PTT raportteja 244
PTT Reports 244

Value of ecosystem services? Examples and experiences on forests, peatlands, agricultural lands, and freshwaters in Finland

Anna-Kaisa Kosenius
Emmi Haltia
Paula Horne
Matleena Kniivilä
Olli Saastamoinen

Helsinki 2013

Pellervon taloustutkimus

ITÄ-SUOMEN YLIOPISTO

PRO AERE AQUA TERRA
MAJ JA TOR NESSLINGIN SÄÄTIÖ

Pellervon taloustutkimus PTT
Eerikinkatu 28 A
00180 Helsinki
Puh. 09-348 8844
Faksi 09-3488 8500
Sähköposti ptt@ptt.fi

ISBN 978-952-224-143-6 (painettu)
ISBN 978-952-224-144-3 (PDF)
ISSN 1456-3215 (painettu)
ISSN 1796-4776 (PDF)

Helsinki 2013

Kosenius, A-K., Haltia, E., Horne, P., Kniivilä, M. and Saastamoinen O. 2013. Value of ecosystem services? Examples and experiences on forests, peatlands, agricultural lands, and freshwaters in Finland. PTT Reports 244. 103 p. ISBN 978-952-224-143-6 (printed), ISBN 978-952-224-144-3 (PDF), ISSN 1456-3215 (printed), ISSN 1796-4776 (PDF)
Abstract: Ecosystem services are material or immaterial benefits that produce wellbeing for the society – either in economic or non-economic terms. Forests, peatlands, agricultural lands, and inland waters alltogether provide many ecosystem services for the society. While some ecosystem services, such as wheat, timber, and peat, have a market value, other services can be enjoyed without charge, such as beautiful scenery, or they contribute to the supply of another service, such as pollination or water purification. Valuation of ecosystem services with economic methods brings up the monetary value of services free of charge. Making costs and benefits commensurable allows for the application of the cost-benefit analysis of plans and policies. Economic estimates are less reliable if the plan substantially reduces the nature's ability to respond to environmental changes (resilience) or the value depends strongly on the current state of the ecosystem. Economic valuation approach expresses the value in one monetary measure or in range, while non-economic valuation methods keep separate the ecological, socio-cultural, and economic dimensions of the value. Both economic and non-economic valuation produces information for the planning of sustainable use of natural resources by revealing the viewpoints of different stakeholders and the distribution of the benefits of the actions. Valuation helps in assessing how the forms of use of an ecosystem and changes in forms affect the gained societal benefits. The valuation studies conducted in Finland cover a large range of forest and water related ecosystem services. The studies and their results are always tied to a certain well-specified policy and the generalizability and applicability to other situations is case dependent. Usually the studies are related to only one ecosystem and one service and spatial and temporal issues are not handled. In the future, a more integrated approach to valuation would be needed, for instance, to assess one policy or plan from the viewpoint of many ecosystems. Also the coexistence of the services should be better considered. Furthermore, the simultaneous application of economic and non-economic methods to assess the same policy or plan would bring usable and comprehensive information on the related values and beneficiaries.
Keywords: *ecosystem services, valuation methods, forests, peatlands, agricultural lands, inland waters*

Kosenius, A-K., Haltia, E., Horne, P., Kniivilä, M. ja Saastamoinen O. 2013. Ekosysteemipalveluiden arvo? Esimerkkejä ja kokemuksia Suomen metsistä, soista, maatalousmaista ja sisävesistä. PTT raportteja 244. 103 s. ISBN 978-952-224-143-6 (painettu), ISBN 978-952-224-144-31 (PDF), ISSN 1456-3215 (painettu), ISSN 1796-4776 (PDF)
Tiivistelmä: Ekosysteemipalvelut ovat aineettomia ja aineellisia hyötyjä, joista ihmiset saavat hyvinvointia niin taloudellisessa kuin ei-taloudellisessa mielessä. Metsät, suot, pellot ja sisävedet tuottavat erikseen ja yhdessä lukemattomia ekosysteemipalveluita yhteiskunnalle. Osalla ekosysteemipalveluista, esimerkiksi vehnällä, tukkipuulla tai energiaturpeella, on markkinoilla määräytyvä taloudellinen arvo. Osasta ekosysteemipalveluita taas voi nauttia ilmaiseksi, esimerkiksi maisemasta tai virkistysmahdollisuuksista. Osa vaikuttaa toisen palvelun tuottamiseen, esimerkiksi pölytyspalvelu tai veden puhdistaminen. Taloustieteelliset arvottamismenetelmät tuovat ilmaisten ja itsestään selvänä pidettyjen palveluiden rahamääräisen arvon esille, jotta tietyn hankkeen tai politiikan yhteismitallisia hyötyjä ja kustannuksia voidaan tarkastella yhteiskunnallisen kustannus-hyötyanalyysin kehikossa. Rahamääräisten arvioiden luotettavuus heikkenee, jos hanke voi merkittävästi heikentää luonnon kykyä vastata muutoksiin (ns. resilienssi), tai arvo riippuu suuresti ekosysteemin nykytilasta. Pitkän ajan päästä toteutuvien vaikutusten ennustaminen ja niiden taloudellinen arvottaminen on vaikeaa. Taloudellinen arvottaminen pelkistää ekosysteemipalveluiden arvon yhteen rahasummaan tai vaihteluväliin, ja tuottaa tietoa eri ekosysteemipalveluiden arvostuksen taustalla olevista tekijöistä. Ei-taloudellinen arvottaminen taas hahmottaa ja arvottaa hankkeen ulottuvuuksia – ekologisia, sosio-kulttuurisia ja taloudellisia – ja niiden painotuksia. Ekosysteemipalveluiden arvottaminen, niin taloudellinen kuin ei-taloudellinen, tuo tietoa eri kohderyhmien näkemyksistä ja hankkeiden hyötyjen kohdentumisesta luonnonvarojen kestävän käytön suunnittelun tueksi. Suomessa on arvotettu melko kattavasti metsiin ja vesistöihin liittyviä ekosysteemipalveluita. Useimmiten tutkimuksissa arvostus liittyy johonkin tiettyyn suunnitelmaan tai politiikkaan, eikä vaikutuksia ajassa ja paikassa ole käsitelty. Arvojen yleistäminen toiseen kohteeseen on harkittava tapauskohtaisesti. Tulevaisuudessa tarvittaisiin integroidumpaa ekosysteemipalveluiden arvottamista esimerkiksi arvioimaan yhtä politiikkaa tai hanketta monien eri ekosysteemien kannalta samanaikaisesti. Myös taloudellisten ja ei-taloudellisten arvottamismenetelmien käyttö rinnakkain saman tapauksen selvittämisessä tuottaisi hyödyllisellä tavalla monipuolista tietoa.

Avainsanat: *ekosysteemipalvelut, arvottaminen, metsät, suot, pellot, sisävedet*

Esipuhe

Ekosysteemipalvelukäsite on vakiintumassa monitieteiseen tutkimuskeskusteluun ja suunnittelu- ja päätöksentekoprosesseihin. Luonnon tarjoamia hyötyjä, niiden kohdentumista, markkinattomien hyödykkeiden arvoa ja ihmisten näkemyksiä erilaisista luonnonvaroihin ja ympäristöön liittyvistä toimenpiteistä on arvioitu pitkään. Tulevaisuuden haasteena on huomioida ekosysteemien ja ekosysteemipalveluiden yhteisvaikutukset ja tuottaa sopivilla menetelmäyhdistelmillä monipuolista tietoa luonnonvaroihin liittyvän päätöksen teon tueksi.

Osana PTT:n ja Itä-Suomen yliopiston yhteishanketta kerättiin yhteen kokemuksia ja esimerkkejä erilaisista arvottamismenetelmistä sovellettuna ekosysteemipalveluiden arvottamiseen Suomen metsissä, soilla, maatalousmailla ja sisävesillä. Raportin tarkoituksena on selventää arvottamisen lähtökohtia ja huomioon otettavia seikkoja sekä esitellä esimerkinomaisesti erilaisiin tilanteisiin sovellettuja monipuolisia arvottamismenetelmiä.

Hankkeen muiden osien tuloksia on esitelty Itä-Suomen yliopiston, PTT:n ja Suomen ympäristökeskuksen julkaisusarjoissa. Tekijät haluavat kiittää Maj ja Tor Nesslingin säätiötä tutkimuksen rahoituksesta.

Helsingissä joulukuussa 2013

Pasi Holm
toimitusjohtaja
Pellervon taloustutkimus PTT

Paula Horne
tutkimusjohtaja
Pellervon taloustutkimus PTT

Tiivistelmä (Summary in Finnish)

Ekosysteemipalvelut ovat aineettomia ja aineellisia hyötyjä, joista ihmiset saavat hyvinvointia niin taloudellisessa kuin ei-taloudellisessa mielessä. Metsät, suot, pellot ja sisävedet tuottavat erikseen ja yhdessä lukemattomia ekosysteemipalveluita yhteiskunnalle. Osalla ekosysteemipalveluista, esimerkiksi vehnällä, tukkipuulla tai energiaturpeella, on markkinoilla määräytyvä taloudellinen arvo.

Osasta ekosysteemipalveluita voi nauttia ilmaiseksi, esimerkiksi maisemasta tai virkistysmahdollisuuksista, tai ne vaikuttavat toisen palvelun tuottamiseen, esimerkiksi pölytyspalvelu. Näiden palveluiden taloudellinen arvo ei näy suoraan lopputuotteiden hinnoissa. Toisaalta myöskään esimerkiksi luontoa köyhdyttävä toiminta ei näy markkinatuotteiden hinnoissa.

Taloustieteelliset menetelmät tuovat ilmaisten ja itsestään selvänä pidettyjen palveluiden rahamääräisen arvon esille. Markkinahinnattomien ekosysteemipalveluiden arvottamiseen kehitettyjä taloustieteellisiä menetelmiä on useita. Osa perustuu tietoihin todellisilta markkinoilta, osa nimenomaan kysymyksenasettelun selvittämiseksi rakennettuilta markkinoilta ja osa pyrkii hyödyntämään jo tehtyjä tutkimuksia.

Rahamääräisen arvon määrittäminen ei kuitenkaan ole itse tarkoitus, vaan väline hyötyjen ja kustannusten yhteismitallistamiseksi. Tällöin voidaan yhteiskunnallisen kustannus-hyötyanalyysin kehikossa arvioida jonkin sellaisen hankkeen kannattavuutta, jonka kustannukset tiedetään, ja suunnata toimenpiteet sinne, missä niistä saatava hyöty on suurin.

Taloudellinen lähestymistapa arvottamiseen soveltuu tyypillisesti jonkin hankkeen tai suunnitelman aiheuttamien ympäristömuutosten taloudellisen arvon määrittämiseen, ja menetelmästä riippuen muutokset voivat olla tapahtuneita tai niiden arvioidaan tapahtuvan tulevaisuudessa, jos hanke toteutuu. Taloudellisten arvojen luotettavuus kuitenkin heikkenee, jos hanke voi merkittävästi heikentää luonnon kykyä vastata muutoksiin (ns. resilienssi), tai muutoksen arvo riippuu suuresti siitä, mikä on ekosysteemin nykytila. Paitsi pitkän ajan päästä toteutuvien

vaikutusten ennustaminen, myös niiden taloudellinen arvottaminen, on vaikeaa.

Taloudelliset arvottamismenetelmät pelkistävät ekosysteemipalveluiden arvon yhteen rahasummaan tai vaihteluväliin, ja parhaassa tapauksessa tuottavat myös tietoa siitä, mitkä tekijät aiheuttavat eroja eri ekosysteemipalveluiden arvostuksessa. Ei-taloudelliset arvottamismenetelmät taas pyrkivät esimerkiksi osallistavien menetelmien kautta hahmottamaan ja arvottamaan hankkeen ulottuvuuksia – ekologisia, sosio-kulttuurisia ja taloudellisia – ja niiden painotuksia.

Ekosysteemipalveluiden arvottaminen, niin taloudellinen kuin ei-taloudellinen, tuo tietoa luonnonvarojen kestävän käytön suunnittelun tueksi. Arvottaminen paljastaa eri kohderyhmien näkemyksiä ja sitä, kenelle hyödyt tietyistä hankkeista kohdentuvat. Arvottamisesta on apua, kun arvioidaan sitä, miten ekosysteemin eri käyttömuodot (esimerkiksi soidensuojelu tai turvetuotanto) ja muutokset niissä vaikuttavat ekosysteemipalveluista saataviin yhteiskunnallisiin hyötyihin.

Suomessa on arvotettu melko kattavasti metsiin ja vesistöihin liittyviä ekosysteemipalveluita, soihin ja peltoihin liittyviä tutkimuksia taas on vähemmän. Muutama tutkimus selvittää metsien merkitystä taloudellisessa toiminnassa, mutta useimmiten tutkimuksissa arvostus liittyy johonkin tiettyyn suunnitelmaan tai politiikkaan. Siksi arvojen yleistäminen ja sopivuus toiseen kohteeseen on harkittava tapauskohtaisesti. Useimmiten on käsitelty vain yhtä ekosysteemiä ja yhtä palvelua, eikä vaikutuksia ajassa ja paikassa ole käsitelty.

Tulevaisuudessa tarvittaisiin integroidumpaa lähtökohtaa arvottamiseen, esimerkiksi arvioimaan yhtä politiikkaa tai hanketta monien eri ekosysteemien kannalta samanaikaisesti. Myös esimerkiksi taloudellisten ja ei-taloudellisten arvottamismenetelmien käyttö rinnakkain saman tapauksen selvittämisessä tuottaisi hyödyllisellä tavalla monipuolista tietoa.

Executive summary

Ecosystem services are material or immaterial benefits that produce wellbeing for the society – either in economic or non-economic terms. Forests, peatlands, agricultural lands, and inland waters alltogether provide many ecosystem services for the society. While some ecosystem services, such as wheat, timber, and peat, have a market value, other services can be enjoyed without charge, such as beautiful scenery, or they contribute to the supply of another service, for instance pollination service. The economic value of these is not directly seen. For instance the actions that deteriorate the nature are not reflected in the market price of the products.

Valuation of ecosystem services with economic methods brings up the monetary value of services free of charge. Defining the monetary value is, however, not the aim as such but rather a tool for making costs and benefits commensurable. This allows for the application of the cost-benefit analysis and the analysis of efficiency of plans, the costs of which are known. Both economic and non-economic valuation produces information for the planning of sustainable use of natural resources. Valuation reveals the viewpoints of different stakeholders, and how the benefits of the actions are distributed. Valuation helps in assessing how the forms of use of an ecosystem (such as protection of peatlands and peat production) and changes in forms affect the gained societal benefits.

Economic applications typically apply to the definition of the economics value of the changes resulting from a plan or a policy. Depending on the method, the changes have already taken place or they are expected to realize if the plan is implemented. The methods are not so well applicable to the situations where the plan substantially reduces the nature's ability to respond to environmental changes (resilience) or the value of the change depends strongly on the current state of the ecosystem. Economic approaches to ecosystem services valuation aim at commensuration of the value by expressing it in one monetary measure or in range. Instead, non-economic valuation methods keep separate the ecological, socio-cultural, and economic dimensions of the value.

The valuation studies conducted in Finland cover a large range of forest and water related ecosystem services, while the applications related to peatlands or agricultural lands are rare. The studies and their results are always tied to a certain well-specified policy and the generalizability and applicability to other situations is case dependent. Usually the studies are related to only one ecosystem and one service and spatial and temporal issues are not handled.

In the future, a more integrated approach to valuation would be needed, for instance, to assess one policy or plan from the viewpoint of many ecosystems. Also the coexistence of the services should be better considered. Furthermore, the simultaneous application of economic and non-economic methods to assess the same policy or plan would bring usable and comprehensive information on the related values and beneficiaries.

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List of valuation examples

By ecosystem (in colors), by services focused on, and by valuation method

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1. Valuation – why, how, what?

1.1 Why ecosystem service valuation is useful

Humans benefit from nature in many ways, directly and indirectly. Complex processes and chains of nature support the wellbeing of the human society in economic and non-economic sense. For instance, primary production, biodiversity, climate regulation, and habitats for species support the production of essential goods for human consumption (food, energy, raw materials), and recreational possibilities. The concept 'ecosystem service' refers to all these benefits of nature. Ecosystem services are valuable functions of ecosystems that support human living and wellbeing. (Fisher et al. 2009, Haila 2010)

The society plans projects (land and resource use, management, restoration) that impact on ecosystems and on the quality or quantity of ecosystem services. In environmental decision making, these effects can be considered with the ecosystem approach and valuation of ecosystem services. The seminal work on valuing the global biodiversity (Costanza et al. 1997)[1] was followed by the Millennium Ecosystem Assessment (MA, 2005). National ecosystem assessments with economic focus have been conducted in the United Kingdom (UK NEA 2011). The worldwide project of the economics of ecosystems and biodiversity (TEEB 2010), including the EU TEEB (Brouwer et al. 2013) and the Nordic TEEB (Kettunen et al. 2012), has contributed to the international debate on 'making nature's values visible'.

Economic and non-economic valuation of ecosystem services is one way to highlight the significance of ecosystem services for human wellbeing. Information on value are useful in sustainability analyses and programme evaluations. Economic valuation of natural resources and ecosystem services aims at an efficient allocation of finite resources when the demand exceeds the supply. No-one can be excluded from using

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[1] Among others Pearce et al. (2006, 171), however, argue that it is not sensible to speak of the 'total' value of an ecosystem neither of the total value of all ecosystem in the world.

public resources as property rights have not been defined. This may lead to unsustainable overuse and degradation of the resource. The inefficient unsustainable exploitation fails to maximise monetary value in a long term. The programme evaluation, supports decision making by providing information, in terms of the value of small (marginal) changes, on the impact of implementation of alternative policy options on the provision of ecosystem services. Different policy options can be compared and or the implementation of a specific policy proposal can be evaluated. (Bateman et al. 2011, Farley 2012)

Valuation (non-economic especially) may improve the openness of decision making, as it highlights different aspects of decision problem and reveals conflicting views. Investigating the distribution of benefits (and costs) from ecosystem services for different stakeholder groups helps to identify who support conserving or not conserving an ecosystem (practical view), and how the policies affect particular groups, e.g. poor people or indigenous people (equity view). The identification of the beneficiaries of conservation helps in designing mechanisms to capture these benefits and to idenfity potential financing sources for the ecosystem conservation. (Pagiola et al. 2004)

This report focuses on four ecosystems in Finland: forests, peatlands, agricultural lands, and freshwater ecosystems. Sections 1 and 2 describe issues to consider when assessing the value of services provided by these ecosystems. Sections 3 and 4 present the most common valuation methods with examples of research conducted on ecosystem service valuation in Finland (see Boxes), to describe the current state of ecosystem services valuation in Finland.

1.2 Frameworks for ecosystem service valuation

A relatively new concept of 'ecosystem services' has been subject to redefinition and reclassification, in order to become better applicable for research and practical purposes. The appropriateness of a specific classification depends on the characteristics of ecosystem and ecosystem services in question, and on the decision-making context. (Wallace 2007, Fisher et al. 2009) The Millennium Ecosystem Assessment (MA 2005) presents a complex network of services in which the services interact, and divides ecosystem services in four categories: over-arching supporting services, regulating services, provisioning services, and cultural services.

Other frameworks base on the idea of a chain (rather than network) from ecosystem functions to human wellbeing (see figure 1). The national ecosystem assessment in the United Kingdom (UKNEA) bases on the framework dividing ecosystem services into intermediate and final services. The former contribute to the production of the latter. Final services are available for the society's utilization. Despite the name, the final services are not the end of the chain, as the production of material and non-material goods requires the addition of other capital inputs, such as human labour, to final services. (UK NEA 2011)

The material and non-material goods provide human welfare and have a certain economic value, health value or a shared social value. Shared social values, e.g., for the spiritual value of the environment that is not directly observable, cannot be captured by economic methods. The idea of intermediate and final services is applicable also to the assessment of the role of biodiversity in ecosystem service production. (UK NEA 2011, Mace et al. 2012)

Another classification scheme based on the idea of the chain the so-called cascade model (de Groot et al. 2010). Ecosystem functions reflect the capacity of ecosystems to produce services that humans may utilize. For instance in forest ecosystem, the production of biomass is a function which needs various biological processes. When humans utilize the biomass, it transforms into a service. (de Groot et al. 2010, Kniivilä et al. 2011, Haines-Young & Potschin 2012, Saastamoinen et al. 2013a)

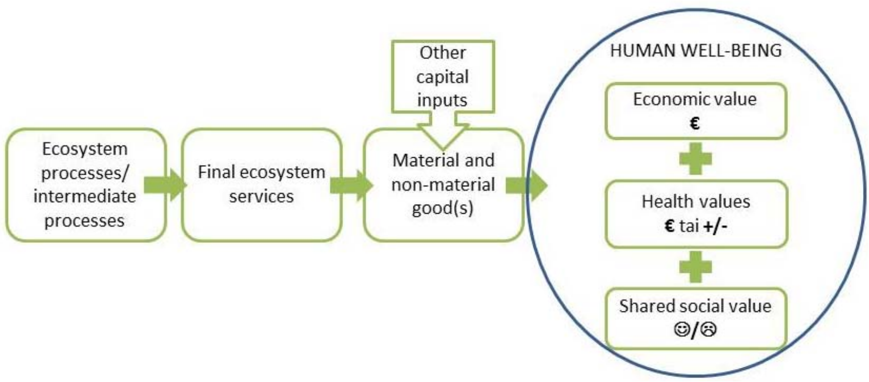

***Figure 1**. Ecosystem-based goods provide human welfare in terms of economic value, health value and shared social value (UK NEA 2011).*

While the idea of the chain is generally accepted, the classification in the cascade-model is not detailed enough for some purposes. Economic valuation, for instance, requires the classification that corresponds to the descriptions used in economics. From the valuation viewpoint, the distinction between intermediate services, final services, and the resulting benefits is essential. Moreover, a 'good' and a 'benefit' should be sharply distincted. Final ecosystem services and other capital inputs (incl. human capital) create goods, and from these goods, the humans draw benefits. The amount of the benefit from a good depends highly on the context and the way and the time the good is used. (Fisher and Turner 2008, Bateman et al. 2011)

Figure 2 presents the framework in this report. It follows the idea of dividing ecosystem processes and services into intermediate and final services (de Groot et al. 2010, Bateman et al. 2011) as well as the classification to supporting, regulating, provisioning and cultural services (MA 2003, UK NEA 2011). Our framework is different from the cascade-model in terms of the terminology and the definition of ecosystem services. The processes, functions, and biophysical structures of the cascade-model are called ecosystem services in our framework. (see Haltia et al. 2013)

Supporting services and a part of regulating services (e.g. regulation of local climate, pollination) are intermediate services. In some circumstances, certain regulation services can also be final ecosystem services (e.g. pollination). With human input, these final services become goods that contribute to health, safety, or economic benefit, and have an economic (or other) value.

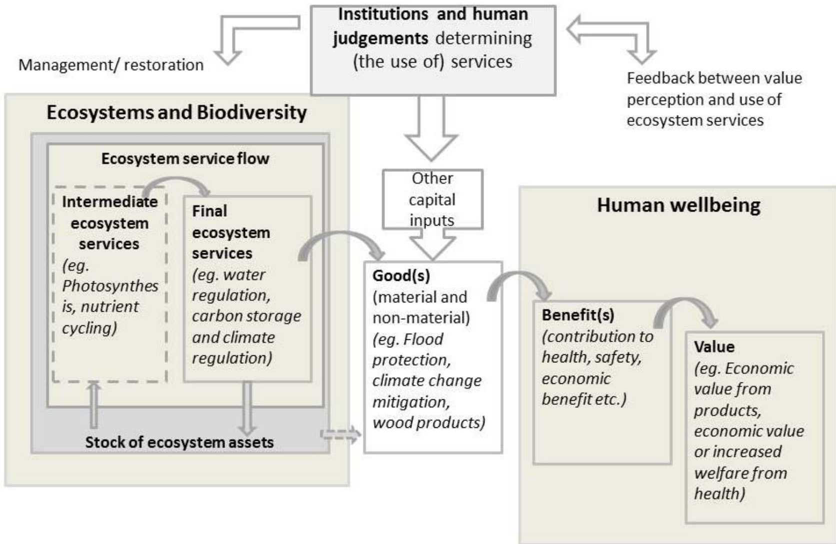

***Figure 2**. Adapted version of the cascade model (Source: Haltia et al. 2013, adapted from de Groot et al. 2010 and UK NEA 2011).*

1.3 Stocks, flows, changes in flows – what to value?

The healthy stock of ecosystem assets is a basic requirement for intermediate ecosystem services which in turn contribute to the provision of final ecosystem services. In other words, the stock of ecosystem asset produces the flows of services from which humans benefit. The idea of stock and flows is linked to sustainable use and management of ecosystems. A share of the flow of ecosystem services is used to increase human welfare. The share not used by humans or not acting as an input in some other ecosystem process will add to the stock of ecosystem assets. However, if the use of ecosystem service exceeds the flow of the service produced, the stock of the assets declines, and in the long run, the sustainable use of service is threatened. In figure 2, a dash line arrow from the stock of ecosystem assets to ecosystem goods indicates this unsustainable use of the stock of ecosystem assets. (Bateman et al. 2011)

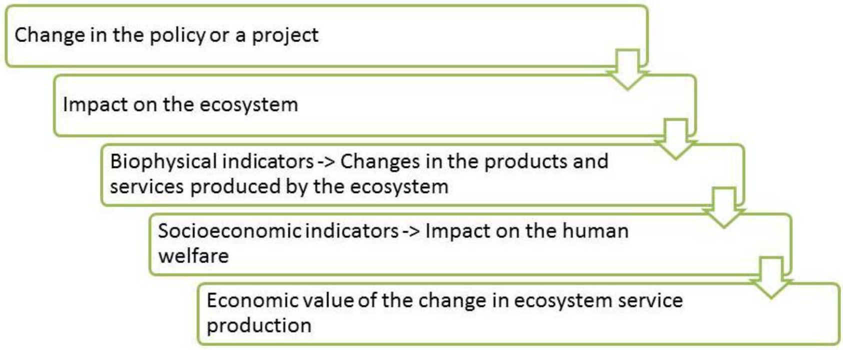

Figure 3. *Valuation of the change in ecosystem services production. (Adapted from DEFRA 2007)*

Most of ecosystem service valuation focuses on the flow of intermediate or final ecosystem services. The flow is the practical measure for many policy analyses and it also fits into ideas of environmental accounting (see, e.g. Boyd and Banzhaf 2007). The valuation of *total flow of benefits* from, e.g. Finnish forest ecosystems, defines how much forests contribute to economic activity (e.g. Matero and Saastamoinen 2007, Lähtinen 2010). Another typical valuation case is the estimation of net benefits of a policy or a project that alters ecosystem conditions. The analysis provides an economic value of a *change in the flow* of ecosystem service (see the last box in figure 3). This information serves the comparison of costs and benefits of the planned policy or project and for the judgement of the decision on its implementation.

An extensive evaluation of all ecosystem services is not always possible or even useful. The assessment of relative differences in impacts of alternative projects on the provision of ecosystem services will serve additional information, sometimes even with a limited scientific data. In many practical applications, a rigorous assessment of the changes in the value of ecosystem services resulting from alternative management schemes can be produced, in addition to the definition of key uncertainties and the assessment of their significance for the results. (Defra 2007)

Whenever possible, the valuation of ecosystem services in monetary terms is preferred, to allow for the measurement of (changes in) services in common units. If monetary valuation is out of question, the next-best option is the quantitative description of changes, followed by the qualitative description of impacts. For example, the National Ecosystem service Assessment in the United Kingdom (UK NEA) aimed at estimating the impact of alternative measures or future visions on the value of ecosystem services. They approached the supply of each ecosystem service by assessing the marginal value in monetary terms (whenever possible). The impacts of alternative measures and future visions on the production of ecosystem services were first evaluated as accurately as possible in natural science research. Then the supply of ecosystem services in these scenarios were compared to the ecosystem services in the base situation, and the difference was multiplied with the marginal value of the service. (Defra 2007, UK NEA 2011)

1.4 Services provided by selected ecosystems

Forest ecosystems provide multiple ecosystem services simultaneously. Following the framework that divides services into intermediate and final services, table 1 presents the examples of the chain from intermediate ecosystem services to material and non-material goods. The intermediate services (supporting services and some regulating services), such as photosynthesis, nutrient cycling, water cycling, and pollination, produce the final services (some regulating services and provisioning and cultural services), such as timber production, clean water, habitats for wild life, environment for outdoor recreation, water purification, noise regulation, pollination, and carbon sequestration. These final services with capital inputs (see figures 1 and 2) create material and non-material goods (logs, game, drinking water, recreation, arts). Humans draw benefits from these goods. However, unlike forests themselves, some forestry operations such as logging and soil scarification may have adverse influences on water quality, for example (e.g. Saastamoinen et al. 2013b).

Table 1. *Examples of the intermediate and final ecosystem services and ecosystem goods of the Finnish forests (Haltia et al. 2013, adapted from UK NEA 2011)*

Intermediate services
Supporting services
Photosynthesis
Nutrient cycling
Carbon cycling
Water cycling
Soil formation
Evolution processes
Regulating services (as intermediate services and processes)
Decomposition of hazardous materials
Regulation of climate
Pollination
Disease control
Pest control

Final services	**Examples of material and non-material goods**
Provisioning services	
Timber	Logs
Bioenergy	Wood chips
Production of berries, mushrooms, and other collectable products	Berries, mushrooms, cones, sap
Habitat for game species	Game
Clean water	Drinking water
Cultural services	
Scenery, environment for outdoor recreation	Recreation
Material for teaching and education	Teaching and education
Arts	National sceneries in visual arts
Regulating services (as final services)	
Carbon sequestration and regulation of global climate	Climate change prevention, smooth climate
Water purification and air for respiration	Drinking water
Regulation for floods, storm damages and erosion	Erosion prevention
Noise regulation	Noise prevention
Pollination	Honey
Regulation of diseases and pests	Disease prevention
	Pest prevention

Marshlands and peatlands provide many services (a bundle of services). The combination of services (the content of the bundle) depends highly on the land use (natural or semi-natural peatland, drained forestryland, conversed agricultural land or peat production area). While the different uses of marshland result in different bundles of services, many services remain the same but in altogether different proportions. Natural peatland and mire ecosystems provide supporting and regulation services, and without or with some management (by building and maintaining recreational infrastructure such as causeways made from halved logs or campfire places), provide recreational services and natural open landscapes. In protected natural peatlands the use of many provisioning services is hindered. Peatland conversed to forestland represents seminatural ecosystem and allows for harvesting timber and alongside, provides game, and berries (but less of those thriving best on natural peatland, e.g., cloudberry), thus nevertheless offering jointly market and non-market goods (logs, recreation, fresh air, flood prevention). The functioning of regulation services and the supply of recreational services is in many cases disminished or altered. Peat production areas provide mainly market-priced provisioning services but also educational and scientific services and severely reduced level of regulating services. The changes of land use in marshland are typically irreversible in short or medium term. (Saastamoinen et al. 2013a, Horne et al. 2013, Tolvanen and Juutinen 2013)

Agricultural land is a man-made ecosystem, and the most significant human benefit comes from provisioning services. Nutrition (e.g., livestock and dairy animals, crops, vegetables) along with materials (e.g., fibre, fertilizer, genetic resources) and energy (biomass and gas) form the basis of the bundle of ecosystem services provided by agricultural ecosystems. The choice of crops or animal stock produced on agricultural land impacts a great deal the bundle of ecosystem services. The production of market commodities is often subsidized by the government, and processes are highly influenced by human management. In addition to market commodities, agroecosystems to some extent regulate and influence the bio-physical, physico-chemical, and biotic environment (e.g., water purification, local and regional climate regulation, seed dispersal) and support flow regulation with vegetative covers, border strips, meadowlands, and pastures. The latter small areas also maintain biodiversity. However, nutrient flows from fields to rivers and lakes form an important adverse influence. Symbolic cultural ecosystem services are jointly produced with provisioning and regulation services. For instance, the same parcels may provide national or provincial landscape values, iconic and traditional animal species along with food, habitats, and climate regulation services. Typically the choice of land use (crops, fallow, grazing) is done in very short time spans, often annually. (Arovuori and Saastamoinen 2013)

Freshwater ecosystems are in close connection to natural and man-made terrestrial ecosystems. Boreal region has a high abundance of freshwaters, but the quality of freshwaters is decreased due to antropoghenic pressures. For instance, recreational possibilities are decreased due to low water quality (besides agriculture and forestry, even more by industries and communities), and the nutrient cycling service may be distorted due to these anthropogenic nutrient loading. Man-made water regulation of lakes and rivers for hydro-energy and flood manamegent purposes also reduce the other aquatic ecosystem services of many inland waters. The provisioning services provided by fresh water ecosystems are, e.g., fish and clean water (surface water and groundwater). Examples of regulating services are water purification and natural hazard regulation. Freshwaters have much cultural value. Cultural services are addressed by nature-based tourism, related to trekking, fishing and hunting. In inland waters recreational fishing is more important than the professional one. The educational services of water ecosystems are provided by national parks and other designated areas with fresh water as the basis of the landscape, where information centres and nature trails near lakeshores inform the public about nature. (Alahuhta et al. 2013)

2 What to consider when valuing ecosystem services

A successful valuation requires not only the proper identification and classification of ecosystem services but also tools to monitor the total flow or the changes in the flow of services with suitable indicators (2.1), the definition of the space and time considered (2.2), the assessment of uncertainties and their effect on the results (2.3), and the decision of value types to be addressed (2.4).

2.1 Indicators – measure of the quantity of services

The valuation of ecosystem services needs support from the natural sciences. The bio-physical indicators of the services provided must be identified and measured. Also monitoring sustainable use of services and the impacts of policy implementations on services require information (measured or otherwise reliable). Information systematically collected and organized for management and policy purposes is usually called as indicators. Indicator data also often contributes to the understanding of the value of services and their trade-off relationships. (Helin et al. 2010, Kniivilä et al. 2013)

Ecosystem services differ in terms of the length of measurement history. For instance, benefits from some provisioning services and the state of the ecosystem have been measured for decades, even for centuries. But still for many services, the data is lacking or is only point data, thus not enabling the assessment of the direction of the development. (Kniivilä et al. 2013)

Extensive evaluation and measurement of ecosystem services with indicators is currently under development at global scale. As reported by World Resource Institute about the Millennium Ecosystem Assessment, the current indicators do not provide information extensive enough for decision-making. The data availability may also be a problem. Many of the currently used indicators fail to measure e.g. the essential aspect of ecosystem services: the impact on human wellbeing. (Layke 2009)

In Finland, as compared globally, plenty of information and measurements are available on several indicators, but they do not necessarily directly fit into the ecosystem services concept and thinking. As described in section 1.2, at global scale several frameworks have been developed during the last few years to illustrate and describe the concept of ecosystem services. These frameworks can be used when assessing what kind of indicators are needed. When defining indicators the classification developed in CICES (Common International Classification of Ecosystem Services) is useful as it divides ecosystem services to concrete and at least to some extent measurable categories.

In Finland, plenty of data are available on all selected ecosystems: forests, peatlands, agricultural lands, and fresh waters. The availability varies with service categories. In general, provisioning services are measured and monitored most closely. However, there are differences in data availability also between provisioning services and more data are available on those provisioning services with the highest easily measurable economic benefit. Among cultural services, quite a lot of data are available, in particular related to recreational services of forests and waters (Sievänen 2001, Sievänen and Neuvonen 2011). Among regulating and supporting services, less directly generalizable data are available, although the results of some individual studies support e.g. the assessment of the state of ecosystem services. The difficulty of measurement is the most important reason for minor amount of data, followed by the fact that benefits from these ecosystem services provide are of indirect nature. Also the relative abundance of regulating services in Finland with few seemingly drastic changes in their flow has not urged the need for data collection. A good example of the need transformed into action is the development of highly sophisticated quantification of carbon stocks and flows after the rise of climate change concerns. For a balanced and comprehensive assessment of ecosystem services, data on all main categories are needed. (Kniivilä et al. 2013)

2.2 Services and benefits - where and when?

Ecosystems have transboundary effects. To mention a few examples: the forest ecosystems contribute to the production of hydro energy but drainage of peatlands for forestry purposes may have adverse impact on the same; agricultural landscape, when managed multifunctionally, provides water protection services, genetic resources, and biodiversity; and peatland ecosystems support the provision of clean drinking water. Ecosystems may also provide disservices for another ecosystem. In a man-made agroecosystem, the annual production of market commodities (food, fiber, bioenergy) may cause loss of biodiversity or wildlife habitat. Nutrient loading from forests, peatlands, and agroecosystems may reduce the quality of water, thus limiting the provision of water recreation services. (Matero and Saastamoinen 2007, Saastamoinen et al. 2013a).

Production of ecosystem services differ in space. The production of one service needs a larger area than the production of another service. The area of beneficiaries for whom the services are relevant varies as well. Moose hunting and berry picking are examples of local services. The value of water purification (a regulating service provided by many ecosystems) is worth assessing at catchment level, while the value of oxygen production at national or global level. Similarly, the sequestration of nitrogen is of regional interest, while the benefits of the greenhouse gas sequestration are enjoyed globally. (Fu et al. 2011, Jenkins et al. 2010)

For some services, the value of service depends negatively on the distance of beneficiaries from the location where the service is provided. This 'distance decay' effect relates to both use and non-use values. The distance decay is important when aggregating the benefit estimates and determining relevant beneficiaries. (Hanley et al. 2003, Bateman et al. 2006)

The benefits from ecosystem services can be enjoyed either on-site or off-site relative to the location of provision. The benefits from reduced water pollution are produced by limnological services in water ecosystem (on-site) and vegetation in forests, peatlands and agricultural lands in the catchment (off-site). Forest ecosystems upstream produce clean drinking water to be utilized downstream. The transformation of land use in one ecosystem may impact negatively on the supply of ecosystem services by near-by ecosystems. People living downstream experience a negative externality if a stream is polluted due to the upstream production of timber, peat, or crop. (Fisher et al. 2009, Barton et al. 2012, Fu et al. 2011)

Ecosystems allow for parallel forms of land use. Forests are typically under multiple use, providing many benefits at the same time for different stakeholders. But in particular in the areas marginal for wood protection the 'optimal' combination require the minimization of wood production (Saastamoinen 1982). In commercial forests, the question is more about the intensity of forest management and the choice of management regimes. Also there, less intensive forest management practices create different recreational and usually more environmental values than more intensive management (e.g. Horne et al. 2005, Tyrväinen et al. 2013, Kosenius et al. 2013). However, the more intensive management produced more timber which can be converted through markets into other goods and services essential for human wellbeing such as schools, health care and governance. In the case of peatlands, one form of land use typically prevents the other form of land use, and drastically changes the related benefits for the society (Tolvanen et al. 2013). The same applies for freshwater ecosystems (Alahuhta et al. 2013). Agricultural land is mainly used for food and fibre production, but it may also contribute to the provision of supporting and regulating services (pollination, soil formation, genetic resources, cultural heritage, scenery, and environment for outdoor recreation (Grammatikopoulou et al. 2012, Arovuori and Saastamoinen 2013).

The time needed for the provision of services varies. Some services are provided continuously (e.g. fish, scenery, educational and scientific services, climate control, carbon sequestration), and others are provided during a certain period (e.g. agricultural food crops, peat). The time frame of production differs greatly even within a service category, provisioning services as an example. Peat as energy source regenerates in thousands of years, timber can be harvested at several decades' intervals, and berries and mushrooms picked annually. The time frame also depends on the scale: a large forest with many plots of different age can provide an annual flow of timber, but each plot would be harvested only at several decades' intervals.

The relative importance of benefits from ecosystem services for the society have changed since the past centuries, both within an ecosystem and between ecosystems. Earlier, inland waters were important in the transportation of logs to the mills and as the energy source for the small industries. Ecosystems have been transferred from peatland to forests or agricultural lands, and from agricultural lands to forests. (Fu et al. 2011, Alahuhta et al. 2013, Saastamoinen et al. 2013a)

2.3 Valuing biodiversity as insurance for future

Biodiversity and its ability to support ecosystem processes is crucial for the resilience capacity of ecosystem. Resilience means the ecosystem's ability to recover from difficult situations and external shocks. If the state of ecosystem is close to a certain threshold, even a small change in the state may result in non-marginal and irreversible changes. This reduces the ecosystem's capacity to generate economic value. The resilience secures the provision of ecosystem services and the generation of benefits in the future. (Walker et al. 2004)

The challenge in valuing biodiversity or resilience, especially, are the ways to handle shocks and uncertainties that might impact the provision of services and reduce the reliability of the associated valuation results. (Daily et al. 2011) The value of biodiversity as an intermediate services is reflected in the value of many final services, but it has also been directly valued with different approaches.

Traditionally the economic valuation of changes in biodiversity has assessed the value of individual species, species diversity, ecosystem functioning or the quality of habitats. The Finnish examples are protection of forests species to establishment of protection areas (Lehtonen et al. 2003, Horne et al. 2009, see also Pouta & Rekola 2004), and the quality of river habitats (Lehtoranta et al. 2012). The studies assess the marginal (small) changes caused by policy investments or other decisions that impact on biodiversity.

Another example for valuing resilience is to assess directly the society's valuation for the ecosystem remaining in its current sustainable state. This demands quantitative measures for how likely the ecosystem shifts from one stable state to another, or, how likely the ecosystem remains in its current stable state. An Australian study focused on the increase in the probability of an ecosystem remaining in its current stable state, the length of this period of increased probability, the reversibility of an ecosystem shift, and an area over which there is an increased probability that the ecosystem remains in its current stable state. Maintaining ecosystem resilience generated positive economic values for the society, and the valuation results allow for the assessment of benefits of policy investments that improve the resilience of the ecosystem. (Walker et al. 2004, Scheufele & Bennett 2012) In the global level, the economic analysis shows that the stated valuations for biodiversity conservation are much higher than actual expenditures to protect biodiversity (the stock of natural capital). (Pearce 2007)

The usability of economic estimates together with ecological information in conservation decisions depends on how far from the ecological threshold the natural capital stock is. Economic estimates for ecosystem services reflect the value of one additional unit of the natural capital stock (marginal value). When natural capital stocks are healthy and resilient (far from the ecological threshold), the marginal use has no essential effect on the sustainability of the resource, and the marginal values are insensitive to small changes in stocks. In this case the valuation results facilitate the allocation between different land uses, e.g., conservation of peatlands or conversion to peat production areas. (Farley 2012, 2008)

The importance of marginal use of the stock (and the sensitiveness of values to small changes) increases when natural capital stocks become less resilient. When approaching the threshold level, the needs of conservation determine the area available for conversion to peat production. When passed beyond the ecological threshold, the ecosystem cannot recover from further degradation without restoration. Infinite marginal value estimates are not appropriate information for the decisions about the land use. As ecosystems are in close interaction with adjacent ecosystems, considering the ecological thresholds, the joint effect of several forms of land use or natural resources must be considered, as the joint effect may exceed the limit that the ecosystem and the production of ecosystem services sustains. (Farley 2012, 2008)

2.4 Valuation addresses use and non-use aspects

The interpretation of any valuation estimates, especially monetary estimates, involves the perception of which value types are addressed and which not. Economic valuation of ecosystem services bases on the concept of total economic value (TEV). This does not refer to the assessment of the total current value of the provision of ecosystem service, but reflects the idea of accounting for multiple aspects of ecosystem services.

In economic valuation framework, all values of ecosystem are defined from *anthropocentric perspective*. By definition, the intrinsic value of nature, independent of humans, is beyond the scope of the economic analysis. Being an ethical and philosophic concept, it cannot be compared to any other value systems, especially to monetary systems. As economic valuation methods differ in terms of the ability to assess different aspects, the assessment of the ecosystem in terms of categories of the total economic value helps in choosing the appropriate method, perceiving the total picture and interpreting the valuation results.

The total economic value divides in two main categories and five subcategories (figure 4). The total economic value of a peatland area consists of the economic values of the *ecosystem services provided by the area simultaneously* (joint production). A person visiting a peatland area may benefit in different ways: a hunting trip to a peatland may produce, in addition to game and cranberries for consumption, a refreshed mind and a fantastic photograph. The total economic value of a peatland is the net value of different forms of land use: value components of the protected part that is in natural condition and of the part that is actively used. The services provided by the peatland ecosystem and their predominance depends on the co-production combinations. For instance, some forms of land use (the protection of peatland) may rule out other forms of land use (peat production). An early application of the total monetary value of forests in Finland was based on the matrix of value categories and forest uses: direct use value was divided into commercial and household use, and 'damage value' to other (eco)systems was included, but there was no estimate for option value, for example (Saastamoinen 1997).

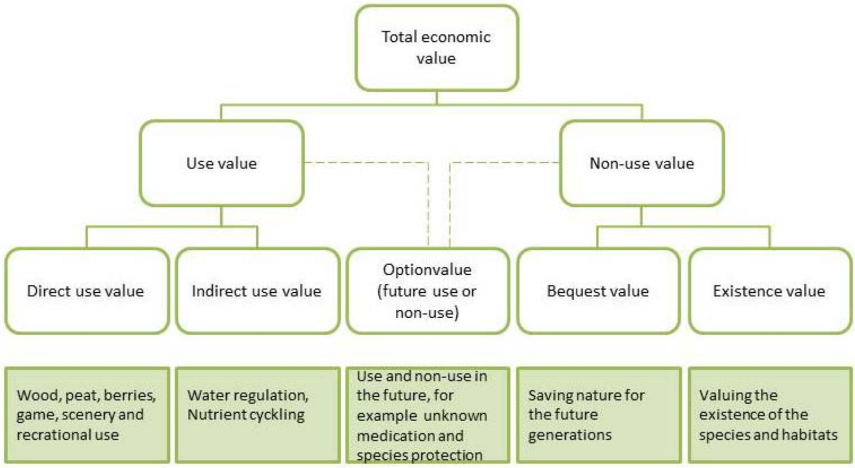

Figure 4. *Components of the total economic value (TEV), peatland as an example (adapted from Hein et al. 2006, Pascual et al. 2010).*

The *use value* provides benefit instantly. The nature of use value can be either direct (typically from provisioning and cultural services) or indirect (typically from supporting and regulating services). Humans consume and benefit from timber, peat, berries, and game, and non-consumptive use values are addressed by recreation and arts. Humans benefit indirectly from, e.g., nutrient cycling, that is invisible but necessary for timber production.

The option value measures the valuation of the future benefits. Basically, there is no ecosystem service into which an option value cannot be linked to. For instance, an option to use a specific area for recreation in the future can be valuable for the society viewpoint, but also those ecosystem services that we do not yet know whether they are important for future generations. It has been argued that even when the ecosystem does not currently generate use or non-use value, it may have significant option value that should be taken into account (Pascual et al. 2010).

The non-use value is divided in two categories. The existence value of an ecosystem service means that humans benefit from the knowledge of the existence of ecosystem service, such as a valuable habitat or a charismatic species. For instance, in the 1950s' the whooper swan (*Cygnus Cygnus*) in Finland was rare but when the danger of extinction was widely communicated, people did value the fact that these rare animals do live in the country. The bequest value is an umbrella category that encompasses all other value categories as it refers to the benefits for future generations.

Commonly people want that the ecosystem services they value remain for the enjoyment of the next generations.

The strong and dynamic interrelationship between man and nature challenges the economic valuation methods. The psycho-cultural view emphasises the need for interdiciplinarity and methodological pluralism. The existence value refers to the value that humans receive from knowing that species or habitats exist. It is not equivalent to the intrinsic value of nature. Economics does not aim at valuing the intrinsic value of nature in monetary terms. In thissense the anthropocentric perspective limits the economic approach. (Kumar and Kumar 2008)

3 Economic valuation – measuring in common units

Economic valuation methods measures the benefits in terms of the change in society's welfare, reflected in the concept 'consumer's surplus'. Methods apply to evaluating small (marginal) changes in the consumption of ecosystem services and the related economic benefits. As alternative economic valuation methods enable addressing different aspects of value, the applicability of a certain method depends on the type of ecosystem service and on value types involved (use or non-use values). (Champ et al. 2003)

Real market data can be utilized directly (3.1) or indirectly (3.2) to value e.g. food and recreational activities, services traded at certain market prices and actually used by citizens. The methods based on constructed markets (3.3) apply for services not traded in markets and associated with abstract issues such as knowledge on the existence of species or an option for future generations to enjoy the goods and services. When a reasonable amount of valuation studies is available and resources (time or money) are limited, the benefits estimated elsewhere can be transferred and adjusted to new situations (3.4). (de Groot et al. 2002; Champ et al. 2003)

3.1 Using market prices and costs

Market prices are easily definable for, e.g., crop, timber, peat, or cloudberry picked for sale. The trade-off of good data availability is that the market price of a commodity only exceptionally reflects the value of ecosystem service. The value of other capital inputs needed for the production of the commodity and the effects of taxation or subsidies on the commodity price must be considered, as well as whether the market is perfect. (Freeman 2003) Also, the price of e.g. beef does not reflect its maximum value to all customers, only the amount balancing the market of supply and demand.

As market prices cannot reveal more abstract aspects, they can be used to define the lower bound estimates for the total economic value. For instance, when using the opportunity cost approach, the value of protected peatland associated to existence values is at the minimum similar to its value in an alternative use, such as forestry or peat production.

The *cost-based methods* are lower bound approximations of the value of environmental benefits when no other data are available. For instance, the costs of biodiversity protection can be used as an estimate of the value of forest biodiversity (Box 1).

The *production-function based methods* are applicable when one ecosystem service is a direct production factor in the production process of another service. The idea is to separate the value of the input of a specified ecosystem service from the value of other inputs used in the production of a good. The models are used to forecast the local provision of ecosystem services, based on land, land use, ecosystem characteristics, and demand for services. The effects can be assessed through producer and consumer surpluses. (Freeman 2003, Kareiva et al. 2011) For instance, in the production function of honey or fruits, biodiversity or pollination are included similarly to other production factors, such as labor, capital, fertilizers, plant protection products (Box 2).

Box 1. Valuing forest biodiversity with cost-based method

Forest Ecosystem – Biodiversity – Costs of provision
Artti Juutinen (Finnish Forest Research Institute) and Mikko Mönkkönen (University of Jyväskylä)

Biodiversity is an important part of ecosystem service provision. However, placing a monetary value to biodiversity is challenging. For example, stated preference methods that directly ask about individuals' valuation, may not provide a sound valuation of biodiversity due to individuals' poor understanding and little experience.

By considering the costs of provision, a rough value estimate for biodiversity can be obtained. The sum reflects the society's willing to pay for biodiversity conservation. For example, to halt further species endangerment, the Finnish government has used a total of 182 M€ for additional conservation efforts in privately owned forests in southern Finland through METSO II program during 2008-2012. This makes approximately 36 M€ per year. The annual sum is about 3–4 % of the total annual operating profit from privately owned forests in Finland in 2010. This cost of provision approach also runs a risk of being based on poor understanding and limited knowledge on the true value of biodiversity.

Despite the difficulties in monetary valuation of biodiversity, an economic analysis provides important information for decision-making. It can be used to identify cost-effective approaches to ensure the maintenance or the provision of ecologically sustainable level of biodiversity. Policy making requires future-oriented assessment through analyses and comparisons of management alternatives and their potential benefits. Information on benefits in terms of maintaining biodiversity and providing goods and services for the society are important for land managers and ecologists to develop land management plans that would ensure social, economic, and ecological sustainability.

Our study aimed to identify cost-effective approaches to provide biodiversity services in forests using multi-objective optimization tools and the data from a boreal forest landscapes consisting of 30 000 forests stands simulated 50 years into the future with seven alternative management regimes. We analyzed the conflicts between habitat provision for a selected set of species or species groups and timber production across a large boreal forest landscape. We investigated the potential of the landscape to simultaneously produce economic benefits and habitats for different species/species groups, the variation of the conflict between habitat provision and timber production among different species/species groups, and searched for an optimal combination of management options that would maximize the habitat provision for given levels of economic returns, or vice versa.

Our results demonstrate that, with landscape level forest management planning, it is possible to achieve large improvements in habitat availability for species groups at relatively low cost. However, the actions needed to achieve these benefits vary among species groups, and no management regime alone maximizes the habitat availability for the species. Systematic use of any single management regime results in considerable reductions in economic returns. Refraining from thinnings on a proportion of stands should be considered as a cost-effective management in commercial forests to reconcile the conflict between economic returns and habitat availability particularly for species associated with dead-wood. In general, a viable strategy would be to diversify management regimes.

Mönkkönen, M., Juutinen, A., Mazziotta, A., Miettinen, K., Podkopaev, D., Reunanen, P., Salminen, H., Tikkanen, O.-P. 2013. Spatially dynamic forest management to sustain biodiversity and economic returns. Manuscript.

Box 2.Value of regulating services in agricultural production

Agricultural land – Regulation services – Production function method
Perttu Pyykkönen (Pellervo Economic Research)

Several Finnish and international studies have estimated the value of regulation services in agricultural production, taking pollination and pest control as examples. Regulation services are probably one of the most extensively studied agro-ecosystem services. Agricultural biodiversity is directly linked to these regulation services. Biodiversity is important to pollinators' well-being and thus, to the honey production as well as to insect-pollinated crops (e.g. fruits, berries, many of the protein crops). Biodiversity can have impact on increase of some harmful insects. Furthermore, agricultural biodiversity as such produces cultural services (see Box 10).

Taking the first step in the production function approach to the ecosystem service valuation, Miettinen et al. (2012) examined the impact of different land management practices on the amount of bumble bees in Finland. They compared the cost-effectiveness of different biodiversity measures in the arable land and in the forest bordering the arable land. Next, the economic value of pollination could be assessed to allow for the estimation of the costs and benefits of different policy measures aimed to increase biodiversity.

The valuation of the pollination depends on the scope (local, national, global) and on the time perspective. In the short run, the value of the pollination may be substantially higher than in the long run, since producers would adapt to the changing situation (for example, changing the plant species or by replacing the natural pollination by commercial pollination). Furthermore, the price relationships, substitution/competition relations of different plants play an important role. Thus, valuing the pollination service at aggregate level is very challenging. The value of pollination services at global level varies between $ 117-200 billion, depending on the study. (Hein 2009)

Biodiversity is an indirect regulation service, that is, a bio control service, contributing to the production of many crops. Swinton and Zhang (2005) presented a production function method to valuate these processes or intermediate services. Landis et al. (2008) examined the effect of reduction in the biodiversity on soybean production in the U.S. The biodiversity decreased with an increase in the maize (ethanol) production, and correspondingly, soybean area decreased due to the changing price ratios. At the same time, however, populations of lady beetle (natural enemy of a major soybean pest) decreased. Thus, as a result of the decrease in the biodiversity the soybean producers experienced losses. Researchers built a production function model that allowed them to calculate the value of the bio control service provided by biodiversity to be $ 239 million (total in four states: Iowa, Michigan, Minnesota, Wisconsin) per year over at 2007/2008 price level.

Hein, L. 2009. The Economic Value of the Pollination Service, a Review Across Scales. The Open Ecology Journal, 2009, 2, 74-82

Landis, D. A., Gardiner, M. M., van der Werf, W. & S.M. Swinton. 2008. Increasing corn for biofuel production reduces biocontrol services in agricultural landscapes. Proceedings of the National Academy of Science of U S A.

Miettinen, A., Alanen E.-L., Hyytiäinen, K. & Kuussaari, M. 2012. Peltoluonnon monimuotoisuutta edistävät toimenpiteet edullisuusjärjestykseen. Maataloustieteen päivät.

Swinton, S. M. & Zhang, W. 2005. Rethinking Ecosystem Services from an Intermediate Product Perspective. Selected paper. AAEA annual meeting.

3.2 Using market data to value use aspects

The methods based on observed market behavior utilize market data available on sale prices of houses (hedonic pricing method) or information on money and time spent for travelling to visit a recreational area (travel cost method). These methods are applicable to the assessment of use-related values and thus to a limited set of ecosystem services. The availability of the data is critical to the success of valuation. (Champ et al. 2003)

The idea of *the hedonic pricing* is to distinguish the impact of non-market benefits (value of ecosystem services) on the price formation of the property. The researcher builds a statistical model that explains the effect of different aspects on price, thus revealing the value of the ecosystem service or environmental quality. For instance, the forest scenery from the window and the proximity of urban forests rises the apartment prices (Tyrväinen and Miettinen 2000). Similarly, the quality of fresh water and the related ability to provide recreational services is reflected in summer house prices (Box 3), while the availability of nutrients recycled from manure is reflected in agricultural land prices (Box 4).

Box 3. Hedonic property pricing method in water quality

Water ecosystem – Recreation – Hedonic pricing
Janne Artell (MTT Agrifood Research Finland)

Water recreation is an important ecosystem service that provides direct use values. Typically water recreation could be valued using the travel cost method, but the method overlooks values capitalized into property prices near water recreation sites. Summer houses are typically associated with water recreation in Finland; some 18 % of short water recreation trips originate from a summer house, and 85 % of the summer house stock resides within 100 meters from water. Thus they provide an excellent case study on the value of price-capitalization of water quality.

This case study used sales registry data of over 1 800 undeveloped summer house lots purchased in 2004 to determine if there was demand for water quality, and therefore an attributed value. As the hedonic pricing method is data dependent, the undeveloped lots provided a good source of information with relatively few gaps in information. The sales data from the National Land Survey of Finland included lot-specific information on the type of adjacent water body, location, planning status, and the type of land cover. Water quality data was appended to the data from the water usability index upheld by the Finnish Environment Institute. Further GIS work provided data on congestion in the area.

The water usability index was chosen to represent water quality as it focuses on use-related issues. The index describes water usability in five steps with descriptions on the quality and the potential for recreational activities. Such a commensurate quality index was also important as the sales data included sales on the coast of the Baltic Sea, inland lakes, and rivers. A simpler quality indicator, such as water clarity, would have been more dependent on the type of adjacent water body in the analysis. Figure B3-1 shows the water usability index and location of the sales used in this case study.

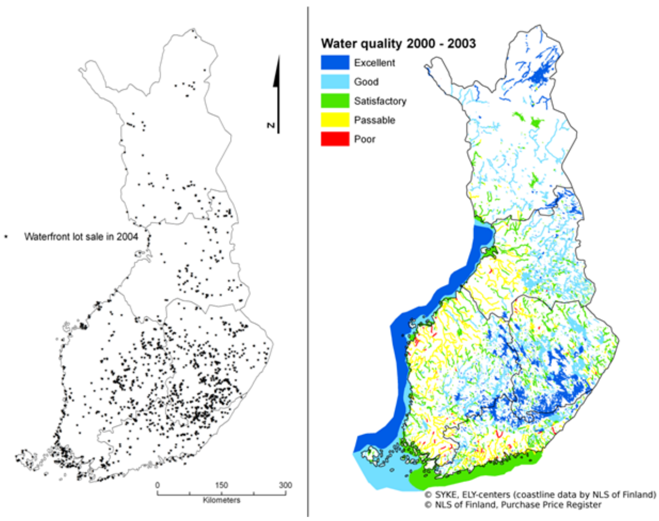

Figure B3-1. *The location of the sales and the water usability index*

The hedonic analysis revealed that water quality has a significant price-effect in summer house lot prices. A change from a "satisfactory" usability status, i.e. a water body with frequent recreational hindrances, to "good" or "excellent" status was accompanied by price effects of some 9 % to 19 %, respectively. For an average unbuilt lot price of 31 000, these figures translate into prices of approximately 2 700 euros to 5 900 euros. As a point of comparison, a shore planning status was worth some 12 000 euros on average.

An interesting feature of the results was that they support findings in earlier literature about a non-linear price for water quality. Subsequently, protecting current water quality is important as the losses from deterioration are disproportionate to equally sized improvements.

Further the hedonic analysis assessed if neighboring sales prices were similar due to unknown local conditions and sellers following the prices set at nearby property sales. The results showed evidence for spatial dependence of prices. Thus changing the water quality on one summer house lot would affect the price of other neighboring lots, even if not bordering the same water body. Local water quality improvements will therefore affect the local market prices of summer houses, not just the immediate benefactors of improved water quality.

Artell, J. 2013. Lots of value? A spatial hedonic approach to water quality valuation. Journal of Environmental Planning and Management. In press.

Box 4. Estimating the value of nutrient recycling from land prices

Agricultural land – Recycling service – Hedonic pricing
Perttu Pyykkönen (Pellervo Economic Research)

The nutrient recycling is an ecosystem service that the crop production provides for the livestock production. Since this recycling opportunity is a service that has a very limited market (excluding the contracts between farmers, however, the contracts are usually for free), it is not possible to measure the value of the service at the market. The hedonic pricing method was applied to study the factors affecting the arable land prices in Finland. The model included also features of traditional present value methods as well as policy impact analyses, and the Geographic Information System (GIS) was utilized to account for spatial issues by spatial econometric approach.

To assess the value of nutrient recycling, one of the control variables in the model was the amount of manure produced by livestock in different regions. Nutrient recycling is almost the only possibility to utilize livestock manure, and thus, the value of this opportunity to recycle is capitalized into the land price.

The data consisted of all representative land sales in Finland in the period 1995-2002. The dependent variable was the land price €/ha. The independent variables were divided into three groups. The first group consisted of traditional agricultural variables (such as the quality of land, the size of the sale, and the structure of agriculture) controlling the demand factors of land from pure agricultural perspective. The second group of variables aimed to control the effect of the non-agricultural demand on the land price. The third group consisted of policy variables, which were in the focus of the study. One of the structural development variables was "manure density" that was calculated by dividing the amount of phosphorus in the livestock manure in the region (i.e. municipalities) by the area of arable land in the respective region. As the manure has to be spread pretty much in the same region it has been produced, this variable describes very well the environmental pressure by manure utilization.

According to the results, the manure density had a clear positive and statistically significant effect on the land price, indicating that the value of the recycling service can be extracted from the land price. The results would allow for the evaluation of the value of recycling service from the perspective of food production. This evaluation was not the focus of the study and therefore was not conducted, but anyway the study provides an example on the potential of using the land price models in the ecosystem services valuation (see also Ma and Swinton 2011).

Pyykkönen, P. 2006. Factors affecting farmland prices in Finland. Pellervo Economic Research. Publ. 19.
Ma, S. and S.M. Swinton. 2011. Valuation of Ecosystem Services from Rural Landscapes Using Agricultural Land Prices. Ecological Economics 70(9): 1649-1659.

The *travel cost method* fits well on the assessment of recreational services provided by recreational areas. The idea is to estimate the recreation demand curve using the number of visits as the quantity and the money and time costs of travel as the price variable. Based on the estimated recreation demand model, a measure of benefits per visit, reflecting consumer surplus, can be computed after the estimation of the statistical model that accounts for several characteristics of the visit, such as environmental quality and recreational facilities of the area. (see, e.g. Bockstael 1995) Recreational services of forest recreational areas and national parks (Box 5) and inland waters (Box 6) are examples of common applications.

Box 5. Valuing recreation in the Teijo hiking area – travel cost method with visitor-reported travel costs

Forest Ecosystem – Recreation – Travel cost method

Ville Ovaskainen & Marjo Neuvonen (Finnish Forest Research Institute), Eija Pouta (MTT Agrifood Research Finland)

The travel cost method (TCM) has been much used for the estimation of recreational benefits provided by areas such as national parks and hiking areas that are available free of charge. While firmly based on economic theory, the travel cost method also involves a major difficulty: the price of recreational travel is inherently unobservable and subjective (Randall 1994). Therefore, researcher-assigned travel cost estimates have commonly been substituted for the travel price. However, the relevant perceived travel cost varies across individuals as regards the mere driving cost, let alone the cost of travel time. Not accounting for this individual variation results in welfare measures that are ordinally measurable rather than uniquely absolute-valued.

For a solution to the resulting calibration problem, our TCM study of the Teijo hiking area in south-western Finland employed respondent-reported driving as well as time costs of travel to represent the perceived individual trip price. Models based on respondent-reported driving costs per kilometre and stated values of travel time savings, due to a substitute area or a new alternative route, were compared with the standard practice with a uniform rate of driving cost and a third of the hourly wage for the time cost.

The results show that using the respondent-reported driving costs – either the individual estimates or the average rate – is a usable approach for calibrating the basic benefit estimates. The same applies to the stated cost approach to the cost of travel time. The stated time cost per hour was expectedly associated with income, alternative use of time, and the respondent being a driver on the trip, and had plausible effects on the benefit estimates. Table B5-1 shows the estimated average benefits per visit. These range from 25–30 €/visit when excluding the time cost to 46–59 €/trip when including the stated cost of travel time.

Table B5-1. *Estimated benefits per visit (consumer surplus €/predicted trip) based on alternative specifications of the travel cost variable.*

	Benefit estimate €/visit	St. error €	St. error %
Driving cost only			
At average rate of cost per km	25,13	5,55	22,1
At individual rates of cost per km	29,68	7,46	25,1
Combined driving and time costs			
Driving cost at average rate + 1/3 hourly wage	28,10	4,77	17,0
Driving cost at individual rate + value of travel time saving	59,31	15,12	25,5
Driving cost at individual rate + predicted value of travel time saving	46,32	11,23	24,2

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.

Randall, A. 1994. A difficulty with the travel cost method. Land Economics 70: 88–96.

Box 6. Travel cost method in water quality valuation

Water ecosystem – Recreation -Travel cost method
Tuija Lankia (MTT Agrifood Research Finland)

Studying how water systems and water quality affects recreation benefits of leisure homes is an important case when valuing water ecosystem services. This is supported by the fact that it has been estimated that as many as 60% of the Finnish population have access to a leisure home and 85% of the leisure homes locate within 100 meters from water (Statistics Finland). This case study used survey data collected from Finns who had purchased a leisure home in Finland in 2004. In total, 2700 leisure homes were sold, and 1350 persons responded to the survey either by mail or completing the questionnaire on the internet. The final sample analyzed consisted of 343 mail answers since the question about the frequency of leisure home visits was included only in the mail survey. Presence of algae that prevents recreation in a nearby body of water at least once a year and existence of a beach at a leisure home represented water quality and possibilities to water recreation. In addition to these characteristics, it was studied how the electrification of a leisure home affects the recreation value.

Traditionally, travel cost analyses focus on a particular recreation site (say, a national park). This focused on the leisure home stock as a whole instead. As quality of surrounding environment varies among leisure homes, this approach enabled capturing the effects of the environmental quality on the demand for leisure home trips and on the recreation value of a trip.

According to the travel cost analysis, one trip to a representative leisure home without recreation-preventing algae and with a beach available yields a recreation value of 194-205 euros. Disruptive algae decrease the value to 121-125 euros and the lack of a beach to 108-111 euros. The percentage decrease in recreation value due to disruptive algae is approximately 40%, and due to the lack of a beach about 45%.

Multiplying the per trip value of leisure home recreation with the total leisure home trip frequency, 2,6 million trips in the 2008 summer season (Statistics Finland),produces an aggregate recreation value of 430-530 million euros per summer for visits to an electrified leisure home without detriment to recreation from algae and with a beach available. The importance of the well-being of water ecosystem for the provision of recreational services nationwide is reflected in the following calculation. As algae blooming prevents recreation at least once during a typical summer at approximately 18% of leisure homes in the sample and recalling that it reduces the value of a trips by 40%, the decrease in the aggregate recreation value due to algae is approximately 30 million euros or 6% annually.

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.

3.3 Constructed markets for use and non-use aspects

Apart from the available market data, ecosystem services can be evaluated through the information from the hypothetical markets constructed and presented to the respondents in a survey (stated preferences methods). The sample population depends on the relevance of ecosystem service, for instance, whether the aim of the hypothetical project is at increasing biodiversity of a peatland area or at promoting conditions for nature-based tourism.

Several challenges relate especially to monetary valuation. Stated preferences methods need significant inputs on the data collection as every application needs its own data. The success of the methods (in providing reliable estimates to aid the decision making) demands that the respondents know the service to be valued well enough or, alternatively, get the appropriate information during the survey, to be able to form their own stable impression on the issue and to assess their own willingness to pay for the additional provision of the service (or the improvement of the state of nature that contributes to the provision of the service). In the presence of ecological thresholds, the project implementation may change the supply of ecosystem services and affect the marginal value of the service, making the estimated marginal values inapplicable in new situation. (Christie et al. 2006, Bateman et al. 2009, Champ et al. 2003, Farley 2008)

Uncertainty is one of the main concerns in the stated preference methods (eg. Pascual et al. 2010). The uncertainty may relate to the uncertainty of the outcomes of the regime shifts, which could make the construction of the plausible hypothetical choice scenarios very challenging. Other kind of uncertainty may relate to the preferences of the respondents. If the valued good is not very well known, the preferences may be completely nonexisting or vague.

Contingent valuation

In the *contingent valuation method*, willingness to pay reflects the benefits of the change in the provision of the certain ecosystem service (e.g. biodiversity), or the project (e.g. the water regulation plan or the salmon restoration plan) in terms of the sum of money that the respondent is willing to sacrifice other consumption in order to get the proposed change (Champ et al. 2003).

The respondent directly states the maximum sum willingness to pay for the implementation of the proposed project in the open question format. A payment card technique proposes the respondent alternative sums to choose for a specified change in ecosystem services. Alternatively, the respondents face a dichotomous choice between two alternatives. One is the implementation of the proposed project accompanied with a certain payment and another is the current situation with no payments. The respondent states which one maximizes his or her utility.

Besides the monetary value estimate, the knowledge on its determinants is valuable. For instance, the local people's willingness to pay for a more stable water level depends on their proximity to the lake (Box 7). From certain ecosystem services, benefits may be accrued even if living far away, for example the valuation of non-local anglers for the restoration of the salmon river (Box 8). The monetary value estimates may also depend on socio-demographic factors and previous experiences on restoration programmes (Box 9).

Box 7. The monetary value of decreased water-level fluctuations in Lake Pielinen

Water ecosystem – Recreation – contingent valuation
Virpi Lehtoranta (Finnish Environment Institute)

The natural fluctuation of water level in Lake Pielinen, the largest non-regulated lake in Finland, damages recreational, occupational, and housing possibilities. Fluctuation refers to high water levels in spring and of low water levels in summer months. Decrease in water levels in late spring and summer will take place in future due to the effect of the climate change on large seasonal changes in runoff and water levels (Veijalainen et al. 2010). Fluctuations have been discussed on for decades without agreement on the implementation of the regulation.

Our study focused on recreational services provided by the lake by determining the degree of support for a possible regulation project among the residents of the area and by measuring in monetary terms the benefit from keeping water level at optimum level for recreational purposes in summertime. The plan was to raise the water level in the lake by 30–40 cm in summer and autumn, and to cut high water level by 15 cm in spring. The contingent valuation method with a payment card technique was applied. The questionnaire was sent to 2,244 randomly sampled residents in five municipalities around the lake. 1,010 (45 %) responded.

The majority of respondents supported the plan absolutely or probably, and a minority (9%) opposed the plan. Among the 'absolute' supporters of the regulation plan, 60% were willing to pay. The shares of respondents having a positive willingness to pay decreased with the decrease in the level of support, and among the strongest opponents of the implementation of the regulation plan, none were willing to pay. Altogether, almost half of the respondents chose a positive payment.

The estimates of households' annual mean willingness to pay varied depending on the model. On average, annually, the respondents were willing to pay EUR14.20–25.80 (non-parametric Turnbull estimator) or EUR 14.30 (Tobit model) for the described water level regulations. The latter was close to the lower bound of the former estimate, as expected by the model assumptions. When the respondent characteristics and experience was taken into account, the mean WTP of the owners of the shoreline properties was EUR 24, and the WTP of other residents was EUR 7 (figure B7-1). In addition to living near the shore, the WTP increased with higher income, young age, having a boat, being aware of the regulation plans and having no difficulties with the questions.

Figure B7-1. *Household's mean willingness to pay (WTP, compensating surplus) for having lower fluctuated water level in Lake Pielinen. (Picture: Turo Hjerppe)*

From the policy and decision making viewpoint, the aggregated economic benefits are of interest as they could be compared to the estimated costs of the plan. The aggregate WTP for all 17,000 households around the lake was calculated by accounting for the response rate (45 %). The preferences (WTP) and characteristics of those who did not respond were assumed to be similar to the respondents. The aggregated annual household WTP for the regulation plan of the lake Pielinen in five surrounding municipalities was EUR 243,100 (Tobit model) or EUR 241,400–438,600 (non-parametric Turnbull estimator).

The application of the choice experiment method or contingent ranking method would reveal the preferences and WTP estimates over different aspects of the ecosystem. This, however, would require more knowledge on measurable ecosystem impacts.

Lehtoranta, V., Seppälä, E. & Kosenius, AK. 2013. Willingness to pay for water level regulation in lake Pielinen, Finland. Journal of Environmental Economics and Policy, Vol 2, 148-163.
Lehtoranta, V. & Seppälä, E. 2011. Asukkaiden näkemykset ja maksuhaluk-kuus Pielisen säännöstelystä. (Pielinen water level regulation: Residents' views and willingness to pay). Finnish Environment 35. 60p. ISBN 978-952-11-3960-4 (PDF). In Finnish.
Veijalainen, N., Dubrovin, T., Marttunen, M. & Vehviläinen, B. 2010. Climate Change Impacts on Water Resources and Lake Regulation in the Vuoksi Watershed in Finland. Water Resources Management, Vol 24(13), 3437-3459.

Box 8. Benefits of the salmon stock restoration for recreational anglers of the river Iijoki

Water Ecosystem – Recreational services – Contingent valuation
Katja Parkkila (University of Helsinki) and Emmi Haltia (Pellervo Economic Research)

This pilot study explored non-local anglers' opinions about the restoration of salmon stock into the river Iijoki, and how much this change would benefit the anglers. The research was carried out with the contingent valuation method and it is the first application on this issue in Finland.

The sample (1 000 anglers) was collected from those anglers who had purchased rod fishing license for the river Iijoki in the year 2009. The data collection was implemented by the internet survey. Due to the low response rate (17%), the sample is not representative for the population and the results are tentative.

In the questionnaire, respondents chose the most pleasing alternative between the current situation and two different programs aiming to restore the salmon stock. The current situation was supported by less than 10% of the respondents, whereas the fish ladder alternative was supported by 85% and over transfer and restocking alternative 5% of the respondents.

According to the results, the majority of respondents considered restoration of naturally reproductive salmon stock as very important. The anglers were willing to pay on average EUR 25,6 per year as a salmon management fee to restore the salmon stock. The results indicate that the recovery of salmon stock into the river Iijoki would produce, over a period of ten years, at least a million euro additional benefit for non-local anglers. The total benefits are likely to be larger because the valuations of local inhabitants are lacking from the estimate. In addition, the restoration of salmon stock would bring benefits for potential non-local anglers at the river Iijoki, who currently do not visit there.

Parkkila, K., Haltia, E. & Karjalainen, T.P. 2010. Iijoen lohikannan palauttamistoimien hyödyt virkistyskalastajille – pilottitutkimus ehdollisen arvottamisen menetelmällä. (Engl. The Iijoki river salmon restoration plan – benefits for recreational anglers) Riista- ja kalatalous. Tutkimuksia ja selvityksiä, nro 4, 2011, 28 s. In Finnish, English summary.

Box 9. The significance of streams for residents of City of Helsinki – Contingent Valuation Study

Water ecosystem – Biodiversity – Contingent valuation
Virpi Lehtoranta (Finnish Environment Institute)

The objective of the Small Water Action Plan of the city of Helsinki, published in 2007, was to promote biodiversity conservation according to the Finnish Biodiversity Action Plan. The plan links also to the European Union Water Framework Directive that obligates member states to pursue the good ecological status of the surface and ground waters by the year 2015. According to the vision of the Small Water Action Plan, numerous small waters in the city of Helsinki constitute a diverse network that contributes to biodiversity conservation and forms an integral part of the local identity.

The contingent valuation survey focused on estimating the value of improvement in ecological status of streams, resulting from dedicated restoration actions. Moreover, the streams and their surroundings supply a range of other ecosystem services: storm water treatment, flood protection, improvements to the morphological and ecological diversity of the stream bed and aesthetic value. The study measured, in monetary terms, the consumer preferences for the improvement in having better condition and water quality of small waters. More specifically, the condition referred to ecological status and morphological and ecological diversity of streams in the city of Helsinki.

To define the benefits of restoration, the measures were described as concrete as possible: storm water would be filtered through wetlands before entering to the stream, floodplains would be constructed to prevent adverse flooding of the stream, and streams would provide shelter for the fauna enabling the spawning of the highly endangered sea trout. Furthermore, possible changes to the scenery and recreational use of streams were described. The contingent valuation method with a multiple bounded discrete choice technique was applied, allowing the respondents to state uncertainty on paying offered payments. The questionnaire was sent to 700 randomly sampled residents of the city of Helsinki. The response rate was 38 %.

The results showed that the residents with high income, low age, exercising outdoors and living near the streams of Tapaninkylänpuro, Tapaninvainionpuro or Longinoja were willing to pay more for the improvement of the streams. The aggregate benefit estimate was at least 1.4 million Euros per year and about 7.2 million Euros for the five year period of the fictional and regional Small Water Fund.

The net social benefits were positive indicating that the implementation of the Small Water Action Plan is socially desirable. Furthermore, respondents' previous experience on the outcomes and benefits of restoration measures may explain the high willingness to pay in specific watersheds (figure B9-1). For example in stream Longinoja restoration measures have been carried out gaining high publicity in the local media.

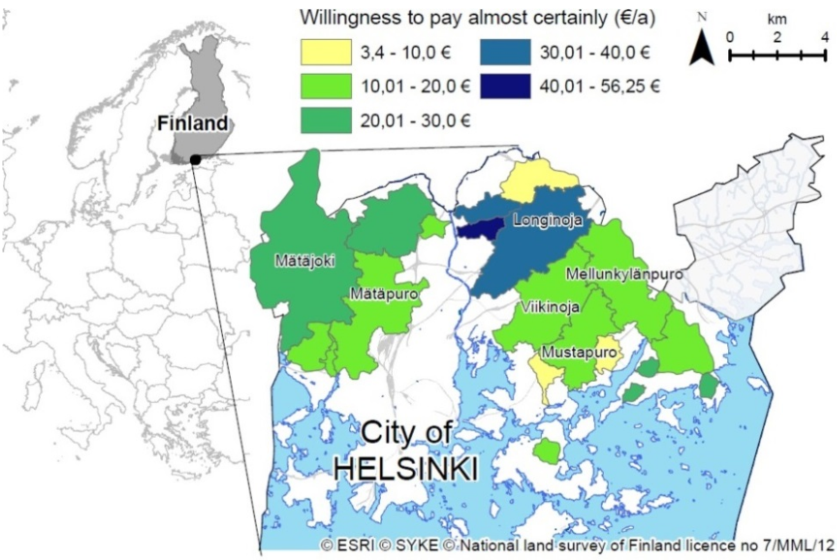

Figure B9-1 *The mean WTP for improvement in ecological status and morphological and ecological diversity of streams in the city of Helsinki. (Picture: Turo Hjerppe)*

Lehtoranta, V., Sarvilinna, A., and Hjerppe, T. 2012. Purojen merkitys helsinkiläisille – Helsingin pienvesiohjelman yhteiskunnallinen kannattavuus. The significance of streams for the residents of the City of Helsinki Contingent Valuation Study for the feasibility of the Small Water Action Plan. Finnish Environment Institute SYKE. Finnish Environment 5. 66 p. ISBN 978-952-11-3984-0 (PDF). In Finnish.

Choice experiment

While the contingent valuation assesses the value of specified change, the *choice experiment method* allows for estimation of several aspects of change. The respondent faces choice tasks, and chooses the preferred utility-maximising alternative, e.g. a combination of services provided by agricultural landscape. Alternatives are described with aspects relevant for policy makers and respondents, e.g. several impacts of management in the landscape characteristics (attributes), such as number of animals, water protection zones, and the share of uncultivated fields, and formed with help of a statistical procedure. (Bennett and Blamey 2001)

The payment attribute allows for the monetary assessment of any policy alternative (combination of attribute levels) and the marginal willingness-to-pay for attributes. The levels of attributes reflect the current situation and the potential future situations. The idea is to model the choice information gathered from hypothetical markets and to estimate the effect of changes in attributes levels on the choice and to determine the trade-offs between attributes. (Bennett and Blamey 2001, Louviere et al. 2000)

The choice experiment applies well when an ecosystem produces simultaneously many services (joint production), such as the agricultural landscape contributing to aesthetics, water protection, animal species, and cultural heritage (Box 10). The method can be applied even without the payment attribute. The citizen valuations for alternative uses of peatlands is one example (Box 14).

Box 10. Value of agricultural landscape management

Agricultural land – Several ecosystem services – Choice experiment
Eija Pouta & Ioanna Grammatikopoulou (MTT Agrifood Research Finland)

In planning landscape-related policy, such as agri-environmental measures, the European Landscape Convention emphasizes the need to account for the benefits that the population and various stakeholder groups obtain from the landscape. In this study, a choice experiment was employed to evaluate a program that provides certain landscape attributes in a typical agricultural area. The attributes of a local landscape program were the share of uncultivated fields, number of plant species in cultivation, existence of grazing animals in landscape, management of water protection zones and the condition of production buildings.

The study also tested the feasibility of a local landscape value trade scheme as a policy tool so as to provide landscape ecosystem services. The program was described as a local voluntary trade for landscape management in the Nummenpää–Lepsämä river valley area (the area of the survey). Respondents were told that the residents would pay for the landscape services provided by the landowners contributing this way to increase landscape value and prevent landscape deterioration. Landowners, on the other hand, would provide landscape management if they perceived the compensation for their landscape services to be sufficient.

The case study area for conducting the survey was selected from Nurmijärvi Southern Finland such that the typical southern Finnish agricultural landscape was represented. The data were collected via a questionnaire survey in March 2008 which yielded 630 responses from both landowners and residents without land ownership.

The results showed that most valued attributes were the renovation of production buildings and the presence of grazing animals. Results on the importance of landscape characteristics revealed that in the agricultural landscape, the separate visible landscape elements such as grazing horses and cattle and the condition of production buildings were of particularly important. The average willingness to pay ranged from € 147.57 to € 227.52 for various levels of the landscape program directed to these attributes. Allowing heterogeneity of respondents' preferences provided a versatile picture of the landscape values. The four identified resident segments differed considerably from each other, but only one segment opposed landscape improvements while the remaining three segments attached a positive value to any change from the current state of the landscape. Although the segment of 21.07% opposing the management policies existed, the actual landscape changes would not cause compensation needs if participation in the policy was voluntary, as suggested in this study. However, the heterogeneity of preferences would still complicate the formulation of the content of the management policy, even on the local level.

The results demonstrated that the challenge for landscape value trade was mainly on the sellers' side. 43% of landowners (sellers) were negative towards participating in the landscape value trade. Those who were positive or indecisive towards the trade scheme particularly appreciated the idea of improving the landscape through a higher proportion of cultivated land, an attribute that was less important for local citizens, i.e. buyers. Landowners demanded compensation that exceeded the anticipated expenses, especially for attributes demanded by residents such as the renovation of production buildings and presence of grazing animals. The requirement for compensation exceeding the expenses of landscape improvements reveals the low personal benefits from such landscape measures.

The results do not encourage revision of the intensification of crop production as such. The results indicated high benefit-cost ratio for producing simple positive focal points such as the presence of animals as a landscape attraction and the avoidance of landscape damage due to ramshackle production buildings. Although the present study was a local case, its findings may apply in a broader context, in that it provided empirical results regarding preferences for the agricultural landscape attributes of a typical agricultural production landscape in Northeastern Europe. It demonstrated that the landscape is not a simple one-dimensional public good, but the perceptions of this ecosystem service can vary greatly among population groups.

Grammatikopoulou,I. & Pouta, E. 2013. A locally designed payment scheme for agricultural landscape services. Land use policy, 32:175-185.
Grammatikopoulou,I., Pouta, E., Salmiovirta, M. & Soini, K. 2012. Heterogeneous preferences for agricultural landscape improvements in southern Finland. Landscape and Urban Planning, 107: 181–191.

3.4 Transfer of adjusted value estimates

Previous valuation estimates can be transferred and adjusted to new policy situations if resources (time and money) are constrained. The reliability of benefit transfer results increases with the availability of carefully chosen qualified estimates and the use of advanced econometric methods, but transfer errors are unavoidable. (Nelson and Kennedy 2009, Plummer 2009, Pascual et al. 2010)

The simplest way to generalize the results of existing studies is to *utilize directly the results* of a study concerning a situation and a good as similar as possible (value transfer). Unfortunately though, rarely the applications are similar enough to enable the results of acceptable accurance. Another way is to use the *average values from several studies* (mean value transfer). This may produce good estimates when several studies are available, the target of valuation is very similar, and the valued policy has the same extent. (Champ et al. 2003, Bateman et al. 2011)

Not only the similarity of the ecosystem is essential but the broader valuation context. For instance, the recreational values are typically calculated from very popular areas and the value is affected by the infrastructure and services in the area. These values cannot be generalized to the same ecosystems if the area is not so well-known or easily achievable (Plummer 2009). Also the policy frame of providing an ecosystem service might affect the results (Horne 2006).

If no studies of sufficient similarity are available, the *meta-analysis of studies available* is an option. An extensive data base of suitable studies concerning various valuation situations, policy sizes, and value estimates is used in *the estimation of the model to predict the valuations* in various situations (value function transfer). Meta-analysis has been applied to evaluate agricultural genetic resources (Box 11).

Box 11. Value of agricultural genetic resources

Agricultural land – Genetic resources – Meta-analysis
Heini Ahtiainen & Eija Pouta (MTT Agrifood Research Finland)

Genetic resources in agriculture can be considered as provisioning and supporting services of agricultural ecosystems. Plant or crop genetic resources (PGR) refer to the genetic material within cultivated species and other plant species that can be of value for food production and agriculture. Animal genetic resources (AnGR) include all animal species, breeds and strains that are of interest in terms of food and agricultural production. According to the FAO (1996), the loss of diversity in agricultural genetic resources has been substantial and the process of genetic erosion continues. The main cause of the erosion is the replacement of local varieties by improved or exotic varieties and species (FAO 1997).

For a meta-analysis of the value of agricultural genetic resources, studies were searched from databases such as CAB Abstracts, ISI Web of Knowledge, EconLit, Agricola, FSTA and IFPRI BioConserv bibliography. The literature included journal articles, book chapters and also publications from the 'grey' literature. During the first stage, the information retrieval was maintained on a general level and the keywords used were genetic resources and valuation. From the search results those empirical studies that used established valuation methods (i.e. contingent valuation, choice experiments, hedonic pricing) to provide monetary value estimates for genetic resources in agriculture were included in the data set. The object of valuation in a study could be a breed or a variety, a specific trait or a conservation programme. The purpose was to obtain an understanding of the benefits (or in some cases the negative benefits) of conserving genetic resources. Based on the aforementioned criteria, 22 studies were identified, of which 14 could be included in the meta-analysis. These 14 studies provided 93 separate value estimates. The data was first examined qualitatively and then with meta-regression models. The meta-regression explained the value of farm genetic resources with a set of explanatory variables, such as the characteristics of the environmental good, the population studied, the methodology used and other study-specific features.

The meta-regressions revealed that the focus of valuation has a significant effect on the value of genetic resources. Grain genetic resources were valued lower compared to AnGR and agrobiodiversity, and the values of breeds or varieties and conservation programmes were higher than those of individual attributes. In addition, the value measure (WTP, WTA) had an effect on the value estimates and values seemed to have declined over time. A challenge was that although different genetic resources, geographic locations and valuation methods were covered in the studies, the possibilities to generalise the findings were modest. For example, only two European studies were found on the value of genetic resources in agriculture.

The meta-regression results were tested for European benefit transfer. Agrobiodiversity received the highest WTP, followed by the animal breed and the crop conservation programme. This might indicate a preference for a comprehensive approach on genetic resource conservation, although it should be noted that the results on the value of agrobiodiversity are based on only one study. WTP ranged from $343 to $629 per household. The value estimates should be regarded as indicative due to the limited amount of data.

The meta-analysis revealed future research needs on the value of agricultural genetic resources. These include improving our knowledge of the value of PGR, obtaining value estimates for maintaining the genetic diversity in Europe and the United States, estimating the relative magnitude of use and nonuse values and determining the value consumers place on genetic resources and diversity in agriculture.

Ahtiainen, H. & Pouta, E. 2011. The value of genetic resources in agriculture: a meta-analysis assessing existing knowledge and future research needs. International Journal of Biodiversity Science, Ecosystem Services & Management 7, 1: 27-38.

FAO (Food and Agricultural Organization) 1996. Report on the state of the world's plant genetic resources for food and agriculture. Paper presented at: International Technical Conference on Plant Genetic Resources; 1996 Jun 17–23; Leipzig, Germany.

FAO (Food and Agricultural Organization) 1997. State of the world's plant genetic resources for food and agriculture. Rome (Italy): FAO.

4 Non-economic valuation – revealing multiple aspects and conflicts

The research on ecosystem services has increased the amount of ecosystem services identified and this trend will probably continue. Another trend, characteristic to 'postmodern' societies, has been the fragmentation of the values. Two decades ago, only one political process on biodiversity (CBD 1994) recognised the following categories of values of biodiversity and its components: intrinsic, ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values. The growing plurality of values in the society and the increasing diversity of goods and services of nature may call for further methodological development and advice to recall the valuation and assessment approaches which have been used before and alongside the development of economic valuation.

4.1 Physical accounting

The physical accounting of the stock resources and annual growth and use (flows of ecosystem services) is a fundamental method for any decision making situation and provides nowadays vital information about the most common provisioning goods entering the markets and, increasingly, also about other goods and services. In most cases physical accounting also makes the only reliable source of information to monitor the sustainability of the utilization of the resources. For example, the National Forest Inventory (NFI) in Finland has been done twelve times since it was first done in 1921 – 1924. The prevailing pressures have been to capture more and more information from the field (or airborne) inventories, although financial resources have not always allowed to realize these needs (NFI 2012).

One may ask whether the biophysical measurements of ecosystem services represent valuation at all? It may depend on the context. In the case of Finland, the considerable investments allocated into the national forest inventories ninety years ago reflected a prevailing conception that forests are the most important natural assets of Finland, a need to organize their use in sustainable way and to facilitate the just taxation of forest properties. The results have been used to monitor the development in the frame of sustainability but also for evaluating silvicultural needs as well as predicting and planning sustainable production possibilities. These were done using physical measurements and planning procedures, although it also facilitated the shorter term economic planning and follow-up and considerations of protective and other environmental influences of forests.

Physical accounting demonstrates the value given to forests, provides data for the monetary valuation of forests stocks and the future incomes forests provide, and is necessary to maintain sustainable or progressive forestry. Nevertheless, almost all the planning of the future and debate of the alternatives, were based on the physical units including the qualitative assessments of wood assortments and silvicultural state of the forests. In that sense, the cubic metre was (implicitly) regarded more important (and reliable) unit of "valuation" than the changing stumpage prices in the changing and unpredictable economic conjunctures. The long rotation period of boreal forest even nowadays necessitates basically the similar approach although the use of economic and profitability calculations have significantly increased for different purposes.

At the same time it needs to be recognized that basically forest inventory is a tool for monitoring the changes of forest stocks (growing stock) and flows (growth and drain) and therefore of fundamental importance for the development of indicators.

4.2 Ecological valuation

Ecological valuation can be based on different criterions and can be done at different ecological levels. Regarding the valuation of species, one aspect is the importance of their role(s) in the system. The functional value of a species is dependent on the extent of other species' ability to substitute and maintain the role or function, if the species is removed.

Most common way of ecological valuation of single species is based on the risk of becoming extinct. Those species classified as threatened are classified as critically endangered, endangered and vulnerable. The higher the risk of extinction, the more resources are usually allocated for protection, meaning also higher ecological valuation of the species. The impact of scarcity to increase value is well-known in economics but applies also elsewhere.

At ecosystem level, resilience against external disturbances is a vital feature. Biodiversity is regarded to be a key factor in maintaining the resilience of the ecosystems. The ecological valuation of resilience can be done by measuring the degree of biodiversity using the indexes developed for that purpose. However, as biodiversity is a complex concept covering several levels from genes to ecosystems its measurement is not easy. Biodiversity is primarily related to the conservation value of the ecosystems and is in that regard also seen as an intrinsic value - a value independent on the benefits people may get from it or from ecosystems. Although this definition seems to separate intrinsic values from ecosystem services, in reality it may not be entirely so, because the human beings are the only one who can articulate it. Operationally, the biodiversity value of forest ecosystems or forest stands has found a concrete valuation tool which can easily be measured on site. It is the amount of coarse wood debris (CWD), which even itself forms habitats for many threatened species.

Biodiversity is closely related to naturalness which, generally speaking, is the lack of human impact in the ecosystems. For example, a natural forest has no recognisable signs of human activity or at least a sufficiently long time has passed from human interventions. Naturnalness often supports some maintenance and regulating services, such as providing habitat for species. Along the centuries of rapidly increasing human impacts on nature, the naturalness of ecosystems has become one of the their most valued characterics producing – at first sight a bit paradoxically – mostly cultural ecosystem services such as heritage and unique landscape values.

In conservation ecology and management, qualitative and quantitative evaluation and valuation approaches are traditionally used in the assessment of the naturalness. Naturalness can also be a criterion among many others features when assessing the ecological value of ecosystems or their parts. For example, Salminen (2012) assessed the basic-ecological value/meaning of smaller undrained (natural) peatlands and mire sites locating mainly in the areas where most peatlands were drained for forestry purposes. The minimum size was 20 hectares in southern and 50 ha in the northern part of Finland. The major criteria were naturalness of the border of the site, the state of peatland surrounding it and its impact on undrained site, general features of nature types and mire types at different levels, the structural and other diversity of mire sites, and some other special features. Each site studied was classified into one of three value classes within the larger forest vegetation zones: not significant, rather significant, or significant. Results are used for the update of conservation needs and programmes.

Naturalness is often related to the "balance of nature", earlier seen as the ideal in ecology and environmental ethics. In the latter context, White and Jentsch (2005) see that the new "paradigm of flux" possesses a challenge to environmental ethics: since nature is in flux there appears to be no reference state by which to evaluate human caused change. Just as the shift from the "balance of nature" to the paradigm of flux is seen, there is a need to focus the ethics of sustainability: the capacity for dynamic balance at multipatch scales. A human-landscape is sought that allows a dynamic system of diverse elements to retain its capacity to adapt. Ultimately this is based on the proposition that resilience itself, in turn, depends on biodiversity. (White and Jentsch 2005)

Finally, we can ask whether ecological valuation has one or many yardsticks for valuation? The above criterions may refer to the existence of several ones. However, biodiversity, while seen a common currency for ecologists and nature conservation, also supplies the raw material for future changes and adaptational responses (White and Jentsch 2005). Should one conclude that ecological valuation is parallel to economic valuation in that having a common currency, although it does not talk as directly as money does.

4.3 Aesthetics and ethics in valuation of ecosystem services

Aesthetic valuation is probably the most common way of people to observe and recognize features of nature and its ecosystems. For instance, besides forests and lakes, peatlands and mires are essential and unique parts of the Finnish landscape. Natural peatlands and mires often represent the most original wilderness scenes of Finland being untouched since their formation after the last Ice Age. Two major tools for valuing aesthetic ecosystem services systematically are aesthetic or visual analysis of the landscape and scoring of landscape values by people using slide presentation or on-site visits. (Sepänmaa 2007, Komulainen 2010)

Aesthetic approach to nature occurs not only at the landscape level but even at the individual species level, where people often connect it to the ecological value. Beautiful and handsome animals and plants are regarded also ecologically significant while insects and other invertebrates "which run the world" are least appreciated (Niemelä 2000). The ability to observe the species is the key in aesthetic valuation. For instance, the ground vegetation of peatland is composed of *Spaghnum*-species, regarded as one of those modest common species which are walked over without having any specific visual value. However, for instance a book identifying one hundred *Spaghnum* –species with photos uncovers a hidden treasure of visual values under one's boots (Laine et al. 2011). Ornamental plants, although their essence is in their visual beauty, have usually categorized as provisional services – an example of the layered structure of ecosystem services.

The defence of aesthetic values is the moral obligation (Sepänmaa 2007). This idea is included also in the statement of Aldo Leopold in *Land ethic*: "A thing is right when it tends to promote the *integrity, stability and beauty* of the biotic community. It is wrong when it tends otherwise" (Leopold 1949). Land ethic may be implemented through recognizing the intrinsic values of nature (Forbes and Linquist, 2000), but it can also be interpreted as an expression of a need to combine in a more balanced way ecological, economic and social aspects when applying ethics in the real management of nature (Saastamoinen 2005).

Ethical values are attached in many ways to ecosystem goods and services. The mere definition of these as "benefits people get from nature" is basically an expression of utilitarian ethics. As the defence of aesthetic values, identification of the habitat services for endangered species is motivated by duty ethics. When looking more closely the moral motivation behind the supporting, maintenance, and regulating services, one can perhaps trace aspects of consequentalism, that is, the moral value of an action is defined by its consequencies. However, they are in reverse order as nature's services are used to remediate the consequences of illplanned human actions. On the other hand, this may lead also to changes in polluting activities.

Moral valuation in the more restricted sense is focused to human behaviour towards nature and its uses: what are the right activities in nature and which ones are wrong. Among the moral criterions, *justice* is one of the most fundamental. (Sandel 2010). By modifying Leopold's statement, related to biotic community, to the societal context we may end up to the following: "A thing is right when it tends to promote *justice, integrity and common good* of the social community. It is wrong when it tends otherwise" Although not discussing with Aldo Leopold, the conclusions about the strong links between 'a strong sense of community' (seen here as integrity), common good and justice in Sandel (2010) gives a waterproof support to the formulation given above, the modified Leopold's statement. For example: "If a just society requires a strong sense of community, it must find a way to cultivate in citizens a concern for the whole, a dedication to the common good". (Sandel 2010). Moral evaluation needs to address even the concept of ecosystem services itself. In which ways it improves the relationship between people and nature, and complements the overall framework of sustainable development? Is there a risk that formulation of many common and familiar products or services of nature (fish, landscape, flood protection) into a "less familiar" umbrella concept of ecosystem services will alienate people from the debates on nature? Saastamoinen et al. (2014), as the popularized synthesis of the ecosystem service research project, on its part tries to minimize that risk.

4.4 Cultural and social valuation

Among the ecosystem services, cultural services form probably the most heterogenous major groupings. This is, on one hand, due to the wide amplitude of the concept 'culture' and, on the other hand, due to decisive role of human cognition and imagination in the creation of cultural services. Culture includes all the material, spiritual and intellectual resources from the past, covers additional everyday activities of to-day and creates images of the future which may change the cultural conceptualization of our times. Many varieties of the cultural services are seen to be beyond the economic calculations, although, for example, recreational values have been the first non-market services where economic valuation has been exercised.

Many spiritual values of the ecosystems are not directly observable, and perhaps not even easily communicated. At the other end, spiritual values of nature are very prominent, and their valuation is widely recognized. The most valuable things in all cultures are considered to be sacred. These include burial grounds, sites related to historic events, sacred sites like rocks, caves, and ponds, and sacred trees (Anttonen 1996, Virtanen 2002). Less valuable but important in our times are memory trees dedicated for important events or honoured people. The idea of "sacred" in nature can be found in wider context even in our times. Valuation of forest, symbolically and conceptually seen, is based on theological, philosophical, and personal argumentation. In "forest's theology", forest represents also other nature, and, as believed, it can help the citizens to get rid from the alienation from their home and nature and to "relocate themselves in the universe" (Kainulainen 2013).

Sociology, cultural studies and social anthropology have long claimed the decisive roles of the society in the development of values and preferences (Graeber 2001). Vatn and Bromley (199*4)* stated simply that the preferences are not in the genes of human beings, and that the most decisions concerning the environment are done without prices. Evidence from behavioural economics, psychology, neuroscience, and evolutionary biology points out that individual-based valuation has severe limitations in capturing the complexities of human decision making, in particular when long-term irreversible effects of human activity are of concern. (Liu et al. 2010, Parks and Gowdy 2013)

To provide an alternative for unrealistic assumptions of human rationality and to account for the fact that human values are social not individual, and to evaluate ecosystem services with not only efficiency, but also fairness, support from transdisciplinary methodologies, such as participatory assessment, group valuation, and the practice of integrating valuation with GIS and ecosystem modelling is essential. (Liu et al. 2010, Parks and Gowdy 2013)

Deliberative valuation, involving a group of selected persons who, through a process of reasoned discourse, explore the values for guidance for social decision making, is a way to elicit truly social valuation. (Howarth and Wilson 2006, cited in Parks and Gowdy 2013). Besides a method for valuation, deliberative valuation can also assist in conflict resolution to reach agreement by exploring arguments and developing understanding and trust (Parks and Gowdy 2013).

Finally, one may ask also here whether cultural and social valuation is one-dimensional or multidimensional? In terms of "cultural relativism" denying the possibility to compare values between different cultures the answer is strictly negative: the universal currency does not exist. The multitude of social values referred earlier even within one society – usually included in the wide definitions of well-being (as adopted in UK NEA 2011) – may also suggest the use of several approaches and indexes for measurements. However, although theoretical units of utility, satisfaction or happiness are sometimes considered as providing units for measurement, they seem to work only in theory. Is there any unit comparable to monetary one which would be able to act as a measure for aggregation? A well-known phrase suggests that "time is money". In the study on the everyday nature-related activities of the Finns based on the primary data of the time-budget survey of the Statistics Finland, it has been proposed that use of time (hours per year) may offer the only operational currency for valuation working outside the real monetary units (Saastamoinen and Vaara 2009). According to modern philosophy, the common currency for valuation hardly exists. Value, in itself, is a multidimensional concept (Niiniluoto 2000) and the plural society is based on the existence of different yardsticks (Oksanen 2000). The results of economic and non-economic valuation will nevertheless form an essential evidence in the democracy of deliberation. More generally, all that may lead to the politics of public engagement with questions of good life, just society and common good (Sandel 2010).

4.5 Multi-criteria methods

Although multi-criteria methods have been adopted in Finland already in the 1990s, its further development and applications demonstrate that there already are at least partial answers to the challenges given for deliberative valuation.

Multi-criteria methods aim at considering multiple dimensions of the planning problem by participatory processes. The idea of the *multi-criteria decision analysis* is to present the aspects of the decision problem and clarify the relative importance of these criteria, measured in different units, for different stakeholders. Stakeholder meetings reveal multiple objectives of the project, being of ecological, economic, social, and strategic nature, as well as alternative ways to implement the project. When the impacts of alternatives have been defined in terms of several criteria, the stakeholders assess the goodness of the criteria, and weight them according to their importance. Finally, the ranking of management alternatives (combinations of criteria) can be assessed. (Karjalainen et al. 2013)

Considering multiple criteria assists in solving conflicts, e.g., related to the controversy between alternative uses of forested land in Finnish Upper Lapland (Mustajoki et al. 2011), and implementing long-term projects when commitment of different parties is necessary, e.g. the restoration of the river to secure the provision of multiple ecosystem services (Box 12). Multi-criteria decision analysis serves also planning the multiple use of state-owned forests (Box 13).

Box 12. Valuing river restoration with Multi-Criteria Decision Analysis - focus on values or services

Water ecocystem – several services – multi-criteria decision analysis
Timo P. Karjalainen (University of Oulu) and Mika Marttunen (Finnish Environment Institute)

Multi-Criteria Decision Analysis is the discipline that provides methods and procedures to analyse problems with multiple conflicting criteria. MCDA aims at helping to identify and structure people's objectives and preferences, to systematically compare alternatives having incommensurable impacts, and to identify key trade-offs. An MDCA framework may focus on stakeholders' values and objectives or ecosystem services.

The project "The return of migratory fish to the River Iijoki (2008–2010)" involved an interactive MCDA process, focusing on the values of stakeholders from fishing co-operatives, a hydropower company, a local environmental association as well as officials from the environmental and fishing administration. Stakeholders' objectives were discussed and structured in workshops, potential measures for improving migratory fish stocks were identified and their desirability, costs and benefits were systematically evaluated. Altogether 25 interviews with Web-HIPRE software were realized to find out stakeholders' views of three options and their effects. All the interviewed stakeholders considered the construction of fish ladders and large-scale restoration measures as the best option. The fish ladder options were the most expensive due to the high construction costs, but they also provided the greatest benefits in terms of migratory fish stocks, local identity and fishing tourism.

The material of the River Iijoki project was utilized also in another study where we compared the value-focused MCDA approach with a desktop application of the ecosystem services (ES) -focused MCDA approach. The main finding is that the concept of ES can bring added value to the assessment process. It enables the framing and the valuation of especially provisioning services – final services –, such as salmon catch, in a more understandable way for the stakeholders. Besides, it takes into account ecosystem processes and supporting services more precisely.

There are also some potential problems in the ES-based approach. The concept and the thinking in ES framework can be difficult for those who are unfamiliar with the concept. Focusing on ES may neglect the trade-offs between ecosystem services and other relevant value categories, such as hydropower (losses for hydropower when water is allocated for fish ladders). Thus, although the promises of the ES framework, it should not form a rigid 'checklist' for environmental assessments. Rather, it should be used to widen perspectives about potential issues linking ecosystem properties to human benefits and values.

Karjalainen TP, Rytkönen A-M, Marttunen M, Mäki-Petäys A, Autti, O. (2011) Monitavoitearviointi Iijoen vaelluskalakantojen palauttamisen tukena. (The support of multicriteria assessment in restoring migratory fish stocks in the River Iijoki). Suomen Ympäristö/Finnish Environment (luonnonvarat/Natural resources), 11/2011. Available in pdf-format in the URL: http://www.ymparisto.fi/download.asp?contentid=127545&lan=fi

Karjalainen TP, Marttunen M, Sarkki S, Rytkönen A-M (2013). Integrating ecosystem services into environmental impact assessment: an analytic-deliberative approach. Environmental Impact Assessment Review 40 (April 2013), 54-64.

Box 13. Use of Internet decision support tool in participatory forest planning

Forest ecosystem – Several ecosystem services – Multi-criteria decision analysis
Mikko Kurttila & Jouni Pykäläinen (Finnish Forest Research Institute)

Practically all Finnish forests are under multiple use, providing several ecosystem services. However, without proper planning, conditions for multiple use of forests may remain far from optimal. Especially in planning of large regions, considering the wishes of different stakeholders fairly and transparently and utilizing their knowledge in making decisions that have long-term effects on forest ecosystems may help in finding a good solution and in avoiding conflicts in the future. In combination, these two challenges create a space for the use of different methods and approaches that support collaborative decision making.

Several multi-criteria decision analysis (MCDA) tools have been used for supporting decision making in area level stakeholder groups of Metsähallitus, the organization that manages the Finnish state owned forests. For example, the Mesta decision support tool was used in eastern and western Lapland. Mesta was used in examining and evaluating the strategy alternatives from the viewpoint of the stakeholders' objectives. The final aim in the process, applying an Internet decision support tool, was to decide on the area's land-use allocation and the corresponding forest management operations for state-owned forests within the planning regions.

Figure B13-1 shows an example of the user interface and the selected aspects to be considered in the decision making among alternative scenarios. Several ecosystem services were included. Timber production (aspect 2), biodiversity (3-5), recreation (7-8) and reindeer husbandry (6) were defined more accurately by using altogether ten different indicators. Moreover, social aspects were considered through indicators that were related to employment (10) and the turnover of Metsähallitus (1 and 9).

Colourful boxes describe the effect of alternative scenarios in terms of selected aspects (represented by numbers 1-10 above). The user moves the thick black lines representing the acceptance thresholds (white=acceptable, grey=unacceptable) with computer mouse according to his/her preferences until at least one solution that is accepted with respect all criteria is found. For instance, this decision maker accepts only relatively high values for criterion Lichen areas (6), and he/she would also like to have slightly more old forests (4) that the Basic alternative would result in. At this phase, no single alternative exceed all the acceptance thresholds and the decision maker needs to continue the MCDA analysis and lower some acceptance thresholds.

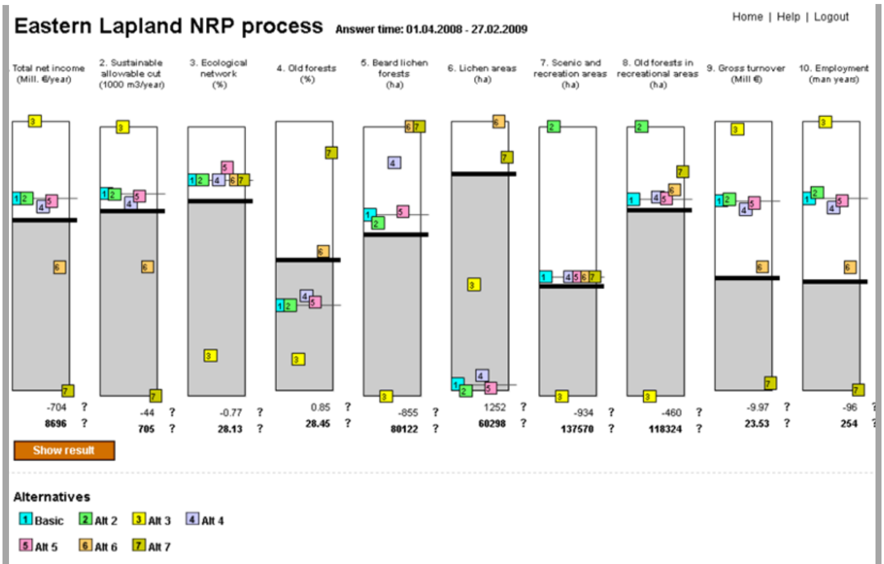

Figure B13-1. *An example of the user interface of the Mesta internet application.*

The stakeholder group collaborated throughout the whole planning process, thus becoming familiar with the properties of the planning area. They were also involved in the creation of alternative strategies, mainly concerning the forest use principles and intensity within the planning area. The actual impact analyses (e.g. GIS analyses and planning calculations) for the alternative strategies were made by experts. As the result of this co-operation between stakeholders and researchers, quantitative criteria values were produced for all ten criteria.

In participatory planning situations, Mesta includes two phases:

1. Each participant uses Mesta individually and defines the alternative that is the most suitable for her/him. At the same time, the corresponding threshold values for the criteria are defined.
2. The results from the first phase are collected and reported to all participants. For example, the participants can be informed which alternatives became selected and by how many participants. After this, the Mesta application can be used to support the group's negotiation process. The negotiation process can start from the mean acceptance threshold values and the participants can go through criteria and try to agree if it is possible to lower the acceptance threshold of some criteria so that new alternatives

The result of the negotiation in Lapland was that the participants were able to collaboratively decide on their recommendation for the future land-use allocation and the forest management principles to be applied in the planning regions. The main benefit of Mesta as a decision-support tool during the negotiation process of the group was that the participants were forced to concentrate on essential aspects of the planning situation and to merge their preferences with the realistic production possibilities of the planning region.

Hiltunen, V. 2012. Developing decision support in participatory strategic forest planning in Metsähallitus. Dissertationes Forestales 141. 47 p. Available at http://www.metla.fi/dissertationes/df141.htm
Hiltunen, V., Kurttila, M., Leskinen, P., Pasanen, K. & Pykäläinen, J. 2009. Mesta: An internet-based decision-support application for participatory strategic-level natural resources planning. Forest Policy and Economics 11: 1-9.
Kangas, A., Kangas, J. & Kurttila, M. 2008. Decision support for forest management. Managing Forest Ecosystems 16. Springer. 222 p.

4.6 Non-monetary choice modeling

The monetary valuation method based on alternatives defined by characteristics of attributes, the choice experiment, can be used without the monetary attribute. Although not typical, this would be an alternative when the monetary payment does not fit to the context, for instance when the local residents were to be asked for how much they would be willing to pay to allocate the peatland to peat industry (Box 14).

Box 14. Analyzing benefits of ecosystem services with non-monetary method

Forest Ecosystem – Several ecosystem services – Non-monetary choice experiment
Anne Tolvanen & Artti Juutinen (Finnish Forest Research Institute)

The choice experiment method is typically used in placing a direct monetary value on ecosystem services. It can also be utilized to investigate factors that determine the demand for ecosystem services as it reveals people's willingness to accept the trade-offs between benefits from ecosystem services provided, that is, how much people are willing to give up some benefit to gain another. Trade-offs can relate to alternative land use options. Depending on which option is realized, people simultaneously win and lose some benefits, such as environmental health, recreation opportunities or employment. The identification of trade-offs helps in finding possibilities to build consensus and solve conflicts in environmental planning.

We present results from a survey being a part of a regional peatland programme in Northern Finland. The programme aims at fitting of peatland management options in the regional plan and it follows the principles presented in the Finnish Government Programme for the sustainable use of Mires and Peatlands, launched in 2012. We investigated residents' opinions towards five peatland use options: timber production, peat production, protection, restoration, and recreation. Our aim was to analyze the potential for socioeconomically sustainable peatland use by investigating conflicting interests, by revealing trade-offs that people are willing to accept, and by studying whether opinions are dependent on socioeconomic and demographic factors. Choice experiment was used to reveal trade-offs between the land use options, and the groups of respondents with different preferences were identified using a latent class model.

We identified three classes of respondents. Environmentalists showed a high preference towards the cessation of peat production and increase of peatland restoration. The Production-oriented class preferred an increase in timber and peat production areas, and the Current use supporters agreed on the present land use policy. All respondent classes however agreed on the increase of nature protection and the present level of timber production and disagreed on the cessation of restoration. The analysis revealed that environmentally minded people who are likely to consider the indirect use values and existence values important are less willing to make trade-offs between ecosystem services than those who emphasize direct use values. As peatland restoration occurs in commercially unproductive peatlands, it improves both the direct use and existence values without reducing provisioning services of peatlands. Therefore, restoration is commonly accepted by the public, in contrast to management options that involve clear trade-offs between ecosystem services.

We conclude that revealing trade-offs that people are willing to accept can enhance sustainable land use planning. Understanding the factors behind people's land use preferences is important because it helps the decision-makers convey the reasons behind their decisions in a way that the general public understands. In implementing land use strategies, such as the Government Programme for the sustainable use Mires and Peatlands in Finland, it may be unrealistic to expect a solution on peat production that all interest groups would completely accept. It is therefore important to openly justify the decisions by facts. For example, peat production should be justified by regional economic effects, or alternatively prohibit it using clear environmental arguments. However, conflicts in themselves are not necessarily a negative thing: they may highlight problems, increase understanding and promote the creation of sustainable solutions.

Tolvanen, A., Juutinen, A., Svento, R. 2013. Preferences of local people for the use of peatlands: The case of the peatland-richest region in Finland. Ecology and Society 18(2), http://dx.doi.org/10.5751/ES-05496-180219

5 Experience on valuation of ecosystem services

The studies valuing ecosystem services have highlighted that preserving the healthy, productive and diverse ecosystem provides benefits to the human society. The ultimate aim of ecosystem service valuation is to assist in reconciling multiple uses of ecosystems, in planning sustainable use of natural resources and in securing the future provision of ecosystem services. Sustainability is supported by regulation at international and national level (legislation), at local level (land use planning), and economic incentives.

About the concept

Ecosystem service concept is established in environmental discussion. The concept aims at clarifying the complex issue of nature's diversity, and illustrates how everything impacts everything. Does it provide any added value or does introducing a new concept make everything even more difficult?

The key is the term 'service'. It reflects coexistence and interaction of nature and the human society. The existence and well-being of the society is dependent on natural resources and their sustainable use. The idea of services is familiar from every-day life and defining the value of services in monetary terms is intuitive.

Classifying and defining links and networks between ecosystem services spotlights even the often invisible supporting and regulating services. These services are essential for the functioning of the ecosystem and for the production of final ecosystem services as intermediate processes.

Besides natural functions and processes, the classification of ecosystem services account for the benefits from the society's use of ecosystems. Utilizing natural resources today and knowing how they have been used in history is part of our cultural heritage and our cultural identity.

The current knowledge on the value of ecosystem services in Finland?

Ecosystem services related to forests and waters are quite comprehensively valued in monetary and non-monetary terms. Less studies concern peatlands and agricultural land. Most Finnish economic valuation applications have focused on the evaluation of projects, such as examples presented in Boxes 1-14. The accounting approach, revealing the economic activity related to an ecosystem, is less common.

Appendices 1 and 2 present lists, though not comprehensive, of economic valuation focusing on project evaluations in Finland. Besides valuation methods, applications are diverse in terms of geographical scale, and in how many services are considered. Most valuation studies concentrate on one ecosystem and on ecosystem services that are of local or regional significance. Recreational services are the most extensively studied in forest and water ecosystems at local, regional, and national level. Most valuation studies relate to a certain sub-national plan or policy. Although many studies related to many planning situations are available, the appropriateness of the results to another project evaluation must be considered case by case.

The value of forest ecosystem services is most extensively valued using wood production national accounting data and several types on environmental-economic calculations. For other ecosystems, the basic provisioning services can be found also from national accounting data (see Kettunen et al. 2012) but the national level ’price tags’ for non-market ecosystem services are not yet available. Besides the ‘total’ value of Finnish forests, the relative importance of services is of interest. The monetary estimates based on expanded national accounting approach may, however, provide different information on the relative importance of services compared to the non-economic approach (Box 15).

Box 15. Ecosystem services in forest accounting – a Finnish case

Forest ecosystem – several services – expanded national accounting, sociological survey
Jukka Matero and Olli Saastamoinen (School of Forest Sciences, University of Eastern Finland)

"Green" accounting aims to expand traditional national accounting systems to include the impacts of human activities on ecosystem goods and services. This is important as the System of National Accounts (SNA) is the major vehicle to measure welfare in the societies. While there are other useful tools (e.g., Human Development Index), no system can compare with SNA in their systematic and detailed coverage of the economy, including use of natural resources.

SNA provides reliable statistics for practically all provisioning services that enter markets and includes, in principle, also products from nature directly used by households. Some maintenance and regulating services – such as dilution and cleaning of waste waters – are included in negative or positive way in the values of industrial, forestry, agricultural, and other products, but they are hidden, not visible in statistics. The task is to trace these services, such as waste disposal and recreation services, and make their value visible.

For example, in the study that attempted to expand Finnish forest account in regard to forest ecosystem goods and services (Matero and Saastamoinen 2007), the disposal services (nutrient retention) of forest for industries were valued using marginal emission abatement costs of available technology (1255 €/t for annual SO_2 emission of 100 000 t and 412 €/t for NO_x emission of 87 000 t), making total 201 M€. When incorporating this into the expanded national account, the same value was deducted from the value of forest industry production to avoid double counting.

The calculation of the value of climate change abatement by forests took into account the effects of forests and forestry on the stock of carbon by emissions from harvesting and decay following natural mortality, sequestration by trees (forest growth), change in mineral soil carbon stock, and the effect of drainage on peat carbon fluxes. The balance between these components makes the annual value of the total contribution to be 1123 M €.

The value of recreational services was based on multiplying time (hours per year, calculated from primary time-use data of Statistics Finland) used by the Finns (aged 10+) for various outdoor recreation activities in forests (Vaara and Saastamoinen 2002), by average net hourly wage rate, multiplied by the share of employed in the population aged 15-74 years, 0.59. This approach resulted in the recreational value of 807

M€ for the forests. An alternative estimate of the value of recreational forest visits, 1316 M €, resulted from multiplying a willingness to pay (WTP) estimate, 4.5 € per visit (Ovaskainen et al. 2001), by a half of the total number of annual forest visits (585 millions) by the Finns. As these forest visits are not a part of commercial tourism, the recreational value of forests would be an additional component of an expanded national account.

Table B15-1. *Value of forest ecosystem services in the Finnish economy in 1995-2002, million € (2000) per year (Matero and Saastamoinen 2007)*

Ecosystem service		**Value m (million €)**
TIMBER		
Net stumpage	59.4 Mm^3 total roundwood removal	1498
Wages in logging		293
Other items (silviculture wages etc.)		244
Carbon tax for harvesting		-1123
Net change in the (living) timber stock	(+) 12.36 Mm^3 stemwood	140
Total		***1052***
FOREST BASED TOURISM	(incl. in VA of tourism ? 2695 M€)	
DISPOSAL SERVICES (nutrient retention incl)		
NOx deposition	55000 t	30
SO2 deposition	105000 t	171
Total		***201***
NONTIMBER SERVICES		
Lichen for decoration		1
Reindeer meat	2.2 M kg +1400 inds	7
Christmas trees		7
Picking berries and mushrooms	37 M h (no land rent)	192
Hunting and game management	21 m h (positive land rent)	109
Other recreational activities in forests	98 M h (no land rent)	509
Total		***825***
BIODIVERSITY LOSS	Existence demand for 650 threatened species	***-463***

CLIMATE CHANGE ABATEMENT		
Emissions (harvesting and natural mortalit/decay)	85.5 Mt CO_2/year (-17.5€/m3 stemwood)	-1184
Sequestration by trees (forest growth)	101.3 Mt CO_2/year	1876
	(23.4€/m^3 stemwood)	
Change in mineral soil carbon stock	+7.3 Mt CO_2/year	136
Effect of drainage on peat CO_2, CH_4 and N_2 fluxes	+15.9 Mt CO_2 eqv year	295
Total		***660***
CHANGES IN SOIL AND WATER 'NUTRIENT' STOCKS		
Nitrogen	3900 t (2700 t to Baltic Sea, 600 t inorganic)	
Phosphorus	300 t(240 t to Baltic Sea)	
Suspended sediments (total erosion by drainage)	63 000 t	
Total		***-129***
TOTAL		***2609***

Table B15-1 lists the values of some other ecosystem services. In all, the calculations show the limited scope of conventional economic accounts in tracing the multiple ways in which forests ecosystem services contribute to human welfare. The study also demonstrates the trade-offs between services, both within forest ecosystem and between the services of forests and other ecosystems.

How the estimates of market and non-market values of forest ecosystem services relate to the results of sociological surveys assessing about the same time the importance of forest uses, benefits and values (Kangas and Niemeläinen 1995 and 3 provincial surveys)? In the surveys, people expressed that they appreciate most forest vitality and health, beauty of landscape, avoiding damages to water, and picking berries and mushrooms as top priorities in this order. Wood production was ranked next to the lowest ranked hunting and game management. However, monetary estimates of wood production were five to ten times larger than any of the monetary estimates of carbon sequestration, nature tourism, nature conservation, and other outdoor recreation. One explanation was that, through surveys, people perhaps highlighted in particular those benefits and values they wish to be better taken into account in future. (Saastamoinen 1997)

The future of environmental and ecosystem accounting seems to be in a stepwise progress. After 20 years of development the UN statistics committee agreed in 2012 the central framework for environmental accounting as a recommendation to all countries. A proposal for experimental ecosystem accounting is also in progress (Kolttola 2012). The safe "make haste slowly"- policy seems to allow much room for ecosystem economists to pursue their important exercises.

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Choosing an appropriate method

A diverse set of valuation approaches is available for valuation of a complex set of interlinked ecosystem services from various viewpoints. None of the methods provides an absolute truth on the value of ecosystem services. The most appropriate method(s) depends on the application.

The advantage of using market data and information on preferences revealed in real markets is that usually no intensive data collection is needed, and the data is based on real choices in real situations instead of hypothetical constructed markets. Real market data reflects the use values of final services.

The stated preference methods apply well in a broad set of services and service combinations. Typically they are the only methods applicable when non-use aspects of ecosystem services are of interest, or when market-based information is not available (e.g., when the change in the provision of ecosystem services will take place in the future).

The advantages of the benefit transfer method are savings in time and money. Compared to other countries, the US especially, Finland has much shorter history of economic valuation and the less great availability of studies. In Finland, the conduction of original studies is highly recommended instead of transferring benefits, to ensure the reliability of estimates.

The several non-economic valuation methods available do serve the complicated planning situations. Ecological, cultural, and social values are often intermingled and layered in the ways that can not be easily translated into economic dimension only. Issues concerning social and environmental justice in ecosystem service governance and distribution of benefits are value ladden and may similarly require deeper analysis than mere economic one can provide.

Sociological surveys provide usually wide information on the preferences of different stakeholders. Apples and oranges can be compared by nutrition values and taste. By highlighting different viewpoints, the potential conflicting views become public, thus increasing the openness of the decision making. Many important ecosystem services are public goods, and their valuation should also reflect the social values along the individual ones.

Applying economic valuation methods

Purely trying to put a price tag on environment is not the main point in economic valuation. Rather, the key point is an attempt to make incommensurable benefits commensurable, measured in same units. Monetary estimates should not be taken as exact numbers but rather illustrations on how each service contributes to the ecosystem functioning or to the wellbeing of the society.

Monetary valuation reveals the welfare changes of ecosystem management decisions. Alternative projects or plans supporting the provision of ecosystem services can be compared to each other. When reliable information on the cost of project are available, monetary valuation of ecosystem services enable justifying whether the plan is worth implementing. Costly implementations are justified if benefits for the society exceed the costs.

Due to interlinkages of ecosystem services, assessing the monetary value of intermediate services is not straightforward. Their monetary value is reflected in the value of final services, and double-counting is to be avoided.

Concerning the generalization of the value of ecosystem services, the values estimated in one context are not easily transferable to another project evaluation. The results of stated preference methods, although applicable in most valuation situations, are always highly dependent on the policy context described in the questionnaire.

Uncertainties

The effect of uncertainties related to valuation of ecosystem services concern the value estimations and the measurement of services on results is worth assessing, especially when the results are used for policy or project evaluation.

The impacts of dynamic effects and feedbacks related to the use and management of the services on the reliability and generalizability of valuation results is crucial especially when ecosystems approach the critical ecological threshold, and the change in ecosystem is reversible only at high cost or irreversible.

At the moment, we may neither be aware of all services nor be able to measure them. The option value refers to future unknown benefits that may be gained from ecosystems, such as not-yet-known medicines or raw materials. Although valuing them in monetary terms is challenging, the sustainable management and use of ecosystems protects these unknown future benefits.

Research and development

When studying the value of changes in ecosystem services, the need to know the initial ecological state as well as to forecast the effects of alternative policies on the ecological state emphasizes the importance of co-operation between natural and social sciences in the ecosystem services valuation research.

The development of appropriate and comprehensive indicator system with monitoring is necessary for the reliable valuation of ecosystem services. The integrated valuation of services provided by several ecosystems requires the understanding of co-operation of ecosystems and of cross effects of values.

Getting a more comprehensive view on the value of ecosystem services of Finnish nature would benefit from a more integrated approach to ecosystem service valuation. Several value categories are to be caught as well as a variety of spatial and temporal scales. Methodological development helps to respond to the diversifying valuation needs of emerging new services and values in changing contexts.

There will probably be growing needs towards integrated valuations and methodological interactions to find each method their own niches where they may best serve the overall aims to satisfy the needs of policy and decision making and management. The diversity calls more systematic analysis how the commensurable and incommensurable measurement approaches can complement each other. In particular, this concerns interactions between economic and non-economic valuation methods. The simultaneous use of economic and non-economic valuation approaches benefits from their comparative advantages and produces useful and more comprehensive information for decision making.

The consideration of interlinked ecosystems (forests, peatlands, agricultural lands, inland waters – and also marine waters and urban ecosystems) and interlinked ecosystem services within an ecosystem and between ecosystems serves several decision situations, including those related to integrated multi-ecosystem management.

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Appendix 1. Economic estimates per person: forest ecosystem

Table below presents the estimated values for several forest ecosystem services, estimated for project evaluation purposes. The list is not comprehensive as the studies conducted in 2005-2012 are missing. The values are per person or per household estimates instead of aggregated annual estimates to the population. The values have been adjusted to €(2012) values using the cost-of-living index.

For reviews on forest ecosystem services, see, e.g. Pouta and Rekola (2004) and Lindhjem (2007).

Year (publ)	Authors	Services	Scope	Area	Population	Valuation method	Scenario	Value in €	Value in €(2012)**
2001	Ovaskainen et al.	recreation	regional	National parks in South Finland	visitors	travel cost	annual recreational value of national parks and hiking areas in Southern Finland	11	13
2001	Huhtala et al.	recreation	national	all national parks	visitors	contingent valuation	annual value of possibility to use national parks and hiking areas	16	19
2001	Huhtala et al.	recreation	national	all national parks	visitors	contingent valuation	annual value of possibility to use national parks and hiking areas	42	51
2001	Siikamäki	biodiversity	national	Finland	citizens	contingent rating	275 000 additional hectares for protection of key biotopes	47	57
2001	Siikamäki	biodiversity	national	Finland	citizens	contingent rating	825 000 additional hectares for protection of key biotopes	78	94
2001	Siikamäki	biodiversity	national	Finland	citizens	contingent rating	550 000 additional hectares for protection of key biotopes	86	104
2002	Mäntymaa et al.	biodiversity	national	private forests	citizens	contingent valuation	155 000 additional hectares	40	48
2002	Mäntymaa et al.	biodiversity	national	private forests	citizens	contingent valuation	430 000 additional hectares	50	60
2002	Mäntymaa et al.	biodiversity	national	private forests	citizens	contingent valuation	705 000 additional hectares	70	83
2002	Kniivilä et al.	biodiversity	regional	municipality of Ilomantsi	residents	contingent valuation	20 000 hectares maintenance of protection area, otherwise used for forestry, peat industry or tourism	49	58
2002	Kuuluvainen et al.	biodiversity	regional	South Finland and Ostrobotnia	residents	contingent valuation	258 000 additional hectares	109	130
2002	Kuuluvainen et al.	biodiversity	regional	South Finland and Ostrobotnia	residents	contingent valuation	1 033 000 additional hectares	202	241
2004	Huhtala	recreation	national	all national parks and recreational areas	citizens	contingent valuation	annual value of possibility to use national parks and hiking areas	19	22
2013	Tyrväinen et al.*	biodiversity	local	Ruka-Kuusamo tourism area	visitors	choice experiment	10 % of 200 endangered species becomes extinct	-37	-37
2013	Tyrväinen et al.*	biodiversity	local	Ruka-Kuusamo tourism area	visitors	choice experiment	10 % of 200 endangered species increase in population size	10	10
2013	Tyrväinen et al.*	recreation	local	Ruka-Kuusamo tourism area	visitors	choice experiment	amount of routes reduce from 100km to 80 km	-10	-10
2013	Tyrväinen et al.*	recreation	local	Ruka-Kuusamo tourism area	visitors	choice experiment	amount of routes increase from 100km to 120 km	n.s.	n.s.
2013	Tyrväinen et al.*	scenery	local	Ruka-Kuusamo tourism area	visitors	choice experiment	traces of intensive forest management 20% -> 10%	11	11
2013	Tyrväinen et al.*	scenery	local	Ruka-Kuusamo tourism area	visitors	choice experiment	traces of intensive forest management 20% -> 0 %	12	12
2013	Tyrväinen et al.*	carbon sequestration	global	Ruka-Kuusamo tourism area	visitors	choice experiment	sequestration reduces from 100 000 tourists' emissions to 80 000 tourists' emissions	n.s.	n.s.
2013	Tyrväinen et al.*	carbon sequestration	global	Ruka-Kuusamo tourism area	visitors	choice experiment	sequestration increases from 100 000 tourists' emissions to 120 000 tourists' emissions	n.s.	n.s.

n.s. = not significantly different from zero. *) Values are per respondent per week. **) Cost-of-living index Official Statistics of Finland (OSF): Consumer price index [e-publication]. ISSN=1799-0254. Helsinki: Statistics Finland [referred: 21.11.2013]. Access method: http://www.stat.fi/til/khi/index_en.html.

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Appendix 2. Annual economic value estimates: water ecosystem

The table below presents the estimates on annual values of water related benefits in Finland. The list is not comprehensive. The estimates are aggregate estimates for the population specified in the study. The values have been adjusted to €(2012) values using the cost-of-living index.

For Nordic reviews on the value of ecosystem services related to waters, see, e.g., Barton et al. (2012) and Söderqvist and Hasselström (2008).

	Authors	Services	Scope	Area	Population	Valuation	Scenario	Payment	Annual value in	Annual value
1993	Mäntymaa	recreation, non-use values	local	Lake Oulujärvi	residents and cottage owners	CVM	improvement of the status of the lake with one class change in usability	?	9,7*	2,2
1993	Mäntymaa	recreation, non-use values	local	Lake Oulujärvi	residents and cottage owners	CVM	prevention of deterioration of the status of the lake	?	14*	3,2
2004	Toivonen et al.	recreational fishing	national	undefined	citizens	CVM	protection of current fish stocks	?	967*	201,9
2005	Parkkila	recreation	regional	River Simojoki	anglers	CVM	growth of salmon stock and doubling of catch	1	0,03	0,04
2008	Ahtiainen	recreation	local	Lake Hiidenvesi	residents and cottage owners	CVM	quality improvement (described with algae blooms, fish, vegetation and, sight depth)	5	0,6	0,6
2008	Ahtiainen	recreation	local	Lake Hiidenvesi	residents and cottage owners	CVM	quality improvement (described with algae blooms, fish, vegetation and, sight depth)	5	7,7	8,3
2010	Vesterinen (Artell) et al.	recreation	national	Finland	swimmers	TC	impact of 1 meter improvement in sight depth on recreational value of one day	1	61,8	76,7
2010	Vesterinen (Artell) et al.	recreation	national	Finland	anglers	TC	impact of 1 meter improvement in sight depth on recreational value of one day	1	86,1	106,9
2010	Parkkila et al.	recreational	regional	River Iijoki	non-local anglers	CVM	restoration of salmon stock	10	1,0	1,1
2012	Lehtoranta et al.	biodiversity, flood	local	Helsinki	residents	CVM	good ecological status of streams by 2015	1	1,4	1,5
2012	Huhtala and Lankia	recreation	national	Finland	cottage owners	TC	summer cottage without algae	1	30,0	35,4
2013	Lehtoranta	recreation	local	Lake Vesijärvi	residents	CVM	improvement of recreational use possibilities and reduction in algae blooms	5	0,6	0,6
2013	Lehtoranta	recreation	local	Lake Vesijärvi	residents	CVM	improvement of recreational use possibilities and reduction in algae blooms	5	1,1	1,2
2013	Lehtoranta et al.	recreation	local	Lake Pielinen	residents	CVM	implementation of the regulation plan of the lake Pielinen	1	0,2	0,2

**) Original values in MFIM. 1 EUR = 5,94573 FIM. Time period of benefit unspecified. **) Cost-of-living index Official Statistics of Finland (OSF): Consumer price index [e-publication]. ISSN=1799-0254. Helsinki: Statistics Finland [referred: 21.11.2013]. Access method: http://www.stat.fi/til/khi/index_en.html.*

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