values of ecosystem services and environmental improvements. However, no comprehensive inventory of these studies is available. Continuous collection of valuation results in a valuation inventory would provide an important outlook on nationally held ecosystem service values and their history. The inventory should include up-to-date information on valuation studies and their results, and therefore be of interest both to decision makers and researchers. International valuation inventories already exist, but their reach is limited and they have not been updated with the most recent valuation studies conducted in Finland.

### 8.1.4
### Assessing and developing policy and knowledge systems for ecosystem services

In contemporary Finnish regulations, numerous connections to the concept of ecosystem services can be found. These connections can be found for instance in the Land Use and Building Act, which provides key mechanisms for accommodating diverging land use interests. However, these connections are not made explicit and contemporary legislation does not provide clear authorization for consideration of ecosystem services in decision-making. However most of the norms do not directly block the consideration of ecosystem services in decision-making either. Thus, the situation could be improved, at least to some extent, even without changes to legislation by providing guidance on where, when and how the concept of ecosystem services can be utilized in decision-making. This requires further legal analysis to identify those norms that provide a platform for utilizing the concept of ecosystem services.

In addition to the guidance on the creative interpretation of existing norms, the development of regulations is advisable. Our analysis revealed several weaknesses of the current regulatory system from the perspective of protecting ecosystem services. Whilst the regulatory system gives adequate legal protection for places of special importance and specific environmental values, the protection of ecosystem services requires consideration of broader environmental values and landscape level management. As already mentioned, there are flexible instruments such as land use planning and water management planning, which allow for the consideration of broader environmental values, but the flexibility of those instruments leaves lot

of discretion to the planners. Thus instead of balancing and accommodating diverging interests in decision-making, one interest can override another one. In addition to this, even if plans were drawn up keeping ecosystem services in mind and utilizing an ecosystem service approach, the problem is that the links between planning law and laws regulating single decision-making processes, such as permit processes, are not always clear. For instance the effectiveness of water management plans ultimately depends on how authorities "give due consideration" to plans in their decision-making. Thus, in order to utilize existing planning instruments to better protect ecosystems and the services they provide, the connections between different instruments should be strengthened.

Furthermore, an effective legal system for ecosystem services requires mechanisms that facilitate restoration and other active conservation measures. The existing regulations do not provide adequate tools for this. There are only a few norms that directly require or can be used to require the conduction of restoration measures. Currently, ecosystem restoration is largely left to the public sector and is highly dependent on public financing. Thus, developing legislation to encourage the private sector to conduct restoration measures is advisable. For instance, legislation could be developed to allow obligations for restoration measures to be included in permit conditions. Finally, the coherence of the regulatory system should be strengthened. In this regard, efficiency could be improved by removing and/or redirecting subsidies that cause environmental harm.

Developing a regulatory framework that allows or requires ecosystem services to be taken into account in decision-making is important, but inadequate for protecting ecosystems and the services they provide. In addition to this, information about ecosystem services is needed to give content for decisions, thus the knowledge systems that decision-makers utilize need to be developed as well. Based on the survey conducted as part of this study, the key weaknesses of the current knowledge systems are that they do not provide information on ecosystem services. In addition to this, the sector specificity of knowledge systems was seen as problematic. Furthermore, it was also recognized that not all relevant information is made available for decision-makers. Finally, the lack of resources, time and skills for utilizing knowledge systems and databases were seen as barriers for taking ecosystem services into account in decision-making.

8.1.5

### Piloting and adapting compensation mechanisms and incentives – Habitat banking and Payments for ecosystem services (PES)

Ecological compensation is one potential mechanism to be used to prevent or slow down the degradation of biodiversity and ecosystem services. Ecological compensation and especially habitat banking should be piloted in Finland.

If used in Finland, ecological compensation should follow the mitigation hierarchy, being a tool only, if avoidance and minimization of loss are not enough to eliminate the damage.

There is also a potential for developing PES-type measures in Finland, especially for water related ecosystem services. River basin management plans under the Water Framework Directive hold potential as a framework to implement PES schemes. At local level and regional level, several instruments could be adopted to develop – or to complement – PES schemes. These include municipal water and storm-water fees, LIFE+ pilot programs and schemes financed by private companies, supported by off-on investments in green infrastructure.

8.1.6

### Ecosystem services and green economy

Ecosystem services are an integral part of a number of economic sectors relevant to green economy in Finland, namely the forest sector, water, tourism, the agriculture and food sector, game and fisheries, and renewable energy. In addition to these, ecosystem services are perceived as an integral part of growing green economy sectors such as the textile industry, life and health style business (LOHAS), cosmetics and pharmaceuticals.

The integration of a whole range of ecosystem services into green economy helps to ensure that green economy is both environmentally and socially sustainable and 'truly green', i.e. also brings benefits for biodiversity. However, in order to achieve the synergies between the management of ecosystem services and related biodiversity, they need to be secured in concrete investment and management decisions, i.e. focusing on the management of a single ecosystem service only can also negatively impact on biodiversity conservation.

Policy coherence is needed in order to provide consistent regulation and guidance for private companies and other stakeholders. Promotion of green economy requires wide collaboration between different stakeholders and policy sectors. Consequently, ecosystem services need to be taken

into consideration systematically when greening these sectors in the future. Ecosystem services must be more systematically integrated into policy level strategies and recommendations, especially in the bioeconomy strategy.

It is recommended that systematic ecosystem services assessments are an integral part of 'greener' decision and policy making within different economic sectors in the future. The connections between ecosystem services and green economy identified in the context of this assessment can be systematically assessed and conceptualized through the framework presented in Figure 7.1.1.

At a company level, tools to supporting the integration of ecosystem services into companies' sustainability management systems and product/service chains already exist, e.g. WBCSD's guidelines for ecosystem service review and ecosystem services valuation. Similar tools could also be developed to be applied at the level of national and regional sectoral policy (see Sections 7.1.1–7.1.4).

8.1.7

## Natural capital accounting

The future work on natural capital accounting in Finland is anticipated as focusing more closely on aligning ongoing work on indicators with the existing framework for national and environmental-economic accounts, leading to the development of ecosystem (capital) accounts in Finland. The key immediate next step in Finland would be to identify a number of ecosystem services and related indicators that could support the development of a pioneering set of ecosystem accounts. Building on the existing statistical frameworks for forestry, water resources and tourism it appears sensible to focus on exploring how these frameworks could take on board broader information on forest, water and recreation related ecosystem services (see more in Section 7.2.4).

The development of monetary accounts for ecosystem services does not seem to be an immediate a priority and there are no immediate plans to attempt to adjust the GDP to take into account ecosystem degradation and loss of associated capacity to deliver ecosystem services. The latter is not currently seen as practical or feasible, due to the lack of a robust empirical base and international standards. However, in the longer run the possibilities for such monetary accounts – when relevant and feasible – could be considered. Also in the longer run, ecosystem accounts are considered to be most useful for decision-making when linked to spatial data. This kind of development will need further research, methodological development and experimentation, but it is already seen as a promising direction and it is mentioned in the revised version of the third volume of the SEEA.

Recommendations concerning the development and uptake of natural capital accounting in Finland:

- Aligning the ongoing work on indicators with the existing framework for national and environmental-economic accounts, with a view to develop a set of pioneering ecosystem (capital) accounts for water, forests (including forest carbon), fisheries and fish stock and nature-based tourism.). This should be carried out within the general framework currently being developed under the EU-wide MAES initiative.
- In the longer run, explore the opportunities to link the ecosystem accounts to spatial data (ecosystem types, land use practices, proximity to populations centres), to make the accounts increasingly useful for decision-making at different levels.
- Focus largely on the biophysical data in accounts in the immediate future as this will allow a wider range of issues to be addressed. Selective use of monetary indicators could be useful if and where they can help contribute to important policy questions and provide meaningful results. This could help ensure political commitment to the development of environmental economic accounting.

Finally, even the most comprehensive accounts cannot fully capture issues related to the irreversible depletion or erosion of natural resources, ecosystems and ecosystem services (ecological limits and thresholds, non-linearity). Consequently, it is crucial to keep in mind transparency as regards to what accounts can or cannot when developing the accounts in the future.

8.2

## Roadmap for decision-makers: summary of policy recommendations

**All researchers**

8.2.1

### Towards a more thorough consideration of ecosystem services in society

- Ecosystem services should be a concern at all levels of society. Securing their provision requires coordination across administrative and economic sectors and the involvement of private companies and non-governmental organizations alike.
- Ecosystem services should be taken into account systematically whenever drafting or reviewing policies, laws and regulations that have impacts on the use of land and natural resources. Adopting ecosystem service reviews/assessments as a compulsory part of relevant (sectoral) policy and decision-making processes could be an effective way to achieve this.
- New compensation instruments should be developed for situations where avoidance and mitigation of major negative impacts on biodiversity and related ecosystem services is not possible. Habitat banking (Section 6.3) could be an example of such compensatory instruments. Also creating market mechanisms for voluntary actions to provide ecosystem services should be encouraged.
- New instruments – legislative and/or voluntary – should be developed to encourage land use planning and land/resource management approaches that build on an understanding of the full range of ecosystem services and related biodiversity. Payment for Ecosystem Services (PES) schemes for water management could be one possible example of such instruments.
- Economic subsidies that have major negative impacts on critical ecosystem services and related biodiversity need to be identified and re-directed or phased out. There is also a need to develop positive incentives that support the sustainable use of ecosystem services and related biodiversity.

8.2.2

### Basing decision-making on solid knowledge of ecosystem services

- The role of ecosystem services in society needs to be strengthened and concretized using up-to-date biodiversity and ecosystem service indicators that are based, as far as possible, on quantitative monitoring data. This requires the maintenance and development the current collection of biodiversity and ecosystem service indicators (www.biodiversity.fi), which provides data for the Finnish national indicator system (www.findicator.fi). The Biodiversity.fi portal should also be integrated in the monitoring system of Finnish environment (MONITOR2020) to secure its maintenance, and also to improve its data availability and applicability.
- Relevant key ecosystem service indicators should be incorporated into the National Capital Accounting system of Finland[12], allowing for a more balanced view of the state of Finland's natural resources and well-being than the current indicators, such as Gross Domestic Product (GDP). With the help of this inclusion, ecosystem service indicators can also be systematically integrated into all relevant policy assessments and the development and implementation of sector policies.
- Evaluating impacts on ecosystem services should become a standard part of the Environmental Impact Assessments (EIA).
- Information gaps related to ecosystem services and biodiversity need to be filled actively. In particular the lesser known, but important regulating, maintenance and cultural ecosystem services require more attention.
- Mapping and assessment of ecosystem services and their values provide useful, spatially explicit information that needs to be integrated in land use planning, decision-making and management on all scales.

[12] The Convention on Biological Diversity (CBD) has recently produced a toolkit for countries that are planning or starting a process of incorporating the values of natural capital into their accounting systems (Ecosystem Natural Capital Accounts: a Quick Start Package, CBD Technical Series No. 77/2014).

8.2.3

### Emphasizing the socio-economic importance of ecosystem services

- In particular, current knowledge of the economic value of regulating, maintenance and cultural ecosystem services is limited and needs to be increased in further studies. This includes, for example, estimating the damages and economic costs resulting from the loss of ecosystem services and related biodiversity that do not have a market-value.
- A cost-benefit analysis, including valuation of environmental impacts, should be used to incorporate ecosystem service values into the evaluation of projects and policies with significant effects on ecosystem services and related biodiversity.
- More information is needed on the value of changes in ecosystem services and on the link between the ecosystem characteristics and values. Also solutions that safeguard sustainable multiple use of natural resources and land for different purposes based on the green economy principles need to be promoted.
- Valuation data and results should be systematically collected and included within an open access ecosystem services valuation database. This will also improve the utilization of data and research produced.
- Wider consideration of ecosystem services and related biodiversity in society can provide possibilities for new business models and employment activities which are based on the sustainable use of these assets. This kind of development activities should be encouraged and supported.
- Private companies should be encouraged to integrate the consideration of ecosystem services and related biodiversity into their management systems and business models through the systematic use of ecosystem services and biodiversity reviews and, where appropriate, ecosystem services valuation. To support this development, Business & Biodiversity initiatives should be further strengthened.

8.2.4

### Raising public awareness and appreciation of ecosystem services

- The socio-economic assessment of ecosystem services and related biodiversity provides an effective way to communicate how human societies are dependent on the provision of these assets and why the conservation and sustainable use of natural ecosystems is important for human well-being.

## REFERENCES


Ahtiainen, H. 2007. Willingness to pay for improvements in the oil spill response capacity in the Gulf of Finland – an application of the contingent valuation method. Discussion Papers no 18, Department of Economics and Management, University of Helsinki.

Ahtiainen, H. 2008. Benefits of lake water quality improvements: A case study of Lake Hiidenvesi (Järven tilan parantamisen hyödyt. Esimerkkinä Hiidenvesi). The Finnish Environment 47. Finnish Environment Institute. Helsinki.

Ahtiainen, H., Artell, J., Czajkowski, M., Hasler, B., Hasselström, L., Huhtala, A., Meyerhoff, J., Smart, J.C.R., Söderqvist, T., Alemu, M., Angeli, D., Dahlbo, K., Fleming-Lehtinen, V., Hyytiäinen, K., Karlõševa, A., Khaleeva, Y., Maar, M., Martinsen, L., Nõmmann, T., Pakalniete, K., Oskolokaite, I. & Semeniene, D. 2014. Benefits of meeting nutrient reduction targets for the Baltic Sea – a contingent valuation study in the nine coastal states. Journal of Environmental Economics and Policy 3(3): 278–305.

Amelung, B., Nicholls, S. & Viner, D. 2007. Implications of Global Climate Change for Tourism Flows and Seasonality. Journal of Travel Research vol. 45 no. 3, p. 285-296.

Amelung, B. & Moreno, A. 2012. Costing the impact of climate change on tourism in Europe: results of the PESETA project. Climatic Change 112: 83–100.

Antikainen, R., Lemola, R., Nousiainen, J. I., Sokka, L., Esala, M, Huhtanen, P. & Rekolainen, S. 2005. Stocks and flows of nitrogen and phosphorus in the Finnish food production and consumption system. Agriculture, Ecosystems & Environment. Volume 107, Issues 2–3. pp. 287–305.

Antikainen, R., Tenhunen, J., Ilomäki, M., Mickwitz, P., Punttila, P., Puustinen, M., Seppälä, J. & Kauppi, L. 2007. Bioenergy production in Finland – new challenges and their environmental aspects (Bioenergian uudet haasteet Suomessa ja niiden ympäristönäkökohdat. Nykytilakatsaus.) Suomen ympäristökeskuksen raportteja 11/2007. Available at: http://hdl.handle.net/10138/39770.

Arnold, C. & Gunderson, L. 2013. Adaptive Law and Resilience. Environmental Law Reporter Vol. 43.

Artell, J. 2014. Lots of Value? A Spatial Hedonic Approach to Water Quality Valuation. Journal of Environmental Planning and Management 57(6): 862–882. doi:10.1080/09640568.2013.772504.

Autio, N., Piirainen, A., Salomaa, E. & Vahvelainen, S. 2013. Ympäristötilinpito kansantalouden tilinpidon täydentäjänä. Kansantaloudellinen aikakauskirja 109(3): 331–350.

Bagstad, K. J., Jonhson, G. W., Voigt, B. & Villa, F. 2013. Spatial dynamics of ecosystem service flows: A comprehensive approach to quantifying actual services. Ecosystem Services 117–125.

Baró, F., Haase, D., Gómez-Baggethun, E. & Frantzeskaki, N. Assessing mismatches in ecosystem services supply and demand using environmental quality standards. The case study of five European cities. Ecological Indicators. [Manuscript]

Barton, D.N. Lindhjem, H., Magnussen, K., Norge, S. & Holen, S. 2012. Valuation of Ecosystem Services from Nordic Watersheds. From awareness raising to policy support? (VALUESHED). TemaNord 2012: 506.

Bastian, O., Haase, D. & Grunewald, K. 2012. Ecosystem properties, potentials and services - The EPPS conceptual framework and an urban application example. Ecological Indicators 21: 7–16.

Bateman, I,J., Mace, G.M., Fezzi, C., Atkinson, G. & Turner, K. 2011. Economic Analysis for ecosystem service assessments. Environmental & Resource Economics 48: 177–218.

Bateman, I.J. 2009. Bringing the real world into economic analyses of land use value: Incorporating spatial complexity. Land Use Policy 265: 30–42.

BBOP (Business and Biodiversity Offsets Programme) 2009a. Business, biodiversity offsets and BBOP: Design Handbook, BBOP, Washington, D.C.

BBOP (Business and Biodiversity Offsets Programme) 2009b. Biodiversity Offset Implementation Handbook, BBOP, Washington, D.C.

BBOP (Business and Biodiversity Offsets Programme) 2012. Standard on Biodiversity Offsets. BBOP, Washington, D.C. Available at: http://bbop.forest-trends.org/guidelines/Standard.pdf

Bekessy, S.A., Wintle, B.A., Lindenmayer, D.B., Mccarthy, M.A., Colyvan, M., Burgman, M.A. & Possingham, H.P. 2010. The biodiversity bank cannot be a lending bank. Conservation Letters 3: 151–158.

Berninger, K., Schulman, A., Poltimäe, H. & Peterson, K. 2011. Report on implementability of Agri-Environmental Targets in Finland. Baltic Compass report, Helsinki. Available at: http://www.balticcompass.org/National%20reports/Finland_National%20Report_Final%2010%208%202011.pdf, last accessed 31 July 2013.

Bishop, J., Kapila, S., Hicks, F., Mitchell, P. & Vorhies, F. 2008. Building biodiversity business. Shell International Limited & the International Union for Conservation of Nature. 164 pp.

Bishop, J. Bertrand, N. Evison, W., Gilbert, S., Grigg, A., Hwang, L., Kallesoe, M., Vakrou, A., van der Lugt, C. & Vorhies, F. 2010. TEEB – The Economics of Ecosystems and Biodiversity Report for Business - Executive Summary. TEEB - The Economics of Ecosystems and Biodiversity. Available at: http://www.teebweb.org/wp-content/uploads/Study%20and%20Reports/Reports/Business%20and%20Enterprise/Executive%20Summary/Business%20Executive%20Summary_English.pdf.

Borgström, S. 2014 (forthcoming). Assessing the capacity of nature conservation law to help biodiversity adapt to climate change: The case of Finland. Accepted for publication in Review of European, Comparative and International Environmental Law.

Borgström, S. & Kistenkas, F.H. 2014. The compatibility of the Habitats Directive with the novel EU Green Infrastructure policy. European Energy and Environmental Law Review 2: 36–44.

Boyd, J. & Banzhaf, S. 2007. What are ecosystem services? The need for standardized environmental accounting units. Ecological Economics 63: 616–626.

Brown, G. 2013. Relationships between spatial and non-spatial preferences and place-based values in national forests. Applied Geography 44: 1–11.

Brouwer, R., Brander, L., Kuik, O., Papyrakis, E. & Bateman, I. 2013. A synthesis of approaches to assess and value ecosystem services in the EU in the context of TEEB. Final Report. University of Amsterdam, Institute for Environmental Studies. 144 pp.

BSR. 2013. Private Sector Uptake of Ecosystem Services Concepts and Frameworks. The Current State of Play. March 2013, www.bsr.org.

Burkhard, B., Krol, F., Müller, F. & Windhorst, W. 2009. Landscapes' capacities to provide ecosystem services - a concept for land-cover based assessments. Landscape Online 15: 1–22.
Burkhard, B., Kroll, F., Nedkov, S. & Müller, F. 2012. Mapping ecosystem service supply, demand and budgets. Ecological Indicators 21: 17–29.
Buzbee, W. 2005. The regulatory fragmentation continuum, Westway and the Challenges of Regional Growth, J.L. & POL. (21).
Camacho, A. 2009. Adapting governance to climate change: managing uncertainty through learning infrastructure. Emory Law Journal 59.
Chan, K. M. A., Guerry, A. D., Balvanera, P., Klain, S., Satterfield, T., Basurto, X., Bostrom, A., Chuenpagdee, R., Gould, R., Halpern, B. S., Hannahs, N., Levine, J., Norton, B., Ruckelshaus, M., Russell, R., Tam, J. & Woodside, U. 2012. Where are cultural and social in ecosystem services? A framework for constructive engagement. BioScience 62(8): 744–756.
Commissariat général au développement durable (CGDD). 2012. Compensating for damage to biodiversity: an international benchmarking study. Etudes & documents 68: 1–129.
Compton, J. E., Church, M. R., Larned, S. T., & Hogsett, W. E. 2003. Nitrogen export from forested watersheds in the Oregon Coast Range: the role of N2-fixing red alder. Ecosystems 6: 773–785.
Cosens, B. 2010. Transboundary river governance in the face of uncertainty: resilience theory and the Columbia River Treaty. Journal of Land Resources and Environmental Law 30(2).
Costanza, R., d'Arge, R., de Groot, R., Farberk, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P. & van den Belt, M. 1997. The value of the world's ecosystem services and natural capital. Nature 387: 253–260.
Crossman, N. D., Burkhard, B., Nedkov, S., Willemen, L., Petz, K., Palomo, I., Drakou, E. G., Martín-López, B., Mcphearson, T., Boyanova, K., Alkemade, R., Egoh, B., Dunbar, M. B. & Maes, J. 2013a. A blueprint for mapping and modelling ecosystem services. Ecosystem Services 4: 4–14.
Crossman, N.D., Bryan, B.A., de Groot, R.S., Lin, Y.-P. & Minang, P.A. 2013b. Land science contributions to ecosystem services. Current Opinion in Environmental Sustainability 5(5): 509–514.
D'Amato, D. & Kettunen, M. 2014. Potential for the uptake of Payments for Ecosystem Services (PES) in Finland. Feasibility assessment related to water purification and water regulation. An unpublished manuscript for the Finnish Environment Institute.
de Groot, R. S., Alkemade, R., Braat, L., Hein, L. & Willemen, L. 2010. Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making. Ecological Complexity 7: 260–272.
Dendoncker, N., Keune, H., Jacobs, S. & Gómez-Baggethun, E. 2013. Inclusive ecosystem services valuation. In: Jacobs, S., Dendoncker, N. & Keune, H. (eds.). Ecosystem services: Global issues, local practices. Sand Diego and Waltham, U.S., Elsevier. Pp. 3–12.
Ecologic (Institute for International and European Environmental Policy) 2006. Water Framework Directive meets Common Agricultural Policy – Opportunities for the Future. Thematic Priority 8.1 Policy Oriented Research. Deliverable 2.1 WFD and Agriculture – Linkages at the EU Level Analysis of the Policy and Legal Linkages between CAP and WFD. Available at: http://www.ecologic.eu/1369, last accessed 31 July 2013.
Egoh, B., Reyers, B., Rouget, M., Richardson, D. M., Le Maitre, D. C. & van Jaarsveld, A. S. 2008. Mapping ecosystem services for planning and management. Agriculture, Ecosystems and Environment 127: 135–140.
Egoh, B, Drakou, E.G., Dunbar, M.B., Maes, J. & Willemen, L. 2012. Indicators for mapping ecosystem services: a review. JRC Scientific and Policy Reports. European Union. 107 pp.
Eigenbrod, F., Armsworth, P. R., Anderson, B. J., Heinemeyer, A., Gillings, S., Roy, D. B., Thomas, C. D. & Gaston, K. J. 2010. The impact of proxy-based methods on mapping the distribution of ecosystem services. Journal of Applied Ecology 47(2): 377–385.
Ekins, P. 1992. A four-capital model of wealth creation. In: Ekins, P. & Max-Neef, M. (eds). Real-Life Economics: Understanding Wealth Creation. Routledge, London. Pp. 147–155.
Ekins, P., Dresner, S. & Dahlström, K. 2008. The four-capital method of sustainable development evaluation. European Environment 18: 63–80.
Environment 2014. Monthly hydrological reports Available at: http://www.ymparisto.fi/fi-FI/Kartat_ja_tilastot/Hydrologiset_havainnot/Hydrologiset_kuukausitiedotteet.
European Commission. 2011. The EU Biodiversity Strategy to 2020. Publications Office of the European Union, Luxembourg. Doi: 10.2779/39229
European Commission 2013a. Mapping and Assessment of Ecosystems and Their Services. An analytical framework for ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020. Discussion paper – Final, April 2013. Technical report – 2013 – 067. Brussels. 57 pp.
European Commission 2013b. System of Environmental-Economic Accounting 2012. Experimental Ecosystem Accounting. 183 pp. White cover publication, pre-edited text subject to official editing.
European Commission 2013c. Report from the Commission to the European Parliament and the Council Regulation (EU) No 691/2011 of the European Parliament and of the Council of 6 July 2011 on European environmental economic accounts. Brussels, 9.12.2013 COM(2013) 864 final
European Commission 2013d. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Green Infrastructure (GI) - Enhancing Europe's Natural Capital. COM(2013) 249 final. Brussels.
European Environment Agency 2010. The European environment – state and outlook 2010, Country assessments, Finland. Available at: http://www.eea.europa.eu/soer/countries/fi/soertopic_view?topic=freshwater
European Environment Agency 2011. An experimental framework for ecosystem capital accounting in Europe. Technical report No. 13/2011.
European Environment Agency. 2014. Spatial analysis of green infrastructure in Europe. EEA Technical report No 2/2014. Luxembourg, European Environment Agency. 53 pp.
Finland's tourism strategy to 2020. Available at: https://www.tem.fi/files/28018/Finlands_Tourism_Strategy_to_2020.pdf [cited 1.9.2014]
Finnish Bioeconomy Strategy 2014. Sustainable growth from bioeconomy. Ministry of Employment and the Economy, Ministry of the Environment, Ministry of Agriculture and Forestry. 30 pp. Helsinki. Available at: http://www.biotalous.fi/facts-and-contacts/finnish-bioeconomy-strategy/?lang=en

Finnish Customs 2014. http://www.tulli.fi/en/index.jsp
Finnish government 2014. Suomi kestävän luonnonvaratalouden edelläkävijäksi 2050. Valtioneuvoston luonnonvaraselonteon "Älykäs ja vastuullinen luonnonvaratalous" linjausten päivitys eduskunnalle 2014.(Abstract: Finland as the path setter for natural resources economy in 2050 – Review of the policies for the government's natural resources report "Intelligent and Responsible Natural Resources Economy" to the parliament in 2014). Työ- ja elinkeinoministeriön julkaisuja, Energia ja ilmasto – MEE Publications, Energy and the climate 24/2014: 1-62.
Fisher, B., Turner, R. K. & Morling, P. 2009. Defining and classifying ecosystem services for decision making. Ecological Economics 68: 643–653.
Flores, N.E. 2003. Conceptual framework for nonmarket valuation. Chapter 2 in: Champ, P.A., Boyle, K.J. & Brown, T.C. (eds). A primer on nonmarket valuation. Kluwer Academic Publishers. 576 pp.
Folke, C., Carpenter, S., Walker, B., Scheffer,M., Elmqvist, T., Gunderson, L. & Holling C.L 2004. Regime Shifts, Resilience, and Biodiversity in Ecosystem Management. Annual Review of Ecology, Evolution, and Systematics 35: 557–581.
Forsius, M., Anttila, S., Arvola, L. Bergström, I., Hakola, H., Heikkinen, H.I., Helenius, J., Hyvärinen, M., Jylhä, K., Karjalainen, J., Keskinen, T., Laine, K., Nikinmaa, E., Peltonen-Sainio, P., Rankinen, K., Reinikainen, M., Setälä, H. & Vuorenmaa, J. 2013. Impacts and adaptation options of climate change on ecosystem services in Finland: a model based assessment. Current Opinion in Environmental Sustainability 5: 26–40.
Frischmann, B. 2013. Infrastructure. The social value of shared recourses. Oxford University Press.
Fu, B., Wang, S., Su, C. & Forsius, M. 2013. Linking ecosystem processes and ecosystem services. 700 Current Opinion in Environmental Sustainability 5(1): 4–10.
GGKP 2013. Moving towards a common approach on green growth indicators. Green Growth Knowledge Platform, April 2013, Available at: http://www.greengrowthknowledge.org/sites/default/files/downloads/resource/GGKP%20Moving%20towards%20a%20Common%20Approach%20on%20Green%20Growth%20Indicators.pdf.
Gómez-Baggethun, E., Martín-López, B., Barton, D., Braat, L., Kelemen, E., García-Llorente, M., Saarikoski, H., van den Bergh, J., Arias, P., Berry, P., Potschin, M., Dunford, R., Keune, H., Schröter-Schlaack, C. & Harrison, P. 2014. State-of-the-art report on integrated valuation of ecosystem services. EU FP7 OpenNESS Project Deliverable 4.1, European Commission FP7. 33 pp.
Grammatikopoulou, I., Pouta, E., Salmiovirta, M. & Soini, K. 2012. Heterogenous preferences for agricultural landscape improvements in southern Finland. Landscape and Urban Planning 107: 181–191.
Green, O., Garmestani A, van Rijswick H., & Keessen A. 2011. EU Water governance: Striking the right balance between regulatory flexibility and enforcement? Research, part of a special reature on law and social-ecological resilience, Part I.
Gren, I. M., Lindahl, O., & Lindqvist, M. 2009. Values of mussel farming for combating eutrophication: an application to the Baltic Sea. Ecological engineering 35(5): 935–945.
Grieber, T 2009. Payments for Ecosystem Services, Legal and Institutional Frameworks. IUCN. Available at: http://data.iucn.org/dbtw-wpd/edocs/EPLP-078.pdf, last accessed 31 July 2013.
GTK 2014. Mineral resources and exploration. Geological Survey of Finland. http://new.gtk.fi/mineral_resources/industry.html [cited at 6.6.2014].
Gustafsson, M. & Stage, J. 2004. Willingness to pay for improved sea water quality around Aland Islands (Betalningsviljan för renare havsvatten runt Åland). Ekonomiska Samfundets Tidskrift 57(3): 109–116.
Hanski, I., von Hertzen, L., Fyhrquist, N., Koskinen, K., Torppa, K., Laatikainen, T., Karisola, P., Auvinen, P., Paulin, L., Mäkelä, M.J., Vartiainen, E., Kosunen, T.U., Alenius, H., Haahtela, T., 2012. Environmental biodiversity, human microbiota, and allergy are interrelated. P. Natl. Acad. Sci. USA. 109(21): 8334–8339.
Hamilton, J.M. & Tol, R.S.J. 2007. The impact of climate change on tourism in Germany, the UK and Ireland: a simulation study. Regional Environmental Change 7: 161–172.
Haines-Young, R. & Potschin, M. 2010a. The links between biodiversity, ecosystem services and human well-being. In: Raffaelli,D. & Frid, C. (Eds.), Ecosystem Ecology: A New Synthesis. Cambridge University Press.
Haines-Young, R. & Potschin, M. 2010b. Proposal for a Common International Classification of Ecosystem Goods and Services (CICES) for Integrated Environmental and Economic Accounting. Report to the EEA, http://unstats.un.org/unsd/envaccounting/ceea/meetings/UNCEEA-5-7-Bk1.pdf,
Harris, R. & Khan, J. 2013. Ecosystems accounting in the UK. Presentation at the 19th London Group Meeting London, UK, 12-14 November 2013. Available at: http://unstats.un.org/unsd/envaccounting/londongroup/meeting19.asp.
Hietala, J., Alhola, K., Horne, P., Karvosenoja, N., Kauppi, S., Kosenius, A-K., Paunu, V.-V. & Seppälä, J. 2014. Kaivostoiminnan taloudellisten hyötyjen ja ympäristöhaittojen rahamääräinen arvottaminen. PTT raportteja 247. Pellervo Economic Research, Helsinki.
Hirsch, F., Clark, D. Vihervaara, P. & Primmer, E. 2011. Payments for forest–related ecosystem services: What role for a Green Economy? UNECE/FAO Forestry and Timber Section. Available at: http://www.unece.org/fileadmin/DAM/timber/meetings/20110704/06062011pes_background_paper.pdf, last accessed 31 July 2013.
Hoehn, P., Tscharntke, T., Tylianakis, J. M. & Steffan-Dewenter, I., 2008. Functional group diversity of bee pollinators increases crop yield. P. Roy. Soc. B.-Biol. Sci. 275: 2283–2291.
Holling, C. S. 1973. Resilience and stability of ecological systems. Annual Review of Ecological Systems 4:1–23.
Holling, C. S. 1996. Engineering resilience versus ecological resilience. In: Schulze, P.C. (ed.). Engineering within ecological constraints. National Academy Press, Washington, D.C., USA.
Holmberg, M., Akujärvi, A., Anttila, S., Arvola, L., Bergström, I., Böttcher, K., Feng, X., Forsius, M., Huttunen, I., Huttunen, M., Laine, Y., Lehtonen, H., Liski, J., Mononen, L., Rankinen, K., Repo, A., Piirainen, V., Vanhala, P. & Vihervaara P. 2015. ESLab application to a boreal watershed in southern Finland: preparing for a virtual research environment for ecosystem services. Landscape Ecology. Available at: http://dx.doi.org/10.1007/s10980-014-0122-z
Hook, P.W. & Shadle, S.T. 2013. Navigating wetland mitigation markets: A study of risks facing entrepreneurs and regulators. Available at: www.watershedconnect.com/documents/files/navigating_wetland_mitigation_markets_a_stud_of_risks_facing_entrepreneurs_and_regulators.pdf

Horne, P., Boxall, P.C. & Adamowicz, W.L. 2005. Multiple-use management of forest recreation sites: a spatially explicit choice experiment. Forest Ecology and Management 207: 189–199.
Huhtala, A. & Pouta, E. 2008. User fees, equity and the benefits of public outdoor recreation services. Journal of Forest Economics 14: 117–132.
Huhtala, A. & Lankia, T. 2012. Valuation of trips to second homes: do environmental attributes matter? Journal of Environmental Planning and Management 55(6): 733–752.
Huhtala, M., Kajala, L. & Vatanen, E. 2010. Local economic impacts of national park visitors' spending: The development process of an estimation method. Working Papers of the Finnish Forest Research Institute 149. 20 p. Available at: http://www.metla.fi/julkaisut/workingpapers/2010/mwp149.htm
Hyyrynen, M. 2013. Environmentally harmful subsidies. (Ympäristön kannalta haitalliset tuet) Reports of the Ministry of the Environment 13 (Ympäristöministeriön raportteja 13). Ministry of the Environment, Helsinki.132 pp.
Hyytiäinen, K. & Ollikainen, M. (eds.) 2012. Economic Aspects of Baltic Sea Protection (Taloudellinen näkökulma Itämeren suojeluun). Reports of the Ministry of the Environment 22/2012 (Ympäristöministeriön raportteja 12). Ministry of the Environment, Helsinki. 134 pp.
Hölttä, P. 2008. Kasvillisuuden torjunnan menetelmät rautateillä – Esiselvitys. Espoo. Teknillinen korkeakoulu. (in Finnish).
ICF GHK 2013. Exploring potential demand for and supply of habitat banking in the EU and appropriate design elements for a habitat banking scheme. Final report submitted to DG Environment. 132 pp.
ICMM IUCN. 2012. Independent report on biodiversity offsets. Prepared by The Biodiversity Consultancy. Available at: www.icmm.com/biodiversity-offsets
Ilola, H. & Aho, S. 2003. Mikä parasta Suomessa - seitsemän Euroopan maan matkailijoiden näkemänä. Lapin yliopisto, Taloustieteiden ja matkailun laitos. Available at: http://www.mek.fi/studies/mika-parasta-suomessa-seitseman-euroopan-maan-matkailijoiden-nakemana/
IPCC 2014: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
Juutinen, A., Mitani, Y., Mäntymaa, E., Shoji, Y., Siikamäki, P. & Svento, R. 2011. Combining ecological and recreational aspects in national park management: A choice experiment application. Ecological Economics 70: 1231–1239.
Jylhä, K., Laapas M., Ruosteenoja, K. et al 2014. Climate variability and trends in the Valkea-Kotinen region, southern Finland: comparisons between the past, current and projected climates. Boreal Environment Research 19(Suppl. A): 4–30.
Jäppinen, J.-P., Tyrväinen, L., Reinikainen, M. & Ojala, A. (eds.) 2014. Luonto lähelle ja terveydeksi. Ekosysteemipalvelut ja ihmisen terveys Argumenta-hankkeen (2013–2014) tulokset ja toimenpidesuositukset (Abstract: Nature for Health and Well-Being in Finland – results and recommendations from the Argumenta project Ecosystem Services and Human Health (2013-2014)). Suomen ympäristökeskuksen raportteja 35/2014. 104 pp. Helsinki.
Jäppinen, J.-P., Seppälä, J. & Salo, J. 2004. Ekosysteemilähestymistapa biodiversiteetin suojelussa, hoidossa ja kestävässä käytössä (Abstract: The Ecosystem approach in the conservation, management and sustainable use of biological diversity). The Finnish Environment 733. Ministry of the Environment, Helsinki. 46 pp.
Jääskeläinen, A. 2007. Talousveden riskienhallinnan kustannus-hyötyvertailu – Esiselvitys. Savonia-ammattikorkeakoulun julkaisusarja. Kuopio. (in Finnish)
Kaartinen, T., Sormunen, K. & Rintala, J., 2013. Landfill mining potential of closed MSW landfills in Finland. Presentation in International Academic Symposium on Enhanced Landfill Mining, 21.10.2013.
Kareiva, P., Tallis, H., Ricketts, T. H., Daily, G. C. & Polasky, S. (eds.) 2011. Natural capital. Theory and practice of mapping ecosystem services. New York, United States, Oxford University Press. Oxford Biology.
Karjalainen, E., Sarjala, T. & Raitio, H., 2010. Promoting human health through forests: overview and major challenges. Environmental Health and Preventive Medicine 15(1): 1–8.
Kauppi, P. E., Posch, M., Hänninen, P., Henttonen, H. M., Ihalainen, A., Lappalainen, E., Starr, M. & Tamminen, P. 1997. Carbon reservoirs in peatlands and forests in the boreal regions of Finland. Silva Fennica 31 (1): 13–25.
Kauppila, J. 2011. Pintaveden normatiivinen tila. Ympäristöpolitiikan ja -oikeuden vuosikirja 2011. (in Finnish)
Kauppila, P., Räisänen, M-L. & Myllyoja, S., 2011. Metallimalmikaivostoiminnan parhaat ympäristökäytännöt. Suomen ympäristö 29/2011, Finnish Environment Institute, Helsinki.
Kelemen, E., García-Llorente, M., Pataki, G., Martín-López, B. & Gómez-Baggethun, E. 2014. Non-monetary techniques for the valuation of ecosystem services. In: Potschin, M. & Jax, K. (eds.). OpenNESS Reference Book. EC FP7 Grant Agreement no. 308428. Available via: www.openness-project.eu/library/reference-book.
Kettunen, M., Vihervaara, P., Kinnunen, S., D'Amato, D., Badura, T., Argimon, M. & ten Brink, P. 2012. Socio-economic importance of ecosystem services in the Nordic Countries – Synthesis in the context of The Economics of Ecosystems and Biodiversity (TEEB). Nordic Council of Ministers, Copenhagen. 290 pp.
King, D.M., Mazzotta, M.J. & Markowitz. K.J. 2000. Ecosystem valuation – website. Funded by US Department of Agriculture Natural Resources Conservation Service (USDA) and National Oceanographic and Atmospheric Administration (NOAA). www.ecosystemvaluation.org (cited 23.6.2014).
Kitti, H. 2013. The benefits of ensuring the quality and purification of groundwater in Finland. A literature study and proposal for further research (Pohjavesien laadullisen turvaamisen ja puhdistamisen hyödyt Suomessa. Kirjallisuusselvitys ja ehdotus jatkotutkimustarpeista). Reports of the Finnish Environment Institute 34/2013.

Kivimäki, A.-L., Reinikainen, J., Tuominen, S., Nystén, T., Eskola, P., Hjorth, S., Järvikivi, M., Sarkkila, J. & Heino, P. 2009. Pohjaveden puhdistaminen reaktiivisella seinämällä – Koekohteena Oriveden Asemanseudun pilaantunut pohjavesialue. Finnish Environment 15/2009. Finnish Environment Institute, Helsinki.

Kniivilä, M., Kosenius, A.-K. & Horne, P. 2014a. Luontoarvopankkien hyödyt ja haitat sekä soveltuvuus Suomeen (Abstract: Habitat banking - The pros, and cons and applicability in Finland). PTT Working Papers 161. Pellervo Economic Research, Helsinki. 50 pp.

Kniivilä, M., Kosenius, A.-K. & Horne, P. 2014b. Creating market for biodiversity by using habitat banking: preliminary assessment of applicability to Finland. Forthcoming in the proceedings of the SSFE conference held in Uppsala 21-23 May 2014. 8 pp.

Kniivilä, M., Horne, P., Hytönen, M., Jäppinen, J.-P., Naskali, A., Primmer, E. & Rinne, J. 2011. Monia hyötyjä metsistä – ekosysteemipalveluiden yhteistuotanto ja tuotteistaminen. PTT Working Papers 227. Pellervo Economic Research, Helsinki. 66 pp.

Kopperoinen, L., Itkonen, P. & Niemelä, J. 2014. Using expert knowledge in combining green infrastructure and ecosystem services in land use planning: an insight into a new place-based methodology. Landscape Ecology 29: 1361–1375.

Korpela, K., Tyrväinen, L., Silvennoinen, H. & Ylen, M. 2011. Determinants and strength of restorative (stress-alleviating) experiences in favourite green, waterside and urban environments in Finland. In: Green City Europe - for Better Life in European Cities. ELCA Research Workshop. European Landscape Contractors Association, Bad Honnehef, Germany. pp. 30–32.

Koundouri, P., Kougea, E., Stithou, M., Ala-aho, P., Eskelinen, R., Karjalainen, T. P., Klove, B., Pulido-Velazquez, M., Reinikainen, K. & Rossi, P. M. 2012. The value of scientific information on climate change: a choice experiment on Rokua esker, Finland. Journal of Environmental Economics and Policy 1(1): 85–102.

Kosenius, A.-K. 2004. Estimating the Benefit from Algal Bloom Reduction – an Application of Contingent Valuation Method. Master's Thesis. Department of Economics and Management, University of Helsinki.

Kosenius, A.-K. 2010. Heterogeneous preferences for water quality attributes: The case of eutrophication in the Gulf of Finland, the Baltic Sea. Ecological Economics 69(3): 528–538.

Kosenius, A.-K. 2013. Preference discontinuity in choice experiment: Determinants and implications. Journal of Socio-Economics 45: 138–145.

Kosenius, A.-K. & Ollikainen M. 2012. Ecosystem benefits from coastal habitats in Finland, Sweden, and Lithuania. Paper presented in the Annual Conference of European Association of Environmental and Resource Economists (EAERE) in Prague, Czech Republic, 28th June, 2012.

Kosenius, A.-K., Haltia, E., Horne, P., Kniivilä, M. & Saastamoinen, O. 2014 Value of ecosystem services? Examples and experiences on forests, peatlands, agricultural lands, and freshwaters in Finland. PTT Working Papers 244. Pellervo Economic Research, Helsinki. 103 pp.

Kosoy, N. & Corbera, E. 2010. Payments for ecosystem services ad commodity fetishism. Ecological economics 69: 1228–1236.

Kumar, P. (ed.) 2010. The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations. An Output of TEEB: The Economics of Ecosystems and Biodiversity. Earthscan, London. 456 pp.

Kumpula, J., Colpaert, A., & Nieminen, M. 2000. Condition, potential recovery rate, and productivity of lichen (Cladonia spp.) ranges in the Finnish reindeer management area. Arctic 53(2): 152–160.

Kyttä, M., Broberg, A., Tzoulas, T. & Snabb, K. 2013. Towards contextually sensitive urban densification: location-based softGIS knowledge revealing perceived residential environmental quality. Landscape and Urban Planning, 113: 30–46.

Kyttä, M. & Kahila, M. 2011. SoftGIS methodology - building bridges in urban planning. GIM International (The Global Magazine for Geomatics), 25(3): 37–41.

Lankia, T. & Pouta, E. 2012. Effects of water quality changes on recreation benefits in Finland: Combined travel cost and contingent behaviour model. A paper presented at the 19th Annual Conference of the European Association of Environmental and Resource Economists 27-30 June, Prague.

Lankia, T., Neuvonen, M., Pouta, E. & Sievänen, T. 2014. Willingness to contribute to the management of recreational quality on private lands in Finland. Journal of Forest Economics 20: 141–160.

Lankia, T., Kopperoinen, L., Pouta.., E. & Neuvonen, M. 2015. Valuing recreational ecosystem service flow in Finland. Journal of Outdoor Recreation and Tourism (forthcoming).

Layton, D.F. & Siikamäki, J. 2009. Payments for Ecosystem Services Programs: Predicting Landowner Enrollment and Opportunity Cost Using a Beta-Binomial Model. Environmental and Resource Economics, 44: 415–439.

Lehtoranta, J., Ekholm, P., Vihervaara, P. and Kortelainen, P. (eds.) 2014. Coupled biogeochemical cycles and ecosystem services. [Toisiinsa kytkeytyneet ainekierrot ja ekosysteemipalvelut.] Reports of the Finnish Environment Institute 21. Finnish Environment Institute, Helsinki.

Lehtoranta, V. 2013. The economic value of water management for Lake Vesijärvi (Vesienhoidon arvo Vesijärvelle). The Finnish Environment 10/2013. Finnish Environment Institute, Helsinki.

Lehtoranta, V., Sarvilinna, A. & Hjerppe, T. 2012. The significance of streams for the residents of the City of Helsinki. Contingent valuation study for the feasibility of the Small Water Action Plan (Purojen merkitys helsinkiläisille. Helsingin pienvesiohjelman yhteiskunnallinen kannattavuus). The Finnish Environment 5/2012. Finnish Environment Institute, Helsinki.

Lehtoranta, V., Seppälä, E., Martinmäki, K. & Sarvilinna, A. 2013. Residents' view of and willingness to participate in water management in the River Kalimenjoki catchment area (Asukkaiden näkemykset ja halukkuus osallistua vesienhoitoon Kalimenjoen valuma-alueella). Reports of the Finnish Environment Institute 18/2013. Finnish Environment Institute, Helsinki.

Lepistö, A., Granlund, K., Kortelainen, P. & Räike, A. 2006. Nitrogen in river basins: Sources, retention in the surface waters and peatlands, and fluxes to estuaries in Finland. Science of the Total Environment 365: 238–259.

Lindahl, O. & Kollberg, S. 2008. How mussels can improve coastal water quality. Mussel farming – a way to combat eutrophication. Bioscience explained 5(1): 1–14.

Lindahl, O. & Kollberg, S. 2009. Can the EU agri-environmental aid program be extended into the coastal zone to combat eutrophication? Hydrobiologia 29: 59–64.

Liski, J. & Westman, C. J. 1997. Carbon storage in forest soil of Finland II size and regional patterns. Biogeochemistry 36: 261–274.

Liski, J. & Kauppi, P. 2000. Carbon cycle and biomass. In: FAO. Forest Resources of Europe, CIS, North America, Australia, Japan and New Zealand (industrialized temperate/boreal countries), UN-ECE/FAO Contribution to the Global Forest Resources Assessment 2000, Main Report. New York: United Nations. Pp. 155–226.

Luoto, I. 1998. Recreation and its economic value in lake Öjanjärvi (Öjanjärven virkistyskäyttö ja sen taloudellinen arvottaminen). Studies of the Chydenius Institute 8/1998.

MAES 2014. Mapping and Assessment of Ecosystems and their Services. Indicators for ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020. 2nd Report – Final, February 2014. Technical Report - 2014 - 080, European Union. 80 p. Available at: http://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/2ndMAESWorkingPaper.pdf

Maes, J., Egoh, B., Willemen, L., Liquete, C., Vihervaara, P. Schägner, J.P., Grizzetti, B., Drakou, E.G., La Notte, A., Zulian, G., Bouraoui, F., Paracchini, M.L., Braat, L., Bidoglio, G. 2012. Mapping ecosystem services for policy support and decision making in the European Union. Ecosystem Services 1(1): 31–39.

Maes, J., Hauck, J., Paracchini, ML., Ratamäki, O., Termansen, M., Perez-Soba, M., Kopperoinen, L., Rankinen, K., Schägner, JP., Henrys, P., Cisowska, I., Zandersen, M., Jax, K., La Notte, A., Leikola, N., Pouta, E., Smart, S., Hasler, B., Lankia, T., Andersen, HE., Lavalle, C., Vermaas, T., Mohammed Hussen Alemu, Scholefield, P., Batista, F., Pywell, R., Hutchins, M., Blemmer, M., Fonnesbech-Wulff, A., Vanbergen, AJ., Münier, B., Baranzelli, C., Roy, D., Thieu, V., Zulian, G., Kuussaari, M., Thodsen, H., Alanen, E-L., Egoh, B., Sørensen, BP., Braat, L., Bidoglio, G. 2012. A spatial assessment of ecosystem services in Europe: methods, case studies and policy analysis. - phase 2. PEER Report No 4. Ispra: Partnership for European Environmental Research.

Maes, J., Teller, A., Erhard, M., Liquete, C., Braat, L., Berry, P., Egoh, B., Puydarrieux, P., Fiorina, C., Santos, F., Paracchini, M. L., Keune, H., Wittmer, H., Hauck, J., Fiala, I., Verburg, P. H., Condé, S., Schägner, J. P., San Miguel, J., Estreguil, C., Ostermann, O., Barredo, J. I., Pereira, H. M., Stott, A., Laporte, V., Meiner, A., Olah, B., Royo Gelabert, E., Spyropoulou, R., Petersen, J. E., Maguire, C., Zal, N., Achilleos, E., Rubin, A., Ledoux, L., Brown, C., Raes, C., Jacobs, S., Vandewalle, M., Connor, D. & Bidoglio, G. 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, Luxembourg, Publications office of the European Union.

Maron, M., Hobbs, R.J., Moilanen, A., Matthews, J.W., Christie, K., Gardner, T.A., Keith, D.A., Lindenmayer, D.B. & McAlpine, C.A. 2012. Faustian bargains? Restoration realities in the context of biodiversity offset policies. Biological Conservation 155: 141–148.

Martínez-Harms, M. J. & Balvanera, P. 2012. Methods for mapping Ecosystem Service supply: a review. International Journal of Biodiversity Science, Ecosystem Services & Management 8(1-2): 17–25.

Marttila, V., Granholm, H., Laanikari, J., Yrjölä, T., Aalto, A., Heikinheimo, P., Honkatukia, J., Järvinen, H., Liski, J., Merivirta, R. & Paunio, M. 2005. Finland's National Strategy for Adaptation to Climate Change. Ministry of Agriculture and Forestry of Finland Publication 1a/2005.

Matkailun toimialaraportti 2011. Matkailu. Toimialaraportti 9/2011. TEM:n ja ELY-keskusten julkaisu, 1.12.2011.

Mattheiss, V., Goral, F., Volz, P. & Strosser, P. 2010. Economic instruments for mobilizing financial resources for supporting IWRM. Additional information and illustrations for the OECD initiative. ACTeon's support to the OECD initiative on financing IWRM. Available at: http://www.oecd.org/env/resources/46228724.pdf, accessed 18 October 2013.

Maunula, M. 2012. Implementation of Water Framework and Flood Directive in Finland. Finnish Environment Institute. Available at: http://www.unece.org/fileadmin/DAM/env/water/npd/Maunula_Implem_Water_Framework_and_Flood_Directive_in_Finland.pdf, last accessed 31 July 2013.

Mazza, L., Bröckl, M., Ahvenharju,S., ten Brink, P. & Pursula, T. 2013. Natural Capital in a Nordic context - Status and Challenges in the Decade of Biodiversity, TemaNord 2013:526, Nordic Council of Ministers, Copenhagen.

McCauley, D.J. 2006. Selling out on nature. Nature 443: 27–28.

McKenney, B.A. & Kiesecker, J.M. 2010. Policy development for biodiversity offsets: a review of offset frameworks. Environmental Management 45: 165–176.

Mertens, K., Cliquet A. & Vanhausen B.2012. Ecosystem services. What's in it for a Lawyer? European Energy and Environmental Law Review 21(1): 31–40.

Metla 2000. Recreational Use of Forests. Finnish Forest Research Institute. http://www.metla.fi/metinfo/monikaytto/lvvi/index-en.htm, http://www.metla.fi/metinfo/monikaytto/lvvi/en/tietoa-valtakunnalliset-tilastot-en.htm

Metla 2001–2013. Statistical Yearbooks of Forestry. Finnish Forest Research Institute. http://www.metla.fi/metinfo/tilasto/julkaisut/vsk/2013/index.html

Metla 2010. Recreational Use of Forests. Finnish Forest Research Institute. http://www.metla.fi/metinfo/monikaytto/lvvi/index-en.htm, http://www.metla.fi/metinfo/monikaytto/lvvi/en/tietoa-ulkoilusta-2010-en.htm

Metla 2012. Statistical Yearbooks of Forestry. Finnish Forest Research Institute. http://www.metla.fi/metinfo/tilasto/julkaisut/vsk/2013/index.html

Metla 2013a. Ex-situ -suojelu. Finnish Forest Research Institute. http://www.metla.fi/palvelut/geenivarat/geenivarat-ex-situ.htm.

Metla 2013b. Geenireservimetsät. Finnish Forest Research Institute. http://www.metla.fi/palvelut/geenivarat/geenivarat-geenireservimetsat.htm.

Metla 2013c. Finnish Statistical Yearbook of Forestry. Finnish Forest Research Institute, Vantaa, Finland. Available at: www.metla.fi/julkaisut/metsatilastollinenvsk/

Metsähallitus NHS 2013. Metsähallituksen kansallispuistojen käyntimäärät 2001–2013. Metsähallitus Natural Heritage Services. Available at: http://www.metsa.fi/sivustot/metsa/fi/eraasiatjaretkeily/asiakastieto/kayntimaarat/kansallispuistotyhteensa/Sivut/Kansallispuistotyhteensa.aspx

Metsähallitus 2014. Habitat restoration work at Metsähallitus. Available at: http://www.metsa.fi/sivustot/metsa/en/NaturalHeritage/SpeciesandHabitats/HabitatRestoration/Sivut/HabitatRestorationWorkatMetsahallitus.aspx

Milcu, A., Hanspach, J., Abson, D. & Fischer, J. 2013. Cultural ecosystem services: a literature review and prospects for future research . Ecology and Society 18(3): 44.

Millennium Ecosystem Assessment (MA) 2005. Ecosystems and Human Well-being: Biodiversity Synthesis. World Resources Institute. 86 pp. Washington, D.C.

Ministry of Agriculture and Forestry 2003. Finnish national plant genetic resources programme for agriculture and forestry. Available at: http://www.mmm.fi/attachments/ymparisto/5zS2zZ2if/Kasvigeenivaraohjelma.pdf.
Ministry of Agriculture and Forestry 2004. Suomen kansallinen eläingeenivaraohjelma. Available at: http://www.mmm.fi/attachments/ymparisto/5zV1uH2YQ/Suomen_kansallinen_elaingeenivaraohjelma.pdf
Ministry of Agriculture and Forestry 2010. Kansallinen ammattikalastusohjelma 2015. Maa- ja metsätalousministeriö 2010. 19 p. Available at: http://www.mmm.fi/attachments/kalariistajaporot/5nUA8SvWg/100212_ammattikalastusohjelma_rappari.pdf
Ministry of Employment and the Economy 2013. The mining industry. Available at: https://www.tem.fi/en/enterprises/the_mining_industry [cited at 6.6.2014].
Ministry of Employment and the Economy 2014. Matkailun merkitys Suomen kansantaloudelle. Available at: https://www.tem.fi/yritykset/matkailu/matkailun_merkitys_suomen_kansantaloudelle.
Ministry of the Environment 2012. Government Resolution on the Strategy for the Conservation and Sustainable use of Biodiversity in Finland for the years 2012–2020, ´Saving Nature for People´. Ministry of the Environment, Helsinki. 26 p. Available at: http://www.ym.fi/download/noname/%7BDF4D24DF-6F32-4546-97E9-C89E85F62662%7D/92064
Ministry of the Environment 2013a. Biodiversity Essential for Life. Saving Nature for People. National action plan for the conservation and sustainable use of biodiversity in Finland 2013–2020. Ministry of the Environment, Helsinki. 105 p. Available at: http://www.ym.fi/download/noname/%7BEA60AA4E-861F-414D-9EFE-E8B967313381%7D/96885
Ministry of the Environment 2013b. Everyman´s right. Available at: http://www.ym.fi/en-US/Latest_news/Publications/Brochures/Everymans_right%284484%29. [Cited 9.4.2014]
Ministry of the Environment 2014a. Nationally valuable landscapes. Available at: http://www.ymparisto.fi/en-US/Nature/Landscapes/Nationally_valuable_landscapes
Ministry of the Environment 2014b. Fifth National Report to the Convention on Biological Diversity, Finland. Ahokumpu, A.-L., Auvinen, A.-P., Pylvänäinen, M. & von Weissenberg, M. (eds.). Ministry of the Environment, Helsinki. 138 pp.
Minkkinen, K. 1999. Effect of forestry drainage on the carbon balance and radiative forcing of peatlands in Finland. PhD Dissertation. Department of Forest Ecology, University of Helsinki. 42 p.
Mononen, L., Ahokumpu, A.-L., Auvinen, A.-P., Rönkä, M., Tolvanen, H., Aarras, N., Kamppinen, M., Viirret, E., Kumpula, T. & Vihervaara, P. 2014. National ecosystem service indicators: measures of social-ecological sustainability. Ecological Indicators. Submitted manuscript.
Moilanen, A., Van Teeffelen, A. J. A., Ben-Haim, Y. & Ferrier, S. 2009. How much compensation is enough? A framework for incorporating uncertainty and time discounting when calculating offset ratios for impacted habitat. Restoration Ecology 17: 470–478.
Moisseinen, E. 1997. Contingent Valuation – The Case of the Saimaa Seal. Doctoral Thesis. Publications of the University of Joensuu.
Murray, B. R., Hose, G. C., Eamus, D. & Licari, D. 2006. Valuation of groundwater-dependent ecosystems: a functional methodology incorporating ecosystem services. Australian Journal of Botany 54(2): 221–229.
Mäenpää, M. & Tolonen, S. (eds.) 2011. The summary of the River Basin District’s River Basin Management Plans until 2015. (Kooste vesienhoitoalueiden vesienhoitosuunnitelmista vuoteen 2015). The Finnish Environment 23/2011. Finnish Environment Institute, Helsinki.
Mäntymaa E. 1993. Valuing Environmental Benefits Using the Contingent Valuation Method (Ympäristöhyötyjen arviointi contingent valuation -menetelmällä). Research Report, University of Oulu.
National Audit Office of Finland (NAO) 2007. Developing fisheries (Kalatalouden kehittäminen). Valtiontalouden tarkastusviraston toiminnantarkastuskertomukset 155/2007. 56 pp. (in Finnish)
National Research Council 1997. Valuing Ground Water: Economic Concepts and Approaches. National Academy Press, Washington D.C. Available at: http://www.nap.edu/openbook.php?record_id=5498
Naumann, S., Davis, M., Kaphengst, T., Pieterse, M. & Rayment, M. 2011. Design, implementation and cost elements of Green Infrastructure projects. Final report to the European Commission, DG Environment, Contract no. 070307/2010/577182/ETU/F.1. Ecologic institute and GHK Consulting. 142 pp.
Nelson, G. C., Bennett, E., Berhe, A. A., Cassman, K. G., DeFries, R., Dietz, T. & Dobson, A. 2005. Chapter 7. Drivers of Change in Ecosystem Condition and Services. In: Millennium Ecosystem Assessment. Ecosystems and Human Well-Being: Scenarios - Volume 2. Island Press. Pp. 175–222. Available at: http://www.millenniumassessment.org/documents/document.331.aspx.pdf.
Norgaard, R. B. 1989. The case for methodological pluralism. Ecological Economics 1(1): 37–57.
Nuutinen, V., Terhivuo, J., Ketoja, E., Nieminen, M. & Sirén, T. 2007. Regional variation of field earthworm communities in relation to soil properties and land use (In Finnish with English abstract). Pages 313–330 in Salonen, J., Keskitalo, M. & Segerstedt, M. (eds.) Peltoluonnon ja viljelyn monimuotoisuus. Maa- ja elintarviketalous 110.
OECD 2005. Environmentally Harmful Subsidies, Challenges for Reform. OECD, Paris.
OECD 2010. Guidelines for Cost-effective Agri-environmental Policy Measures. OECD Publishing, ISBN 978-92-64-08665-4.
OECD. 2011. Towards Green Growth. OECD, Paris.
OECD 2013. Scaling-up Finance Mechanisms for Biodiversity. OECD Publishing.
Ojajärvi, M., Heikkonen, M., Siltala, S., Tainio, E., Pekka, K., Karhula, M., Pyy, M., Välipirtti, K. L., Valli, R. & Huhtinen, T. 2003. Liikennehankkeiden ympäristöhaittojen vähentämisen kustannukset. Liikenne- ja viestintäministeriön julkaisuja 37/2003. Helsinki. (in Finnish)
OSF Official Statistics of Finland 2014a. Annual national accounts. Statistics Finland. http://www.tilastokeskus.fi/til/vtp/index_en.html
OSF Official Statistics of Finland 2014b. Energy supply and consumption. Statistics Finland. http://www.tilastokeskus.fi/til/ehk/index_en.html
OSKE 2013. OSKE – Matkailun ja elämystuotannon klusteriohjelma 2011 – 2013 (Finnish Centres of Expertise Program 2011 - 2013) http://www.experiencebusiness.fi/ [cited at 12.5.2014].

Ovaskainen, V., Mikkola, J. & Pouta, E. 2001. Estimating recreation demand with on-site data: an application of truncated and endogenously stratified count data models. Journal of Forest Economics 7: 125–144.
Ovaskainen, V., Neuvonen, M. & Pouta, E. 2012. Modelling recreation demand with respondent-reported driving cost and stated cost of travel time: A Finnish case. Journal of Forest Economics 18: 303–317.
Overton, J., Stephens, R.T.T. & Ferrier, S. 2013. Net present biodiversity value and the design of biodiversity offsets. Ambio 42: 100–110.
Pajunen, H. 2004. Järvisedimentit kuiva-aineen ja hiilen varastona. Summary: Lake sediments as a store of dry matter and carbon GTK, Tutkimusraportti 160. Geological Survey of Finland, Report of Investigation 160.
Parkkila, K. 2005. Estimating the Willingness to Pay for Catch Improvements in the River Simojoki - An Application of Contingent Valuation Method (Simojoen lohen saalismäärän lisääntymisen taloudellinen arviointi contingent valuation -menetelmällä). Master's thesis. Department of Economics and Management, University of Helsinki.
Parkkila, K., Haltia, E. & Karjalainen, T.P. 2011. Benefits of the salmon stock restoration for recreational anglers of the river Iijoki – pilot study with contingent valuation method. Riista- ja kalatalous - Tutkimuksia ja selvityksiä 4/2011. (In Finnish with English summary).
Parviainen, J. & Västilä, S. 2011. Suomen metsät 2011. Kestävän metsätalouden kriteereihin ja indikaattoreihin perustuen. Maa- ja metsätalousministeriö 5/2011. Maa- ja metsätalousministeriö & Metsäntutkimuslaitos.
Pearce, D.G., Markandya A., Barbier E. 1989. Blueprint for a Green Economy. Earthscan, London.
Peh, K. S.-H., Balmford, A., Bradbury, R. B., Brown, C., Butchart, S. H. M., Hughes, F. M. R., Stattersfield, A., Thomas, D. H. L., Walpole, M., Bayliss, J., Gowing, D., Jones, J. P. G., Lewis, S. L., Mulligan, M., Pandeya, B., Stratford, C., Thompson, J. R., Turner, K., Vira, B., Willcock, S. & Birch, J. C. 2013. TESSA: A toolkit for rapid assessment of ecosystem services at sites of biodiversity conservation importance. Ecosystem Services(5): 51–55.
Peifer, H. 2009. CORILIS version 3 - A short technical description. European Environment Agency, November 2009. Available at: http://www.eea.europa.eu/data-and-maps/data/corilis-2000-2/#tab-methodology. Last accessed 10.12.2014.
Penttinen, R. 2001. Maaperän ja pohjaveden kunnostus – Yleisimpien menetelmien esittely. Suomen ympäristökeskuksen moniste 227. Finnish Environment Institute, Helsinki.
Pereira, H.M., Ferrier, S., Walters, M., Geller, G., Jongman, R., Scholes, R.J., Bruford, M.W., Brummitt, N., Butchart, S.H.M., Cardoso, C., Coops, N.C., Dulloo, E., Faith, D.P., Freyhof, J., Gregory, R.D., Heip, C., Höft, R., Hurtt, G., Jetz, W., Karp, D., McGeoch, M.A., Obura, D., Onoda, Y., Pettorelli, N., Reyers, B., Sayre, R., Scharlemann, J., Stuart, N., Turak, E., M. Walpole, M. & Wegmann, M. 2013. Essential Biodiversity Variables. Science 339: 277–278.
Pettenella, D., Vidale, E., Gatto, P. & Secco, L. 2012. Paying for water-related forest services: a survey on Italian payment mechanisms. iForest 5: 210–215.
Pouta, E. & Ovaskainen, V. 2006. Assessing the recreational demand for agricultural land in Finland. Agricultural and Food Science 15: 375–387.
Pouta, E., Neuvonen, M. & Sievänen, T. 2009. Participation in cross-country skiing in Finland under ciimate change: Application of multiple hierarchy stratification perspective. Journal of Leisure Research 41: 91–108.
Pouta, E., Grammatikopoulou, I., Hurme, T., Soini, K., Uusitalo, M. 2014. Assessing the Quality of Agricultural Landscape Change with Multiple Dimensions. Land 3: 598–616.
Prager, K., Reed, M. & Scott, A. 2012. Encouraging collaboration for the provision of ecosystem services at a landscape scale – Rethinking agri-environmental payments. Land Use Policy 29: 244–249.
Primmer, E. & Furman, E. 2012. Operationalising ecosystem service approaches for governance: Do measuring, mapping and valuing integrate sector-specific knowledge systems? Ecosystem Services 1(1): 85–92.
Primmer, E., Kopperoinen, L., Ratamäki, O., Vihervaara, P., Rinne, J., Inkiläinen, E., Mashkina, O. & Itkonen, P. 2012. Ekosysteemipalveluiden tutkimuksesta hallintaan – kirjallisuuskatsaus ja tapaustarkasteluita. The Finnish Environment 39/2012. Finnish Environment Institute, Helsinki.
Putkuri, E., Lindholm, M. & Peltonen, A. 2014. The state of the environment in Finland 2013. Finnish Environment Institute, Helsinki.
Pölönen I. 2013. YVA-direktiivin uudistaminen – Euroopan komission muutosehdotuksen arviointi. Reports of the Ministry of Environment 18/2013.
Quigley, J.T. & Harper, D.J. 2005a. Effectiveness of fish habitat compensation in Canada in achieving no net loss. Environmental Management 37: 351–366.
Quigley, J.T. & Harper, D.J. 2005b. Compliance with Canada's Fisheries Act: a field audit of habitat compensation projects. Environmental Management 37: 336–350.
Rassi, P., Hyvärinen, E., Juslén, A., Mannerkoski, I., (eds.) 2010. The 2010 Red List of Finnish Species. Ministry of Environment & Finnish Environment Institute. Helsinki. 685 pp.
Ratamäki, O., Vihervaara, P., Furman, E. & Tuomisaari, J. 2011. Ekosysteemipalveluiden tutkimus osaksi ympäristö- ja luonnonvarojen hallintaa. Reports of the Finnish Environment Institute 7/2011. Finnish Environment Institute, Helsinki.
Raunio, A., Anttila S., Kokko A., Mäkelä K. 2013. Luontotyyppisuojelun nykytilanne ja kehittämistarpeet – lakisääteiset turvaamiskeinot. Finnish Environment 5/2013. Finnish Environment Institute, Helsinki.
Raymond, C. M., Bryan, B. A., Hatton MacDonald, D., Cast, A., Strathearn, S., Grandgirard, A. & Kalivas, T. 2009. Mapping community values for natural capital and ecosystem services. Ecological Economics(68): 1301–1315.
RKTL 2013. Lohikannan tila Simojoessa. Game and Fisheries Research Institute. http://www.rktl.fi/kala/kalavarat/simojoen_lohi/lohikannan_tila_simojoessa.html
RKTL 2014a. Hunting. Game and Fisheries Research Institute. http://www.rktl.fi/english/statistics/statistics_by_topic/hunting/
RKTL 2014b. Recreational fishery. Game and Fisheries Research Institute. http://www.rktl.fi/english/statistics/statistics_by_topic/recreational_fishery/
RKTL 2014c. The status of the Tornionjoki salmon stock. Game and Fisheries Research Institute. Available at: http://www.rktl.fi/english/fish/fish_resources/atlantic_salmon_and/the_status_of_12.html
Rosenberger, R.S. & Loomis, J.B. 2003. Benefit Transfer. Chapter 12 in Champ P.A., Boyle K.J. & Brown T.C. (eds). A primer on nonvmarket valuation. Kluwer Academic Publishers. 576 pp.
Ruhl, J. B. & Salzman, J. 2007. The law and policy beginnings of ecosystem services. Journal of Land use & Environmental Law 22.

Ruhl, J.B. 2011: Ecosystem services and the clean water act: Strategies for fitting new science into old law. Environmental Law 2/1(2011).
Ruhl, J.B. 2012. Panarcy and the law. Law and Social-Ecological Resilience 17(3).
Ruhl, J. B. & Salzman, J. 2013. Climate change meets the law of the horse. Duke Law Journal 62(5).
Ruosteenoja, K., Jylhä, K. & Tuomenvirta, H. 2005. Climate scenarios for Findapt studies of climate change adaptation. Finnish Environment Institute Mimeographs 345, FINADAPT Working paper 15.
Russi D. & ten Brink P. 2013. Natural Capital Accounting and Water Quality: Commitments, Benefits, Needs and Progress. A Briefing Note. The Economics of Ecosystems and Biodiversity (TEEB).
Rämö, A.-K. & Kniivilä, M. & Horne, P. & Primmer, E. & Hytönen, M. & Jäppinen, J.-P. 2013. Monien hyötyjen metsä – ekosysteemipalvelut metsänomistajan näkökulmasta. Ekonet-hankkeen osatutkimusten yhteenvetoraportti. Pellervo Economic Research, Helsinki.
Saastamoinen, O., Matero, J., Haltia, E., Horne, P., Kellomäki, S., Kniivilä, M. & Arovuori, K. 2013. Concepts and considerations for the synthesis of ecosystem goods and services in Finland. Publications of the University of Eastern Finland. Reports and Studies in Forestry and Natural Sciences. No 10. 108 pp.
Saastamoinen, O., Kniivilä, M., Alahuhta, J., Arovuori, K., Kosenius, A.-K., Horne, P., Otsamo, A. & Vaara, M. 2014. Yhdistävä luonto: ekosysteemipalvelut Suomessa (Extended abstract: Integrative nature: Ecosystem services in Finland). Publications of the University of Eastern Finland, Reports and Studies in Forestry and Natural Sciences 15. 203 pp.
Salminen, J., Nystén, T. & Tuominen, S. 2010. Vaihtoehtoiset liukkaudentorjunta-aineet ja pohjavesien suojelu - MIDAS2 -hankkeen loppuraportti. The Finnish Environment 22/2010. Finnish Environment Institute, Helsinki.
Schoukens, H. Cliquet, A. De Smedt, P. 2010. The Compatibility of "Temporary Nature" with European Nature Conservation Law. 19 European Energy and Environmental Law Review, Issue 3.
Schägner, J.P., Brander, L., Maes, J., Hartje, V. 2013. Mapping ecosystem services' values: Current practice and future prospects. Ecosystem Services 4: 33-46.
Secretariat of the Convention of Biological Diversity 2010. Global Biodiversity Outlook 3. Montreal, Canada. 94 pp.
Secretariat of the Convention of Biological Diversity 2014. Draft Executive Summary of the Fourth edition of the Global Biodiversity Outlook-4. In: Draft Executive Summary with the main messages of the Fourth Edition of the Global Biodiversity. Note by the Executive Secretary of CBD. UNEP/CBD/SBSTTA/18/2. 16 pp. Montréal.
Shantiko, B., Purnomo, H. & Harini Irawati, R. 2013. Furniture, timber and forest ecosystem service value chains: Proceedings of the symposium (IPB Convention Center Bogor, 14 February 2013). 174 pp.
Sherrouse, B. C. & Semmens, D. J. 2012. Social values for ecosystem services (SolVES): Documentation and user manual, version 2.0. Geological Survey Open-File Report 2012-1023. Reston, Virginia, USA, U.S. Department of the Interior. U.S. Geological Survey. 55 pp.
Sievänen, T., Tervo, K., Neuvonen, M., Pouta, E., Saarinen, J. & Peltonen, A. 2005. Nature-based tourism, outdoor recreation and adaptation to climate change. Finnish Environmental Institute Mimeographs, FINADAPT Working paper 11. Finnish Environment Institute, Helsinki.
Sievänen, T. & Neuvonen, M. (eds.) 2011. Outdoor recreation in the year 2010 (Luonnon virkistyskäyttö 2010). Metlan työraportteja / Working Papers of the Finnish Forest Research Institute 212.
Siitonen, J. 2001. Forest management, coarse woody debris and saproxylic organisms: Fennoscandian boreal forests as an example. Ecological Bulletin 49: 11–41.
Silander, J., Vehviläinen, B., Niemi, J, Arosilta, A., Dubrovin, T., Jormola, J., Keskisarja, V., Keto, A., Lepistö, A., Mäkinen, R, Ollila, M., Pajula, H., Pitkänen, H., Sammalkorpi, I., Suomalainen, M. & Veijalainen, N. 2006. Climate change adaptation for hydrology and water resources. FINADAPT Working Paper 6, Finnish Environment Institute Mimeographs 336. Finnish Environment Institute, Helsinki.
Silvennoinen, S. 2012. "Pittäähän niitä soita olla". Soiden ekosysteemipalvelut paikallisten kokemana Lieksan Pankakoskella. Master's thesis. Department of history and geological sciences, University of Eastern Finland. Geography.
Similä, J., Borgström S., Kopperoinen L., Itkonen P., Auvinen A., Koivulehto, M. Ekosysteemipalveluiden ja luonnon monimuotoisuuden riippuvuus vihreästä infrastruktuurista ja ohjausjärjestelmän muutostarpeet (forthcoming).
SLL 2014. Haitalliset tuet kestävän kehityksen esteenä – Tukipolitiikan hinta meillä ja maailmalla. (Harmful subsidies as barriers to sustainable development. The price of subsidy policy in Finland and the developing world). The Finnish Association for Nature Conservation Helsinki. (in Finnish)
SMAL 2013. Suomen matkatoimistoalan liitto ry. Mitä on kestävä matkailu? Available at: http://www.smal.fi/index.php?430
Smith, S., Rowcroft, P., Everard, M., Couldrick, L., Reed, M., Rogers, H., Quick, T., Eves, C. & White, C. 2013. Payments for Ecosystem Services: A Best Practice Guide. Defra, London.
Soille, P. & Vogt, P. 2009. Morphological segmentation of binary patterns. Pattern Recognition Letters 30(4): 456-459.
Statistics Finland 2014. National accounts. Available at: http://www.tilastokeskus.fi/til/kan_en.html
Statistics Finland www-pages. http://www.stat.fi/tup/ympparistotilinpidon-teemasivut/tilastotietoa_en.html.
Stern 2006. The Economics of Climate Change. Stern Review Report. Cambridge Books, Cambridge, UK. 712 pp.
Sukhdev, P., Wittmer, H., Schröter-Schlaak, C., Nesshöver, C., Bishop, J., ten Brink, P., Gundimeda, P. & Simmons, B. 2010. The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A Synthesis of the Approach, Conclusions and Recommendations of TEEB. 36 pp.
Suomen virallinen tilasto 2012. Teollisuustuotanto 2012. Tilastokeskus, Helsinki. Available at: http://tilastokeskus.fi/til/tti/2012/tti_2012_2013-11-27_tie_001_fi.html [cited at 30.6.2014]
SYKE 2013. Pohjavesialueet. Finnish Environment Institute. http://www.ymparisto.fi/fi-FI/Vesi_ja_meri/Vesien_ja_merensuojelu/Pohjaveden_suojelu/Pohjavesialueet
SYKE 2014. Pohjavesien määrällinen ja kemiallinen tila. Finnish Environment Institute. http://www.ymparisto.fi/fi-FI/Vesi_ja_meri/Pohjavesien_tila
System of Environmental-Economic Accounting 2012. Central Framework Available at: http://unstats.un.org/unsd/envaccounting/White_cover.pdf.

System of Environmental-Economic Accounting. Experimental Ecosystem Accounting 2012. Available at: http://unstats.un.org/unsd/envaccounting/seea_White_cover.pdf.
System of National Accounts 2008. Available at: http://unstats.un.org/unsd/nationalaccount/docs/SNA2008.pdf.
TEEB 2011. The Economics of Ecosystems and Biodiversity in National and International Policy Making. Edited by Patrick ten Brink. Earthscan, London and Washington.
TEEB Arctic 2014. TEEB for the Arctic Scoping Study. The Conservation of Arctic Flora and Fauna (CAFF) Working group of Arctic Council, The United Nations Environment Programme (UNEP), The UNEP TEEB Office, WWF Global Arctic Programme & GRID-Arendal. 2 pp. A project description. Available at: www.tinyurl.com/teebarctic.
TEEB for Business – The Netherlands 2012. The Economics of Ecosystems and Biodiversity. Available at: http://en.biodiversiteit.nl/teeb/teeb-voor-het-nederlandse-bedrijfsleven/teeb-for-business-the-netherlands.pdf, last accessed 31 July 2013.
ten Brink, P. (ed.) 2011. The Economics of Ecosystems and Biodiversity in National and International Policy Making. An Output of TEEB: The Economics of Ecosystems and Biodiversity. Earthscan. 390 pp. 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. Available at: http://www.ieep.eu/assets/999/Nature_and_its_role_in_the_transition_to_a_Green_Economy.pdf
ten Brink, P. & Russi, D. (eds) 2014. The use of (economic & social) values of NC/ES in national accounting (September draft), internal discussion paper for EU FP7 OPERAs project.
TIKE 2014. Yearbook of Farm Statistics. Official Statistics of Finland: Agriculture, forestry and fishery. Information Centre of the Ministry of Agriculture and Forestry (Tike). Helsinki.
Toivonen, A.-L., E. Roth, S., Navrud, G., Gudbergsson, H., Appelblad, B., Bengtsson, B. & Tuunainen, P. 2004. The Economic Value of Recreational Fisheries in Nordic Countries. Fisheries Management and Ecology 11(1): 1–14.
Tolvanen, A., Juutinen, A. & Svento, R. 2012. Preferences of local people for the use of peatlands: the case of peatland richest region in Finland. Ecology and Society 18(2): 19.
Tolvanen, H., Rönkä, M., Vihervaara, P., Kamppinen, M., Arzel, C., Aarras, N. & Thessler, S. 2014. Spatial information in ecosystem service assessment: data applicability in the cascade model context. Journal of Land Use Science, 1–18.
Trouwborst, A. 2011. Conserving European biodiversity in a changing climate: The Bern Convention, The European Union's Birds and habitats directives and the adaptation of nature to climate change. Review of European Community and International Environmental Law 20.
Turner, R., Morse-Jones, S., & Fisher, B. 2010. Ecosystem valuation – A sequential decision support system and quality assessment issue. Annals of the New York Academy of Sciences. Issue: Ecological Economics Reviews 1185: 79–101.
Tyrväinen, L. 2001. Economic valuation of urban forest benefits in Finland. Journal of Environmental management 62: 75–92.
Tyrväinen, L. & Tuulentie, S. (eds.) 2007. Luontomatkailu, metsät ja hyvinvointi. Metlan työraportteja 52. 227 p. Available at: http://www.metla.fi/julkaisut/workingpapers/2007/mwp052.htm.
Tyrväinen, L., Mäntymaa, E., Ovaskainen, V. 2013. Demand for enhanced forest amenities in private lands: The case of the Ruka-Kuusamo tourism area, Finland. Forest Policy and Economics (in press). doi: 10.1016/j.forpol.2013.05.007
UK NEA 2011. The UK National Ecosystem Assessment: Synthesis of the Key Findings. UNEP-WCMC, Cambridge. 85 pp.
UNEP. 2011. Towards a Green Economy: Pathways to sustainable development and poverty eradication, Available at: www.unep.org/greeneconomy, (cited 11.2.2013).
UNWTO 2005, Making Tourism More Sustainable - A Guide for Policy Makers. UNEP and UNWTO, p.11-12
Valkeajärvi, P. & Salo, H. 2000. Fishing and its value in Lake Päijänne in 1996 (Kalastus ja kalastuksen arvottaminen Päijänteellä vuonna 1996). Fisheries and Game Reports 196. Finnish Game and Fisheries Research Institute.
Veijalainen, N., Lotsari, E., Alho, P., Vehviläinen, B. & Käyhkö, J. 2010. National scale assessment of climate change impacts on flooding in Finland. Journal of Hydrology 391: 333–350.
Vesterinen, J., Pouta, E., Huhtala, A. & Neuvonen, M. 2010. Impacts of changes in water quality on recreation behavior and benefits in Finland. Journal of Environmental Management 91(4): 984–994.
Vihervaara, P., Mononen, L., Auvinen, A.-P., Virkkala, R., Lü, Y., Pippuri, I., Packalen P., Valbuena, R. & Valkama, J. 2015. How to integrate remotely sensed data and biodiversity for ecosystem assessments at landscape scale. Landscape Ecology. http://dx.doi.org/10.1007/s10980-014-0137-5
Vihervaara, P., Kumpula, T., Ruokolainen, A., Tanskanen, A. & Burkhard, B. 2012. The use of detailed biotope data for linking biodiversity with ecosystem services in Finland. International Journal of Biodiversity Science, Ecosystem Services & Management 8(1-2): 169–185.
Virtanen, K., Hänninen, P., Kallinen, R.-L., Vartiainen, S., Herranen, T. & Jokisaari, R. 2003. Suomen turvevarat 2000. Summary: The Peat Reserves of Finland in 2000 GTK, Tutkimusraportti 156 – Geological Survey of Finalnd, Report of Investigation 156.
Walker, S., Brower, A.L. Stephens, R.T.T. & Lee, W.G. 2009. Why bartering biodiversity fails. Conservation Letters 2: 149–157.
WBCSD 2011. Guide to Corporate Ecosystem Valuation. A framework for improving corporate decision-making. World Business Council for Sustainable Development. World Business Council for Sustainable Development.
Weber, J.-L. 2014. Ecosystem Natural Capital Accounts: A Quick Start Package, Montreal, Technical Series No. 77, Secretariat of the Convention on Biological Diversity. Available at: http://www.cbd.int/doc/publications/cbd-ts-77-en.pdf
Whitehead, J.C., Haab, T.C. & Huang, J.-C. 2000. Measuring recreation benefits of quality improvements with revealed and stated behavior data. Resource and Energy Economics 22: 339–354.
Whitehead, J.C. 2005. Combining willingness to pay and behavior data with limited information. Resource and Energy Economics 27: 143–155.

Winquist, E., Björklöf, K., Schultz, E., Räsänen, M., Salonen, K., Anasonye, F., Cajthaml, T., Steffen, K. T., Jørgensen, K.S. & Tuomela, M. 2014. Bioremediation of PAH-contaminated soil with fungi–From laboratory to field scale. International Biodeterioration & Biodegradation 86: 238–247.
World Bank. 2014. GDP per capita (current US$). Available at: http://data.worldbank.org/indicator/NY.GDP.PCAP.CD, (cited 2.7.2014).
World resource forum, 2012. Urban Mining at VIII ADF, Meeting Report.
Wünscher, T., Engel, S. & Wunder, S. 2008. Spatial targeting of payments for environmental services: a tool for boosting conservation benefits. Ecological Economics 65: 822–833.
Ympäristö 2011. Water protection. Available at: http://www.ymparisto.fi/default.asp?node=6043&lan=en
Zandersen, M., Grønvik Bråten K. & Lindhjem H. 2009. Payment for and Management of Ecosystem Services – Issues and Options in the Nordic Context. Nordic Council of Ministers, Copenhagen, Denmark. Available at: http://www.norden.org/fi/julkaisut/julkaisut/2009-571, last accessed 31 July 2013.

## APPENDIXES

Appendix 1. The data themes used in GreenFrame analyses of ecosystem services' supply potential, scored by experts.

| DATA THEME | DATASETS | SOURCE |
|---|---|---|
| 1. Conservation areas | 1.1 Natura 2000 areas | © SYKE |
| | 1.2 Nature reserves on public and private land, founded based on the Nature Conservation Act | © SYKE |
| | 1.3 Nature conservation program areas | © SYKE |
| | 1.4 Forest Service property reserved for conservation purposes | © Metsähallitus |
| | 1.5 Conservation areas of regional plans | © SYKE |
| 2. Valuable landscapes | 2.1 Nationally significant landscapes | © SYKE |
| | 2.2 Regionally significant landscapes: national database on regional plans | © SYKE |
| 3. Valuable cultural heritage environments | 3.1 Cultural environments of Uusimaa | © Uusimaa Regional Council |
| | 3.2 Nationally significant built heritage | © Finland's National Board of Antiquities |
| | 3.3 Relics | © Finland's National Board of Antiquities |
| | 3.4 Protected built heritage | © Finland's National Board of Antiquities |
| 4. Traditional agricultural biotopes | 4.1 Traditional agricultural biotopes | © SYKE |
| 5. Important forest habitats | 5.1 Habitats of special importance according to the Forest Act | © Finnish Forest Centre |
| 6. Undrained peatlands | 6.1 Undrained peatlands | © SYKE |
| 7. Important bird areas (IBA) | 7.1 Important bird areas (IBA) | © SYKE |
| 8. Valuable geological features | 8.1 Nationally significant bedrock outcrops | © SYKE |
| | 8.2 Nationally significant moraine landforms | © SYKE, Geological Survey of Finland GTK |
| | 8.3 Nationally significant windblown and shore deposits | © SYKE, Geological Survey of Finland GTK |
| 9. Groundwater areas | 9.1 Groundwater areas | © SYKE, Centres for Economic Development, Transport and the Environment |
| 10. High Nature Value farmlands | 10.1 High Nature Value farmlands | © SYKE |
| 11. Good and continuous agricultural areas | 11.1 Good and continuous agricultural areas | © Uusimaa Regional Council |
| 12. Surface waters of high or good ecological status | 12.1 Surface water formations of the Water Framework Directive, second planning term | © SYKE, Centres for Economic Development, Transport and the Environment |
| 13. Surface waters with low or very low level of human-induced alterations | 13.1 Hydrologic-morphological status of surface waters | © SYKE, Centres for Economic Development, Transport and the Environment |
| 14. Regional recreational areas | 14.1) National database on regional plans | © SYKE |
| | 14.2) Recreational areas of the Association of Uusimaa recreational areas (Uudenmaan virkistysalueyhdistys) | © Uudenmaan virkistysalueyhdistys |
| 15. Groundwater areas at risk | 15.1 Groundwater areas | © SYKE, Centres for Economic Development, Transport and the Environment |
| 16. Sealed surfaces | 16.1 Urban Layer | © SYKE |
| 17. Land extraction sites | 17.1 Finnish National CORINE Land Cover raster 25 m | © SYKE (partly ©METLA,MMM,MML,VRK) |
| 18. Peat extraction sites | 18.1 Draining status of peatlands | © SYKE |
| 19. Surface waters of moderate, poor or bad ecological status | 19.1 Surface water formations of the Water Framework Directive, second planning term | © SYKE, Centres for Economic Development, Transport and the Environment |
| 20. Sites of frequent algae bloom observations | 20.1 National algal bloom monitoring database / Järvi-Wiki | © SYKE |
| 21. Surface waters with moderate or high level of human-induced alterations | 21.1 Hydrologic-morphological status of surface waters | © SYKE, Centres for Economic Development, Transport and the Environment |
| 22. Land cover | 22.1 Finnish National CORINE Land Cover raster 25 m | © SYKE (partly ©METLA,MMM,MML,VRK)) |

Appendix 2. Matrix of expert scores given to each pair of data themes and ES groups. The experts were asked to assess the effect of each theme on the supply potential of ES in question. Positive values indicate a favorable effect, negative values indicate a harmful effect and zero values indicate no effect or a neutral effect.

| DATA THEME | ES GROUP CODE | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | P1 | P2 | P3 | P4 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 | R9 | R10 | R11 | R12 | C1 | C2 | C3 | C4 | C5 |
| 1. Conservation areas | 0 | 2 | 2 | 2 | 0 | 1 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2.5 | 2 | 2.5 | 3 | 3 | 2 | 3 | 3 |
| 2. Valuable landscapes | 3 | 1.5 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 0 | 1 | 2 | 2 | 3 | 2 | 2 |
| 3. Valuable cultural heritage environments | 2 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 2 | 1 | 1 | 1 | 1 | 0 | 1 | 3 | 1.5 | 3 | 2 | 2 |
| 4. Traditional agricultural biotopes | 2 | 2 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 3 | 3 | 1 | 2 | 1 | 0 | 1 | 2 | 2 | 3 | 2 | 3 |
| 5. Important forest habitats | 0 | 2 | 1.5 | 1.5 | 1 | 1 | 1 | 2 | 1 | 2 | 3 | 1 | 2 | 2 | 1 | 1 | 2 | 3 | 2 | 2 | 3 |
| 6. Undrained peatlands | 0 | 2 | 2 | 2 | 1 | 0 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2.5 | 1 | 2 | 2 | 3 | 2 | 3 | 3 |
| 7. Important bird areas | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 3 | 1 | 1 | 1 | 0 | 1 | 2 | 3 | 2 | 2 | 3 |
| 8. Valuable geological features | 0 | 1 | 3 | 2 | 1 | 2 | 1.5 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 0 | 1 | 2 | 2 | 2 | 2 | 3 |
| 9. Groundwater areas | 0 | 1 | 3 | 3 | 0 | 1 | 1 | 3 | 1 | 1 | 1 | 0 | 2 | 3 | 0 | 1 | 1 | 1 | 1 | 1 | 2 |
| 10. High Nature Value farmlands | 3 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 2 | 2 | 1 | 1 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 2 |
| 11. Good and continuous agricultural areas | 3 | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 2 | 0 | 0 |
| 12. Surface waters of high or good ecological status | 0 | 2 | 3 | 3 | 0 | 0 | 0 | 2 | 0 | 0 | 3 | 2 | 0 | 3 | 0 | 0 | 3 | 3 | 2 | 2 | 3 |
| 13. Surface waters with low or very low level of human-induced alterations | 0 | 2 | 2 | 3 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 1 | 0 | 3 | 0 | 0 | 2 | 2 | 2 | 2 | 3 |
| 14. Regional recreational areas | 1 | 2 | 1 | 1 | 0 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 3 | 2 | 2 | 2 | 2 |
| 15. Groundwater areas at risk | -2 | -1 | -3 | -2 | -3 | 0 | 0 | -1 | 0 | 0 | 0 | 0 | 0 | -3 | 0 | 0 | 0 | 0 | 0 | 0 | -1 |
| 16. Sealed surfaces | -3 | -3 | -3 | -3 | -2 | -1 | -2 | -3 | -2 | -2 | -3 | -1 | -3 | -2 | -1 | -2 | -3 | -3 | -3 | -3 | -3 |
| 17. Land extraction sites | -2 | -3 | -2 | -2 | -2 | -3 | -2 | -2 | -1 | -2 | -2 | -1 | -3 | -2 | -1 | -1 | -3 | -2 | -2 | -3 | -3 |
| 18. Peat extraction sites | -2 | -3 | -2 | -2 | -2 | -2 | -2 | -2 | -1 | -1 | -2 | -1 | -3 | -3 | -2 | -1 | -3 | -3 | -3 | -3 | -3 |
| 19. Surface waters of moderate, poor or bad ecological status | -1 | -1 | -2 | -2 | -1 | 0 | 0 | 0 | 0 | 0 | -1 | -1 | 0 | -2 | 0 | 0 | -2 | -1 | -2 | -2 | -2 |
| 20. Sites of frequent algal bloom observations | -2 | -2 | -2 | -2 | -1 | 0 | 0 | 0 | 0 | 0 | -1 | -1 | 0 | -2 | 0 | 0 | -2 | -1 | -2 | -2 | -2 |
| 21. Surface waters with moderate or high level of human-induced alterations | 0 | -2 | -2 | -2 | -1 | 0 | 0 | -1 | 0 | 0 | -1 | -1 | 0 | -2 | 0 | 0 | -2 | -2 | -2 | -2 | -2 |

3: Very favorable effect, 2: Favorable effect, 1: Slightly favorable effect, 0: No effect / neutral effect,
-1: Slightly harmful effect, -2: Harmful effect, -3: Very harmful effect

Appendix 3. Matrix of expert scores given to each pair of land cover classes and ES sections. The experts were asked to assess the effect of different land cover types on the supply potential of ES section in question. The higher the value, the better the prerequisites for ES supply.

| **ES SECTION** | | | **LAND COVER** |
|---|---|---|---|
| **P** | **R** | **C** | **CORINE Land Cover 2006 (level 4)** |
| 0 | 0 | 1 | Continuous urban fabric |
| 0.5 | 1 | 1.5 | Discontinuous urban fabric |
| 0 | 0 | 0 | Industrial or commercial units |
| 0 | 0 | 0 | Road and rail networks and associated land |
| 0 | 0 | 0 | Port areas |
| 0 | 0 | 0 | Airports |
| 0 | 0 | 0 | Mineral extraction sites |
| 0 | 0 | 0 | Dump sites |
| 0 | 0 | 0 | Construction sites |
| 1 | 1 | 2 | Holiday cottages |
| 0 | 0 | 1.5 | Other sport and leisure facilities |
| 0 | 0 | 1 | Golf courses |
| 0 | 0 | 0.5 | Horse racing tracks |
| 3 | 1 | 1 | Non-irrigated arable land in use |
| 2 | 2 | 1 | Non-irrigated arable land not in use |
| 3 | 2 | 1.5 | Fruit trees and berry plantations |
| 3 | 2.5 | 1.5 | Pastures |
| 3 | 3 | 3 | Broad-leaved forest on mineral soil |
| 2 | 3 | 2 | Broad-leaved forest on histosol |
| 3 | 3 | 3 | Coniferous forest on mineral soil |
| 2 | 3 | 2 | Coniferous forest on histosol |
| 1 | 2 | 2.5 | Coniferous forest on bare rock |
| 3 | 3 | 3 | Mixed forest on mineral soil |
| 2 | 3 | 2 | Mixed forest on histosol |
| 2 | 2 | 3 | Mixed forest on bare rock |
| 2 | 2 | 3 | Natural grassland |
| 1.5 | 2 | 2 | Moors and heathland |
| 1.5 | 2 | 2 | Transitional woodland/shrub, cc < 10% |
| 2 | 2 | 2 | Transitional woodland/shrub, cc 10–30%, on mineral soil |
| 1.5 | 2 | 1.5 | Transitional woodland/shrub , cc 10–30%, on histosol |
| 1 | 1.5 | 2 | Transitional woodland/shrub , cc 10–30%, on bare rock |
| 1 | 2 | 2 | Transitional woodland/shrub, above coniferous timber line |
| 2 | 2 | 1 | Transitional woodland/shrub, arable lands not in use |
| 0 | 2 | 3 | Beaches, dunes, and sand plains |
| 0 | 1 | 3 | Bare rock |
| 2 | 3 | 2 | Terrestrial inland marshes |
| 2 | 3 | 1.5 | Aquatic inland marshes |
| 1.5 | 3 | 2 | Peatbogs |
| 0 | 0 | 0 | Peat extraction sites |
| 1 | 2.5 | 2 | Terrestrial salt marshes |
| 1.5 | 2.5 | 2 | Aquatic salt marshes |
| 3 | 3 | 3 | Rivers |
| 3 | 3 | 3 | Lakes |
| 3 | 3 | 3 | Sea and ocean |

Appendix 4. The impedance scores given for each land cover class. A higher score indicates lower permeability.

| **CORINE Land Cover 2006 class, level 4** | **Impedance score (1–100)<br>Higher score indicates lower permeability** |
|---|---|
| Continuous urban fabric | 100 |
| Discontinuous urban fabric | 90 |
| Industrial or commercial units | 100 |
| Road and rail networks and associated land | 90 |
| Port areas | 100 |
| Airports | 100 |
| Mineral extraction sites | 70 |
| Dump sites | 60 |
| Construction sites | 100 |
| Holiday cottages | 70 |
| Other sport and leisure facilities | 70 |
| Golf courses | 50 |
| Horse racing tracks | 90 |
| Non-irrigated arable land in use | 50 |
| Non-irrigated arable land not in use | 20 |
| Fruit trees and berry plantations | 50 |
| Pastures | 20 |
| Broad-leaved forest on mineral soil | 1 |
| Broad-leaved forest on histosol | 1 |
| Coniferous forest on mineral soil | 1 |
| Coniferous forest on histosol | 1 |
| Coniferous forest on bare rock | 1 |
| Mixed forest on mineral soil | 1 |
| Mixed forest on histosol | 1 |
| Mixed forest on bare rock | 1 |
| Natural grass land | 10 |
| Moors and heathland | 10 |
| Transitional woodland/shrub , cc < 10% | 10 |
| Transitional woodland/shrub, cc 10–30%, mineral soil | 1 |
| Transitional woodland/shrub, cc 10–30%, on histosol | 1 |
| Transitional woodland/shrub, cc 10–30%, on bare rock | 1 |
| Transitional woodland/shrub, above coniferous timber line | 10 |
| Transitional woodland/shrub, arable lands not in use | 10 |
| Beaches, dunes, and sand plains | 20 |
| Bare rock | 20 |
| Terrestrial inland marshes | 20 |
| Aquatic inland marshes | 20 |
| Peatbogs | 20 |
| Peat extraction sites | 80 |
| Terrestrial salt marshes | 20 |
| Aquatic salt marshes | 90 |
| Rivers | 20 |
| Lakes | 20 |
| Sea and ocean | 90 |

Appendix 5. Valuation studies of recreation in Finland.

| Study | Focus of valuation | Method | Study area | Data | Estimated average values |
|---|---|---|---|---|---|
| Ovaskainen, V., Mikkola, J. & Pouta, E. 2001. Estimating recreation demand with on-site data: an application of truncated and endogenously stratified count data models. | Recreation at forest recreation sites near Helsinki | TC | Three adjacent recreation sites in Nuuksio Lake Plain | On-site survey of visitors, n=656. | FIM 70-72/trip (€12/trip) |
| Huhtala, A. & Pouta, E. 2008. User fees, equity and the benefits of public outdoor recreation services. | Recreation in state owned recreation and conservation areas | CV | Finland | National outdoor recreation inventory, n=1871. | Users of the areas: FIM 128/year (€ 21.5/year)<br>Nonusers: FIM 107/year (€18/year) |
| Tyrväinen, L., Mäntymaa, E. & Ovaskainen, V. 2013. Demand for enhanced forest amenities in private lands: The case of the Ruka-Kuusamo tourism area, Finland. | Forest amenities: landscape and biodiversity | CE | Ruka-Kuusamo tourism area | A visitor survey, n=922. | No visible traces of intensive forestry operations: €12/one week visit. Traces of intensive forestry operations visible on 10% of the sides of routes: €11/one week visit. Populations of endangered species increase by 10%: €11/one week visit. 10% of species extinct: € - 37/one week visit. |
| Juutinen, A., Mitani, Y., Mäntymaa, E., Shoji, Y., Siikamäki, P. & Svento, R. 2011. Combining ecological and recreational aspects in national park management: a choice experiment application. | National park characteristics: recreational facilities and biodiversity | CE | Oulanka National Park | A visitor survey, n=473. | Populations of endangered species increase by 10%: €7/visit. Biodiversity stays at the current state: €5/visit. 15 species extinct in the park: € -12/visit |
| Pouta, E. & Ovaskainen, V. 2006. Assessing the recreational demand for agricultural land in Finland. | Recreation in agricultural areas | TC | Finland | National outdoor recreation inventory, n=5535. | Agricultural land at destination: € 22/day trip, €51/over-night trip. No agricultural land at destination: € 20/day trip, €57/over-night nature trip. |
| Grammatikopoulou, I., Pouta, E., Salmiovirta, M. & Soini, K. 2012. Heterogeneous preferences for agricultural landscape improvements in southern Finland. | Agricultural landscape attributes | CE | Nurmijärvi | A household survey, n=630. | Presence of grazing animals: € 82/year. Renovated production buildings: € 36/year |
| Horne, P., Boxall, P.C. & Adamowicz, W.L. 2005. Multiple-use management of forest recreation sites: a spatially explicit choice experiment. | Forest amenities: landscape and biodiversity | CE | Five outdoor areas owned by the city of Helsinki | Visitor interviews, n=431. | Average WTP for management practice with two of the sites left unmanaged to enhance biodiversity and three remaining under the present management regime to focus on recreational use € -11 |
| Tyrväinen, L. 2001. Economic valuation of urban forest benefits in Finland. | Recreation in urban forests | CV | Salo and Joensuu | A resident survey, n= in Joensuu: 322, in Salo: 224. | In Joensuu: FIM 42-53/month (€ 7.1-8.9/month). In Salo: FIM 9-17 /2-hour visit (€ 2-3/2-hour visit) |
| Ovaskainen, V., Neuvonen, M., & Pouta, E. 2012. Modelling recreation demand with respondent-reported driving cost and stated cost of travel time: A finnish case. | Recreation | TC | Teijo National Hiking area | A visitor survey, n=235. | €25-59/trip |

| Study | Focus of valuation | Method | Study area | Data | Estimated average values |
|---|---|---|---|---|---|
| Huhtala, A. & Lankia, T. 2012. Valuation of trips to second homes: do environmental attributes matter? | Recreation at leisure homes | TC | Finland | A leisure home owner survey, n=343. | €170-205/trip |
| Lankia, T., Pouta, E.., Neuvonen, M. & Sievänen, T. 2014. Willingness to contribute to the management of recreational quality on private lands in Finland. | Forest management practices affecting recreational quality | CV | Finland | National outdoor recreation inventory, n=2761. | €92/year, 5 days/year |
| Lankia, T., Kopperoinen, L., Pouta, E. & Neuvonen, M. 2015. Valuing recreational ecosystem service flow in Finland. | Recreation | TC | Finland | National outdoor recreation inventory, n=8895. | Close-to-home recreation: €2-97/visit. Nature trips: €29-252/trip |

Appendix 6. Valuation studies of surface and groundwater in Finland.

| Study | Focus of valuation | Water body | Ecosystem services | Ecosystem services | Study population | Valuation method | Estimated average values |
|---|---|---|---|---|---|---|---|
| Ahtiainen, H. 2007. Willingness to pay for improvements in the oil spill response capacity in the Gulf of Finland – an application of the contingent valuation method. | preventing harm from future oil spills | Gulf of Finland | cultural | recreation, existence | national population | contingent valuation | €28/person (one-time payment) |
| Ahtiainen, H. 2008. Benefits of lake water quality improvements: A case study of Lake Hiidenvesi (Järven tilan parantamisen hyödyt. Esimerkkinä Hiidenvesi). | reduced eutrophication | Lake Hiidenvesi | cultural | recreation, existence | residents and cottage owners in nearby municipalities | contingent valuation | €14–29/household/year |
| Ahtiainen, H. et al. 2014. Benefits of meeting nutrient reduction targets for the Baltic Sea - a contingent valuation study in the nine coastal states. | reduced eutrophication | the Baltic Sea | cultural | recreation, existence | national population | contingent valuation | €42–60/person/year |
| Artell, J. 2014. Lots of value? A spatial hedonic approach to water quality valuation. | improved water quality | lakes, rivers and sea areas | cultural | recreation | sales information of unbuilt summer house lots | hedonic pricing | good water quality: 9% (€4,500)/unbuilt lot excellent water quality: 20% (€9,000)/unbuilt lot |
| Gustafsson, M. & Stage, J. 2004 Willingness to pay for improved sea water quality around Aland Islands (Betalningsviljan för renare havsvatten runt Åland). | reduced eutrophication | sea around Åland Islands | cultural | recreation, existence | population of Åland | contingent valuation | €222/person/year |
| Huhtala, A. & Lankia, T. 2012. Valuation of trips to second homes: do environmental attributes matter? | recreational value of holiday cottages | lakes, rivers and sea areas | cultural | recreation | holiday cottage buyers | travel cost method | recreation value: €170–205/trip to holiday cottage, with disruptive algae: €121–125/trip |

| Study | Focus of valuation | Water body | Ecosystem services | Ecosystem services | Study population | Valuation method | Estimated average values |
|---|---|---|---|---|---|---|---|
| Koundouri, P. et al. 2012. The value of scientific information on climate change: a choice experiment on Rokua esker, Finland. | groundwater management attributes groundwater | Rokua esker | cultural and provisioning | recreation, water quantity | local inhabitants and recreational users | choice experiment, contingent valuation | improved recreation €10–12/ household, increased water quantity €13–26/ household |
| Kosenius, A.-K. 2004. Estimating the Benefit from Algal Bloom Reduction - an Application of Contingent Valuation Method. | reduced eutrophication | Gulf of Finland | cultural and provisioning | recreation, aesthetic, food | tourists to the city of Hanko | contingent valuation | €26/person/ year |
| Kosenius, A.-K. 2010. Heterogeneous preferences for water quality attributes: The case of eutrophication in the Gulf of Finland, the Baltic Sea. | reduced eutrophication | Gulf of Finland | cultural | recreation, existence | national population | choice experiment | €149–611/ household/ year |
| Kosenius, A-K. & Ollikainen M. 2012. Ecosystem benefits from coastal habitats in Finland, Sweden, and Lithuania. | marine attributes | Finnish-Swedish archipelago | cultural and provisioning | recreation, food, existence | national population | choice experiment | healthy vegetation €40–69/ person, pristine areas €70/ person, fish stocks €37–53/person |
| Lankia, T. & Pouta, E. 2012. Effects of water quality changes on recreation benefits in Finland: Combined travel cost and contingent behaviour model. | water recreation | lakes, rivers and sea areas | cultural | recreation | national population | travel cost method, contingent behavior | €18/swimming trip, improved water quality: €46/ swimming trip |
| Lehtoranta, V. 2013. The economic value of water management for Lake Vesijärvi (Vesienhoidon arvo Vesijärvelle). | reduced eutrophication | Lake Vesijärvi | cultural | recreation, existence | residents of the city of Lahti and municipality of Hollola | contingent valuation | €11–22/ household/ year |
| Lehtoranta, V., Sarvilinna, A. & Hjerppe, T. 2012. The significance of streams for the residents of the City of Helsinki. Contingent valuation study for the feasibility of the Small Water Action Plan (Purojen merkitys helsinkiläisille. Helsingin pienvesiohjelman yhteiskunnallinen kannattavuus). | restoration of streams | streams in Helsinki | cultural | recreation, landscape, existence | residents of the city of Helsinki | contingent valuation | €8–16/ household/ year |
| Lehtoranta, V., Seppälä, E., Martinmäki, K. & Sarvilinna, A. 2013. Residents' view of and willingness to participate in water management in the River Kalimenjoki catchment area (Asukkaiden näkemykset ja halukkuus osallistua vesienhoitoon Kalimenjoen valuma-alueella). | restoration, water quality improvement | River Kalimenjoki catchment area | cultural | recreation, landscape, existence | residents and cottage owners in the catchment area | contingent valuation | €19–26/ household (one-time payment) |
| Luoto, I. 1998. Recreation and its economic value in lake Öjanjärvi (Öjanjärven virkistyskäyttö ja sen taloudellinen arvottaminen). | recreation day | Lake Öjanjärvi | cultural | recreation | Cottage owners and beach visitors | contingent valuation | €3/day/ beach visitor, €34/ day/cottage owners |

| Study | Focus of valuation | Water body | Ecosystem services | Ecosystem services | Study population | Valuation method | Estimated average values |
|---|---|---|---|---|---|---|---|
| Moisseinen, E. 1997. Contingent Valuation - The Case of the Saimaa Seal. | protection of Saimaa ringed seal | Lake Saimaa | provisioning and cultural | genetic resources, existence | national population | contingent valuation | €14–60/household (one-time payment) |
| Mäntymaa E. 1993. Valuing Environmental Benefits Using the Contingent Valuation Method (Ympäristöhyötyjen arviointi contingent valuation -menetelmällä). | reduced eutrophication | Lake Oulujärvi | cultural | recreation, existence | residents and cottage owners in nearby municipalities | contingent valuation | €114–166/household/year |
| National Audit Office of Finland (NAO) 2007. Developing fisheries (Kalatalouden kehittäminen). | recreational fishing | River Tornionjoki | cultural | recreation | fishermen | travel cost method | €183/fishing day |
| Parkkila, K., Haltia, E. & Karjalainen, T.P. 2011. Benefits of the salmon stock restoration for recreational anglers of the river Iijoki – pilot study with contingent valuation method (Iijoen lohikannan palauttamistoimien hyödyt virkistyskalastajille – pilottitutkimus ehdollisen arvottamisen menetelmällä). | recreational fishing | River Iijoki | cultural | recreation | fishermen | contingent valuation | €26/person/year |
| Parkkila, K. 2005. Estimating the Willingness to Pay for Catch Improvements in the River Simojoki - An Application of Contingent Valuation Method (Simojoen lohen saalismäärän lisääntymisen taloudellinen arviointi contingent valuation -menetelmällä). | additional salmon catch | River Simojoki | cultural | recreation, existence | fishermen | contingent valuation | €50–56/person/year |
| Toivonen, A.-L., Roth, E. S. Navrud, S., Gudbergsson, G:, Appelblad, H., Bengtsson, B. & Tuunainen, P. 2004. The Economic Value of Recreational Fisheries in Nordic Countries. | recreational fishing | lakes, rivers and sea areas | cultural | recreation | fishermen | contingent valuation | €83/person/year |
| Valkeajärvi, P. & Salo, H. 2000. Fishing and its value in Lake Päijänne in 1996 (Kalastus ja kalastuksen arvottaminen Päijänteellä vuonna 1996). | recreational fishing | Lake Päijänne | cultural | recreation | residents and property owners in nearby municipalities | contingent valuation | €8–16/trout caught |
| Vesterinen, J., Pouta, E., Huhtala, A. & Neuvonen, M. 2010. Impacts of changes in water quality on recreation behavior and benefits in Finland. | water recreation | lakes, rivers and sea areas | cultural | recreation | national population | travel cost method | €6–19/day/person |

# Summary

This report presents the results from the research project *National Assessment of the Economics of Ecosystem Services in Finland (TEEB Finland) – Synthesis and Roadmap*, financed by the Finnish Ministry of the Environment. This pioneering project aimed to initiate a systematic national process for the integration of ecosystem services and related biodiversity (i.e. natural capital) into all levels of decision-making. TEEB for Finland was carried out according to the models of previous international TEEB studies (e.g. TEEB Nordic) and alongside the EU's MAES project (*Mapping and Assessment of Ecosystems and their Services*).

The results of TEEB for Finland (2013–2014) help to support the Ministry of the Environment and other national decision-makers in identifying the value and social significance of ecosystem services. The study has produced information and knowledge for the implementation of the Finnish National Biodiversity Strategy and Action Plan (NBSAP) 2013–2020 'Saving Nature for People', and for the reporting of national actions connected to the Convention of Biological Diversity's (CBD) Strategic Plan for Biodiversity 2011–2020 and the EU's Biodiversity Strategy 2020, and their obligations regarding ecosystem services and natural capital.

TEEB for Finland provides preliminary estimates on the economic importance of some key services. The main focus has been on those so far under-recognized regulating and cultural services, while not forgetting traditional provisioning services, the value of which has been traditionally recognized due to their vital importance for the Finnish economy and society. The study included a review of the most relevant ecosystem services in Finland, the main drivers and future trends affecting the provision of ecosystem services, methods to assess the state and future trends of ecosystem services, for example, suggestions for ecosystem service indicators, and a description of an example of the spatial assessment and mapping of ecosystem services and green infrastructure in the Helsinki–Uusimaa region.

Further, the study also considered possible elements for improving the regulatory and management systems (e.g. legislation, payments for ecosystem services (PES), habitat banking) that could enable securing the future provisioning of ecosystem services and their foundation, the biological diversity of Finland. It reviews policy and governance issues (incl. knowledge base, laws and other guiding instruments), a scoping assessment and recommendations for natural capital accounting, and a review of the relationship between ecosystem services and a Green economy.

Regarding multiple provisioning services, such as harvests and other types of utilized yields in general, the trends have been relatively stable over the last two decades. As the economy has simultaneously grown in other areas, the relative significance of primary production (forestry, agriculture and fishery) has decreased. At the same time, the relative importance of cultural ecosystem services used is increasing (e.g. nature-based tourism and recreational fishing).

TEEB for Finland shows that the knowledge of many regulating services, for example, ecosystem processes, is still poor, but encouragingly, many such processes are now under investigation. As human-induced climate change advances, the role of the carbon cycle and associated climate regulation has become an important topic. Markets for carbon emissions and sequestration are already developing, which is not (yet) the case for other regulating services. Most regulating services have been traditionally taken for granted and their role in sustaining human well-being and the economy has only become visible via the effects of disturbances in ecosystem processes on the availability of provisioning services. Such critical issues in Finland are related to, for instance, the flow and retention of water and nutrient dynamics; for example, eutrophication in the Baltic Sea and the reproduction of some economically valuable species.

Besides regulating services, cultural ecosystem services are receiving more attention. Especially questions related to the recreational use of nat-

ural areas are being studied intensively and the beneficial impacts of nature on human health and well-being are gaining more attention. The high value of recreational services is enabled by everyman's right to use forests, water areas and agricultural landscapes for recreation, areas which are used for the production of provisioning ecosystem services, such as timber, bioenergy and food. However, a limited amount of quantitative (or any systematically collected) data on many of the cultural services complicates their presentation in an indicator format.

Spatially explicit mapping provides a concrete method for making ecosystem services visible, as it helps in defining the most important areas for safeguarding the flow of services vital for the society. While a wealth of various methods for mapping ecosystem services and their values are available, the quality of these analyses is always dependent on the available data. In land use planning and resource management, both supply (ecological) and demand (societal) aspects of ecosystem services should be considered. The early-enough timing of these assessments is critical for ensuring consistent analysis of sufficient quality for the purposes of well-informed and justified decision-making.

The Aichi Targets of the CBD, the EU's Biodiversity Strategy 2020 and the "Fitness check" of the EU's nature directives (Bird and Habitat Directives) require analysis of existing biodiversity, habitat and ecosystem service data, and continuous development of scientific methods and policy actions. Combatting these challenges will require more research and development, for example, on the mapping and assessment of ecosystems and their services on the EU Member State level.

The assessment of the value of ecosystem services and related biodiversity brings benefits for the development of the sustainable use of natural resources by demonstrating the societal benefits of biodiversity, for instance, through green and blue growth, human health and well-being, and nature-based solutions. It also helps to set priorities for future policy actions, through identifying and integrating the importance and the true value of ecosystem services and related biodiversity into decision-making processes. Additionally, it provides a picture of the mutual and interlinked supply of ecosystem services and their effect on human well-being and the economy. Considering the value of ecosystem services can enable a more holistic natural resource and land use planning procedure, save financial costs, boost new enterprises and other job creating actions, enhance the quality of life and secure sustainable livelihoods nationally, regionally and globally.

Ecosystem services are an integral part of a number of economic sectors relevant to a green economy in Finland, namely, the forest sector, water, tourism, agriculture and food sector, game and fisheries, and renewable energy. In addition, ecosystem services are perceived as an integral part of growing green economy sectors such as the textile industry, life and health style business (LOHAS), cosmetics and pharmaceuticals.

Green economy and ecosystems are cross-cutting to various policy sectors. Policy coherence is needed in order to provide consistent regulation and guidance for private companies and other stakeholders. The use of a systematic assessment and description can help decision-making by highlighting: a) how ecosystem services enable business activities in different sectors by providing resources for the sector; and b) how the economic sector has an effect on ecosystem services either through their degradation or improvements in their state. Such an assessment framework was introduced in this report.

Recently, the Finnish government has presented the policies for the government's natural resources report *Intelligent and Responsible Natural Resources Economy*, to the Finnish Parliament. The vision and objective of this new policy framework is to enhance cross-sectoral policies in a way that improves the opportunities for Finland to be as a leader in a sustainable natural resources economy in 2050. The assessment of ecosystem services and related biodiversity is an integral part of activities in this renewed policy framework, and the results of TEEB for Finland are in harmony with and supportive of this policy.

# Yhteenveto

Ympäristöministeriö tilasi vuonna 2012 arvion ekosysteemipalvelujen taloudellisesta merkityksestä Suomessa. Tutkimuksen pohjana tuli käyttää vuosina 2010–2011 toteutettua kansainvälistä *The Economics of Ecosystems and Biodiversity* (TEEB) -tutkimusta sekä vuonna 2012 julkaistua alueellista TEEB Nordic -selvitystä.

Hankkeessa tuli erityisesti selvittää:

- Suomen tärkeimpien ekosysteemipalvelujen nykytila ja arvio tulevasta kehityksestä.
- Kehittää edelleen Pohjoismaiden TEEB:in tuloksia tärkeimpien ekosysteemipalvelujen taloudellisesta merkityksestä Suomessa.
- Laatia suosituksia ekosysteemipalvelujen integroimisesta nykyistä paremmin osaksi keskeisiä politiikkaprosesseja.
- Arvioida keskeisten ekosysteemipalvelujen merkitystä ja mahdollisuuksia vihreän talouden edistämisessä.
- Tehdä suosituksia ohjauskeinoista luontopääoman ja ekosysteemipalvelujen turvaamiseksi Suomessa sekä keskeisimmistä jatkoselvitystarpeista.

Tarjouskilpailun jälkeen tutkimuksen toteuttajaksi valittiin Suomen ympäristökeskuksen (SYKE) johtama tutkimusryhmä, jonka muina osapuolina ovat olleet Maa- ja elintarviketalouden tutkimuskeskus (MTT) sekä Euroopan ympäristöpolitiikan instituutti (IEEP). Hankkeeseen on osallistunut myös Pellervon taloustutkimus (PTT) sekä tutkijoita Itä-Suomen, Helsingin ja Lapin yliopistoista.

Suomen TEEB -raportti sisältää mm. hankkeen tulokset sekä yhteenvedon ekosysteemipalvelujen tilaa ja taloudellista merkitystä koskevasta suomalaisesta tutkimuksesta. Raportti antaa päättäjille suosituksia siitä, kuinka ekosysteemipalvelut ja niiden pohjana oleva luonnon monimuotoisuus tulisi ottaa huomioon osana luonnonvarojen kestävää käyttöä ja vihreän talouden kehittämistä.

Raportti tarjoaa alustavia arvioita eräiden tärkeimpien ekosysteemipalvelujen taloudellisesta merkityksestä. Päähuomio on kohdistettu toistaiseksi vähemmälle tarkastelulle jääneisiin säätely- ja kulttuuripalveluihin, unohtamatta kuitenkaan perinteisiä tuotantopalveluja (esim. metsien raaka-ainelähteitä), joiden arvo on pitkään tiedetty merkittäväksi maamme taloudelle ja yhteiskunnalle.

Raportti sisältää yhteenvedon maamme tärkeimpiin ekosysteemipalveluihin ja niiden tarjontaan vaikuttavista tekijöistä, esityksiä tavoista arvioida palvelujen tilaa ja kehitystä, ehdotuksia tätä kehitystä kuvaaviksi indikaattoreiksi, sekä esimerkin ekosysteemipalvelujen ja vihreän infrastruktuurin spatiaalisesta arvioinnista ja kartoituksesta Helsinki–Uusimaa alueella.

Raportti esittelee ekosysteemipalvelujen säätely- ja hallintakeinojen parantamisen välineitä (esim. lainsäädäntöä, ekosysteemipalvelujen tuottamisesta perittäviä maksuja, luontoarvopankkia), jotka edistävät ekosysteemipalvelujen kestävää saatavuutta sekä niiden perustan, Suomen biologisen monimuotoisuuden turvaamista. Tutkimus luo katsauksen asiaan liittyviin toimintapolitiikan ja hallinnan keinoihin mukaan lukien tietoperustaan, lakeihin ja muihin ohjauskeinoihin. Raportti sisältää myös luontopääoman kansallisen tilinpidon (natural capital accounting) nykytilan arvion sekä suosituksia tilinpidon edistämiseksi, kuten myös katsauksen ekosysteemipalvelujen ja vihreän talouden suhteesta.

Ihmisperäisen ilmastonmuutoksen edetessä hiilen kierto ja siihen liittyvä ilmastonsäätely ovat tulleet tärkeiksi yhteiskunnallisiksi teemoiksi. Hiilipäästöihin ja hiilen sitomiseen liittyvät markkinat ovat jo kehittymässä. Muutoin useimmat säätelypalvelut on perinteisesti otettu itsestään selvinä ja niiden rooli ihmisten hyvinvoinnin ja talouden ylläpitäjänä on nähty lähinnä ekosysteemiprosessien häiriöiden yhteydessä, jotka ovat heijastuneet tuotantopalvelujen saatavuuteen. Suomen TEEB -hankkeen tulokset osoittavat, että tiedot ekosysteemiemme monista säätelypalveluista, esimerkiksi ekosysteemeissä tapahtuvista prosesseista, ovat edelleen vähäiset. Rohkaisevaa kuitenkin on, että monet ekosysteemiprosessit ovat jo nousseet tutkimuksen kohteeksi.

Kulttuuripalveluja, erityisesti luonnon virkistyskäytön kysymyksiä, on tutkittu säätelypalveluja enemmän. Esimerkiksi luonnon myönteiset vaikutukset ihmisten terveyteen ja hyvinvointiin ovat saaneet lisää huomiota. Luonnon tarjoamien virkistyspalvelujen suuri hyödyntämisarvo kansalaisten keskuudessa perustuu suomalaiseen jokamiehenoikeuteen liikkua vapaasti metsissä, vesialueilla ja maaseudulla. Näitä alueita käytetään samanaikaisesti myös tuotantopalvelujen, kuten raakapuun, bioenergian ja ruoan tuotantoon. Viime aikoina luontomatkailun ja virkistyskalastuksen suhteellinen arvo on korostunut, samalla kun perinteisten maa-, metsä-, ja kalatalouden tuotantopalvelujen ”ylivalta” taloudellisissa tarkasteluissa on alkanut pienentyä.

Ekosysteemipalvelujen tarkka sijoittaminen kartoille, josta Suomen TEEB -raportissa on esimerkkejä, tarjoaa konkreettisen menetelmän ekosysteemipalvelujen visualisointiin ja edistää myös näitä hyötyjä yhteiskunnalle tuottavien tärkeimpien alueiden määrittämistä ja turvaamista. Tarkastelujen, joissa huomioidaan sekä ekologiset että sosio-ekonomiset näkökohdat (ml. palvelujen kysyntä ja tarjonta) laatu riippuu suuresti analyyseissä tarvittavien paikkatietojen saatavuudesta. Lopputuloksen kannalta on oleellisen tärkeää saattaa analyysien tulokset riittävän ajoissa päätöksentekijöiden ja maankäytön suunnittelijoiden tietoon.

Koska ekosysteemipalvelujen ja niiden perustana olevan biologisen monimuotoisuuden sosio-ekonomisen, ekologisen ja kulttuurisen arvon tunnistaminen osoittaa luontopääoman hyödyt taloudelle ja hyvinvoinnille, luontopääoman arviointi on erittäin hyödyllistä luonnonvarojen kestävän käytön kehittämisen kannalta. Suomen luontopääoman todellisen arvon yhteiskunnallisia hyötyjä voidaan havaita esimerkiksi vihreän ja sinisen kasvun, ihmisten terveyden ja hyvinvoinnin sekä luontoon perustuvien ratkaisujen kokonaisvaltaisissa tarkasteluissa.

Luontopääoman arvon arviointi mahdollistaa nykyistä tasapainoisemmat luonnonvarojen suojelun ja kestävän käytön sekä maankäytön tarkastelut, säästää taloudellisia kustannuksia, edistää uutta yritystoimintaa ja muita työllisyyttä parantavia toimenpiteitä, parantaa kansalaisten elämänlaatua sekä turvaa kestävän elinkeinotoiminnan harjoittamista kansallisesti, alueellisesti ja maailmanlaajuisesti.

Ekosysteemipalvelujen tarkastelu ja ymmärtäminen on olennaisen tärkeää monille vihreän talouden kehittämisen kannalta tärkeille sektoreille, kuten maa-, metsä- ja vesitaloudelle sekä ravinnontuotannolle ja uusiutuvien energialähteiden kestävälle käytölle. Vihreän talouden kannalta keskeisiä elinkeinoja ovat myös tekstiiliteollisuus ja terveyteen liittyvä yritystoiminta sekä kosmetiikka- ja lääketeollisuus.

Tällä hetkellä kvantitatiivisen tai yleensä systemaattisesti kerätyn ekosysteemipalvelutiedon (datan) puute vaikeuttaa kulttuuripalvelujen ja erityisesti säätelypalvelujen tarkastelua esimerkiksi indikaattoreiden avulla. Toisaalta, kansallisten tarpeiden rinnalla, Biologista monimuotoisuutta koskevan yleissopimuksen (Convention on Biological Diversity, CBD) Aichi-tavoitteet, Euroopan unionin biodiversiteettistrategia 2020 ja EU:n luonnonsuojeludirektiivien (habitaatti- ja lintudirektiivi) toimivuuden arviointi, ns. “fitness check”, edellyttävät luonnon monimuotoisuuden nykytilan ja kehityssuunnan arviointia, habitaatti- ja ekosysteemipalvelutietoa, sekä tutkimusmenetelmien ja politiikkatoimien jatkuvaa kehittämistä.

Suomen TEEB -hankkeen tavoite on ollut, että projektin tulokset tukevat ympäristöministeriötä sekä muita kansallisia päätöksentekijöitä ja toimijoita maamme tärkeimpien ekosysteemipalvelujen tunnistamisessa, niiden tilan ja kehityssuuntien arvioinnissa, taloudellisessa ja muussa arvottamisessa sekä tiellä kohti ekosysteemipalvelujen kestävää hallintaa.

Tuotettua tietoa on mahdollista käyttää Suomen kansallisen biodiversiteettistrategian ja toimintaohjelman toteutuksessa sekä raportoitaessa EU:lle ja CBD-yleissopimukselle maamme toimista kansainvälisten biodiversiteettiin liittyvien velvoitteiden toimeenpanossa. Koska TEEB -luonteiset tutkimukset ovat suuren kansainvälisen mielenkiinnon kohteena, Suomen TEEB -raportti julkaistaan englanniksi, jotta havainnot olisivat myös kansainvälisten tutkijoiden ja muiden tahojen käytettävissä.

Vuoden 2014 lopussa Suomen hallitus luovutti eduskunnalle valtioneuvoston luonnonvaraselonteon päivityksen “Suomi kestävän luonnonvaratalouden edelläkävijäksi 2050” (TEM 2014). Suomen TEEB:in tulokset tukevat hallituksen selonteon tavoitteita ja ovat harmoniassa niiden kanssa. Ekosysteemipalvelujen ja niiden perustan, luonnon monimuotoisuuden, tunnistaminen ja arviointi ovat olennainen osa matkalla kohti luonnonvarojen kestävän käytön edellä kävijän roolia, johon hallituksen selonteko pyrkii.

Suomen TEEB -hankkeen tulokset tukevat maamme hallitusta jatkamaan systemaattista kehitystyötä ekosysteemipalvelujen ja niiden pohjana olevan luonnon monimuotoisuuden arvon (luontopääoman) sisällyttämiseksi kaikentasoiseen päätöksentekoon. Suomen TEEB -projektia on esitelty eduskunnan ympäristövaliokunnalle sen avoimessa kokouksessa 4.11.2014.

## DOCUMENTATION PAGE

| | | | | |
|---|---|---|---|---|
| *Publisher* | Ministry of the Environment<br>Department of the Natural Environment | | | *Date*<br>January 2015 |
| *Author(s)* | Jukka-Pekka Jäppinen and Janne Heliölä (eds.) | | | |
| *Title of publication* | **Towards A Sustainable and Genuinely Green Economy. The value and social significance of ecosystem services in Finland (TEEB for Finland) – Synthesis and roadmap** | | | |
| *Publication series and number* | The Finnish Environment 1en \| 2015 | | | |
| *Theme of publication* | Natural Resources | | | |
| *Abstract* | This report presents the results from the research project National Assessment of the Economics of Ecosystem Services in Finland (TEEB Finland). This pioneering project aimed to initiate a systematic national process for the integration of ecosystem services and related biodiversity (i.e. natural capital) into all levels of decision-making. TEEB for Finland was executed according to the models of previous international TEEB studies (e.g. TEEB Nordic) and alongside with EU's MAES project (Mapping and Assessment of Ecosystems and their Services).<br><br>The TEEB for Finland provides preliminary estimates on the economic importance of some key ecosystem services. The main focus has been on those so far under-recognized regulating and cultural services, but not forgetting traditional provisioning services, the value of which has been traditionally recognized due to their vital importance for the Finnish economy and society.<br><br>The trends regarding multiple provisioning services, such as harvests and other types of utilized yields, have been relatively stable over the last two decades. As the economy has simultaneously grown in other areas, the relative significance of primary production has decreased. At the same time, the relative importance of cultural ecosystem services used is increasing. Knowledge on many regulating services, e.g. on ecosystem processes, is still poor, but encouragingly, many such processes are now under investigation. Also cultural ecosystem services are currently receiving more attention.<br><br>Recently, the Finnish government has reviewed the policies for the government's natural resources report Intelligent and Responsible Natural Resources Economy, to the Finnish Parliament. The vision and objective of this new policy frame is to enhance cross-sectoral policies in a way that improves the possibilities of Finland becoming a path setter for sustainable natural resources economy in 2050. The assessment of ecosystem services and related biodiversity is an integral part of needed activities in this renewed policy frame, and the results of TEEB for Finland are in harmony and supportive with this policy. | | | |
| *Keywords* | Ecosystem services, biodiversity, environmental accounting, green economy, natural resources, environmental indicators, habitat banking, payment for ecosystem services, sustainable use | | | |
| *Financier/ commissioner* | Ministry of the Environment | | | |
| | ISBN<br>978-952-11-4339-7 (pbk.) | ISBN<br>978-952-11-4376-2 (PDF) | ISSN<br>1238-7312 (print) | ISSN<br>1796-1637 (online) |
| | *No. of pages*<br>144 | *Language*<br>English | *Restrictions*<br>For public use | |
| *For sale at/ distributor* | The publication is available on the internet:<br>www.ym.fi/julkaisut | | | |
| *Financier of publication* | Ministry of the Environment | | | |
| *Printing place and year* | Helsinki 2015 | | | |

# KUVAILULEHTI

| | | |
|---|---|---|
| *Julkaisija* | Ympäristöministeriö<br>Luontoympäristöosasto | *Julkaisuaika*<br>Tammikuu 2015 |
| *Tekijä(t)* | Jukka-Pekka Jäppinen ja Janne Heliölä (toim.) | |
| *Julkaisun nimi* | **Towards A Sustainable and Genuinely Green Economy. The value and social significance of ecosystem services in Finland (TEEB for Finland) – Synthesis and roadmap**<br>(Kohti kestävää ja aidosti vihreää taloutta. Ekosysteemipalvelujen arvo ja yhteiskunnallinen merkitys Suomessa (Suomen TEEB) – synteesi ja tiekartta) | |
| *Julkaisusarjan nimi ja numero* | Suomen ympäristö 1en/2015 | |
| *Julkaisun teema* | Luonnonvarat | |
| *Tiivistelmä* | Tämä raportti sisältää kansallisen ekosysteemipalvelujen arviointihankkeen (National Assessment of the Economics of Ecosystem Services in Finland – TEEB for Finland) tulokset. Suomen TEEB -projektin tavoite on ollut edistää kansallista prosessia, jonka avulla ekosysteemipalvelut ja niiden perustana oleva biologinen monimuotoisuus (ns. luontopääoma) otetaan systemaattisesti huomioon kaikentasoisessa päätöksenteossa. Suomen TEEB on toteutettu kansainvälisten TEEB -luonteisten selvitysten (esim. TEEB Nordic) sekä Euroopan Unionin MAES-projektin (Mapping and Assessment of Ecosystems and their Services) esimerkkien pohjalta.<br><br>Suomen TEEB tarjoaa alustavia arvioita eräiden keskeisten ekosysteemipalvelujen taloudellisesta merkityksestä Suomessa. Päähuomio on kohdistettu toistaiseksi vähemmälle tarkastelulle jääneisiin säätely- ja kulttuuripalveluihin kansallisena voimavarana, unohtamatta kuitenkaan perinteisiä tuotantopalveluja, joiden arvo on pitkään tiedetty merkittäväksi maamme taloudelle ja yhteiskunnalle.<br><br>Monien tuotantopalvelujen saatavuuteen liittyvät trendit ovat olleet suhteellisen vakaita parin viimeisen vuosikymmenen aikana. Niiden suhteellinen merkitys kansantalouden osana on kuitenkin laskenut, muiden elinkeinojen kehityttyä niiden rinnalle. Samaan aikaan kulttuuripalvelujen suhteellinen merkitys on kasvamassa. Tiedot monista säätelypalveluista, kuten ekosysteemiprosesseista, ovat yhä heikot. Rohkaisevasti monet säätelypalvelut ovat nykyään kasvavan tutkimuksen kohteena. Myös kulttuuripalvelujen tutkimus on lisääntymässä.<br><br>Vuoden 2014 lopussa Suomen hallitus luovutti eduskunnalle valtioneuvoston luonnonvaraselonteon päivityksen “Suomi kestävän luonnonvaratalouden edelläkävijäksi 2050”. Uudistetun selonteon tavoite on edistää sektorirajat ylittävää luonnonvarapolitiikkaa, jotta Suomen mahdollisuudet kehittyä kestävän luonnonvaratalouden edelläkävijämaaksi vuoteen 2050 mennessä paranevat. Suomen TEEB -hankkeen tulokset tukevat hallituksen selonteon tavoitteita ja ovat harmoniassa niiden kanssa. Ekosysteemipalvelujen ja niiden perustan, luonnon monimuotoisuuden, tunnistaminen ja arviointi ovat olennainen osa matkalla kohti luonnonvarojen kestävää käyttöä. | |
| *Asiasanat* | Ekosysteemipalvelut. Luonnon monimuotoisuus. Ympäristötilinpito. Vihreä talous. Luonnonvarat. Ympäristöindikaattorit. Luonnonarvokauppa. Kestävä käyttö. | |
| *Rahoittaja/ toimeksiantaja* | Ympäristöministeriö | |

| | | | | |
|---|---|---|---|---|
| | ISBN<br>978-952-11-4339-7 (nid.) | ISBN<br>978-952-11-4376-2 (PDF) | ISSN<br>1238-7312 (pain.) | ISSN<br>1796-1637 (verkkoj.) |
| | *Sivuja*<br>144 | *Kieli*<br>Englanti | *Luottamuksellisuus*<br>julkinen | |
| *Julkaisun myynti/ jakaja* | Julkaisu on saatavana internetistä:<br>www.ym.fi/julkaisut | | | |
| *Julkaisun kustantaja* | Ympäristöministeriö | | | |
| *Painopaikka ja -aika* | Helsinki 2015 | | | |

## PRESENTATIONSBLAD

<table>
<tr><td>Utgivare</td><td colspan="3">Miljöministeriet<br>Naturmiljöavdelningen</td><td>Datum<br>Januari 2015</td></tr>
<tr><td>Författare</td><td colspan="4">Jukka-Pekka Jäppinen och Janne Heliölä (red.)</td></tr>
<tr><td>Publikationens titel</td><td colspan="4">Towards A Sustainable and Genuinely Green Economy. The value and social significance of ecosystem services in Finland (TEEB for Finland) – Synthesis and roadmap<br>(Mot en hållbar och genuint grön ekonomi. Värdet och den sociala betydelsen av ekosystemtjänster i Finland (TEEB Finland) – en syntes och färdplan)</td></tr>
<tr><td>Publikationsserie och nummer</td><td colspan="4">Miljön i Finland 1en/2015</td></tr>
<tr><td>Publikationens tema</td><td colspan="4">Naturtillgångar</td></tr>
<tr><td>Sammandrag</td><td colspan="4">I denna rapport presenteras resultaten från forskningsprojektet kring en nationell bedömning av värdet av ekosystemtjänster i Finland (National Assessment of the Economics of Ecosystem Services in Finland, nedan TEEB Finland). Syftet med detta pionjärprojekt var att inleda en systematisk riksomfattande process för att integrera ekosystemtjänster och biologisk mångfald (dvs. naturkapital) i beslutsfattande på alla nivåer. TEEB Finland utfördes enligt modellerna för tidigare internationella TEEB-undersökningar (t.ex. TEEB Nordic) och parallellt med EU:s MAES-projekt (Mapping and Assessment of Ecosystems and their Services).<br><br>TEEB Finland ger preliminära bedömningar av vissa centrala ekosystemtjänsters ekonomiska betydelse. Fokus har framför allt legat på reglerande och kulturella tjänster som hittills inte identifierats i tillräcklig utsträckning, men även på traditionella försörjande tjänster, vilkas värde av hävd har identifierats på grund av tjänsternas stora betydelse för den finska ekonomin och samhället.<br><br>Utvecklingstrenden när det gäller multipla försörjande tjänster, såsom skördar och andra typer av tillgodogjord avkastning, har varit ganska stabil under de senaste två decennierna. I takt med att ekonomin under samma tid har stärkts inom andra områden har primärproduktionens relativa betydelse minskat. Samtidigt ökar den relativa betydelsen av de kulturella ekosystemtjänster som utnyttjas. Kunskapen om många reglerande tjänster, t.ex. ekosystemprocesser, är fortfarande mycket begränsad, men positivt är att många sådana processer nu undersöks. Även kulturella ekosystemtjänster får nuförtiden allt större uppmärksamhet.<br><br>Statsrådet har nyligen sett över riktlinjerna i redogörelsen Smart och ansvarsfull naturresursekonomi, statsrådets naturresursredogörelse till riksdagen. Visionen och målen för de nya riktlinjerna är att främja sektorsövergripande politik på ett sätt som förbättrar Finlands möjligheter att bli en föregångare när det gäller hållbar naturresursekonomi 2050. Bedömningen av ekosystemtjänster och biologisk mångfald utgör en oskiljaktig del av de åtgärdsbehov som nämns i de reviderade riktlinjerna, och resultaten av TEEB Finland överensstämmer med och stöder dessa riktlinjer.</td></tr>
<tr><td>Nyckelord</td><td colspan="4">Ekosystemtjänster, biologisk mångfald, miljöbokforing, grön ekonomi, naturresurser, miljöindikatorer, naturvärdeshandel, hållbar användning</td></tr>
<tr><td>Finansiär/ uppdragsgivare</td><td colspan="4">Miljöministeriet</td></tr>
<tr><td></td><td>ISBN<br>978-952-11-4339-7 (hft.)</td><td>ISBN<br>978-952-11-4376-2 (PDF)</td><td>ISSN<br>1238-7312 (print)</td><td>ISSN<br>1796-1637 (online)</td></tr>
<tr><td></td><td>Sidantal<br>144</td><td>Språk<br>Engelska</td><td>Offentlighet<br>Offentlig</td><td></td></tr>
<tr><td>Beställningar/ distribution</td><td colspan="4">Publikationen finns tillgänglig på internet:<br>www.ym.fi/julkaisut</td></tr>
<tr><td>Förläggare</td><td colspan="4">Miljöministeriet</td></tr>
<tr><td>Tryckeri/tryckningsort och -år</td><td colspan="4">Helsingfors 2015</td></tr>
</table>

This report presents the results from the research project *National Assessment of the Economics of Ecosystem Services in Finland (TEEB Finland) – Synthesis and Roadmap*, financed by the Finnish Ministry of the Environment. This pioneering project aimed to initiate a systematic national process for the integration of ecosystem services and related biodiversity (i.e. natural capital) into all levels of decision-making. TEEB for Finland was carried out according to the models of previous international TEEB studies (e.g. TEEB Nordic) and alongside the EU's MAES project (*Mapping and Assessment of Ecosystems and their Services*).

The results of TEEB for Finland (2013–2014) help to support the Ministry of the Environment and other national decision-makers in identifying the value and social significance of ecosystem services. The study has produced information and knowledge for the implementation of the Finnish National Biodiversity Strategy and Action Plan (NBSAP) 2013–2020 'Saving Nature for People', and for the reporting of national actions connected to the Convention of Biological Diversity's (CBD) Strategic Plan for Biodiversity 2011–2020 and the EU's Biodiversity Strategy 2020, and their obligations regarding ecosystem services and natural capital.

TOWARDS A SUSTAINABLE AND GENUINELY GREEN ECONOMY

Ympäristöministeriö
Miljöministeriet
Ministry of the Environment

**ISBN 978-952-11-4339-7 (pbk.)**
**ISBN 978-952-11-4376-2 (PDF)**
**ISSN 1238-7312 (print)**
**ISSN 1796-1637 (online)**