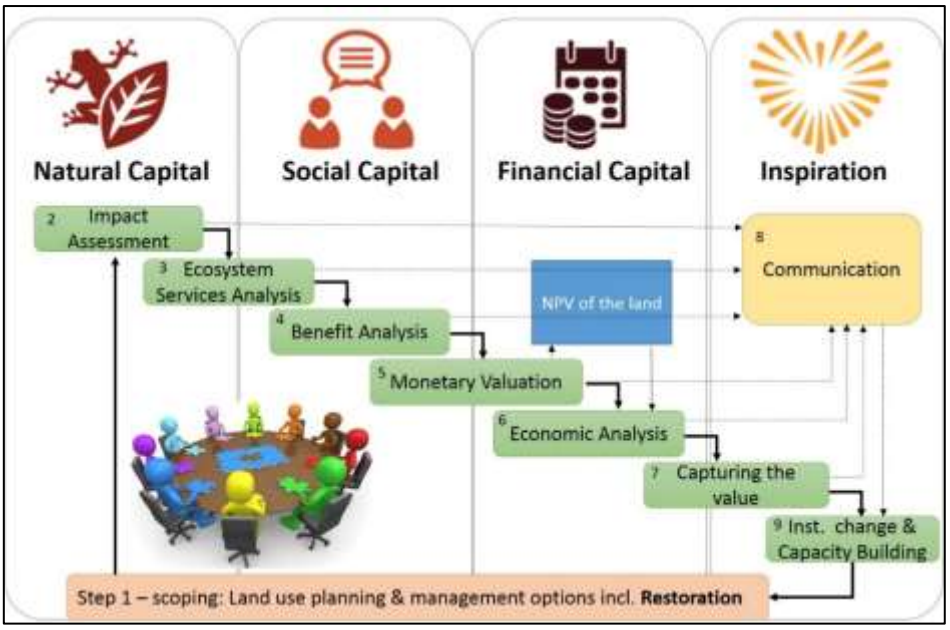
The ESP Guidelines in a Nutshell

(to analyse and capture the benefits of landscape restoration, nature conservation, and sustainable land management)

(Draft - September 2018)

R E S T R I C T E D
(still subject to peer review –comments welcome)

Rudolf de Groot[1,3,5], Simon Moolenaar[2,5], Martine van Weelden[3,5], Iskra Konovska[3,5], Joris de Vente[4]



1) Wageningen University & Research (WUR)
2) Commonland Foundation
3) Foundation for Sustainable Development (FSD)
4) Spanish National Research Council (CSIC)
5) Ecosystem Services Partnership (ESP)

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Foundation for Sustainable Development

ESP Ecosystem Services Partnership

WAGENINGEN UNIVERSITY & RESEARCH

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NOTE: Chapter 3 and 5 are not included in this Nutshell-version

*) Only Annex 1 is included in the hard-copy of these Guidelines; all annexes are or will be made available ONLINE on www.es-partnership.org/esp-guidelines

DISCLAIMER

This is a first draft of these Guidelines (building on an Outline produced in February 2017 (de Groot et al., 2017) which will be continuously updated, and supported by an interactive website. Your comments and active involvement are very welcome (see Box 1 for further details regarding the review and updating process). Please do not quote or distribute these guidelines without permission of the first author: dolf.degroot@wur.nl

Preface and way forward

In spite of increasing evidence of the many benefits of 'nature's contributions to people' ecosystem degradation and loss of biodiversity still continue on a large scale. An important reason is that money spent on nature conservation, landscape restoration and sustainable land management is still seen as a *cost* and not as an *investment* with a high return in benefits: ecological, social and economic. These guidelines should help to analyse and quantify these benefits in a standardised, transparent, and eventually certified way.
This idea for these Guidelines took concrete shape in the fall of 2016 when the Commonland Foundation (www.commonland.com) asked the Foundation for Sustainable Development (www.fsd.nl) to develop a practical methodology to analyse the benefits of their large scale landscape restoration projects in terms of return of natural capital, social capital, financial capital and inspiration.
A first outline of the Guidelines was presented in the spring of 2017 (de Groot et al., 2017) and since then, these Guidelines have been used in several thesis-projects of students from Wageningen University in case study-sites in Spain, South Africa, Morocco and the Galapagos Islands (see acknowledgements). These student-projects helped to test if the Guidelines are applicable to different projects in different environmental and socio-cultural contexts and can be used in a short period of time under often data-poor conditions.
Based on these student projects the Outline was developed further into this first draft of the Guidelines for "*Integrated Ecosystem Services Assessment to analyse and capture the benefits of landscape restoration, nature conservation and sustainable land management*" presented in this Working Paper. As shorthand we will be using the term ESP-Guidelines from here-on[1]

These Guidelines now consist of 9 steps, supported by Annexes with specific information how to implement each step. Both the Guidelines and supporting material are 'living documents' that will be further improved and updated in subsequent versions. An interactive website is being developed to support easy access to the materials: www.es-partnership.org/esp-guidelines . This website is hosted by the Ecosystem Services Partnership (ESP) which is a global network to enhance the science, policy and practice of ecosystem services assessment (www.es-partnership.org).

Set-up of this Working Paper
Chapter 1 explains the purpose and context of these Guidelines in more detail. Chapter 2 presents the Guidelines and the Framework that connects the '4 returns' or benefits of landscape restoration as coined by Commonland (return of natural capital, social capital, financial capital and inspiration) to the 9 steps of the Guidelines, in a nutshell. Chapter 3 describes all 9 steps in more detail, including for each step the aims, possible tools, data needs and data sources. The focus is on the main question: how to determine the effects of ecosystem and landscape restoration on changes in the (monetary) 'Value of the Land'. Chapter 4 provides an overview of more than 80 tools that can be used and a first attempt to develop a decision tree how to choose appropriate tools for different steps to facilitate the practical application of the Guidelines. It also gives a first outline of a system for verification and certification of the appropriate application of the Guidelines and to give assurance to stakeholders and investors of achieving the envisioned conservation measures, restoration efforts and sustainable land management effects. Finally, Chapter 5 presents an example of the application of the Guidelines in one of the Commonland-restoration landscapes (AlVeLal territory in Spain) using the results of the student projects.
The Working Paper is supported by 7 appendices that provide much more detail on the tools, data-collection methods, fact sheets and key sources and references. Most of the Appendices are 'living documents' that will be continuously updated and are available on www.es-partnership.org/esp-guidelines .

[1] To avoid confusion with other guidelines and to not have to use the long title all the time, the term 'ESP Guidelines' is proposed for now since the Ecosystem Services Partnership (ESP) will facilitate the review process and the supporting website (see Box 2 for details)

Way forward
To develop truly comprehensive and practical guidelines to analyse and capture the benefits of landscape restoration, nature conservation and sustainable ecosystem and land management, further testing in real case study situations is essential. In addition to continue carrying out fieldwork in the Commonland restoration sites, other partners will be approached to use the guidelines, give feedback and share data. The Ecosystem Services Partnership (ESP) is ideally suited to provide the online-infrastructure to store and retrieve data that is needed to conduct these integrated ecosystem assessments in a rapid and systematic way.
As a next step we invite everyone who is interested to provide feedback and, possibly, join the team of Lead and Contributing authors (see Box 1).

Also other organisations and potential user-communities will be involved in a next phase (for example GIZ (ELD), IPBES, IUCN, SER, TEEB, UNCCD, WRI, WWF, and others, see box 2) to eventually come to standardized and commonly accepted, and certified, guidelines for *Integrated Ecosystem Services Assessment.*
Once a consolidated version is available, engagement with the business community (eg. the Natural Capital Coalition (https://naturalcapitalcoalition.org/) will be important to stimulate the use in natural capital accounting and other institutional changes needed to take better account of the true value of ecosystems, the true costs of their loss and true benefits of their restoration (see Box 4, Step 6).

BOX 1 **How you can contribute to the further development of the Guidelines:**

This is a first draft of these Guidelines which will be continuously updated. Your help is especially welcome to further develop and improve:
-The framework (fig 4.): is this intuitive, are there steps missing, etc.?
-The steps, e.g. are the descriptions correct/up-to-date, sufficiently detailed, referenced, etc.
-The overview of tools: are you missing tools in section 4.1 (and Annex !)
-The description of the tools (fact sheets)
-Applications of tools and examples of case studies
Your comments on these and other aspects of the guidelines can be sent to dolf.degroot@wur.nl

Also your active involvement as **Lead or Contributing author** is very welcome. For example, we aim to develop each of the 9 steps further by a small but dedicated team of lead and contributing authors supported by ESP. If you are interested please send an email to dolf.degroot@wur.nl
ESP will facilitate the review-procedure and further develop the online data storage and sharing system through an interactive website.
A very first draft can already be accessed here: www.es-partnership.org/esp-guidelines

These ESP Guidelines will be an integral part of the work of the Ecosystem Services Partnership (ESP) ensuring continuous feedback and updating based on application and testing in projects and case studies by ESP members and the global network (now more than 2500 individuals and over 40 organisations). This network can also be instrumental in the development of a quality control mechanism and possibly a certification system. This will be done in close collaboration with related initiatives such as by the Society for Ecological restoration (SER) which released new International Standards for the Practice of Ecological Restoration in 2016 (see also Chapter 4)

Acknowledgements
These Guidelines are the result of a collaborative effort that started in September 2016 by the Foundation for Sustainable development (FSD) with the support of the Commonland Foundation. In addition to FSD staff (notably Martine van Weelden and Iskra Konovska) the very first Outline (De Groot et al., February 2017) was produced with help from Nuket Ipek Cetin (Guest researcher at FSD), and several interns: Nikolaos Symeonidis, Betsheba Muchiri, Gabriela Arabadzhieva, Manjing Xiang, Yingying Xie).
Since February 2017, the guidelines have been tested by many students (see below) who gave valuable feedback and provided important data.

The Commonland landscape restoration project in Spain (AlVeLal-region) was chosen as pilot-project to further test and develop these Guidelines and we much appreciate the help from people at the Spanish National Research Council-CSIC (i.e. Ana Belén Robles and Maria Eugenia Ramos in Granada, and Joris deVente in Murcia) in supervising the students and sharing their knowledge and experience with us.
We thank Helen Ding (WRI), Arnold van Vliet (WU), and Namue Lee (director ESP Asia Office) for comments on earlier drafts, Arjan de Groot for help with Chapter 4 (the overview of methods and tools) and Simone Quatrini for providing some first thoughts on the development of a verification and certification system (Box 9)
With apologies to anyone we may have forgotten! In that case please send a message to dolf.degroot@wur.nl so we will correct this in future versions.

List of student names and projects 2017-2018

Catalina Rodriguez: Ecosystem services and social benefits of different farming systems as perceived by farmers in the AlVeLal-territory, S. Spain (August 2017)

Paula Duske: Effects of landscape restoration and climate change on Water Yield and Crop Pollination in the Segura River Catchment, Spain, using InVEST (August 2017)

Felipe Castano: Effects of landscape restoration and climate change on sediment retention and carbon storage and sequestration in the Segura River Catchment, southeast Spain (Sept 2017)

*Amanda Alfonso Hererra**: Restoring nature to improve livelihoods: effects of ecological restoration on rural livelihoods in the Baviaanskloof, S.Africa (September 2017)

*Jorge Villa Cedeno**, Ecosystem services and benefits of the Miconia Zone on Santa Cruz Island, Galapagos, and incentives for sustainable management (February 2018)

François Laurent: Benefits and socio-economic values of cultural ecosystem services (CES) of different land use systems in the Alvelal territory (April 2018)

Valentina Bedoya: Benefits and values of provisioning and habitat services of different land use types in the AlVelAl drylands, Southeast Spain (May 2018)

Davide Angelucci: Benefits and values of regulating services of different land use systems in the AlveLal territory, South-Eastern Spain (May 2018)

*We also thank the *Friends of the Galapagos Islands* Netherlands for their financial support of the Thesis-work done by Jorge Villa Cedeno on applying an early draft of the Guidelines on assessing the befits of the Myconia-zone in the Galapagos Islands and '*Living Lands'* https://livinglands.co.za/ for their support with the thesis-work done in S.Africa by Amanda Alfonso to use the Guidelines to analyse the effects of ecological restoration on rural livelihoods in the Baviaanskloof, S.Africa

1. Purpose and context of the Guidelines

Most land use (and land use change) decisions are still based on incomplete information about the real welfare effects (costs and benefits) because many so-called externalities (positive and negative) associated with the change in land use and management are ignored or unaccounted for. This leads to loss and degradation of landscape and ecosystems[2] and their services affecting human well-being. Worldwide more than 25% of the land surface is now more or less degraded (UNCCD Global Land Outlook, 2017), costing between 4 and 20 trillion US$/year in terms of damage, repair or replacement costs (Costanza et al., 2014). To 'turn the tide' UNCCD has developed a Framework for Land Degradation Neutrality (LDN) (Orr et al., 2017) and the ESP Guidelines, and underlying website and feedback mechanism, can be seen as a concrete contribution to operationalise the LDN-Framework.
To achieve more sustainable land management, better information and communication is needed on the benefits (monetary and non-monetary) of conservation, restoration and sustainable use of ecosystems and landscapes. To better communicate the benefits of landscape restoration, the Commonland Foundation (www.commonland.com) developed the concept of '4 returns, 3 zones, 20 years' (Fig 1).

Figure 1. The four returns strategy for landscape restoration based on three zones and 20 years (Source: Commonland, 2016).

These 4 returns include:

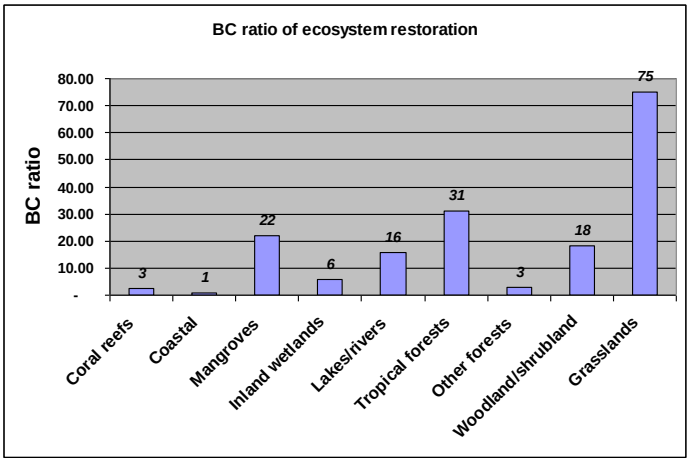
- ✓ *Return of Natural capital*: restoring degraded landscapes brings back biodiversity and a 'healthier' environment;
- ✓ *Return of Social Capital*: e.g. local communities regain opportunities for improving their livelihood and cultural identity;
- ✓ *Return of Financial capital*: including direct monetary effects of restoration (eg. increased income and 'value of the land') and wider economic benefits, both by reduction of the negative 'externalities' caused by degradation (e.g. erosion, land-slides, flooding, loss of resources etc.) and by providing opportunities for (meaningful) employment and increase of new economic activities and new sources of income.

[2] Throughout this Working Paper we will primarily use the term 'ecosystem' to avoid too much repetition of using 'ecosystems and landscapes' since landscapes consist of a mosaic of ecosystems (see also the Glossary)

- ✓ *Return of Inspiration*: the above 'returns' give people hope and a sense of purpose when restoring their landscapes. Inspiration sparks the joint vision that is essential for every restoration process, it is the fuel to keep the process going and it is the result of better knowledge, awareness and practical activities that impact both ecosystems and communities in landscapes.

Restoring ecosystems and managing landscapes more sustainably costs money (in the US alone each year 25 billion US$ is spent on restoration activities (box 4), but if all the benefits provided are properly accounted for, usually the financial and economic returns are much more than the money spent. As Fig 2 shows, the benefit/cost ratio of ecosystem restoration is positive for all ecosystem-types up to a factor of 75 for grassland systems (de Groot et al., 2013). Money spent on restoration should therefore not be seen as *costs* but rather as an *investment* with a high financial and economic return, in addition to the return of natural and social capital.

Figure 2 ***Benefit-Cost ratio of ecosystem restoration*** (De Groot et al, 2013)



An important purpose of the Guidelines is to quantify and, if possible, monetise all the benefits of ecosystem (or landscape) restoration in a credible and verified way, to demonstrate that the investment pays back through multiple returns. In Box 4 (step 6) some examples are given of the monetary and economic benefits of ecosystem restoration based on actual case studies as information and inspiration for further developing these guidelines.

Context

To assess the many benefits ecosystem restoration, nature conservation and sustainable land management in a systematic, effective and efficient way, clear guidelines supported by practical tools and online databases, are essential. Only recently, several organisations have produced guidance documents for assessment of ecosystem services for use in environmental planning, management and decision making (see Box 2).

Box 2 shows that especially in the last few years (since about 2016) several organisations have started producing comprehensive guidelines and toolkits (e.g. GIZ, WRI, IUCN, UNCCD (LDN/ELD), whereby Stanford & WWF started already many years ago with the InVEST model which is one of the most used tools for ES assessment.

Besides being often rather lengthy documents (250 pages and more) these existing guidance documents, toolkits and project-manuals usually focus on selected aspects of the assessment (quantification, valuation, financing etc). or on specific applications (CBA, planning, management, policy), or biomes (e.g. wetlands, forests etc.) and are not always easy to implement. Also, most lack a mechanism to regularly update and further improve the guidelines and tools, and often have no direct access to databases (on indicators, values, case studies etc.).

The ESP Guidelines presented in this Working Paper build on this knowledge base and aim to condense the already existing information into a practical guide supported by an interactive website that is easy-to-use for on the ground quantification, valuation, economic analysis and capturing of the benefits.

BOX 2: Related guidelines and toolkits for Integrated Ecosystem Services Assessment

Some key-guidelines and tools, produced by international organisations, are listed below in alphabetical order. Full references are given in the Reference list at the end of these Guidelines. In addition, there are many national organisations working on ES-assessment guidelines. A more complete list of ES-assessment methods and tools is given in Annex 1 (and Chapter 4) which will be updated regularly by the **Ecosystem Services Partnership** (see ESP website under 'SERVICES' for Guidelines & Toolkits (www.es-partnership.org).
In addition to the below organisations also the websites from the MA (www.maweb.org), TEEB (www.teebweg.org) and IPBES (www.ipbes.net) provide many useful reports and links, as well as EU supported initiatives: www.oppla.eu and www.maes-explorer.eu which give access to many Europe projects and initiatives such as ESMERALDA, OpenNESS, OPERA's, CICES, MAES, etc.
In the US the National Ecosystem Services partnership (NESP) is very active: https://nicholasinstitute.duke.edu/focal-areas/national-ecosystem-services-partnership/

GIZ (German Development Assistance Agency): the GIZ-program on "**Integrating Ecosystem Services (IES) into development Planning**" (2012-2018) has several useful guidance documents (http://www.aboutvalues.net/). GIZ also supports several other important initiatives, such as the ESAV-program (to increase policy impact of ES Assessment and Valuation) and the Economics of Land Degradation ELD-initiative (http://www.eld-initiative.org/) with UNCCD and Korean Forest Services (KFS)

IUCN: **Tools for measuring, modelling and valuing ecosystem services: guidance for Key Biodiversity Areas, natural World Heritage Sites, and protected areas**. Neugarten, et al, 2018. www.iucn.org/pa_Guidelines, complementary resources: www.cbd.int/protected/tools

UNCCD Orr et al., 2017 Scientific **conceptual framework for land degradation neutrality**: a report of the Science-Policy Interface. UNCCD, Bonn 128 pp

UNEP-WCMC: guide to select and measure ecosystem service indicators (Brown et al., 2014)

World Resources Institute: produced many useful guidance reports: "**A guide to selecting ecosystem service models for decision making**" (Bullock & Ding, 2018), **"Roots of Prosperity: the economics and Finance of Restoring Land",** Ding et al., 2017. And several reports by Landsberg et. al on use of ES in Impact Assessment and Corporate ES reviews

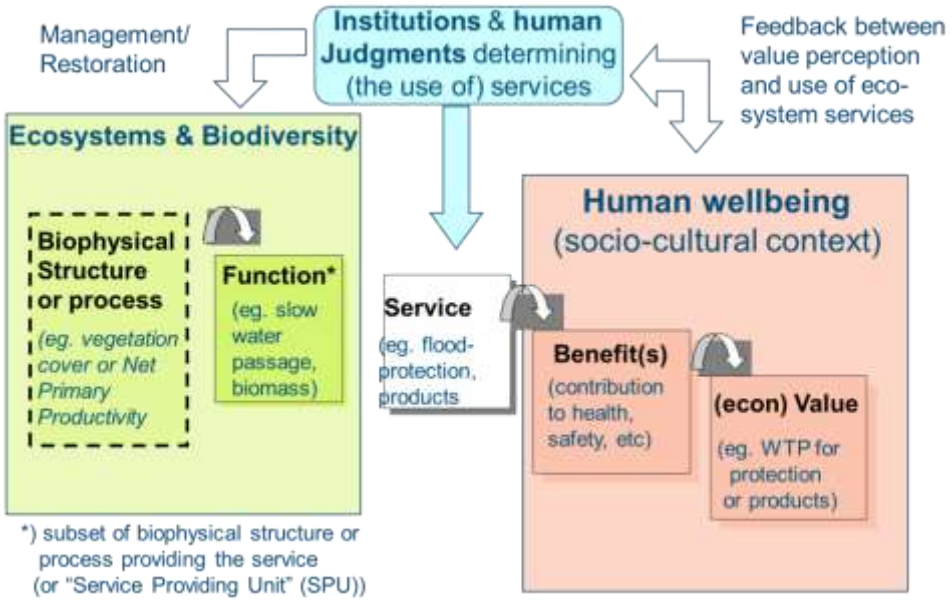
Some more specific Guidelines focussed an particular biomes or tools*: (alphabetical)
-DEFRA (2007): An introductory guide to valuing ecosystem services. (63 pp) www.defra.gov.uk
-ES-assessment Support Tool: http://www.guidetoes.eu/
-ES Natura 2000 sites http://ww2.rspb.org.uk/Images/natura_2000_guidance_manual_tcm9-399208.pdf
-Ecosystem Services Toolkit: Value of Nature task Force (2017), Canada
-INVEST: Natural Capital Project https://naturalcapitalproject.stanford.edu/invest/
-LIFT: -Shames, Scherr and den Besten, 2017. Landscape Investment Finance Tool (LIFT): Manual and Kit. Publ. by Eco-agriculture Partners and IUCN-NL
-Maes et al., 2016. An indicator framework for assessing ecosystem services
-NESP, 2014: Federal Resource Management and Ecosystem Services Guidebook
-Natural Capital Protocol (via Natural Capital Coalition): focussed on the business community
-Ramsar: Guidelines for valuing the benefits from wetlands (de Groot et al, 2006)
-TESSA: Birdlife International and WCMC: TESSA* (Peh et al., 2013)

* These are some popular tools that cover some of the aspects included in the Guidelines presented in this Working Paper (**see Annex 1 and Chapter 4 for a more complete overview incl. references**)

2. The Guidelines in a nutshell

To develop practical Guidelines for Integrated Ecosystem Services Assessment to analyse and capture the benefits of landscape restoration, nature conservation and sustainable land use, it is important to understand the 'full' (integrated) effects, directly and indirectly, on human wellbeing. To make the links between ecosystems and human wellbeing more clear, the framework developed for the TEEB study (The Economics of Ecosystems and Biodiversity) (www.teebweb.org) is a useful starting point (see Figure 3).

Figure 3 TEEB Framework to link ecosystems to human wellbeing.

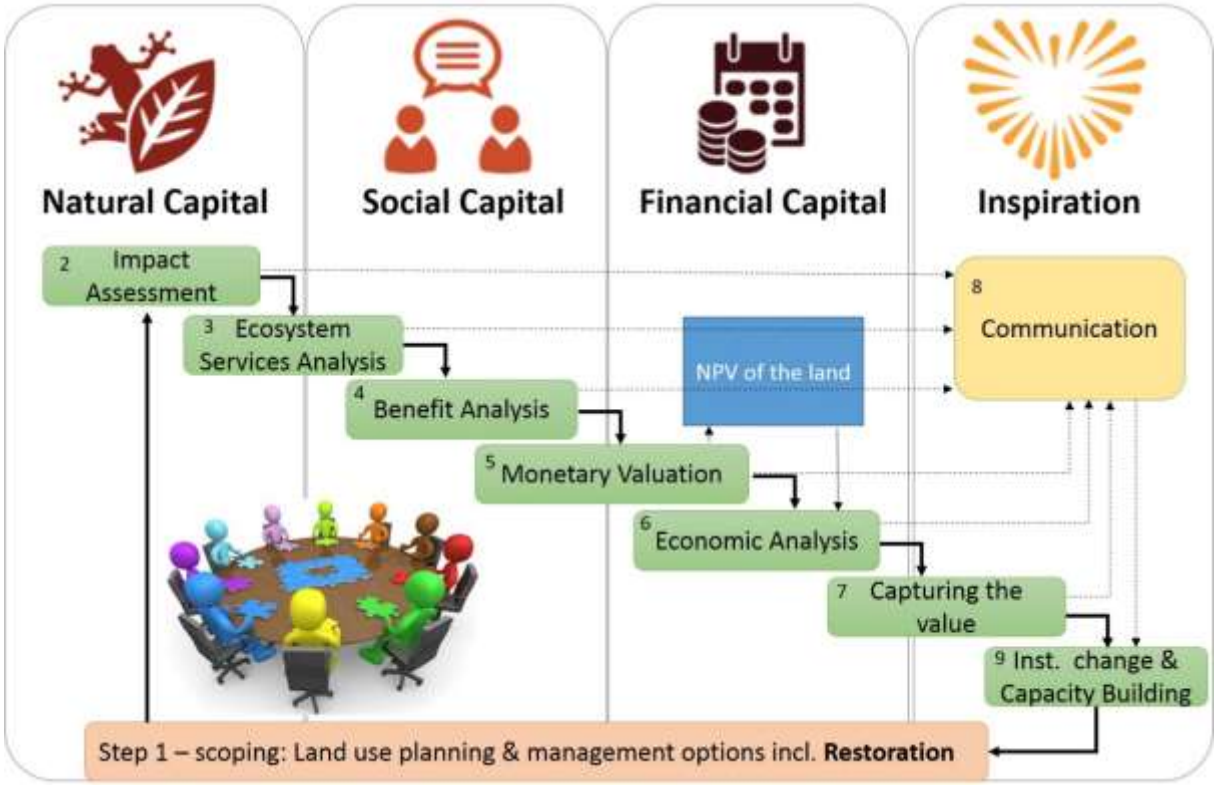


Source: de Groot et.al, 2010 (adapted from Haines-Young, R. and M. Potschin, 2010)

Figure 3 shows the central role of the concept of Ecosystem Services to understand, and quantify, the connection between Ecosystems and Human Wellbeing. In the TEEB study, Ecosystem Services are defined as the direct and indirect contributions of ecosystem to human wellbeing (de Groot et al., 2010). Slightly different definitions are given by the Millennium Ecosystem Assessment (MA, 2005), IPBES (2015) and others but the common aim is to demonstrate that ecosystems contribute to human wellbeing in many ways, including so-called provisioning services (clean water, food, raw materials and many other resources), regulating services (e.g. prevention and reduction of environmental risks such as flooding and erosion, carbon sequestration, biological control, pollination and many other beneficial processes), habitat services (maintenance of biodiversity and nursery-areas) and cultural services (non-material benefits such as recreation, inspiration for culture and art, science and education).
These services provide many benefits (health, safety etc.) which can, if needed, be quantified in monetary terms (market and non-market values), and measured in terms of wider economic benefits (e.g. contribution to employment and national accounts). Information about the monetary and economic value should be communicated to the institutions involved in planning and decision-making. Improved knowledge and awareness will, hopefully, lead to changed perceptions on the importance of ES and the development of incentives for, and investments in more sustainable ecosystem management and restoration (de Groot et al., 2010).

Building on the TEEB framework, the Commonland approach and other sources of inspiration a *Framework for Integrated Ecosystem Services Assessment* was developed (see Fig 4).

Fig. 4 Framework for integrated ecosystem services assessment
(to analyse effects of land use change and ecosystem management)



Note: Although the steps (2-9) largely coincide with the 4 Returns, there is not a strict 1 to 1 relationship. Also a strict separation between steps (eg. monetary valuation and economic analysis) and even between 'Capitals' (eg. employment is, or can be, part of both social and financial capital) is often not possible. The Framework is therefore mainly conceptual, showing all the components of the 'system' and their main relations. For analytical purposes much more detail is needed on methods and tools needed to implement each step, and associated indicators. This is explained in chapter 3

The 9 steps in the Framework, and of the Guidelines are briefly explained below.

1) Scoping: Before starting an assessment, the scope, context and purpose of the assessment should be made clear, in close consultation with the most relevant stakeholders, to avoid collecting unnecessary data or forgetting important aspects.

2) Impact Assessment: this step involves assessing the direct impacts (positive and negative) of restoration, or other intervention in the landscape, on ecosystem structure & processes (vegetation, runoff) as well as the secundary effects in terms of changes in the functioning of the landscape (i.e. the (carrying) capacity of the landscape to provide services) compared to the baseline (e.g. loss of vegetation leading to erosion and loss of productive capacity).

3) Ecosystem Services analysis: effect (of restoration or other intervention) on changes in actual, and potential, use of specific ecosystem services. E.g. planting trees will reduce erosion (see step 2) thus enhancing the capacity of the landscape to provide resources (eg. wood, fruit), clean the air, provide habitat for biodiversity and increase aesthetic quality possibly providing more recreational benefits. On the other hand, it might negatively affect water availability for irrigation or consumption. Thus, the **total** bundle of ES should be taken into account, including trade-offs, when analysing the return of Natural Capital.

4) Benefit analysis: changes in ES as analysed in Step 3 will have effect (positive or negative) on health, livelihood, cultural identity, and other wellbeing (social & human-capital) indicators (e.g. jobs, education, security, social-cohesion). In this step these benefits are quantified in non-monetary terms.

5) Monetary valuation: once we understand, and preferably quantified, the effects of land use change (e.g. restoration) on ecosystem services (step 3) and benefits (step 4) we can analyse the monetary effects using direct market values, indirect market values and non-market values to determine changes in Total Economic Value of the bundle of ES provided by the restoration activities. If so desired, the TEV can be used to calculate changes in the Capital or Net Present Value (NPV) of the land after restoration (or other land use change measures).

6) Economic analysis: this step investigates the implications of ecosystem restoration for the local/regional/national economy in terms of economic indicators, e.g. employment, increased tax revenues, corporate profits, return to investors, etc. Also the change (usually increase) in value (NPV) of the land (see step 5) should be part of the economic analysis.

7) Capturing the value: based on step 5 and 6, which together provide information on the return of financial capital, incentives (financial or otherwise) can be developed to invest in ecosystem restoration and/or sustainable management.

8) Communicating the value (and benefits) to generate awareness and support ('inspiration') for the measures needed to implement the incentives, communication activities can be employed after any of the steps (e.g. simply providing information on the return of ecosystem services (step 3) and their benefits (step 4) might be enough to move to step 9 (changing institutions and behaviour) without having to go through the more complicated and time-consuming efforts to calculate monetary (step 5) and economic (step 6) effects.

9) Capacity building and institutional change: to ensure implementation of the outcome of the assessment in long term policy, institutional and management changes at relevant scale levels (eg. ranging from local capacity building programs to national policies and institutions) are needed.

For a comprehensive assessment of the effects of restoration (or other interventions in the landscape) ideally all 9 steps should be included. Depending on the situation (available data, time and funding) and required level of detail this can be done in just a few months or may take several years (especially if it includes long-term monitoring and establishing societal change).

It should also be noted that there is some overlap between steps, and in practice some steps can, and should be performed simultaneously. Also, not all assessments will be able (or require) to perform all steps in the same detail depending on the aim and context of the assessment.

4 Overview of available assessment tools

With over 80 tools (see Table 8 and Annex 1) it is not easy to quickly decide which tool is most appropriate to be used for which assessment step and under which circumstances. Usually different tools can be used for each step and often one tool can be useful for several steps. Ideally, a 'decision-tree' should be developed to help the user find the most appropriate tool(s) for the purpose of the assessment at hand.

For each method/tool separate factsheets have been made that give much more detailed information (Annex 2). **Annex 1** gives a more detailed overview with key information about each method/tool and hyperlinks to websites and additional literature [=excel table]

Table 8 Overview of tools and their relation to the 9 steps
For a detailed description of the tools see Annex 1 and 2

Methods & Tools	**Step 1** Scoping	**Step 2** Impact Assess-ment	**Step 3** Ecosys-tem Services Analysis	**Step 4** Benefit Analysis	**Step 5** Mone-tary Valuatio n	**Step 6** Econo-mic Analysis	**Step 7** Capturin g the value	**Step 8** Commu nicating. the value	**Step 9** Inst. change and Cap. builidng
Aries	X		X	X	X				
Bayesian Belief Network		X	X	X	X	X			
Benefit Transfer					X				
Choice Modelling					X				
CLIMSAVE		X		X		X			
Contingent Valuation					X				
Cost-Benefit Analysis						X			
Cost-Effectiveness Analysis				X	X	X			
Co$ting Nature		X	X						
Damage cost avoided				X	X				
Deliberative assessment			X	X					
Defensive expenditure					X				
EcoAIM		X	X						
EcoMetrix			X				X		
ECOPLAN		X	X	X	X	X			
Ecosystem Portfolio Model		X							
Ecosystem Services Review	X	X	X						
Ecosystem Valuation Toolkit					X				
Environmental Profit & Loss Account						X			
Environmental & Social Impact Assessment	X	X	X						
Ecosystem Services Review for Impact Assessment	X	X							
ESTIMAP			X						
ESValue			X						
FOPIA									
GISCAME		X	X						
GLOBIO		X							
GRACE			X						

Group/participatory valuation					X				
Hedonic pricing					X	X			
IBAT			X						
Influence and Importance Matrix									X
InVEST		X	X	X		X			
IPBES	X			X					X
i-Tree		X	X						
Language recommendations									X
LUCI		X	X						
Macro-ecological models		X	X						
MA	X								
MIMES		X	X						
Multi-criteria analysis				X		X			
Narrative assessment			X	X					
NAIS					X				
Natural Capital Protocol	X			X		X			
Net factor income					X				
OPAL		X	X						
Q-methodology		X	X	X					X
PGIS			X						
PES							X		
Phenomenological models		X	X						
Photo-elicitation surveys			X						
PA-BAT				X					
Production function					X				
Process-based models		X	X						
Public pricing					X				
RAWES									
Replacement cost					X				
Restoration cost					X				
RESTS	X								
Scenario planning		X	X						
SolVES			X		X				
Spatial proxy models		X	X						
Spreadsheet methods		X							
State and transition models		X	X						
SEA		X	X	X					
SEEA Central framework						X			
TEEB	X	X	X	X	X	X	X		X
Time-use assessment					X				
TESSA	X	X	X	X	X	X	X		X
Trait-based models			X						
Travel cost					X				
UNEP-SETAC on LCA	X	X	X	X		X			
Value transfer				X	X				

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Annex 1 Alphabetical list, and short description, of methods, tools and models relevant to Ecosystem Service Assessment

Name of tool or method	Abbreviation	Brief description	Basic source(s) or references
Acting on Ecosystem Service Opportunities	ESO	• The ESO guidelines provide a detailed step-by-step guide for identifying and planning an economic instrument for conservation and for sustainable local development. • The focus is on involving communities in areas with high biodiversity or important ecosystems and enhancing their stewardship role. The methods assists in designing and implementing the selected instruments.	http://www.aboutvalues.net/method_database/#
Artifical Intelligence for Ecosystem Services	ARIES	• ARIES is a networked software that redefines ES assessment and valuation by mapping ES flows. • ARIES aims to quantify ES in a manner that acknowledges dynamic complexity and its consequences, but keeps its models sufficiently simple to remain tractable, general and scalable to varying levels of detail and data availability (Villa et al, 2014).	http://aries.integratedmodelling.org/ Villa et al., 2014 Villa et al., 2009
Bayesian Belief Network	BBN	• BBN is a diagrammatic representation of socio-ecological systems, developed by combining knowledge of scientists and practitioners about the supply and demand of ecosystem services (ES). • BBN generates a framework of nodes and links to formalize the flows of information from ecology to economics and enhances transparency about the data in question. In general, it is is a graphical representation of a probabilistic dependency model.	Loch Leven case study http://openness.hugin.com/caseStudies/LochLeven_Habitat
Benefit Transfer and Use Estimating Model Toolkit		• Benefit Transfer and Use Estimating Model Toolkit can facilitate a quick benefit transfer analysis to quantify annual economic benefits from a variety of ecosystem services by using primarily secondary data. It provides publicly available spreadsheets, and uses function transfer to value changes in ecosystem services in the U.S. • The method is based on using data from one study site and applying them to a (potentially far-away but still similar) second study site.	http://dare.agsci.colostate.edu/outreach/tools/ Loomis & Richardson, 2008
Choice experi-ments		• Choice Experiments belongs to the family of stated preference valuation methods. It is a hypothetical method in such that it asks people to make a choice based on a hypothetical scenario. The method relies on the idea that any good or service can be described in terms of its attributes or characteristics. Changes in attribute levels essentially result in a different good, and choice modelling focuses on the value of such changes in attributes. Values are inferred from the hypothetical choices or tradeoffs that people make between different combinations of attributes. • The method is especially suited to policy decisions where a set of possible actions might re sult in different impacts on ecosystem services.	Koetse et al., 2015
Climate Change Int. Ass Method for Cross-Sectoral Adaptation and Vulne-rability	CLIMSAVE	• The CLIMSAVE impact assessment platform is a user-friendly, interactive web-based tool that allows stakeholders to assess climate change impacts and vulnerabilities for a range of sectors, including agriculture, forests, biodiversity, coasts, water resources and urban development. • The linking of models for the different sectors enables stakeholders to see how their interactions could affect European landscape change. Outputs from the linked models are translated into ES in order to link climate change impacts directly to human well-being.	http://www.climsave.eu/climsave/index.html Harrison et al., 2015
Contingent valuation		• The contingent valuation (CV) method is a method of estimating the value that a person places on an ecological good. It can be used to estimate economic values for all types of ecosystem services. • The method involves directly asking people for their maximum willingness to pay (WTP) for a positive change in an ecosystem service, or for their minimum willingness to accept (WTA) a negative change in an ecosystem service. • The underlying premise of the method is that a hypothetical, yet realistic, market for buying or selling the use and/or preservation of an ecosystem service can be described in detail to an individual, who then participates in the hypothetical market by responding to a series of questions.	Koetse et al., 2015
Corporate Ecosystem Services Review		• ESR is an analytical framework, which consists of a structured methodology that helps managers proactively develop strategies to manage business risks and opportunities arising from their company's dependence and impact on ecosystems. Businesses can either conduct an ESR as a stand-alone process or integrate it into their existing environmental management systems.	Hanson et al., 2012
Cost-benefit analysis	CBA	• Cost-benefit analysis (CBA) is a framework method which allows for the systematic consideration of the economic costs and benefits of development activities including policies, programmes and projects. • All the benefits and costs of a proposed policy or project are valued, added and compared. When the benefits outweigh the costs (the 'net benefit' is positive), the proposed change is considered to be economically efficient.	http://aboutvalues.net/data/method_navigator/values_method_profile_cost_benefit_analysis_en.pdf

Cost-effectiveness analysis	CEA	• Cost-effectiveness analysis is a method for comparing the costs of different options for achieving a similar or given outcome. It thus treats outcomes or benefits as common to all alternatives although potentially to varying degrees and focuses only on the costs associated with achieving these outcomes. The results can greatly assist decision makers in assessing a program's efficiency.	http://aboutvalues.net/data/method_navigator/values_method_profile_cost_effectiveness_analysis_en.pdf
Co$ting Nature		• Co$ting Nature is a web based tool for analysing ES provided by natural environments, identifying the beneficiaries of these services and assessing the impacts of human interventions. This Policy Support System (PSS) is a tested for the development and implementation of development and conservation strategies focused on sustaining and improving ES and their environmental foundations. • It calculates the spatial distribution of ES for water, carbon, hazard mitigation and tourism and combines these with maps of conservation priority, threatened biodiversity and endemism to understand the spatial distribution of critical ecosystems. • The tool identifies the potential and realised services. These data are combined with analysis of current human pressures and future threats on ecosystems and their services in order to assess conservation priorities.	https://ebmtoolsdatabase.org/tool/costing-nature-coting-nature http://www.policysupport.org/costingnature Brown et al., 2014
Damage cost avoided		• The damage cost avoided is a method that estimates values of ecosystem services based on the value of property protected or the cost of actions taken to avoid damages, as a measure of the benefits provided by an ecosystem.	Koetse et al., 2015
Deliberative assessment		• Deliberative valuation is based on the assumption that valuation is a social process in which values are discovered, constructed and reflected in a dialogue with others (Wilson and Howarth 2002). Therefore, deliberative valuation invites stakeholders and citizens (the general public) to form their preferences for ecosystem services together through an open dialogue, which allows consideration of ethical beliefs, moral commitments and social norms beyond individual and collective utility (Aldred 1997, Satterfield 2001, Wegner and Pascual 2011). • Deliberative valuation is highly appropriate to elicit sociocultural values and those value dimensions which are directly related to the quality of life (human well-being). They can also be used to elicit economic values if they are combined with monetary approaches.	Barton et al., 2017
Defensive expenditure		• The method is based on the assumption that individuals and communities spend money on mitigating or eliminating damage caused by adverse environmental impacts. This is the case, for example, for double-glazed windows designed to reduce traffic noise, extra filtration for purifying polluted water, air conditioning for avoiding polluted air, among other benefits. These expenses can be considered as minimum estimates of the benefits of mitigation, since it is assumed that the benefits derived from avoiding damage are higher than or at least equal to the costs incurred for avoiding it.	Markandya, 2014
Ecologicical Asset Inventory and Management	EcoAIM	• EcoAIM is a decision support framework and GIS-based tool to map and value ecosystem services at the landscape scale. • The tool is designed to (1) inventory ecological services and help in making decisions regarding development, transactions, and ecological restoration; (2) develop specific estimates of ecosystem services in a geographically relevant context, and (3) offer the means for evaluating tradeoffs of ecosystem services resulting from different land or resource management decisions. • EcoAIM consists of two components: a decision support framework and a geospatial modeling tool. The decision support framework is developed as part of an initial problem formulation step in EcoAIMTM, and it consists primarily of a scalable and iterative structured stakeholder engagement process. The information garnered from these stakeholder interactions is used to identify the models that would best describe the biophysical production functions that link endpoints to land-use changes. Stakeholder engagement is also intended to determine the importance of stakeholder preferences regarding ES to land-use decisions, and if sufficiently important, to elicit preference weightings for ES.	Booth et al., 2014
EcoMetrix		• EcoMetrix is a proprietary software system that aims to help local governments in designing and implementing ES conservation programs, including payment for ES programs. EcoMetrix tool is used to quantify the impacts and benefits to ecosystem functions and ecosystem services that result from development or restoration activities. • EcoMetrix is based on algorithms for determining ecosystem function scores describing how well each relevant function is performed. These algorithms are developed for the EcoMetrix data base in a four step process.	http://www.parametrix.com/
ECOPLAN Assessment Tools		• ECOPLAN aims to create spatially explicit information and tools for the assessment of ES. These tools are for the evaluation of functional ecosystems as a cost-efficient and multi-purpose strategy to improve environmental quality. ECOPLAN will develop open source end-product to identify, quantify, value, validate and monitor ecosystem services.	https://www.uantwerpen.be/en/rg/ecoplan/

		• 7 tools are developed under ECOPLAN; ECOPLAN monitor, ECOPLAN webviewer, ECOPLAN impact database, ECOPLAN QUICKScan, ECOPLAN Scenario evaluator, ECOPLAN Trade-off, ECOPLAN participation tool	
Ecosystem Porfolio Model	EPM	• EPM integrates ecological, socio-economic information and associated values of relevance to decision-makers and stakeholders. It uses a multi-criteria scenario evaluation framework, GIS analysis and spatially-explicit land-use/land-cover change-sensitive models to characterize changes in important land-cover related ecosystem values related to ES and functions, land parcel prices, and community quality-of-life metrics.	http://pubs.usgs.gov/sir/2009/5181/ Labiosa et al., 2013
Ecosystem Services Review for Impact Assessment	ESR	• The Ecosystem Services Review for Impact Assessment (ESR for IA) provides a step by step guidance on assessing a project's impacts and dependence on ecosystem service and thereby helping managers proactively develop strategies to manage business risks and opportunities. • Businesses can either conduct an ESR as a stand-alone process or integrate it into their existing environmental management systems. • The ESR for IA provides practical instructions for Environmental and Social Impact Assessment (ESIA) practitioners to address ecosystem services throughout the ESIA process in a systematic and efficient manner.	Hanson et al., 2012 Landsberg et al., 2011 Landsberg et al., 2014 http://www.wri.org/publication/ecosystem-services-review-impact-assessment
Ecosystem Services Value	ESValue	• Ecosystem Services Value (ESValue) is a computer based decision support tool that maps stakeholder preferences for ecosystem services. • The ESValue tool facilitates the comparison of what can be produced (i.e., the production function) with what participants want to be produced (i.e., the valuation function) to evaluate tradeoffs between natural resource management strategies. • The objective of the tool is to integrate existing information and expert opinion with stakeholder values to efficiently and effectively identify the key site-specific ecological effects and resulting change in economic value for different management strategies.	Bagstad et al., 2013
Ecosystem Valuation Toolkit	EVT	• Ecosystem Valuation Toolkit (EVT) is a comprehensive, searchable database of ecosystem service values. The quantity and quality of the data and the advanced filtering and reporting tools allows the database to quickly generate reliable ecosystem service values for virtually any location and ecosystem in the world. • EVT gives nature a voice at the negotiating table by providing transparent and defensible monetary values for natural assets. • EVT offers researcher's library, SERVES (web-based tool for calculating ES values and performing natural capital appraisal), resources	http://esvaluation.org/
Environmental Profit & Loss Account	EP&L	• An Environmental Profit and Loss Account (E P&L) is an effort to account, in financial terms, for the Ecosystem Services upon which a company and its entire value chain rely. It aims to place a monetary value on the environmental impacts of an organisation and its value chain. In the EP&L, the "Profit" refers to any company activity that benefits the environment, whereas the "Loss" refers to activities that adversely impact the environment. How is an EP&L applied? • Awareness and Transparency Tool • Identification of Environmental Hot Spots • Risk Management • Sustainable Supply Chain Management	Novo Nordisk 2014 (http://www2.mst.dk/Udgiv/publications/2014/02/978-87-93178-02-1.pdf)
Environmental and Social Impact Assessment	ESIA	• ESIA is a way to identify, predict and assess the type and scale of potential biodiversity impacts, and opportunities to benefit conservation, associated with any business activities or projects.	Landsberg et al., 2011 www.ifc.org/BiodiversityGuide
EnVision		• EnVision is is an agent-based simulation model for the development and anslysis of spatially explicit land change simulations. It consists of a spatially explicit, multiparadigm modeling framework for the analysis of natural/human systems as well as allows for exploring alternative future scenarios. • It is a GIS-based tool for scenario-based community and regional integrated planning and environmental assessments. It provides a robust platform for integrating a variety of spatially explicit models of landscape change processes and production for conducting analyses of alternative future scenarios.	http://envision.bioe.orst.edu/
ESTIMAP		• ESTIMAP is is a GIS model based approach to quantify and model ecosystem services. It consists of a suite of separate models for a spatially explicit assessment of three ecosystem services (recreation, pollination and coastal protection) at continental scale. They are all developed following the CICES classification (Haines-Young & Potschin, 2013) and framed in the ES cascade model which connects ecosystem structure and functioning to human well-being through the flow of ES.	Zulian et al., 2013 Zulian et al., 2014

		• The models are dynamically linked to LUISA, the JRC land use modeling platform (Lavalle et al 2011). This provides the opportunity to evaluate the impact of different scenarios of land use changes on ES provision.	
GISCAME	(formerly "Pimp Your Landscape")	• GISCAME is a web-based software that is designed to support "the simulation, visualization, and evaluation of land use changes and a comparative assessment of ES". Due to its modular structure, problems can be elaborated individually from different perspectives. • The primary objectie of the program is to provide an evaluation of the land use according to the knowledge available in the studied region and to provide guidance on weighing alternative options for a proposed action. GISCAME considers the landscape as an integrative layer for interactions between different land use types, land users, and ecosystem processes, which contribute to the provision of ecosystem services. • It allows to test alternatives for LULC scenarios and their impact assessment on the targets for land use planning which can be presented as ES (Koschke, 2015).	http://www.giscame.com/giscame/english.html Furst et al., 2013 Koschke, 2015
Global Environmental Flow Calculator	IWMI	• Users of this software apply environmental flow curves – graphical representations of the percentage of time that rivers or streams reach specific discharges (m3/s) – to inform river management decisions. Healthy ecological functioning in rivers requires a minimum discharge. Users therefore find the tool helpful in: i) identifying anticipated hydrological implications of land use planning, and ii) making management decisions based on predicted flow regimes. A map interface allows the model user to view flow duration curves of six 'environmental management classes', ranging from "unmodified" to "critically modified" conditions, for their river of interest.	http://www.aboutvalues.net/method_database/#
Global Biodiversity Model for Policy Support	GLOBIO	• GLOBIO is a modelling framework to calculate the impact of environmental drivers on biodiversity for past, present and future. • GLOBIO is based on cause-effect relationships, derived from the literature. To use GLOBIO no detailed species data are needed. Instead, the model uses spatial information on environmental drivers as input.	Schipper et al., 2016 http://www.globio.info/home
Guidance for the Rapid Assessment of Cultural Ecosystem Services	GRACE	• GRACE defines cultural ecosystem services as encompassing environmental spaces (e.g. forests, gardens, desert, seascapes, farmland) and cultural practices (e.g. creating and expressing, producing and caring, playing and praying) that together give rise to the experience of valued material and non-material benefits (Church et al., 2014, UK National Ecosystem Assessment Follow-on. Work Package Report 5: Cultural ecosystem services and indicators. UNEP-WCMC, LWEC, UK). • Primarily aimed at conservation and development NGOs working with communities, GRACE is intended to help decision makers recognise and understand the cultural benefits provided by the natural world, and take them into account in decisions about how to use and manage nature. • There are three key questions that are central to GRACE: (1) What aspects of nature do people benefit from? (2) How do these contribute to well-being, and to whose? (3) How might changes affect the delivery of these services and the well-being derived from them?	https://www.iucn.org/content/guidance-rapid-assessment-cultural-ecosystem-services Infield et al., 2015
Hedonic pricing		• The hedonic pricing method measures the implicit price of an ecosystem service that is not traded on a market, as revealed through the observed price of a product that is traded on markets (Rosen, 1974). • Two products are needed that are identical in most regards, but different regarding a certain environmental characteristic, e.g., two houses but one suffers from traffic noise or one houses being in the vicinity of a park, etc. The difference in the sales prices of these two commodities can then be interpreted as the revealed willingness to pay for the ecosystem service. The hedonic pricing method may be used to estimate economic benefits or costs associated with environmental quality (e.g., air pollution, water pollution, noise), and environmental amenities (e.g., aesthetic views, proximity to recreational sites).	Koetse et al., 2015
Integrated Biodiversity Assessment Tool	IBAT	• IBAT provides up-to-date biodiversity information to decision-makers from the private and public sectors through a single, reliable web-resource. • IBAT provides companies and government agencies with globally compiled spatial and tabular data drawn from established sources on protected areas (World Database on Protected Areas), sites of global conservation importance (Key Biodiversity Areas, including Important Bird Areas and Alliance for Zero Extinction sites) and globally threatened species (the IUCN Red List). • IBAT comprises a 'family' of web-based tools, in different sectors, ranging from conservation science to corporate business. a) IBAT for business b) IBAT for Research and conservation)	http://www.birdlife.org/datazone/sowb/casestudy/254 https://www.ibatforbusiness.org/ https://www.ibat-alliance.org/ibat-conservation/login
Influence and Importanc		• The influence and importance metrix helps to map out stakeholders and their opinion, need and interest concerning a particular issue. It generates insights on the importance and influence of each	http://www.managingforimpact.org/tool/influence-and-importance-matrix

e Matrix - Identifying target groups		stakeholder. With this information, it becomes possible to develop a specific approach and strategy for each of the identified stakeholders. The project proponent can prioritize the stakeholders to be involved in. It is one of the tools used for a stakeholder analysis.	
Integrated Valuation of Ecosystem Services and Tradeoffs	InVEST	• InVEST is a suite of modeling tools that map, measure and value the goods and services that sustain human life. It can help to assess quantified tradeoffs within alternative management choices and to identify areas where investment in natural capital can enhance human development and conservation. • InVEST currently has 18 ES models for terrestrial, freshwater, marine, and coastal ecosystems and it can assess the changes in ecosystem function or ES through scenario analysis.	http://www.naturalcapitalproject.org/invest/ Sharp et. al., 2016
Intergovernmental Platform on Biodiversity and Ecosystem Services	IPBES	• The IPBES Conceptual Framework is a highly simplified model of the complex interactions between the natural world and human societies that are most relevant to IPBES's goal - 'conservation and sustainable use of biodiversity, long-term human well-being and sustainable development'. • The conceptual framework for biodiversity and ecosystems services is used to support the analytical work of the IPBES Platform, to guide the development, implementation and evolution of its work programme, and to catalyse a positive transformation in the elements and interlinkages that are the causes of detrimental changes in biodiversity and ecosystems and subsequent loss of their benefits to present and future generations.	www.ipbes.net/conceptual-framework
i-Tree Eco	i-tree Ec	• i-Tree is a suite of peer-reviewed softwares that provide urban and rural forestry analysis and benefits assessment tools. It helps to strengthen the forest management and advocacy efforts by quantifying the structure of trees and forests and the environmental services that trees provide. It is developed by USDA Forest Service and numerous cooperators, i-Tree Tools are freely available.	http://www.itreetools.org/
i-Tree (Tools for Assessing and Managing Forests and Community Trees	i-Tree	• i-Tree is peer-reviewed software suite from the USDA Forest Service that provides urban and rural forestry analysis and benefits assessment tools. It helps to strengthen the forest management and advocacy efforts by quantifying the structure of trees and forests, and the environmental services that trees provide	http://www.itreetools.org/
Language recommendations		• If communicating the value of ecosystems to the public, there are some useful tips on how to formulate the message in a way that people tend to react more positively to.	https://www.conservationgateway.org/Documents/Summary%20Memo%20Polling.pdf
Land Utilisation & Capability Tool (formerly Polyscape)	LUCI	• LUCI is a Geographic Information System (GIS) based, spatially explicit ecosystem services modelling tool. It explores the capability of a landscape to provide ecosystem services, such as agricultural production, erosion control, carbon sequestration, flood mitigation, habitat provision, etc. It compares services provided by the current utilisation of the landscape to estimates of its potential capability. Based on this information, it can identify areas where a change might be beneficial, and where maintenance of the status quo might be desirable. • The framework aims to highlight areas with maximum potential for improvement instead of advising on which methods should be applied to reach a higher potential (Jackson et al., 2013). The underlying algorithms allow identification of locations where interventions or changes in land use might deliver improvements in ecosystem services (Sharps et al., 2017).	http://www.lucitools.org/ Jackson et al., 2013 Sharps et al., 2017
Life Cycle Assessment (UNEP-SETAC guideline on LCA)	LCA	• Life Cycle Assessment (LCA) is a tool to support decision making widely used to assess the potential environmental impacts of a given product/service at each step of its life cycle. • The basic idea of a LCA is that all environmental burdens connected with a product or service have to be assessed, from the use of raw materials to the removal and management of waste.	Koellner et al., 2013
Macro-ecological models	MEM	• Macrological modelling (MEM) is an approach to model species richness (SR), the number of taxa occurring in a defined geographic unit, by statistically relating SR to values of environmental variables that characterize the same unit (Dubuis et al., 2011). In MEM, the number of species found at a given location is expected to depend on various control factors such as unit size, resources available, environmental heterogeneity and disturbance levels (Dubuis et al., 2011). • Macroecological modelling can be implemented using a variety of modelling techniques, including curve-fitting, predictive simulation and correlative approaches (Distler et al., 2015).	GISCAME, 2018
Marxan		• Marxan is a widely used tool for conservation planning and can solve a range of spatial prioritization problems beyond the selection of reserves. • The goal in Marxan is to minimize a combination of the cost of the reserve network and the boundary length of the entire system, whilst meeting a set of biodiversity targets.	http://www.aboutvalues.net/data/method_navigator/values_method_profile_marxan.pdf

		• Marxan finds good solutions to a mathematically well-specified problem which means that there is no ambiguity about what the software is trying to achieve.	
Millennium Ecosystem Services Assessment Framework	MA	• The Millennium Ecosystem Assessment introduced a framework for analyzing socio-ecological systems. The conceptual framework for the MA places human well-being as the central focus for an assessment, while recognizing that biodiversity and ecosystems also have intrinsic value and that people take decisions concerning ecosystems based on considerations of well-being as well as intrinsic value. • The MA conceptual framework assumes that a dynamic interaction exists between people and ecosystems, with the changing human condition serving to both directly and indirectly drive change in ecosystems and with changes in ecosystems causing changes in human well-being. • The assessment framework developed for the MA offers decision-makers a mechanism to identify options that can better achieve core human development and sustainability goals, to better understand the trade-offs involved-across sectors and stakeholders in decisions concerning the environment, and to align response options with the level of governance where they can be most effective.	http://www.millenniumassessment.org/en/index.html
Multi-scale Integrated Models of Ecosystem Services	MIMES	• MIMES is an open source dynamic modelling system for mapping and valuing ES. It is a suite of models for land use change and marine spatial planning decision making by quantifying the effects of land and sea use change on ES and can be run at global, regional, and local levels. • MIMES, an analytical framework designed to assess the dynamics associated with ES function and human activities. It integrates diverse types of knowledge and elucidate how benefits from ES gained and lost. MIMES formalizes how materials are transformed between natural, human, built and social capital. and due to analyzing multiple ecological and human dynamics, outputs can be interpreted through different temporal and spatial lenses to assess the effects of different actions in the short and long term and at different spatial scales (Boumans et. al, 2015)	http://www.afordablefutures.com/orientation-to-what-we-do/services/mimes Boumans et. al, 2015 Altman et al., 2012
Multi-criteria analysis	MCA	• The MCA provides a systematic approach for supporting complex decisions. MCA consists of a family of methods to evaluate, weigh and rank alternative solutions according to pre-determined criteria and objectives. • MCA is particularly suitable for complex decision problems that involve multiple and conflicting objectives and criteria. It allows identifying a single preferred alternative, or to rank or short-list of possible alternatives. Criteria can be expressed in different units such as the costs of a given alternative in monetary terms, the impacts on the environment in biophysical units, or the effect on the aesthetic quality of the landscape in a qualitative scale.	http://www.aboutvalues.net/method_database/#
Narrative assessment		• The Narrative methods aim to understand and describe the importance of nature and its benefits to people with their own words. By using narrative methods, the research participants (residents of a certain place, users of a certain resource, or stakeholders of an issue) can articulate the plural and heterogeneous values of ecosystem services through their own stories and direct actions (both verbally and visually). • Narrative methods usually collect qualitative data from individuals, but they can be also suitable to measure some aspects of human-nature relations in quantitative or semi-quantitative terms. They can be combined with more structured methods (both non-monetary and monetary ones) such as preference assessment, time use study, choice experiment or multi-criteria decision analysis (MCDA). Here, the term 'narrative methods' is used as an umbrella term under which several tools from ethnographic, historical and qualitative social scientific research are brought together (e.g. in-depth and semi structured interview, observation, voice and video recording of events, artistic expression).	http://www.openness-project.eu
Natural Assets Information System	NAIS	• The NAIS was developed to estimate Ecosystem Service Values (ESV) using 'state of art' value transfer methods and geospatial science. Value transfer involves the adaptation of existing valuation in formation to new policy contexts where valuation data is absent lor limited. • For ESV, this involves searching the literature for valuation studies on ecosystem services associated with ecological resource types present at the policy site.	https://sig-gis.com/ecosystem-services/ Troy & Wilson, 2006
Natural Capital Protocol		• The Natural Capital Protocol is a framework designed to help generate trusted, credible, and actionable information that business managers need to inform decisions. Until now, natural capital has for the most part been excluded from decisions and when it is included it has been largely inconsistent, open to interpretation or limited to moral arguments. The Protocol responds by offering a standardized framework to identify, measure and value impacts and dependencies on natural capital.	http://naturalcapitalcoalition.o
Net factor income		• The productivity method, also referred to as the net factor income or derived value method, is used to estimate the economic value of	King and Mazzotta, 2018

		ecosystem products or services that contribute to the production of commercially marketed goods. • It is applied in cases where the products or services of an ecosystem are used, along with other inputs, to produce a marketed good.	
Net-Map Tool		• The Net-Map Tool is an interview-based mapping tool that helps people understand, visualize and discuss how actors are involved and connected in a particular network – and why. • For assessing ecosystem services it can be used to better understand the socio-economic and socio-political context, and in particular the roles and interactions of actors relevant for the main issues at stake.	http://www.aboutvalues.net/method_database/# https://netmap.wordpress.com/about/
Offset Portfolio Analyzer and Locator	OPAL	• OPAL is a tool for quantifying the impacts of development and the value of potential protection or restoration activities to biodiversity and ecosystem services. OPAL helps to identify mitigation options that can restore ecosystem service benefits back to the same people affected by a development project and tracks the amount of mitigation needed to meet biodiversity and ecosystem service mitigation targets." (Biodiversity Offset, 2016). • OPAL is a tool that is valid for "both supply and delivery of ES benefits to beneficiary groups, as well as impacts to terrestrial ecosystems".	Mandle et al., 2016
Open Nonpoi Source Pollut and Erosion Comparison T	Open NSPECT	• The Open Nonpoint Source Pollution and Erosion Comparison Tool (NSPECT) is an open-source software that assesses erosion and pollution for surface waters in (un-)developed landscapes. The software estimates surface water volumes, pollutant concentrations and sediment loads, mapping their spatial distribution on land and at the coastal interface. Users can input land use scenarios to predict future water quality in rivers, lakes, and marine bodies of water. • Open NSPECT can therefore be used to select development strategies that minimize adverse impacts on water quality-enhancing ecosystem services. It can also be used to identify cost-effective solutions to restore these ecosystem services. Model outputs are nitrogen, phosphorous, and suspended solids, estimated for simulated land cover types.	https://coast.noaa.gov/digitalcoast/tools/opennspect?redirect=301ocm
Our Ecosystem web-mapping platform	OE	• The OE - Our Ecosystem is a web-based mapping platform for communicating and visualising spatial information about the environment through the use of spatial data from satellites and other sources. • Currently, eight apps are freely available, which, for example, show carbon storage potential of changes in agricultural practice or reveal linkages between armed conflict and fire incidents in sub-Saharan Africa. • New apps can also be developed for user-defined areas of interest. OE apps can be adapted to a range of different questions and spatial data queries. They are fast and easy to apply, even without any GIS proficiency. Furthermore they can be combined with all methods or tools that produce geo-data.	http://www.aboutvalues.net/method_database/#
Q-Methodology		• Q-methodology is particularly useful when researchers wish to understand and describe the variety of subjective viewpoints on an issue. The name "Q" comes from the form of factor analysis that is used to analyze the data. Normal factor analysis, called "R method," involves finding correlations between variables (say, height and age) across a sample of subjects. Q, on the other hand, looks for correlations between subjects across a sample of variables. Q factor analysis reduces the many individual viewpoints of the subjects down to a few "factors," which are claimed to represent shared ways of thinking.	Van Exel and De Graaf, 2005
Participatory Valuation Methods		• There is no clear standardized definition of participatory economic valuation methods. They can assume either a non-deliberative approach or a deliberative approach, whereby non-deliberative methods include surveys, polls, public comments, public information sessions and public hearings, and deliberative methods consist of focus groups, citizens' juries, consensus conferences, deliberative monetary valuation, social multicriteria evaluation, advisory committees and visioning workshops. Deliberation implies that all participants are gathered in one place with the explicit purpose of debating and exchanging information, ideas and arguments about the problem considered, after which either a final decision is made or the process is repeated.	Carnoye and Lopes, 2015
Participatory mapping and assessment of ecosystem services	PGIS	• Participatory mapping methods are a group of tools that develop maps based on and in close collaboration with local knowledge and perceptions in order to improve capabilities of communities and people to use this knowledge to their advantage. • PGIS evaluates the spatial distribution of ecosystem services according to the perceptions and knowledge of stakeholders via workshops and/or surveys. PGIS allows for the participation of various stakeholders in the creation of an ES map (e.g. community members, environmental professionals, NGO representatives, decision-makers) and integrates their perceptions, knowledge and values in the final maps of ecosystem services.	http://www.aboutvalues.net/method_database/#

Payment of Ecosystem Services	PES	• Payments for Ecosystem Services (PES) is an innovative approach to nature conservation that comprises a variety of arrangements through which the beneficiaries of environmental services (from watershed protection and forest conservation to carbon sequestration and landscape beauty) reward those whose lands provide these services with subsidies or market payments. • Payments for Ecosystem Services encourages the maintenance of natural ecosystems through environmentally friendly practices that avoid damage for other users of the natural resources by providing compensation for applying these practices. In addition to preserving natural resources, this method improves rural areas and rural lifestyles.	Kolinjivadi et al., 2015 http://www.teebweb.org/media/2012/01/TEEB-For-Business.pdf
Phenomenological models		• Describe qualitative or semi-quantitative relationships between biodiversity components and ES supply, based on an understanding of biological mechanisms underpinning ES supply. They assume a relationship between elements of the landscape – quite often represented by land cover or land use classes – and the provisioning of and/or the demand for ecosystem services. In difference to purely empirical approaches parameters (or a part of the parameters) are not derived from observed data from the location of the model application. Instead parameters are transferred from other studies or meta-analysis.	Young, 2010
Photo-elicitation surveys		• Photo-elicitation surveys, although still quantitative by nature, follow a different logic to explore and translate people's visual experiences and perceptions of landscapes related to ecosystem services. It is based on the simple idea of inserting a photograph into a research interview. The difference between interviews using images and text, and interviews using words alone lies in the ways we respond to these two forms of symbolic representation. This is some of the reasons why photo elicitation interview are not simply an interview process that elicits more information, but rather one that evokes a different kind of information.	OpenNESS, 2018
Polyscape		• Polyscape is a GIS toolbox for negotiating the provision of multiple ES on landscape scale. To improve the provision of ES through targeted land management it require to implement policy in a spatially explicit context, so that features located where they will have greater benefit for ES are valued more highly than those in locations where they will have less impact. • Polyscape, a multi-criteria GIS toolbox was developed that identify and communicate synergies, trade-offs and opportunities of where protective actions may be beneficial under consideration of local knowledge • Polyscape is designed to facilitate spatially explicit policy implementation, integrate policy implementation across sectors (e.g., water, biodiversity, agriculture and forestry), and to facilitate stakeholder participation.	http://www.polyscape.org/
Preferences assessment		• Preference methods are used to provide an indication of which benefits from nature are perceived to be more valuable than others. They provide a deeper understanding of what individuals or groups of people think about the benefits of nature, how they value them and which aspects of nature they deem most important. • Many different preference methods exist, each with different nuances, but all have in common that they are generally applicable in almost any given context. Moreover, they can usually be done in a short time frame and at limited costs, although exceptions such as more deliberative multi-criteria analyses exist as well. They are particularly useful as an initial step into a given study context and study area, as they help to define the field of study and the main issues to be addressed. Moreover, they can be applied in those situations where stakeholders with conflicting views and interests are affected.	http://www.aboutvalues.net/method_database/#
Protected Area – Benefits Assessment Tool	PA-BAT	• The PA-BAT has been primarily designed for use by protected area managers to work with stakeholders to identify important values and the benefits that they bring to a range of stakeholders, from local to global. • The PA-BAT can also be used by local communities to identify values/benefits and by protected area advocates, such as NGOs, to help promote the range of benefits a protected area can bring. Because the tool has developed a standard typology of values and benefits the results from the tool can be aggregated to provide an overview of a portfolio of protected areas (e.g. regional groups, national systems, biome groups etc). This can be used as a planning tool at system level (e.g. developing policies for specific resource uses) or as an advocacy tool for supporting protected areas. • The PA-BAT aims to help collate information on the full range of current and potential benefits of individual protected areas. It is a contributory methodology for the overall Arguments for Protection series, but is also hopefully a stand-alone tool that will be of wider use to the protected areas community. Although developed primarily for use in protected areas, the tool could have wider application, for example in assessing wider benefits of forest management units, agricultural landscapes or areas set aside for recreation.	http://wwf.panda.org/wwf_news/?174401/PABAT Stolton & Dudley, 2009

Production function		• It is statistical estimation of production function for a marketed good including an ecosystem services input. It can be assessed ecosystems that provide an input in the production of a marketed good. • It is useful to answer the question of how much do ecosystem services contribute to other income and production processes? Ecosystem services are assessed and quantified by looking at the (monetary and/or non-monetary) changes in production that result from ecosystem change. In principle, any production or consumption process that uses ecosystem services as an input or depends on them for output is amenable to the application of this technique. Effect on production methods are most commonly applied to regulating and supporting services (e.g. pollination, soil productivity, water flow regulation, fisheries breeding and habitat).	http://aboutvalues.net/data/method_navigator/values_method_profile_effect_on_production.pdf
Process-based models		• They rely on the explicit representation of ecological and physical processes that determine the functioning of ecosystems. They provide functional means of plant and ecosystem processes that are universal rather than specific to one biome or region. One purpose of such models is to explore the impact of perturbations caused by climatic changes and anthropogenic activity on ecosystems and their biogeochemical feedbacks. Many process-based models allow the net effects of these processes to be estimated for the recent past and for future scenarios. In terms of ecosystem services, these types of models are most widely applied to quantify climate regulation, water supply from catchments, food provision but also in the wider frame of habitat characterisation.	Maes et al., 2012 Morin and Thuiller, 2016
Public Pricing		• It is used for ecosystem services for which there are public expenditures. Public expenditure or monetary incentives (taxes/subsidies) for ecosystem services as an indicator of value.	
Replacement Cost		• The replacement cost is generally that of a modern equivalent asset, which is one that provides similar function and equivalent utility to the asset being valued, but which is of a current design and constructed or made using current cost-effective materials and techniques. • Generally, replacement cost is the cost that is relevant to determining the price that a market participant would pay as it is based on replicating the utility of the asset, not the exact physical properties of the asset. Usually replacement cost is adjusted for physical deterioration and all relevant forms of obsolescence.	CMS, 2018
Resource Investment Optimization System	RIOS	• RIOS provides a standardized, science-based approach to watershed management. RIOS is an open source software that supports the design of cost-effective investments in watershed services. It combines biophysical, social and economic data to help users identify the best locations for protection and restoration activities in order to maximize the ecosystem service (ES) return on investment, within the bounds of what is socially and politically feasible. • RIOS processes and presents scientific information in a way that is useful for managers. The software is flexible enough to be applied in many different environmental, social, and legal contexts. RIOS can facilitate the design of investments for a single management goal or several at once, including erosion control, water quality improvement (for nitrogen and phosphorus), flood regulation, groundwater recharge, dry season water supply, and terrestrial and freshwater biodiversity.	http://www.naturalcapitalproje org/pubs/ScienceChronicles20 08_RIOS.pdf
Restoration Cost		• The restoration cost approach values an environmental good according to the cost incurred in restoring it to its original state after it has been damaged. This approach is used extensively because it is relatively easy to find estimates of such costs.	MacAlister Elliott and Partners Ltd., 2001
Restoration Ecosystem Service Tool Selector	RESTS	• RESTS framework that describes key characteristics of 13 ES assessment tools*. Tools are filtered and presented based on five evaluative criteria: scalability, cost, time requirements, handling of uncertainty, and applicability to benefit-cost analysis. (*RESTS framework uses comperative content of different assessment tools as ARIES, Costing Nature, EcoMetrix, EnSym, Envision, ESR for IA, EVT, InVEST, LUCI, MIMES, NAIS, SolVES, TESSA)	Christin et al., 2016
Scenario planning		• Scenario planning applies various tools and techniques (e.g. individual interviews, brainstorming or visioning exercises in workshops, often complemented with modelling) to develop plausible and internally consistent descriptions of alternative future options. Assumptions about future events or trends are questioned, and uncertainties are made explicit to establish transparent links between changes of ecosystem services and human well-being.	Pastor, 2009
Simulation of Terrestrial Environments	SITE	• SITE is a modelling platform for integrative, spatially explicit land use modelling. Within the SITE framework models can be developed that combine different datasets to analyse the suitability of a certain region for a specific land use, e.g. the potential for an agricultural use. Furthermore, land use scenarios can be developed based on various drivers, such as regulations and regional preferences. Results can be used to describe probable impacts of land management decisions, e.g. as input for regional spatial planning. • Potentially all ES can be assessed if programmed in a 'SITE case study'. Typical outcomes from SITE case studies are annual maps of	http://www.ufz.de/index.php?en=37508

		past and expected future land use change. SITE is best suited for regional applications. New modules can be added, and other models on decision making or biophysical processes can also be employed.	
Social Values for Ecosystem Services	SolVES	• SolVES (Social Values for Ecosystem Services) is a GIS application for assessing, mapping, and quantifying the social values of ecosystem services. It was designed to examine and articulate the values which people attribute to publicly available benefits from nature, such as the beauty of a landscape, or the cultural or recreational value of a native forest. Shared social values (as opposed to private values) can be evaluated for various stakeholder groups, which may differ in their attitudes and preferences.	http://solves.cr.usgs.gov/ Sherrouse et al., 2015 Sherrouse et al., 2011
Soil and Water Assessment Tool	SWAT	• SWAT is a watershed model for assessing the impact of land-use and land use changes on selected ecosystem services. It was developed to evaluate the impact of agricultural management practices (e.g. crop rotations, tillage operations, fertilizer applications, or conservation practices such as terraces or filter strips) on catchment hydrology and water quality. • SWAT is a process-based, spatially semi-distributed watershed model that can be used to predict a wide range of biophysical variables at a daily resolution. SWAT outputs are also used as indicators for several ecosystem services related to water (e.g. provisioning of fresh water, water purification) and biomass production (e.g. provisioning of food and/or bioenergy crops), as well as to assess trade-offs among such services.	http://swat.tamu.edu/
Spatial-proxy models		• Spatial proxy models are related ES indicators to land cover, abiotic and possibly biotic (although not often used beyond vegetation type) variables by way of calibrated empirical relationships. Therefore, they can provide the most basic form of incorporation of 'biodiversity' effects on ES supply. It is desirable, and in practice most common for such models to be derived from well-known causal relationships between environmental variables.	Maes et al., 2012 Naidoo et al., 2008 Nelson et al., 2009
Spreadsheet methods		• The Spreadsheet method is a quick and simple way to get an overall spatially-explicit picture of the ES in case study areas. The method is based on the idea of linking tabular spreadsheet data and spatial data together, i.e. joining external datasets to spatial units to create maps. • The spreadsheet format data can be collected, for example, as expert evaluation or constructed from indicators or statistics. Simple application of the approach typically involves land use or land cover (LULC) datasets, although other datasets can be used.	OpenNESS, 2018
State and transition model		• State-and-transition models (STMs) are conceptual models of ecosystem dynamics after disturbances based on alternate state theory. In contrast to succession theory, which predicts that ecosystems recover from disturbances and return to a reference (undisturbed) state, alternate state theory maintains that disturbances may trigger a regime shift in critical processes (e.g. population recruitment, nutrient cycling) that will maintain the ecosystem in a state that differs from the reference state. The new state has different structural properties (e.g. functional diversity, species composition and dominance) from the reference state. The disturbances that trigger these changes are natural factors (e.g. droughts, windfalls, fire), management (e.g. clear-cutting, grazing by domestic animals), and the interactions among them; and the shifts in ecosystem condition that they trigger are irreversible in the absence of specific interventions. STMs acknowledge non-linear responses of ecosystem properties to human interventions; alternate states represent abrupt changes in ecological properties (EU FP7 OpenNESS Project Deliverable 3.2, 2015).	OpenNESS, 2018
Story Maps by ESRI		• Story Maps can be used for presenting messages and visualising results of a study or an ecosystem service assessment. It is a way to inform and engage people with your story that involves spatial information, or reference to places, landscapes, regions. Story Maps provides a list of different application templates, which can be used for building and/or illustrating your story. Users can add your data in many different formats, including tabular data from spreadsheets. It is possible to combine these data with authoritative data published by esri and many other leading agencies. Most of the apps have interactive builders that make it easy to assemble your story. This method profile provides some key aspects of Story Maps and how this method is applicable for conveying an ecosystem services perspective.	http://storymaps.arcgis.com/en/
Strategic Environmental Assessment	SEA	• SEA is a potential tool to integrate ecosystem services in strategic decisions and improve the understanding of the consequences of policies, plans and programs on human wellbeing.	UNEP, 2014 OECD, 2010
Spatial Tools for River basins Analysis & Management	STREAM	• The STREAM instrument is an instrument for river basin studies with emphasis on management aspects. STREAM uses a spatially distributed water balance model for simulating the water balance in larger river basins. This model enables the analysis of the impacts of climate change and land use changes on the fresh water hydrology of a river basin. The instrument uses remotely sensed data for determining land use.	http://www.biodiversity.ru/coastlearn/planning-eng/stream.html

System of Environmental-Economic Accounting	SEEA Central Framework	• The System of Environmental-Economic Accounting (SEEA) is a framework that integrates economic and environmental data to provide a more comprehensive and multipurpose view of the interrelationships between the economy and the environment and the stocks and changes in stocks of environmental assets, as they bring benefits to humanity. It contains the internationally agreed standard concepts, definitions, classifications, accounting rules and tables for producing internationally comparable statistics and accounts. • The framework uses concepts, definitions and classifications consistent with the SNA in order to facilitate the integration of environmental and economic statistics. The SEEA is a multi-purpose system that generates a wide range of statistics, accounts and indicators with many different potential analytical applications. It is a flexible system that can be adapted to countries' priorities and policy needs while at the same time providing a common framework, concepts, terms and definitions.	UN, 2014
The Economics of Ecosys-tems and Biodiversity	TEEB	• TEEB aims to mainstream the values of biodiversity and ecosystem services into decision-making at all levels. It aims to achieve this goal by following a structured approach to valuation that helps decision-makers recognize the wide range of benefits provided by ecosystems and biodiversity, demonstrate their values in economic terms and, where appropriate, capture those values in decision-making.	http://www.teebweb.org/
Time-use assessment		• Time use study is an innovation of the conventional stated preference techniques taken from the contingent valuation approach. In this case, the payment vehicle is expressed in labour hours rather than monetary units (as used in the classical willingness to pay studies) (Kenter et al. 2011). Willingness to give up time (WTT) creates a hypothetical scenario using surveys to estimate the value of ecosystem services by directly asking people how much time they would be willing to invest for a change in the quantity or quality of a given ecosystem service or conservation (or restoration) plan.	OpenNESS, 2018
Toolkit for Ecosystem Services Site-based Assessment	TESSA	• TESSA provides practical guidance on how to identify which services may be significant at a site of interest, what data are needed to measure them, what methods or sources can be used to obtain the data and how to communicate the results. • TESSA provides a net benefits framework through applying a set of appropriate methods for two alternative states of a site. It recommends use of existing data where appropriate and places emphasis on enabling users to collect new field data at relatively low cost and effort. • TESSA emphasises the importance of comparing estimates for alternative states of a site (ex: before and after conversion to agric. so that decision-makers can assess the net consequences of such a change, and hence the benefits for human well-being that may be lost through the change or gained by conservation (Peh et al., 2013b)	http://tessa.tools/ Peh et al., 2013a Peh et al., 2013b
Trait-based models		• Trait-based models quantify ES supply based on (statistical) relationships between functional traits of Ecosystem Service Providers (ESP) and ecosystem properties considered either by experts or by stakeholders to support a given ecosystem service. • Trait- based models are an emerging tool in ecology with the potential to link community dynamics, environmental responses and ecosystem processes. These models represent complex communities by defining taxa with trait combinations derived from prior distributions that may be constrained by trade- offs.	Allison, 2012
Travel Cost Method		• The travel cost method (TCM) uses the revealed preferences of visitors to an area to estimate the area's recreational or touristic value. • The method as uses data from visitors to determine the value of an area's ecosystem services. The underlying principle is that there is a direct correlation between travel expenses and a site's value. • This method uses questionnaires to determine who visitors are, how old they are, where they come from, how much they spend (to get to the site, to get into the site, while they're there), what their motivations for visiting are and how often they visit. This information is used to estimate a demand curve.	http://www.aboutvalues.net/method_database/#
World Overview of Conservation Approaches and Technologies database	WOCAT	• WOCAT provides a global open-access database for documenting, evaluating and disseminating on sustainable land management (SLM) practices for soil and water conservation. It allows searching for tools and case studies from all over the world, according to different criteria (e.g. geographic scope, target group, thematic issue, etc.). WOCAT does not assess ecosystem services, but focuses on efforts to prevent and reduce land degradation. This can enhance the provision of various ecosystem services (e.g. fresh water, erosion prevention, moderation of extreme events, soil fertility, etc.). • WOCAT is provided by a network of over 60 institutions worldwide. The aim is to improve land use and livelihood through sharing knowledge about sustainable land management, networking for sustainable land management specialists, and developing standardized tools and methods for knowledge management and decision support.	https://www.wocat.net/