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IVM Institute for Environmental Studies

IUCN National Committee of The Netherlands

Master Thesis
Environment and Resource Management (ERM)

THE ECOSYSTEM QUESTION: How can Ecosystem Services assessment tools be better understood and used more effectively by companies?

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Foreword

This paper is the thesis report written as part of the Environment and Resources Management Master at the Vrije Universiteit in Amsterdam.

I would like to thank the IUCN Netherlands Committee for welcoming me in their organization and team of experts during my research project. Special thanks go to Mathew Parr for his great support through the whole period of my internship as well as Rob Regoort – TEEB specialist - and Willem Ferweda - IUCN NL director.

I would like to thank as well Pieter van Beukering who supervised my thesis from an academic perspective and all the experts from various organizations who provided me with critical information and relevant data – as well as Eva Zabey from WBCSD who kindly took the time to review my thesis.

Disclaimer

The paper carries the name of the author and should be cited accordingly. The findings, interpretations, and conclusions expressed in this paper are entirely those of the author. They do not necessarily represent the view of IUCN NL, WBCSD, BSR, ERM, EEA, the interviewed experts, and the thesis supervisors.

Recommendations

« [your report] is very interesting to read, and it actually is yet another proof-point for WBCSD to be developing a mapping / database of different ES tools that we are planning to do next year. It is also a good starting point for developing a framework / categories and if we use your content, we will be sure to reference you.»

Eva Zabey – Business and Ecosystems Professional – WBCSD

Executive Summary

For companies to take actions on managing their impacts and dependencies on ecosystem services and biodiversity, it is key that they are given the right tools to identify, measure and analyse them. One of IUCN Netherlands' main missions is to support companies in this process. The main purpose of this study is to orientate companies in this tools profusion. The first step was to review the literature available on the ES assessment tools to be able to identify the key tools currently available on the market.

9 tools were identified as suitable for the purpose of assessing multiple ecosystem services in the business context. Key experts in the field were then interviewed, and asked their viewpoint on the idea of developing a categorization of ES assessment tools, and on the categorization that are proposed in this study. Nine tools (ARIES, InVEST, MIMES, ESR, CEV, NVI, EcoAIM, EcoMetrix and ESValue) have been identified during this study as the most important tools able to assess the risks and opportunities resulting from companies' dependencies and impacts on ecosystem services. The main result of this research is a categorization structure for those tools, to help companies identifying the most suitable tool(s) for them to identify, measure and value their impacts and dependencies on ecosystem services. This can be found in paragraph 2-3. A list of criteria has been established mainly based on findings in the literature. The categorization structure was then tested onto 2 of the most important ES assessment tools available to-date on the market and has shown that it can give companies a valuable insight on the selection of adapted tools.

One of the main recommendations of this study is the creation of an online database exhaustively categorizing and reviewing all ES assessment tools for business available on the market today and those which will become available in the future. This may be an activity picked up by the WBCSD for 2012. Another recommendation is the establishment of a consortium on Ecosystem Services Assessment Tools that can initiate the creation of the online database and ensure objective assessment of the tools by the tools developers and users. Or - an interesting alternative to using the available tools on the market, can also be to create very simple tailor-made tools to match the company specific requirements, rather than using the BES tools which are available for other specific purposes and may often lack flexibility.

Table of Content

Abbreviations

ARIES	Assessment and Research Infrastructure for Ecosystem Services
BES	Biodiversity and Ecosystem Services
BSR	Business for Social Responsibility
CBD	Convention on Biological Diversity
CEV	Corporate Ecosystem Valuation
EEA	European Environmental Agency
ENVEST	Environmental Intelligence for Tomorrow's Markets
ERM	Environmental Resources Management
ES	Ecosystem Services
ESR	Ecosystem Services Review
EU	European Union
IUCN NL	International Union for the Conservation of Nature, National Committee of the Netherlands
InVEST	Integrated Valuation Ecosystem Services and Tradeoffs
MIMES	Multi-scale Integrated Models of Ecosystem Services
NAIS	Natural Assets Information System
NGO	Non-governmental organization
OEE	Other Environmental Externalities
SMART	Specific, Measurable, Attainable, Realistic and Time-bound
SME	Small and Medium Enterprises (MKB in dutch)
TEEB	The Economics of Ecosystems and Biodiversity (In this study, when TEEB will be mentioned, it will always refer to TEEB for Business – unless mentioned otherwise)
UNPRI	United Nations Principles for Responsible Investment
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute
WWF	World Wide Fund For Nature

Glossary of terms

Tools:
A tool is a device that can be used to produce an item or achieve a task, but that is not consumed in the process. Informally the word is also used to describe a procedure or process with a specific purpose. Tools that are used in particular fields or activities may have different designations such as Instrument*, Utensil, Implement, Machine, or Apparatus* (*Wikipedia*). In the context of this research, a tool is any device or instrument - used to assess ecosystem services - from a concept, via a simple spreadsheet to a complex software program. Tool and instrument will be used here interchangeably.

Tools Effectiveness:
Effectiveness means the capability of producing an effect – more specifically a specific and desired effect. It can be a qualitative measure but mostly a quantitative measure of a performance. In this study, tools effectiveness will be measured for each of the criteria defined in chapter 3.

TEEB operationalization:
Operationalization is the process of strictly defining variables into measurable factors. The process defines fuzzy concepts and allows them to be measured, empirically and quantitatively. In the context of this study, operationalizing TEEB means identifying, selecting, and implementing the adequate tools to manage the corporate impact and dependencies on ecosystem services.

TEEB Implementation:
The implementation or operationalization of TEEB will be used interchangeably in this study.

Biodiversity:
'Biodiversity' is short-hand for 'biological diversity'. We follow the UN Convention on Biological Diversity (CBD), which defines biodiversity as: "The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems".

Decision tree:
A decision tree is a decision support tool that uses a tree-like graph or model of decisions and their possible consequences and is one way to display an algorithm. Decision trees are specifically in decision analysis, to help identify a strategy most likely to reach a goal.

Ecosystems Services:
According to the CBD, ecosystems are thus one component of biological diversity. This is consistent with definitions subsequently adopted by the Millennium Ecosystem Assessment (MA 2005), which identifies an ecosystem as "a dynamic complex of plant, animal, and micro organism communities and the non-living environment interacting as a functional unit". The main contribution of the MA is the elaboration of the concept of 'ecosystem services', defined simply as the benefits people receive from ecosystems.

1 – Introduction

Business and enterprise have a huge role to play in how we manage, safeguard and invest in our natural capital. For example, a study for the UNPRI estimated that 3,000 listed companies in the world were responsible for environmental 'externalities' amounting to over US$ 2 trillion in Net Present Value terms. The key externalities are greenhouse gas emissions (69% of the total), overuse and pollution of water, particulate air emissions, waste, and unsustainable harvesting of fish and timber. These all contribute to the loss of biodiversity. (Sustainable Prosperity, 2011). Individual businesses have an interest to pay for the maintenance of well-functioning ecosystems when everyone relies upon them (see figure 1 in appendix 7): Firstly for risk mitigation related to unpredictable weather, shifting rainfall and water shortages. Secondly because policymakers are beginning to incorporate ecosystem services principles into policy dialogues and new legislation. And thirdly because companies today could position themselves for winning new business, investors and regulatory goodwill within this shifting environmental context. It is however increasingly clear that many of the current corporate environmental performance measures fail to capture impacts on broader ecological dynamics. (Waage and al., 2008).

The Economics of Ecosystems and Biodiversity (TEEB) study is a major international initiative to draw attention to the global economic benefits of biodiversity, to highlight the growing costs of biodiversity loss and ecosystem degradation, and to draw together expertise from the fields of science, economics and policy to enable practical actions moving forward (European Environment Agency, 2011). However, TEEB is not a methodology nor a business guide, it is a synthesis of the current state of knowledge that provides a basis for evaluating the stock of natural capital and the flow of ecosystem services, and It needs to be operationalized. Ecosystem services assessment tools started to emerge before TEEB (e.g. the ESR was released in 2008), however tool proliferation and profiling appears to have increased in response to the need for operationalization of TEEB. These "decision-support" and "rapid-assessment" tools aim to help corporate managers and policy makers anticipate how proposed activities could change ecosystem performance. For example, many extractives companies have the opportunity to restore land that they own through a wide range of activities—from reforestation, development of conservation zones, or support for income-generating activities linked to natural resources for local communities. Tools to help them anticipate how each scenario could impact ecosystem performance as well as local communities would allow them to make decisions based on sound science, data, and local stakeholders' preferences. (Linda Hwang et al., 2010).

The Dutch Committee of IUCN created in 2010 a TEEB working group with the objective to provide practical guidance to companies based in The Netherlands on the issues and the opportunities created by the inclusion in mainstream business practices of ecosystem- and biodiversity-related considerations. This Msc. thesis study is aimed at making a high-level inventory of the main tools available on the market today and proposing a categorization structure for those tools. It will support the IUCN NL TEEB working group in achieving its mission by advising companies and sectors on the use of the most suitable ecosystem services assessment tools.

1-1 TEEB: The Economics of Ecosystems and Biodiversity

The Economics of Ecosystems and Biodiversity (TEEB) study is a major international initiative initiated by the G8+5 in 2008 to draw attention to the global economic benefits of biodiversity, to highlight the growing costs of biodiversity loss and ecosystem degradation, and to draw together expertise from the fields of science, economics and policy to enable practical actions moving forward. The intent of the study is to sharpen awareness of the value of biodiversity and ecosystem services and facilitate the development of effective policy, as well as engaged business and citizen responses. (TEEB, 2010)

The TEEB Study consists of a series of reports for distinct end-users:

- for ecologists and economists
- for international and national policy makers
- for local and regional policy
- for business
- for citizens

TEEB for Business provides companies information and cases studies on managing business risks, addressing business opportunities, and measuring the consequent impacts and dependencies of their business activities on ecosystems and biodiversity. It is composed of 7 key points:

1. Identify the impacts and dependencies of your business on biodiversity and ecosystem services
2. Assess the business risks and opportunities associated with these impacts and dependencies
3. Develop BES information systems, set SMART targets, measure and value performance, and report your results
4. Take action to avoid, minimize and mitigate BES risks, including in-kind compensation ('offsets') where appropriate
5. Grasp emerging BES business opportunities, such as cost-efficiencies, new products and new markets
6. Integrate business strategy and actions on BES with wider corporate social responsibility initiatives
7. Engage with business peers and stakeholders in government, NGOs and civil society to improve BES guidance and policy

The TEEB initiative has greatly improved the awareness around the impact and dependencies of ecosystems in the corporate world; however there is still a missing link for companies to translate TEEB in their own business environment. That is what the ES assessment tools intend to address by "operationalizing TEEB" a step further.

1-2 Problems definition

There are currently hundreds of Ecosystem Services Assessment tools available for all audiences on the market, but only a very few are meant and/or suitable for use in the corporate world. There is to-date no complete analysis made of all those tools and this

makes it very complex for companies to choose the most suitable tool for their own situation. Another challenge has been that the usefulness and added value of these emerging ecosystem services tools has been difficult to determine, most notably due to a limited number of tests in corporate settings, as well as uncertainty related to the internal and external data required to run the tools (Linda Hwang and al., 2010).
Furthermore, because tool applications are limited within corporate decision-making processes, some believe it is not yet clear what additional value ecosystem services tools will add to the existing approaches companies use to assess performance (Waage and al., 2011).

1-3 Goal, research question and deliverable

1-3-1 Goal

The main goal of this study will address the first challenge mentioned above: the objective will be to create a categorization structure to be able to classify the various ES assessment tools. This should facilitate the ES tools selection process for companies. The outcome of this study is meant to be used for further relationship between IUCN NL and the private Dutch/European sector – to support IUCN NL can help companies engage with TEEB.

1-3-2 Research question

> How can Ecosystem Services assessment tools be better understood and used more effectively by companies?

Additional possible research questions identified during this study are documented in Appendix 6.

1-3-3 Deliverable

The output of the study is a final master thesis which will serve as reference for the IUCN NL TEEB team and IUCN NL members, Dutch companies interested in the implementation of TEEB, and possibly national management authorities, NGOs, and scientists. The report is expected to yield a comprehensive categorization system for the Ecosystem Services assessment tools to help the Dutch private sector identifying the most suitable tool(s) for them to identify - measure and value their impacts and dependencies on ecosystem services. To ensure the scientific quality of the product, bi-weekly consultations with the IUCN NL research supervisor as well as 2-3 times report drafting will be conducted.

1-4 Scope

1-4-1 Sectors in scope

IUCN NL has a sector-oriented approach, therefore it was one of their requirement to classify the tools by sector of activities. The existing relevant sectors categorizations are the following:

- The 9 economic key focal areas as defined by the Dutch Ministry of Economy (life sciences, high tech materials and systems, agro-food, water, energy, horticulture, chemicals, creative industry and logistics).

- The 6 priority business sectors identified by the European Commission; Agriculture, Food Supply, Forestry, Extractive industry, Financial sector and Tourism.

- The 9 top sectors used by IUCN NL (aligned with those defined by the Dutch government) (agro-food, horticulture, water, energy, chemicals, high tech, logistics, life science, creative industry)

The 4 sectors on which we will focus are those with the highest risk and/or impact related to the ecosystems (Biodiversiteit en ecosystemen: kansen voor de topsectoren - IUCN NL, 2011) - so with direct impacts on ecosystems and biodiversity and/or those who depend on healthy ecosystems and biodiversity for production, such as:

- Agro-food
- Energy (incl. oil and gas)
- Extractive industry (mining)
- Water

However, this study has shown that the differentiation per sector is not relevant for the ES assessment tools that intend to cover a large scope of ecosystem services. Most of them are not sector-specific as it will be demonstrated in chapter 3. The sector criterion is mostly relevant for local tools which generally deal with one ecosystem at a time.

1-4-2 Ecosystem Services in scope

- De Groot defined for the Millennium Ecosystems Assessment a categorization of 22 ecosystem services split in 4 ecosystem services groups – which is now widely recognized by most environmental economists and ecologists worldwide (see appendix 13). In his paper

- "Putting a price on nature", Spurgeon proposed a sub-set of De Groot´s ES categorization (see appendix 13).

- At the Ecosystem, Tools and Market (ESTM) Working Group roundtable organized by BSR in 2010, the focus was made on four key ecosystem service parameters:
  - Water provisioning
  - Carbon sequestration
  - Cultural services
  - Biodiversity (even though biodiversity is not an ecosystem service, its role in ecosystem structure and function makes it considered in that study as a significant parameter.)

As the objective of this research is to provide a categorization useable for companies to select a tool, a compromise has to be found and we have decided not to opt for the 2 ES categories defined by De Groot and Spurgeon as they are too detailed for our structure. The proposal of BSR which focus on only 4 key ecosystem services parameters is therefore a fair alternative that we will use in our categorization.

1-4-3 Tools in scope

There are numerous types of tools available on the market, each one having different and sometimes multiple purposes. The tools in scope of this study are the:

- Tools to raise awareness on biodiversity and ecosystems services
- Tools to assess and/or value impacts & dependencies on ecosystems and biodiversity
- Tools to identify (business) risks and opportunities
- Tools to facilitate the company decision-making process
- Tools developed for use in different sectors of activities
- Tools developed for multi-ecosystem services

1-5 Limitations

The implementation of TEEB for Business is at a very early stage, it is still a state-of-the-art theory with limited implementation worldwide so far. Recommendations that will be made in this study have to be kept within their context and can not be extrapolated without careful consideration. This study is a preliminary study of the ES tools categorization system and should be followed up by further research.

1-6 Significance of the study

There is a growing evidence and recognition by large influential corporations and companies of the importance of ecosystems and biodiversity. A large number of established Dutch corporations have acknowledge these risks, the responsibilities that go with them and/or the market opportunities in managing them better. They are however struggling to find the most effective way to address the risks and capture the opportunities. (Parr, 2011). ES assessment tools are intended to help companies in that perspective. Businesses are eager to get a clearer picture of the tools available on the market today and what they can do for them. This study is one step further into that direction.

1-7 Research placement and research team

The research is facilitated by the IUCN Dutch Office (www.iucn.nl) based in Amsterdam, the Netherlands. This research is part of a larger program of IUCN NL TEEB for Business Netherlands led by Mathew Parr. One of its main aims is to contribute to applying the TEEB theory in the Netherlands, thus strengthening Dutch businesses, potentially Dutch government economic policy, as well as conserving biodiversity and improving well-being at home and abroad (Parr, 2011).

The program leader as well as the IUCN NL supervisor of this study will be Mathew Parr. The IVM supervisor is Pieter van Beukering. The IUCN NL TEEB workgroup is also composed of Rob Regoort who will provide additional guidance to this research project as well as Laurens Gomes, Henk Simons, Marielies Schelhaas, and Daan Wensing (Leaders For Nature).

1-8 Structure of this paper

After the description of the context of this research and the definition of the problems addressed in this study that will be described in this first chapter, this paper will explain the methodology that has been implemented to select the criteria of the categorization structure for the ES assessment tools. Then the categorization structure will be further explained and a presentation of the key ES assessment tools will be given. Afterwards two assessment tools will be selected and tested in the categorization structure and finally the results of the evaluation of the categorization system will be presented. A summary of the discussions held with the experts interviewed will be given in the last paragraph and the key players in the field will be briefly described together with their key findings. Finally recommendations for the next steps will be made.

2- Methodology

The study will involve mainly literature study and feedback discussions to answer the main research question. Study will be mainly desk based.

2-1 Literature review

The literature review will consist of reviewing key references and several case studies in the existing literature. It will focus as well as existing research already conducted by companies or research and consultancy organizations. It has to be noted that the only literature available on the topic is soft literature and that no hard literature on the topic have been found.

2-2 Surveys

No large-scale company's surveys will be conducted (as the response rate is usually quite low), however specific companies may be contacted during this study.

2-3 ES assessment tools categorization structure and criteria

As stated by most of the key organizations working with ES assessment tools (ERM, BSR, WBCSD) we are still at an early development stage of those tools, which will in the future continue to evolve and proliferate. A categorization (or taxonomy) appears therefore to be a good approach to facilitate the selection of tools in specific contexts. It is also the approach proposed by BSR who states that a taxonomy for the emerging ecosystem services tool domain would assist with selecting tools that are best suited for specific applications. To create this categorization, the following 4 steps methodology is being proposed:

Step A: Categorizing the company types: We will define a structure to categorize the companies' profile.
Step B: Defining the scope of the ES assessment: We will define a series of criteria to classify the ES scopes types.
Step C: Identifying the available resources: We will define criteria to classify the available resources a company has to run as ES assessment.
Step D: Clarifying the company business needs: We will define criteria to categorize the type of results the tools can yield to, including their effectiveness to address each TEEB step.

To define the categorization criteria that will constitute our categorization structure, the following aspects are taken into consideration:

- the reasons why a specific tool was created and/or used for a particular context
- the limitations of the tools described in the case studies and tools definition
- the business relevance
- the ecological impact relevance

As well as:

- the categories proposed by EEA (see appendix 5)
- the categories proposed by EBM (see appendix 10)
- the categories proposed by BSR (see appendix 11)

It is important to find the right balance between having too many categories which would make the categorization system too complex for companies to use – and having too little categories which would render the categorization system useless. This resulted in the establishment of the above methodology which is detailed below:

Step A: Categorizing the companies´ type

One important way to categorize the ES assessment tools, is to know at first for which specific type of companies the tool is intended or suitable. This will help any business down-selecting the suitable tools for their situation.

→ Sector type
As defined in paragraph 1-4-1, we have selected the following4 key sectors as categorization:

- Agro-food
- Energy (incl. oil and gas)
- Extractive industry (mining)
- Water

→ Business size
A second set of criteria is the size of the company – as SME´s and multinational companies have due to their size very different business processes with which the ES tools outputs may be integrated (it is to be noted that 99 % of all enterprises in the EU are SME´s)

Companies' size can be measured in different ways: by turnover, by number of employees, by capital employed, by profit or stock market value (Business Studies Online, 2011)
Using employee numbers is rather unreliable since a company with a small number of employees can create a large turnover and consequently having a large impact and/or dependency on ecosystems. The same logic applies to the profit which depends greatly on the sector in scope. It makes the most sense to use the company turnover to measure the size of a company.

Classification of the tools by turnover:

- Small ≤ € 10 million
- Medium ≥ € 10 million and ≤ € 50 million
- Large ≥ € 50 million

As defined by the European Commission (European Commission, Enterprise and Industry, 2005)

→ Legal structure
The categorization in function of the governance and legal structure of the company (government/shareholders) will be out of scope of this study (ex: family-owned, shareholders, public, etc…)

Step B: Defining the scope of the ES assessment:

It is important to understand what the company wants to assess, at least on a high-level if it doesn't know yet the details of the ecosystem services in scope – this will also help in the selection of the adequate tool.

→ Ecosystem services in scope

In paragraph 1.4.2, the selection of ecosystem services in scope is explained.

- Water provisioning
- Carbon sequestration
- Cultural services
- Biodiversity

→ Geographical area in scope

It is important to categorize the tools in term of geographical scale as companies may want to assess local ecosystems or on the contrary look at the global picture. The geographical significance in scope in the tool is going to be categorized:

- Global scale
- Regional scale
- Local scale

→ Value chain stage

ESR proposes to look at the stage of the value chain the company wants to focus on: One alternative is to look "upstream" in the value chain. This approach would look at their key suppliers and the business risks and opportunities related to ecosystem services that these may pose to the company inducting the study. Another alternative is to focus on the company's own operations, providing an insight into the direct implications. Another possibility is to look "downstream which would provide an insight into the implications of ecosystem services trends for the company's major customers. (Hanson & al., 2011).

- Suppliers - «upstream»
- Company
- Customers - «downstream»

This approach will be used in the categorization system as it allows having a broader perspective on the ecosystems services impacted by all the company-related activities.

Step C: Identifying the available resources

The next step is to define the criteria to classify the available resources a company has to run as ES assessment.

→ Data Input

- High quantity data demand (do-it-yourself)
- Low quantity data demand (pre-loaded databases)
- High-quality data demand
- High-level data demand (for quick scan)
- Accuracy and reliability of the tool's built-in data

→ Budget available

Budget available to conduct an ES assessment is probably one of the most important factors, as often a limitative factor in the private sector that will need to justify internally of the investment and potentially the Return on Investment of that assessment. Based on the estimated number of hours required to conduct ES assessments as described by the BSR working group (Waage, 2011), the budget ranges were estimated.

→ ***Stakeholder engagement type***

At what level tool require engaging with stakeholders?

- Local community
- international community

Step D: Clarifying the company business needs

The last step, and one of the most important one, is to understand the needs of the companies who want to conduct as ES assessment, to ensure the selected tools will be able to respond to their needs.

Step D1:

Monetizing the value of an ecosystem service doesn't necessarily have more impact. Therefore we will assess all the following types of results: (See figure 2)

- *Qualitative results*
- *Quantitative results*
- *Monetary results*

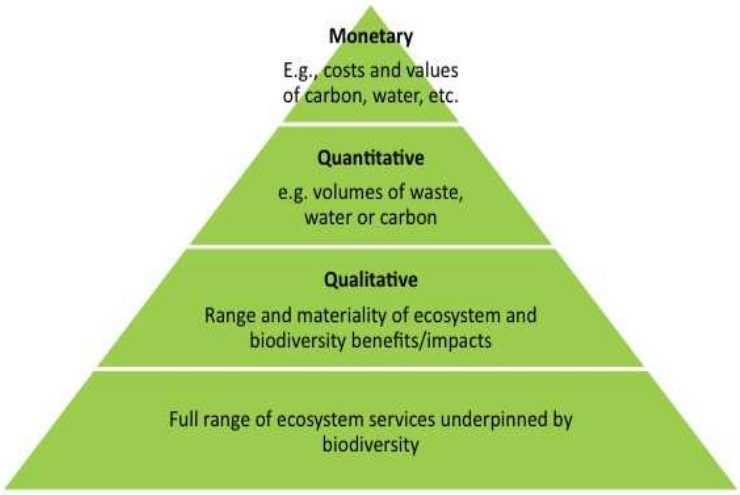

Figure 2 - Adapted from Source: P. ten Brink, Workshop on the Economics of the Global Loss of Biological Diversity, 5-6 March 2008, Brussels

Qualitative data includes data such as words (e.g., from interviews), pictures (e.g., video), or objects (e.g., an artifact), while quantitative data are numerical data.

→ ***Qualitative results***

- List of priority ecosystems
- Spatially-explicit maps
- Sensitivity or risk/opportunity analysis results for scenario planning

→ ***Quantitative results***

- Valuation analysis

→ ***Monetary results***
- Return on Investment prediction

Step D2:

→ ***Results Quality***
- High quality data output
- High-level data output

→ ***Business requirements***
- Ability to generate and compare scenarios
- Scalability and adaptability for different locations/conditions/sectors

→ ***Prominent tool features***
- Ease of use of the tool ("plug and play")
- Required knowledge/experience in BES to use the tool
- Transparency of tool design (no black boxes)
- Free public access for basic version
- Exportable formats of tables, maps and charts

→ ***Intended target audience***
- Corporate managers/decision makers
- Environmental/CSR managers

→ ***Business Objectives (based on TEEB)***
- *Identifying the impact and dependencies of your business on BES*
- *Assessing the impact and dependencies of your business on BES*
- *Valuing the impact and dependencies of your business on BES*
- *Identifying the consequent business risks and opportunities*
- *Assessing the consequent business risks and opportunities*
- *Developing BES information systems: measurements, value performance and reporting*
- *Taking action to respond to BES risks, including in-kind compensation where appropriate*
- *Grasp emerging BES business opportunities (cost-efficiencies, new products, new markets ...)*
- *Comparing the tradeoffs various projects would involve*
- *Facilitating the company decision-making process on BES*

Finally, some additions key tools specifications are added to the categorization:

→ ***Tool developer***
- *Non-profit/NGO*
- *Private firm*
- *Education or research institute*

→ ***Tool Key Specs***
- *Purpose/Objective of the tool*
- *Scope/Applicability*

- *Key Assumptions Built into Tool*
- *Key Limitations of Tool*

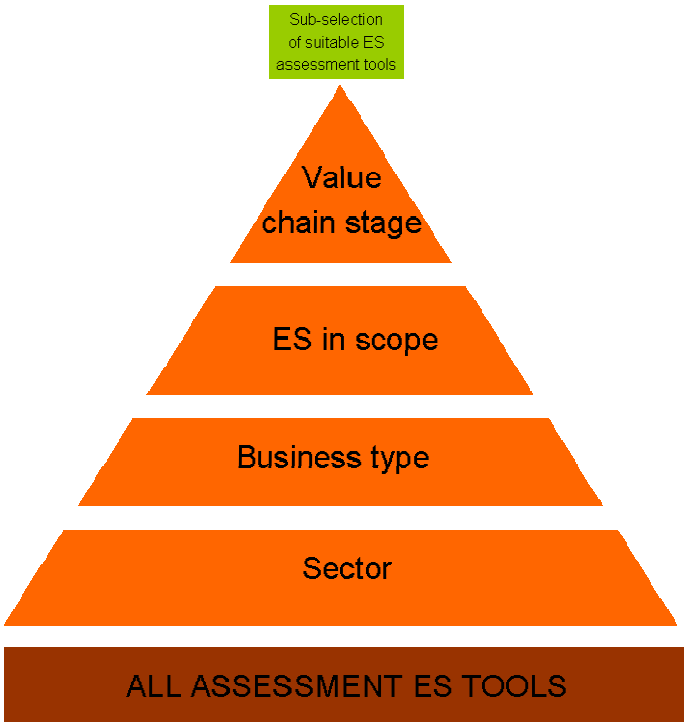

Fig 3: Logical framework showing the added value of the categorization system on the selection of ES assessment tools for a specific situation.

→ The full **ecosystem services assessment tools categorization structure** is available in appendix 12. Its added value is represented in figure 3.

2-4 Feedback discussions

Feedback discussions with relevant partner stakeholders and/or companies were conducted when considered suitable and necessary for this research. Examples of the questions asked to the respondents are documented in the appendix 1, their answers in appendix 3.

3- Applications

3-1 The Ecosystem Services assessment tools

Over the past few years, academics, NGOs and public sector have been developing tools to enable key decision makers — in public, private and non-profit sectors — to integrate ecosystem service concepts into their strategies as well as their daily operations. The growing number of initiatives can make it challenging to figure out which tools are applicable for which decision-making circumstances. However, the number of tools that are created specifically for companies to assess, value and respond to the risks and opportunities generated by their impacts and dependencies on multiple Ecosystem Services – and for multiple types of sectors – still remains limited. The little literature available has been studied and researches on internet websites for more recent tools development have been conducted. Two important consultancy and research organizations BSR and ERM have been assessing the suitability of a series of tools for use in business context. Tools selected by BSR and ERM are being reviewed in this paragraph – with the focus on the tools that do address all the ecosystems (including biodiversity) and are meant for use in business context – which is the scope of this study. Some of the tools proposed are specifically focused on biodiversity like BBOP, IBAT and IBAP. So they were excluded from the scope of this study as we want to address a wider scope. HCV has developed the HCVF Toolkit intended to cover all ecosystem services but remains in practise much more forest oriented and is not particularly targeted to companies but mostly forest managers and decision-makers. (source: www.hcvnetwork.org). This study can be considered as a follow-up of the study made by BSR. It takes into consideration some additional tools that are potentially fit for the intended purpose: EBS, ESValue, EcoAIM, EcoMETRIX, and CEV. The overview of the analysis of those tools can be found in the consolidated figure 4 below.

Tool name	Description	Intended Users	Characteristics
Multi-Ecosystem Service Assessment Tools			
ARIES	A computer model and decision-support infrastructure to assist decision makers and researchers by estimating and forecasting ecosystem services provision and their correspondent range of economic values in a specific area.	Policy makers, NGO's Consultants, Companies	«» Probabilistic, nondeterministic model designed for continual updating «» Transparent, so users know information sources «» User-friendly interface despite complexity of model «» Builds on University of Vermont's Ecosystem Services Database, which contains spatially-explicit, peer-reviewed valuation data as well as methods of analysis, publications and project models «» Will be pilot tested via Conservation International and Earth Economics
ESR	A sequence of questions that helps managers develop strategies to manage risks and opportunities arising from a company's dependence on ecosystems.	Corporate managers	«»Offers a methodical, logical sequence of guiding questions «» Most advanced in terms of "road-testing" with companies «» Plans to provide guidance on integration into existing Environmental Management Systems as well as valuation techniques
InVEST	A decision-making aid to assess how distinct scenarios may lead to different ecosystem services and human-well-being related outcomes in particular geographic areas.	Government agencies, Farmers and individual landowners	«» Enables users to input their own site-specific data «» Allows for expert opinion as data to address data gaps «» Enables consideration of present and future tradeoffs from alternative resource management «» User-friendly with few data requirements «» Identifies where ecosystem service benefits originate
MIMES	A multi-scale, integrated suite of models that assess the true value of ecosystem services, their linkages to human welfare, and how their function and value may change under various management scenarios.	Scientists, Policymakers, Natural resource managers	«» Value can be denominated in monetary terms, land area or other parameters «» Is already populated with reliable, publicly available data «» Can be scaled for additional data input «» Model is open source and has been successfully implemented
NVI	An evaluation benchmark methodology for assessing biodiversity and ecosystem services-related risks and opportunities in the food, beverage and tobacco sectors	Corporate managers, Financial analysts	«» Promotes greater awareness within the finance sector of the links between biodiversity, ecosystem services and investment value, including the risks associated with mismanagement «» Creates a company risk profile and offers case studies based on both publicly available information and direct corporate engagement
ESValue	A strategic decision support tool that integrates scientific and economic information to show the impact and value of alternative environmental management strategies on ecosystem services.	Environment and Economy Experts, Corporate Managers	«» 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
EcoAIM	A new tool to inventory ecological services and help in making decisions regarding development, transactions, and ecological restoration.	Corporate Managers	«» specific estimates of ecosystem services in a geographically relevant context «» evaluating tradeoffs of ecosystem services resulting from different land or resource management decisions.
EcoMETRIX	Seen as the new upcoming tool by BSR. It is an environmental measurement and modeling tool that supports sustainable infrastructure, restoration projects, and enterprise-level program decision-making.	Companies	«» quantifies changes within an ecosystem, enabling users to evaluate the positive or negative effects of different scenarios and alternative designs on ecosystem services
CEV	Released in Spring 2011. WBCSD decided to develop the CEV as no other tool or guide where available to respond to the need of the companies. CEV makes use of other valuation tools and techniques to provide a valuation of business risks and opportunities.	Companies	«» provide trade-off analysis «» sustainable financing and compensation analysis «» covers both financial and social values «» is based in the total economic value of ES «» enables companies to improve their decision-making

Biodiversity-Focused Tools Linked to Ecosystem Services			
BBOP	A toolkit that assesses whether biodiversity offsets are appropriate and provides guidance on offset design	Corporate managers, Gov Agencies	«» Offers biological and socioeconomic indicators to show net gain or loss of biodiversity «» Designed to eventually sync with Environmental Impact Assessments (EIAs) «» Codesigned by corporate, government and conservation organizations
IBAT	A screening tool to help companies incorporate biodiversity into their risk analysis, decision-making and planning processes	Companies	«» Builds on locally collected scientific knowledge and data «» Delivers a cost-effective product in a timely manner «» Limited to biodiversity "hot spots" and protected areas «» Designed to eventually inform Biodiversity Action Plans and EIAs
IBAP	Initial assessment tool to identify biodiversity assets and risks and develop an action plan.	Companies	not defined
EBS	EBS came onto the market in Spring 2011, is meant specifically for companies but is more focused on biodiversity. EBS is currently looking at ways to further incorporate ecosystem services evaluation in the assessment process.	Companies, Corporate managers, Auditors	«» focused on biodiversity «» meant for delivering a certificate to companies than having them take actions to mitigate their risks and opportunities related to their impacts and dependencies onto ecosystems
Forestry-Focused Tools Linked to Ecosystem Services			
HCV	Intergrated evaluation approach to identify six different categories of high conservation and social use value areas	Gov, Resource managers, Companies	not defined

Fig 4 – Overview of Ecosystem Service Assessment Tools adapted from BSR (Measuring Corporate Impact on Ecosystems: A comprehensive review of new tools) and from ERM (Putting a price on nature).

So from what has been found in the literature during this study, it appears that those 9 tools (ARIES, InVEST, MIMES, ESR, CEV, NVI, EcoAIM, EcoMetrix and ESValue) are the main tools being able to assess the risks and opportunities resulting from companies' dependencies and impacts on ecosystem services. A more complete description of all those tools can be found in Appendix 8.

3-3 Testing of 2 assessment ES tools in categorization structure

Due to a lack of time during this study, only 2 tools have been tested in the categorization system. Testing the 7 other ES assessment tools identified in this report would be a valuable addition to this study.

ESR:
The first of the 2 tools that have been tested in the categorization matrix is ESR. The choice of ESR was obvious; as most experts interviewed and literature reviewed align on the fact that ESR is the only general BES assessment tool currently available on the market to-date. The details of the test are thoroughly documented in the XLS sheet accessible from the Appendix of this document. The applicability of ESR for each categorization criterion is illustrated by a statement that has been found in the literature. In the case of ESR, the statements come from the Corporate Ecosystem Services Review guidelines published by WBCSD and WRI.

CEV:
The second tool that has been tested in the categorization structure is CEV. It has been released by WBCSD in Spring 2011 and appears to be so far the most suitable tool according to the experts interviewed in this study. In particular, Eva Zabey (WBCSD) explained during her interview that WBCSD decided to develop the CEV as no other tool or guide where available to respond to the need of the companies. "Although a multitude of related guidelines already exist, none cater directly for the needs of business.". CEV makes use of other valuation tools and techniques to provide a valuation of business risks and opportunities.

ECOSYSTEM SERVICES ASSESSMENT TOOL	ESR	CEV
ORGANIZATION	WBCSD	WBCSD
STEP A - WHAT YOUR COMPANY IS		
What is your company sector?		
Energy sector	YES	YES
Agro-food sector	YES	YES
Extractive industry sector	YES	YES
What is the size of your business?		
Small (Turnover ≤ € 10 million)	YES	YES
Medium (≥ € 10 million and ≤ € 50 million)	YES	YES
Large (≥ € 50 million)	YES	YES
STEP D - WHAT YOU NEED		
Qualitative results		
List of priority ecosystems	YES	INDIRECTLY
Spatially-explicit maps	NO	INDIRECTLY
Sensitivity or risk/opportunity analysis results for scenario planning	NO	YES
Quantitative results		
Valuation analysis	NO	NO
Monetary results		
Return on Investment prediction	NO	NO
Results Quality		
High quality data output	NO	YES
High-level data output	YES	YES

Fig 5 – Result of the test of CEV and ESR in the categorization structure.

The detailed result of the assessment of CEV and ESR in the proposed classification structure can be found in Appendix 12. The overview is shown in figure 5 above.

Due to time limitations, the 7 other selected tools haven't been tested yet in the ES tools categorization system, but the analysis of the 2 most important ES assessment tools gives sufficient data to perform a first analyse the categorisation structure.

3-4 Evaluation of the ES tools categorization

Based on the testing of CEV and ESR, some evaluations of the categorization structure will be given below:

We see that both tools are suitable for all company's types, all ecosystems as well as all sectors – which make them both suitable for every possible case. Looking at step B, the categorization can already indicate which tool is more suitable for which specific purpose. Then moving on to step C, the categorization structure already helps narrowing down the choices a company has to address the issues with the data and means which are available to the company. The step D will help further refining the choice of tool(s) – if the 3 first steps haven't succeeded in selecting the most adequate tool. Most of the information used to fill in the categorization for ESR and CEV has been found in respectively the ESR Guide and CEV Guide. The detailed information can be found in the comment of the cells directly in the spreadsheet (Appendix 12).

A way to assess the validity of the categories chosen for the categorization system would be by looking at the diversity in the answers throughout the tools. If they all are positive – or all negative – the relevance of the category would therefore be limited and could be removed. As the assessment is done only over 2 tools in this study, such conclusions over the relevance of categories won't be possible. However, the proposed categorization structure seems to give sufficient information to companies on the scope, capacities and characteristics of each tool to be able to down select a tool.

3-5 Key experts interviews and key players in the field

During this research, key players have been identified as being thought leaders in the field of ES assessment tools for companies. Their background and key findings on the subject are summarized below. To confirm the results of this study, interviews of key experts of ES assessment tools have been conducted. Most of the experts interviewed are related to the organizations/institutions of the key players. Detailed scripts of all those interviews and further information about the interviewers can be found in the appendices 2 and 3. The selection of experts has been made by researching the literature, completed by recommendations made by those experts themselves. In this section, you will find the key points highlighted by the experts during the interviews. The conclusions drawn from those interviews will be detailed in the conclusions section. The information below reflects the opinions of each expert and may therefore be different with each other.

3-5-1 BSR

BSR is to-date the only key organization which has conducted an in-depth assessment of the existing ES assessment tools for the corporate world. One of the key references for this study is a study undertook by BSR (Linda Hwang and al., 2010). BSR is an NGO with member companies. BSR does advisory work - to help the member companies address sustainability issues and has also a small research component to retain a long view on key business trends.

BSR launched a Working Group on Environmental Services, Tools & Markets in 2007 which compared the performance of multiple tools for one possible corporate application. Seven tool-developer teams were asked to apply their tools to the same scenario.

- It appeared that side-by-side tool comparisons are difficult, given the tools very different definitions of ecosystem services units and scopes.
- Also, one of the challenges identified is that none of the studied tools mesh with key existing corporate processes.
- Furthermore, the working group concluded that the added value of such tools to existing approaches companies use to assess performance is not yet clear.

Those are the attributes identified by BSR that tools should have in order to be useful to most companies:
» Scalability and adaptability for different locations, conditions, and types of sectors
» Ability to generate and compare scenarios
» Ease of use (related to time and resources)
» Generation of spatially-explicit displays of information (e.g., maps)
» Transparency (no "black boxes
» Avoidance of new corporate-level metrics
» Levels of (un)certainty
» 'Roll up' and 'roll down' findings
» Highlight trends
» Benchmarks
» Maps, charts, and tables—exportable in MS Suite
» Development of internal corporate plug-and-play applications

More criteria for a tool taxonomy proposed by BSR can be found in appendix 11.

Interview of Sissel Wage and Linda Hwang

- What appeared from the gatherings of tools developers organized by BSR is that it is not always in the developers' best interest to work together - as most of them want to promote their own approach. Therefore there was limited willingness to collaborate: we are working before all in a business competition environment.

- Companies and organizations really want to have a taxonomy as it would make everybody´s life easier. However most tool developers are not too keen on having a taxonomy made - as most of them want to develop their own tools for commercial purposes – and do not want them compared to the other tools on the market.

- Sissel believes that we are not at a point that we can build a strong taxonomy, as we don´t know enough about those tools – including the tools developers which are still working on the development of their tools. Furthermore, the risk of creating one taxonomy is to put in the open a comparison of apples and pears.

- BSR stresses that it is key that in the future, developers work much closer with businesses to genuinely understand what the value is for the company and for its stakeholders.

3-5-2 European Environmental Agency

The European Environment Agency (EEA) is an agency of the European Union whose task is to provide sound, independent information on the environment. The EEA are a major information source for those involved in developing, adopting, implementing and evaluating environmental policy, and also the general public. The EEA has issued a report (Jaeger, 2008) to promote the idea of the creation of an online model inventory for the myriad of simulation-based models that have been made to projecting environmental changes. This inventory would be used as information portal to facilitate interactions between the providers of modelling tools and the users of models and their results.

Such an inventory could provide an information source on modelling tools to underpin future state of the environment assessments and help to:

- expand and complete the overview of existing modelling tools initiated,
- update this overview as new models or new versions of existing models become available
- broaden the perspective of both model developers and model users,
- point to interesting but currently unknown models, and facilitate interactions between modelling teams

The main concept behind an online model inventory can best be described as a kind of web-based encyclopaedia written collaboratively by the developers and users of environmental models — i.e. following a 'wiki'-inspired approach to knowledge management. (Jaeger, 2008). This concept of creating on online inventory for environmental changes model is perfectly adaptable to the situation of the ES assessment tools as the same context and conditions apply. It will be further detailed in the recommendations section of this study.

Interview of Manuel Winograd

- According to Manuel, TEEB is much too academic. TEEB has lots of case studies but it lacks giving an overall perspective on the ecosystems services issues. Academic, politics and industries are interested in BES but at a very different time scale. Therefore most tools developed so far are not suitable to all.

- Tools assessed by BSR are not designed for the industry therefore not adapted for the targeted users. They have been developed by academic for industries without much of their involvement. Manuel worries that collaboration with companies may not be optimum as we may be selling them inadequate tools.

- After more than 20 years of working with models, Manuel came to the conclusion that what is relevant is to focus on the processes, and not the tools.

3-5-3 Environmental Resources Management

Environmental Resources Management (ERM) defines itself as a leading global provider of environmental, health and safety, risk, and social consulting services. ERM delivers innovative solutions for business and government clients, helping them understand and manage their impacts on the world around them.

According to ERM, valuation tools can produce a broad range of results depending on the valuation approach being used. As a consequence, numerous valuation tools have

emerged over the last few years and this process is likely to continue. In its report «Putting a price on Nature», ERM asserts that the key is to understand exactly what a company's objective is, and to select the most appropriate tool accordingly (see figure 6). However, ERM advocates that the best solution will be for a company to develop their own tailored approach, drawing upon the best elements of existing tools. ERM, a WBCSD-member, developed the CEV methodology in partnership with WBCSD.

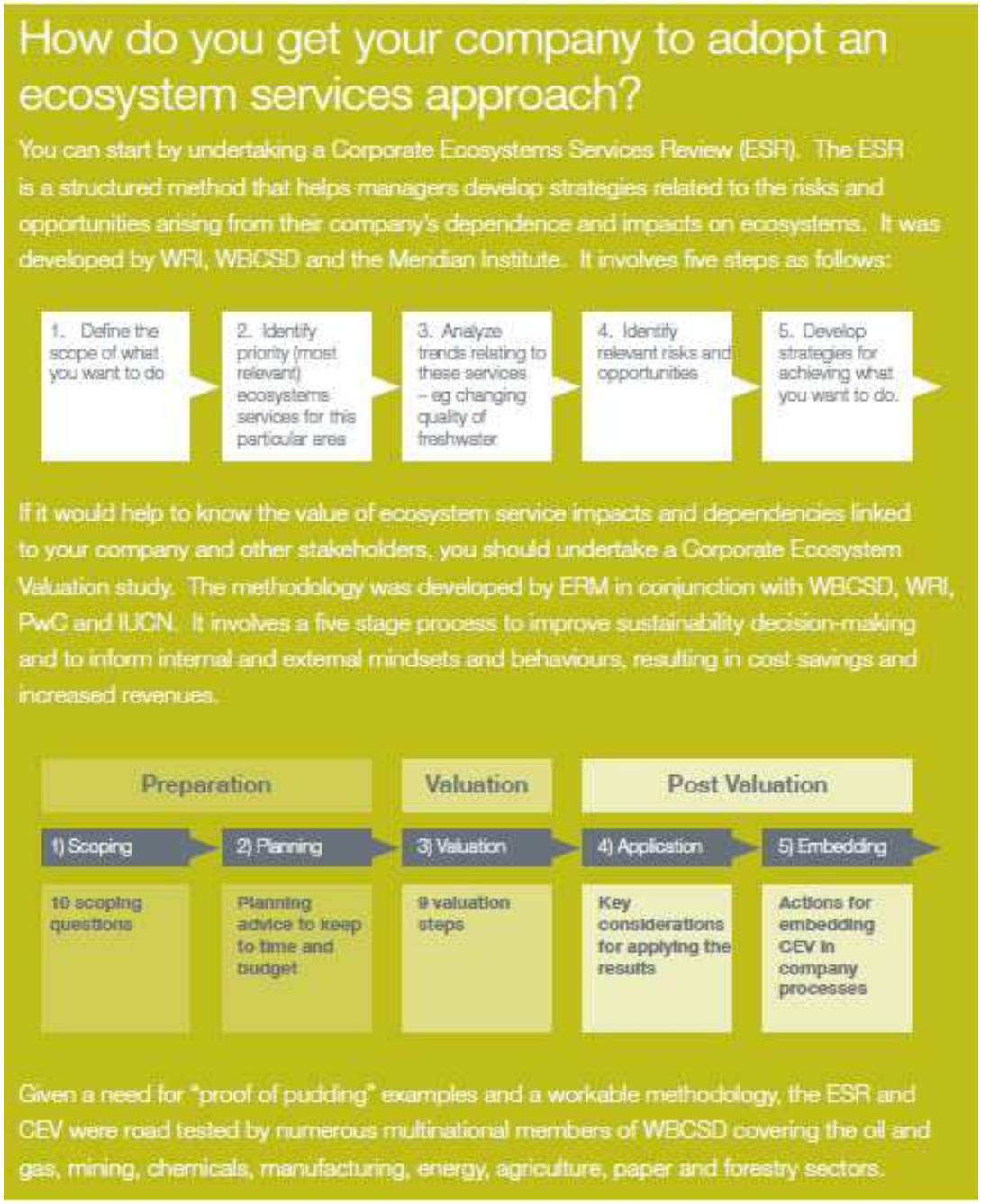

Fig 6. Recommendation to companies – Putting a price on nature – J. Spurgeon, ERM.

Interview of James Spurgeon

- The next step is for tools to help developing the CEV (some have already done it). Most tools available today on the market are very specific in terms of locations and use of certain of parameters, which make then not very flexible. ESR and CEV give together a flexible and powerful approach to companies. Simpler and more flexible tools for companies now need to be developed.

- There are so many different ways companies may want to tackle their BES problems, that custom-made tools are often necessary. Simple tailor-made approaches following the essence of ESR and CEV are also a good option for a company as they will address their specific needs.

- James sees in the future new sets of tools more user-friendly will be developed in the coming 2 to 5 years. Also increased standardization on those tools.

3-5-4 International Union for the Conservation of Nature (IUCN NL)

Interview of Rob Regoort

- it is very important to link biodiversity to already existing business tools such as environmental impact assessment: companies do not like to have to add extra tools.

- Even more important is to develop a high level pre-screening step, where a company can identify what area of their products have the biggest impact on bio-diversity, looking at the total value-chain, both up- as downstream ("cradle to gate" and "gate to grave".

- It is important to develop a simple mind map together with companies, academic institutes, NGO's, consultants and governments - which guides companies through this very complex field and links the outcome with existing business tools. This could be the follow up for the TEEB project.

3-5-5 World Business Council for Sustainable Development

The World Business Council for Sustainable Development (WBCSD) is a CEO-led, global association of some 200 companies dealing exclusively with business and sustainable development. The Council provides a platform for companies to explore sustainable development, share knowledge, experiences and best practices, and to advocate business positions on these issues working with governments, non-governmental and intergovernmental organizations. One of the Council's objectives is to demonstrate the business contribution to sustainable development solutions and share leading edge practices among members. WBSCD has been working on ecosystems and biodiversity for over 15 years, and over the years has become a leading business voice on ecosystems, working closely with organizations such as IUCN with which they have a Memorandum of Understanding since 2004. WBCSD worked with World Resources Institute (WRI) to develop the ESR in 2008, and led the development of CEV along with IUCN, WRI, ERM and PwC. WBCSD also works on capacity building and is developing a complete curriculum called Business Ecosystems Training (BET) that will be available in February 2012. All WBCSD material and tools are freely available and open source. (Source http://www.wbcsd.org)

Interview of Eva Zabey

- WBSCD says that the evolution of ES tools goes very fast – so implies that having a system in place like a database would be very valuable for companies trying to navigate through this complex area, even though it would require a high-maintenance to keep it up-to-date.

- WBCSD sees ESR as the best first step for companies, including for those who are new in this area. It is a high level assessment of "Priority Ecosystem Services". Some companies are more focused on water, biodiversity, carbon, etc … but if a company just wants to explore the full range of ecosystem services to uncover some potentially unknown risks / opportunities, ESR is the right and only tool currently available to give a qualitative assessment. It is also accessible for "learners" and relatively quick to go through.

- CEV is performed when quantitative results are required – as it is much more result intensive than ESR. ESR is referenced greatly in the CEV, as it is a "step 1" before going onto CEV ("step 2") if necessary and appropriate depending on the business decision that is being made. A slightly updated version of the ESR will be available early 2012, and makes clear that a potential next step after the ESR is CEV.

3-5-6 Ecosystem-Based Management Tools Network

The Ecosystem-Based Management Tools Network (NatureServe 2008) has developed a database of tools that consider bundled ecosystem services emphasizing coastal and marine systems. EBM tools database is an online database for tools and projects for innovative interdisciplinary coastal-marine spatial planning and ecosystem-based management. In June 2009, the Ecosystem Services Tools database contained approximately 235 records and this number is increasing. The purpose is to provide an evolving searchable database of tools, approaches, and techniques that can be applied in analytic-deliberative decision support processes accounting for improving decisions that may affect ecosystem services. The objectives of the EBM Tools Network are to:

- Increase awareness of existing EBM tools
- Promote the development and maintenance of EBM tools
- Promote the effective use of EBM tools (Source: http://ebmtoolsdatabase.org)

Fig 7 – screenshot of the EBM tools database

EBM proposes like the EEA an evolving searchable database of tools which best practices will be integrated in the recommendations of this study (see figure 7).

4- Conclusions and recommendations

Though the future of corporate ES assessment tools remains unclear, it appears more and more that companies are moving slowly from simple energy and/or carbon footprints to more holistic approaches focusing on all ecosystem services they impact and/or depend on. The goal of this research was to answer the following question: How can Ecosystem Services assessment tools be better understood and used more effectively by companies?

There are currently many Ecosystem Services Assessment tools available on the market, but only a very few are meant and/or suitable for use in the corporate world. And there is to-date no complete analysis made of all those tools which makes it very complex for companies to choose the most suitable tool for their own situation. BSR also conclude in its study that a taxonomy for the emerging ecosystem services tool domain would assist with selecting tools that are best suited for specific applications. One way to help companies understanding those tools is to offer them an exhaustive and structured overview of the tools available on the market, and more importantly how those tools can respond to their needs. This study has been touching upon creating such an overview: 9 tools (ARIES, InVEST, MIMES, ESR, CEV, NVI, EcoAIM, EcoMetrix and ESValue) have been identified as the tools able to assess the risks and opportunities resulting from companies' dependencies and impacts on ecosystem services. The large majority of experts interviewed agree with each other on the fact that the ES tools will continue evolving at a high-pace, and the tools available today on the market won't be the same tomorrow. In 2 to 5 years, some tools will probably become market leaders though it is difficult to predict today which ones – though improved versions of ESR and CEV will most probably still be around. Ecometrix is also an upcoming tool (BSR, 2011). Creating a database where all the ES assessment tools are categorized would therefore greatly facilitate the ES tools selection process for companies. A possible categorization structure to be able to classify the various ES assessment tools has therefore been proposed in this study: it can help more systematically compare tools to one another and understand them in this context. The categorization structure has been tested on 2 main ES assessment tools, ESR and CEV and gives a good impression of what a tool can offer to a company, depending on its requirements and its available resources.

So what should a company do to start with addressing its impacts and dependencies on ecosystem services? It appears quite clearly in the literature and all the interviews conducted with ES assessment experts that ESR remains to-date the unique tool available to do a qualitative (pre-) assessment of ecosystem services in a business context, which is in most cases sufficient for companies to make strategic decisions or choose among different possible scenarios. ESR can always be followed up by the use of a more specific/detailed methodology/tool for companies willing to have more specific and/or quantitative or monetary results. For example, ESR could offer a structure for priority setting prior to doing a landscape-level assessment using either ARIES or InVEST. The EcoMetrix tool could then assist with site-level analysis (Waage, 2010). Furthermore, WBCSD informed us that the link between ESR and CEV will be made clearer in the future (for example in ESR v.2), which will strengthen the combination of ESR/CEV. Another complementary suggestion proposed by IUCN NL is to develop a pre-screening step prior to conducting an ESR, where a company can identify what area of their products have the biggest impact on biodiversity, looking at the total value-chain, both upstream as well as downstream. I believe this is important especially for companies who are new to the concept of ecosystem services and might start focusing too quickly on one part of their value-chain which might not be the most relevant to address. Or

- an interesting alternative to using the available tools on the market, can also be to create very simple tailor-made tools to match the company specific requirements, rather than using the BES tools which are available for other specific purposes and may often lack flexibility. This recommendation is supported by experts such as James Spurgeon – who mentions that tools such as ESR (available in spreadsheet format) can easily and rather quickly be customized by ES assessment professionals.

The next steps would be to ask tools developers as well as companies having used some of those tools to assess the categorization structure developed in this study. But instead of a static taxonomy, it could be a great added value to create an online database (Wikipedia type) for tools developers and users to gather and retrieve information over all the available BES tools for business on the market. To deal with the fast pace of BES tools development, WBCSD recommends as well to create a consortium of Tools Developers that would create an exhaustive database of all the existing tools, and would maintain it. A new consortium on Ecosystem Services Assessment Tools could be established – or it could leverage on an existing platform such as the EU Business @ Biodiversity platform or preferably a similar platform covering multi-ecosystem services (and not only biodiversity). (See appendix 9 for information on the EU B&B platform). The role of the Consortium could be to:

- Maintaining a knowledge base of existing ES assessment tools
- Action as the Single Point of Entry for all stakeholders - including companies – looking for the right tool
- Initiate an online database where all available ES assessment tools would be categorize by the tools developers according to a pre-defined structure
- Review the input provided by the tools developers to maintain objectivity (quality-control)
- Encourage users (companies) to actively assess and review the tools based on their experience
- Watching for new tools being proposed on the market
- Staying informed by tools developers of their latest developments
- Developing best practices for tool development to promote tool utility, sustainability, and interoperability (source: EBM)
- Developing best practices for using tools
- Assessing tool needs of companies and gaps in tool functionality
- Providing training on key ES assessment tools (optionally – this would greatly include resource needs. Note that ESR and CEV are included in WBCSD's upcoming Business Ecosystems Training capacity building program to be launched Feb 2012, which will be open source).

The EEA also proposed a similar approach for ES models (Jaeger, 2008) with the objective of establishing an information portal to facilitate interactions between the providers of modelling tools and the users of models and their results. The main concept behind an online model inventory can best be described as a kind of web-based encyclopaedia written collaboratively by the developers and users of environmental models — i.e. following a 'wiki'-inspired approach to knowledge management. Members of such consortium would ideally be independent entities at the interface between science and policy, in order to avoid a bias towards one or other specific ES assessment tools and thus ensure a comprehensive and fair assessment. Members could be entities as:

- Convention on Biological Diversity (CBD)
- Food and Agriculture Organization of the United Nations (FAO)

- Global Environment Facility (GEF)
- UN Convention to Combat Desertification (UNCCD)
- UN Framework Convention on Climate Change (UNFCCC)
- United Nations Foundation
- United Nations Development Programme (UNDP)
- United Nations Environment Programme (UNEP)
- World Bank
- International Union for the Conservation of Nature (IUCN)
- World Health Organization (WHO)
- World Business Council for Sustainable Development (WBCSD)
- World Resources Institute (WRI)

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Cost-benefit analysis in the context of ecosystem services for human well-being: A multidisciplinary critique

Ecosystem services – Bridging ecology, economy and social sciences
Ecological Complexity, Volume 7, Issue 3, September 2010, Pages 257-259
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Global Environmental Change, In Press, Corrected Proof, Available online 21 January 2011
Giulia Wegner, Unai Pascual

Appendixes

Appendix 1: Examples of questions asked during the feedback discussions

Planned questions to companies:

- What did your company do to implement TEEB or to take into consideration BES in its business strategy? If it was a tool:
- What are the main functions of this tool?
- What is your experience with this tool?
- What have been results of using this tool?
- What are the reasons why the implementation of the tool was successful (if applicable)?
    - Was an environment manager appointed?
    - Was there Executive Management commitment?
- For which sector and company type would you recommend this tool and why?
- According to you, what are the strengths of this tool?
- According to you, what are the weaknesses of this tool?
- According to you, how could this tool be improved?

In order to find out which tools have been used by companies, we also contacted some of the organizations that develop those tools.

Planned questions to organizations that developed the tools:

- How many companies have used your tool so far (for instance: how many licences have you sold, etc ...) or how many times it has been used to-date?
- Do you know how many companies have been using your tool for strategic decision-making purpose?
- What are the strong points of your tool regarding its usability for business?
- What are the points you would like to develop in order to further operationalize your tool for companies' usage?
- How do you see the future of biodiversity and ecosystems services measurement and decision tools in the coming 5 years?

Appendix 2: Experts interviewed

Sissel Wage & Linda Hwang	**Business for Social Responsibility**
Eva Zabey	**World Business Council for Sustainable Development**
Manuel Winograd	**European Environmental Agency**
Rob Regoort	**IUCN Netherlands**
James Spurgeon	**Environmental Resources Management**
Frederiek van Lienen	**University of Wageningen**

Name:	**Linda Hwang**
Organization:	BSR
Job Role:	Manager, Research
Publications:	New Business Decision-Making Aids in an Era of Complexity, Scrutiny, and Uncertainty - Tools for Identifying, Assessing, and Valuing Ecosystem Services / Measuring Environmental Performance: The Business Case for New Tools / Measuring Corporate Impact on Ecosystems: A comprehensive review of new tools.

Name:	**Eva Zabey**
Organization:	World Business Council for Sustainable Development
Job Role:	Business and Ecosystems Professional

Name:	**Manuel Winograd**
Organization:	EEA
Job Role:	Advisor

Name:	**Rob Regoort**
Organization:	IUCN NL (and former Akzo Nobel sustainability manager)
Job Role:	External consultant

Name:	**James Spurgeon**
Role (from 01/09/2011):	Independent consultant
Organization:	formerly ERM / currently: SustainValue
Web:	www.sustainvalue.co.uk
Publications:	Spurgeon and al., Putting a price on nature, an ERM guide to ecosystem services, January 2011.

Name:	**Frederiek van Lienen**
Role:	PhD Student
Organization:	Wageningen Universiteit and Good Company
Address:	PO Box 47, 6700 AA Wageningen, The Netherlands

Appendices 3: Interviews with experts

Appendix 3-1: Manuel Winograd - European Environmental Agency

The Netherlands is well placed in the global BES research, but is very much focused on the BES models (for ex: valuation tools). The problem is that modelisation often focuses on details and the overall perspective is lost. According to Manuel, the priority should not be given to modelling/developing new tools, but rather on the processes. It is one global body: ecosystems are not the sum of ecosystem services. Ecosystems issues can not be solved only with models. What we need is organisations that start analysing the results of the models. The University of Wageningen currently works more specifically on the processes to analyse the results of the models (cf. quickscans). According to Manuel, TEEB is much too academic. TEEB has lots of case studies but it lacks giving an overall perspective on the ecosystems services issues. The World Resources Institute (WRI) who also contributed to the creation of ESR – did work with lots of companies and initiated an Ecosystem Services assessment which is industry-oriented. Also analysed case studies in specific industries. The problem with the private sector is that it remains difficult to understand of companies are interested in BES to really internalise their costs or as a marketing tool.

The problem we are facing is mostly a timeframe issue:

Academic	50 years
Politic	4 years
Industry	1 year

Academic, politics and industries are interested in BES but at a very different time scale. Therefore most tools developed so far are not suitable to all. Tools assessed by BSR are not designed for the industry therefore not adapted for the targeted users. They have been developed by academic for industries without their involvement. Manuel refers to the SENSOR project whose main product is SIAT (Sustainability Impact Assessment Tool) – which is a quantitative multi-modelling tool providing prospective scenario assessment across disciplines, sectors and sustainability dimensions. It includes the valuation of simulated environmental, social and economic effects in terms of sustainability impacts. This project (which costs over 34 millions €) resulted in lots of scientific literature and a tool which is not flexible (black box) and not user-friendly either. It is important that industries get tools to analyse upstream and downstream impacts and dependencies so usually they will need several tools for each pinpointed problem.

Manuel makes an analogy with medicine: both general practitioner and specialist doctors are required, depending on the health issue – in the same way, both generalist and specifc models are required – but the problem in Europe is that we go too quickly to specific tools and jump too fast to conclusions.

What is relevant is to establish some interfaces that can help decision-makers to use all results provided by models to analyse them. After more than 20 years of working with models, Manuel came to the conclusion that what is relevant is to focus on the processes, and not the tools. What is required is more processes which can help users make analyse and make decisions - and less tools. What is also important, is to understand the functionalities of the tools that allow the resolution of the problems. Manuel worries that we will loose the battle with companies as we are selling them inadequate tools.

Appendix 3 -2 James Spurgeon – Environment Resources Management

In his report "Putting a price on nature", James Spurgeon (ERM) states that companies should develop tailored-made approach drawn on best elements of existing tools. James Spurgeon is one of the main contributor of the CEV. He was contacted during this study to understand better his viewpoint. The details of this interview can be found below:

ESR is only a framework. CEV is a generic framework that be be used to put monetary value on it. It highlights some possible applications in companies, but mostly fairly specific tools (per location).

What is the next step in BES tools according to you?

The next step is for tools to help developing the CEV (some have already done it).
Most tools available today on the market are very specific in terms of locations and use of certain of parameters, which make then not very flexible. ESR and CEV give together a flexible and powerful approach to companies. Simpler and more flexible tools for companies now need to be developed.

Who are the market leaders?

At the moment, James Spurgeon is developing simple tools for multinational companies. There are so many different ways companies may want to tackle their BES problems, that custom-made tools are often necessary.

What approach should company take?

It depends on what a company wants: It could be ESR or a own modified version of ESR. Simple tailor-made approaches following the essence of ESR and CEV are also a good option for a company as they will address their specific needs. Most of the time, companies have limited budget and time to analyse and address the BES issues in their companies. Therefore it is often easier to develop a new simple tool (spreadsheet type).

What James advise companies to do is:

Define what their objectives are in terms of BES and what their context is. Review compatibility of objective versus tools/framework available. When reviewing/assessing a tool it is important to review the objectives of the organization that develop this tool (private versus public organization).

How do you see the future in the BES tools sector?

New sets of tools more user-friendly will be developed in the coming 2 to 5 years. Also increased standardization on those tools.

Appendix 3-3 Frederiek van Lienen – PhD University of Wageningen

Frederiek van Lienen PhD over "Innovative and sustainable use of biodiversity as a competitive advantage for business". The purpose of her PhD is to look at ES issues from the perspective of the companies.

How companies can make use and/or profit of BES in a sustainable way?

She is using SharedValue, a CSR concept and look into companies CSR reports to see if they do interger biodiversity in their policies and business models. Frederiek hasn´t decided yet which tool to use, but will focus one tools that assess natural resources consumption and pollution.

Appendix 3-4 – Sissel Wage and Linda Hwang - BSR

The assessment resulted in several key insights, including:
» Comparing tools side-by-side is difficult, given their very different definitions of ecosystem services, as well as their distinct analytical "architectures.", use of units, …
» Ecosystem services tools offer insights that can be relevant to corporate decision-making processes, particularly in terms of dependencies on natural resource–based inputs that most businesses have not traditionally considered. None, however, readily mesh with key existing corporate processes and thus do not appear to be ready for immediate, widespread, off-the-shelf business application without considerable effort and cost.
» These tools have been applied to corporate decision-making processes infrequently to date, and these new business tools have not yet been compared to the current corporate processes. It is not yet clear what additional value ecosystem services tools provide when compared with existing approaches companies use to assess performance. The intention of BSR is focus on the global scope – though beside the Netherlands and Sweden, not many European tools developers are mostly looking at single ES and not multi-ES at the same time – while there are much more tools available and in use in the US addressing multi-ES. Main initiatives BSR have looked at are Natural Capital; Invest; Aries.

A roundtable was held in 2009 which concluded that - as tool developers were using different languages –a comparative tools assessment was necessary in order to have a sense how those tools were operating. It has to be noted that the first time the major ES developers gathered together was thanks to BSR in 2008, and then the second time in 2009 thanks to BSR again. What appeared from those gatherings is that it is not in the developers' best interest to work together - as each of them wants to promote its own approach. Therefore there was/is not much willingness to collaborate. BSR proposed a side by side tool assessment – the tools developers were not very pleased with what they called a "beauty contest". But BSR pushed it as thought it is required for the future development of performing ES tools. In January 2010 none of the developers' company was ready to engage or had time in a comparative tools assessment. Invest and Aries were the 2 first to accept it, then 5 other tools were drawn in early 2010. Quickly it was found out that a technical analyst with GIS expertise at PhD level was required. BSR was very transparent with the tools developers regarding the requirements and concerns of the member companies. What BSR found out, is that before dealing with different tools, you are dealing with different individuals with their own personality and political agenda, and that you are working before all in a business competition environment. Some high-level results of the assessments have shown that:

- EcoMetrix is new upcoming tool.
- ESR best place to start for a company.

The emphasis is on multiple ES tools – (we note that BBOP and IBAT do not necessarily cover all ES.) The trends BSR are looking at are more coming from thought leaders rather than US regulations. BSR has always been collaborating with Manuel Winograd from the EEA - his approach is more about developing smaller models that can be coupled with each other in function of the needs, rather than developing grand tools like in the U.S. Main NGOs have been looking for ways to shift... better leverage and recognise into social sustainability but need to look at it more holistically. Contradictory to BSR predictions, it appeared to be more difficult to be working with tools developed from NGOs and Universities as they can be less customer oriented and also understand less that business organizations how the business work, and therefore what are the real needs of the companies. One of them has shown to be the exception – and has developed an easy-to-use and very pragmatic tool.

Typically, businesses are looking for specific business criteria. One requirement from business is that they need a transparent and more operational tool. They are generally concerned with "black box" type of tools and complex models, as they can´t explain the details to their stakeholders. The biggest challenge remains to make ecosystems a business model.
It is key that in the future developers work much closer with businesses to genuinely understand what the value is for the company and for its stakeholders.

BSR and TEEB

Regarding TEEB, BRS started working on the subject before TEEB was created - and BSR is more focus on tools - so TEEB wasn't necessarily helpful to BSR to analyse the tools. TEEB is great conceptually, but has little relevance though for specific businesses.

Next steps

Companies and organizations really want to have a taxonomy as it would make everybody´s life easier. However tool developers are not too keen on having a taxonomy made - as they want to develop their own tools to be able to sell it – and don´t be able to be compared to the other tools on the market. But BSR and especially Sissel have been pushing for it. However, Sissel believes that we are not at a point that we can build a strong taxonomy, as we don´t know enough about those tools – including the tools developers which are still working on the development of their tools. Furthermore, the risk of creating one taxonomy is to put in the open a comparison of apples and pears. Her recommendation however for the moment is to build a decision tree – which can help create a fluid discussion in the companies – with asking questions such as:
What are the gaps that you think you have in your ES?
What is your budget to conduct an ES analysis?
What is the timeframe your company have to conduct an ES analysis?
Which issues are you interested in?
This would allow keeping the focus more on the qualitative aspect rather than on firmly defined categories. The decision tree would suggest a company to consider looking at certain tools when they respond to certain criteria.

The majority of the tools currently on the market are still in their first phase of pilot/testing phase – and lots still need to be done to have them fully operational. As we speak it is still not 100% clear what which tool can provide to a certain company. Also, it is important to note that those tools might only be the first generation of tools – therefore we shouldn't focus too much on the tools themselves, but rather on the questions to be asked to the companies. The challenge however it that most questions need to be specific to each company: What do you want to know and why? How will the information be used? How long will it take to obtain these pieces of information? It will also be difficult to come up with a general approach as questions will very probably be project specific - but that will need to be refined internally depending on the business objectives of the specific companies. One of the key entries for a decision tree is around business dependencies - because business track impacts quite well. For instance, the INVEST tool – which is a complex tool - is still being refined as we speak. Their water element wasn't working and is being fixed at the moment. The way developers see it is that there will be choices of tools for different contexts. However at the moment tools are mainly designed for municipalities than for large businesses.

Appendix 3-5 – Rob Regoort - IUCN NL

- To Rob´s opinion, it is very important to link bio-diversity to already existing business tools such as environmental impact assessment, LCA etc. Companies hate to add extra tools to the already long list of required reporting data.

- Even more important is to develop a high level pre-screening step, where a company can identify what area of their products have the biggest impact on bio-diversity, looking at the total value-chain, both up- as downstream.

- Companies are only beginning to evaluate (sometimes together with their suppliers) the total impact "cradle to gate" (meaning upstream production including own production). For instance, Akzo Nobel has covered roughly 90% of this part (not covering the total of bio-diversity impact yet). Only a few companies have started to incorporate the downstream part ("gate to grave"). It is known from some companies that their own impact is only 10 to 20% of the impact of the total chain, therefore it is crucial to have an impression of the total chain, in order to make a good judgement of the risks and opportunities.

- It is important to develop a simple mind map, which guides companies through this very complex field and links the outcome with existing business tools. This is, to his opinion an important next step for TEEB. This could be developed together with companies like Akzo, Unilever etc, WBCSD, academic institutes, who are developing different tools, NGO's (like IUCN-NL and HQ), consultants (KPMG, PWC, Arcadis) and governments. This could be the follow up for the TEEB project.

Business & Biodiversity - Impact and opportunities - A proposal for next steps *(by Rob Regoort)*

The TEEB project has greatly improved the awareness around the impact and dependencies of ecosystems, however it did not yet result in an easy to use approach for business. Therefore the World Business Council for Sustainable Development (WBCSD) decided to develop a series of methodologies to help business in addressing these issues. The Corporate Ecosystems Services Review (ESR) was launched in 2008 to help in the development of strategies to manage the business risks and opportunities in relation to the dependency and impact on ecosystems. Recently the Corporate Ecosystem Valuation (CEV) was launched, which addresses the valuation of eco-system degradation and the benefits of ecosystem services. The ESR is a very good first step for a company to identify their "priority ecosystem services", in line with the first recommendations of TEEB for business, while the CEV offers a first attempt in the valuation of eco-systems. During the process of both ESR and CEV it can be necessary to use more specific tools depending on the type of eco-system at stake. More often specific expert advise is needed then, in order to use the specific tools in the proper way. Although both tools are a good first step, three important aspects can be further improved in order to make it fit for use for the business community:

1.Pre-scoping step (Step 0):

Mostly the business activities are spread out over a large number of product-lines in different sectors. It is therefore important to start with a high level assessment of the risks and opportunities of the different value-chains on a strategic level, enabling the companies to

adjust their business strategy taking the impact and dependencies of eco-systems into account.
This assessment is not yet available and needs to be developed in a practical way together with the business community. Depending of the outcome of that strategic analysis a decision can be taken to execute a more detailed analysis of certain value chains either at high risk of with challenging new opportunities. An ESR can then be a good start, provided that the whole value chain is explored. Via the ESR it can then be decided to execute a CEV and/or use more detailed specific tools with the help of specific experts.

Figure 6: Steps and Tools for Applying Ecosystem Services in Corporate Settings

BSR (New Business Decision-Making Aids in an Era of Complexity, Scrutiny, and Uncertainty report, May 2011)

2.Taxonomy of the different tools/methodologies:

An array of different tools has been developed or is being developed by different parties; not all of them are well suited for use in the business environment. Furthermore the definitions with respect to eco-systems are not all aligned. More tools are coming up, valuation of the tools and a proper comparison of the different tools are often lacking. Recently an attempt was made by BSR to evaluate and compare the different tools. Their conclusion was that a proper comparison of tools is very difficult, due to the various definitions and approaches. Furthermore the set up of the tools is not always transparent and sometimes too complex and academic in order to make it suitable for the business environment. To our opinion it is therefore important to develop a kind of mind-map, which can guide the user through the different tools and methodology towards the most suitable one for his specific situation. It is important to develop such a mind-map in close cooperation with the different developers in order to include the most recent updates and extensions. Independent 3d party review is important in order to ensure credibility. For business it can be very useful to be engaged in the piloting of the different tools in order to gain experience and to influence the set up of practical tools in this area.

3.Integration of these tools in existing environmental management systems:

Business is confronted each time again with new reporting requirements, which most of the time seem totally unrelated. It is therefore important to develop a methodology, which can be easily combined with existing systems such as LCA and environmental impact assessment tools (LCA).

4.Proposal for next steps:

IUCN-NL has the intention to initiate a project to realize the three formulated objectives in close cooperation with the TEEB-foundation and other parties. IUCN-NL is well positioned to take that role as we can make use of our active platform of motivated managers from our Leaders for Nature (LfN) network of Dutch based companies. We will do so in close cooperation with our IUCN Headquarters in Gland, who was actively involved in the TEEB project, our Dutch members, other NGO's, different public and private organizations and institutions. We welcome contributions of the mentioned organizations in cash and kind for the duration of the project. The project will be separated in the three mentioned areas, each of them with a separate project-plan, deliverables, budget and time-plan. We envision a total duration of the whole project of around three years. Total required staffing, deliverables and budget will be worked out in more detail together with the different parties involved. In the coming month we will have intensive consultations with the different parties involved to work out the details of this proposal.

Appendix 3-6 – Eva Zabey - WBCSD

Global Water Tool (GWT):
In 2007, the GWT was launched, which enables companies to assess their water-related risks by mapping site locations against a variety of different water datasets. In August 2011 WBCSD incorporated a biodiversity layer to the GWT, which made it possible to assess which sites were in or near a biodiversity hotspot. In future more layers may be added. Over 300 companies have already used the Global Water Tool which is freely accessible.

ESR:
WBCSD sees ESR as the best first step for companies, including for those who are new in this area. It is a high level assessment of "Priority Ecosystem Services". Some companies are more focused on water, biodiversity, carbon, etc … but if a company just wants to explore the full range of ecosystem services, ESR is the right and only tool currently available to give a qualitative assessment. It is also accessible for "learner" and quick to go through. ESR is the gateway to ES assessment. ESR is sufficient in most cases when qualitative results are sufficient to inform a business decision. Since its launch in 2008, the ESR methodology has been picked up by over 300 companies and is still the best practical approach for companies to assess their ecosystem-related risks and opportunities and integrate these into their strategy.

CEV:
CEV is performed when quantitative results or values are required – as it is much more result intensive than ESR. CEV can be seen as a logical next step after ESR, if such a quantitative or values-based assessment is necessary and appropriate.

IBAT: For biodiversity issues, some companies, such as Holcim, have been using IBAT.

Appendix 5: template for standardized model descriptions (EEA)

Template for standardised model descriptions

Each model documented in an online model inventory should be described in entries of reasonable detail to allow a quick model overview for audiences acquainted with a basic understanding of environmental models. For this a short and general model summary would ideally be complemented by more detailed information on the model dimension, model development and the use of the model in environmental assessments.

The template below outlines key categories and leading questions to help fill out such template. Not all the categories outlined in this template will be appropriate to describe all models that are featured in a particular model inventory. Nevertheless a suite of core information should be required from any model included: at the very least core information for each model should include details on thematic focus, geographical coverage, and analytical technique.

Model dimension	
Thematic coverage	Which themes (i.e. environmental issues, sectors and activities, or environmental media) does the model address explicitly? (Note: see categories introduced in Table 2.1)
Input (key drivers)	Which are the key driving forces, input data or parameters used by the model?
Output (key Indicators)	Which are the key indicators/primary output variables computed by the model?
Geographical coverage	What spatial coverage/geographical extent does the model operate on and provide output for? And at what spatial resolution?
Temporal coverage	For what time horizon does the model deliver results? And for what time steps?
Analytical technique	What kind of model is it? What is the underlying analytical technique applied? (Note: see categories introduced in Chapter 2)
Model structure	Please add a diagram that summarises the main model structure here (if available)
Information on model development	
Model developers/ owners	Who has developed the model? And who sponsors its development and who owns it?
Model development history	When did model development start, is it still being further developed? Which version of the model is currently used? Which software has been used for the development?
Target group/users	For which audience has the model been developed? Who has used the model and its outputs? Has the model been used for policy purposes?
Calibration	Against which datasets has the model been calibrated? To what goodness-of-fit?
Validation	Has the model been validated against independent datasets? Which?
Uncertainty analysis	Is the model suitable for undertaking uncertainty analysis (such as Monte Carlo simulations, variants, stress testing for boundary conditions)?
Key reference	What is the key (peer-reviewed) publication that describes the model?
Information on use of model in environmental assessments	
Level of integration	What level of integration across environmental themes (see above) does the model allow? Are feedbacks addressed, e.g. between response options and drivers?
Links to other models	Has the model been linked to other models for integrated assessment of environment? Please provide relevant examples of models or projects.
Ease of use // Accessibility	Is the model easy to use for non-developers? Is the model free to access? What restrictions apply? Are results publicly available? Is there a user manual?
Use in participative processes	Has the model - or a simplified versions of the model - been used in interactive settings or participative processes (please give examples)?

Appendix 6: additional potential research questions

- What is the current status of Ecosystem Services tools?
- Which ES tools can best help companies to address their ES issues?
- What are the tools currently used by business to identify, measure and value the impacts on biodiversity and ecosystem?
- What ES tools are the most suitable to address the TEEB steps?
- What are the upcoming ES tools that are becoming available on the market?
- What can concretely be done to support the Dutch private sector to implement TEEB?
- What is the current perception of companies in The Netherlands about the internalisation of social costs related to ecosystems services and biodiversity?
- What contribution to social/environmental costs can we expect from the private sector in The Netherlands regarding ecosystems and biodiversity?

Appendix 7: additional figures

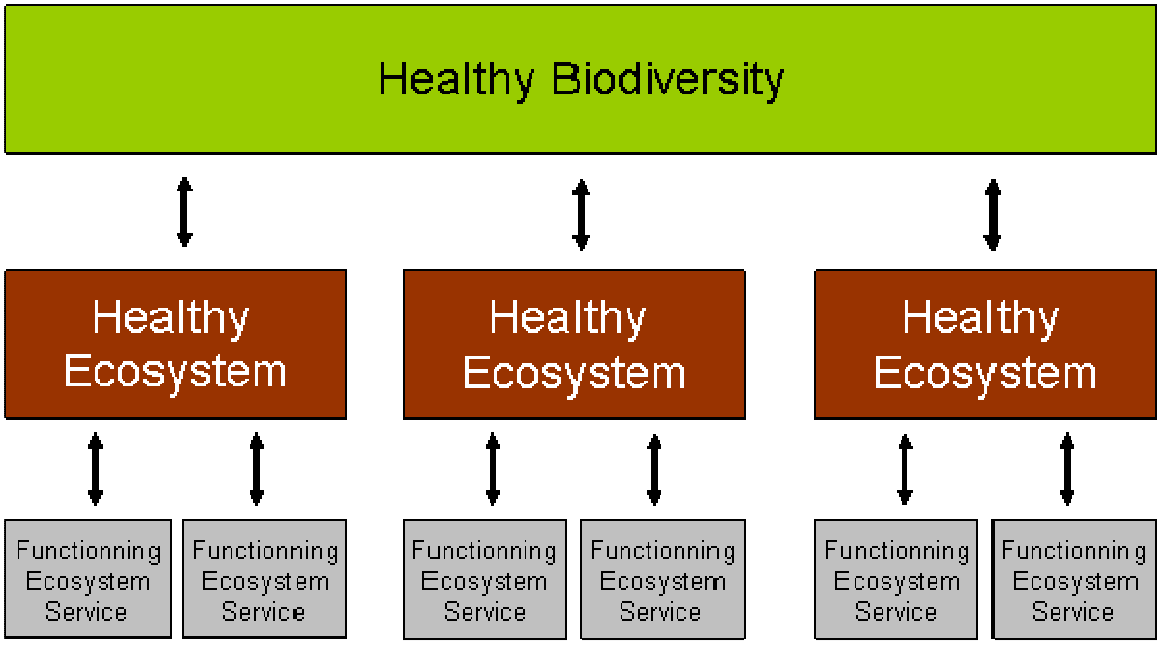


Figure 1 – Definition of the interaction between biodiversity and Ecosystem Services according to Rashila Tong, Holcim Relationship Manager, Sustainable Development.

Appendix 8: Introduction of the key tools

ARIES
ARtificial Intelligence for Ecosystem Services
"ARIES is a web-based technology offered to users worldwide to assist rapid ecosystem service assessment and valuation. Its purpose is to make environmental decisions easier and more effective. ARIES helps discover, understand, and quantify environmental assets and what factors influence their values, in a geographical area and according to needs and priorities set by its users. ARIES can accommodate a range of different use scenarios, ncluding spatial assessments and economic valuations of ecosystem services, optimization of payment schemes for ecosystem services, and spatial policy planning."
www.ariesonline.org
ARIES is a web-based technology offered to users worldwide to assist rapid ecosystem service assessment and valuation (ESAV). Its purpose is to make environmental decisions easier and more effective. ARIES helps discover, understand, and quantify environmental assets and what factors influence their values, in a geographical area and according to needs and priorities set by its users. ARIES can accommodate a range of different use scenarios, including spatial assessments and economic valuations of ecosystem services, optimization of payment schemes for ecosystem services, and spatial policy planning.
Source: http://ebmtoolsdatabase.org/tool/aries-artificial-intelligence-ecosystem-services

InVEST
Integrated Valuation of Ecosystem Services and Tradeoffs
"InVEST is designed to help local, regional, and national decision-makers incorporate ecosystem services into a range of policy and planning contexts for terrestrial, freshwater, and marine ecosystems, including spatial planning, strategic environmental assessments, and environmental impact assessments. InVEST models are based on production functions hat define how an ecosystem's structure and function affect the flows and values of ecosystem services. The models account for both service supply (e.g., living habitats as buffers for storm waves) and the location and activities of people who benefit from services e.g., location of people and infrastructure potentially affected by coastal storms). Since data are often scarce, the first version of InVEST offers relatively simple models with few input requirements. These models are best suited for identifying patterns in the provision and value of ecosystem services. With validation, these models can also provide useful estimates of the magnitude and value of services provided."
Source: www.naturalcapitalproject.org

EcoAIM
Ecological Asset Inventory and Management
A new tool "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."
http://conference.ifas.ufl.edu/aces/Presentations/Wednesday/Coyote-B-E/PM/Yes/0135%20P%20Booth.pdf

EcoMetrix
" An environmental measurement and modeling tool that supports sustainable infrastructure, restoration projects, and enterprise-level program decision-making. EcoMetrix models and

quantifies changes within an ecosystem, enabling users to evaluate the positive or negative effects of different scenarios and alternative designs on ecosystem services.

EcoMetrix is a site-level ecosystem services evaluation methodology. It supports environmental decision-making and impact analyses. Its application involves these primary steps:

- Measure existing conditions by characterizing the ecosystem services and functions.
- Assess functional performance by measuring and evaluating key indicators of functions.
- Develop baseline and proposed future condition scenarios.
- Analyze change from baseline to future, across all services and functions. This permits analysis of minimization or mitigation options.
- Relate the results to landscape-level analyses and goals to meet policy objectives.

www.parametrix.com/cap/nat/_ecosystems_ecometrix.html

ESR
Ecosystem Services Review
"A structured methodology for corporate managers to proactively develop strategies for managing business risks and opportunities arising from their company's dependence and impact on ecosystems."
www.wri.org/project/ecosystem-services-review

WBCSD sees ESR as the best first step for companies, who are new in this area. So does ERM. It is a high level assessment of "Priority Ecosystem Services".
ESR is the gateway to ES assessment. ESR is sufficient in most cases if qualitative results are sufficient for the business decision being made.

CEV
CEV can be quite resource intensive and is recommended only if quantitative results or monetary values are required.
Corporate Ecosystem Valuation (CEV) can be defined as a process to make better-informed business decisions by explicitly valuing both ecosystem degradation and the provided by ecosystem services. By including ecosystem values, the company's aim is to improve corporate performance in relation to social and environmental goals and the financial bottom-line. Valuation can make decision making around ecosystems more compelling and practical, thereby enhancing sustainable development strategies and outcomes. The WBCSD Guide to CEV is a framework for companies to use, thereby providing a highly flexible structure that can then use a number of different valuation techniques and methodologies.
www.wbcsd.org

ESValue
"A strategic decision support tool that integrates scientific and economic information to show the impact and value of alternative environmental management strategies on ecosystem services. 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."
www.entrix.com

NAIS
Natural Assets Information System
"The Natural Assets™ Information System (NAIS) was developed by Spatial Informatics Group (SIG) to estimate Ecosystem Service Values (ESV) using "state of the art" value transfer methods and geospatial science. Value transfer involves the adaptation of existing valuation information to new policy contexts where valuation data is absent or limited. For ESVs, this involves searching the literature for valuation studies on ecosystem services associated with ecological resource types (e.g., forests, wetlands, etc.) present at the policy site. Value estimates are then transferred from the original study site to the policy site based on the similarity of ecological resources at the policy site. Value transfer is a 'second-best' approach for gathering information about the value to humanity of ecosystem goods and services. However, the alternative, primary valuation research is extremely costly and is rarely feasible in the context of the policy and planning process. Therefore, value transfer integrated with geospatial science has proven to be a critical tool in decision making and planning."
www.sig-gis.com/pg-services-eco.php

IBAT
Target Audience:
According to BSR, IBAT is not targeted at specific industry sectors, although interest has been greatest from companies operating in the oil & gas and mining & minerals sectors, with more limited interest from agriculture, construction and consultancies. A major target audience is public and private organizations in the finance sector (e.g. International Finance Corporate, Equator Principles Financial Institutions, development banks).
IBAT for business is an innovative tool designed to facilitate access to accurate and up-to-date biodiversity information to support critical business decisions. The tool is the result of a ground-breaking conservation partnership among BirdLife International, Conservation International, IUCN and UNEP WCMC.
https://www.ibatforbusiness.org/
WBCSD recommends to use IBAT for biodiversity issues

GWT
Some years ago the GWT was launched, which enables individual sites to assess the water-stress.
In aug. 2011 WBCSD will incorporate a biodiversity layer to the GWT, which will make it possible to check bio-diversity hotspots around that specific site.
In future more layers will be added.

HCV:
The High Conservation Value (HCV) concept was originally devised in the context of forest certification (High Conservation Value Forests or HCVF), but it is also applicable to all kinds of ecosystems and habitats. It has developed into a valuable and flexible toolkit for a variety of uses, including land-use planning, conservation advocacy, and designing responsible purchasing and investment policies.
IUCN supports the High Conservation Value (HCV) concept which was originally divised in the context of forest certification (High Conservation Value Forests of HCVF), but is also applicable to all kinds of ecosystems and habitats. The HCV concept has proven to be a flexible concept promoting sustainable use of natural resources. High Conservation Value Areas (HCVA) can be identified on the site-level and landscape level, it can assist in land-use

planning and in identifying conservation priorities, in a multi-stakeholder setting.

The High Conservation Values Areas are based on six principles:
1. Areas containing globally, regionally or nationally significant concentrations of biodiversity values (e.g. endemism, endangered species, refugia).
2. Globally, regionally or nationally significant large landscape-level areas where viable populations of most if not all naturally occurring species exist in natural patterns of distribution and abundance.
3. Areas that are in or contain rare, threatened or endangered ecosystems.
4. Areas that provide basic ecosystem services in critical situations (e.g. watershed protection, erosion control).
5. Areas fundamental to meeting basic needs of local communities (e.g. subsistence, health).
6. Areas critical to local communities' traditional cultural identity (areas of cultural, ecological, economic or religious significance identified in cooperation with such local communities).

EBS

The European Biodiversity Standard (EBS) is a tool for biodiversity assessment only. Many companies operate environmental management systems, often certified to ISO 14001 or EMAS. However, biodiversity issues are frequently neglected or even omitted, despite their importance. The new EBS provides a Europe-wide process for you to use in your company, to measure, improve and demonstrate publicly your ecological performance. EBS is:

● A new way to assess your company's impact on the natural environment;
● An independent process open to every company;
● A ten-point system to certify your company's ecological performance;
● The standard against which to measure your company's progress."

The EBS assesses a company's impact on the natural world and helps it to contribute positively to the environment. In the process, the EBS also shows the company's commitment towards biodiversity. To acquire the EBS, a company needs to meet the ten components: Commitment, Survey, Assessment, Legislation, Planning, Implementation, Measurement, Partnerships, Communication and Review.

www.europeanbiodiversitystandard.eu

MIMES

MIMES is a multi-scale, integrated set of models that assess the true value of ecosystem services. These sophisticated models allow ecosystem managers to quickly understand the dynamics of ecosystem services: the ways in which ecosystem services are linked to human welfare, how they function, and how the value might change under various management scenarios. It helps to facilitate an understanding of the contextual spatial patterns of land use, their dynamics of value, and the scale at which information is available for estimating ecosystem services at various scales (e.g. watershed, national and global). It has been developed in collaboration with a large international group of scientists and is being applied at a broad range of sites and scales, both in the US and abroad.

Appendix 9: The EU Business @ Biodiversity

The EU B&B platform will engage with businesses, industry associations, governments and civil society on the development of best-practice guidance concerning the main risks, responsibilities and opportunities for companies in relation to nature and biodiversity conservation. The guidance will build on existing guidelines and handbooks previously produced with business organisations and private companies. Insofar as relevant, this component will take account of EU nature legislation, notably biodiversity-relevant EU agreements and directives. The platform will work with the interested priority business sectors identified by the European Commission; Agriculture, Food Supply, Forestry, Extractive industry, Financial sector and Tourism to promote their awareness of and engagement in biodiversity protection. To reach these objectives, the EC took the initiative to engage with businesses, from SMEs to larger organizations, to set up a technical platform on Business and Biodiversity (B@B) in order to help businesses finding solutions to biodiversity challenges related to their activities ensuring a fair income and sustainable growth, while providing benefits for biodiversity and ecosystems;
http://ec.europa.eu/environment/biodiversity/business

Appendix 10: EBM Tools Database

Tool categories
- Modeling and analysis
- Decision support
- Visualization
- Decision support - Conservation and restoration planning
- Modeling and analysis - Other modeling and analysis
- Decision support - Coastal and watershed land use planning
- Decision support - Coastal zone management
- Stakeholder engagement and outreach
- Data processing and management
- Decision support - Fisheries management
- Modeling and analysis - Watershed modeling
- Decision support - Hazard assessment and resiliency planning
- Modeling and analysis - Estuarine and marine ecosystem modeling
- Data collection
- Modeling and analysis - Habitat suitability and species distribution modeling
- Modeling and analysis - Socioeconomic modeling
- Project management
- Data collection - Geophysical data collection
- Decision support - Multi-objective planning and management
- Modeling and analysis - Conceptual modeling
- Data collection - Biological data collection
- Modeling and analysis - Oceanographic and dispersal modeling
- Decision support - Marine spatial planning/Ocean zoning
- Modeling and analysis - Cumulative impact assessment
- Monitoring and assessment
- Data collection - Socioeconomic data collection

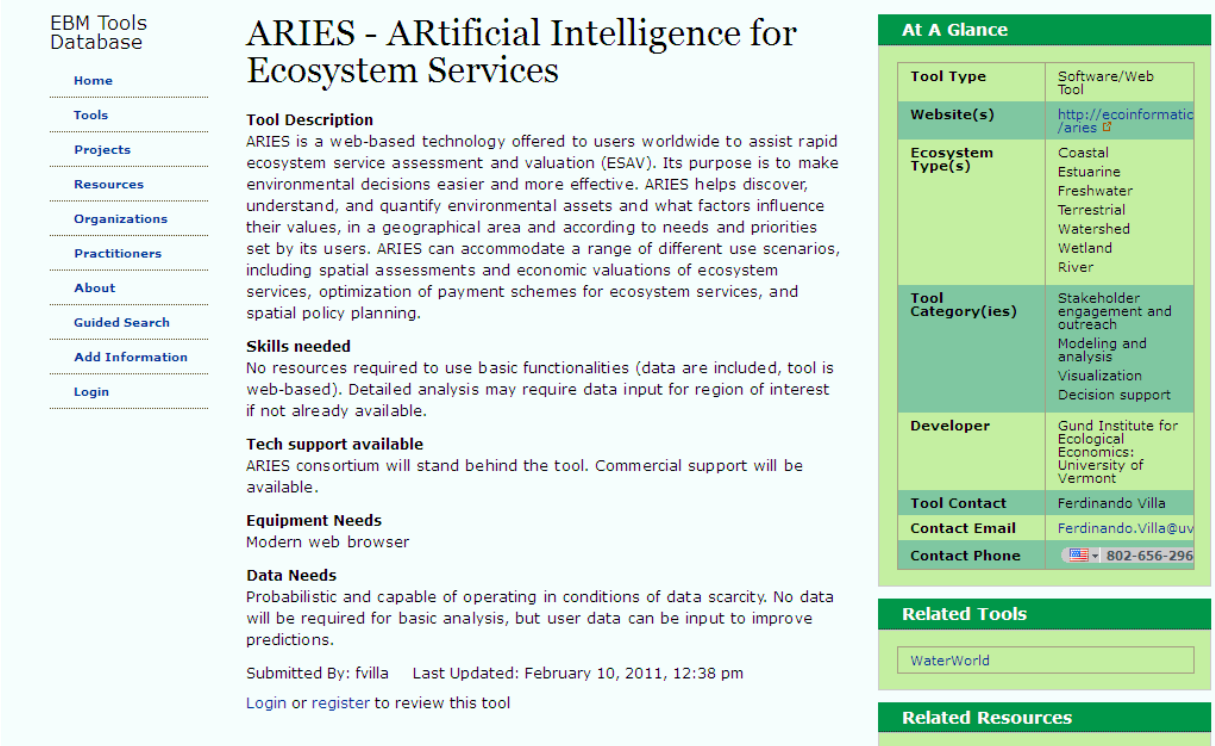
Tool Type
- Software/Web tool
- Comprehensive process
- Method
- Other

Organization Type
- Non-profit/NGO
- Private firm
- Education or research institute

GovernmentTool Cost
- Free
- Varies with applications
- < $100
- $100< < $500
- > $500

Strengths
Skills needed
Tech support available
Equipment Needs

Data Needs



Example for the ARIES tool

Appendix 11- BSR Categories:

1/ Study 1: Measuring Corporate Impact on Ecosystems: A Comprehensive Review of New Tools:

- Valuation focus: high/low
- Detailed ecological analysis: high-low
- Scenario planning and sensitivity analysis at corporate level
- Investment prioritisation at corporate level
- Basic risk screening at corporate level
- Results: spatially explicit maps
- Results: risk and/or opportunities analysis

2/ Study 2: New Business Decision-Making Aids in an Era of Complexity, Scrutiny, and Uncertainty - Tools for Identifying, Assessing, and Valuing Ecosystem Services:

Figure 7: Potential Ecosystem Services Tool Taxonomy

Target User	Policymaker	Corporate	Academic and NGO
User Motivation	» New policy designs or elimination of subsidies » Regulatory enforcement » Mapping of new protected areas » Education » Seeding of new environmental markets	» Risk mapping for ecosystem decline » Strategy and policy design » Location screening » Footprint measurement » Liability transfer » New revenue-generating transactions » Social license-to-operate	» Advancement of conservation science techniques » Recommendations for delineation of protected areas » Integration of data sets with other organizations
Desired Outputs	» Spatially-explicit maps » Valuation analysis » ROI prediction » Sensitivity-analysis results for scenario planning	» Spatially-explicit maps » Valuation analysis » ROI prediction » Sensitivity-analysis results for scenario planning	» Spatially-explicit maps » Valuation analysis » ROI prediction » Sensitivity-analysis results for scenario planning
Primary Ecosystem Services of Interest	» Supporting services (from MEA) » Provisioning services » Regulating services » Cultural services	» Regulating services » Cultural services	» Supporting services (from MEA) » Provisioning services » Regulating services » Cultural services
Quality of Input Data	» High quality » Medium quality » Low quality	» High quality » Medium quality » Low quality	» High quality » Medium quality » Low quality

3/ Study 3: Sustainable Water Relevant Database Oriented Tools:

- Purpose/Objective of the tool
- Tool Developer/ partner
- Target Audience(s)

- Year of creation/tool launch
- Scope/Applicability
- Database used
- External input data required/possible
- How the tools operates
- Geographical coverage of databases
- Database Quality & Maintenance
- Format of Outputs
- Transparency of Tool Design and Operation
- Key Assumptions Built into Tool
- Key Limitations of Tool
- Ease of Use & Time / Personnel Demands for Applications
- Availability to Users (current/planned)
- Potential corporate activity-decision interface(s)
- Current corporate sponsors/users
- Existing/potential future links with ES tools

Appendix 12- ES assessment tools categorization structure:

In most cells a comment is available: by highlighting it with your cursor, you will be able to read the source of the information given.

Alexandra Aubertin -
ERM Master Thesis TE

The complete ecosystem services assessment tools classification structure is shown in the figure below:

ECOSYSTEM SERVICES ASSESSMENT TOOL	ESR	CEV
ORGANIZATION	WBCSD	WBCSD
STEP A - WHAT YOUR COMPANY IS		
What is your company sector?		
Energy sector	YES	YES
Agro-food sector	YES	YES
Extractive industry sector	YES	YES
Water	YES	YES
What is the size of your business?		
Small (Turnover ≤ € 10 million)	YES	YES
Medium (≥ € 10 million and ≤ € 50 million)	YES	YES
Large (≥ € 50 million)	YES	YES
STEP B - WHAT YOU WANT TO ASSESS		
Ecosystem services in scope		
Water provisioning	YES	YES
Carbon sequestration	YES	YES
Cultural services	YES	YES
Biodiversity	YES	YES
Temporal coverage in scope		
1 year	POSSIBLE	YES
5 years	YES	YES
15 years	YES	YES
30 years	YES	YES
Geographical area in scope		
Global scale (whole company)	YES	POSSIBLE
Local scale (one site)	YES	YES
Stage of the value Chain in scope		
Suppliers - «upstream»	YES	POSSIBLE
Company	YES	YES
Customers - «downstream»	YES	POSSIBLE

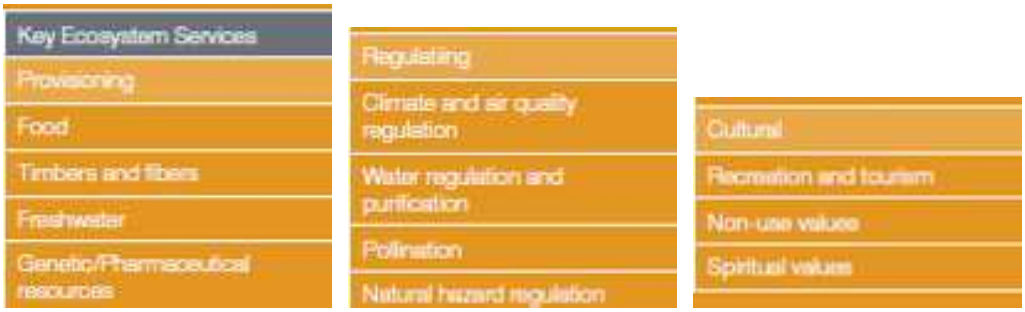
STEP C - WHAT YOU HAVE		
Data available		
High quantity of data	POSSIBLE	DEPENDS
Low quantity of data	YES	YES
High quality data	POSSIBLE	YES
High-level data	YES	POSSIBLE
Pre-loaded data available	NO	NO
Time available to conduct the ES assessment		
< 50 hours	NO	NO
50-200 hours	NO	NO
> 200 hours	YES	YES
Budget available to conduct the ES assessment		
< 10.000 €	NO	NO
> 10.000 €	YES	YES
Required access to stakeholders type		
Local community	YES	YES
International community	YES	YES
STEP D - WHAT YOU NEED		
STEP D1		
Qualitative results		
List of priority ecosystems	YES	INDIRECTLY
Spatially-explicit maps	NO	INDIRECTLY
Sensitivity or risk/opportunity analysis results for scenario planning	NO	YES
Quantitative results		
Valuation analysis	NO	NO
Monetary results		
Return on Investment prediction	NO	NO
STEP D2		
Results Quality		
High quality data output	NO	YES
High-level data output	YES	YES
Business requirements		
Ability to generate and compare scenarios	NO	YES
Scalibility and adaptibility for different locations/conditions/sectors	POSSIBLE	tbd
Intended target audience		
Corporate managers/decision makers	YES	YES
Environmental specialist / analyst	YES	YES
Business Objectives (based on TEEB)		
Identifying the impact and dependencies of your business on BES	YES	NO
Assessing the impact and dependencies of your business on BES	YES	YES
Valuing the impact and dependencies of your business on BES	NO	YES
Identifying the consequent business risks and opportunities	YES	NO
Assessing the consequent business risks and opportunities	YES	YES
Developing BES information systems: measurements, value performance and reporting	NO	NO
Taking action to respond to BES risks, including in-kind compensation where appropriate	NO	NO
Grasp emerging BES business opportunities (cost-efficiencies, new products, new markets ...)	INDIRECTLY	YES
Comparing the tradeoffs various projects would involve	YES	YES
Facilitating the company decision-making process on BES	YES	YES
Prominent tool features		
Ease of use of the tool ("plug and play")	YES	DEPENDS
Knowledge/experience in BES to use the tool not required	YES	NO
Transparency of tool design (no black boxes)	YES	?
Free public access for basic version	YES	YES
Exportable formats of tables, maps and charts	YES	YES
Easy link with other existing company processes	YES	YES

Appendix 13- Ecosystem Services Definition

Definition	22 Service types
Provisioning	1 - Food
	2 - Water
	3 - Raw Materials
	4 - Genetic resources
	5 - Medicinal resources
	6 - Ornamental resources
Regulating	7 - Air quality regulation
	8 - Climate regulation (including carbon sequestration)
	9 - Moderation of extreme events
	10 - Regulation of water flows
	11 - Waste treatment
	12 - Erosion prevention
	13 - Maintenance of soil fertility
	14 - Pollination
	15 - Biological control
Habitat/Supporting	16 – Maintenance of migratory species
	17 – Maintenance of genetic diversity
Cultural [provide opportunities for:]	18 - Aesthetic enjoyment
	19 - Recreation & tourism
	20 - Inspiration for culture, art & design
	21 - Spiritual experience
	22 - Cognitive development

De Groot et al., 2009

Spurgeon proposed in his paper "Putting a price a Nature" a sub-set of those 22 ecosystem services:



Putting a price on nature – Spurgeon, 2011.