OpenNESS

Operationalisation of Natural Capital and Ecosystem Services

Preliminary guidelines for integrated assessment and valuation of ecosystem services in specific policy contexts

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SEVENTH FRAMEWORK PROGRAMME

From concepts to real-world applications

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Acronyms

BBN	Bayesian Belief Networks
BT	Benefit Transfer
CE	Choice Experiment
CES	Cultural Ecosystem Services
CICES	Common International Classification of Ecosystem Services
CV	Contingent Valuation
DV	Deliberative Valuatin
EIA	Environmental Impact Assessment
ES	Ecosystem Services
GIS	Geographical Information System
HPP	Hedonic Property Pricing
IPBES	Intergovernmental Platform for Biodiversity and Ecosystem Services
KIP – INCA	Knowledge Integration Project – Integrated system for Natural Capital and ecosystem services Accounting
MA	Millennium Ecosystem Assessment
MAES	Mapping and Assessment of Ecosystem Services
MCDA	Multi-Criteria Decision Analysis
MESEU	Mapping of Ecosystems and their Services in the EU and its Member States
OOBN	Object-Oriented Bayesian Networks
PFA	Production Function Approach
PGIS	Participatory GIS
PPGIS	Public Participatory GIS
SEEA	System of Environmental-Economic Accounting
SP	Stated Preference methods
TEEB	The Economics of Ecosystems and Biodiversity
TEV	Total Economic Value
UKNEA	UK National Ecosystem Assessment
VT	Value Transfer
WTP	Willingness to pay
WTT	Willingness to give up time

Executive summary

- Decision-making about nature needs to address values, therefore policy-making and management need assessment and valuation methods. But the association of 'valuation' with 'money' and 'economics', while a powerful language to some in certain contexts, is also alienating to others in many situations. 'Integrated valuation' aims to provide valuation practitioners across different disciplines with a more inclusive frame and language for discussing the importance of ecosystem services with a wider range of stakeholders, in a wider range of contexts, at the same time as being clearer about the purpose of valuation.

- The aim of the deliverable is to provide **accessible information on the various ways integrated assessment and valuation of ecosystem services can be carried out to support decision making** at local scale, and its relevance for policy support at the national, EU and global scale. The deliverable builds on the conceptual and methodological foundations developed earlier in OpenNESS WP4 (D4.1 State-of-the-art report on integrated valuation; and D4.2 Framework for integration of valuation methods).

- We understand **integrated valuation** as **a process of synthesising relevant knowledge and information to elicit the various ways in which people conceptualize and appraise ecosystems services values**. Integration starts at the very beginning of the process by considering the decision support context, then continues with a comprehensive assessment of the natural and social environment and the subsequent choice and application of context-specific method(s) to elicit ES values on the basis of different disciplinary approaches, knowledge systems and levels of societal organization, and finally ends up with the synthesis of valuation results to support decision making accross scales.

- The OpenNESS Integrated Valuation Framework considers **valuation as being inherently embedded in the decision context.** Decision contexts mobilize different stakeholders, with different perspectives, perceptions, preferences, and principles depending on where and when they are faced with decisions. Therefore it is necessary to acknowledge that **valuation is specific to**:
  - **the governance context**, which suggests that values are determined by the stakeholders involved, their relationship to one another, their multiple perspectives and their expectations of what constitutes plausible and useful ways of measuring value
  - **the purpose of decision support**, which suggests that valuation methods can be applied to purposes of advocacy, accounting, priority setting, instrument design and liability, among others, involving different degrees of accuracy and information costs;
  - **the action/choice situation**, which suggest that value plurality is inevitable and it is the result of the combination of diversity of nature, of citizens' perspectives on nature, and different situations in which choices are made.

- Integrated valuation recognises plural values, which can be described using ecological, socio-cultural and monetary metrics.[1] By using a 'language' of plural values assessments are more likely to engage a variety of stakeholders, contributing more information to the assessment.

[1] We use 'monetary' valuation throughout to clarify the metrics used. While usually one might think of the 'economic' as defined by orthodox neoclassical economics, other schools of thought in economics (e.g. feminist, institutional, ecological, etc.) argue for a broader conception of the term 'economic' where market relations are just a subset of the sphere of the economy. Therefore 'economic' valuation methods are sometimes associated with mixed metrics (e.g. cost-effectiveness, socio-economic indicators) or qualitative metrics (preference ranking, conjoint analysis).

- Integrated valuation recognises that assessment and **valuation methods are value articulating institutions** that do not merely reveal pre-existing values but also shape them during the valuation process itself. Considering valuation methods as institutions **increases the transparency of the methodological choice, and improves the relevance of valuation results** by making the process owner aware of the specificities and possible consequences of choosing one or another method. Framing considerations that can be used to make the method selection more transparent include: 1) the subject of valuation, 2) the meaning of value, 3) the role and rationality of the valuing agent, 4) the range of relevant data, 5) the range of relevant scales, and 6) the legitimacy of processes.

- Delineating the biophysical as well as the socio-economic and cultural boundaries of the valuation context is an important step of integrated valuation. It is however often difficult to draw an explicit demarcation line between assessment and valuation, since many assessment methods offer fora for preference formation and record personal value judgements, which already belongs to the act of valuing. Therefore the **OpenNESS Integrated Valuation Framework is integrated also in the sense that it considers assessment and valuation as flexible phases of the process**, often interlinked and carried out by methods that can be used interchangeably. Assessment and valuation used iteratively make learning between methods possible, providing mutual evidence support and improving their reliability.

- The deliverable provides a **general description of 18 different methods** applied for the assessment and/or valuation of ecosystem services. Major aims, targeted ecosystem services, relevant decision support contexts and scales are discussed, and practical requirements, advantages and limitations of each method are listed in summary templates. In most cases the template also includes a diagram of the stepwise process of method application, as well as the list of OpenNESS case studies where the method has been used. In addition, each method is evaluated briefly in terms of which value types can be elicited by it.

- The deliverable offers a **comparative analysis** of the 18 methods described along two different aspects. First, we compared valuation methods according to their practical requirements. Second, we analysed valuation methods along the value types they can elicit by using a combined value typology from existing ones, namely TEEB (incl. ecological, sociocultural and monetary values), IPBES (incl. non-anthropocentric, instrumental and relational values) and TEV (inc. direct use, indirect use, option, bequest and existence values). Results show that:
    - There is a **gradient of new data demand and resource needs** from methods that require primary data and collaboration with scholars from the same or other disciplinary field(s) to methods that do not require considerable new data, time and other resources.
    - **Some methods are specialized towards certain value types, while others are generalist** methods able to capture multiple values. All value types are covered appropriately by one or more methods, but **all methods have blind spots** which imply conditional application, risks of bias when applied alone, but also opportunities for complementarity when applied in combination.
    - **There is a clear valuation gap in the relational and non-anthropocentric values**, where only some generic methods are partly suitable. Biophysical methods, which are not included in this analysis (covered by D3.2), could cover the non-anthropocentric (intrinsic, nature, ecological) values better, but the relational values (focusing on quality of life) remain a valuation gap.
    - Selecting **a set of methods is a key step in the valuation process**, if one wants to obtain a balanced coverage of all relevant value types. The method requirements demonstrate that more integration does not necessarily mean an increased need for time, skills or other resources.

- Turning back to the applicability of integrated valuation in different decision contexts, the deliverable presents the **OpenNESS Integrated Valuation Framework in light of key guidelines and initiatives on valuation of ecosystem services at different governance levels**:
    - **International level (IPBES):** A key lesson for OpenNESS is the emphasis on **diverse conceptualizations on nature** covering a range of different value systems and cosmologies, including indigenous ones. In OpenNESS, most methods apply a western scientific worldview which fits to the geographic scope of the project, but this guidance also acknowledges and opens the floor to various, non-science-based discourses (e.g. based on lay, local or traditional knowledge). As the IPBES regional assessment of Europe and Central Asia continues until the first half of 2018, empirical results of individual OpenNESS case studies, as well as synthesis results and recommendations from the whole project can be channeled into the IPBES regional assessment.
    - **EU and Member State level (MAES, MESEU, KIP):** At EU level there are high expectations for policy analysis and decision-support which in most cases go beyond ecosystem mapping, **requiring valuation with higher spatial resolution and reliability** than required by valuation for awareness raising. Socio-cultural and deliberative valuation methods have thus far not been discussed as relevant for these EU level initiatives, although deliberative approaches in national level scenario analysis such as the UK MEA have been based on both monetary and importance indicators as input. OpenNESS is (still) faced with the challenge of demonstrating how natural capital accounting information at national level can complement monetary and socio-cultural valuation at local level, and how local level valuation can qualify national accounting data so that value transfer from national accounts is not used indiscriminately for municipal and project level policy analysis.
    - **Local government level:** At the local level valuation faces its strongest challenge in terms of operationalization. Valuation methods are often criticized for being too slow, too expensive, inaccurate, unreliable, and unrepresentative. We hypothesize that a **'monetary valuation gap' exists for assessment at small spatial scales** where study costs are more likely to exceed the benefits of the additional information. OpenNESS demonstrates that this gap can be filled with socio-cultural valuation methods.

    - Overlap in valuation of ecosystem service benefits and values is an apparent **'double counting weakness'** from a national accounting perspective and benefit-cost-analysis. However, when valuation outputs are considered as 'arguments', **conceptual overlap and similar findings from different valuation methods provide 'mutual support'** in demonstrating the value of ecosystem services. This interpretation of valuation outputs could be valid in quite different decision-contexts.

- As D4.3 is a Preliminary guidelines document, **several points have been raised that should be discussed and elaborated** in the Final guidelines deliverable (D4.4):
    - Socio-cultural valuation methods – and underlying conceptual frameworks, including the theory of shared and social values – are less documented than economic ones both in terms of methodological lessons learnt and possible fields of application for decision support. This knowledge gap should be filled based on OpenNESS case study results and theoretical development.
    - Comparative analysis of assessment and valuation methods should be expanded to include biophysical methods as well (described in D3.2) to be able to cover a full range of value types captured by integrated valuation.
    - Further research is needed on 'valuation gaps' – based on the realization that there are certain contexts where monetary valuation of ecosystem services cannot be expected to provide support because of information costs particular to the situation and the methods.

- Finally, OpenNESS should address the question of ‘when to value or not to value’ both from a practical and a philosophical point of view. The integrated valuation framework is relevant for unstructured decision-problems which assume that decision-makers and researchers have the possibility to structure the problem ‘from scratch’. However, in many cases, practitioners may face decision-problems about nature management that are already highly structured by institutions that are already in place (e.g. an Environmental Impact Assessment regulation). In such cases integrated valuation may be difficult to implement in all its steps, but can serve as a benchmark for improving the valuation process where norms and rules allow for flexibility and interpretation.

1. Introduction

Decision-making about nature needs to address values. Therefore, policy-making and management need assessment and valuation methods. But the association of 'valuation' with 'money' and 'economics', while a powerful language in some contexts, is also alienating to a variety of affected parties in many situations. 'Integrated valuation' aims to provide valuation practitioners across different disciplines with a more inclusive frame and language for discussing the importance of ecosystem services with a wider range of stakeholders, in a wider range of contexts, at the same time as being clearer about valuation's purpose. Integrated valuation makes societal decisions more transparent by making explicit as much supporting information as possible. Available information promotes learning. It emphasises an integration process whereby researchers and stakeholder can improve their understanding of oneanothers values and valuation methods through methodological pluralism, iteration and learning.

The main aim of this deliverable is to provide OpenNESS case studies and other place-specific valuation processes outside the project with accessible information on the various ways integrated assessment and valuation of ecosystem services can be carried out, supporting them in the operationalization of the concept of ecosystem services in decision-making and management. We are aware that the audience of integrated valuation guidelines may reach well beyond scientists and practitioners who actually do valuation to include policy makers reaching from local to international levels. Hence we also aim to discuss in this deliverable the potential of integrated valuation at different governance levels from a scientific perspective. In a separate policy brief we will provide a summary for policy makers. The main aim of D4.3 can therefore be operationalized through the following steps:

(1) to provide guidance on integrated valuation (what is integration, how it happens, which criteria should integrated valuation fulfil) by
(2) giving an overview of methods for ecosystem services valuation, as well as for the integration and synthesis of plural and heterogeneous values, and by
(3) discussing the potential of integrated valuation for supporting decisions at different governance levels.

This deliverable explicitly builds on D4.1 (Gómez-Baggethun *et al.*, 2014) and D4.2 (Braat *et al.*, 2014) as it goes through the whole process of integrated valuation to provide description and methodological support for each consecutive valuation step and analyses critically how the criteria for integration can be met during the process. This deliverable has also explicit links to other work packages of OpenNESS:

- it supports the operationalization of the ecosystem services concept by providing guidelines for integrated valuation that support the decisions on ecosystem management and governance and that make the links (and potential misfits) more explicit between values articulated through a valuation process and the perceived changes of wellbeing that lie behind these values (WP1),
- it analyses the existing or potential role of integrated valuation in biodiversity policy at different governance scales (with special emphasis on MAES) and discusses the potential of scenario development as a method for assessment (WP2),
- it bridges the valuation of the supply side of ecosystem services (WP3) with the demand side, and
- it gives methodological support for case studies (WP5).

Providing 'preliminary' guidelines means that this deliverable gathers and shares methodological and practical information on valuation methods mainly based on literature and the authors' previous experiences. As a next step, we will collect reflections from OpenNESS case studies on the methods offered here, and these real life place-specific experiences will be used to refine and illustrate the 'final' guidelines in D4.4. This process also allows us to reconsider some of the above mentioned overarching questions that bridge several OpenNESS work packages and to develop answers in a collaborative way.

According to D4.1 integrated ecosystem services valuation refers to *"the process of synthesizing relevant sources of knowledge and information to elicit the various ways in which people conceptualize and appraise ecosystems services values, resulting in different valuation frames that are the basis for informed deliberation, agreement and decision"* (Gómez-Baggethun *et al.,* 2014: 20). This working definition suggests that integration is not only one step in a valuation / decision support process concerning ecosystem services, but that it starts by the very beginning of the process with a comprehensive assessment of the natural and social context where the valuation process takes place, then continues with the conscious choice and application of context-specific method(s) to elicit plural and heterogeneous values of ecosystem services across disciplines, knowledge systems and levels of societal organization, and finally ends up by the synthesis of valuation results that supports decision making at different spatial and temporal scales. Valuation is inherently embedded in the decision and management context: this is what defines the purpose of valuation and what generates demand for specific types of valuation results. The decision context can therefore be considered as both the starting point and the endpoint of valuation, as it is captured by Figure 1.1. representing the process of integrated valuation, proposed by OpenNESS.

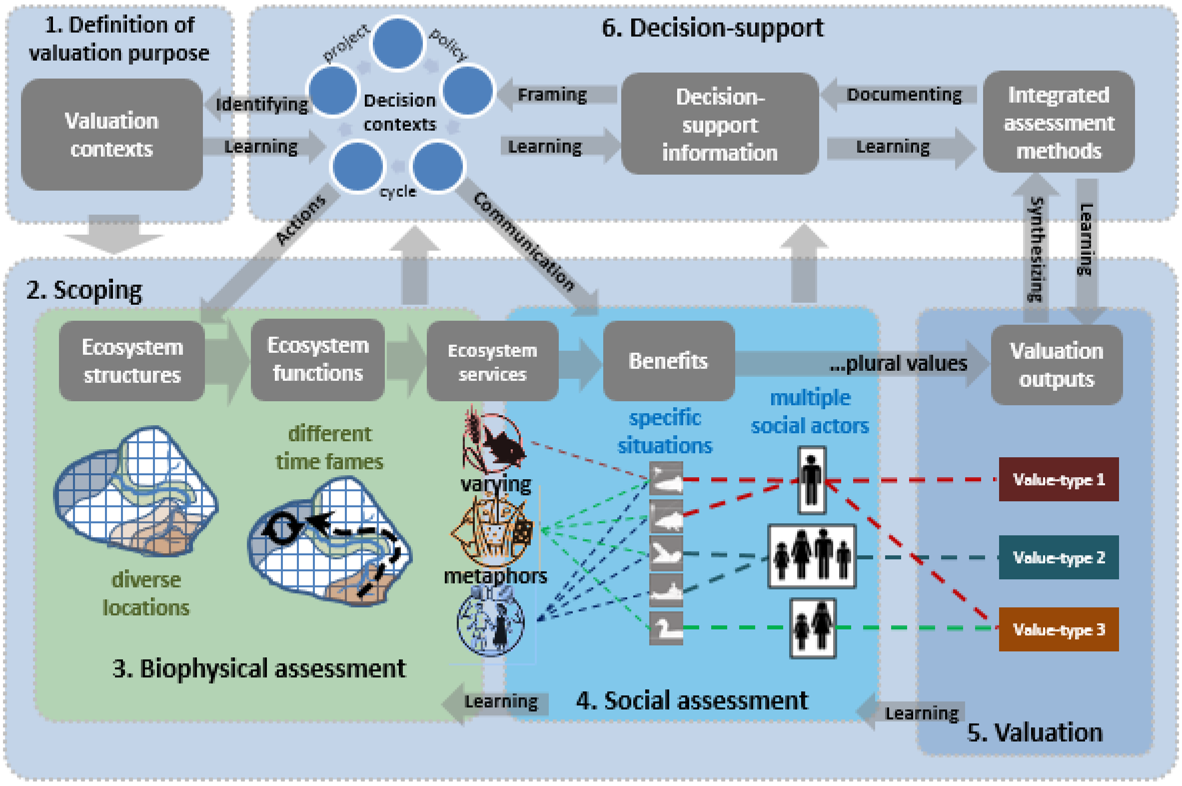

Figure 1.1. The process of Integrated Valuation[2]

The Integrated Valuation Framework (Figure 1.1.) builds on the ecosystem service cascade (Haines-Young and Potschin, 2010) and illustrates the need for integrated assessment across ecological, social and economic

[2] Note that there is an ongoing discussion in OpenNESS on whether ecosystem functions should be part of the cascade and how to represent intermediate services in it. Further development of this figure for D4.4 will take into account the joint decision of the OpenNESS community on this conceptual issue.

assessment methods. The Integrated Valuation Framework extends this framework by identifying the purpose of conducting valuation, which relies on identifying relevant decision contexts in the project or policy cycle (including both management and policy contexts). In the Integrated Valuation Framework we assume that decision-support contexts for valuation can be identified, although this may not be the case in some situations with high levels of conflict[3]. Scoping considers which ecosystem services are affected by the decision-problem and which biophysical, social assessment and valuation methods are potentially relevant. Multiple perspectives mean that actors may not share the same ecosystem service metaphors at the outset, therefore the scoping phase in integrated valuation is also about identifying different metaphors and plural perspectives at the outset. The Integrated Valuation Framework emphasises that ecosystem services have plural values because they are formed by multiple social actors in specific situations with multiple time frames and at diverse locations. Integrated valuation focuses on addressing this heterogeneity and plurality. Furthermore, the Integrated Valuation Framework emphasises the importance of communication and learning in the decision-support process. Decision support involves communication with/feedback from social actors. Integrated valuation also recognises that assessment and valuation methods are value articulating institutions which are chosen by researchers with specific displinary training and which frame valuation information differently depending on the decision-support needs. Valuation contexts and decision contexts are often mismatched. Integrated valuation places emphasis on mutual learning between researchers and decision-makers to make valuation more consistent with the decision-problem. Integrated valuation also emphasises feedback and iteration – biophysical assessment may be updated by learning from social assessment, which may be updated through learning from valuation, and so on. An emphasis on learning also means an increased awareness of the cost of obtaining valuation information and comparing it to the benefits of better decisions (or reducing the chance of poor decisions such adopting costly actions or ingoring beneficial ones). The choice of when and where to value with different methods is determined by practicality and the extent to which valuation contributes to making decision that meets fundamental criteria that transcend particular theoretical frameworks (Kallis *et al.,* 2013). In D4.2 Braat *et al.* (2014) discuss the following criteria for integrated valuation:

- Criterion 1: Policy & Management relevance
- Criterion 2: System Approach
- Criterion 3: Value plurality (incommensurability)
- Criterion 4: Value heterogeneity (context dependency)
- Criterion 5: Inter- and transdisciplinarity
- Criterion 6: Levels of societal organization
- Criterion 7: Consistent "scaling" of plural values
- Criterion 8: Consistent comparison of plural values in decisions

While these are not necessary conditions to qualify as "integrated valuation", they serve as a checklist or benchmark that can help guide studies in the right direction. Newertheless, the question of when to value and not to value is still openly debated in the project and will be a focus of D4.4.

Table 1 compares the OpenNESS framework for integrated valuation with previous initiatives that addressed the assessment and valuation of ecosystem services in a decision-oriented, integrated way, namely the MA, the TEEB and the IPBES. From this comparison we can see the 'evolution' of assessment frameworks over time. The MA focused on the global assessment of ecosystem services, hence it put strong emphasis on understanding the links between ecosystems and human well-being by identifying ecosystem services, their societal context and their drivers of change, as well as on assessing historical and potential future change through indicators. Valuation was limited to evaluating the impacts of (historical and possible future)

[3] Note that valuation may be conducted in support of conflict resolution. OpenNESS is in the process of distinguishing decision contexts and conflict management contexts of valuation. See discussion in Chapter 5.

changes, and direct links to decision making were not made explicit. From the TEEB on, valuation has been separated more clearly from the previous step of generally assessing the situation, which includes the definition of the purpose of valuation on one hand, and scoping for valuation on the other (in TEEB these two phases are mentioned together under the notion of 'recognising' value). Valuation then is primarily considered a technical issue which aims to assess the consequences of changes in ecosystem services, and which can be supported by various methods and forms of expertise. Both the IPBES and the OpenNESS Integrated Valuation Framework acknowledge, however, that not all values can be elicited through this production-function type of valuation approach, and quest for a pluralistic approach both in terms of values and methods. The decision supporting role of valuation has also become visible with TEEB stating that the last phase of valuation should be 'capturing' ecosystem service values by management decisions and institutional interventions. The comparison makes it clear that the OpenNESS Integrated Valuation Framework framework proposed has many structural similarities with IPBES. What still makes them different is how the consecutive steps of valuation are interpreted, namely scoping, integration and decision support. This deliverable invites the reader to go through these steps and understand the logic of integrated valuation in detail. By doing this, we not only provide guidelines on integrated valuation to scientists and practitioners, but also make it transparent how our approach builds on – and in some points transcends – other well-established frameworks for ecosystem services valuation.

Table 1: Comparing frameworks for the valuation of ecosystem services (ES)

Steps of ES valuation	MA (2003)	TEEB (2013)	IPBES (2015)	OpenNESS Integrated Valuation
1) Identify the purpose	-[4]	Recognise value: - Identify issues - Assess services	Identify the purpose	Definition of valuation purpose
2) Scoping	Identify ESs Link ESs to society Identify drivers of change of ESs Select indicators Assess historical trends and current state		Scoping (world views, focus and types of value, scale, social engagement, broader social context, practicalities)	Scoping (informed and context-dependent choice of methods for): - biophysical assessment - social assessment - valuation
3) Valuation	Evaluate the impact of change Develop scenarios Evaluate alternative future options	Demonstrate value: assess the consequences of changes resulting from alternative management options	Valuation of ES (biophysical, cultural and social, economic, health-based, holistic-indigenous methods)	
4) Integration	-	-	Integration and bridging	Synthesising valuation results
5) Decision support	Communicate uncertainty	Capture value: incorporate the value of ES into decision making through incentives	Communicate with the public and decision makers Review the process according to scoping considerations	Support informed deliberation, agreement and decision

The structure of the deliverable follows the process of integrated valuation proposed by OpenNESS (fig. 1). Chapter 2 discusses how the valuation purpose can be defined taking into account the variability of management and decision contexts. Chapter 3 first explains why scoping is an inevitable step of integrated

[4] The MA took one general purpose (to assess the impact of ecosystem degradation on human well-being), but does not consider the identification of the purpose as a specific step in the assessment process (leading possibly to different purposes for different contexts).

valuation, and which aspects of valuation should be considered (and transparently reflected) in this step. Then it outlines the approaches that can be used for the assessment of the biophysical and socio-economic context of valuation. Chapter 4 drives us to the act of valuation by providing a detailed description for a wide variety of methods (including non-monetary, monetary and integrative ones) frequently used in ecosystem service valuations. Chapter 5 compares and evaluates the methods presented in the previous chapter along the criteria of integrated valuation, aiming to develop a value-based conceptual analysis (axiological approach) for integrated valuation. Finally in Chapter 6 we link back to the decision context by discussing the potential of integrated valuation to support decisions at different governance levels.

1.1. References

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2. Definition of the valuation purpose

In this section we are concerned with the purpose of valuation for management and decision support. The starting point is that decision-making requires the uncovering of different stakeholders' values by facilitating open societal debate about the values and worldviews pertaining to the decision-making situation and combining individual values according to a certain set of rules to set priorities (e.g. through consensus, majority voting, cost-benefit rules etc.). Valuation methods can contribute to recognizing, demonstrating and capturing ecosystem service values in policy, planning and management (TEEB 2010). Ecological, socio-cultural and monetary valuation methods are designed to capture different types of values (Gómez-Baggethun et al. 2016(forthcoming)). Decision contexts mobilize different stakeholders, with different perspectives, perceptions, and preferences depending on where and when they are faced with decisions. This means that different decision contexts involve diverse value dimensions such as preferences, principles, virtues and variation across stakeholders (Chan et al. 2012, Gómez-Baggethun et al. 2014).

However, decision alternatives may (i) be poorly defined, or (ii) those on the table may be contested/in conflict. Can valuation play a role in helping to define alternatives? Valuation methods may be used for scoping in order to help define alternatives or to help choose between alternatives. Can valuation play a role when decision alternatives are contested? Yes, valuation can help provide information to stakeholders about their differences in preferences, or information to policy-makers about the value conflicts. With information about differences in values stakeholders and decision-makers can (i) more easily negotiate solutions amongst themselves, and/or (ii) make transparent decisions in the face of value conflict. To be sure, value information can also be used strategically; therefore it is important to ensure openness and pluralism.

Different policy and conflict management purposes frame what kind of valuation methods are feasible and legitimate. For example, an infrastructure project leading to land use change, but offering compensation will mean landowners are faced with unique and exceptional choices, and may not have clear preferences, or on the other hand may be unconditionally opposed to the project and in open conflict with authorities and developers. In either case stated preference surveys are inappropriate. A deliberative valuation approach may help the landowner express her values in the former case, while in the latter the conflict may be so strong as to bar the use of any formal valuation methods, requiring some form of mediation. Another example at a higher governance scale could be account for degradation of ecosystems as assets in national accounts. The System of Environmental-Economic Accounting 2012 Experimental Ecosystem Accounting (SEEA EEA) (UN et al. 2014) recommends that exchange valuation principles are required for ecosystem accounting to be compatible with the system of national accounts (SNA). Valuation methods based on welfare measures such as consumer surplus are not admissible to avoid double counting of welfare (Obst et al. 2015). Other decision contexts such as priority-setting use benefit-cost analysis based on monetary valuation of consumer surplus. Value plural decision-making in multi-criteria decision analysis is designed to address both economic and non-economic indicators of value (Gómez-Baggethun et al. 2014).

2.1. Valuation is specific to a governance context

Decisions are about actions which have diverse consequences, both negative and positive, to different societal actors, both individuals and stakeholder groups, as well as societies. The ecosystem services cascade emphasises the links between decision that affect ecosystem structures and biodiversity, ecosystem function, ecosystem services and different measures of human well-being (Haines-Young and Potschin 2010). With a governance perspective on the ecosystem service cascade (Primmer et al. 2015) all causal links from ecosystem structure through services to ecosystem values are mediated by governance. In each governance context decisions are based on 'indicators of importance' emphasising different parts of the ecosystem service cascade. 'Ecosystem values' have particular importance for higher level governance, but 'indicators of importance' can be devised for all aspects of the ecosystem service cascade. Indicators of importance represent instrumental 'values' (Gómez-Baggethun et al. 2014) when they inform and are conditioned by decisions. Values are also discussed in the sense of deeply held worldviews which may not vary much across governance or decision contexts. While such values are more context free and are not instrumental per se, they are decision-relevant to the extent that they co-determine peoples' choices.

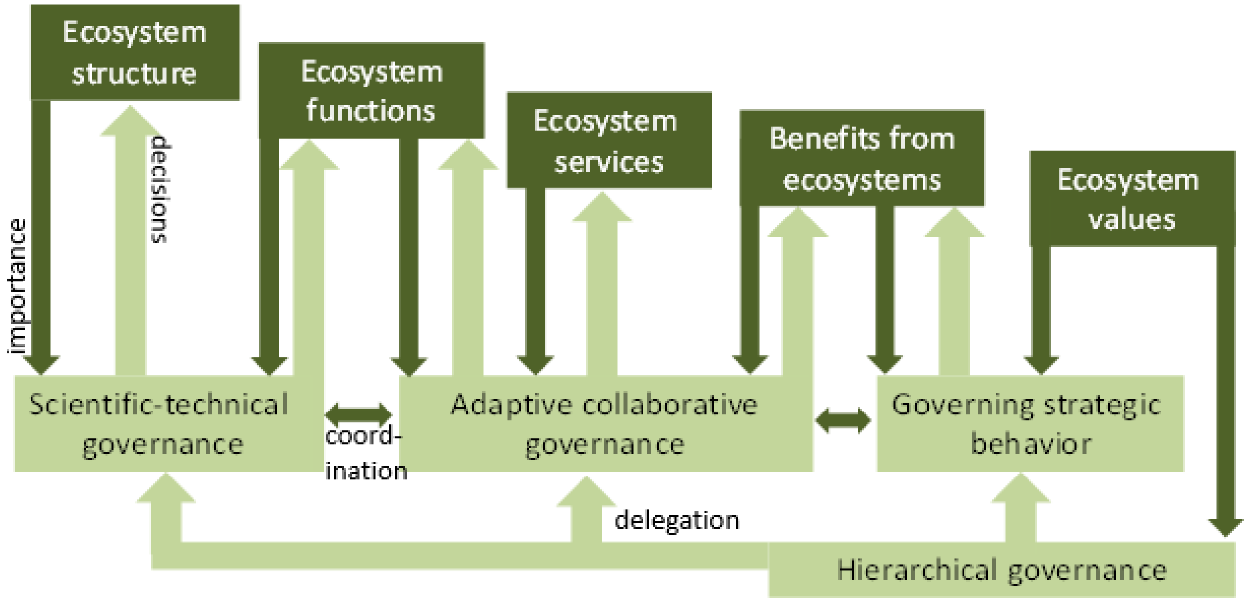

Figure 2.1. Ecosystem services cascade – ecosystem values are determine by decisions. Source: Primmer et al. (2015)

Within a broad governance context and stage of the ecosystem service cascade, further specification of the decision context and *stakeholder expectations of the valuation methods for that context* is a condition for carrying out valuation that is perceived as plausible and useful. It also encourages the decision-maker to think through whether it is plausible that valuation will provide credible decision-support, before commissioning a study.

2.2. Valuation is specific to a decision-support purpose

Although, much of the valuation literature has an academic focus (Laurans et al. 2013), these guidelines concern valuation with the purpose of decision support. This purpose is reflected in the TEEB reports' (TEEB 2010) reference to first recognizing value, then demonstrating value, and finally capturing value in decision-making. Figure 2.2 suggests five main types of decision support from *awareness-raising*, *accounting, priority-setting*, through *instrument design* to calculation of *liability.* The framework suggests that the requirements for accuracy and reliability are expected to increase successively when moving from a policy setting requiring simply awareness raising (e.g. regarding costs of ecosystem service loss); to accounting for green infrastructure in balance sheets; to priority-setting of the location of an infrastructure project; to instrument design of e.g. user fees to finance public utilities; or finally to calculation of economic liability for damage compensation in a litigation case.

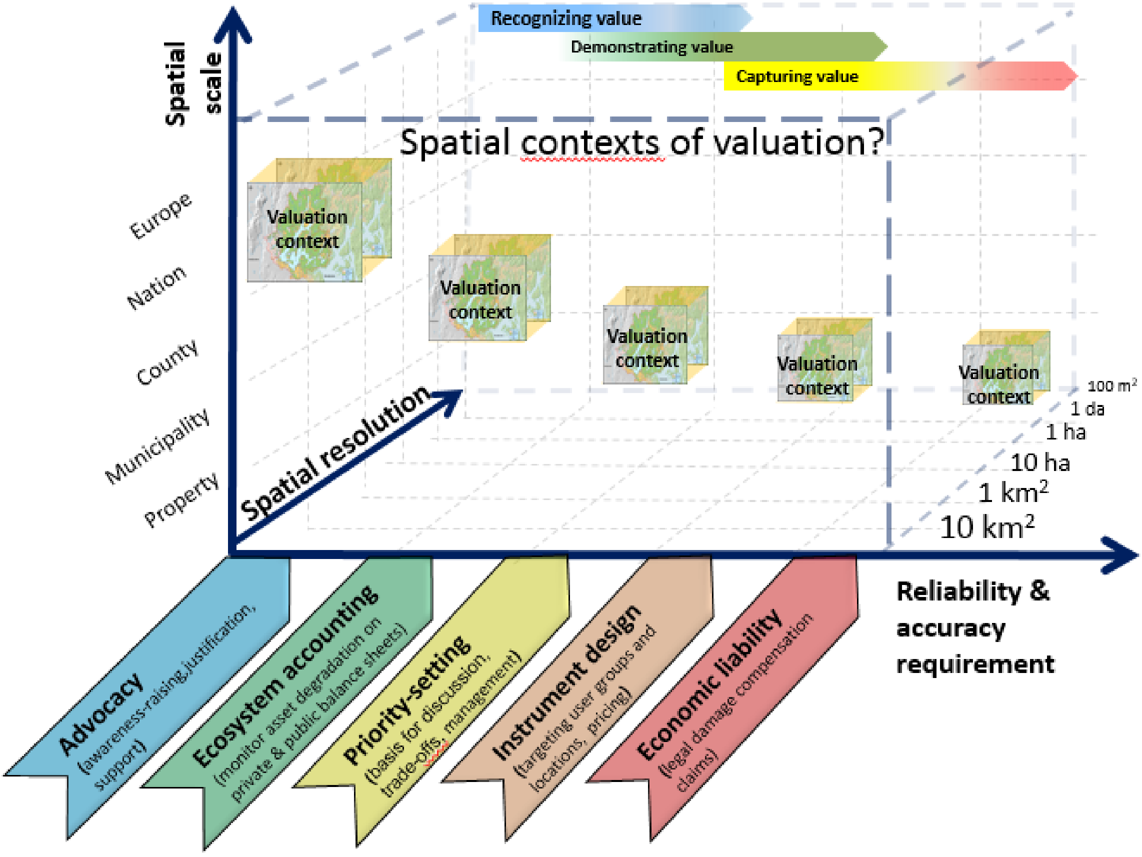

Figure 2.2. A Framework for policy-relevant valuation of ecosystem services at different scales Source:adapted from Gómez-Baggethun and Barton (2013)

The ordering of decision contexts in terms of information costs along the horizontal axis refers to quantitative valuation methods – and monetary valuation methods in particular. Information costs increase with the increasing demand for accuracy and reliability of quantitative valuation methods. Information demands also increase with increasing geographical scale and spatial resolution of the decision-support context. Some of these characteristics of decision contexts are broadly relevant for both socio-cultural and monetary valuation methods, for instance awareness raising and priority-setting are broad purposes of valuation shared by both monetary and socio-cultural valuation methods. However, socio-cultural valuation is a relatively young methodological field including methods that are less conceptualized and empirically tested, comparing to monetary methods. Many tools, grouped under the umbrella of socio-cultural valuation, came from different disciplinary backgrounds, from ethnography through geography and political ecology to alternative approaches within economics such as feminist or ecological economics. They have been applied to ecosystem services valuation as a reflection to the criticism of monetary valuation methods.

Socio-cultural valuation in most cases is not directly linked to decision making, or at least there is a lack of published evidence on how socio-cultural valuation methods can be taken up by policy at different decision making levels. According to a few empirical examples on socio-cultural valuation, these tools can be best used to initiate and guide participatory planning processes (i.e. designing land use plans or creating rules for protected areas)(Palacios-Agundez et al. 2013, Palomo et al. 2014)) or to develop culture-specific informal institutions for the management of ecosystem services (von Heland and Folke 2014). They can also be applied to gain information on how ecosystem services are managed (as well as the underlying motives behind the actual use patterns) and to share this information both within the user groups and with the relevant decision making bodies (Chan et al. 2012, Kelemen et al. 2013, Klain et al. 2014). Through this information brokering process, socio-cultural valuation raises awareness and builds a diverse knowledge base for ecosystem services related decisions which can be utilized as input information for various other valuation tools (e.g. MCDA, BBN or monetary methods). A few examples pinpoint that additional application areas of socio-cultural valuation can be conflictual decision making situations where sociocultural valuation can help understand the roots of the conflicts and discover alternative solutions (Gómez-Baggethun et al. 2014, Kovács et al. 2015). In spite of this sporadic information on the relevant decision making contexts for socio-cultural valuation, a systematic conceptualization of the valuation purposes is still missing. Developing such a typology, and combining it with the decision-support contexts of monetary valuation (Figure 2.2) is therefore and important task for D4.4, especially taking into account that OpenNESS case studies can provide genuine data on the applicability of socio-cultural valuation in different contexts across different scales.

2.3. Values are specific to an action/choice situation

What are the value-relevant dimensions of choice situation? Value plurality is the result of the combination of diversity of nature, of citizens' perspectives on nature, and different situations in which choices are made. Individual and collective choices need to be made for a huge combination of contexts across a landscape. Sources of variation in decision context can be grouped into at least five 'value-types' (Figure 2.3.).

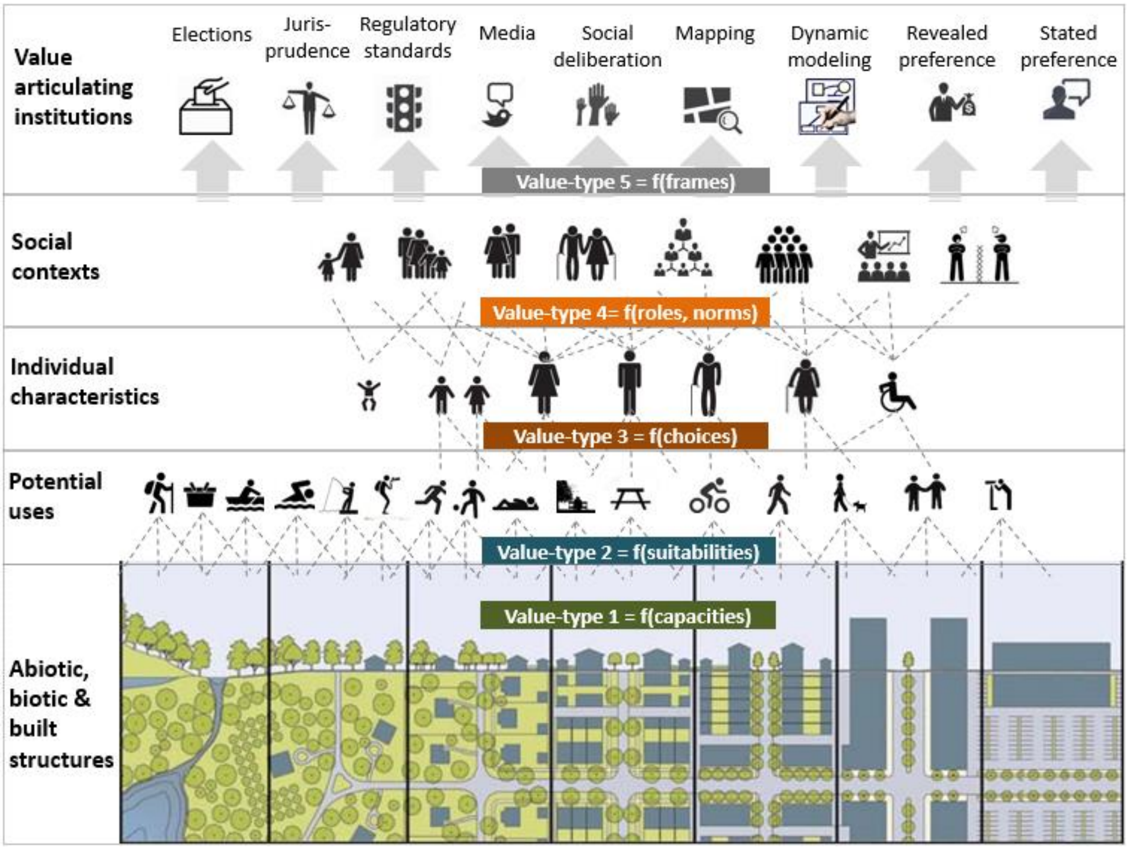

Figure 2.3. Many choice contexts – plural values. Why are perspectives on and preferences for nature so diverse? Examples of contexts affecting recreational values. Source: David N. Barton. Landscape graphics adapted from Duany Plater-Zyberk & Company freeassociationdesign.files.wordpress.com

All value types, listed in Figure 2.3, are functions of:

1) Capacity of blue-green structures and spaces for different uses.

2) Suitability for different uses, defined by minimum user requirements relative to capacity.
3) Individual activity-location choices conditional on blue-green structures' capacity and suitability.
4) Individual roles in social contexts determine norms which condition choices. Individuals can have different roles in different choice settings.
5) Value articulating institutions. These are choice contexts in which values are expressed, either explicitly using valuation methods, or implicitly where choices are made individually or collectively.

Part of defining the purpose of valuation also involves discussing whether there are other ways in which decisions can be made than using formalised valuation methods structured in benefit-cost analysis, multi-criteria analysis or other integrated assessment tools for decision-support. This discussion is in fact part of a scoping exercise.

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3. Scoping – Constituting shared evidence for decision context

The scoping process – as a preliminary step of integrated valuation – sets the ecological and socio-economic context, including the human-nature interactions, where the valuation process takes place. Through scoping the boundaries of valuation are delineated and the decision alternatives and criteria are explored. This is in line with the process of environmental impact assessment (EIA), where the impacts to be predicted are defined in the scoping stage. The careful consideration of the biophysical and the social-cultural-economic boundaries of valuation is of key importance to match valuation methods with contextual specificities, to reduce bias and methodological failures, and to arrive at truly integrated results across disciplines, knowledge systems, data sources, scales and value dimensions (Gómez-Baggethun *et al.*, 2014). Scoping also increases the transparency about the intended and (potential) unintended effects of the valuation process and the following decisions, such as the distributional impact of valuation (who wins and who loses).

In other well-known valuation frameworks (see Table 1), the preliminary step to valuation is either a biophysical and social assessment including the mapping and assessment of ecosystems and their services and the understanding of the drivers of change (e.g. in case of the MA and the TEEB), or the consideration of a set of methodological issues that should influence the choice of methods (in case of the IPBES). Here we propose a combined approach to scoping, which

- takes into account that valuation methods are in fact value articulating institutions (Vatn, 2005a) that influence how ecosystem services are framed (e.g. as public goods or commodities) and valued against which value types (e.g. monetary, socio-cultural or ecological), and
- offers a toolbox for the assessment of the biophysical and social-cultural-economic context of valuation to substantiate the flexible and context-specific choice of methods.

3.1. General framing considerations for the methodological choice

It is the wider political, socio-cultural and decision-making context which determines the valuation framework such as its aims, scope and relevance, therefore, valuation is shaped by institutions (cf. chapter 2). At the same time, valuation influences institutions by determining the range of relevant actors, the types of knowledge included, as well the roles of decision-makers. Therefore, one can argue that valuation methodologies are institutions themselves, containing a set of rules for articulating values (Jacobs, 1997; Vatn, 2005a; 2005b; 2009).

Ontological and epistemological principles (i.e. what we mean by the subject of the research, and what we think about the possible ways of discovering and analyzing the subject of the research) are inherent to any scientific method and shape both the procedure and the outcome of research projects. This is true also for valuation processes which generate a special microcosm where valuing agents are invited to articulate values for the subject of valuation. This special microcosm is, however, not necessarily in line with the actual socio-cultural and political context if basic methodological assumptions of the selected method(s) are not considered. This might result that the valuation outcome has no relevance to real world decisions (Gasparatos, 2010) or has unintended consequences such as motivation crowding-out (Frey and Oberholzer-Gee, 1997) or crowding-in (Vatn, 2005b).[5] Considering valuation methods as value articulating institutions

[5] Beyond the problems of crowding-in and crowding-out various other challenges might also be faced when the aim is to make a valuation process both policy relevant and reliable. For example, it might happen that people have some positive values for 'cleaner' water, but the practical way how to get there might be either uncertain entirely unknown. If this link between values and 'decisions' on concrete actions is missing, value articulation might remain an adademic excercise. The same applies if the place of observing, using and valuing a particular ES is entirely different from the place where cost-effective measures (decisions) could be made (e.g., transboundary ground water bodies).

does not only increase transparency of the methodological choice, but also improves the relevance of valuation results by making the process owner (being either scientist or practitioner) aware of the specificities and possible consequences of choosing one or another method.

Drawing on literature (Vatn, 2005a and 2009, O'Connor, 2000, Wilson and Howarth, 2002) we suggest a set of general framing considerations for method selection differentiated along the underlying assumptions behind valuation methods.

1) **Ontological aspects of valuation** (i.e. the cognitive elements of value articulating institutions which determine what 'reality' is for the process owner and the valuing agents within the frame of the valuation process):
    a. *The subject of valuation:* What is the subject of valuation? Is it the ecosystem services, the benefits derived from them, or the underlying ecological structures and functions? How do we understand and conceptualize this subject – from a western scientific point of view, from an indigenous knowledge holder's point of view, or from any another aspect? Is the possibility of competing worldviews, multiple understandings, complexity and ignorance acknowledged?
    b. *The meaning of value:* How does the method define value? Does it reflect the changes in utility in a narrow or a broad sense (i.e. welfare or well-being)? Does it take into account moral aspects of value? Does it take into account the plurality, the heterogeneity and the (in)commensurability of values?
    c. *The valuing agent:* Who does the valuation – is it the process owner only, or a broader range of valuing agents who takes part in the process? What is their task during the process (who takes decisions, who expresses preferences, who interprets meanings, etc.)? Special emphasis should be placed on two different aspects of participation in valuation:
        i. The role of the valuing agents: Are valuing agents supposed to act in the role of consumers, experts, stakeholders or citizens?
        ii. The expected rationality of the valuing agents: Are valuing agents characterized by individual or collective rationality, or a context-dependent mixture of different rationalities?
2) **Epistemological aspects of valuation** (i.e. the normative and regulative elements which determine how knowledge is gained about the values attached to the subject of valuation):
    a. *Relevant data:* What types of data count as relevant – quantitative, qualitative or both? What is the relevant source of knowledge? Are diverse knowledge sources (e.g. scientific, expert, local and traditional knowledge) acknowledged and incorporated into the valuation?
    b. *Relevant scale:* Which scales of time, space and social organization is considered as relevant by the method? Which methodological approaches are considered as relevant and reliable when moving from smaller to larger scales (i.e. generalizing)?
    c. *Legitimate processes:* Which forms of human interaction (instrumental vs. communicative) valuing agents are expected to follow by the method? Which techniques are used for collecting and analyzing data and producing the results?

Table 2 gives a general overview of scoping considerations offered by this Deliverable and compares them to other existing frames available in the literature. The table highlights that scoping considerations proposed by OpenNESS do not add additional layers to scoping, rather they combine different considerations from earlier literature, and give equal weight to ontological and epistemological aspects.

Table 2 Different sets of scoping considerations to better inform the methodological choice

<table>
<tr><td>Vatn (2009)</td><td>IPBES (2015)</td><td colspan="2">OpenNESS IV</td></tr>
<tr><td rowspan="3">The good</td><td>Worldviews</td><td rowspan="2">Subject of valuation</td><td rowspan="5">Ontology</td></tr>
<tr><td>Focus of valuation</td></tr>
<tr><td>Types of values</td><td>Meaning of value</td></tr>
<tr><td rowspan="2">Rationality</td><td>Social engagement</td><td rowspan="2">Valuing agent:
- role
- rationality</td></tr>
<tr><td>Broader social context</td></tr>
<tr><td rowspan="3">Human interactions</td><td>Scales</td><td>Relevant scales</td><td rowspan="3">Epistemology</td></tr>
<tr><td rowspan="2">Practical considerations</td><td>Relevant data</td></tr>
<tr><td>Legitimate processes</td></tr>
</table>

In this guidance document we focus on methods for the assessment and valuation of ecosystem services, which already restricts the possible interpretations of the subject of valuation. At the most general level we frame the subject according to recent scientific understandings of ecosystem services acknowledging their complexity and uncertainty. However, different valuation methods show some variability on whether they are open to other non-scientific (local, lay or traditional) conceptualizations and aim at discovering them, or apply the scientific worldview rather strictly throughout the whole valuation process. Even larger differences can be realized between valuation methods when they are compared along the values and the valuing agents they focus on, or the scales, data and processes they consider as relevant. Some of them open up to various value types, while others focus only on one or a few of them. Some tools and techniques incorporate the knowledge and opinion of a wide range of valuing agents either from a consumer, a citizen or a stakeholder perspective, while others apply limited participation. They are different in terms of the spatial and temporal scales they can reliably address, as well as in terms of data they can handle (qualitative, quantitative or both) and the processes they consider as legitimate (e.g. ranking, free-listing, weighting alternatives, allocating money, deliberating arguments, etc.).

In Chapter 4 each method is presented using a common set of criteria based on the general scoping considerations listed above. However, if the aim is to choose the most appropriate method for different situations, being aware of the ontological and epistemological assumptions that lie behind the methods available is only half of the work. It is equally important to gain an in-depth understanding of the issue at hand (which triggered the process of valuation) and its contextual characteristics. To this end, the biophysical and the social boundaries of the valuation (the left-hand side and the right-hand side of the ecosystem service cascade) should be delineated through an assessment process. Assessments can be built on quantitative and/or qualitative data (often spatially explicit) and can take various formats from formal synthesis to less structured stakeholder oriented processes, but in any case their major aim is to gain information on the relevant natural and socio-economic factors in relation to specified ecosystem management decisions (Levin *et al.,* 2009) by building up and utilizing science-policy-practice interfaces (Fletcher *et al.,* 2014; deReynier *et al.,* 2010).

OpenNESS has also developed a structured and flexible approach which – containing guidance questions about the ecological, social and policy contexts of the decision making situation – allows for a comprehensive and in-depth understanding of the issue at hand (Potschin *et al.,* 20153). This heuristics can be considered as a general framework for the social and biophysical assessment, which offers relevant theoretical concepts (related to human well-being, sustainable ecosystem management, governance and competitiveness) as well as available tools and techniques to carry out the assessment phase. The heuristics also pinpoints to “exit doors” where there is a necessary shift from understanding the broader picture to defining and evaluating alternatives, or in other words, where there are explicit links from concepts to methods and tools for the assessment and valuation of ecosystem services.

In D4.2 Braat *et al.* (2014) considered both biophysical and social assessment as stepwise procedures embedded in the Integrated Valuation Framework (see boxes 2.1 and 2.2 in Figure 1.1, p. 6.). The object of biophysical assessment is "the biophysical systems and processes in real world landscapes that generate, via so-called ecosystem services, benefits for humans and thus are recognized as sources of value", while the object of social assessment is "the socio-political environment because what is recognised as a source of value depends not only on the biophysical system but also on social processes and policy contexts". In the next two sections we start with this conceptualization of biophysical and social assessment and reiterate the stepwise processes developed in D4.2. Next we populate these assessment frames with available tools and methods and highlight that in practice the boundary between assessment and valuation is sometimes thin and blurred. We are aware that these general framing considerations are most relevant in unstructured decision-problems which assume that decision-makers and researchers have the possibility to structure the problem 'from scratch'. However, in many cases, practitioners may face decision-problems about nature management that are highly structured by institutions already in place (e.g. an Environmental Impact Assessment regulation). In such cases the Integrated Valuation Framework may be difficult to implement in all its steps, but can serve as a benchmark.

3.2. Biophysical assessment

Defining the biophysical boundaries of the valuation can be considered as the process of mapping and assessing ecosystem properties (ecosystem structures and functions) that provide ecosystem services (i.e. the supply side of the ecosystem service cascade). Braat *et al.* (2014) divided this process into four major steps (Figure 3.1.): (1) mapping and assessing ecosystems, (2) mapping and assessing their actual conditions, (3) mapping the potential supply of ecosystem services and (4) assessing the actual and the potential supply under different scenarios (alternatives) based on dynamic simulation models.

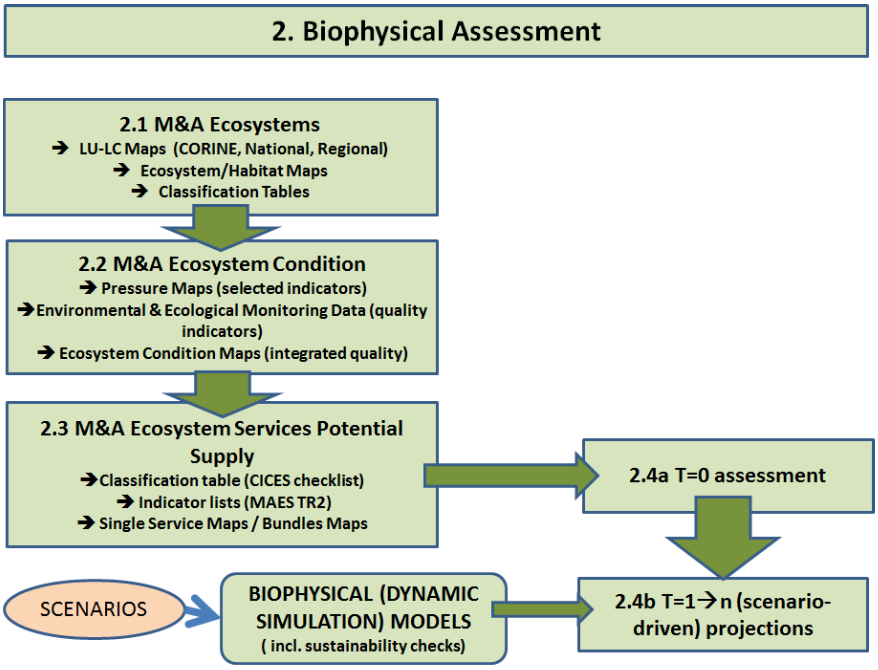

Figure 3.1. The Biophysical Assessment procedure (cited from Braat et al., 2014)

The major outcomes of such an assessment procedure are the detailed description of the current state and ecosystem service providing capacity (incl. thresholds, tipping points) of the ecosystem with indicators, the identification of bundles/trade-offs between ecosystem services from a biophysical perspective, and the exploration/assessment of potential future changes through modeling. Various tools are available for mapping and modelling the supply of ecosystem services. In OpenNESS WP3 six key tools have been offered to and tested empirically by project partners, and two additional tools for global modelling have been used for scenario development (WP2), but case studies used several other methods beside these. In D3.2 Harrison *et al.* (2015) provide detailed guidelines for all of these methods, namely:

1) Spreadsheet type methods
2) ESTIMAP
3) Bayesian Belief Networks
4) State and transition models
5) QuickSCAN
6) InVEST
7) *Species distribution*
8) *Ecoplan-QuickSCAN*
9) *MapNat smartphone application*
10) *RUSLE Erosion Model*
11) *Blue-green factor scoring*
12) *Photoseries analysis*
13) *ECO Chain*
14) GLOBIO-ES
15) CLIMSAVE Integrated Assessment Platform

(The first six tools in the list are the general OpenNESS mapping and modeling techniques, the next seven tools in italics are those used by a few case studies, and the last two tools in bold are the global models. Since D3.2 gives in-depth information and methodological guidance on these tools, we do not provide here more detail.)

Although the general framework for biophysical assessment (Figure 3.1.) as well as the tools offered by WP3 supposed to focus solely on the supply side by mapping, modelling and assessing the ecosystem properties that deliver ecosystem services, some of the listed tools go beyond this aim and incorporate knowledge and information from stakeholders. For instance BBN and QuickSCAN are often used in group settings in a discourse-based manner, where participants are invited to contribute with their unique knowledge about the ecosystem, and also to take part in the definition of some criteria for the assessment. When these tools 'assess' the supply side, they integrate different knowledge systems and build on the personal judgments of the participants, which are never independent from the individual value system one holds – so the value articulating aspect (directly or indirectly) is already involved in these assessment tools. The valuation aspect is even stronger in the case of the MapNat tool or the Photoseries analysis, where not only information on ecosystem characteristics is collected from participants, but also their preferences are recorded (in the latter case even without letting them know that they are considered valuing agents in a valuation process). These examples highlight that personal value judgements can be present already in the biophysical assessment phase, which might also suggest that assessment and valuation is not easily separable in some cases, and therefore reflection on institutional aspects of valuation is already relevant at this stage.

3.3. Social assessment

Defining the social, economic and political boundaries of the valuation process is the major aim of social assessment carried out in the scoping phase of integrated valuation. Braat *et al.* (2014) used the term socio-economic assessment and described it as a three-step formal process (see Figure 3.2.) which builds on biophysical assessment and leads to definitive tables of ecosystem service benefits (specific to scale, time and stakeholder group) for each alternative that has been modeled in the last step of the biophysical assessment process. The three major steps within this process are (1) defining and mapping stakeholders, (2) mapping and quantifying the demand towards ecosystem services, and (3) mapping and assessing demand versus supply (that is, linking back to the last step of the biophysical assessment). It is important to recognize, however, that to accomplish these steps the process owners do have to have some background understanding of the wider social context where the process is embedded.

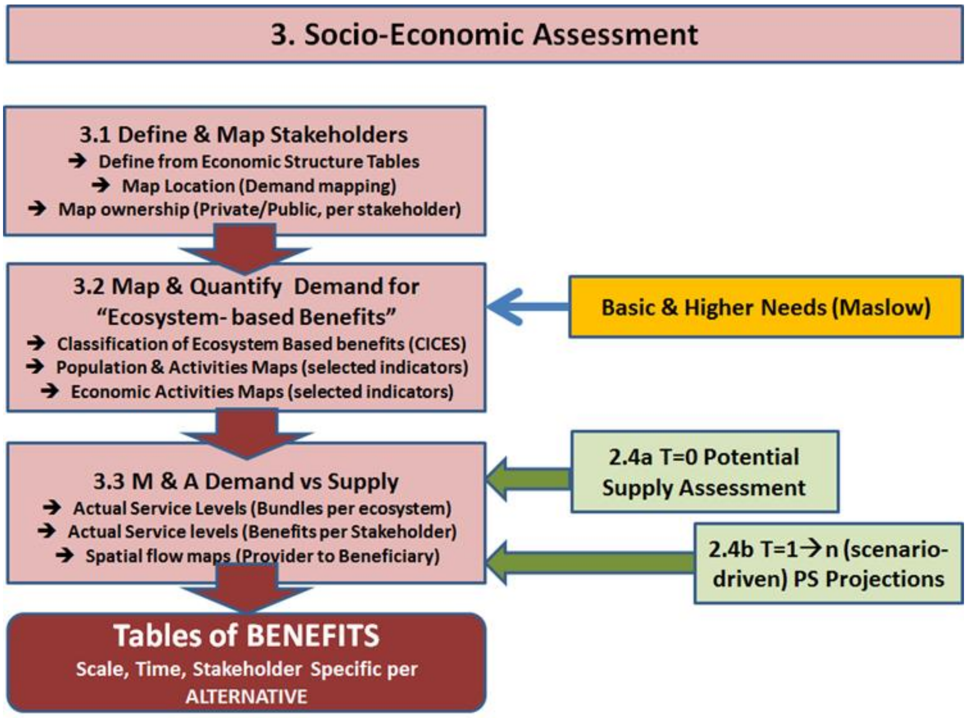

Figure 3.2. The stepwise process of Socio-economic Assessment (cited from Braat et al. 2014, p. 27)

For the definition and mapping of stakeholders (step 1), it is key to explore not only the relevant user groups (who have a market-based or production function based relationship to ecosystem services) but also those stakeholders who are depending on ecosystem services, and hence to broaden up the process to those actors who used to be marginalized due to their weak economic activity related to their age, gender, ethnicity, etc. (to underlie this argument please check OpenNESS Synthesis Papers on stakeholder involvement (Hauck *et al.,* 2015), social justice (Kretch and Kelemen, 2015) and gender (Kelemen *et al.*, 2015)). Defining and mapping stakeholders should be done with the purpose of incorporating their preferences and values in the process of valuation. Therefore a wide range of methods available for stakeholder analysis and involvement is offered beyond mapping the location of key (economic) stakeholder groups (Lovens *et al.,* 2015 provide an in-depth overview of tools and techniques frequently used for stakeholder analysis in ecosystem management processes).

For mapping and quantifying the demand for ecosystem service related benefits (step 2), one has to explore the different perceptions and conceptualizations of ecosystem and its services to people as part of the characterization of the dominant uses. Recent studies highlighted that different stakeholder (user) groups might understand ecosystem services from a different angle than western science does, which also influences how they use or maintain these services and actually how their demand changes over time (de Oliviera and Berkes, 2014, Klain *et al.,* 2014). Understanding the underlying motives behind ecosystem use is also key to choosing the most appropriate indicators along which the demand can be mapped – in specific context it is even desirable to invite people to define indicators or take an active part in the mapping phase (see e.g. the application areas of deliberative mapping).

Figure 3.2. also suggest that for characterizing ecosystem service demand (and to quantify how certain ecosystem services contribute to human well-being) the needs hierarchy should be used as a baseline (Maslow, 1970). Undoubtedly, we need basic reference points to be able to define the value of something as

a means to satisfy ones needs. However how needs and satisfaction is understood by people is context dependent, and whether needs can be ordered in a hierarchical way (Maslow himself later acknowledged that there is no necessary hierarchy among needs, see e.g. Koltko-Rivera, 2006). Therefore, to accomplish step 2 of the socio-economic assessment, the deeper (and contextualized) understanding of well-being aspects is necessary, which can be based on more complex and nuanced conceptualizations of well-being such as the capability approach of Sen (see e.g. Polischchuk and Rauschmayer, 2012) (to understand the well-being approach adapted in OpenNESS please check the Synthesis Paper no. 19 by Jax and Heink, 2015.).

Based on the arguments above we suggest that the formalized process of socio-economic assessment, characterized mainly by activities of quantifying and mapping, should indeed incorporate context specific and qualitative data that explore and explain human-nature relationships relevant at the given spatial and temporal scale. This can be achieved by fundamental social engagement in the scoping phase (biophysical and social assessment) and throughout the whole process of integrated valuation and/or by applying hermeneutic approaches (e.g. narrative valuation, ecosystem service card game) in the social assessment phase.

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4. Methodological guidelines for ES valuation

In this chapter we provide an overview of methods offered to OpenNESS case studies for the operationalization of the ES concept in real life decision contexts with the double aim of:

i) providing information on the ontological and epistemological foundations of the methods and
ii) providing guidance on the practical requirements and context-specific applicability of the methods.

Method templates shared in this chapter are preliminary guidelines, which means that they have been developed and used by OpenNESS case studies and will be developed further into final guidelines (D4.4) by incorporating context specific empirical results of their application by case studies. The templates build on previous methodological expertise which has been shared and tested with case studies during several training occasions organized within OpenNESS (January 2014: MCDA, April 2014: non-monetary methods, October 2014: monetary methods and mapping & modelling tools). The templates also underwent an internal reviewing process. Templates were commented by two reviewers, one having an in-depth knowledge of the specific methodological approach and another one with expertise in other methodological fields, to collect both insider and outsider views to the templates. Templates for monetary methods were exceptions as they were reviewed by only one expert of the field (this is justified because most monetary methods are extensively documented and frequently applied). Based on reviewers' comments the templates were checked and revised to increase clarity and coherence.

We argued in the previous chapter that biophysical and social assessment (scoping), although often considered as a preliminary step of valuation, is seriously intertwined with valuation, and the boundary between these two is often thin and blurred. Following this line of argumentation, chapter 4 applies an inclusive approach and presents a wide range of methods that can be used either in the assessment (scoping) or the valuation phase (or sometimes in both of them). The scientific literature basically groups ecosystem service valuation methods into three broad categories: economic (monetary) methods revealing the economic value of ecosystem services, socio-cultural methods revealing the cultural values of ecosystem services, and biophysical methods revealing the ecologic values of ecosystem services. This chapter presents socio-cultural and economic methods as well as some complex approaches focusing on integrated valuation, but does not introduce mapping and modelling which belong to biophysical assessment – the latter ones are discussed in detail in OpenNESS Deliverable 3.2. Taking these two preliminary guidelines deliverable (D3.2 & D4.3) together, OpenNESS guidelines cover almost all of methods offered to ecosystem service assessment and valuation by the IPBES (c.f. IPBES D3(d) on values and valuation), except health-based assessment methods and holistic and indigenous knowledge based valuation methods.

Each method description in this chapter follows the same structure which first highlights the key features of the method, then reviews its contextual specificities (for which purposes, at which scales and in which decision context it is applicable), and finally sums up its technical requirements, as well as its advantages and limitations. This way the method templates allow for an in-depth comparative analysis of methods both from a practical and an axiological point of view. Method templates also cover the various potential aspects of integration listed in D4.1 as the following ones: (1) disciplinary domains, (2) knowledge systems, (3) qualitative and quantitative information, (4) values emerging at different levels of societal organization, and (5) value articulating institutions. This way the comparative analysis of the method templates can help identify to what extent and at which aspects each method contributes to integration.

Methods are presented in alphabetic order.

4.1. Cost-based methods

Method expert: David N. Barton (david.barton@nina.no)

Introduction to method

Cost-based valuation methods are a group of 'exchange-based' techniques that use the cost of actual measures to maintain ecosystem service provision as a proxy for the value of avoiding, mitigating or restoring the loss of services ecosystems provide. As costs are estimated based on observable market-prices it is a group of methods that is also accepted in guidelines on systems for economic and environmental accounting (SEEA)(UN 2014). Cost-based methods give a conservative estimate of the value of ecosystem services provided that the most cost-effective actions for avoiding, mitigating, restoring, compensating and offsetting environmental damages have been undertaken. Actions may be specifically designed to address a particular ecosystem service, but costs are often representative of bundles of ecosystem services. Cost-based valuation methods are associated with steps of the "mitigation hierarchy" (BBOP 2009).

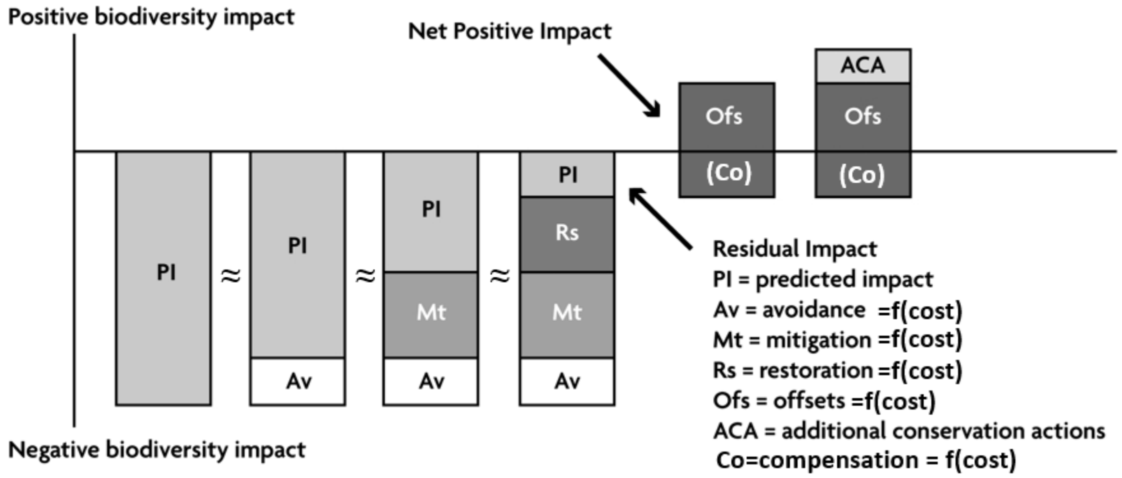

Figure 4.1. The mitigation hierarchy. Source: adapted from BBOP (2009)

While the aim of avoidance, mitigation, restoration, compensation or offsetting actions is 'no net loss' to ecosystem services, the sum of action costs is not necessarily equal to the economic impacts if no actions had been undertaken. In other words, the costs of actions do not necessarily equal the welfare effects of impacts. The assumption is that if actions have been undertaken their costs are less than the expected damages to ecosystem services. In practice, actual avoidance, mitigation, restoration, compensation costs incurred may be inflated by ineffective actions. The cost of actions depends on the regulatory standards for environmental liability in the particular jurisdiction of the project (Vatn et al. 2014). Monetary compensation (Co) for damages may in some jurisdictions be required because of negligence (no averting, mitigating or restoration actions have been undertaken). In this way cost-based methods are 'value articulating institutions' conditioned by institutional context (although not in the same way as stated preference methods).

Keywords: avoidance, mitigation, restoration, compensation, offset costs

Why would I use this method?

Cost-based methods are accepted for SEEA purposes. They are seen as more reliable because they are based on observed market-prices. Ideally, costs are 'operational' in that they are the result of observed actions as part of environmental planning, impact assessment and management. The valuation objective is to determine the sum of costs imposed by environmental regulatory standards, under the assumption that they are a proxy for social value of the ecosystem services protected by the standards. Broadly speaking, cost-based methods are often proxies for multiple ecosystem services - averting and restoring actions target ecosystem condition, rather than specific services. Some mitigation actions and compensation costs may be aimed at particular ecosystem services.

Cost-based methods are landscape and project specific, local scale and high-resolution. They have been applied across a number of decision contexts – awareness-raising, recommended for SEEA purposes, used in priority-setting in benefit-cost analysis of project alternatives, in design of biodiversity offsets, and are the basis for economic liability.

Requirements

Requirements		**Comments**
Data collection requierement	**X Data is available** □ Need to collect some new data (e.g. participatory valuation) □ Need to collect lots of new data (e.g. valuation based on surveys)	If based on actual or potentially feasible measures
Type of data required	**X Quantitative** □ Qualitative	
Expertise and production of knowledge needed	**X Working with researchers within your own field** □ Working with researchers from other fields □ Working of non-academic stakeholders	Working with project managers
Software requirements	**X Freely available** □ License required □ Advanced software knowledge required	Spreadsheet
Time requirements	**X Short-term (less than 1 year)** □ Medium-term (1-2 years) □ Long-term (more than 2 years)	
Economic resources	**X Low-demanding (less than 6 PMs)** □ Medium-demanding (6-12 PMs) □ High-demanding (more than 12 PMs)	
Other requirements		

Type of values

Cost based methods are highly appropriate to value ecological values and intrinsic values of nature, as well as to elicit option values. They are less suitable to unfold socio-cultural values and relational values, and not appropriate to capture existence value.

Advantages

Methodological

- ease of use
- speed of use
- draws on existing data
- covers wide range of ES

Governance

- regulatory compatibility
- recognised and established accounting approach

Constraints and limitations

Methodological constraints

- does not include welfare measures
- uncertain effectiveness of mitigation, restoration and offsetting actions are not possible to quantify ex ante (see appendix). The less effective a measure the more valuable the ecosystem services appear.
- when applied without basis in actual projects, ad hoc assumptions regarding environmental liability standards and potentially feasible actions are required (generating hypothetical costs). When exploring cost-effectiveness of actions the method has commonalities with 'shadow pricing'.
- environmental modeling may be required to assess effectiveness of averting, mitigating and restoring actions on ecosystem services (modeling costs)

Governance constraints

- may not reflect environmental liability legislation

Steps required to apply the method within a case study

Figure 4.2. Stepwise approach to apply cost based methods.

When aiming to apply cost-based methods, it is important to take into account that these methods are conservative and uncertain proxies for the value of avoiding variable future ecosysem service losses.

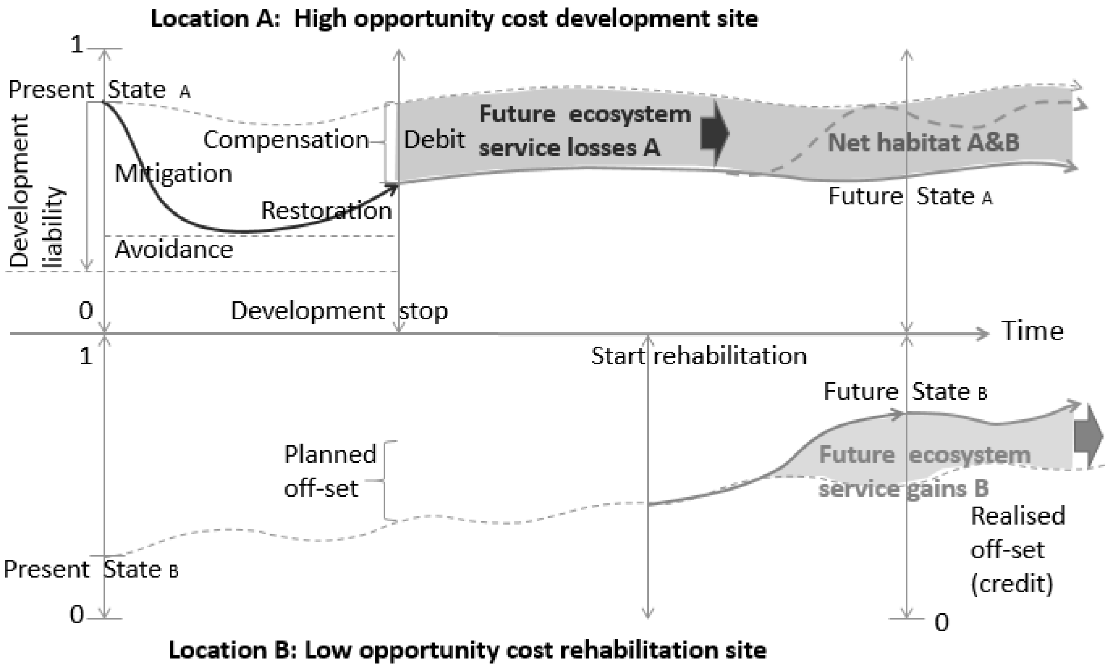

Figure 4.3. Application of cost based methods. Source: adapted from Barton et al. (2011)

As the figure above suggests, avoiding, mitigation and restoration actions are substitutes and should be subject to cost-effectiveness. As a regulatory rule avoidance is preferred to mitigation, which is preferred to restoration and offsetting – following the principle that early precautionary measures are preferrable to ex post reparation. In some regulatory contexts monetary compensation for environmental liability may be required in cases of willfull negligence (lack of avoidance). Off-site offseting offers the possibility of more cost-effective approach to no net loss of ecosystem services. The equivalence and cost-effectiveness of offset measures over time is more uncertain than on site measures. In summary, the more cost-effective the design of actions, the lower the inferred value of ecosystem services.

Illustration of practical applications of the method using the OpenNESS case studies

Cost-based methods are implemented in case 3. Oslo.

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4.2. Deliberative valuation (DV)

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Introduction to method

Deliberative valuation is not one particular valuation method, but it is a valuation paradigm (Raymond et al. 2014) providing a framework to combine various tools and techniques that bridges citizens and academia as well as different disciplines within science. Deliberative valuation is based on the assumption that valuation is a social process in which values are discovered, constructed and reflected in a dialogue with others (Wilson and Howarth 2002). Therefore, deliberative valuation invites stakeholders and citizens (the general public) to form their preferences for ecosystem services together through an open dialogue, which allows consideration of ethical beliefs, moral commitments and social norms beyond individual and collective utility (Aldred 1997, Satterfield 2001, Wegner and Pascual 2011).

Keywords: deliberation, public engagement, participation, discourse, relational values, social values, equity

Why would I use this method

Deliberative valuation is considered particularly appropriate when valuing ecosystem services and benefits derived from them, because they are common goods the existence of which has consequences for other people, in other parts of the world, and across generations. These choices are fundamentally ethical and hence the right question is not what "I want for me" (reflecting the self-oriented values that follow individual rationality) but rather what is "right to do" (reflecting the others-oriented values that follow collective rationality) (Vatn 2009, Chan et al. 2012). Open discourse, generated by deliberative techniques, is able to unfold relational values and reflect upon the social context of valuation. Therefore, deliberative methods are also proposed to account for social equity issues in valuation (Wilson and Howarth 2002). Deliberative valuation is particularly suited for understanding the meanings that people attribute to ecosystems and their services, such as holistic concepts of the land, and it can accommodate diverse world views and forms of information. Therefore, deliberative valuation is found helpful for addressing cultural ecosystem services such as traditional knowledge, sense of place, spiritual value and cultural diversity (e.g. Chan et al. 2012, Kenter et al. 2011), and can also be used to promote social learning (Kenter et al. 2015) by engaging the general public in an open discussion about the intrinsic (ecological) value of ecosystem functions and processes (e.g. Kelemen et al. 2013) or the value of nature for future generations (i.e. bequest values).

As previous field experiences prove, deliberative valuation can be applied in several decision contexts ranging from awareness raising through learning at the individual or the group level (e.g. Aldred and Jacobs 2011, Kenter et al. 2011) to priority setting (e.g. Randir and Shriver 2009), intrument design (see e.g. Maynard et al. 2015 where deliberative valuation of ecosystem services served as a basic input for renewing regional development plans and nature protection rules) and mediation between conflicting interests (rather than liability) (e.g. Málovics and Kelemen 2009), to the extent institutional mechanisms are open to bottom-up decision making processes and public engagement. This also means that in more rigid, top-down institutional systems the results of deliberative valuation might seem to be less relevant for decision makers. Since deliberative valuation employs a huge number of tools and techniques from various disciplinary backgrounds, both the spatial scale and the spatial resolution of the valuation process range from the very small to the very high.

Requirements

Requirements		Comments
Data collection requierement	▫ Data is available ▫ **Need to collect some new data (e.g. participatory valuation)** ▫ Need to collect lots of new data (e.g. valuation based on surveys)	The amount of new data to be collected depends on existing knowledge and information about the situation. In most cases the joint problem framing and the knowledge co-generating phase involves data collection.
Type of data required	▫ **Quantitative** ▫ **Qualitative**	Both qualitative and quantitative data can be used in DV processes.
Expertise and production of knowledge needed	▫ Working with researchers within your own field ▫ **Working with researchers from other fields** ▫ **Working with non-academic stakeholders**	In most cases DV processes engage researchers from different disciplines. Public participation is an inherent part of DV.
Software requirements	▫ **Freely available** ▫ License required ▫ Advanced software knowledge required	Many DV tools and techniques are low-tech by nature, but if DV is used in combination with other approaches (e.g. choice experiment, MCDA), licences may be required.
Time requirements	▫ Short-term (less than 1 year) ▫ **Medium-term (1-2 years)** ▫ Long-term (more than 2 years)	The length of DV processes varies between a few months and several years, depending on the issue at hand and the commitment of the decision maker and stakeholders.
Economic resources	▫ Low-demanding (less than 6 PMs) ▫ **Medium-demanding (6-12 PMs)** ▫ High-demanding (more than 12 PMs)	The organization and facilitation of the DV events as well as the analysis and communication of results require a rather strong involvement on behalf of the scientists.
Other requirements	Professional facilitation and communication skills.	

Type of values

Deliberative valuation is highly appropriate to elicit sociocultural values and those value dimensions which are directly related to the quality of life (human well-being). They can also be used to elicit economic values if they are combined with monetary approaches (e.g. deliberative monetary valuation), although the interpretation of results might be challenging from a philosophical point of view.

Advantages

- Contributes to balancing the power asymmetries between stakeholders:
    - by giving voice to more marginalized social groups and
    - by empowering them (if necessary)
- Integrates various knowledge forms (e.g. local, traditional, expert, scientific)
- Allows for social learning among the participants and the general public
- Improves the understanding of plural and incommensurable values and hence contributes to framing and managing conflicts
- Increases the legitimacy of decisions that build on the outcomes of deliberation

Constraints and limitations

- Operates with small samples which are not statistically representative (although political representativity can be achieved),

- Timely process requiring professional skills
- It has to be combined with other approaches (e.g. MCDA) to reach quantitative results
- Its success of partly depends on participants' availability and general debating culture
- Participation fatigue might emerge
- Some institutional contexts are less open towards public participation

Steps required to apply the method within a case study

Since deliberative valuation is not one method per se, it is difficult to provide a stepwise description of how it goes in practice. Here we propose a toolbox approach along three major steps within a general deliberative valuation process. In the Appendix we provide detailed descriptions for the tools listed in the table

Steps of the valuation process	**Main objective**	**Proposed tools**
Problem framing	Understand the main problems related to ecosystem management through the eyes of local stakeholders and commit them to the valuation process	Stakeholder analysis and in-depth interviews (these are general techniques with no deliberative characteristics)
Knowlegde co-generation	Co-generate knowledge with local stakeholders and citizens on the local perceptions of ecosystem services, and initiate an open dialogue to form preferences to ecosystem services collectively	citizens' science applications, photovoice method, focus groups variations (concept mapping groups, photo elicitation groups)
Decision support	Broaden and democratize the decision making process by involving the general public and / or the local stakeholders	citizens' juries, MCDA

Illustration of practical applications of the method using the OpenNESS case studies

Deliberative valuation is applied in the Hungarian case study.

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4.3. Ecosystem services card game

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Introduction to method

The ecosystem services card game is a method developed to capture the sociocultural values related to ecosystem services. This method specifically focuses on exploring and understanding human preferences and perceptions on ecosystem services. This makes it a useful tool for assessing landscapes that provide various direct benefits to individuals, especially cultural landscapes which have been shaped by long-term human impacts and which are frequent targets of human use and enjoyment.
The ecosystem services card game method combines photo-elicitation with a rating exercise. It serves a double purpose. On one hand it encourages interviewees to discuss why an ecosystem services is important to him/her and thus provides qualitative information. On the other hand, by rating ecosystem services according to usefulness, importance or other locally relevant factors, a quantitative ranking of ecosystem services by order of importance can be obtained (Fontaine et al., 2013).

Keywords: ecosystem services, sociocultural valuation, photo-elicitation, ranking method

Why would I use this method?

The card game is a method to rate ecosystem services according to their importance, and then compare their rating to obtain their relative values (i.e. define the importance of one ecosytem service in comparison with others'). The method can be used to answer different research questions:

1. Description of the area: Which ecosystem services are currently present in the study area?
2. Vision development: Which ecosystem services are desirable for the future?
3. Identification of ecosystem service stakeholders: Which stakeholders are involved in the regulation, management, use and enjoyment of ecosystem services provided by the area?

This method can be used to collect knowledge and opinions about a wide range of ecosystem services, as well as to understand preferences over these ecosystem services. It is suitable to characterize provisoning and cultural services from the point of view of stakeholders, but regulating services are sometimes undervalued if stakeholder knowledge is limited on these topics.

The method is suitable to awareness raising as it can highlight a wide range of benefits and values attached to ecosystem services. It can also be used as a supporting tool for priority setting, as the rating and comparison of ecosystem services leads to a priority list of locally relevant ecosystem services which then can be serve as a basis for land use planning. The card game also provides information on the preferences and motivations of different stakeholder groups (including different groups of users), which can be used as an input to instrument design (i.e. when developing access/restriction rules for recreational areas).

The method can be easily applied at smaller spatial scales (from property to municipality or county level). Applying it to larger spatial scales is also possible (depending on the framing of the questions and the list of ecosystem services used in the exercise), but might be slightly more difficult because interviewees usually have less personal experiences with ecosystem services at larger scales. Spatial scale should match the knowledge of the interviewed people. The spatial resolution offered by the method is rather coarse.

Requirements

Requirements		Comments
Data collection requierement	□ Data is available □ **Need to collect some new data (e.g. participatory valuation)** □ Need to collect lots of new data (e.g. valuation based on surveys)	Data is collected through in-depth face-to-face interviews or group discussions (lasting approx. 60-90 minutes). The ideal number of interviews/group discussions depends on the heterogeneity of stakeholders and the size of the research area. As a rule of thumb, each key stakeholder group should be represented by at least 2-4 representatives in the sample. In average, the number of interviewees ranges between 20-25 people.
Type of data required	□ **Quantitative** □ **Qualitative**	The method elicits both quantitative (rating and ranking the cards representing different ESs) and qualitative (narrative explanation of the cards) information.
Expertise and production of knowledge needed	□ Working with researchers within your own field □ **Working with researchers from other fields** □ **Working with non-academic stakeholders**	The interviewing phase requires social scientific skills and expertise, while the choice of ESs to be ranked can be based on ecological expertise and local use expertise. Non-academic stake-holders are involved through the interviews.
Software requirements	□ **Freely available** □ **License required** □ Advanced software knowledge required	The valuation of different respondents can be presented in a graph with a spreadsheet application. The arguments mentioned during the interviews, can be structured and analysed in word processing software, or in specific software, e.g. NVivo
Time requirements	□ **Short-term (less than 1 year)** □ Medium-term (1-2 years) □ Long-term (more than 2 years)	Average number of interviews is around 20-25 (depends on the heterogeneity of stakeholders), average lenght of interviews ranges between 60-90 minutes.
Economic resources	□ **Low-demanding (less than 6 PMs)** □ Medium-demanding (6-12 PMs) □ High-demanding (more than 12 PMs)	Both time requirements and economic resources depends on how many participants are involved in the valuation study. If only a small sample (<25) is used, less than 6 PMs can be enough.
Other requirements	-	

Type of values

The card game is especially suitable to elicit socio-cultural and anthropocentric (both instrumental and relational) values to ecosystem services. It has limitations to grasp indirect use values, option values and ecological values.

Advantages

- Relatively simple and quick
- Card sets can be tailor-made according to specific situations
- Includes local knowledge
- Stimulates stakeholders to think within a holistic ecosystem services framework ("social learning")

Constraints and limitations

- Good interview skills are indispensable
- Not all classes of ecosystem services might be appropriately valued when valuation methods using stakeholder preference are used (Agbenyega et al., 2009; Carpenter et al., 2006). It is suitable to characterize provisoning and cultural services from the point of view of stakeholders, but regulating services are sometimes undervalued if stakeholder knowledge is limited on these topics.
- It is important to keep in mind that the card game only values perceptions of stakeholders.
- Trade-offs between the actual use of services and the use of services in the future (intergenerational trade-offs)
- Working with a predifined list of ecosystem services has a framing effect on the results (i.e. it restricts the potential list of ecosystem services if there is no option to add new services during the game)

Steps required to apply the method within a case study

As a preliminary step of the card game, relevant ecosystem services (that are presented on the cards) are selected based on expert knowledge and scientific information. To this end, review of scientifi literature and expert interviews can be conducted. The actual steps followed during the card game are presented below.

Open interview	The interviewer asks questions about how the respondent uses the area without the "restriction" of cards.
Ranking the cards	The cards with the individual ESS are shown one by one. The respondent is asked to rate the cards according to 6 categories. "++", "+" "0", "-", "- -" or "I don't know".
Interviewing the cards	The respondent explains why (s)he rated the cards in a certain and tells more about the link between these ESS and the area.
Identifying the most important cards	Extra columns "+++" and "- - -" are added. The respondent is asked to choose the most important cards from the "++" category and the most disturbing cards from the "- - " category to put them in the new categories and asked to justify her/his selection.
Processing results	The valuation of different respondents can be added for each ESS and shown in a graph. The arguments supporting consensus or contrasts told during the interviews, can be structured and analysed in word processing software, or in specific software, e.g. NVivo. Results give an overview of the degree of consensus and/or contrasting views on the valuation of the different services.

Figure 4.4. Stepwise approach to apply the ecosystem services card game

Illustration of practical applications of the method using the OpenNESS case studies

This method has been used in the OpenNESS case study "De Cirkel" (CS 13). The project "De Cirkel" is part of a comprehensive farm land consolidation project in which the reorganization of parcels enabled a more efficient agricultural activity in the area of "Jesseren". 18 individual interviews were conducted with stakeholders who are not actively involved in the project of "De Cirkel". Nevertheless, the opinion of these stakeholders were considered important to increase local support and to generate benefits of the natural elements for a wide range of stakeholders. In addition to the valuation exercise, the most important ecosystem services were marked on a map in order to make thel ecosystem service demand side spatially explicit. Win-wins and trade-offs were extracted from the interview results. The interviews were analyzed and feedback was provided to the project managers of “De Cirkel” (Demeyer, 2014 (in Dutch)).

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4.4. Hedonic property pricing (HPP)

Author(s): David N. Barton (david.barton@nina.no)

Introduction to method

Hedonic pricing is the study of multi-correlation between environmental characteristics of a good and its sales price. The Hedonic property pricing (HPP) method can be used to estimate monetary values for ecosystem services that directly affect ‘amenities’ of properties which in turn are reflected in property prices. The HPP method requires large data sets of property sales statistics with physical characteristics of the property itself - and particularly for ecosystem services - e.g. characteristics of green infrastructure in the neighborhood. Proximity and accessibility to green structures must be calculated using GIS. GIS data of high resolution is needed if the analysis is also to capture quality of green infrastructure, which is key to linking the analysis to ecosystem services. Econometric methods are used to control for differences in property and neighborhood characteristics. In particular, spatial regression techniques are used to control for spatial auto-correlation between neighborhood characteristics related to green infrastructure, and other non-environmental characteristics.

Keywords: property prices, amenities, spatial analysis, awareness raising

Why would I use this method?

HPP is potentially powerful for *awareness raising* purposes because it can demonstrate to individual property owners the increase in private market values of public goods from green infastructure amenities (whether public or private property). While marginal values for a specific green space on a given property may be small, aggregating values across all properties in the neighbourhood of a green space can show large total values, which may compete with real estate values of developing the green space. However, there are few applications of HPP to actual land-use & zoning decisions. Perhaps this is due to few studies using GIS data that controls for site qualities, and problems in finding robust econometric hedonic price functions because of spatial auto-correlation.

The spatial scale at which HHP works best is for whole urban areas with a high spatial desnity of property sales and large variability in availability of green infrastructure across neighbourhoods. The HPP method cannot distinguish directly between ecosystem services, but rather between the importance of different green infrastructures. The link from a property's green structures to ecosystem functions has to be inferred using other data (e.g. green spaces may mitigate property flood risk as well as provide recreation). Such ecosystem functional inferrences are easier if it the spatial resolution of the analysis is good enough to include qualities of green infrastructure, other than proximity affect prices. However, neighbourhood amenities that are directly percievable to house buyers are those likely to affect prices, typicaly related to cultural ecosystem services.

Requirements

Requirements		**Comments**
Data collection requierement	□ Data is available □ Need to collect some new data (e.g. participatory valuation) □ **X Need to collect lots of new data** (e.g. valuation based on surveys)	
Type of data required	**X Quantitative** □ Qualitative	
Expertise and production of knowledge needed	□ Working with researchers within your own field **X Working with researchers from other fields** □ Working of non-academic stakeholders	
Software requirements	**X Freely available** □ License required □ Advanced software knowledge required	For example "R"
Time requirements	□ Short-term (less than 1 year) **X Medium-term (1-2 years)** □ Long-term (more than 2 years)	If property sales data is available
Economic resources	□ Low-demanding (less than 6 PMs) **X Medium-demanding (6-12 PMs)** □ High-demanding (more than 12 PMs)	If property sales data is available
Other requirements	-	

Type of values

Hedonic property pricing is highly appropriate to elicit monetary values, direct use values and anthropocentric instrumental values related to the benefits of nature. They are not suitable to elicit intrinsic values of nature as well as bequest and existene values. They also have limitations to grasp ecological values, indirect use values and option values.

Advantages

- Recognised and established approach

- Draws on existing data
- Covers wide range of ecosystem services
- Uncertainty can be addressed
- Provides capital values of ecosystem services directly for use directly in natural capital accounting
- Provides both public and private economic rationales for providing ecosystem services /amenities from green infrastructure
- Can be linked directly to land use zoning proposals

Constraints and limitations

- Requires large panel data sets of property sales data
- Requires extensive GIS pre-processing of neighbourhood characteristics
- Results are sensitive to modeling assumptions regarding spatial auto-collinearity

Steps required to apply the method within a case study

The flowchart below provides with a short description of the steps to apply hedonic property pricing. The steps can roughly be divided in two parts. The first analytical part (steps 1-3) organises the data, conducts the spatial statistical analysis and estimates the marginal individual contributions of each property characteristics. This is often as far as many research papers take the analysis. The second application part (steps 4-6) will vary depending on the decision context. In the flowchart below the steps relate to using the method for finding aggregate values for awareness-raising purposes.

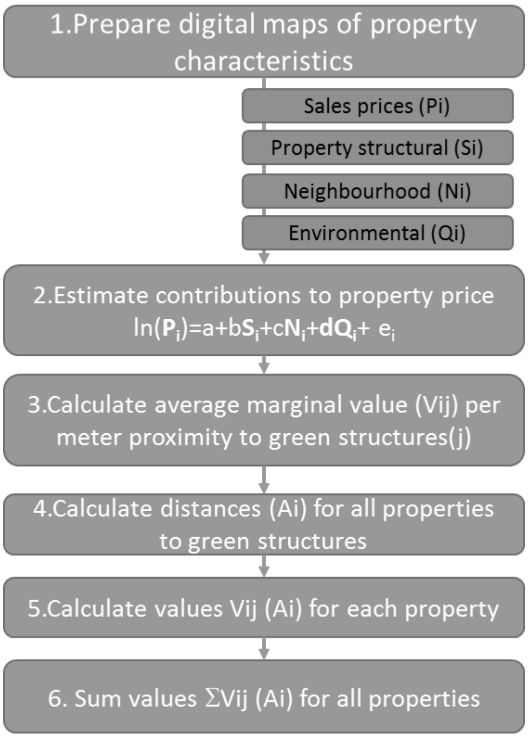

Figure 4.6. Stepwise approach to the HPP method

Illustration of practical applications of the method using the OpenNESS case studies

The hedonic property pricing methods has been tested in the Oslo case study at municipal level (Barton et al. 2015a,b) and at neighbourhood level (Reinvang. et al. 2015).

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4.5. Multi-criteria Decision Analysis (MCDA)

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Introduction to method

MCDA is an "umbrella term to describe a collection of formal approaches which seek to take explicit account of multiple criteria in helping individuals or groups explore decisions that matter" (Belton and Stewart, 2002, p. 2). The basic idea of MCDA methods is to evaluate the performance of alternative courses of action (e.g. management or policy options) with respect to criteria that capture the key dimensions of the decision-making problem (e.g. ecological, economic and social sustainability), involving human judgment and preferences. They are rooted in operational research and support for single decision-makers but recently the emphasis has shifted towards multi-stakeholder processes to structure decision alternatives and their consequences, to facilitate dialogue on the relative merits of alternative courses of action, thereby enhancing procedural quality in the decision-making process (Mendoza and Martins 2006).

Keywords: multi-criteria decision analysis, multi-criteria evaluation, decision support tools, non-monetary valuation

Why would I use this method?

MCDA methods are used to address complex decision-making situations with multiple and often conflicting objectives that stakeholders groups and/or decision-makers value differently. A typical example of a decision-making situation assisted by MCDA methods is determination of an appropriate water regulation policy, which has a variety of economic, ecological and social consequences regarded as desirable by some stakeholders (e.g. downstream farmers) and undesirable by others (e.g. recreational fishermen).

MCDA methods can be used to address trade-offs between multiple ecosystem services because they allow comparison of ecological objectives with socio-cultural and economic ones in a structured and shared framework. They can incorporate ecological criteria such as carbon sequestration and water quality; economic criteria such as costs and economic impacts of alternative courses of action; and socio-cultural criteria such as cultural heritage and aesthetic values. MCDA methods can also be used to combine information about the performance of the alternatives with respect to the criteria (scoring) with subjective judgments about the relative importance of the evaluation criteria in the particular decision-making context (weighting).

MCDA is a decision support tool and hence it has been mostly used for priority setting, i.e., ordering alternatives according to the participants' and/or decision makers' value positions. The results can be aggregated to present a single preference order of the alternatives for the whole group. However, this requires inter-personal comparison of how much we valuate various stakeholder groups' opinions. The other option is a disaggregated way to illustrate how different stakeholders have weighed the criterion and consequently prioritized the alternatives, with an aim to better understand the various viewpoints related to the problem. The valuation element in MCDA (normalization and weighting) can also be used for awareness raising by enabling citizens/stakeholders/decision-makers to probe their preferences and underlying value positions.

MCDA methods have been applied on local as well as regional and some cases also national level (see Kiker et al. 2005), mostly on a spatial resolution more than 10 km^2.

Requirements

Requirements		Comments
Data collection requierement	□ Data is available □ **x Need to collect some new data (e.g. participatory valuation)** □ Need to collect lots of new data (e.g. valuation based on surveys)	Participatory MCDA applications require a close contact with key stakeholders throughout the process, at least in the weighing stage. MCDA methods can make use of existing data but usually additional information (e.g. biophysical assessment or economic analyses) is required after defining the evaluation criteria with stakeholders.
Type of data required	□ x Quantitative □ x Qualitative	MCDA allows both for quantitative and qualitative information (scales can be used to translate qualitative information into quantitative scores).
Expertise and production of knowledge needed	□ **x Working with researchers within your own field** □ **x Working with researchers from other fields** □ **x Working with non-academic stakeholders**	MCDA applications usually require interdisciplinary teams that work with stakeholder representatives
Software requirements	□ **x Freely available** □ **x License required** □ **x Advanced software knowledge required**	Some software are freely available but their use requires some software knowledge and knowledge on how to interpret the results
Time requirements	□ **x Short-term (less than 1 year)** □ Medium-term (1-2 years) □ Long-term (more than 2 years)	6-24 months
Economic resources	□ Low-demanding (less than 6 PMs) □ **x Medium-demanding (6-12 PMs)** □ High-demanding (more than 12 PMs)	MCDA processes can be carried out in less than 6 months if data is available and stakeholders can work intensively; it can also take more than 12 PMs, depending on the level of ambition and demands for preciseness
Other requirements	Software and decision analyst to use the software is usually needed	

Type of values

MCDA is highly appropriate to elicit both anthropocentric and non-anthropocentric values, including ecological, sociocultural and monetary values of ecosystem services. Not all MCDA processes can however address incommensurable criteria such as rights and duties, hence their applicability is limited in the case of eliciting bequest values.

Advantages

- Covers wide range of ecosystem services
- Trade-offs can be evaluated
- Can facilitate multi-stakeholder processes, transparency and discussion about the subjective elements in policy analysis
- Can structure an assessment along both cognitive and normative dimensions

- Uncertainty can be addressed by sensitivity analysis

Constraints and limitations

- Representativeness (only a small group of stakeholders usually involved)
- Some criteria such as cultural heritage or provisioning services vital for sustenance might not be amenable for trade-offs
- Allows manipulation and closing down of policy discourses if not used in participatory and transparent way
- Requires commitment form stakeholder to be involved throughout the process

Steps required to apply the method within a case study

The basic steps in a MCDA process are presented in Figure 4.7. The first steps are related to clarifying the decision context and structure the problem according to the objectives and evaluation criteria as well as the alternatives to be examined. The next step is the model building. In this step, the performances of the alternatives are assessed with respect to the criteria. The results are usually compiled into an impact matrix using natural measures (e.g. Euros or hectares), proxy measures (e.g. the number indicator species can be used as a yardstick of biodiversity); and constructed measures, which report the achievement of the objective using a scale tailored to the decision context (Keeney and Gregory, 2005). Next, the measurement values are translated into performance scores (scoring). For example, in Multi-Attribute Value Theory (MAVT), this is carried out by constructing value functions for each criterion that normalize individual impacts to a common scale of comparison. The value functions define the preferences for each criterion 'internally', i.e., how much a person values incremental changes in the measurement values of a single criterion in different parts of the scale (intra-criterion evaluation). The next phase is weighting where participants are asked to assign weights to the evaluation criteria (MAVT), or rank them (Rank-based methods use ordinal scale instead of cardinal scale), according to their preferences and value judgments (inter-criteria evaluation). The outcome of the analysis is the overall value for each alternative reflecting its overall performance under all criteria taken together compared to the other alternatives. Under certain assumptions (see e.g. Keeney and Raiffa 1976), one can use an additive model to obtain the overall values for each alternative by multiplying the criteria-wise performance scores with corresponding criteria weights and then summing them up. The results can either be fully aggregated or disaggregated according to stakeholder groups (see e.g. Mustajoki et al. 2011).

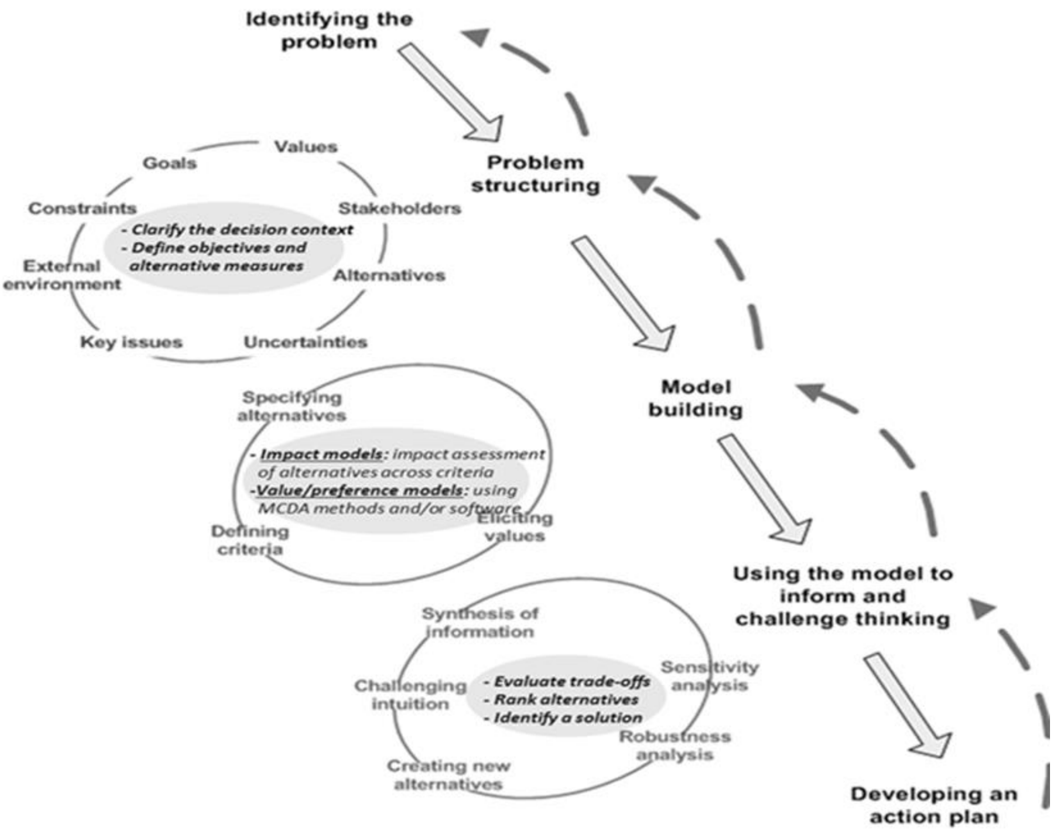

Figure 4.7. Stepwise approach to Multi-criteria Decision Analysis

Illustration of practical applications of the method using the OpenNESS case studies

Case 6. To meet the new EU renewable energy targets, Finland has increased the use of logging residues for energy production. However, collection of residues also has other impacts, e.g. on carbon sequestration capacity, CO_2 emissions, water quality, local economy, biodiversity and recreation. MCDA with stakeholder interviews was applied to study the feasiblibily of forest bioenergy production from different perspectives and provide recommendations about sustainable bioenergy production strategies.

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4.6. Narrative methods

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Introduction to method

Narrative methods aim to understand and describe the importance of nature and its benefits to people with their own words. By using narrative methods we allow the research participants (residents of a certain place, users of a certain resource, or stakeholders of an issue) to articulate the plural and heterogeneous values of ecosystem services through their own stories and direct actions (both verbally and visually). Narrative methods usually collect qualitative data from individuals, but they can be also suitable to measure some aspects of human-nature relations in quantitative or semi-quantitative terms. They can be combined with more structured methods (both non-monetary and monetary ones) such as preference assessment, time use study, choice experiment or multi-criteria decision analysis (MCDA). In this guide we use the term 'narrative methods' as an umbrella term under which several tools from ethnographic, historical and qualitative social scientific research are brought together (e.g. in-depth and semi structured interview, observation, voice and video recording of events, artistic expression).

Keywords: interview, observation, ethnography, ethnoecology, oral history, qualitative analysis

Why would I use this method?

Narrative methods do not constrain research participants to valuing nature within one dominant frame (i.e. the frame of ecosystem services which understands nature as the provider of goods and services) but allows them to articulate their values freely, in accordance with their own worldviews (de Oliviera & Berkes 2014, Satterfield 2001). Therefore, narrative methods can improve understanding why certain ecosystem services are important to people, can shed light on the bundled qualities of cultural and social values linked to ecosystem services, and can highlight hidden aspects of human-nature relationships (Klain et al. 2014, Gould et al. 2015).

These methods can be applied to any ecosystem services, but the key area where they are most frequently used is the assessment of cultural ecosystem services (CES). Narrative methods are also proposed to identify bundles of ecosystem services (both in the supply side and in the demand side, in terms of socio-cultural values).

Narrative methods are frequently applied to collect background information on actual land use patterns and the motivations and perceptions driving land use decisions of individuals, households or communities (de Oliviera & Berkes 2014). They can also be useful in highlighting gaps between scientific and local knowledge (Rodríguez et al. 2005, Kaplowitz and Hoehn 2001). Information collected through narrative methods can be feed into awareness raising campaigns but can also be used to inform priority setting processes or instrument designs as part of deliberative processes, suggested by some complex valuation studies (e.g. Pereira et al. 2005, Palomo et al. 2011). Narrative methods are suitable to apply at lower spatial scales (from property to municipality or to a region including several municipalities). The spatial boundaries should be well-defined and meaningful to the participants. Spatial resolution differs from method to method. If narrative valuation is combined with mapping, fine resolution can be achieved. Using mainly verbal and visual expressions often implies coarse resolution of spatial data. In sum, narrative methods can perfectly complement local level hybrid and integrated assessments using multiple methods by collecting background information, understanding local perceptions and engaging stakeholders in the valuation process.

Requirements

Requirements		Comments
Data collection requierement	□ Data is available □ Need to collect some new data (e.g. participatory valuation) □ **Need to collect lots of new data (e.g. valuation based on surveys)**	Collecting new data through interviews, observations etc. is key for narrative methods.
Type of data required	□ **Quantitative** □ **Qualitative**	Predominantly qualitative, but suitable to collect some quantifiable data.
Expertise and production of knowledge needed	□ Working with researchers within your own field □ Working with researchers from other fields □ **Working with non-academic stakeholders**	Information is collected from non-academic research participants. They can also be involved in interpreting the data.
Software requirements	□ **Freely available** □ License required □ Advanced software knowledge required	Many narrative methods are low-tech by nature, but data analysis may require licensed software (e.g. Nvivo for qualitative analysis)
Time requirements	□ Short-term (less than 1 year) □ **Medium-term (1-2 years)** □ Long-term (more than 2 years)	Required time ranges from medium to long-term, also depending on the nature of the study (e.g. ethnographic studies are often longer than 2 years)
Economic resources	□ Low-demanding (less than 6 PMs) □ **Medium-demanding (6-12 PMs)** □ High-demanding (more than 12 PMs)	Medium to high-demanding, depending the exact nature of the method.
Other requirements	Social scientific and good communication skills are required, often the personal presence and participation of the researcher in local events is necessary to collect and interpret data.	

Type of values

Narrative methods are highly appropriate to elicit sociocultural values, but not suitable for monetary values (especially use values). Narrative methods, however, are capable of providing contextualized and qualitative information on how different value dimensions (including ecological and economic) are interpreted and framed by individuals or local communities.

Advantages

- Help to include local, traditional knowledge in the process of valuation

- The valuation process and its results are inclusive and accessible for a large variety of different stakeholders.
- Allow participants to articulate the values of ecosystem services in their own terms and worldviews.
- Allow the elicitation of plural and heterogeneous values
- Highlight the bundled qualities of ecosystem services

Constraints and limitations

- The process is often lengthy and may require the strong commitment of the scientist
- The topic of the research or some of the prompts can be difficult to conceptualize by local resource users, avoiding scientific jargon is therefore crucial
- Since the researcher is personally involved in the study, her/his presence can influence the outcomes
- Uncertainty about the quality of answers exists, therefore triangulation of data sources and methods might be necessary
- Provide lengthy textual outputs (descriptions, narratives) which are difficult to quantify and to generalize at larger spatial or social scales.
- Strong responsibility at the scientists' side in not 'overusing' the participants

Steps required to apply the method within a case study

Narrative valuation involves various methods, such as observations, semi-structured or in-depth interviews, storytelling or drawing exercises, which all have their own logical sequence and which are well described in existing literature on qualitative social scientific methods. Hence we provide here a rather general, stepwise approach to illustrate how narrative methods can be applied to assess the values related to ecosystem services.

In general we can split up narrative valuation into the following key steps (Figure 4.8.):

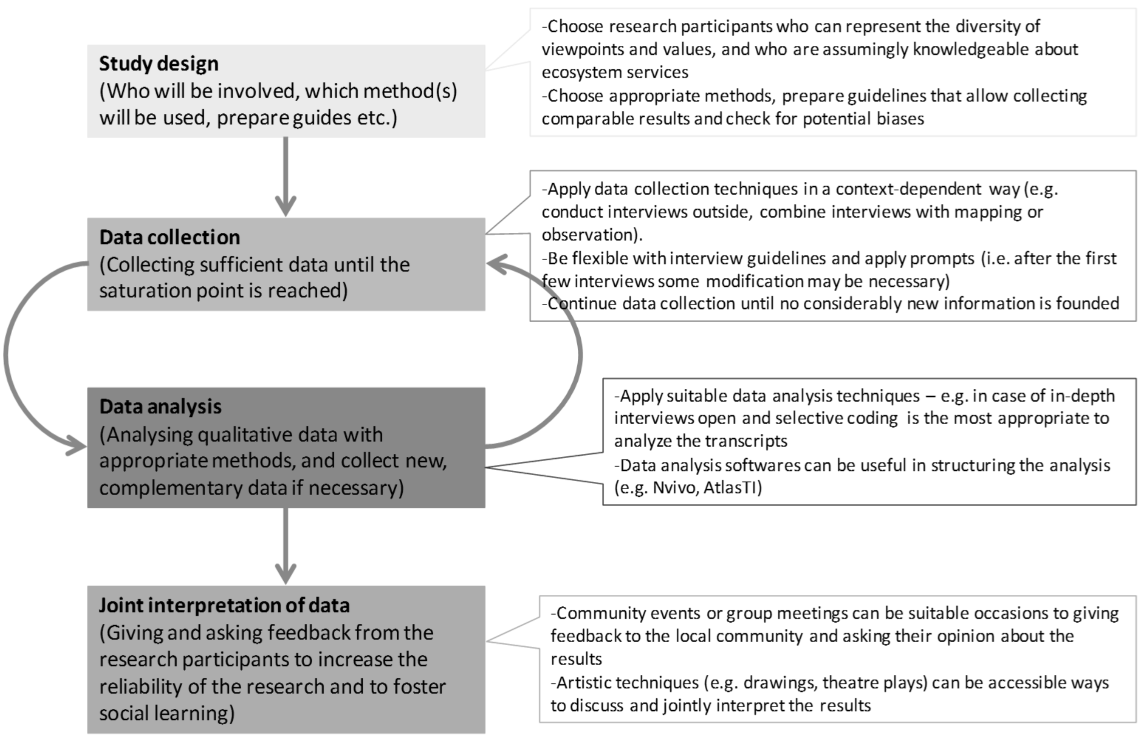

Figure 4.8. Stepwise approach to narrative methods

Data collection and data analysis are usually iterative steps of the process, new data is collected if the analysis highlights knowledge gaps or controversies, until the saturation point is reached (i.e. newly collected data does not add significantly new knowledge to the process). According to some empirical results, the saturation point for understanding the diverse conceptualization of values linked to ecosystem services is around 30 in-depth interviews within a local community (including one or a few settlements) (Gould et al. 2015).

Illustration of practical applications of the method using the OpenNESS case studies

Case 2 (Trnava region), Case 12 (Kiskunság), Case 23 (East Godavari River Estuarine)

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4.7. Object-oriented Belief Networks (OOBN) as Decision Support

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Introduction to method

Bayesian belief networks are not a valuation method per se, but an approach to synthesising valuation and ecosystem function knowledge fro decision support. Bayesian belief networks are useful for (i) eliciting stakeholders understanding of cause-effect linkages in a visual network and formalising their knowledge of the strength of effects as as a series of conditional probabilities, (ii) linking biophysical and socio-economic model input-outputs together in a consistent ecosystem services cascade or driver-pressure-state-impact-response chain, handling cumulative uncertainty consistently as a series of conditional probability tables, and (iii) analysing costs and benefits of decisions in terms of cost-effectiveness analysis (CEA), cost-benefit analysis (BCA) and multiple criteria analysis (MCA)(see appendix for examples). Sub-networks representing sub-model input-outcomes can be represented as model 'objects' within a Bayesian network – called Object-Oriented Bayesian Networks (OOBN). D3.3 addresses OOBNs in the context of (i) and (ii) while this section of D4.3 addresses (iii). See also a briefing note on BBNs (Haines-Young et al. 2014). When variables(nodes) for costs and benefits (utilities) are added to chains of conditional probability tables (representing ecosystem functions) Bayesian networks are called "influence diagrams"(Kjaerulff and Madsen 2007).

Keywords: object-oriented bayesian networks, influence diagrams, cost-effectiveness, cost-benefit, multi-criteria analysis, decision-support

Why would I use this method?

Motivations for using OOBNs for decision-support:

OOBNs make it possible to link 'upstream' costs of decisions to 'downstream' benefits of those decision, making use of all available information, and accounting for the cumulative uncertainty of using information sources of different quality. This makes it well-suited for operationalising the ecosystem services cascade framework (Haines-Young 2011b, Landuyt et al. 2013). OOBNs for decision-making are useful where more than one biophysical models need connecting to costs and benefits of decisions(Barton et al. 2012). In principle any eccosystem service can be addressed by this generic tool. In practice it has seen many applications on watershed management related problems looking at model chains from upper catchment to impacts in water bodies (Barton et al. 2008). OOBNs are seeing greater use in studying ecosystem service impacts that are spread over a landscape – spatially disaggregated – as the interface between BBNs and GIS improves. This means that applications for e.g. cultural ecosystem services are likely to increase in future.

The Decision context OOBNs apply to here is 'priority-setting' using different appoaches to valuation. OOBNs are generic and can be applied to any spatial scale. OOBNs strength lie in describing uncertainty – variance that is generated from spatial heterogeneity and temporal variation – meaning that OOBNs spatial and temporal resolution is often coarse and they are most useful for synthesising 'large data' problems. If high-resolution modeling of ecosystems ervices is required – it is better to use bespoke biophysical models. OOBNs makes them ideal for the kind of synthesis that is needed for assessing decision alternatives across landscape variation.

Requirements

Requirements		Comments
Data collection requierement	□ Data is available **X Need to collect some new data (e.g. participatory valuation)** □ Need to collect lots of new data (e.g. valuation based on surveys)	
Type of data required	**X Quantitative** □ Qualitative	
Expertise and production of knowledge needed	□ Working with researchers within your own field **X Working with researchers from other fields** **X Working of non-academic stakeholders**	
Software requirements	□ Freely available **X License required** □ Advanced software knowledge required	Hugin, Netica, Bayesia, Quickscan
Time requirements	**X Short-term (less than 1 year)** □ Medium-term (1-2 years) □ Long-term (more than 2 years)	When data and parametrised models are available
Economic resources	□ Low-demanding (less than 6 PMs) **X Medium-demanding (6-12 PMs)** □ High-demanding (more than 12 PMs)	
Other requirements		

Type of values

While BBN is suitable to most value categories independent of which value typology we take into account, it has some limitations (application implies specific conditions) if it is aimed to elicit non-anthopocentric values of nature as well as bequest and existence values.

Advantages

Methodological advantages

- trans-disciplinary
- integrates qualitative and quantitative data
- draws on existing data (monitoring, modeling)
- formalises expert judgement
- explicit modeling focus on the relationships between modelresolution and uncertainty

Governance advantages

- integrated valuation modeling tool
- covers wide range of ES
- can address a wide range of impact/values types
- participatory approach with stakeholders
- trade-offs can be evaluated
- uncertainty can be addressed (exposes ’garbage-in-garbage-out’)

Constraints and limitations

Methodological constraints

- discretization of data can lead to information loss (but this is a common features of all models, while in BBNs it is directly observable)
- GIS integration is limited but improving
- Handling of time series and feedback effects is limited, but improving (time sliced models)

Governance constraints

- information loss in each modeling link and cumulative uncertainty analysis leads to a bias towards ’no action’ or status quo decision alternatives.

Steps required to apply the method within a case study

The generic modeling steps for setting up a BN for decision support is briefly as follows:

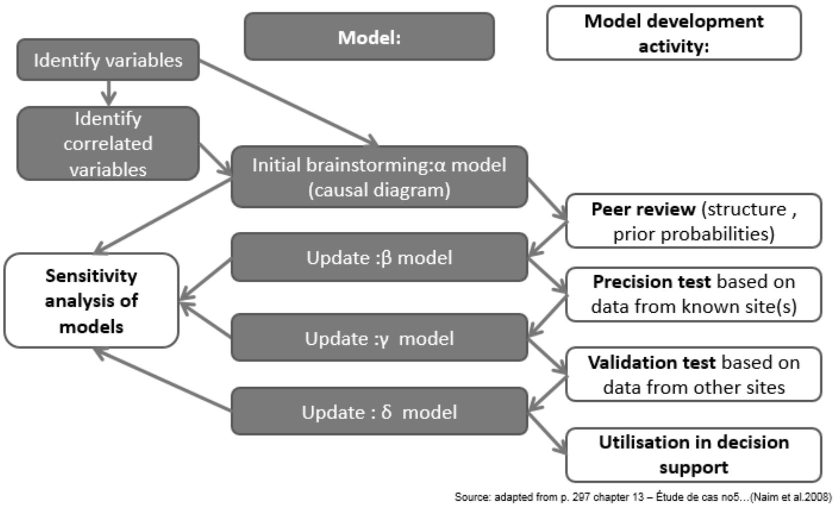

Figure 4.9. Stepwise approach to OBBNs. Source: Naim et al. (2007)

The Appendix shows three simple examples of OOBNs set up to address a cost-effectiveness, benefit-cost and multi-criteria analysis problem.

Illustration of practical applications of the method using the OpenNESS case studies

In OpenNESS OOBNs are being applied the Oslo, Loch Leven and Patagonia cases. BBNs are being applied as MCA in case 15. Gorla Maggiore. More information on BBN examples can be found at http://openness.hugin.com/

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4.8. Participatory GIS

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Introduction to method

Participatory mapping of ecosystem services consists in assessing the spatial distribution of ecosystem services according to the perceptions and knowledge of stakeholders. It englobes different approaches including Participatory GIS (PGIS) and Public Participation GIS (PPGIS) (see Brown and Fagerholm, 2014) to which we broadly refer here as PGIS. In PGIS a plurality of stakeholders can participate in the creation of the map, including local stakeholders and community members, environmental profesionals and techicians, members of environmental NGOs, decision-makers, scientists, etc. PGIS therefore can integrate the perceptions, knowledge (local-based or technical) and values of different stakeholders and presents the outputs in the form of a map of ecosystem services (Fagerholm et al., 2012; Raymond et al., 2009). Most common used methods in PGIS for data collection include web-based surveys, face to face interviews and workshops. The results obtained allow similar data treatment as for non-participatory mapping methods (analysis of trade-offs, correlation analysis among services or with other aspects such as land use change, etc.) (Palomo et al., 2014; Sherrouse et al., 2011). PGIS is being increasingly used in the last years due to several reasons such as: including stakeholder´s perceptions in ecosystem services spatial assessments, incorporating different tipes of knowledge, mapping ecosystem services in data scarce regions, enhancing capacity building and social learning, and integrating stakeholders in a more democratic process oriented to input decision-making (Fagerholm and Palomo, forthcoming).

Keywords: Stakeholders, Geographical Information Systems (GIS), map, values, social learning

Why would I use this method?

PGIS to map ecosystem services allows not only to integrate different knowledge types, perceptions and values into ecosystem services spatial assessments, but a more democratic approach to decision-oriented science. Some types of ecosystem services, such as cultural services, might naturally be better mapped using PGIS than non-participatory methods, due to their direct link to peoples perceptions and values (Plieninger et al., 2013). PGIS has been used to map all service categories as well as the spatial distribution of ecosystem services supply and demand (Palomo et al., 2013; Burkhard et al., 2012). It has also been applied to comapre the perceptions of stakeholder groups towards ecosystem services spatial distribution (García-Nieto et al., 2014). PGIS usually achieves better outcomes when mapping ecosystem services at the local scale, and can be applied in different decision-making contexts, from awareness raising to priority setting and instrument design. The main methods for PGIS (web-based surveys, face to face interviews and workshops), and different approaches such as the matrix approach, allow flexibility in the stakeholder selection and priorization processes, as well as in the general requierements for applying the method (Burkhard et al., 2012; Fagerholm and Palomo, *forthcoming*).

Requirements

Requirements		**Comments**
Data gathering	□ **Low-effort** □ **Medium-effort** □ **Intensive-effort**	Depending on the number of participants and the method used the requirements will vary considerably.
Type of data		
Expertise and production of knowledge	□ Unidisciplinary □ **Interdisciplinary** □ **Transdiciplinary (includes local knowledge)**	While some methods such as surveys and interviews allow interdisciplinary production of knowledge, other such as workshops (deliberative mapping) allow transdisciplinarity.
	□ Only researchers □ **Researchers and non-academic stakeholders**	Allows inclusion of multiple stakeholder types.
Time resources	□ **Short-term (months for getting accurate output)** □ **Medium-term (1-3 years)** □ Long-term (more than 3 years)	Time resources vary accordingly to the data collection method, and also to the planned spatial analysis of the data that are undertaken.
Economic resources	□ **Low-demanding** □ **Medium-demanding** □ High-demanding	This will vary depending on the number of participants and the spatial analysis to perform after data collection.
Other requirements		

Types of values

Participatory GIS is especially suitable to grasp ecological and socio-cultural values as well as instrumental and relational values related to quality of life. The method is not suitable to capture monetary values.

Advantages

- Integrates stakeholder perceptions, knowledge and values regarding ecosystem services (methodological and operational advantage).
- Allows involving multiple stakeholder types and thus creating awareness and fostering social learning related to ecosystem services (methodological and operational advantage).
- Some ecosystem services (such as cultural services) might naturally fit within this mapping approach (methodological and operational advantage).
- Permits mapping ecosystem services in areas where spatial data is unavailable (methodological and operational advantage).
- The GIS skills needed to develop this method are relatively simple (methodological advantage).

Constraints and limitations

- The development of best practices or guideliness for the method is still on going.
- PGIS methods have been mostly applied at local scales and integration of results into decision-making has been elusive.
- The comparability among studies is usually low.
- The spatial resolution of the results and accuracy might be lower for certain services than other approaches.

Steps required to apply the method within a case study

A PGIS study usually begins identifying the most suitable method for data collection (surveys, interviews, workshop) and the desired stakeholders to participate (a broad sample, certain key stakeholders, etc.) for the overall aim of the study. Afterwards the methodology is developed in detail, sometimes deciding which ecosystem services will be mapped and sometimes letting stakeholders map the ecosystem services they choose from a list. A map, usually a topographic map, is designed or adquired for the mapping process. After the process of mapping, data is digitalised or analysed according to the research objectives. Results are usually presented to participants as part of the devolution process.

Characteristics for feeding integrated valuation

Characteristics		**Comments**
Does it address causal relationships in social-ecological system?	□ Yes □ Partially □ **No**	Studying causality is usually not the aim of PGIS
Does it include ecological, socio-cultural and economic data-values?	□ **Yes** □ Partially □ No	It mostky includes socio-cultural values, but economic and ecological values have also been incorporated.
Does it consider undertainty?	□ Yes □ **Partially** □ No	The method can be designed to consider uncertainty
Does it consider spatial variation?	□ **Yes** □ Partially □ No	
Does it consider temporal variation?	□ **Yes** □ Partially □ No	The method can be designed and applied to consider temporal variation
Does it consider different levels of societal organization (i.e. individual, community, society)	□ **Yes** □ Partially □ No	
Is it able to normalize all different values to a common scale?	□ **Yes** □ Partially □ No	

Key Scientific Publications

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Burkhard, B., Kroll, F., Nedkov, S., & Müller, F. 2012. Mapping ecosystem service supply, demand and budgets. Ecological Indicators, 21, 17-29.

García-Nieto, A. P., Quintas-Soriano, C., García-Llorente, M., Palomo, I., Montes, C., Martín-López, B. 2014. Collaborative mapping of ecosystem services: The role of stakeholders profiles. Ecosystem services, 13, 141-152.

Palomo, I., Martín-López, B., Potschin, M., Haines-Young, R., Montes, C. 2013. National Parks, buffer zones and surrounding lands: mapping ES flows. Ecosystem services, 4, 104-116.

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4.9. Photo-elicitation method

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Introduction to method

This method aims to translate the people's visual experiences and perceptions of landscapes in terms of ecosystem services. Although it's main objective is to explore the links between landscape features and social perceptions of ecosystem services. It has been particularly used to explore how landscape multi-functionality (defined as the capacity of ecosystems to provide ecosystem services to society) is related with public perceptions toward landscapes and ecosystem services (García-Llorente et al., 2012). This is based on the idea that visual stimuli could be understood as a socially shared communication channel, and then, with potential to identify and analyse social perceptions of ecosystem services (García-Llorente et al., 2012, López-Santiago et al. 2014). Respondents specify the principal ecosystem services provided by each landscape from a list of potential services provided by the area (in other cases, this step is not conducted during the questionnaires but through an expert focus group; see García-Llorente et al., 2012).

Keywords: landscape appreciation, multi-functionality, photo-questionnaire, scenic beauty, visual perception.

Why would I use this method?

This approach is useful to identify individual preferences toward landscape views. First, it helps to explore whether people appreciate different landscapes and how they are related to different ecosystem services. If pictures are geo-tagged, when focusing on specific services, it could help to reflect in a spatially explicit way (with mapping) the areas where those services are most appreciated (hotspots) (Nahuelhual et al. 2013). Other possible objectives for its applications are: (1) to particularly explore which aesthetic value of landscapes are cultural ecosystem services (García-Llorente et al. 2012); (2) to assess how perceptions change when a landscape intervention is conducted (e. g. afforestation plan, river restoration, etc.) (Petursdottir et al. 2013) and (3) to understand whether there is a correspondence (synergies) or spatial trade-offs between the ecosystem services perceived as provided by a particular landscape and the actual demand (Casado-Arzuaga et al. 2014; Casalegno et al. 2013).

The main problems related with this method are the ones related with applying surveys (see preference assessment methods). This approach could be applied to any ecosystem service that can be illustrated pictorially. This is more challenging for regulating services, but is especially promising for cultural ecosystem services (particularly aesthetic and existence values (García-Llorente et al. 2012).

Decision context to which it has been applied: awareness raising; but can also be used to inform priority setting processes (hot spot analysis) or instrument design through the identification of the areas where specific ecosystem services are supplied and the identification the human settlements where there is a high demand for such services.

This approach has been applied at project, county and regional scales, although is also suitable to apply at national scales where different landscape units can be distinguished. It is worthy to note here that the higher the scale the more generic the photo-description of the ecosystem services.

Spatial resolution at which it has been applied (individual preferences, so it could be very detailed: 100 m^2 – 1 ha), although its later spatial representation with mapping could achieve other resolutions (Nahuelhual et al. 2013).

Requirements

Requirements		Comments
Data collection requirement	☐ Data is available ☐ Need to collect some new data (e.g. participatory valuation) ☐ **Need to collect lots of new data (e.g. valuation based on surveys)**	
Type of data required	☐ **Quantitative** ☐ Qualitative	Quantitative data is key, and qualitative data is recommended.
Expertise and production of knowledge needed	☐ **Working with researchers within your own field** ☐ **Working with researchers from other fields** ☐ Working of non-academic stakeholders	Working with researchers within your own field is required, including other fields is highly recommended. Non-academic stakeholders are the source of data gathering, however usually they do not participate in the data interpretation.
Software requirements	☐ **Freely available** ☐ **License required** ☐ **Advanced software knowledge required**	Statistical software is recommend to enrich the analysis performed.
Time requirements	☐ Short-term (less than 1 year) ☐ **Medium-term (1-2 years)** ☐ Long-term (more than 2 years)	Time required involve a minimum of 12 months (selection of landscape views, questionnaire design, data gathering in field, data analysis).
Economic resources	☐ Low-demanding (less than 6 PMs) ☐ **Medium-demanding (6-12 PMs)** ☐ High-demanding (more than 12 PMs)	
Other requirements	-	

Type of values

This method is suitable for uncovering and estimating socio-cultural values in quantitative and qualitative terms. It is also suitable to explore the ecological values through the analysis of the landscape features that connect with different ecosystem services, particularly the aesthetic appreciation of landscapes. It is also able to estimate the instrumental values of nature's benefits. It can be also suitable for estimating use and non-use values of nature and ecosystem services.

Advantages

- Methodologically, this technique is easy to understand and very dynamic, as long as respondents are receptive to its application.
- Methodologically, this technique could be used to assess a range of landscape views at the same time.

- It allows connecting landscape views with ecosystem services or even with other aspects such as land-use patterns. This is a remarkable aspect to have in mind in terms of governance and landscape planning.
- This technique has been found as very suitable to assess cultural services and with potential to assess a range of values (e.g. spiritual, heritage, aesthetic). This constitutes an important advantage in governance as it gives an opportunity to assess cultural ecosystem services in an explicit way as well as multiple values of ecosystems.
- Results can help to identify potential social conflicts (trade-offs) between social groups – farmers/non-farmers; tourists-local population, etc. Results can also be able to explore differences between stakeholders from different environments (e.g. rural-urban gradient)

Constraints and limitations

- A limitation could be related to the fact that some ecosystem services are not easily linked to the landscape views, being less visually evident (e.g. some regulating services).
- Photos only show a limited and framed view of the surrounding, captured at a specific moment in time (Petursdottir et al. 2013)
- Other constraints are related with the conventional difficulties related with surveys (see the same section in the tool: Survey of preference assessment). In some cases, participants learn about ecosystem services during the interview or questionnaire. This 'learning happened' should be taken into account when interpreting results.
- Problems of generalisation with scale. It is important to have in mind that the higher scale, the more generic the photo description of the ecosystem services.

Steps required to apply the method within a case study

The data collection requires from different steps (Figure 4.10.): (1) Identification of landscape units and selection of landscape views (and photographs) that are representative of the land units; (2) Photographs of the landscape views should maintain similar characteristics (e.g. constant weather, similar % of visible sky, etc.) to avoid biases; (3) Landscapes views represented in pictures are ranked into levels (for example from 1= "do not like at all" to 5= "like very much"), according to how attractive they found each picture (other criteria could be used); (4) Identification of main services provided by landscapes: respondents are asked to assess the degree of ecosystem services delivery by the different landscapes. In other cases, this step is not conducted during the questionnaires but through an expert focus group (see García-Llorente et al., 2012).

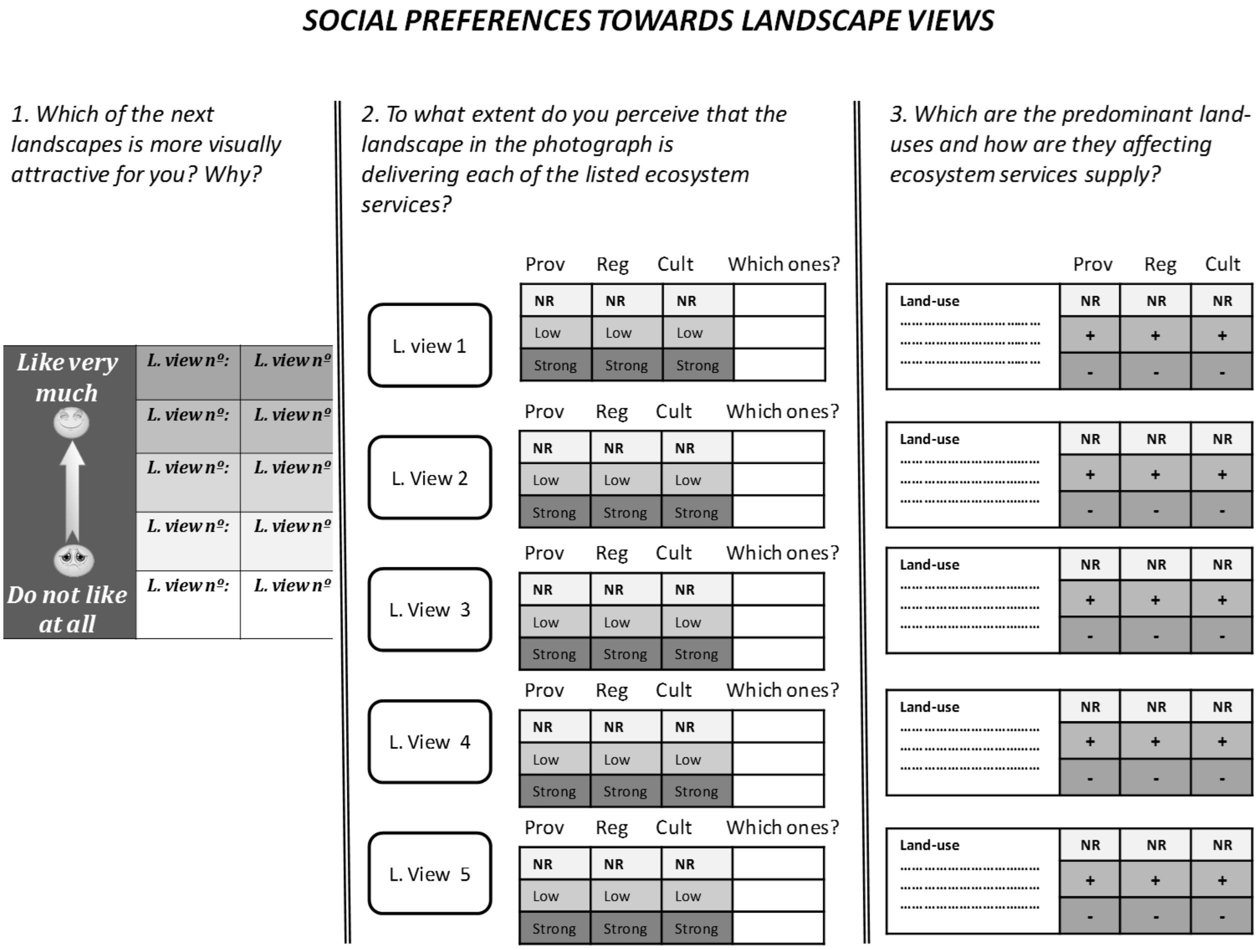

Figure 4.10. Methodological steps taken in a photo-elicitation survey related with preferences towards landscape views (based on García-Llorente et al., 2012). Not all the steps would need to be considered in an exercise, being stage 1 the key one. Landscape views relation with ecosystem services or with land uses are just potential complementary questions that could be assessed through other vehicles.

Illustration of practical applications of the method using the OpenNESS case studies

This method has not been broadly applied in OpenNESS. The only case study which develop this method in OpenNESS is the Costa Vicentina of Portugal (case 21), although in the protected area of Sierra Nevada (Spain; case 10) it was applied few years ago (García-Llorente et al. 2012).

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Petursdottir, T., A. L. Aradottir, and K. Benediktsson. 2012. An evaluation of the short-term progress of restoration combining ecological assessment and public perception. Restoration Ecology 21, 75-85.

4.10. Photoseries analysis

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Introduction to method

Revealed preference on Cultural Ecosystem Services (CES) and spatially explicit data on location for nearby recreation can be obtained from popular social networks. Photoseries databases are obtained from photo-sharing websites such as Flickr, Panoramio and Instagram. The analysis of community contributed photos can be used as a complementary technique of interviews, questionnaires or focus groups to assess preferences of cultural ecosystem services, assuming that visitors are attracted by the location where they take photographs. The method allows to identify the cultural ecosystem services which are perceived as most important by people who take the picture and to map their distribution.

Keywords: cultural ecosystem services, non-monetary values, photo-analysis, social media platforms, social perceptions

Why would I use this method?

This method represents a pragmatic way of gathering space-and time-referenced data on observed people preference related to cultural ecosystem services which are difficult to obtain in a cost-effective way through traditional data gathering techniques (e.g. social surveys). The method allows understand the spatial distribution of cultural ecosystem services in areas with low baseline information (Martínez-Pastur et al. in press).

The objectives addressed by photoseries analysis are the identification of socio-biophysical features of landscapes associated with the cultural ecosystem services provision and the spatial trade-offs and synergies among cultural ecosystem services (Martínez-Pastur et al. in press).

The analysis of geo-tagged photographs from social networks can be used to assess the actual provision of different cultural ecosystem service categories, including recreation, aesthetic, intellectual and existence.

The method can be used for awareness raising, it allows identifying focus areas where landscape plans and ecosystem management strategies should take into account the actual provision of non-material benefit of ecosystem services.

The method can be applied at different spatial scales, ranging from municipality to nation, according to the context. It has been already applied at the continental, regional and city scale (e.g. Martínez-Pastur et al. in press, Richards and Friess, 2015, Tenerelli and Luque, 2015, Willemen et al., 2015). The method is based on volunteered geographic information whose resolution depends on several factors (mainly the accuracy of the used GPS-enabled devices, or the map scale used to specify the photo location). Count data can be produced at different cell size, from 1da to 10 km2, depending on the chosen platform and geographic region (Zielstra and Hochmair, 2013), density of photographs, and scale of analysis.

Requirements

Requirements		Comments
Data collection requierement	□ Data is available □ **Need to collect some new data (e.g. participatory valuation)** □ Need to collect lots of new data (e.g. valuation based on surveys)	Public photos can be downloaded from social networks.
Type of data required	□ **Quantitative** □ Qualitative	Number of uploaded photographs. Socio-biophysical features asociated with CES supply.
Expertise and production of knowledge needed	□ **Working with researchers within your own field** □ **Working with researchers from other fields** □ Working of non-academic stakeholders	Different professionals should discuss the photo content in order to agree on the interpretation. Other methods such as interviews, questionnaires or focus groups should be integrated in order to take into account socio and psycho-cultural aspects which are related to values.
Software requirements	□ **Freely available** □ License required □ Advanced software knowledge required	
Time requirements	□ **Short-term (less than 1 year)** □ Medium-term (1-2 years) □ Long-term (more than 2 years)	
Economic resources	□ **Low-demanding (less than 6 PMs)** □ Medium-demanding (6-12 PMs) □ High-demanding (more than 12 PMs)	
Other requirements		

Type of values

The photoseries analysis method is suitable to elicit sociocultural and direct use values, but it is hardly appropriate to grasp ecological values and intrinsic values of nature, as well as option and bequest values.

Advantages

- Ease of use
- Speed of use
- Draws on existing data
- Allows for spatially explicit analsysis
- Allows identifying focus areas where people benefit from cultural ecosystem services provision

Constraints and limitations

- The method doesn’t allow to directly obtain information related to the user characteristics (socio and psycho-cultural aspects) which are crucial in order to define different values from the point of view of individuals and society.
- Inherent bias is related with the interpretation of pictures by researchers and with the capacity to photograph certain cultural services.
- The photo-sharing community may not be representative of specific social groups: the represented population will be then dependent on the level of access to information technology, education and age, and the user's ability/willingness to correctly geotag the photos.

Illustration of practical applications of the method using the OpenNESS case studies

This method has been applied or is going to be applied in several case studies with different social-ecological contexts: Vercors Mountains Range (France, case 5), Carpathian mountains (Hungary, case 7), Cairgorms National Park (United Kingdom, case 9), the protected area of Sierra Nevada (Spain, case 10), Warwickshire (UK, case 11), Kiskunság (Hungary, case 12), “De Cirkel” project in Belgium (case 13), Costa Vicentina (Portugal, case 21), and Patagonia (Argentina, case 25).

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4.11. Preference assessment surveys

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Introduction to method

It is a direct and quantitative consultative method for analyzing perceptions, knowledge and associated value of ecosystem services demand or use (or even social motivations for maintaining the service) without using economic metrics. It could also be used to understand which ecosystem services are perceived as the most vulnerable, or which make the greatest contribution to human wellbeing. Data is collected through surveys using a consultative approach with different variations, such as free-listing exercises, ecosystem service ranking, rating or ecosystem service selection. It is generally used with an emphasis on individual perceptions (but collective preferences could be also gathered). Preference assessment is a useful approach for identifying relevant services from different stakeholder perspectives with diverging interest or needs. At a consequence, its application could help to uncover differences and similarities in preferences between different social groups on the ecosystem service demand. In some cases, the different preferences between social actors and stakeholder groups fit the trade-offs and synergies of ecosystem services created by land-use management (Martin-López et al. 2012) because different stakeholders might be able to manage the landscape on the basis of their needs, interests and preferences (Nagendra et al., 2013).

Keywords: individual value, demand, quantitative assessment, questionnaire, survey method, social preference, socio-cultural valuation.

Why would I use this method?

The motivation to use this method is to understand which services are in highest demand (or valued most) in a particular context (or the ones that are socially perceived as the most vulnerable). This approach could be helpful to address the following objectives:

(1) to demonstrate the social importance of ecosystem services,
(2) to set priorities within management strategies (e.g. working first on those services characterized as highly vulnerable but highly demanded). To do so, the ecological status of different ecosystem services (decline, stable or improved) could complement and enrich this information,
(3) to understand the multiple needs of different stakeholders and, in doing so, anticipate potential social conflicts derived from policy decisions affecting different ecosystem services.

It could be conducted using different survey options: (1) free-listing exercises where no previous information is provided and respondents are asked to name ecosystem services using an open ended question, (2) ranking or rating of ecosystem services on the basis of panels provided to respondents with some information (e.g. Castro et al., 2011; Martín-López et al., 2012); or (c) selection of ecosystem services that are the most important for respondents individual wellbeing or for the social wellbeing from a pre-defined list of existing services in a given context (Oteros-Rozas et al. 2014). Usually, supporting material is provided including pictures or examples. Additional questions can be useful to capture information on motivations or reasons behind the services selection.

When assessing collective preferences, a small group of participants debates and reaches a consensus-based value of the main ecosystem services in a particular area (Palomo et al. 2012). These surveys and workshops could also include information (qualitative or quantitative) regarding which services are the most important or vulnerable, the main trends in ecosystem service delivery, the drivers of change, or the spatial scale at which an ecosystem service is demanded (García-Nieto et al. 2015). In this template, we are going to focus mainly on the individual survey application. For deliberative valuation approaches, see section 4.2.

Methodologically, the main challenge of individual preferences is related with the quantity of sample size required to collect representative information. The sample size should be representative of the population or sample universe targeted in the analysis. This challenge is also reflected in other methods, such as photo-elicitation or time use.

Any ecosystem service could be assessed and valuated through this tool when the targeted respondents have a fairly good understanding of the services. In fact, a wide range of ecosystem services could be assessed at the same time. Information collected through preference assesment can be feed into awareness raising campaigns but can also be used to inform priority setting processes (with quantitative data) or instrument designs.

This approach is suitable to apply at any spatial scales if sample representation is guaranteed.

Requirements

Requirements		Comments
Data collection requierement	☐ Data is available ☐ Need to collect some new data (e.g. participatory valuation) ☐ **Need to collect lots of new data (e.g. valuation based on surveys)**	This statement only refers to social surveys. For focus groups and deliverative valuation approaches, see section 4.2.
Type of data required	☐ **Quantitative** ☐ **Qualitative**	Quantitative data is key, and qualitative data is recommended.
Expertise and production of knowledge needed	☐ **Working with researchers within your own field** ☐ **Working with researchers from other fields** ☐ Working of non-academic stakeholders	
Software requirements	☐ **Freely available** ☐ **License required** ☐ **Advanced software knowledge required**	Software for statistical analysis is required; the particular software and its availability will depend on the researcher decision.
Time requirements	☐ Short-term (less than 1 year) ☐ **Medium-term (1-2 years)** ☐ Long-term (more than 2 years)	Time requirements will vary in terms of the previous information compiled (literature review or interviews) and the field conducted (for example online surveys would be completed much faster than face-to-face questionnaires). Minimum of 9 months (questionnaire design, data gathering in field, and econometric analysis) could be established, till one or two years for a recommended situation. It is essential to ensure that respondents understand the exercise
Economic resources	☐ Low-demanding (less than 6 PMs) ☐ **Medium-demanding (6-12 PMs)** ☐ High-demanding (more than 12 PMs)	
Other requirements		

Type of values

Preference assessment is highly suitable to ascertain socio-cultural values, as it was originally designed for that purpose. It is also able to estimate the instrumental values of nature's benefits and how people might relate with nature through developing different activities (i.e. relational values). It can be also suitable for estimating use and non-use values of nature and ecosystem services.

Advantages

- It assesses a range of ecosystem services at the same time, and could be used for all different service categories (provisioning, regulating and cultural). It is helpful in governance and landscape planning as it helps to uncover bundles of ecosystem services, as well as potential conflicts.
- It is capable to provide robust quantitative information (from a representative sampling) (Scholte et al. 2015). This is a key advantage in governance and planning as the results obtained can be associated with the population in question. Extra explanatory variables could be included (socio-demographics, wellbeing indicators, etc.) that could help to understand the factors behind the responses gathered. It can contribute to explore relationships between ecosystem services, human wellbeing and the effect of drivers of change in combination with other methods (Iniesta-Arandia et al. 2014).
- Methodologically, it avoids incommensurability issues resulted from the assignation of monetary value to service properties that could not be monetarily measured (Martinez Alier et al. 1998; García-Llorente et al. 2011).
- Methodologically, the standardisation of the questions included could promote comparability with other case studies (e.g. Martín-López et al. 2012).

Constraints and limitations

- Methodologically, as supported by Clement and Cheng (2011), a common limitation of survey techniques is that they capture a point in time, not a trend. In addition, sometimes, extra qualitative information is needed to understand the reasons behind the responses given.
- Key stakeholders (ex. minorities) could be ignored when some characteristics apply for a very limited percentage of the population and could not be used to stratify the sample. This is an important constraint to take into account in when analyzing policy implications.
- Another shortcoming that should be taken into account in governance and landscape planning is that individual surveys could miss very rich information from deliberative processes, such as social learning. Answers focused on the contribution of ecosystem service to respondents' human wellbeing (at the one usually measure in questionnaires) is setting aside shared and social values of ecosystem services (Kenter et al. 2015). For a comparison between individual wellbeing and social wellbeing (i.e., shared and social values) by using this technique, see Oteros-Rozas et al. (2014).

Steps required to apply the method within a case study

The method requires 6 basic steps (see figure 4.11.): (1) to target the ecosystem services in the valuation exercise, (2) to select what specific methodology within the approach of time-use, e.g. restoration initiatives or conservation activities related with ecosystem services, (3) to identify the targeted population, (4) to design the questionnaire, (5) to conduct the survey, and (6) to analyze the WTT metric through econometric analyses.

The design of the questionnaire should differ than other methods, see for example time-use approach. For the questionnaire design, if researchers decide to present a list of ecosystem services to respondents, then it is essential to provide a suitable list of ecosystem services adapted for the case study context. It could be helpful to follow and adapt a recognized ecosystem service classifications such as the common international classification of ecosystem services (CICES; www.cices.eu) (Haines-Young and Potschin, 2013).

A pilot sampling is always recommended to improve the wording of the survey and adapt it to the case study context (e.g. particular ecosystem services, specific activities to invest time, target population).

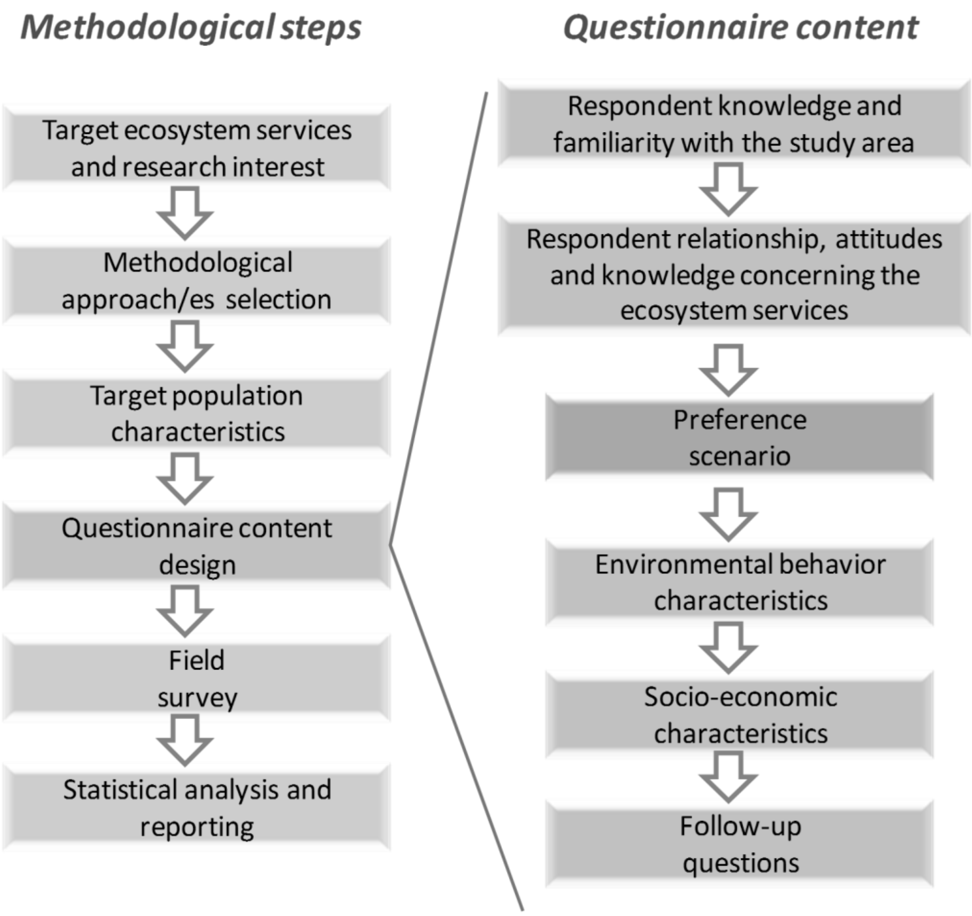

Figure 4.11. Methodological steps to conduct a preference assessment study, including details of the questionnaire content on the right side. The preference scenario or format will be chosen (e.g. ranking, freelisting, etc.).

Illustration of practical applications of the method using the OpenNESS case studies

In its different forms, this method has been applied in several case studies with different social-ecological contexts: Oslo urban area (Norway, case 3), Cairgorms National Park (United Kingdom, case 9), the protected area of Sierra Nevada (Spain, case 10), Kiskunság (Hungary, case 12), “De Cirkel” project in Belgium (case 13), Doñana wetlands (Spain, case 19), Costa Vicentina (Portugal, case 21), East Godavari River Estuarine (India, case 23), Kakamega county (Kenya, case 24).

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4.12. Production function approach (PFA)

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Introduction to method

The production function approach (PFA) can be used in situations where a marketed good or service is produced with input from ecosystems and manmade inputs. For example, many agricultural crops are dependent on insect pollination and the value of increased pollination can be estimated from the increased revenues from higher yields or improved crop quality associated with higher level of pollination by insects. The PFA is therefore a method designed to value indirect use values. The challenges involved in its application are that data on the relationships between the services (regulation and provision services) and on other non-environmental inputs are often difficult to obtain. The method is therefore not as often used even if it has great potential for illustrating the value of taking an ecosystem services approach. It has been used to value e.g. water quality improvements resulting in reduced costs of water purification, increased agricultural productivity due to better pollination and increasing soil carbon stocks. A caveat related to the use of this methodology is that the researcher needs to account for other inputs than the inputs from ecosystems. The production of marketed products requires both manmade input as labour and machinery, as well as land and ecosystem based processes. Not accounting for this can lead to the criticism that the valuation is exaggerating ecosystem service values.

Keywords: production functions, indirect use values, ecosystem services approach.

Why would I use this method?

The methodology is particularly useful in an ecosystem service context to illustrate the invisible value of ecosystem processes. The value of insect pollination securing provision of some agricultural crops is a well-known example. It relies on the functional relationship between ecosystem service, manmade input factors and the production of marketed products. With this information the methodology can be used to raise awareness of the economic rationale for investing in healthy ecosystems to support the production of marketed products.

The spatial scale at which PFA works best is often relatively fine scale e.g. the field scale in relation to agricultural products. Most studies therefore rely on plot data to estimate the functional relationships. Such plot data can be based on long-term field trials or intensive sampling in agricultural fields across many plots. Obtaining this kind of data is therefore the main obstacle to the use of this methodology. In terms of the valuation, the approach is simple as it relies on prices in the market which are directly observable. The approach has been used for awareness raising of the general public, with farmers to help them include this aspect into their farm management, and as a rationale for developing subsidy schemes to improve the sustainability of farming pracises.

Requirements

Requirements		Comments
Data collection requierement	· Data is available □ Need to collect some new data (e.g. participatory valuation) **X Need to collect lots of new data (e.g. valuation based on surveys)**	

Type of data required	**X Quantitative** □ Qualitative	Time series for single plots and/or plots of a representative sample of variation in landuse conditions
Expertise and production of knowledge needed	□ Working with researchers within your own field **X Working with researchers from other fields** □ Working of non-academic stakeholders	Experts in the production technology in question (e.g. agronomists, hydrologists, ecologists)
Software requirements	**X Freely available** □ License required □ Advanced software knowledge required	Any statistics package
Time requirements	□ Short-term (less than 1 year) □ Medium-term (1-2 years) **X Long-term (more than 2 years)**	If the data is not available from a previous study
Economic resources	□ Low-demanding (less than 6 PMs) X **Medium-demanding (6-12 PMs)** □ High-demanding (more than 12 PMs)	For the analysis assuming the data have been collected
Other requirements		

Type of values

The production function approach is highly appropriate to capture ecological and monetary values, as well as antropocentric instrumental values, including both direct and indirect use vaules. It is not appropriate to elicit sociocultural values and intrinsic values of nature. It also has serious limits when used to grasp bequest and existence values.

Advantages

- Recognised and established approach
- Draws on scientific data on the relationships between ecosystem properties and production of marketed goods.
- When the underlying data is rich uncertainties in the linkages can be addressed.
- The method can provide public policy rationales for providing ecosystem services and can be linked directly to land management initiatives and policies.

Constraints and limitations

- Requires collection of large field data sets (cross-sections or time-series) on environmental conditions and inputs to production which can be a constraint for the application to individual case studies.
- Requires modelling competences, which can also be prohibitive.

Steps required to apply the method within a case study

The flowchart below provides with a short description of the steps to apply the production function approach. The steps can roughly be divided in two parts (Figure 4.12.). The first analytical part (steps 1-3) organises the data, conducts the statistical analysis and estimates a production frontier model. The second application part (steps 4-5) will vary depending on the decision context. In the flowchart below the steps relate to using the method for evaluating the consequences of alternative policies eg. giving subsidies to farmers to plant flower strips to support pollination or schemes to promotes management activities to increase carbon stocks in soils, partially to increase long-term productivity of soils.

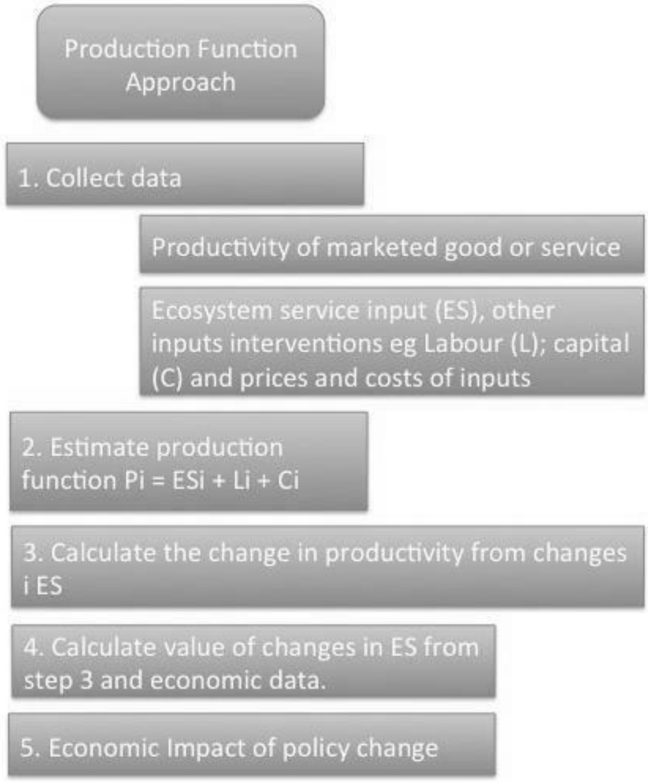

Figure 4.12. Steps in a shadow pricing methodology applied to ES valuation.

Illustration of practical applications of the method using the OpenNESS case studies

The production function may be applied in the Cairngorms case study to value water quality improvements.

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4.13. Scenario planning

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Introduction to method

Scenarios are defined within the OpenNESS project as ”a plausible, simplified description of how the future may develop, based on a coherent and internally consistent set of assumptions about key driving forces” (Priess & Hauck 2015). Scenarios can be developed by the help of expert input or wider public participation, and can take various shapes, including qualitative or quantitative scenarios, exploratory or anticipatory scenarios, and baseline or policy scenarios (Alcamo 2001). Scenario planning is one branch within the broader field of Futures Thinking including diverse methodological approaches (Marien 2002). In scenario planning various tools and techniques are applied (often in combination) to develop plausible and internally consistent descriptions of alternative future options (Johnson et al. 2012). Assumptions about future events or trends are questioned, and uncertainties are made explicit (Bohensky et al. 2006). Scenario planning typically takes place in a workshop settings, where participants explore current trends, drivers of change, key uncertainties, and how these factors might interact to influence the future (Schoemaker 1995). Although scenario planning is not a de facto valuation tool, scenarios can be used to explore how ecosystem services might change in the future and how these changes can influence human well-being. Therefore by comparing and evaluating scenarios we can also reveal the value of related ecosystem services.

Keywords: future thinking, uncertainty, decision support, public engagement, value plurality

Why would I use this method?

Scenario planning is primarily used as a decision supporting tool. It is able to assess the possible future impacts of various drivers of change (including external drivers such as climate change or internal drivers such as different policy interventions) (Priess & Hauck 2014). Scenarios can combine qualitative and quantitative data collected from various information sources. They are suitable to take into account uncertainty and complexity inherent to many decision situations, especially if larger time horizon is involved in the decision (Peterson et al. 2003). The process of scenario development – if it follows a participatory approach – can accommodate creative thinking and social learning (Johnson et al. 2012), and can therefore support joint problem definition and consensus building (Priess & Hauck 2014).

Most cases found in the literature asess only a few selected ecosystem services as part of scenarios (Hauck et al. 2015), but scenario planning can also apply a comprehensive approach to ecosytem services when assessing the possible consequences of changes in ecosystem services provided at a certain place (see eg. the MA scenarios). Scenarios can also pinpoint to the bundles and trade-offs between key ecosystem services, by indicating how they might change under the same conditions (i.e. whether they change together or on the contrary).

Spatial scale at which scenario planning has been applied in the ecosystem services literature ranges from the local to the global (Alcamo et al. 2008). Different spatial scales can be combined in multi-scale scenarios (Kok et al. 2007). Spatial resolution is highly variable depending on the tools and approaches used during the process. If scenarios are developed in a participatory way using various knowledge forms and they are described mainly in qualitative terms, spatial resolution might be coarse. If scenario narratives are used as inputs to modelling, scenarios can be translated into fine-tuned, spatially explicit quantitative estimations (depending on the availability of data and expertise). Taken into account all these information, scenario planning is an advisable decision support tool for awareness raising (by knowledge sharing, see e.g. Johnson et al. 2012), priority setting (by comparing and evaluating future alternatives, see e.g. Geneletti 2012) and instrument design (by discussing the range of policy options and managing the potential conflicts between them, see e.g. Palomo et al. 2011, Pearson et al. 2010).

Requirements

Requirements		Comments
Data collection requierement	□ Data is available □ **Need to collect some new data (e.g. participatory valuation)** □ **Need to collect lots of new data (e.g. valuation based on surveys)**	Data requirement depends on the type of scenario and availability of existing data. Qualitative scenarios require less data which can be collected through participatory workshops. Quantitative scenarios might need extensive numerical data input.
Type of data required	□ **Quantitative** □ **Qualitative**	Scenarios can be both qualitative (sumed up in narratives, images, screenplays) and quantitative (including numerical information in forms of graphs, tables and maps).
Expertise and production of knowledge needed	□ **Working with researchers within your own field** □ **Working with researchers from other fields** □ **Working with non-academic stakeholders**	Scenarios can be developed solely based on scientific knowledge, although including various disciplines and the general public can increase the robustness of scenarios.
Software requirements	□ **Freely available** □ **License required** □ **Advanced software knowledge required**	Depends on the type of scenarios qualitative/ participatory scenarios does not need any extra software support, quantitative scenarios might require licensed software and always necessitates advanced modelling/ programming skills
Time requirements	□ **Short-term (less than 1 year)** □ Medium-term (1-2 years) □ Long-term (more than 2 years)	(It might require more time if stakeholders are heavily involved in a series of workshops or if special data has to be collected9
Economic resources	□ Low-demanding (less than 6 PMs) □ **Medium-demanding (6-12 PMs)** □ High-demanding (more than 12 PMs)	(There might be alterations depending on the applied tools)
Other requirements	Special expertise might be necessary if scenarios are combined with modelling and/or mapping (computation, modelling) or scenarios are developed in a participatory way (facilitation skills)	

Type of values

Scenario planning can help reveal diverse and heterogenous values, including ecological, sociocultural and monetary ones. It is especially suitable to grasp future related values such as option and bequest values. It has however some limitations when unfolding the intrinsic values of nature – to this end combining scenarios with biophysical modelling might be necessary.

Advantages

- Scenarios can address complexity and uncertainty in a transparent and creative way.

- Scenario planning facilitates learning and allows for the integration of diverse knowledge forms and plural and heterogeneous values.
- Scenario development is a well-established approach, there are global and regional scenarios available in the literature (e.g. IPCC, MEA, IPBES is in progress) which can be used for comparison and down-scaling.
- Scenarios can be developed in a participatory way which makes possible the active engagement of decision makers, practitioners, scientists and the general public, and hence can create a science-policy-public interface.
- It is possible to consider a range of policy or response options, and assess how robust those options are to the different scenarios developed

Constraints and limitations

- Robustness and internal consistency of scenarios is a key requirement which can only be guaranteed if quality control mechanisms are built in the process
- The quantification and modelling of narrative scenarios is often highly demanding in terms of expertise, time and other resources
- A participatory scenario planning process requires good facilitation skills and resources
- Participatory scenario planning is time consuming for local stakeholders

Steps required to apply the method within a case study

For detailed information on how scenarios can be developed see the OpenNESS synthesis paper on scenarios (Priess & Hauck 2015). Here we sketch out a general stepwise approach including the major phases of an integrative scenario development process (adapted from Priess & Hauck 2015), but do not go into details of how and with which tools each of these steps can be carried out.

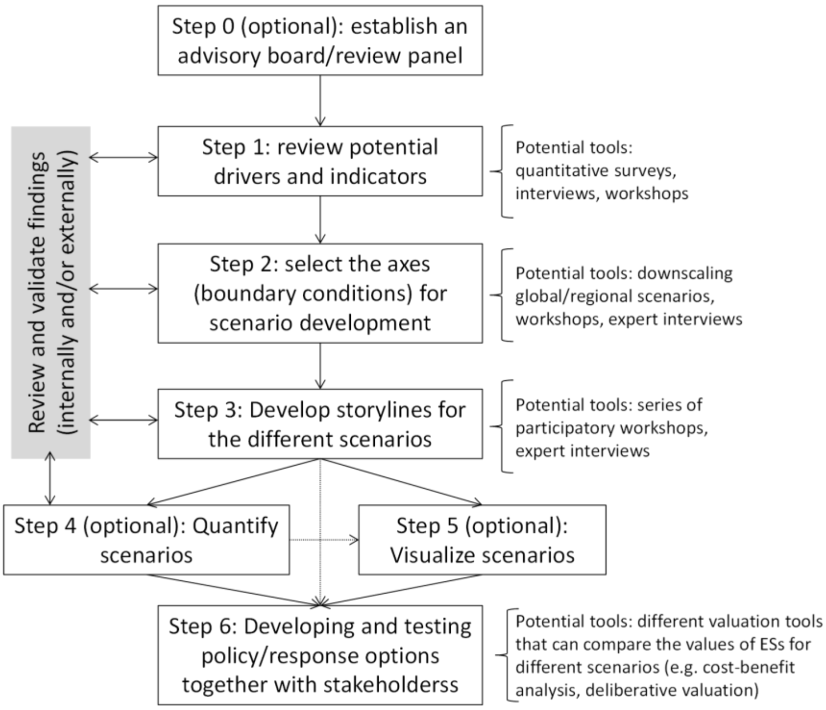

Figure 4.13. Stepwise approach to scenario development

Illustration of practical applications of the method using the OpenNESS case studies

OpeNESS scenarios are developed at the European scale by WP2. Several case studies work with scenarios at local/regional scales which are either down-scaled from the general OpenNESS scenarios or developed in a bottom-up participatory process (e.g. case no. 12, Kiskunság).

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4.14. Shadow pricing

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Introduction to method

When society sets environmental targets on provision of non-marketed ecosystem services it is an implicit valuation of the services. As an example, when a country signs the Water Framework Directive costs will be incurred. The costs incurred to reach the agreed level of water quality can be used as data reflecting the implicit valuation of water quality improvements. It is assumed that it is a social, rational and well-informed decision to produce a specific mix of services. In the example given above, about the Water Framework Directive, an optimal mix of provision of agricultural products and provision of fresh water quality is assumed to be reflected in the agreed targets. The shadow price is the cost of obtaining an additional unit of ecosystem service obtained by implementing the environmental target which restricts production of marketed goods. The shadow price society 'pays' for provision of the ecosystem services is the loss from not obtaining the value from producing marketed goods. The method takes into account that economic actors can choose to adjust their activities when confronted with a target. Taking this into account avoids exaggeration of the costs and in turn the value of the ecosystem services.

Keywords: opportunity costs, implicit valuation, targets for environmental quality.

Why would I use this method?

The methodology is particularly useful in an ecosystem service context to illustrate the scope of ecosystem-based approaches in contrast to technology-based approaches. The value of ecosystem services to provide e.g. clean water and reduced climate change can be quantified using a shadow pricing approach and compared to the costs it would take to provide these services using technology-based approaches or to the costs of policy inaction. Estimating shadow prices requires identifying the most cost-effective ways of achieving the environmental target. If compared with alternatives shadow prices can raise awareness of the economic rationale for using ecosystem-based approaches to reach environmental targets.

The spatial scale at which shadow pricing works best is the scale at which environmental targets are set. Most studies therefore choose a regional or national scale. The shadow pricing method measures the costs of providing services that can be delivered from changes in ecosystems; specifically the costs of changes in land, freshwater and marine management. The main critisism of using this methodology is that it is not based on preference assessment. The assumption that the environmental targets reflects preferences in society at large, can be a strong assumtion and needs to be acknowledged when the method is used. An advantage of using this methodology is that its application generates knowledge about trade-offs and synergies between provision of different ecosystem services. The approach is well-known by economists, but only a few exampels exists in ecosystem services research.

Requirements

Requirements		Comments
Data collection requierement	**X Data is available** □ Need to collect some new data (e.g. participatory valuation) □ Need to collect lots of new data (e.g. valuation based on surveys)	
Type of data required	**X Quantitative** □ Qualitative	
Expertise and production of knowledge needed	□ Working with researchers within your own field **X Working with researchers from other fields** □ Working with non-academic stakeholders	
Software requirements	□ Freely available **X License required** **X Advanced software knowledge required**	For example GAUSS requires a licence and specialist knowledge to derive cost-effective alternatives and implicitly the price.
Time requirements	**X Short-term (less than 1 year)** □ Medium-term (1-2 years) □ Long-term (more than 2 years)	
Economic resources	**X Low-demanding (less than 6 PMs)** □ Medium-demanding (6-12 PMs) □ High-demanding (more than 12 PMs)	
Other requirements		

Type of values

Shadow pricing is highly appropriate to elicit monetary values and anthropocentric instrumental values of nature’s benefits, including both direct use and indirect use values. It is not suitable to unfold the intrinsic value of nature, neither is it applicable to elicit option, bequest and existence values.

Advantages

- It is a recognised principle in economics, it draws on modelling relationships between provision of different outcomes using existing data
- Avoids hypothetical biases related to stated preference methods.
- Well suited to conducting sensitivity analysis as a way of analysing the implications of uncertainty.
- Can be used to provide public policy rationales for providing ecosystem services and can be linked directly to land use policies.

Constraints and limitations

- Requires the compilation of large data sets
- Needs extensive modelling competence.
- The method relies on the estimates of the cost and effectiveness of different management measures.

Steps required to apply the method within a case study

The flowchart below provides with a short description of the steps to apply shadow pricing. The steps can roughly be divided in two parts. The first analytical part (steps 1-3) organises the data, conducts the statistical analysis and estimates a production frontier model. The second application part (steps 4-5) will vary depending on the decision context. In the flowchart below the steps relate to using the method for evaluating the consequences of alternative policies.

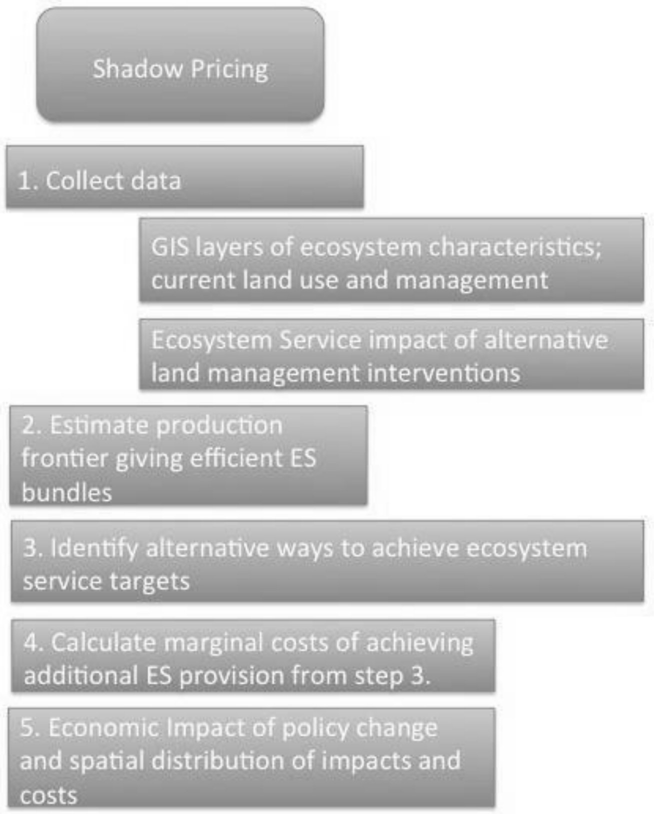

Figure 4.14.: Steps in a shadow pricing methodology applied to ES valuation.

Illustration of practical applications of the method using the OpenNESS case studies

The shadow pricing approach has not been applied in Openness case studies but when appealing to eg. carbon sequestration values they often stem from shadow pricing studies. Production frontier modeling has also been conducted in the context of reserve site selection, including targets for biodiversity conservation targets with targets for ecosystem service bundles (Schröter et al. 2014).

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4.15. Stated preference valuation

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Introduction to method

A family of techniques which use individual respondents' statements about their preferences to estimate change in utility associated with a proposed increase in quality or quantity of an ecosystem service or bundle of services (Bateman et al. 2002). Respondents are presented one or more hypothetical policy or project scenarios describing a project or policy that will lead to a specified environmental change compared to a baseline situation. The answers respondents give, in the form of monetary amounts, ratings, or other indications of preference, are scaled following an appropriate model of preference to yield a measure of value of the proposed ecosystem service change. This value is often monetary in the form of people's willingness to pay (WTP). Stated preferences are often elicited through surveys (typically web, phone, mail or in-person) that use questionnaires following strict guidelines. The surveys are administered to representative samples of the people affected by the environmental change and mean WTP per household or person then aggregated over the relevant population as a measure of welfare change.

The two most common forms of stated preference methods are contingent valuation (CV) and the more recent choice experiments (CE) (and choice, conjoint-analysis (Hensher et al. 2005)). CV elicits WTP by asking respondents directly their WTP for the change in the ecosystem service(s). CE breaks the description of the environmental good into physical attributes, where each attribute has different levels. The respondents then face a number of choice sets with different combinations of physical attribute levels combined with a cost attribute. This design yields indirectly the respondents' trade-offs between money and changes in individual attributes, and their WTP for a general environmental change described by combinations of the attributes.

Keywords: hypothetical policy scenario, willingness to pay, survey, representative sample, individual welfare change, trade-offs

Why would I use this method?

Stated preference (SP) methods are highly flexible. Their flexibility is both an advantage and a potential source of misues. SP can in principle generate monetary willingness to pay (or accept) estimates of direct, indirect or non-use values. Hypothetical scenarios for measures delivering just about any ecosystem service can be defined. SP methods can address a number of decision contexts – they have been used to generate aggregate willingness-to-pay estimates for public goods for the purposes of awareness-raising (recognising values). Their relevance for systems of environmental and economic accounting is limited because of recommendations to use only exchange-based data (UN 2014). Stated preference values are in principle well suited for inclusion in benefit-cost analysis and decision-support for priority-setting, although their application to actual policy choices outside the academic literature has been limited (Laurans et al. 2013).

SP methods are in principle well-suited for instrument design, such as assessing willingness-to-pay in proposed/hypothetical user-financed public utilities, which may be co-produced by ecosystem functions (e.g. water and sewage) (Brouwer et al. 2009). Where the regulatory system permits it, stated preference methods may be used 'as a last resort' to assess the equivalence of resotration measures in natural resource damages (Gard and Desvouges 2013). SP is particularly flexible in terms of defining hypothetical institutional contexts for delivery of ecosystem services. However, this flexibility also means that SP is a 'value articulating institution' (Vatn 2005) and values are highly contingent on the institutional framing used in the survey. SP methods require statistically representative samples of populations concerned with public policies. For this reason they often sample respondents at city-wide, regional or national level spatial scale. At the same time spatial resolution of the SP data can be high where individual respondents are asked to react to hypothetical channges in ecosystem services in their local environment.

Requirements

Requirements		Comments
Data collection requierement	□ Data is available □ Need to collect some new data (e.g. participatory valuation) **X Need to collect lots of new data (e.g. valuation based on surveys)**	
Type of data required	**X Quantitative** □ Qualitative	
Expertise and production of knowledge needed	**X Working with researchers within your own field** **X Working with researchers from other fields** **X Working of non-academic stakeholders**	SP scenarios often defined through focus groups with stakeholders; high quality studies define environmental characteristics of scenarios with natural scientists
Software requirements	□ Freely available **X License required** **X Advanced software knowledge required**	Licenced econometric software packages (e.g.STATA, NLOGIT, Sawtooth)
Time requirements	□ Short-term (less than 1 year) **X Medium-term (1-2 years)** □ Long-term (more than 2 years)	
Economic resources	□ Low-demanding (less than 6 PMs) **X Medium-demanding (6-12 PMs)** **X High-demanding (more than 12 PMs)**	Depending on complexity of the ecosystem service, the scale of the study, and available expertise
Other requirements		

Type of values

Stated preference methods are highly appropriate to elicit monetary values. Taken into account the Total Economic Value framework, SP methods are capable of capturing direct use values, option values, bequest values and existence values. They are limited to unfold ecological values and the intrinsic value of nature.

Advantages

Methodological

- recognised and established approach within environmental economics
- covers wide range of ecosystem services, use and non-use values
- trade-offs between ecosystem services and a few other context characteristics can be evaluated using choice experiments
- uncertainty at the population level can be addressed, as quantified variance in willingness-to-pay across respondents
- representative sampling of populations

Governance

- highly flexible in terms of definining management and policy scenarios
- can be combined with consultative focus group methodologies
- structured opinion polling, referendum-type data

Constraints and limitations

Because of the wide variety of contexts to which SP has been applied, not all problems apply to all SP studies at once. However, looking across SP studies the main challenges can be summarised as (Vatn 2005):

- Information problems
  - Demarcation and composition of ecosystem services; valuation scenarios specify management actions for land or water use which affect multiple ecosystem services;
  - Functional invisibility of ecosystem services; difficulties in communicating multiple ecosystem functions in valuation scenarios
  - Incommensurable or lexicographic preferences; respondents may be unwilling to accept trade-offs between ecosystem services and money
- Individual values, ethics, social choice
  - willingness-to-pay measures assume respondents don't hold rights to the status quo environmental quality;
  - respondents may hold norms and moral commitment to their environment that they are not willing to trade against prices in monetary exchange
- Rational choice assumptions and biases
  - Part-whole bias; the sum of WTP of parts of ecosystems typically exceeds willingness to pay for the system as a whole
  - Sequence bias; the order in which parts of ecosystems are valued affects willingness-to-pay; the framing of choices affects values
  - Yeah-saying; stated preference surveys often overestimate willingness-to-pay relative to what respondents would actually pay in revealed preference situations
  - Prices informing preferences; respondents will not have preformed monetary preferences for ecosystem services; even for market goods price often assists consumers in forming preferences
  - Socially contingent preferences; respondents preferences change with the social setting and their roles in thos settings (as consumers, voters etc.)

Steps required to apply the method within a case study

Stated preference methods are most time consuming in the initial steps of (1) defining the valuation scenario and (2) designing the survey. Once this is ready testing implementation and analysis are relatively punctual activities. The figure is meant to illustrate that values generated are contingent on a large number of interrelated survey design decisions which make SP-values highly context specific. Choice experiment and contingent valuation differ from one another mainly in (2) the design of the choice situation and (7) estimation of willingness-to-pay for ecosystem service. For an overview of the consecutive methodological steps, see Figure 4.15.

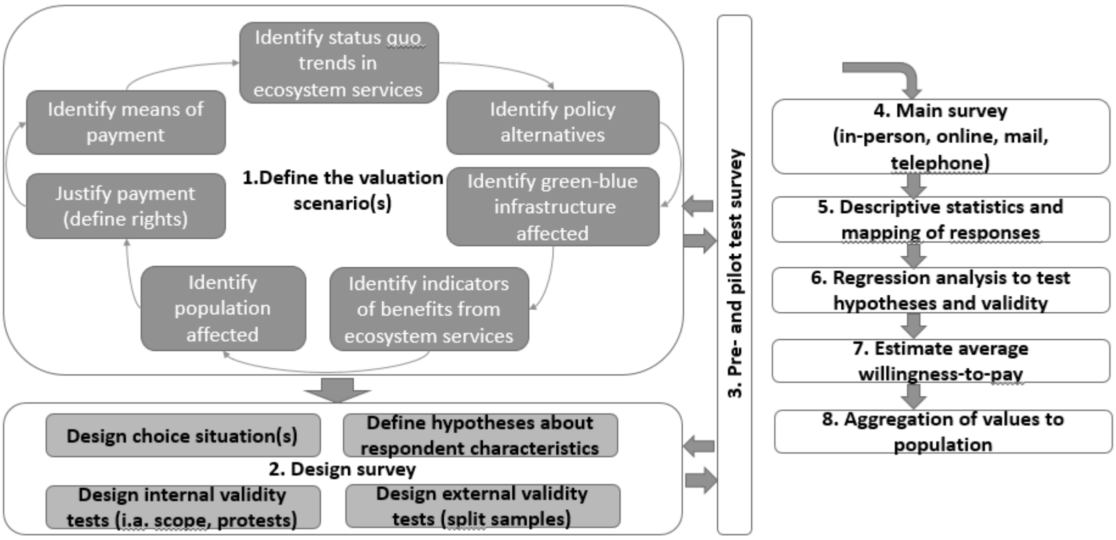

Figure 4.15. Stepwise approach to stated preference methods

Illustration of practical applications of the method using the OpenNESS case studies

Stated preference studies are conducted in case 03 Oslo, 9. Cairngorms, 10. Sierra Nevada, 15. Giorla Maggiore, 17. Lower Danube (choice experiment), 19. Doñana, and 26. São Paulo.

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4.16. Time-use studies

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Introduction to method

Time use study is an innovation of the conventional stated preference techniques, in particular taken from the contingent valuation approach. In this case, the payment vehicle is expressed in labour hours rather than monetary units (use in the classicalwillingness to pay studies) (Kenter et al. 2011). Willingness to give up time (WTT) creates a hypothetical scenario using surveys to estimate the value of ecosystemservices by directly asking people how much time they would willing to invest for a change in the quantity or quality of a given ecosystem service or conservation (or restoration) plan. Besides being an appropriate approach in scenarios where people can invest time for particula activities related with nature; this approach is also useful in areas with income constrains where money is basically used for essential goods (Higuera et al. 2012). It also avoids incommensurating issues resulted from the assignation of monetary value to ecosystem service properties that could not be monetarily measured (García-Llorente et al. 2011).

Keywords: Income constrains; Rural areas; Social preferences; Social Value, Willingness to give up time

Why would I use this method?

The general purpose of time use studies is to capture the willingness to give up time (WTT) per individual to different ecosystem services. This technique is able to estimate the value of multiple ecosystem services (provisioning, regulating and cultural) through depicting scenarios which entail their restoration, management or conservation. It is also able to capture the social factors that determine social preferences.

In general, the main outputs obtained from its application are:

1. The WTT per ecosystem service to understand social demands and priorities for services conservation.
2. The socio-cultural factors or motivations influencing on the individual decision of be willing to give up time.
3. A new indicator to measure social support towards conservation.
4. The economic value of ecosystem services though the translation of willingness to give up time into monetary units, multiplying stated WTT (in hours/month) by net income per month (Euros/month) expressed by each individual during the questionnaire (this values could even be aggregated).

Decision context to which it has been applied: awareness raising; and priority setting. Spatial scale at which it has been applied: county. Spatial resolution at which it has been applied: this method is applied at invidivuals, however the spatial resolution would be determined by the specific service measured.

Requirements

Requirements		Comments
Data collection requierement	□ Data is available □ Need to collect some new data (e.g. participatory valuation) □ **Need to collect lots of new data (e.g. valuation based on surveys)**	
Type of data required	□ **Quantitative** □ Qualitative	
Expertise and production of knowledge needed	□ **Working with researchers within your own field** □ Working with researchers from other fields □ **Working with non-academic stakeholders**	
Softwarerequirements	□ **Freely available** □ **License required** □ **Advanced software knowledge required**	The software requirement will depend on the case and the scientists' skills.
Time requirements	□ Short-term (less than 1 year) □ **Medium-term (1-2 years)** □ Long-term (more than 2 years)	
Economic resources	□ Low-demanding (less than 6 PMs) □ **Medium-demanding (6-12 PMs)** □ High-demanding (more than 12 PMs)	
Other requirements	Statistical knowledge and conometric modelling skills could be needed	

Type of values

This method is suitable for uncovering and estimating socio-cultural values in quantitative terms. It is also able to estimate the instrumental values of nature's benefits and how people might relate with nature through developing different activities (i.e. relational values). It can be also suitable for estimating use and non-use values of nature and ecosystem services.

Advantages

- It is a useful non-monetary technique in contexts where severe income constrains makes WTP studies inappropriate, particularly in rural communities with economic limitations or high rates of unemployment (Higuera et al., 2012; Kenter et al., 2011).
- It avoids incommensurability issues (Martínez-Alier et al. 1998) resulted from the assignation of monetary value to service properties that could not be monetarily measured (e.g. García-Llorente et al., 2011).
- It could be used to assess a range of ecosystem services at the same time, and could be use for all of them (even for those without markets). It could be also used to estimate the importance that people attach to biodiversity in general, and its existence value (García-Llorente et al., 2016).
- Always that the activities are well-defined and established, respondents don't need to have a fairly good understanding of the delivery of ecosystem services because this link could be later done by researchers.

- WTT can be understood as a holistic indicator of human time-sharing initiatives in nature and, thereby, it is able to raise awareness about our ability to harmonize our lifestyles with the rhythms of nature (García-Llorente et al. 2016).
- Beyond the estimation of the value of ecosystem services through the WTT; its real development could engage statakeholders with environmental activities, increase collaboration, social learning and knowledge co-generation (Higuera et al. 2012; García-Llorente et al. 2016).

Constraints and limitations

- WTT is unsuitable for application to cases in which the respondents have little time availability.
- As the income variable must be included in conventional WTP models to be consistent with economic theory; modeling WTT processes requires the inclusion of the time availability as an explanatory variable. Therefore, a daily time analysis should be included in the questionnaire. To gather the information about the time spent in different activities everyday results time-consuming and can entail the respondent’s tiredness.
- Classical methodological biases from conventional stated preference methods could occur.
- It is important to provide a clear description of the activities (and its relation with ecosystem services) to invest time in the hypothetical scenario. If not, the activities might be selected because respondents' preconceived ideas or because the physical effort required performing them.

Steps required to apply the method within a case study

The method requires 6 basic steps as it is indicated in Figure 4.16: (1) to target the ecosystem services in the valuation exercise, (2) to select what specific methodology within the approach of time-use, e.g. restoration initiatives or conservation activities related with ecosystem services, (3) to identify the targeted population, (4) to design the questionnaire, (5) to conduct the survey, and (6) to analyze the WTT metric through econometric analyses.

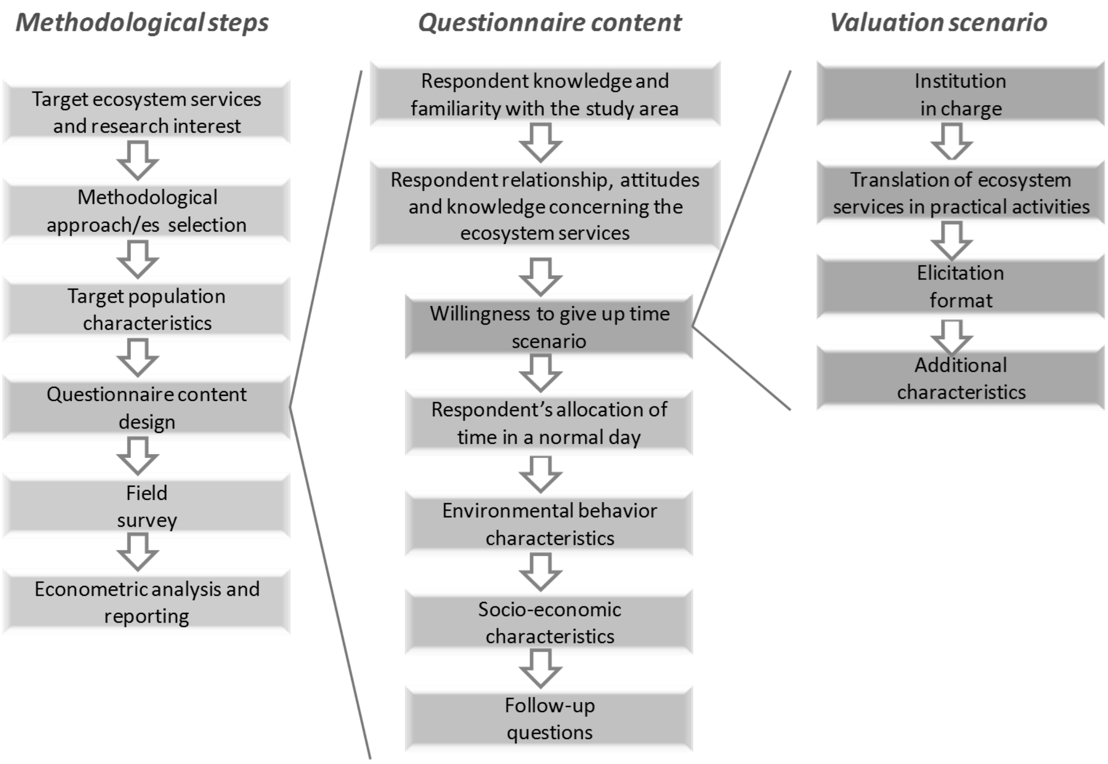

Figure 4.16. Stepwise process of time-use studies

Illustration of practical applications of the method using the OpenNESS case studies

This method has been applied in the urban area of Oslo (Norway, case 3) and in the protected area of Sierra Nevada (Spain, case 10).

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4.17. Travel cost methods

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Introduction to method

The travel cost methods (TCM) is based on the observation that recreational services can only be realised through physical access to nature. This implies that individuals seeking to enjoy the service will need to spend resources (time and money) to travel to the site. The travel activity is a reflection of the use value this service has to people. The travel costs method was first applied in the US in 1959 to value the recreational use of nature. There are basically two different types of travel cost methods; one based on a valuation of a single site and one based on choices between multiple sites. In this overview the use and requirements for these two methods are described separately. The single site method is simple and is appropriate when the site in question is of particular interest and significance. The multi-site method is appropriate when the researcher is interested in valuing the attributes of recreational sites, i.e. to determine the importance of environmental attributes, recreational facilities and accessibility not just site access. Accessibility to the sites must be calculated using GIS and preferably distances to the sites through the road network to generate accurate value estimates. Econometric methods are used to estimate recreational demand functions (single sites) and models of choice of visit (multiple sites).

Keywords: accessibility, recreational services, direct use values.

Why would I use this method?

TCM has been extensively used to demonstrate the value of eg. forests for other services than timber production. This is potentially powerful for awareness raising. In existing studies TCM has successfully been used to show that provisioning services often only account for a small part of the services associated with natural or semi-natural areas. The recreation value has also been used to make the economic case for afforestation initiatives in a general sense. However, there are few applications of TCM in real decision making in relation to concrete project evaluations.

The spatial scale at which TCM works best depends on the type of recreational activites being valued. The scale needs to include the range of distances people travel to experience nature. If the recreational activity includes trips to unique sites to which recreationists travel great distances, the spatial scale of analysis needs to be larger than if the study focuses on park recreation in an urban context. Most studies choose a regional scale or a national scale. The TCM directly measures recreational services. It can be argued that the TCM provides conservative estimate as the value of natural and semi-natural habitats are also reflected in other marksts, such as the house market (see the description of the HPP method). A challenge when applying the TCM is the costing of time, as the researcher needs to make assumption about how respondents could have used their time if not used for recreational travel. Such assumptions are often difficult to validate in empirical studies. In a similar way, spending time on site also reflect that people find the activity worth while as they could have spend their time on competing activities. It is customary to include time in the travel costs by using a share of the hourly wage, reflecting that people usually haven't got completely flexible hours of work. Several studies have analysed the sensitivity of the assumptions about alternative options for people's time and therefore the costs associated with spending time on recreational travel. The time spend on-site is not considered a cost and not accounted for in travel costs studies.

Requirements

Requirements		**Comments**
Data collection requierement	□ Data is available □ Need to collect some new data (e.g. participatory valuation) **X Need to collect lots of new data** (e.g. valuation based on surveys)	
Type of data required	**X Quantitative** □ Qualitative	
Expertise and production of knowledge needed	□ **Working with researchers within your own field** □ Working with researchers from other fields □ Working of non-academic stakeholders	Data on travel costs are mainly collected by economists themselves. GIS estimates of network distances and data on sites attributes are sometimes collected with help from researchers from other fields.

Software requirements	X **Freely available** X License required ☐ Advanced software knowledge required	For example "R" ArcGIS requires a licence Multiple-site travel costs estimates are usually conducted in specialised software such as STATA, NLogit or simlar, but free software exist such as Blogene.
Time requirements	☐ Short-term (less than 1 year) X **Medium-term (1-2 years)** ☐ Long-term (more than 2 years)	
Economic resources	☐ Low-demanding (less than 6 PMs) X **Medium-demanding (6-12 PMs)** ☐ High-demanding (more than 12 PMs)	
Other requirements	-	

Type of values

Travel cost methods are highly appropriate to elicit sociocultural values and anthropocentric instrumental values attached to nature's benefits, including direct use values. It is not appropriate to grasp ecological values, or any kind of intrinsic values of nature. Neither is it applicable to elicit indirect use, option, bequest or existence values.

Advantages

- Travel cost is a recognised and established approach.
- It draws on revealed data which is often stated as an advantage as hypothetical biases from using stated preference methods are avoided.
- The method can be used to provide a public policy rationales for providing green spaces for recreational activities.
- It can be used to study designs of recreational site quality.

Constraints and limitations

- It requires large data sets on recreational activities
- It requires extensive GIS pre-processing of travel cost data and site characteristics (multiple site approach).
- The methods is specific to estimation of recreational service and cannot be generalised to estimate a range of other services.
- Results are highly sensitive to assumptions about cost of time.

Steps required to apply the method within a case study

The flowcharts below provide with a short description of the steps to apply TCM using a single site and a multiple site approach. The steps can roughly be divided in two parts. The first analytical part (steps 1-3) organises the data, conducts the statistical analysis and estimates a model of recreational behavior. This is often as far as many research papers take the analysis. The second application part (steps 4-5) will vary depending on the decision context. In the flowchart below the steps relate to using the method for finding aggregate values of different policy changes for awareness-raising purposes or concrete policy evaluation.

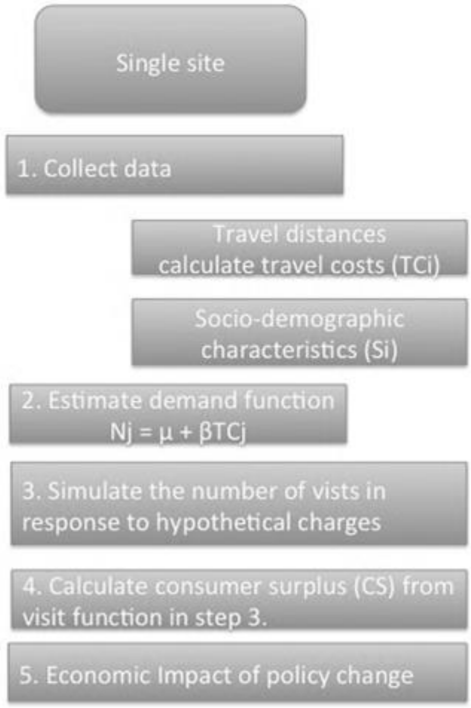

Figure 4.17. Steps in a zonal travel cost analysis; i refers to individual; j refers to geographical zone.

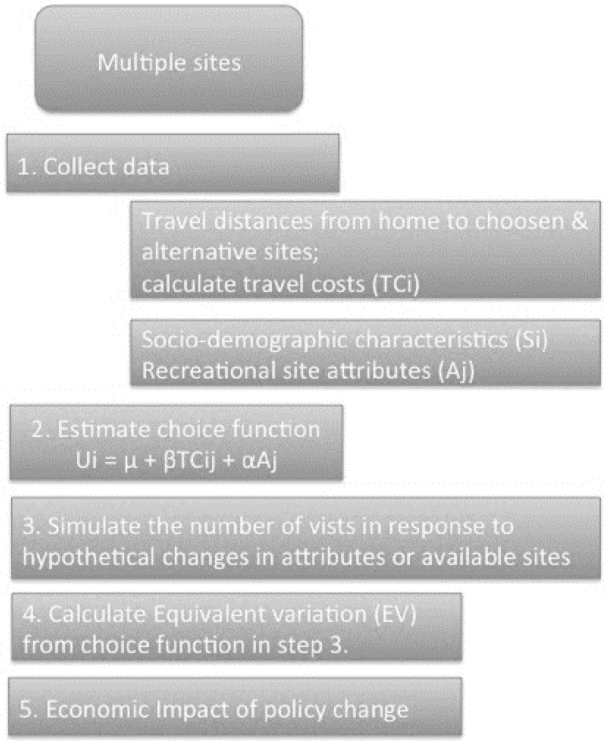

Figure 4.18. Steps in a discrete choice travel costs analysis

Illustration of practical applications of the method using the OpenNESS case studies

The TCM has not been applied as a primary study in Openness case studies. The Oslo case study #3 transfers TCM meta-analysis results, and extrapolates findings from a choice experiment on willingness-to-travel which adjusts for travel costs (Barton et al. 2015c). Many illustrations of the method exists in the literature e.g. Clawson and Knetsch (1966) for the zonal travel cost method and Bockstael et al. (1991) or the multiple site travel costs framework and Termansen et al. (2013) for an application to national scale ecosystem service modelling.

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4.18. Value transfer

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Introduction to method

Benefits transfer (BT), or more generally - value transfer (VT) - refers to applying quantitative estimates of ecosystem service values from existing studies to another context - from a 'study site' with available value estimates, to a 'policy site' where time or resource constraints preclude the possibility of doing a primary valuation study. In the BT literature values have generally been understood to be monetary estimates of benefits or costs (Johnston et al. 2015), often in the context of benefit-cost analysis of project or policy alternatives. Value transfer is not one specific method, but a continuum of approaches depending on the information available:

- **Unit value transfer:** Value estimates are assumed to be correct 'on average' and transferred without any form of adjustment.
- **Adjusted unit value transfer:** Value estimates are transferred with simple adjustments typically for study and policy site differences in income and purchasing power.

- **Value function transfer**: Significant predictors at the study site of willingness-to-pay typically (from CV or CE studies), are identified at the policy site. The average value of predictors at the 'policy site' are then 'plugged into' the 'study site' value-function to derive an adjusted WTP figure for the policy site.
- **Meta-analytic function transfer**: Similar to value function transfer, but the value func-tion is generated from a meta-analysis of many valuation study sites instead of a single study site. The method assumes that there is a meta-value function (i.e. similar preferences) that apply across all the study sites.

Although 'value transfer' is generally reserved for monetary estimates, there is nothing in principle against transferring non-monetary estimates of the benefits of ecosystem services, such as the ranking of ecosystem services, from a study site to a policy site.

Keywords: Benefits transfer, benefit-cost analysis, uncertainty

Why would I use this method?

Value transfer is necessary when a decision context calls for monetary estimation of ecosystem services, but time and resources are insufficient to carry out a primary study on-site. VT can be applied to all types of ecosystem services, as long as monetary valuation is considered a valid basis for decision making. If you believe that people hold pre-formed preferences for spending on the environment, and these preferences are quite stable across decision-context – you are likely to be more inclined to accept VT. The question then becomes whether value transfer errors are expected to be 'too large' relative to reliability required by the decision-maker. A benchmark is the level of confidence with which decision-makers require uncertain benefits to exceed uncertain costs. This will depend on the importance of the decision; for example a routine decision may be taken if expected net benefits are positive with 90% confidence, while a conflictive decision may require expected benefits to exceed costs by several multiples in order to convince political opposition.

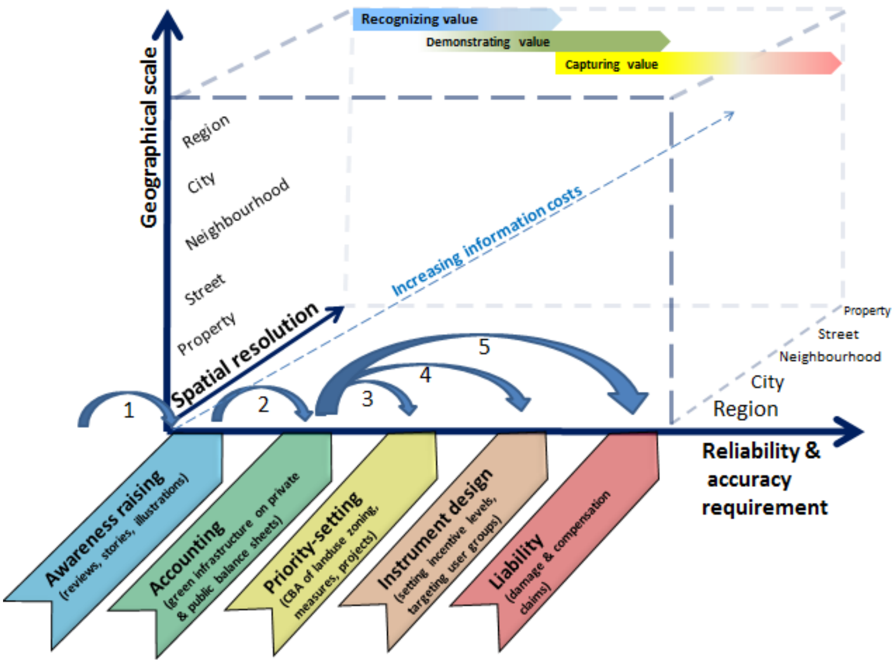

Figure 4.19. Value transfer as stepwise updating of values for different contexts. Starts with simple awareness-raising using value transfer (1) and then updated with new studies on-site information for more demanding contexts (2-5). Source: adapted from Gómez-Baggethun and Barton (2013)

VT may in principle be applied to any decision context (Figure 4.19.), but the more a context requires reliable and accurate monetary valuation estimates, the less likely value transfer will serve the context purpose. Monetary value transfer is well known for its use in public *awareness raising* about the total economic value of natural capital, e.g. Braat and ten Brink (2008). In experimental ecosystem *accounting* (Obst et al. 2015), where monetary estimates must be applied across a landscape, some form of spatial extrapolation is needed, i.e. value transfer. As we move to *priority-setting* using benefit-cost analysis of projects in specific locations, instrument design for specific stakeholders, or liability for natural resource damages that occurred at a specific time and place, requirements for on-site studies are likely to increase. Because information costs are increasing with spatial resolution (figure 1), value transfer for awareness raising (1) or accounting (2) can be updated with progressively more site-specific information as the needs of decision-contexts (3,4,5) require. For example, value function and meta-analytic function transfer collect some data on policy site characteristics such as demographics, accessibility and size of area to adjust original estimates.

All valuation of ecosystem services has at least an element of value transfer when estimates are applied to specific decision contexts (because each decision context is unique and therefore not identical to the decision context in which ecosystem service values were generated in the original study).

Requirements

Requirements		**Comments**
Data collection requierement	**X Data is available** **X Need to collect some new data** (e.g. participatory valuation) □ Need to collect lots of new data (e.g. valuation based on surveys)	Unit value transfer Value function transfer
Type of data required	**X Quantitative** □ Qualitative	Monetary
Expertise and production of knowledge needed	**X Working with researchers within your own field** □ Working with researchers from other fields □ Working of non-academic stakeholders	”Quick, cheap and dirty” approach with minimal requirement for cross-disciplinary. GIS for policy site characteristics if value function transfer
Software requirements	**X Freely available** □ License required □ Advanced software knowledge required	Spreadsheet
Time requirements	**X Short-term (less than 1 year)** □ Medium-term (1-2 years) □ Long-term (more than 2 years)	Weeks
Economic resources	**X Low-demanding (less than 6 PMs)** □ Medium-demanding (6-12 PMs) □ High-demanding (more than 12 PMs)	Weeks
Other requirements		

Type of values

Monetary valuation methods have been applied to ecosystem services with many types of values. Value transfer applies to monetary valuation methods in general, across value types. The distinguishing feature is not the value type, but the reliability and accuracy requirements of the decision-context. Value transfer is inappropriate in cases where monetary value estimates are deemed unacceptable by constituencies and their representatives. Suitability will therefore vary from constinuency/context to context.

Advantages

Methodological advantages

- ease of use, available valuation databases (e.g.
- draws on existing data
- low cost

Governance advantages

- speed of use

Constraints and limitations

Methodological constraints

- potential ease of misuse
- transfer errors cannot be predicted (but can be inferred from similar cases)
- not participatory
- uncertainty of transferred assessment often not assessed (see table A1 appendix)
- existing valuation studies often do not provide site context
- 'context free' average values rather than context specific marginal values often employed

Constraints in **governance**

- decision-makers will often not know their own requirements for statistical reliability of valuation estimates
- insufficient benchmarking of cost uncertainty (as a basis for assessing acceptability of benefit uncertainty
- lacking credibility when on-site information is not used

Steps required to apply the method within a case study

The flowchart below provides a short description of the generic steps used in spatially explicit value transfer. Value transfer is embedded in decision analysis. A more detailed decision-tree can be found in appendix.

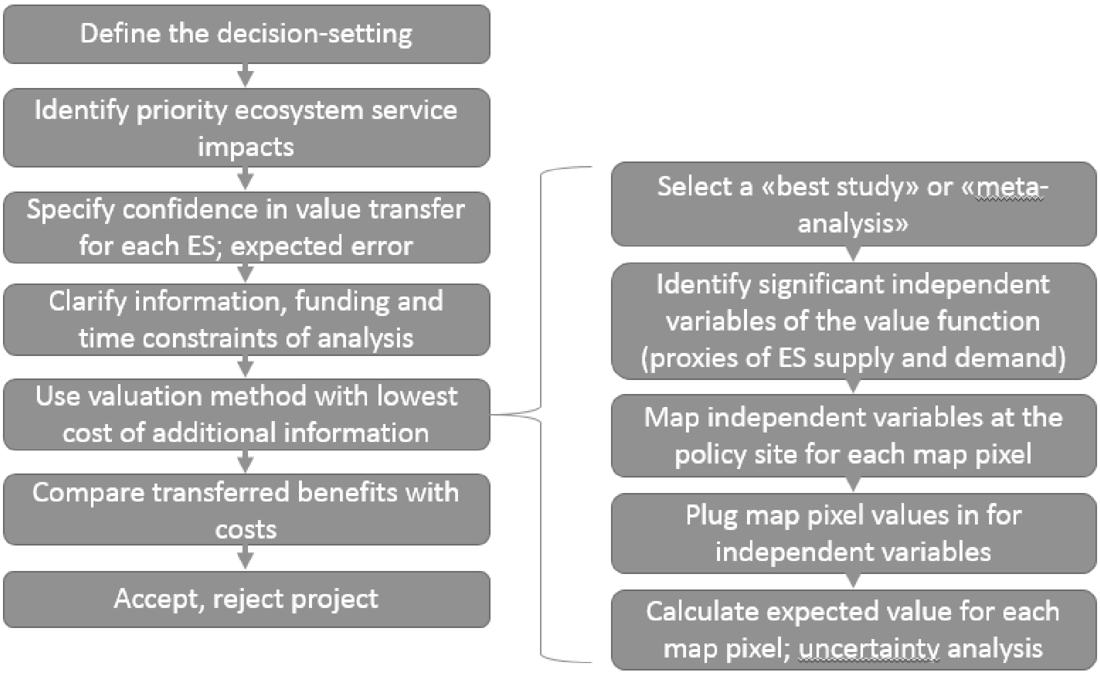

Figure 4.20. Stepwise process of value transfer

Illustration of practical applications of the method using the OpenNESS case studies

Value transfer has been applied by Case Study #3 in estimating the potential willingness to pay for conservation of green spaces in Oslo, based on an international meta-analysis of green spaces (Barton et al. 2015b). Value transfer is also being explored in Case study #6 comparing the results from value transfer methods with the preference information from MCDA methods.

NOTE: it is likely that a lot more case studies are referring to available valuation estimates in the literature to raise awareness about ecosystem services in their case studies, but have not identified this as value transfer as such.

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5. Capturing plural values with integrated valuation: comparison of the proposed methods

This chapter aims at comparing the methods proposed in Chapter 4 for the assessment and valuation of ecosystem services from two distinct perspectives. On the one hand, we analyzed the methodological requirements of the methods to find method clusters that require similar investments in expertise, time and other efforts. On the other hand, we carried out an in-depth analysis of what extent different methods are able to capture a variety of plural and heterogeneous values attached to ecosystem services. Results are summed up in chapter 5.1 and 5.2, respectively.

5.1. Comparative analysis of the proposed methods based on methodological requirements

The integrated analysis of sociocultural and monetary methods regarding the methodological requirements and the scale at which different methods can operate allow us to identify common patterns that relate with the resources investment required for developing each of the methods. The hierarchical cluster analysis of the variables – associated with data requirement, needed collaboration with other scholars and stakeholders, need of advance software skills, requirement of economic and time resources – show that there are six groups of methods (Figure 5.1.):

1) methods that require lots of new data and collaboration with scholars from the same field (i.e. stated preference and travel cost methods),
2) methods that require lots of new data and collaboration with scholars from other filed (i.e. hedonic pricing and production function),
3) methods that require lots of new data, although medium level of economic and time resources;
4) complex integrated approaches (i.e., multi-criteria decision analysis (MCDA), scenarios planning, deliberative valuation, public participatory GIS (PPGIS) and cards games), which require some more data and collaboration with scholars from other field and non-academic stakeholders; and
5) methods that usually work with available data and, thereby, have low requirements of time and resources (i.e. social media analysis, value transfer and cost-based approaches) and that also require
6) special software management skills (i.e. Bayesian belief networks, shadow-pricing).

Therefore, from group 6 to group 1, there is a gradient of new data demand and resource requirements. In fact, at higher level, the three first groups correspond to a cluster, which has as an inherent feature the need of collecting lots of new data for valuing ecosystem services, either in monetary (groups 1 and 2) or non-monetary metrics (group 3). Further, while methods of group 3 are able to value ecosystem services at local and regional scales, methods of group 1 only operate at regional scale and methods of group 2 at local scale. Methods of group 4 are able to value ecosystem services across scales, from local to national.

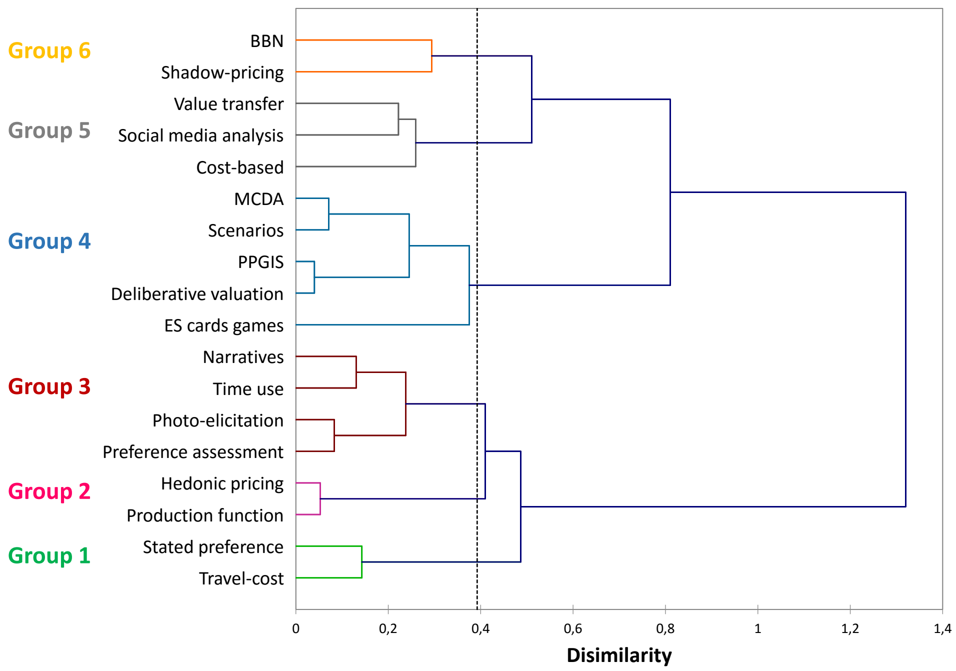

Figure 5.1. Dendogram of methods for value ecosystem services considering their specific technical requirements.

5.2. Comparative analysis of the proposed methods based on their integrative capacity

Value pluralism?

The promise of integrating diverse values through translation into a common monetary unit has proven illusive, and the complexity of the valuation debate defies hopes for a silver methodological bullet. One of the key challenges remains the integration of different value types –which are captured at different moments throughout an assessment process, qualified or quantified using different methods and ethical frameworks – in decisions.

However, in daily life, decisions – also political ones – are *already* based on integration of multiple criteria, both quantitative (*how much will this cost me*) and qualitative (*how damaging is this to my political image*) and spanning all value domains from the economic (*jobs for the region*), through the ecological (*obey environmental legislation*) to the social (*we need to provide for the poor*). Integrated valuation is happening all around us, albeit mostly implicitly.

Integration?

Rather than cherry-picking single valuation results for a predefined cause (economic values to argue for conservation or ecological value to excuse exploitation), more and more decision makers are aiming at improving governance by including as much information as possible, and now argue for broader valuation scopes and capturing multiple values.

Valuation methodologies capturing the values of Nature in one single metric are actually invalid in complex decision contexts. Ground-truthing these valuation exercisces reveals large blind spots (key societal values which are not represented) and biases (values which are gravely under/over-estimated). The central idea of integrated valuation is to make societal decisions more transparent by making explicit as much supporting information as possible. Not the integration itself – which essentially happens in the decision process – but providing the different and diverse information blocks is the methodological challenge. Value pluralism requires methodological pluralism.

Ecosystem services vs. multiple values of Nature

What are these different values of Nature? There are many different value typologies which all seem to be similar but still different, and which have been used in different valuation schools. The total economic value (TEV) typology for instance originates from environmental economics is a very encompassing one which has been applied mainly in monetary/micro-economic perspective. Ecosystem services as an agent of 'values of nature' has proven effective in communicating awareness on the micro-economic value of nature, but does not seem to be consistently linked to broader economic value types. The ecosystem service typology not being a value typology already invokes a risk of blinding certain values which are harder to fit in the ecosystem service framework. One ecosystem service might be also linked to several values: local food production has economic, health and wellbeing effects as well as important cultural components. The cultural ecosystem services category in particular has been topic of ongoing debate as it forms an amalgam of use, non-use and cultural values which is not only hard to capture and structure, but often turns out to be the category of highest societal and political importance (e.g. Chan *et al.,* 2012.). Similar unfinished debates surround the supporting services category, recognized essential but polemic (e.g. the biodiversity-ecosystem service debate, Mace *et al.,* 2012.). This essentially points to the difficulty and challenge of capturing social and ecological values. Although these are recognized – mainly with lip service – alongside economic ones, the application and language of TEEB and CICES has been mainly monetary/economic, and valuation of multiple ecosystem services occurs mostly within this same comfortable value category. This has afflicted ecosystem services with the instrumental/monetary economic association which makes it today even more difficult to be accepted as a framework for social and ecological/ethical valuations. This is recognized/reflected in the broadened values of Nature typology applied in the IPBES assessments (IPBES, 2015) which places ecosystem services in the instrumental value category.

Following the conceptual definitions provided for value categories of the TEV, TEEB and IPBES typologies, a considerable overlap and integration but also a broadening of the valuation scope can be assumed (Figure 5.2.).

<table>
<tr><td>IPBES</td><td colspan="5">Non Anthropocentric (Intrinsic)</td><td colspan="3">Instrumental</td><td colspan="2">Relational</td></tr>
<tr><td>TEEB</td><td></td><td colspan="4">Ecological</td><td>Monetary</td><td colspan="3">Socio-cultural</td><td></td></tr>
<tr><td>TEV</td><td></td><td></td><td>Existence</td><td>Bequest</td><td>Option</td><td colspan="2">Use (direct +indirect)</td><td></td><td></td><td></td></tr>
</table>

Figure 5.2. Conceptual alignment of three value typologies. From TEV to TEEB and IPBES, an integration and broadening of valuation scope can be assumed.

How integrated is our valuation?

The question remains as to how ecosystem service valuations capture the broad range of values associated with Nature. Within the IPBES framework, ecosystem services are considered part of instrumental values (valuing ‘nature’s benefits’). Practical and common sense application of valuation methodologies often cross these theoretical borders in attempts to capture the important, but elusive categories. The following analyses are based on a survey among OpenNESS researchers who are involved in development and application of practice-oriented methodologies for valuation. We have covered monetary, non-monetary as well as more generic methods. Biophysical methods, described in detail in D3.2, are mostly absent from these results. The survey was performed among the respective method development teams, and results were cross-validated by researchers from methods from different categories. For each method, respondents scored the suitability to capture all 11 value categories presented in a flat table (i.e. not aligned like in fig 5.2.). The scores were *Highly appropriate (designed for this), Suitable (without severe conditions), Less suitable (implying conditions), Not appropriate (risk for biased outcomes)*. The resulting analyses reflect the extent to which diverse valuation methods capture specific value types, the extent to which methods have integrative potential as well as which set of complementary methods can be applied to capture multiple values, *as estimated by the researchers that developed the methods*. This was then combined with a synthetic factor based on the implementation requirements (see Chapter 5.1) to further guide the choice of a method set from a parsimony point of view.

Table 5.1. Results from the suitability survey of valuation methods to capture multiple values.

	IPBES values			TEEB values		
	Nature (intrinsic)	Nature's benefits	Quality of life	Ecological	Socio-cultural	Monetary
BBN	Less suitable	Suitable	Suitable	Suitable	Suitable	Suitable
card game	Suitable	Highly appropriate	Highly appropriate	Less suitable	Highly appropriate	Less suitable
cost-based	Highly appropriate	Suitable	Less suitable	Highly appropriate	Less suitable	Suitable
deliberative approach	Suitable	Suitable	Highly appropriate	Suitable	Highly appropriate	Less suitable
hedonic pricing	Not appropriate	Highly appropriate	Less suitable	Less suitable	Suitable	Highly appropriate
MCDA	Highly appropriate	Highly appropriate	Highly appropriate	Highly appropriate	Highly appropriate	Highly appropriate
narrative	Suitable	Suitable	Suitable	Highly appropriate	Highly appropriate	Not appropriate
natmap	Not appropriate	Highly appropriate	Not appropriate	Less suitable	Highly appropriate	Not appropriate
participatory mapping	Less suitable	Less suitable	Highly appropriate	Highly appropriate	Highly appropriate	Less suitable
photo elicitation	Less suitable	Suitable	Less suitable	Suitable	Highly appropriate	Less suitable
photoseries	Not appropriate	Less suitable	Less suitable	Not appropriate	Suitable	Not appropriate
preference assessment	Less suitable	Suitable	Suitable	Less suitable	Highly appropriate	Not appropriate
scenarios	Less suitable	Highly appropriate	Highly appropriate	Suitable	Suitable	Suitable
shadowpricing	Not appropriate	Highly appropriate	Less suitable	Suitable	Less suitable	Highly appropriate
stateandtransistiomodels	Highly appropriate	Highly appropriate	Less suitable	Highly appropriate	Less suitable	Less suitable
stated preference	Less suitable	Suitable	Less suitable	Less suitable	Suitable	Highly appropriate
time use	Less suitable	Suitable	Suitable	Less suitable	Suitable	Less suitable
travel costs	Not appropriate	Highly appropriate	Less suitable	Not appropriate	Highly appropriate	Not appropriate
value transfer	Not appropriate	Suitable	Less suitable	Less suitable	Suitable	Highly appropriate
Degree of value capturing by all methods	Very Low	Very High	High	High	Very High	Low

	Total Economic Values (TEV)					Method potential for integration			
	Direct use values	Indirect use values	Existence values	Bequest values	Option values	IPBES	TEEB	TEV	**TOTAL**
BBN	Suitable	Suitable	Less suitable	Less suitable	Suitable	High	High	High	High
card game	Highly appropriate	Less suitable	Suitable	Suitable	Less suitable	Very High	High	High	High
cost-based	Suitable	Suitable	Not appropriate	Less suitable	Highly appropriate	High	High	High	High
deliberative approach	Less suitable	Suitable	Suitable	Suitable	Suitable	Very High	High	High	High
hedonic pricing	Highly appropriate	Less suitable	Not appropriate	Not appropriate	Less suitable	Low	High	Low	Low
MCDA	Highly appropriate	Highly appropriate	Highly appropriate	Less suitable	Highly appropriate	Very High	Very High	Very High	Very High
narrative	Not appropriate	Not appropriate	Less suitable	Less suitable	Less suitable	High	High	Very Low	Low
natmap	Highly appropriate	Less suitable	Not appropriate	Less suitable	Not appropriate	Low	Low	Low	Low
participatory mapping	Suitable	Less suitable	Highly appropriate	Highly appropriate	Suitable	High	Very High	High	High
photo elicitation	Suitable	Suitable	Suitable	Suitable	Suitable	Low	High	High	High
photoseries	Suitable	Less suitable	Less suitable	Not appropriate	Not appropriate	Very Low	Very Low	Low	Very Low
preference assessment	Suitable	Suitable	Suitable	Suitable	Less suitable	High	Low	High	High
scenarios	Suitable	Suitable	Suitable	Highly appropriate	Highly appropriate	Very High	High	Very High	Very High
shadowpricing	Highly appropriate	Highly appropriate	Not appropriate	Not appropriate	Not appropriate	Low	High	Low	Low
stateandtransistiomodels	Highly appropriate	Suitable	Less suitable	Less suitable	Less suitable	Very High	High	High	High
stated preference	Highly appropriate	Less suitable	Highly appropriate	Highly appropriate	Highly appropriate	Low	High	Very High	High
time use	Suitable	Suitable	Suitable	Less suitable	Less suitable	High	Low	High	High
travel costs	Highly appropriate	Not appropriate	Not appropriate	Not appropriate	Not appropriate	Low	Low	Very Low	Low
value transfer	Less suitable	Less suitable	Less suitable	Less suitable	Less suitable	Low	High	Low	Low
Degree of value capturing by all methods	Very High	Low	Very Low	Very Low	Low				

Method suitability to capture value
- Highly appropriate (designed for this)
- Suitable (without severe conditions)
- Less suitable (implying conditions)
- Not appropriate (risk for biased outcomes

Degree of value capturing by all methods
- Very High
- High
- Low
- Very Low

Method potential for integration
- Very High
- High
- Low
- Very Low

Broadly, the results show that some methods are specialized towards certain value types, while others are generalist methods able to capture multiple values, but not necessarily designed for those. All value types are covered appropriately by one or more methods, but all methods have blind spots which imply conditional application or risks of bias. Consequently, selection of a set of methods is a key step in the valuation process, if one wants to obtain a balanced coverage of all value types. How to select a battery of methods to target value types is discussed in the next section.

How does interpretation of value types correlate with the alignment based on definitions?

Ideally, the suitability of the methods would have to be mapped on the actual pattern of values (qualities and quantities occurring *in reality*), i.e. how methods capture these plural values. This leads to circular reasoning or at least a catch 22, as the only way to quantify or qualify the value objects is through these valuation methods. However, the interpretations/definitions of the value types are implicitly part of these suitability scores, and we can assume that the correlations between value types (regarding 'capturability', Figure 5.3.) are consistent with theoretical alignment based on the definitions (Figure 5.2.). Applying PCA, a multi-value space was created within which correlations between value types can be verified and visually compared.

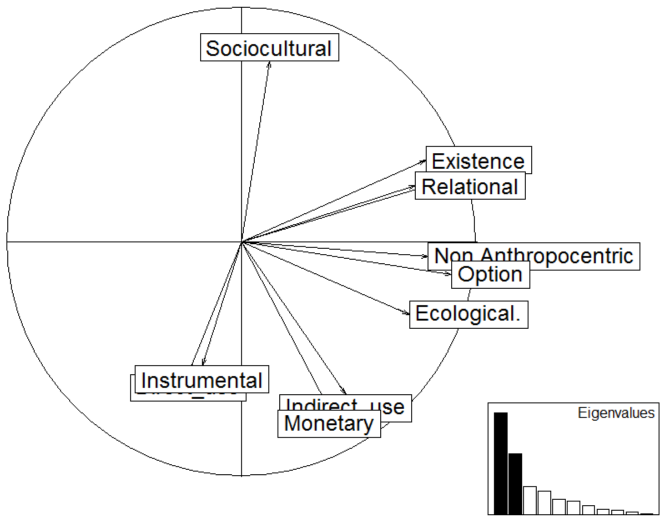

Fig 5.3. Correlation circle of value categories based on the suitability they are captured by openness methods.

Indeed, the correlation of value vectors confirms our theoretical alignment surprisingly well, with the exception of sociocultural which seems to oppose use values while remaining quite independent of the others. As we cannot use these three overlapping typologies all in one for further analysis (and presentation), we applied a combined categorisation: Non-anthropocentric values/Relational values/Sociocultural values/ Indirect anthropocentric values/Direct anthropocentric values.

Capturing plural values: which methods to choose?

Values are captured using methods. We have analysed 19 valuation methods[6] which are here grouped in non-monetary, monetary and generic ones (table 5.2.).

[6] Compared to the 18 methods described in Chapter 4, the NatMap tool (a citizens science app for ecosystem service valuation) and the State-and-Transition model, both described in detail in D3.2, were additionally included while the Production function method was excluded from this analysis, due to available information.

Table 5.2. Methods analysed and method type

Nr	Name	Type
1	BBN	generic
2	card_game	non-monetary
3	cost_based	monetary
4	deliberative_approach	generic
5	hedonic_pricing	monetary
6	MCDA	generic
7	narrative	non-monetary
8	natmap (described in D3.2)	non-monetary
9	participatory_mapping	generic
10	photo_elicitation	non-monetary
11	photoseries	non-monetary
12	preference_assessment	non-monetary
13	scenarios	generic
14	shadowpricing	monetary
15	state-and-transition models (described in D3.2)	generic
16	stated_preference	monetary
17	time_use	generic
18	travel_costs	monetary
19	value_transfer	monetary

The methods all have a distinctive suitability to capture each value type. The plural value space is structured by the opposition of direct use (first axis, right part of the plot) to all other values (except indirect use: slight correlation) along the first axis, and the distinction between sociocultural values and all others along the second axis (Figure 5.3. lower panel).

There is a clear valuation gap in the Relational and Non-anthropocentric values, where only some generic methods are partly suitable. Biophysical methods, which are not included in this analysis, could cover the non-anthropocentric (intrinsic, nature, ecological) values better, but the relational values (focusing on quality of life) remain a valuation gap.

Monetary methods are almost the only ones covering the direct use (one integrative one), but in fact most monetary methods overlap with the non-monetary territory capturing socio-cultural and direct use values (upper right quadrant). The most integrative methods are generic ones, although these seem less able to capture sociocultural values. Note that this effect is determined mainly by one method being “narrative”.

In general, methods to the lower left corner are increasingly integrative, but this integration depends on input from other methods, and thus requires application of multiple methods. No (non-generic) method seems able to capture all five value dimensions adequately. Choosing a single method means trading off reliability in capturing sociocultural and direct use values (upper right quadrant) to the other three value categories. The method requirements in this analysis demonstrate that more integration does not necessarily mean higher requirements. Methods with very low requirements are available for every quadrant, except the socio-cultural one (medium or high requirement).

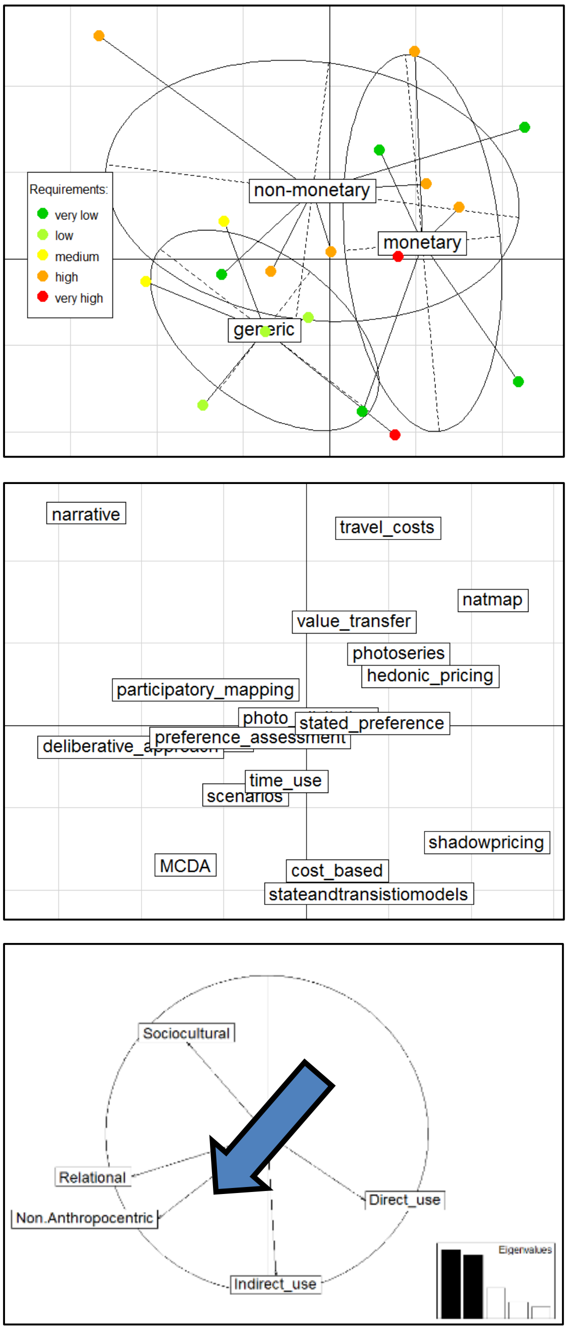

Fig 5.4. Positioning of the 19 Valuation methods per type in the plural value space. Requirements from section 5.1. Blue arrow shows the general direction of 'more integration'

Further analysis

Further analysis should work on defining and verifying the category of socio-cultural and monetary values. In fact, their definition is based on features of the methodology (use of money unit) rather than on the object they value, as is the case with TEV and IPBES typologies.

The typology of methods could also be refined to represent methodological features (e.g. participative, biophysical, etc.) rather than assumption on the valuation object. Linked to that, the generic methods, which require input from other methods, could be left out and regarded as integrative tools which can capture multiple values, depending on which methods are applied to populate them (e.g. BBN, MCDA). Furthermore, the biophysical methods should be added to the analysis. If these steps are taken, OpenNESS could develop an accessible guidance or protocol for selection of complementary methods based on suitability for capturing plural values, the method requirements (cost of implementation), and based on the specific project goals.

5.3. References

Chan, K.M.A., Satterfield, T., Goldstein, J., 2012. Rethinking ecosystem services to better address and navigate cultural values. Ecol. Econ. 74, 8–18. doi:10.1016/j.ecolecon.2011.11.011

IPBES, 2015. Preliminary guide regarding diverse conceptualization of multiple values of nature and its benefits, including biodiversity and ecosystem functions and services (deliverable 3 (d)). Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

Mace, G.M., Norris, K., Fitter, A.H., 2012. Biodiversity and ecosystem services: a multilayered relationship. Trends Ecol. Evol. 27, 19–26. doi:10.1016/j.tree.2011.08.006

6. Decision support at different governance scales

A broad message from previous chapters is that the purpose of valuation is generally different at different governance scales. Different institutional settings and site-specific situations condition the types of values we expect, the types of valuation methods we recommend, and the valuation outputs. The Integrated Valuation Framework under development in OpenNESS emphasises that *"ecosystem services valuation should be primarily practical and aimed at serving operationalization and real-world applications of the ecosystem services concept. It belongs to the science-policy interface and should ideally render information that is digestible and useful for stakeholders, decision-makers, and planners, as well as should allow different stakeholders groups to express the plurality of values and perspectives they hold"* (Gómez-Baggethun et al. 2014). The project developed a set of 'criteria for integrated valuation that would serve this purpose (Braat et al. 2014). While they are not criteria or 'necessary conditions' to qualify as "integrated valuation", they serve as a checklist or benchmark that can help guide studies in the right direction:

- Criterion 1: Policy & Management relevance
- Criterion 2: System Approach
- Criterion 3: Value plurality (incommensurability)
- Criterion 4: Value heterogeneity (context dependency)
- Criterion 5: Inter- and transdisciplinarity
- Criterion 6: Levels of societal organization
- Criterion 7: Consistent "scaling" of plural values
- Criterion 8: Consistent comparison of plural values in decisions

In this chapter we focus on Criteria 1 & 6 – policy and management relevance at different levels of societal organization. In this preliminary guidance we have not provided advice on when and how to scale and compare plural values (criteria 7 & 8), as these steps remain contentious if we want to maintain value plurality. We have yet to provide guidance on decision-contexts in which standardising and aggregating plural values could improve decisions and where it would not.

To 'benchmark' the discussion we present the OpenNESS integrated valuation criteria in light of key guidelines and initiatives on valuation of ecosystem services at different governance levels, including international, EU, Member State and local government level. The international guidance we discuss is represented by the Inter-governmental Panel on Biodiversity and Ecosystem Services (IPBES) "Preliminary guide for diverse conceptualization of multiple values of nature" (IPBES Deliverable 3d). At the level of the EU and Member States we discuss the Integrated Valuation Framework in relation to the projects on Mapping and Assessment of Ecosystem Services (MAES) and the related projects Mapping of Ecosystems and their Services in the EU and its Member States (MESEU) and Knowledge Innovation Project (KIP) on accounting for natural capital and ecosystem services. At the local level we lack a single guidance document that could serve as a point of comparison for the Integrated Valuation Framework. Here we link our tentative integrated valuation criteria to hypotheses we have formulated based on preliminary analyses of OpenNESS case studies. OpenNESS case studies reveal a number of challenges to operationalization of valuation, which are not evident when values are extrapolated, synthesised, and aggregated to higher governance levels.

We therefore finish the chapter with a discussion of the challenges that still lie ahead in the development of the final 'Guidelines for integration of valuation methods to assess ecosystem service policies'. In particular, we discuss 'valuation gaps' or 'valuation dilemmas' – situations where we would expect both monetary and socio-cultural valuation methods to be challenged conceptually, and/or where there is little evidence of their current use in decision-support. In particular, we look at the issue of conflict management, study scale &

resolution, and information costs. In the Appendix (Chapter 7.4) we explore complementary conceptual approaches that shed light on why there are 'valuation gaps'.

6.1. International – valuation in IPBES

IPBES was established to bridge the gap between science and policy in the field of biodiversity and ecosystem services (www.ipbes.net). It builds up an active science-policy interface, and creates links between development and environment, between the local and the global, and between the past and the future (Baste 2015). All IPBES actions and deliverables build on the IPBES conceptual framework that was created by an interdisciplinary group of scientists and indigenous knowledge holders, and was approved by national governments on the IPBES Second Plenary meeting (Díaz et al. 2015). The conceptual framework includes six interlinked components (nature, anthropogenic assets, nature's benefits to people, institutions and governance systems, direct drivers and good quality of life) that operate across different spatial and temporal scales. Beyond bridging these six elements, the conceptual framework also recognizes that this complex system of human-nature relations is embedded in different worldviews and cosmologies, and offers an approach to build a constructive linkage between these (e.g. between the western scientific and indigenous worldviews such at the Mother Earth). Thus, IPBES pinpoints to manifold aspects of integration.

The IPBES Preliminary guide for diverse conceptualization of multiple values of nature and its benefits (IPBES Deliverable 3(d)) builds on the IPBES conceptual framework, and acknowledges that different paradigms and worldviews influence the values that people and societies hold, and consequently assign to nature and its benefits. The Preliminary guide offers an inclusive and diversified valuation approach, which supports the bridging of different world views, values, and knowledge domains (including non-scientific knowledge and different disciplines within scientific knowledge). According to one of the IPBES Multidisciplinary Expert Panel member who co-chairs the valuation expert group, integration in this sense also means that the process of valuation is equitable and inclusive, and mindful of power relations (Pataki 2015). In line with this general approach, the guide covers a broad range of methods that are designed to capture and articulate the values of ecosystem services and biodiversity for human beings and societies, as well as methods that are able to bridge between inherently different valuation approaches.

The OpenNESS Integrated Valuation Framework is consistent with the IPBES framework in proposing context specific valuation methodologies to elicit plural and heterogeneous values of ecosystem services across disciplines, knowledge systems, and levels of societal organization. Like the IPBES guidance document, the OpenNESS guidance on integrated valuation emphasizes plural and heterogeneous values and the need to recognize, integrate and bridge different value categories (see also Table 1 in Chapter 1).

One key difference between the two documents is that the IPBES Preliminary guide makes a clear distinction between a pluralistic notion of value and associated valuation methods such as multicriteria assessments and a narrower approach mostly dominated by a market-based notion of economic value of nature, and takes an explicit stand in favour of pluralistic and integrated notions of value (IPBES 2015). OpenNESS draft Integrated Valuation Framework, in turn, does not recommend any valuation approach at the outset; instead, it starts from the assumption that valuation is context specific and that the relevance of value information for management and decision-making depends on the end-users' needs as well as the problem at hand (Braat et al. 2014). A starting hypothesis is that ecosystem service assessments usually cover multiple ecosystem services, ranging from provisioning services to regulating services and intangible cultural services, and different types of valuation methods are needed to capture the value of different services in different contexts. For instance, monetary valuation methods based on direct market valuation are well-suited for evaluating the economic value of provisioning services and other services that are directly mediated by prices (e.g., tourism), and revealed preferences methods, such as the travel cost method and time use studies, can capture economic aspects of recreational services. Socio-cultural methods are applicable in capturing place-specific values that local people assign to ecosystem services, while deliberative valuation and multicriteria evaluation methods are helpful in conflictual situations with incompatible, and sometimes even incommensurable, values and interests. In addition, different methods perform differently in terms of integrating plural and heterogeneous values, knowledge systems and spatial, temporal and societal organization scales – while some methods offer genuine integration along most of these aspects, others achieve only limited integration or have a rather one-dimensional approach. These hypotheses – underlined by chapter 5 in this Deliverable – will be tested in the case studies and refined, or redefined in D4.4, which revisits the framework in the light of the empirical experiences of OpenNESS.

IPBES regional and sub-regional assessments have started in 2015 and will last for three years, aimed at being approved at the 6th IPBES plenary meeting (April 2018). All regional assessments draw on the Preliminary guide on valuation and are based on secondary data, using existing studies and knowledge to compile an understanding of the current situation. The Preliminary guide proposes a step-wise approach for the assessment process to ensure the coverage of a broad range of values.

1. The first step is to identify which values might be at stake and relevant for a given topic of an assessment. Here it is recommended to refer to the IPBES conceptual framework to consider the different paradigms, worldviews and knowledge systems to avoid a narrow focus, for example, on monetary benefits.
2. The second step is to search for relevant literatures to cover the different value types. It is important not to focus only on monetary valuation studies. For example, anthropological studies are valuable in understanding the meanings of ecosystems and their benefits for local people, for example, in developing country contexts. A special attention should also be paid to indigenous and local knowledges that are often better documented in grey literature and narrative studies than in scientific literature (although good examples exist).
3. The third step is categorizing, sorting, and assessing values found in the literature, with a special emphasis of inclusion of the perspectives of relevant social groups. Here it is also important to highlight the gaps in knowledge and explore the ways to fill-in such gaps.
4. The fourth step is synthesis, up-scaling, and integration of the results of the analysis of the secondary material in order to compare the value information provided by different sources. Here one challenge is to reconcile value types that might be incommensurable, the recommendation is at least to recognize the complexity. It is suggested that multicriteria methods can be used to structure diverse value information. However, in OpenNESS Integrated Valuation Framework MCDA is not viewed as a tool that can be used ex post to bring together results for diverse valuation studies; instead, it is a problem structuring framework that can be used to elicit stakeholder values and support complex decision-making situations with multiple and often conflicting objectives that stakeholders groups and/or decision-makers value differently.
5. Reporting what is known, where the gaps are and what are the potential implications of the value information complied through the process.

The key lesson for OpenNESS learned from the IPBES approach to valuation is the emphasis on diverse conceptualizations on nature, covering indigenous value systems and world views. This perspective is basically included in the definition of integrated valuation and partly covered by the methods templates included in this report, but it does not receive as much attention as in the IPBES document. Given it primary focus on Europe, in OpenNESS, most methods apply a western scientific worldview, and while some of them offer a more inclusive approach, none refers directly to indigenous or local knowledge based, holistic valuation approaches. One reason for this is that OpenNESS has a strong focus on European case studies and therefore fits the methodological tools to the most dominant worldview of western societies. However, being inclusive and opening the floor to various, non-science-based discourses that are marginalized within the dominant western worldview is an important direction to increase the integrative capacity of these methods.

In turn, the IPBES process can also benefit from OpenNESS results. As the IPBES regional assessment of Europe and Central Asia is still going on until the first half of 2018, empirical results of individual OpenNESS case studies as well as synthesis results and recommendations from the whole project can be channeled into the IPBES assessment as existing data and knowledge about the values of ecosystem services within Europe. To some extent, the IPBES process has already benefitted from the work in OpenNESS, particularly on socio-cultural and bio-physical valuation, deliberative valuation and multi-criteria decision analysis methods, thanks to OpenNESS researchers who volunteered in the IPBES valuation expert group. These links have been and will be further strengthened by the inclusion of several OpenNESS researchers in the ongoing regional assessment.

6.2. EU and Member States – valuation in MAES

MAES is a project for Mapping and Assessment of Ecosystems and their Services Indicators for ecosystem assessments under Action 5 of the EU Biodiversity Strategy 2020 (EC 2014). MAES addresses the European Biodiversity Strategy to 2020 and Action 5 aiming 'to make ecosystems and their services key parameters *informing planning and development processes and decisions.'*

A recent evaluation of MAES (Braat 2015) concluded amongst others that bringing economic valuation aspects into mapping may be premature for Member States' MAES because of the ongoing discussion on how to map social and economic demand and value of ecosystem services. It called for the development of an integrated assessment and valuation framework in which biophysical, socio-cultural, and economic value domains are recognized. In the following, we identify some of the policy expectations of valuation methods, and what this means for OpenNESS.

Mapping of ecosystem services has different decision-support purposes in different sectors. MAES has reviewed how it can support policy. High quality information is needed in order to *identify priorities for restoration*, *support the deployment of Green Infrastructure,* and enable development of a *No Net Loss Initiative*. More specifically, in the Common Agricultural Policy MAES aims to *support discussion on public goods provided by agriculture and the assessment of tradeoffs for a better use of resources and improved spatial targeting of policy measures*. In Forest Policy, MAES will contribute to *assessing, mapping and accounting for forest ecosystem services and sustainable forest management* (SFM). In Water and Marine Policy, MAES aims to facilitate more cost-effective protection and management for good ecological status, especially identification of *priority operational actions* for watersheds and spatially based marine conservation measures. In Climate Action, MAES aims to *identify protective functions of ecosystems* preventing or mitigating downstream and coastal flooding, drought, and heat waves, as part of a wider emphasis on nature-based solutions for climate adaptation. In Regional Policy, MAES aims to contribute to *optimising delivery of ecosystem* services through *right decisions about future investments*.

From the above we observe that MAES has high expectations for policy analysis and decision-support which in most cases go beyond ecosystem mapping, requiring valuation. Of note are expectations tied to priority-setting, trade-offs analysis, cost-benefit analysis, and optimisation. These are decision-support needs that require higher spatial resolution and reliability that go beyond valuation for awareness raising purposes. MAES aims to build the bio-physical foundation for subsequent *valuation steps in natural capital accounting* towards 2020. If UN Guidelines on Experimental Ecosystem Accounting are taken as a benchmark for methodology, valuation is assumed in this context to be monetary and restricted to market-price based methods (UN 2014, Obst et al. 2015). EU research projects like ESMERALDA are exploring expert-based scoring of demand across a comprehensive matrix of ecosystem services (Burkhard et al. 2014), i.e. metrics of relative importance (Chan et al. 2012, Gómez-Baggethun et al. 2014).

The MAES pilot on natural capital accounting aims at exploiting the potential for valuation and natural capital accounting at EU and national level. MAES has emphasised the development of the Common International Classification of Ecosystem Services Services (CICES), as a basis for a clearly categorised, well-structured and comprehensive input data set to accounting. The ambition is that natural capital accounts provide a unifying frame for tackling integrated assessment questions such as combined pressures from land to water and biodiversity proofing of other policies.

While MAES ecosystem service classification has become consistent through CICES, a common understanding of decision-support contexts is still rudimentary, often simply referring to TEEB terminology of 'capturing' values. Relatively little work has been done on operational classifications of the decision-contexts that accounting information aims to support, with the aim of understanding the scale, resolution, and accuracy requirements that valuation places on ecosystem mapping. There has been little discussion on how national accounting focused market-price-based values, and broad qualitative importance indicators should complement oneanother in different policy-support contexts faced at EU and Member State level. Socio-cultural and deliberative valuation methods are not discussed as relevant for the national or EU level, although deliberative approaches in national level scenario analysis have been based on both monetary and importance indicators as input (Haines-Young 2011a, Bateman et al. 2014).

MAES recognises that the natural capital concept does not address intrinsic values, and that these are important to include in decision-making. An 'ethical concern for the value of nature in its own right needs to continue to inform public and private decision-making' (EC (2014): p.65). OpenNESS argues that ecological, monetary, and socio-cultural valuation methods are needed to recognize plural values. There is a gap between this principle, and MAES policy expectations of trade-offs analysis and optimisation which face the practical challenge tools that can compare plural value information in the same decision context. For example, the no net loss agenda and rising prominence of biodiversity off-setting and habitat banking in European policies requires operationalisation of habitat equivalency analysis. A broad concept of "equivalency" would look across multiple ecosystem services, but an assessment of multiple ecosystem services begs the question of substitutability, whether one ecosystem service can compensate for another. In the "no net loss agenda" valuation is expected to find ways of compensating between ecosystem services, be it using monetary or other scaling techniques.

MAES recognises that the link between science and policy should be strengthened with more policy-relevant research. Also, the MAES (2014) report stresses that further guidance is needed on upscaling and downscaling data, and on indicators of condition and services in the spatial unit needed for assessment and reporting. Mapping of ecosystem services at a national scale has shown significant spatial mismatches between ecosystem service flows and demands, especially between urbanised areas and non-urban regions (Burkhard et al. 2014). While qualitative ecosystem service mapping makes it possible to observe broad patterns of mismatches there is little research on what types of policy this information can inform. The MAES Urban pilot is a response to the need for finer resolution of mapping data for local decision-support.

OpenNESS local case studies suggest that the challenges of how to upscale and downscale ecosystem service physical units is different from that of scaling 'importance scores' and even more so for monetary values in the context of benefits transfer. The future challenges of decision-support at local scale raise questions about the current MAES expectations of mapping and accounting for ecosystem services at national scale.

The Knowledge Innovation Project (KIP) on 'Accounting for natural capital and ecosystem services' (EC 2015) will provide the EU contribution to testing the UN System of Economic and Environmental Accounts (SEEA). The final aim is to generate indicators at macro-economic scale that complement and go beyond GDP. This will be accomplished by creating a *shared platform which will seek to integrate monetary and non-monetary valuation of ecosystems and their services.* The project envisages an EU layer of main accounts, where

Member States and research institutes can add extra detail or analytical layers. The core of the project is to generate primarily biophysical indicators which could then be used to derive estimates of value of ecosystems and their services. Among the final outcomes of KIP will be methodologies for estimation of economic flows associated to ecosystems, including valuation of ecosystem services. The aim of a *fully functioning integrated accounting system* is to provide information for better management of ecosystems and their services, including at local scales such as the urban agenda. It would provide *a multi-purpose tool that could be used for a range of policies, to evaluate the success and/or impact of most environmental economic and sectoral policies, also at different stages of the policy cycle.*

The KIP ambition of a *multipurpose* tool for a *range* of policies, but based on *a single set of accounts* seems to underestimate the need for different types of valuation at different governance scales, and the decision-context specificity of values (monetary or otherwise). In the EU 'accounting agenda' it should be noted that socio-cultural valuation is not often discussed. Rather the interpretation of 'non-monetary' information is 'environmental' or 'biophysical'. We see a need for better specification of the policy support purpose of natural capital accounting. Defining the relevant policy applications for natural capital accounting data will help determine where value transfer from national to local level is too unreliable and additional information on socio-cultural values is needed. The issues in downscaling and upscaling of bio-physical indicators between local and macro levels are different from those of scaling value indicators. This conclusion is supported by experiences with downscaling the ESTIMAP methodology from EU to local level in OpenNESS. In summary, OpenNESS is (still) faced with the challenge of demonstrating how natural capital accounting information at national level can complement monetary and socio-cultural valuation at local level, and how local level valuation can qualify national accounting data so that value transfer from national accounts is not used indiscriminately for municipal and project level policy analysis.

The MESEU project – Mapping of Ecosystems and their Services in the EU and its Member States (Braat 2015) – has studied the implementation process of MAES. In the MESEU Report, Member States frequently mentioned lacking data inhibiting mapping and assessment. At the same time MESEU concludes that there is a wide ranging supply of maps and data, to the extent that maps and accounting tables as precursors to economic valuation of ecosystem services is not considered a technical problem for Action 5. However, MESEU notes that scientists distrust how policy-makers will use ecosystem services mapping information, fearing that it will be used to the detriment of biodiversity. In particular, MESEU reports that some scientists fear that assessing and especially monetising ecosystems and their services could be used to enhance natural resource consumption under neo-liberal paradigms. From the policy side MESEU finds that ecosystem service assessments need to be made more interesting for policy-makers. 'Questions about the purpose of Action 5 and maps are recurring' (p.15). Also, assessments are incompatible because there is *no agreement on geographical units and resolution to use for each scale*. Furthermore, the time dimension of benefits from ecosystem services is often bypassed in ecosystem service mapping, although acknowledged as important.

In our opinion MESEU's findings indicate ecosystem service mapping has not properly addressed policy needs for information clearly enough. A number of reasons for the gap include ecosystem service mapping not being at the resolution required for operational decision-making, including screening, ranking, and targeting of projects and incentives. Lacking agreement on scales, units of analysis, and resolutions are also a sign that the policy support purposes of ecosystem service mapping (and valuation) have not been clarified or are too manifold to focus efforts. The lack of attention to time in ecosystem service mapping which was referred to above concerns using maps to monitor trends and project scenarios for sustainability analysis. In addition, we would argue that the question of "valuation response times" has wholly been ignored. What do we mean here? Operations research at local level needs valuation methods that have a fast turn-around. Implicit in large spatial scales is also longer study time frames – mapping, assessment, and valuation methods do not downscale linearly to lower levels because decision-windows of opportunity are much narrower at lower spatial scales. The 'response times' of valuation methods must increase as we move from an EU to national to municipal level.

In OpenNESS we think that distrust of how valuation results will be used is due to misinterpretations and different expectations by both research and policy of what valuation methods can deliver, when and where. We think clarification of the specific decision-support purpose of different valuation studies could go some way to allaying such mistrust. Additionally, a stronger science-policy interface would be desirable at the EU and especially at the national level, which allows valuation tools to be tailor-made to specific decision making contexts. In this respect, working mechanisms of the IPBES or tools and techniques frequently used in policy relevant participatory research might offer valuable insights. Bespoke valuation studies have additional cost, which the natural capital accounting agenda aims to minimise. Further research on the cost of valuation information, its accuracy and reliability all relative to 'values at stake' is therefore called for.

6.3. Local government – context specific valuation

At the local level valuation faces its strongest challenge in terms of operationalisation. Land use management outside protected areas is usually delegated to the municipal and provincial level and operationalised in land use zoning plans and permitting. Infrastructure projects are subject to environmental impact assessments, according to national and EU standards, but carried out by private sector consultants at specific locations and under heavy time constraints. As the spatial scale of a proposed land use change becomes smaller and individual land users' interests become visible (resolution increases), limitations to different valuation methods become much clearer. At these operational levels valuation methods are often criticised for being (i) too slow (ii) too expensive (iii) inaccurate (iv) unreliable, and (v) unrepresentative (Laurans et al. 2013, Barton et al. 2015a). But all methods do not suffer from the same weaknesses in the same contexts. By identifying the contexts in more detail OpenNESS is trying to better describe the comparative advantages of ecological, socio-cultural, and monetary valuation methods. This in turn helps identify what methods to use, for what, when, and where.

In the appendix we discuss a number of ways of conceptualising different valuation contexts, distinguishing types of governance, types of decisions, and types of conflicts. Further conceptual integration is needed, but operational descriptions of decision contexts and requirements of valuation are also needed.

Mismatch between monetary valuation research and decision-support needs

At the local level operational descriptions of decision contexts and requirements of valuation methods will help valuation practitioners match methods to policy expectations. Figure 6.1 provides an example of this kind of guidance regarding the relative accuracy expected in different decision contexts of monetary valuation.

In Figure 6.1. monetary valuation for advocacy only needs accuracy to distinguish values in terms of orders of magnitude. For ecosystem accounting valuation needs sufficient accuracy to monitor trends. In benefit-cost analysis used for screening purposes valuation needs to identify projects were expected benefits exceed costs, and for priority-setting net benefits must be sufficiently accurate to rank benefits. In the case of incentive design both marginal compliance costs and willingness-to-pay need to be sufficiently accurate to evaluate whether there exist feasible pricing alternatives. Finally, in litigation in courts, interim damages must be calculated with sufficient confidence to determine monetary compensation as distinct from punitive fines. These are relative accuracy requirements. Absolute accuracy requirements will vary by context, but in general greater accuracy will be expected at lower scales and higher resolutions.

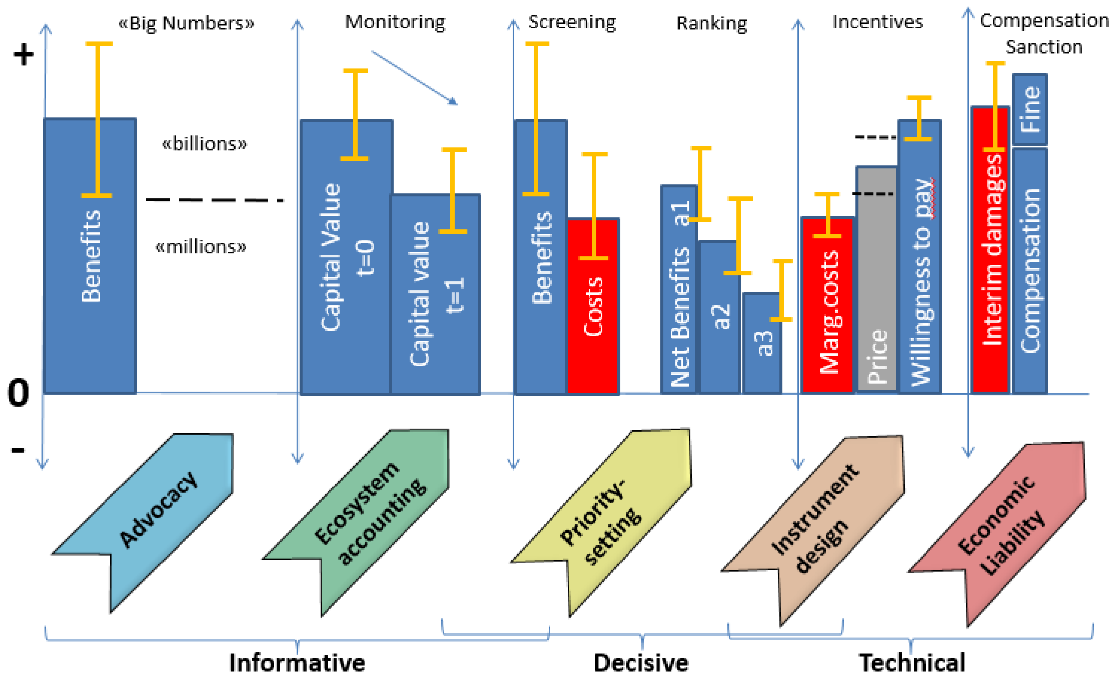

Figure 6.1. Detailing accuracy requirements of valuation methods. Confidence interval bars in yellow. See the Appendix for further discussion of this hypothesis.

Costs and benefits of valuation information

Environmental impact assessment (EIA) consider both priced and unpriced impacts. In fact in some countries ecosystem services are defined in guidance documents as 'unpriced' (Barton et al. 2015a). Guidance documents on EIA often propose qualitative valuation methods based on expert judgment, because of the need for rapid assessment. At local project-relevant spatial scales it is common to find decision-making unsupported by monetary valuation. There is a 'valuation gap' for assessment at small spatial scales where study costs are more likely to exceed the benefits of the additional information (Figure 6.2). Figure 6.2 also suggests that valuation at very large scales may be information inefficient. If there is large spatial heterogeneity, a single study design or value transfer will capture values with decreasing accuracy as scale increases. Taken together this suggests that monetary valuation may have some 'meso-scale' at which it may be information efficient, while at small local and very large scales it is unlikely to be. This is a hypothesis that requires testing, for both monetary and socio-cultural valuation methods.

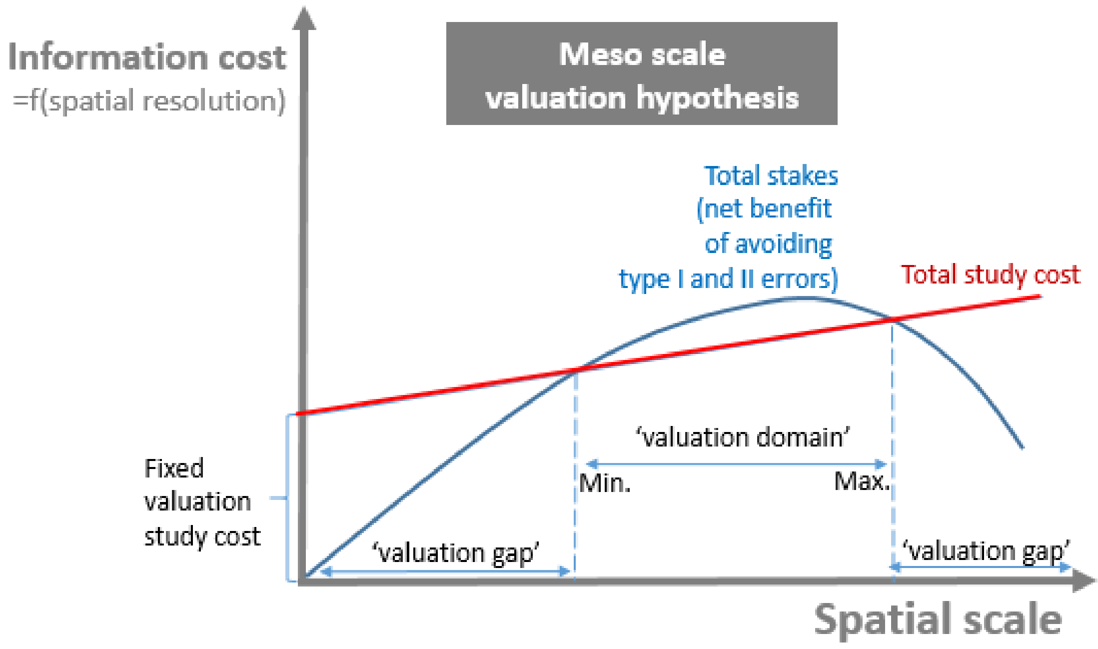

Figure 6.2. Meso-scale valuation hypothesis. Note: See appendix for further discussion of type I & type II errors in valuation for decision-support. See the Appendix for further discussion of this hypothesis.

Integrating decision-support contexts of valuation methods

Valuation methods applied in OpenNESS case studies show a large degree of 'domain overlap' between ecological, monetary, and socio-cultural valuation methods in terms of the tangibility of ecosystem services (Figure 6.3). While some ecosystem services such as provisioning services (e.g. timber) and regulating services (e.g. water purification) are relatively easy to observe and measure, some cultural ecosystem services such as cultural heritage, aesthetic qualities of landscape, or existence value of biodiversity are more difficult to capture in quantitative and particularly in monetary units. The intangibility of ecosystem service values depends on whether we are referring to values as virtues, principles or preferences (Chan et al. 2012). According to Chan and colleagues, values of cultural services tend to be non-market mediated, other oriented, holistic/group related, metaphysical, supporting services, transformative and bio/ecocentric. The hypothesis in Figure 6.3 is that socio-cultural valuation methods are better at describing these types of values. At the other end of the spectrum tangible ecosystem service values are market-mediated, self-oriented, individual, physical, final services, non-transformative and anthropocentric – the mirror hypothesis is that monetary valuation methods are designed to describe these types of values. Figure 6.3 also suggests that ecological valuation metrics often cover some issues that are intangible in the sense of being complex, spatially and temporally distributed (Vatn 2005), but tangible in the sense of being measurable in biophysical terms. In fact, it is difficult to find a classification of valuation domains that clearly distinguishes different valuation methods in terms of tangibility – valuation methods do not easily sort under different ecosystem service types or total economic value types, with many examples of method 'cross-over' methods between service and value types (Gómez-Baggethun et al. 2016(forthcoming)). Valuation methods overlap through adapting and sharing methodological approaches.

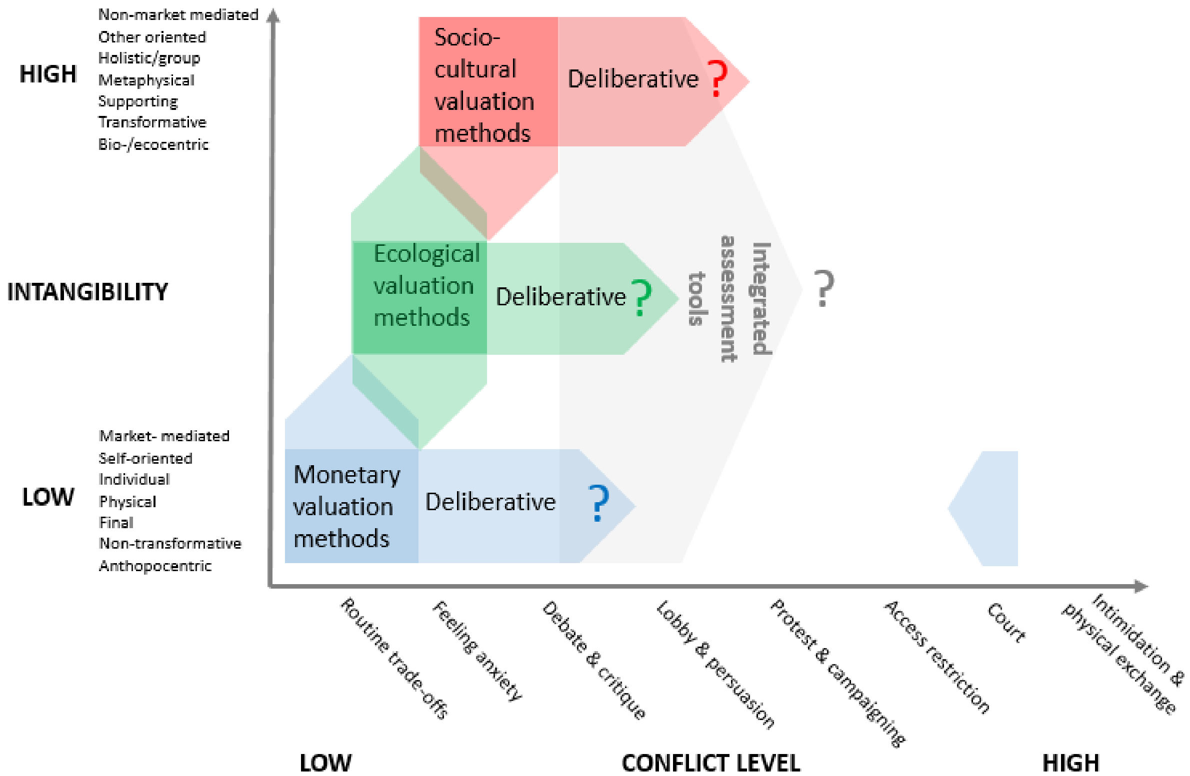

Figure 6.3 Comparative advantage and complementarity of different valuation approaches for different contexts. Source: own elaboration based on frameworks by Chan et al. (2012) and Yasmi et al. (2006)

Ecological, monetary and socio-cultural valuation methods are applied in 'expert-driven' or 'deliberation-driven' valuation processes. Another hypothesis of Figure 6.3 is therefore that the level of conflict is defining for which valuation methods are applied, how they are applied, and situations in which they cannot be applied. Yasmi et al. (2006) provides a classification and meta-anlaysis of escalation in natural resource management conflicts. The advantage of this framework is that the conflict levels are observable and can be used in broad classifications designed to illustrate valuation methods' different domains and complementarity. The hypothesis is that socio-cultural methods are somewhat more amenable to situations of conflict than monetary methods, but that all methods can be adapted to conflict situations by using deliberative techniques. Furthermore, integrated assessment and valuation methods have as an objective to extend the credible – in the eyes of stakeholders – domain of valuation methods by taking into account plural values (Gómez-Baggethun et al. 2014).

Overlap in valuation of ecosystem service benefits and values is an apparent 'double counting weakness' from a national accounting perspective and benefit-cost-analysis (Braat et al. 2014). In this interpretation, outputs from monetary valuation studies are used as marginal value estimates. On the other hand, valuation method outputs can be seen as 'arguments' in support of positions in a negotiation, or as contributions to a deliberative process. When valuation outputs are considered as 'arguments', conceptual overlap and similar findings from different valuation methods provide 'mutual support' in advocating the value of ecosystem services. This interpretation of valuation outputs could be valid in quite different decision-contexts (Figure 6.1) – in both policy advocacy at the one extreme and litigation in a court setting at the other extreme – different types of 'evidence' build a case.

Clarifying and testing the different potentials of ecological, socio-cultural, and monetary valuation in different levels of conflicting interest will help sort out false expectations between researchers and managers (of conflicting interests). It should also help valuation practitioners vying for the same decision-makers' 'attention space' see that they often have complementary rather than competing arguments.

6.4. Conclusions

Guidance on integrated assessment and valuation in OpenNESS aims to identify the comparative advantages of different methods in relation to different decision-support purposes. These purposes can be associated with decision contexts. Monetary valuation methods work best where choice alternatives are well defined, and stakeholder interests can be identified. The conceptual framework in Figure 6.4 was designed to further discussion on the purpose of monetary valuation methods.

Our review of the policy expectations of MAES finds that the ECs promotion vis-a-vis Member States of mapping of ecosystems for natural capital accounting purposes is very ambitious, covering almost all of the decision contexts in the framework. Ambitions for policy relevance will require a number of experiments in applying mapping and accounting data to decision contexts. At the same time initial guidance on Experimental Ecosystem Accounting of the UN SEEA (UN 2014) is strict, barring for example stated preference monetary methods (and by extension other survey and deliberative based valuation methods). In going forward MAES should therefore recognise the need for complementary valuation methods to address other contexts than accounting at national and EU scale. There should also be further research on 'valuation gaps' – based on the realization that there are certain contexts where monetary valuation of ecosystem services cannot be expected to provide support because of structural characteristics of the situation and the methods. In Figure 6.4 this is illustrated by an expected correlation between scale, resolution, and decision-context in terms of valuation contexts that are information efficient.

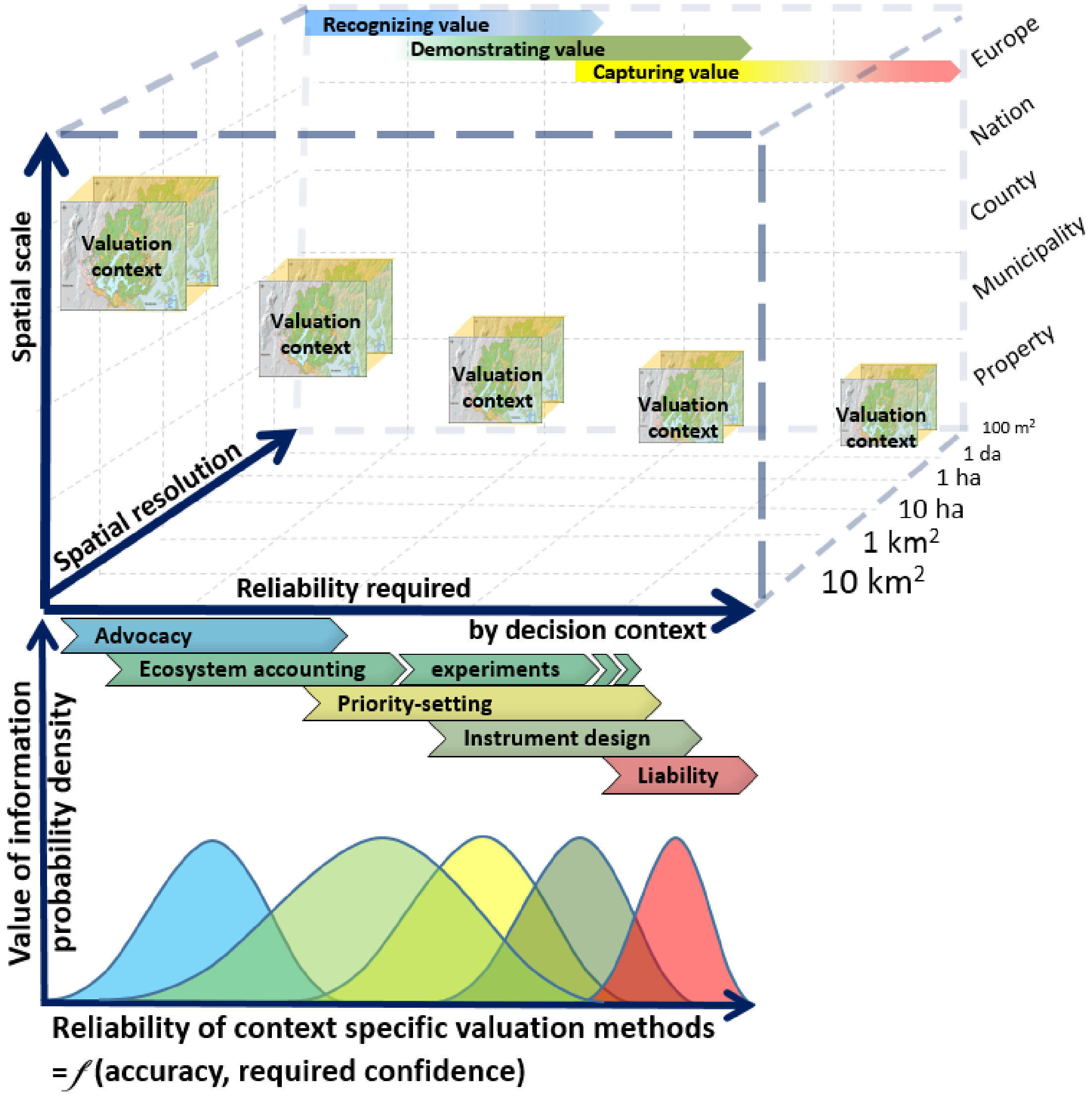

Figure 6.4 Hypothesis of comparative information efficiency advantages of valuation methods in relation to decision contexts. Source: based on Gómez-Baggethun and Barton (2013) and Schroter et al. (2014) .

Socio-cultural valuation methods, especially including deliberative approaches, have been promoted as methods to support conflict management (Wilson and Howarth 2002, Kenter et al. 2011, Kovács et al. 2015). Integrated assessment tools such as multi-criteria analysis hold out similar promise in the academic literature (Vatn 2009, Spangenberg and Settele 2010, Chan et al. 2012).

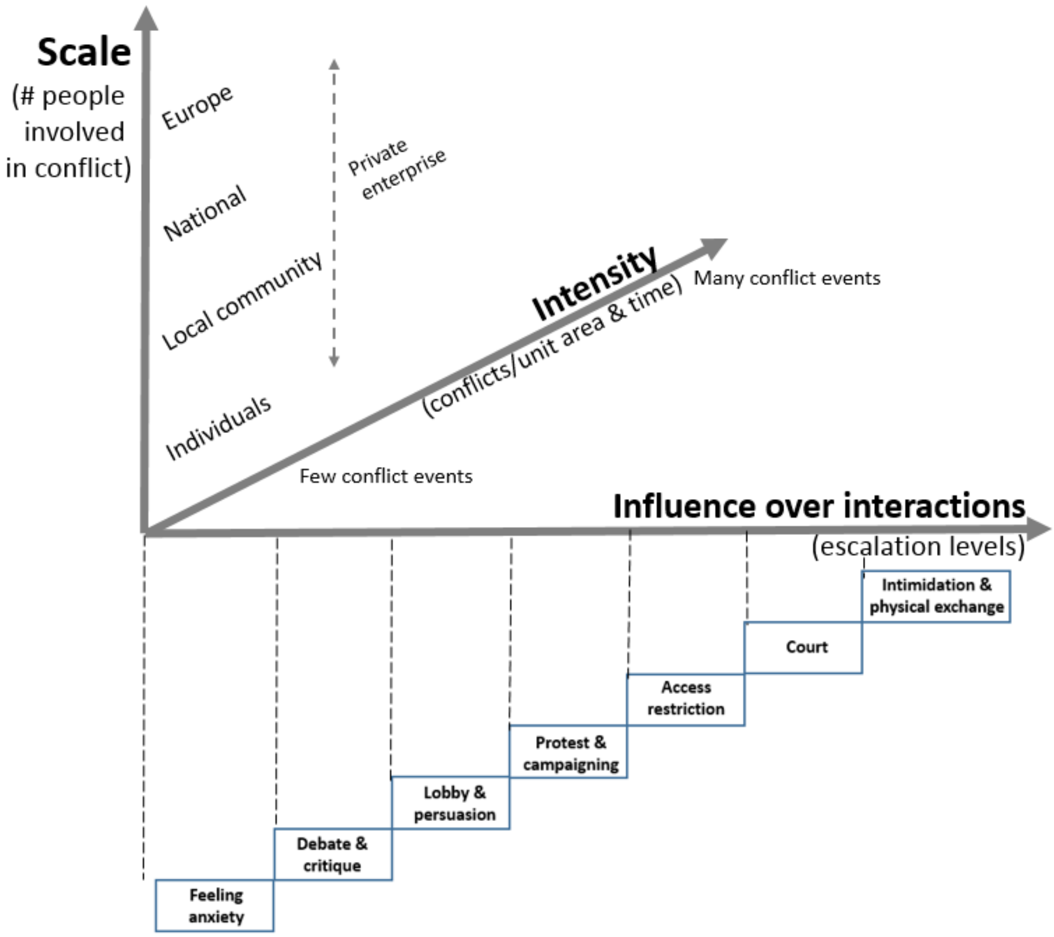

Figure 6.5 Conflict of interest as a basis for generating hypotheses about socio-cultural and deliberative valuation methods. Source: own elaboration based on frameworks by Jehn (1997) and Yasmi et al. (2006). See the Appendix for further discussion of conflict contexts and imlpications for valuation.

We argue that the promise of socio-cultural valuation methods for conflict resolution should be scrutinized as thoroughly as monetary valuation methods are scrutinized for their actual operational contribution to policy and decision-support.

Comparing valuation methods in terms of conflict levels also raises some hard questions about tools for integrated assessment and valuation:

- Are there conflict domains where no valuation or assessment method is feasible or useful?
- Are there limits to useful valuation as conflict escalates?
- Are these limits different for ecological, monetary, and socio-cultural valuation methods?
- Can individual valuation methods relevance be extended to more challenging conflict situations by using deliberative approaches (hybrid valuation methods)?

These are questions that could be examined in greater detail in the final Guidelines (D44) in light of OpenNESS case study findings.

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7. Appendices

7.1. Deliberative valuation methods in detail: citizens science applications, photovoice, focus groups and citizens juries

Citizen science applications

General purpose

The term Citizen Science (CS) refers to the fundamental engagement of citizens in scientific research by contributing to science with their knowledge, observations, intellectual efforts in data analysis and interpretation, as well as with their tools and resources. In CS citizens are not only data providers, but they can take an active part in raising new questions and co-creating scientific knowledge on certain topics. CS thus helps democratize the process of knowledge generation, enables social learning, and serves as a solid basis of evidence-informed decision making (Socientize Consortium 2013, Dickinson and Bonney 2012).

CS is becoming more and more popular thanks to the availability of ICT tools and the wide scale internet access. Mobile applications and online tools have been developed and used in environmental sciences to co-generate scientific knowledge on several topics interrelated to ecosystem services, e.g. monitoring the effects of and the adaptive capacity to climate change, documenting land use changes, monitoring the dynamics of invasive species, detecting rare species, or valuing different landscape elements (e.g. large trees). However, there are only a few documented examples where CS tools have been used to assess ESs.

Technique description

The easiest option is to apply existing tools (open source mobile applications or computer assisted online tools developed by others) to certain tasks of ecosystem services valuation, although there are a very limited number of available apps in this scientific field according to our present knowledge. A promising example is the NatMap mobile application being developed by UFZ to map ecosystem services (especially cultural ESs) – for more information on the application please check D3.2.

The more creative solution is to develop CS by the research team itself in a customized way, by using web-based open access platforms. CrowdCrafting (crowdcrafting.org) is one of the most easily available of such platforms powered by the PyBossa software. This platform enables researchers to create and run projects that utilise online assistance of citizens in performing tasks that require human cognition (e.g. image classification, data collections, geocoding). In the Appendix we provide a list of applications already in function as a possible source of developing new ideas or a combination of existing tools.

Practical aspects

The key requirement of applying CS tools for the non-monetary valuation of ES is the combination of software development expertise with a solid knowledge of ESs and valuation methods. The time and resources needed for CS apps depends largely on the exact tool(s) and on whether they are developed and customized by the research team itself.

Advantages and limitations of the technique

Compared to traditional research where all activities are carried out by scientists, citizen science projects can save lots of time and cost (i.e. Kaartinen et al. (2013) indicated that they saved three-quarters of the costs of their research project that analyzed the relationship between biodiversity and the decomposition of dung with the participation of young people). Key challenges are: to ensure the security of the application and the integrity of the backend database, to recruit citizens to participate, and to ensure the quality and reliability of results.

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Photovoice

General purpose

Photovoice belongs to the family of participatory action research (PAR) methods and aims to shed light and generate public discourse on locally relevant topics to reflect the viewpoint of specific (often oppressed) social groups. The method was developed in the field of public health (Wang 1999) and has been mainly used in community development. Recently it is entering different fields, among others political ecology and environmental anthropology (Gubrium and Harper 2013). It has a strong potential to involve marginalized social groups (e.g. the youth or minorities) in the process of ES valuation, to shed light on social and environmental injustices rooted in ES trade-offs and access regulations, and to bring their special viewpoint into the public discourse as well as the decision making process. However, up till now there are no well-documented empirical examples on how this method can be used for the purpose of ecosystem service valuation.

Technique description for data collection and analysis

The process of doing the Photovoice method can be divided into four key phases (Wang et al. 2004):

1. Preparation: in the preparatory phase the research team has to establish strong relationships and build trust with the community group(s) to be involved. As a first step, a common conceptualization of the problems at hand is needed (e.g. the ongoing deterioration of crucial ESs, or the unequal access to ESs), and then the main goal of the process can be defined in a participatory way. Still in the preparatory phase it is suggested establishing a science-policy interface by recruiting policy makers as the target audience of the results.
2. Taking pictures: volunteers from the community group first attend a training on how to use the cameras and deal with ethical issues of taking photographs. Then they receive the cameras and go out to take photographs individually or in pairs / small groups for a predefined period of time (e.g. for a week). It is also an option to ask the group to meet periodically (e.g. once per week for a month) and go out for only a few hours to take the photographs in the same time. Photographers then select the most important (or simply the favourite) photos themselves to share with the group and the larger audience.

3. Initiating discussions: in the third phase the selected pictures are used to generate group discussions among community members while viewing the photographs. Predefined focus group guidelines (e.g. the SHOWED method) can be used to prompt the discussion (Wang et al. 2004), but simple facilitator-generated questions may also serve to deepen the discussion by discovering personal motivations, stories and strategies for collective action. Narratives should be documented and key issues and themes can be codified.
4. Reaching a wider audience: the last phase of the process aims at communicating to policy makers, institutional representatives or the larger community e.g. through exhibitions where the audience can get in touch with the photographers and discuss the photos informally. In this way the Photovoice method can empower marginalized social groups to communicate their opinion and reach decision makers who are usually inaccessible for them.

Practical aspects

If the research team already has a strong relationship with the community groups to be involved, the whole process can be carried out within 1-2 months. However, the preparatory phase of the project can be much longer (6-8 months) if there is no previous working relationship with the community and trust building has to be started from the beginnings.

It is important to have some experience with facilitation/mediation and community development work, and to be familiar with the social problems of marginalized communities. Additionally, professional experience with photography is necessary during the training session.

Material requirements of the method include disposable or cheap digital cameras (to be distributed to community photographers), laptops and projectors (or moveable printers) to support the photo selection, and room facilities and equipment for the group discussions and closing exhibitions.

Advantages and limitations of the technique

The main advantage of the method is that it provides an alternative way of expressing ideas about a community issue (a problem related to ESs), and therefore it helps include marginalized social groups. It collects detailed information and personal impressions from community members and share these with the wider audience in visually, thus the results are comprehensive and at the same time easily used in the media.

A key challenge of the method is the required high level of trust between the research team and the community, which can be time consuming if there are no existing relationships. It can be costly due to the required equipment (cameras) and the professional staff (facilitators, photographers).

Example

Harper, K., Steger, T., Filcak, R. 2009. Environmental Justice and Roma Communities in Central and Eastern Europe. Environmental Policy and Governance 19(4): 251-268.

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Focus group variatons

General purpose/aim

Focus groups are conversations in a small group of people on a specific topic with the aim of getting to know the group's opinion on the research topic. Group dynamics and interaction between the participants are as important as the answers given to the pre-defined questions (Merton et al., 1990; Barbour, 2007). Focus groups can be used in ecosystem service valuations to initiate an open dialogue on ecosystem services and to form the preferences of stakeholders (community members) collectively, thus they can be used in deliberative valuation processes for knowledge co-generation. The result of focus group discussions is twofold: the list of ESs having a key role in the community, and the understanding of plural values linked to ESs. Additional outcomes of focus groups can include: social learning process between different stakeholders and researchers, discovering and mediating social conflicts rooted in ES trade-offs.

Technique description for data collection and analysis (steps to follow)

A focus group study usually includes 5 key steps, as summarized by the figure below:

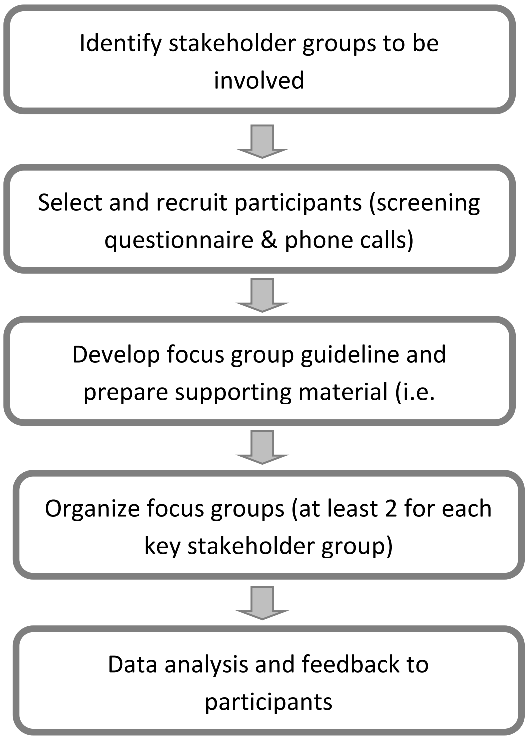

Figure 7.1. Consecutive steps of a focus group study

Different variations of the focus group technique can be applied for knowledge-cogeneration and collective preference formation in relation to ESs:

- Photo elicitation groups: participants of the focus groups are asked to discuss and prioritize photographs representing the key ecosystem services of their surroundings. Expert estimation or previously collected empirical data on local perceptions (e.g. the local inventory of ESs compelled from semi-structured interviews) can be used to choose the services to be represented by photos, but it is useful to follow one of the common ES classifications (e.g. MA, TEEB or CICES) to be able to provide a full list of potential services. Photographs have to be taken and sorted out by the research team prior to the focus groups, and should have similar characteristics (e.g. in terms of visibility, cloudiness etc.). Group discussions have to be recorded (by tape or video recorder), and transcriptions have to be analysed qualitatively with interpretative techniques (e.g. with grounded theory (Charmaz 2006)).
- Concept mapping groups: concept mapping or mind mapping can represent the knowledge structures and mental models of humans visually, showing concepts and their relationships graphically in a drawing (Soini, 2001). In this focus group variation participants are asked to conceptualize one or a few ecosystem services and their embeddedness into the ecological and social system. As a preliminary step, the key service(s) which would be analysed have to be chosen either on the basis of expert knowledge or on empirical data about local perceptions of ESs. In the brainstorming phase participants are asked to note the 3-5 key concepts coming in their mind in relation to the chosen service(s). The brainstorming phase can be used to collect free associations, but can also influenced by the moderator by asking participants to take note on predetermined issues (e.g. the well-being effects of, or the ecological drivers influencing the chosen service(s)). Then each participant has to explain and put down him/her notes on a large flip-chart paper. In the discussion phase, participants are asked to rearrange the notes and link them with lines to build a logical relationship among the concepts. The resulting concept map represents the participants' collective understanding of the chosen service(s).

Practical aspects

The time required to carry out a focus group study depends on several factors, e.g. existing empirical data and expert knowledge about the key ecosystem services of the area, existing relationship with key stakeholder groups, experience in facilitating/moderating group discussions, experience in qualitative data analysis techniques. In general the preparatory phase (identifying potential groups of participants, screening questionnaire to filter the most suitable participants, developing the focus group guideline and supporting material (i.e. photographs) requires 1-2 months, organizing and transcribing the focus groups takes 1 month (but this also depends on the number of focus groups carried out), while analysing data and giving feedback to participants requires another 1-2 months. A solid background in social science is useful for the preparation and the analysis of focus groups, and a trained moderator is needed to facilitate group discussions.

Advantages and limitations of the technique

The main advantage of the method is that interaction within the group provides opportunity to cross-check data and to draw a more complex picture on the subject of discussion. The group setting opens room for creative solutions and possible to jointly conceptualise and understand un-known or unfamiliar research questions, thus it allows for a collective preference formation process. The focus group is a relatively cost-effective method: less time consuming than individual interviews, and the sessions are usually enjoyable for participants.

The main limitation of the method stems from its group-based nature: recruiting is sometimes difficult, participants tend to be self-selective, and group dynamics has a strong impact on data quality, which reinforces that careful moderation is needed (but sometimes not enough to reach a balanced outcome). Since the number of questions and the time allocate to each question is limited, data are often less deep and less detailed than in in-depth interviews.

Example

Kelemen, E., Nguyen, G., Gomiero, T., Kovács, E., Choisis, J.P., Choisis, N., Paoletti, M.G., Podmaniczky, L., Ryschawy, J., Sarthou J.P., Herzog, F., Dennis, P., Balázs, K. 2013. Farmers' perceptions of biodiversity: lessons from a discourse based deliberative valuation study. Land Use Policy, 35: 318-328.

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Citizens' jury

General purpose/aim

The citizens jury method was developed in the 1970ies as a deliberative decision making technique which allows citizens to learn about and discuss the core issue to find a common ground solution, and which support policy makers to include the needs and wants of the informed public in their decisions (The Jefferson Centre 2004). Citizens' juries can be used in various decision making contexts including environmental planning and ecosystem services management (see e.g. Blamey et al. 2000, Cork and Proctor 2005, Kenyon et al. 2001). As a valuation tool, the jury method can integrate data and information from various sources and can bring to the surface different social perspectives on ecosystem services. The result is a publicly acceptable, common ground recommendation reflecting the plurality of values, which can be used to support decision making and policy intervention in the field of ES management.

Technique description (steps to follow)

The main characteristic of the citizens' jury method is the randomly selected and demographically representative panel of citizens which meets for a few days to study and discuss the key topic and finally produces a recommendation acceptable for each juror. Variations of the method address the number of jurors (from 10-14 to 18-24 participants), the length of the process (2-4 days to 6 or more days), and the participants' relationship to the key topic (stakeholders or citizens who have no direct interests in the topic) (for more details on possible variations see Blamey et al. 2000 and The Jefferson Centre 2004).

A stepwise approach for the citizens' jury method is summarized in the figure below.

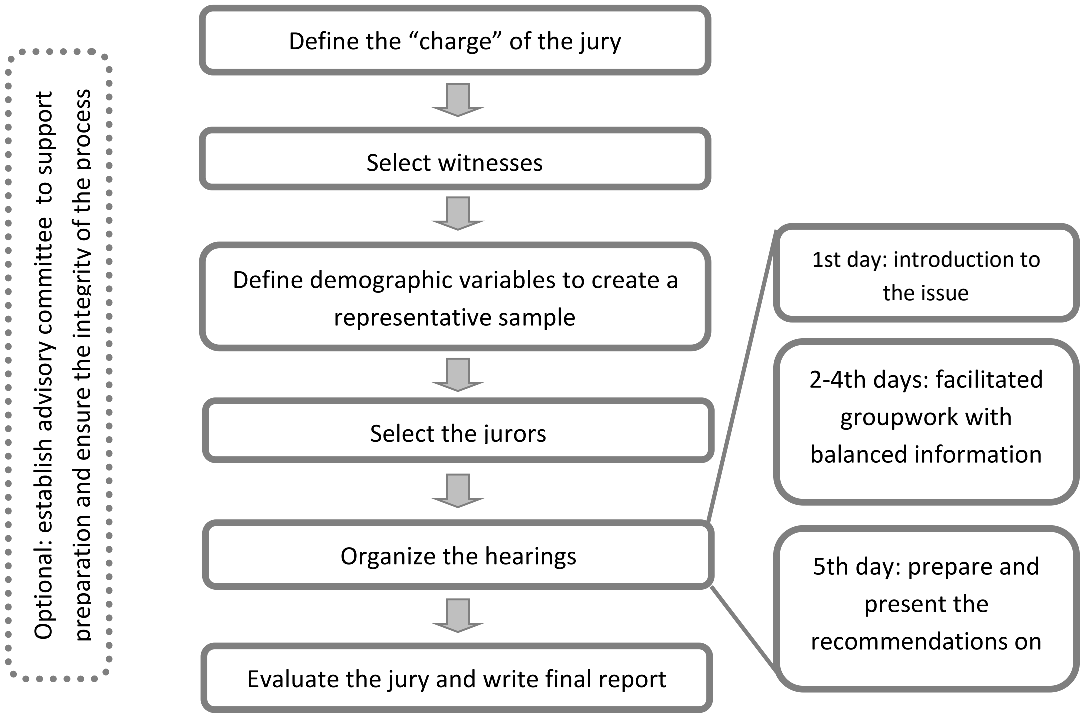

Figure 7.2. The major consecutive steps of organizing a citizens' jury

Following Figure 7.2. we can distinguish four key stages of a citizens' jury project:

1. Preparation: as the first step the key issue – often called the charge of the jury – has to be defined and witnesses have to be selected. The charge usually means one or a series of questions which should be addressed and answered by the jury. It is important to define the key issue in a meaningful way: if the charge is too broad, the jury will not be able to answer it, and the process will have no results. When the key issue is determined, witnesses (resource persons providing information to the jury) have to be identified and invited. There are two types of witnesses: (1) neutral resource persons who are knowledgeable in the key issue but who do not have any direct relationship to it, and (2) stakeholders or advocates who are representing the plurality of values and interests of the different stakeholder groups. Optionally an advisory committee of 4-10 individuals can be set up in the preparatory stage, which helps the research team define the charge, proposes witnesses, and controls the process in terms of integrity and fairness.
2. Selection of participants: a crucial step in the citizens' jury process is the selection of the jurors. Since the jury serves as a "microcosmos of the public", it has to represent the society and at the same time exclude those who have a direct interest in the key issue. Jurors are randomly selected usually through a telephone survey. Demographic (and sometimes attitudinal) variables are used to create a representative sample according to age, gender, educational background and a generally positive or negative attitude to the key issue (and if applicable ethnic group, geographical location, number of children etc.). Usually more participants are selected during the selection process than the required size of the jury in order to have substitutes if somebody withdraws. Jurors are paid for taking part in the process.
3. Hearings (meetings): the hearings start with introducing the key issue to the jurors through the presentations of neutral witnesses. Then facilitated small and large group works provide the opportunity to share ideas, learn from each other and form a common ground. Advocate witnesses

are invited to the hearings to answer the questions of the jury and to represent their own viewpoint. A key aspect at this stage is to provide a balanced and detailed information package to the jury as well as to give enough time and equal opportunity to all participants to deliberate upon the key issue.

4. Closing: on the final day the jury has to reach an agreement and create a written recommendation. Then the jury elects its representatives who will present the recommendations on a public forum (often with media coverage). In the final report of the citizens' jury the recommendations are completed with an evaluation form filled in by each juror, which focuses on the fairness and comprehensiveness of the process and the possible sources of bias. In some cases jurors are also asked to prepare a personal statement about the project.

Practical aspects

The citizens' jury method is relatively time and resource intensive. Although the core part of the method (the hearings) requires only a few days, the preparatory phase (including the problem definition, the selection of witnesses and jurors) may last for 3 months or more, and the final works (i.e. preparing the final report and organizing media coverage) may require one additional work. Demographic data and a sound background in statistics are needed in the selection phase, while skilled facilitators are needed during the hearings. Rooms and computer equipments are required during the hearings, and jurors (and often witnesses) have to be paid for their time.

Advantages and limitations of the technique

The core advantage of the jury method is that it produces a common ground recommendation that is both informed and representative of the public. A valuable outcome of the process is the higher level of legitimacy (public acceptance) of policy decisions which are built on the jury's recommendations. Furthermore, the planning and implementation of a citizens' jury can focus the attention of the media and raise public awareness on the key issue.

However, to organize a successful citizens' jury, one may have to cope with the unequal representation of certain groups, the lack of trust within the jury, and the challenges of balanced information and fair moderation. Another key success factor is the commitment of decision makers to accept the recommendations of the jury, because without a legal acceptance the jury can easily end in apathy (Aldred and Jacobs 2000). Furthermore, moving too quickly towards the consensus may restrict the scope of the discussion (eliminate some less obvious aspects from the dialogue) and limit the learning effect (Huitema et al. 2010).

Example

Cork, S. J., & Proctor, W. (2005). Implementing a process for integration research: Ecosystem Services Project, Australia. Journal of Research Practice, 1(2), Article-M6.

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7.2. Additional information for Object-oriented Belief Networks

The three simple examples of OOBNs below illustrate a cost-effectiveness (Fig. 1), benefit-cost (Fig. 2) and multi-criteria (Fig. 3) analysis for a hypothetical problem of choosing between a “no action” and 3 alternative action measures for buffer strip vegetation in a catchment. The node in white represents a ‘sub-network’ treated as a model ‘object’, hence OOBN.

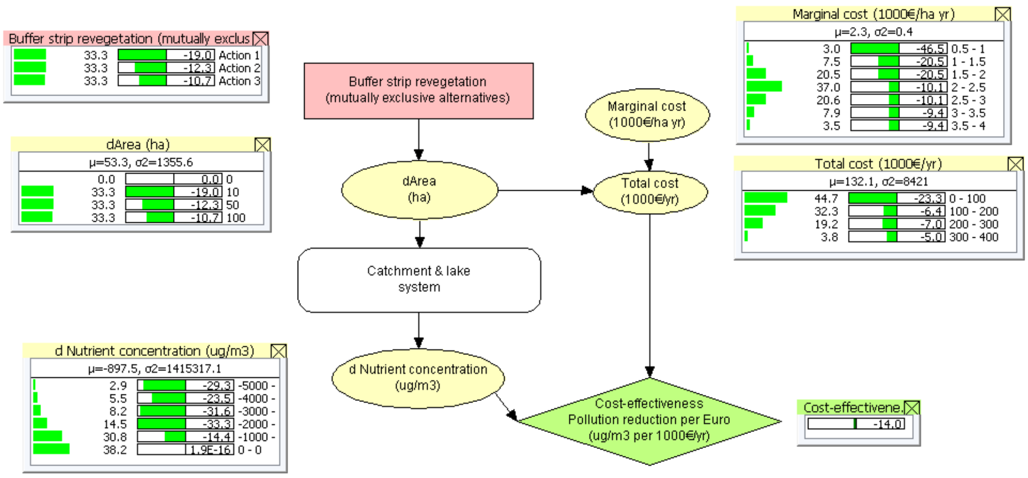


Figure 7.3. Bayesian belief network for cost-effectiveness analysis - buffer strips example

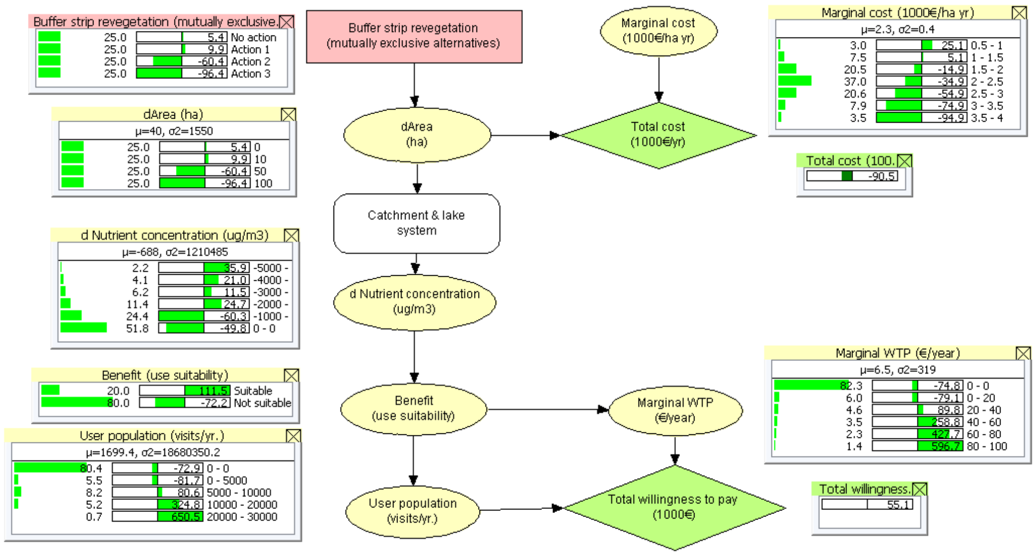


Figure 7.4. – Bayesian belief network for benefit-cost analysis - buffer strips example

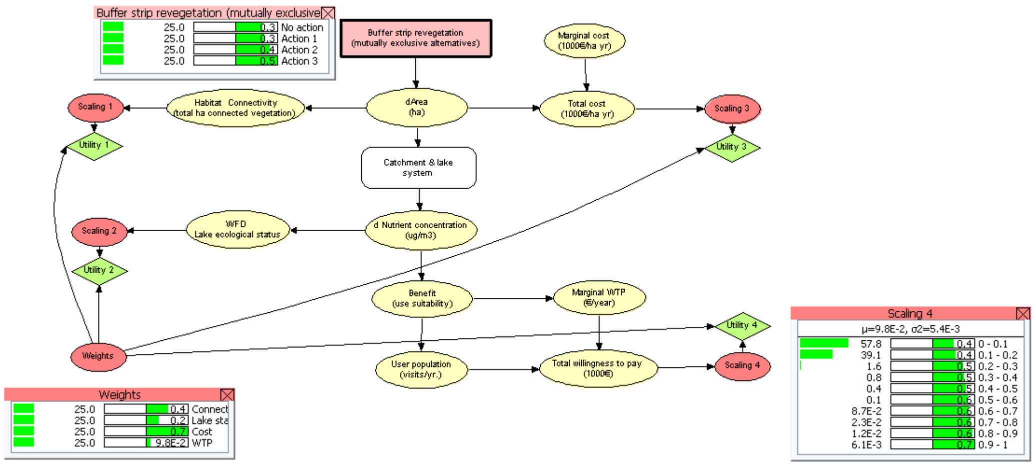


Figure 7.5. Bayesian belief network for multi-criteria analysis - buffer strips example

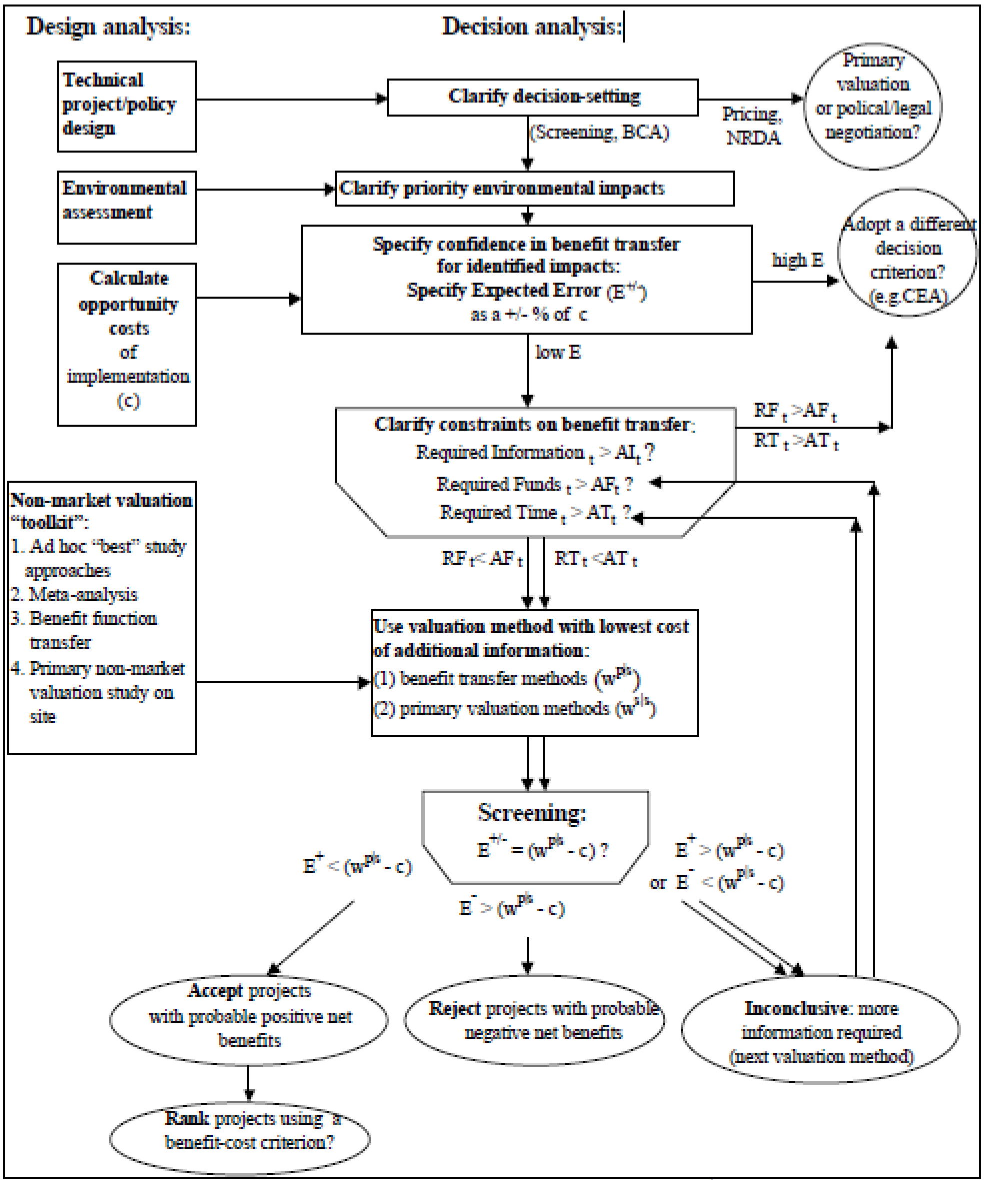
7.3. Additional information for value transfer

Some basic knowledge of potential errors is useful when reviewing value transfer studies. Awareness of the reliability of value transfer will make it clearer whether transferred values can be used for more demanding contexts such as priority-setting. Decision-makers can go through a check-list when assessing valuation results they have commissioned.

Table 7.1. Value transfer checklist

Issue	Explanation
1. Marginal vs. average values?	If the purpose of the valuation is to inform a policy decision affecting a particular area the study should be sensitive to changing marginal values across the landscape. For simple informative uses such as awareness raising or natural capital accounting average values may be adequate.
2. Substitutes or complements?	Has the study considered the landscape configuration of green infrastructure and whether particular sites are substitutes or complements for oneanother in terms of ecosystem services delivery?
3. Aggregation, distance decay?	Does the value transfer make any particular assumptions about accessibility and potential user populations which may change across sites?
4. Distributional impacts and selection bias?	Is it important how costs and benefits are distributed spatially, for example because there are different socio-economic constituencies in the study area? Spatially differentiated transfers are necessary. Check that population characteristics in the original study site cover the range of characteristics at the policy site.
5. Equivalence of positive and negative impacts?	Is the value estimate at the study site generated for the same kind of environmental change as at the policy site? Research has shown that willingness-to-pay for an improvement in ecosystem services, can differ from WTP to avoid a loss, which in turn can be different from willingness-to-accept (WTA) compensation for a loss, or WTA compensation for not obtaining an improvement.
6. Reference levels and perceived rights?	In addition to the +/- direction of the impact on ES, the perception of rights to a reference level of ES determine values. The difference in WTP and WTA is in part explained by differences in the perception of rights to a particular reference level of ecosystem services. If the perception of environmental rights varies between the study and policy site there is further bias.
7. Adaptive behaviour?	If populations at a study and policy site adapt differently to an impact on ecosystem services, valuation can be expected to differ as well. Adaptive behaviour may mitigate realised impact. This also produces a difference between ex ante valuation estimates and actual change in welfare which is a common challenge in all economic benefit-cost analysis.
8. Compatible end-points?	Is the economic valuation estimate expressed in similar units to biophysical models quantifying the 'end-point' impact. This concerns the extent to which models in the ecosystem service cascade or cause-effect chain are well integrated. Making model end-points compatible often involves expert judgement and introduces uncertainty in the integrated valuation estimate.
9. Ad hoc variables?	More generally are variables in a meta-analysis function or value function theoretical justified or do they appear ad hoc?
10. Docu-mentation of uncertainty?	If the original valuation studies document statistical accuracy and model reliability using sensitivity analysis, more rational decision-making approaches can be taken as illustrated in Figure 13 above.

Source: based on Barton (1999)



Note: total policy costs are expressed as a positive number (c>0). In this Figure $w^{p|s}$ is the individual benefit estimate using any one or a combination of the methods in the non-market valuation "toolkit".

Figure 7.6. Detailed decision-tree for value transfer

7.4. Explaining the 'gap' in monetary valuation for policy

The 'valuation gap'

Laurans et al. (2013) reviewed several hundred academic papers on monetary valuation to determine the extent to which they were used for decision support. A small fraction of papers provide documentation on how monetary valuation results would be used for decision-support. We refer to this as a "valuation gap" in the discussion below. Apart from the possibility that academic papers do not reflect a grey literature on the extent of operationalization of monetary valuation, the authors discuss the valuation gap as being due to the following:

1. Decision-makers may not have sufficient *training* in economics
2. The *cost* of ES valuation may restrict their use (situations associated with biodiversity and ecosystem services are very site- and problem specific)
3. ES valuation may too often be *inaccurate*
4. *Political strategies* require a certain opacity or ambiguity
5. *Regulatory frameworks* may not be conducive to ES valuation (damage assessments , CBA new regulations)
6. ES valuation may contain *fundamental inadequacies* (distributional concerns, irreversibility, uniqueness)

These reasons for a 'valuation gap', or barriers to valuation, are discussed further in this appendix. The aim of the discussion is to identify challenges to the value mapping in MAES. The discussion is organised as a series of research hypotheses focusing on cost, uncertainty, and political strategies. In particular, we discuss "political strategies" in terms of the relevance of monetary valuation for conflict management. The same arguments may apply for socio-cultural/deliberative valuation methods, but this appendix does not address this question systematically. The presentation is meant to raise further methodological questions to be addressed in the analysis of case study adoption of valuation methods (as part of Deliverable D 4.4).

Mismatch of reliability and accuracy

There may be an unawareness on the part of valuation practitioners that reliability requirements for monetary valuation differ between decision-contexts – particularly for monetary valuation methods. Valuation methods developed for 'informative purposes' are not necessarily reliable enough for 'decisive' and 'technical purposes'.

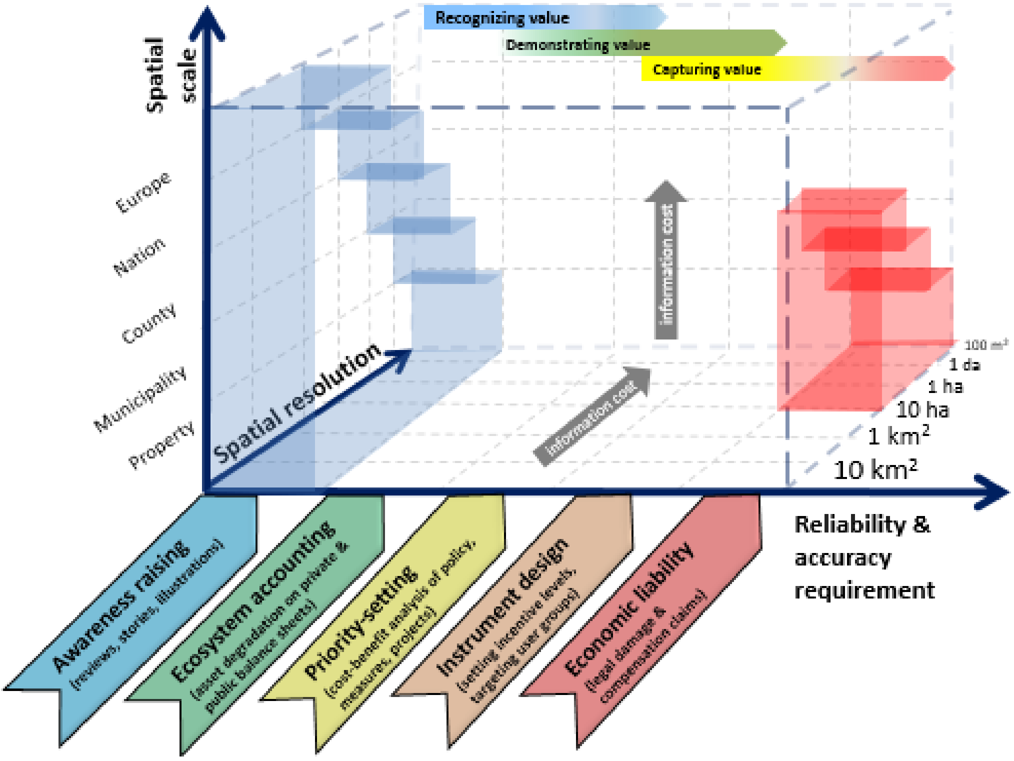


Figure 7.7. Valuation of ecosystem services is decision-context specific.
Source: based on Baggethun and Barton (2013)

H1. The decision-context framework (Figure 7.7.) suggests a hypothesis the ‘valuation gap’ can be explained by a mismatch between the reliability and accuracy required for decision-making and what monetary valuation methods can deliver.

The reason for the mismatch may be that methods have some absolute limitations. If information costs are rising with both scale and resolution at the same time as requirements for accuracy increase from left to right in Figure 7.7., the “field of action” or scope of monetary valuation methods can be expected to decrease. There is a wider scope for applying monetary valuation in awareness raising than in liability contexts.

A mismatch of accuracy and reliability in Figure A1 is one explanation for a ‘valuation gap’ – why monetary valuation methods may not be as common as would be expected from the ‘decision-support’ language used in some of the environmental economics literature.

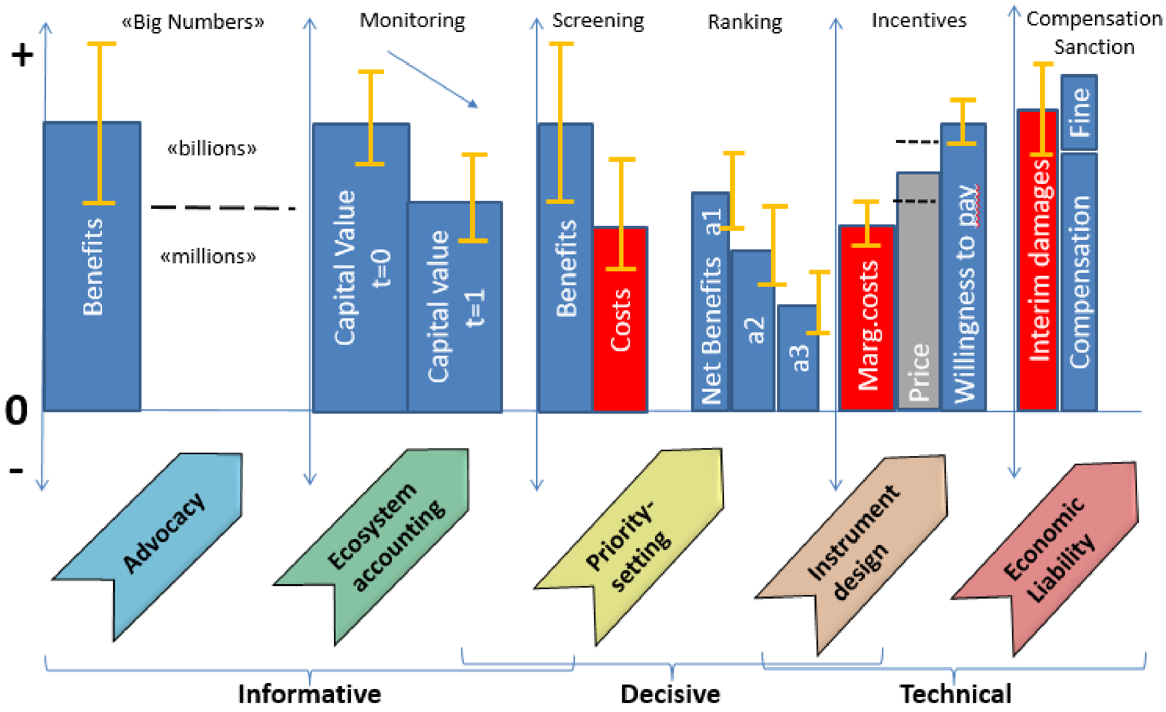


Figure 7.8. Justification for different requirements for accuracy of valuation methods. Yellow whiskers indicate confidence intervals of valuation estimates

Increased requirements for accuracy as one moves from left to right in the decision context framework of Figure A1 can be explained by an increasing number of 'benchmarks' against which valuation estimates must be compared for the different decision contexts.

Poor valuation accuracy can lead to "costly actions" or "missed opportunities". Table A1 defines type I and type II errors exemplified for valuation research on the costs and benefits of landuse change for a well-defined decision support.

A 'well-defined' decision is one in which action alternatives, their benefits and costs can be defined sufficiently to test a null-hypothesis about the net benefits of landuse change.

Hypothesis testing outcomes of an action situation		**Reality *(ex post)***	
		H0 true Costs > Benefits	H1 true Benefits > Costs
Valuation estimates *(ex ante)*	H0 true Costs > Benefits	«Status quo correct»	**Type II error** «Missed opportunity»
	H1 true Benefits > Costs	**Type I error** «Costly action»	«Action correct»

Table 7.2. Type I and Type II errors in a well-defined decision-context about landuse change

Information value of monetary valuation

Laurans et al. (2013) explain the lack of valuation in decision support by costs of conducting studies. The large benefit transfer literature that has arisen in the wake of particularly stated preference valuation (Johnston et al. 2015) confirms this hypothesis, as well as suggesting that the information value of benefits transfer is high. The 'information value of valuation' is the net benefit of an additional value observation in terms of avoiding type I and type II errors. The net benefits of avoiding type I & II errors is defined by the stakes – costs and benefits of the decision – as well as how much an additional observation reduces variance of expected costs and benefits (Barton 2007).

Benefits transfer makes monetary valuation potentially *"ubiquitous",* based on the assumption that the information value of benefit transfer is always higher than information costs (upper lhs Figure 7.9.). An alternative hypothesis is one where valuation is in all contexts *"infeasible"* because costs of information exceed the benefit of avoiding type I & II errors. A third *"minimum scale* valuation hypothesis" is that monetary valuation methods have a minimum required spatial scale because of fixed study costs while the costs of additional observations is lower than the net benefits of making the right decision. Finally, a *"meso scale* valuation hypothesis" suggests that monetary valuation methods have a limited intermediate spatial scale at which their contribution to better decisions exceed their costs. We do not expect any of the hypotheses to be generally valid. Rather they define different problem contexts as discussed briefly below. In all cases, the marginal information costs (vertical axis) scale with increasing spatial resolution.

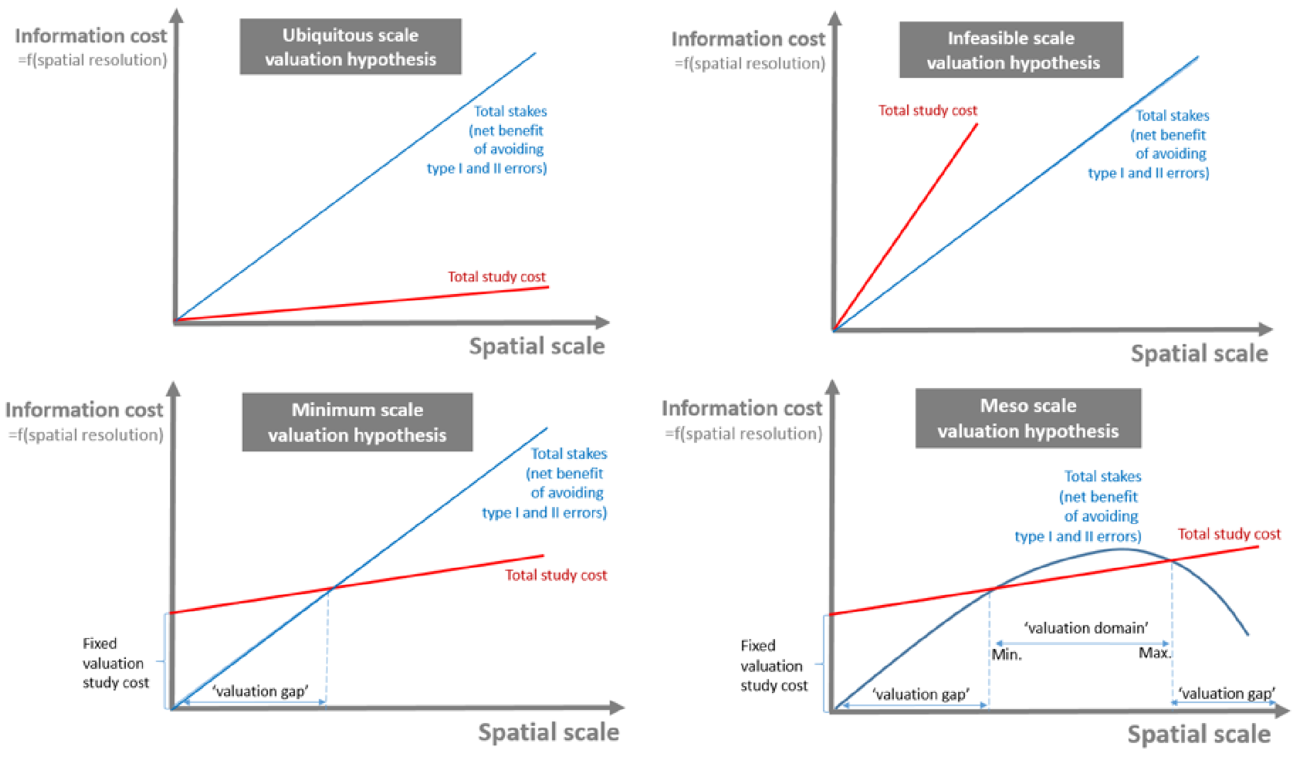


Figure 7.9. Four hypothesis of monetary valuation 'domains' defined by information costs and benefits

Ubiquitous scale valuation hypothesis. A characteristic of a 'benefit transfer situation' is very low/no fixed study costs and low/no marginal costs to increasing the spatial scale of valuation – extreme examples include extrpolating per hectare ecosystem values from available site specific studies to continental or global scales. The marginal net benefits of increasing the scale of the decision and the study is constant if the density of beneficiaries is constant across the study area (similar user population density) and if there are no substitution effects (for an explanation see below).

Infeasible scale valuation hypothesis. This could be characteristic of valuing individuals' decisions on a case-by-case basis – information costs of assessing each individual case may always exceed the individuals' stakes. This is typical of handled by landuse zoning and permitting of individuals' landuse change applications, rather than individual assessments. Here we also assume constant population density and no landuse substitution effects.

Minimum scale valuation hypothesis. This is characteristic of original studies with large samples that must be collected through surveys or data purchase – there are high fixed study costs, while marginal costs of increasing sample size are small once the study has been designed.

Constant population density. No landuse substitution effects. In this situation, the smallest spatial scales have a 'valuation gap'. In this case, literature reviews are expected to find few studies at small spatial scales.

Meso-scale valuation hypothesis. As above this is characteristic of high fixed study costs, while marginal costs of increasing sample size are small once the study has been designed. In this situation, the net benefits of additional valuation observations declines with study scale. Valuation methods at very large scales may be information inefficient. If there is large spatial heterogeneity, a single study design or value transfer will capture values with decreasing accuracy as scale increases. Also if the density of beneficiaries declines as study scale increases, marginal benefits per unit area decrease, while study costs per unit area are constant (or may even rise, if respondents are harder to locate). Finally, as study scale increases substitution effects may become more visible – this is a framing effect seen in stated preference studies where willingness-to-pay for benefits from a given location decline if respondents have knowledge of substitute locations (Brouwer et al. 2009).

Governance of ecosystem services and valuation domains

The decision-context framework has been unsatisfactory in visualising the context dependency of qualitative socio-cultural valuation methods. In the following we briefly suggest other frameworks which widen the scope to non-monetary methods. Primmer et al. (2015) discuss the complementary roles of different types of governance of ecosystem services. Their empirical framework is a useful starting point for identifying the different purposes and roles of different valuation approaches depending on the context. Distinguishing types of governance in this way (Figure 7.10.) makes it clear that different types of valuation methods come into play.

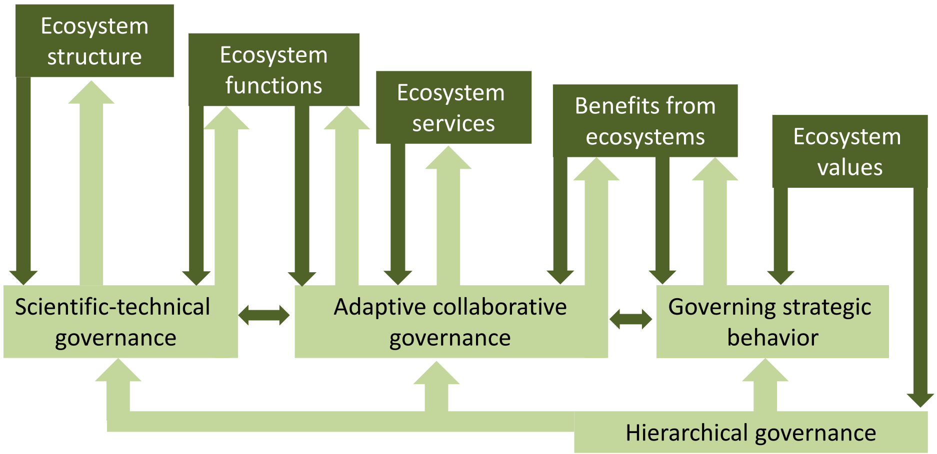


Figure 7.10. Governance frameworks for ecosystem services. Source:Primmer et al. (2015)

In scientific-technical governance, valuation for accounting, priority-setting (cost-effectiveness, benefit-cost) find their place. Valuation for awareness raising is relevant for adaptive collaborative governance, while valuation for instrument design (especially pricing) and litigation are relevant for the purposes of governing (strategic) behaviour. While monetary valuation has relatively little to offer adaptive collaborative governance deliberative valuation methods are designed for this governance context. Monetary valuation apparently has little to offer hierarchical decision-making if this is interpreted as 'ideas or general arguments transferred from higher to lower levels'. Monetary valuation is a bottom-up aggregation. It is notable that valuation methods have such a limited focus in Primmer et al. (2015) discussion of governance, indirectly supporting the idea that output from formal valuation methods is much less decision-relevant information than researchers would like to think.

Further notes on governance characteristics of relevance for choice of valuation methods below extracted from Primmer et al. 2015 (bullet points). This could be developed into a more detailed discussion of monetary and socio-cultural valuation methods in different governance settings. As a monetary valuation practitioner the author has added his interpretation below:

Hierarchical governance

- can be inferred that the persistence of the ideas transferring from the higher level policy to the lower governance levels implies effectiveness of the policy and of the underlying arguments
- hierarchical governance can inform scientific-technical governance only with general arguments that operationalise the goals of the policy

A monetary valuation practitioner's interpretation: In this setting valuation does not play a direct role, but may influence givernance indirectly over time by providing 'arguments' that higher levels can use to support delegation of policies.

Scientific-technical governance

- deviations from technically aided planning processes,which can be identified and solved only by practitioners.
- many analyses with a technical focus take knowledge resources to be the main bottleneck for reaching policy goals, they are also critical of the assumptions of knowledge transfer as just a simple technical task supported by smart information management

- the scale mismatch between the decision context and what is calculated with available methods and data hinder communicating findings to policy
- the starting point of instrument design is often hierarchical: the design is at a central level, e.g. at the state, and the administration implements it or participates in its operationalization. The design and implementation of the instruments can be supported with scientific-technical information.

A monetary valuation practitioner's interpretation: this corresponds with the methodological approach of monetary valuation methods. However, Figure A4 by Primmer et al. does not extend scientific-technical governance to also consider ES values. To be consistent with the conceptual framework in Figure A4, benefit-cost analysis using monetary valuation would have to be a decision-support tool employed 'at a higher level' in hierarchical governance.

Adaptive collaborative governance

- emphasises the importance of knowledge accumulation, collective learning and sensitivity to changes,which are the ideas of adaptive governance of social–ecological systems
- the quality of the decision-making or implementation process, and sensitivity to different context-specific arguments. Focus on overcoming conflicts, as well as securing legitimacy and learning.
- need to consider different stakeholders' views and knowledge in decision-making processes,and initial empirical analyses reveal the crucial role that understanding the different actors has for securing the relevance of more natural science-driven analyses

A monetary valuation practitioner's interpretation: deliberative valuation methods are best suited in this form of governance. But a priori, there do not seem to be any arguments for why socio-cultural valuation methods (without deliberation) should be favoured over monetary valuation methods (without deliberation). Multi-criteria analysis has deliberative aspects, but in order to capture plural values from across the ES cascade, it would have to be applied at a higher level by hierarchical governance. The deliberative aspects of MCDA are at odds with the hierarchical governance. This can be seen in the reluctance of national EIA guidance documents to employ weighting of interests to impact assessments (this is left to higher level institutions, although not necessarily elected politicians).

Governing strategic behaviour

- strategic campaigning against conservation arguments
- biodiversity policies appear to be influenced by strong actors' interests and arguments even in situations that are hierarchically well organised or technically straightforward

A monetary valuation practitioner's interpretation: monetary valuation methods have a potential role to play in designing incentive mechanisms, while socio-cultural valuation methods have a potential role to play in designing "information" or "nudge" instruments. Deliberative methods are likely to be biased or captured by strategic interests.

Conflict dynamics and valuation

Cadoret (2009) offers a conceptual framework on conflict dynamics, based on an empirical analysis of conflicts in the coastal zone in southern France. The framework offers defines different conflict contexts which in turn offer different explanations for challenges facing monetary valuation methods. Some of the challenges apply equally to other assessment methods. In figure A5 Cadoret identifies three basic types of conflict – anticipated, hushed and chronic conflicts – each illustrated with different temporal profiles. Hybrid conflicts combine the different contexts. To the framework we have added some particular difficulties for implementing monetary valuation specific to each conflict type. We have also added ’dynamics’ arrows suggesting that anticipated or hushed conflicts can transition to chronic conflicts over time.

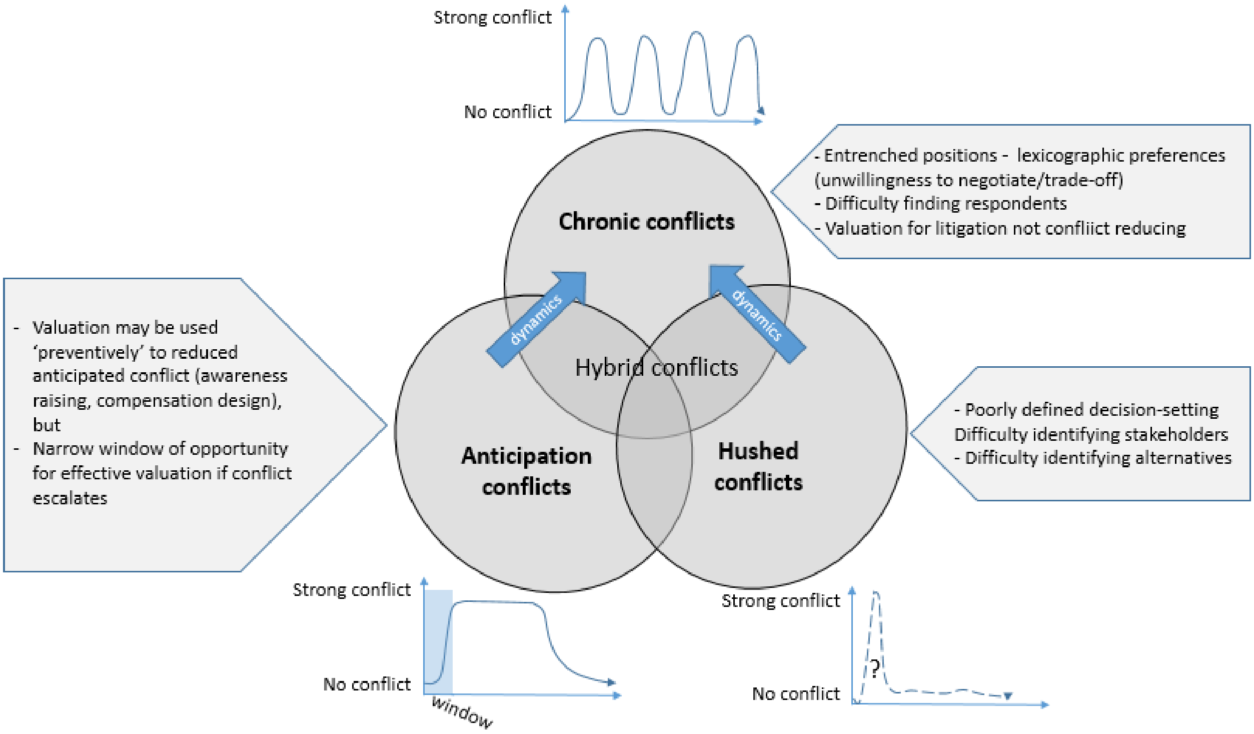


Figure 7.11. Typology of conflicts and challenges for (monetary) valuation Source: adapted from Cadoret (2009)

Chronic conflicts – these are recurring situations. Repeated conflicts over time are in part due to entrenched positions, where unwillingness to negotiate has consequences for valuation methods asking respondents to consider trade-offs, or scenarios affecting their rights. In the stated-preference valuation literature lexicographic preferences are identified as ’protest responses’, but the underlying causes are seldom framed as conflicts. In chronic conflicts it may also be difficult to recruit respondents in the first place.

Hushed conflicts – these situations are hard to identify for outside parties such as reseachers. Actors have an interest in obscuring their interests. In this context, identifying decision-alternatives are fuzzy or invisible and stakeholders are not forthcoming, making formal valuation methods impossible to implement.

Anticipation conflict – they arise in anticipation of plans by other actors that may affect one’s interests. Monetary valuation methods may play a role in awareness-raising among agents with no or small stakes. Valuation of distributional impacts may be used to allay stakeholder fears (as part of benefit-cost analysis), although the opposite outcome will be true for others, in which case valuation may (in theory) be used to calculate compensation for distributional impacts. . While, there seems to be a potential role for monetary valuation in this type of conflict a practical issue is the narrow ’window of opportunity’ for valuation in a situation of escalating conflict.

Conflict escalation

Cadoret (2009) provides limited detail on how conflicts transition or escalate. Yasmi et al. (2006) review a large number of conflict cases in order to identify patterns of conflict escalation in natural resource management. Their conflict escalation model draws on a framewor by Glasl (1999). In Figure A6 we have extracted conflict characteristics (in red) from a longer lists identified for each context in the authors review. We focus on conflict characteristics that in principle match different purposes of monetary valuation identified in the ’decision-context’ model and Laurens et al. (2013).

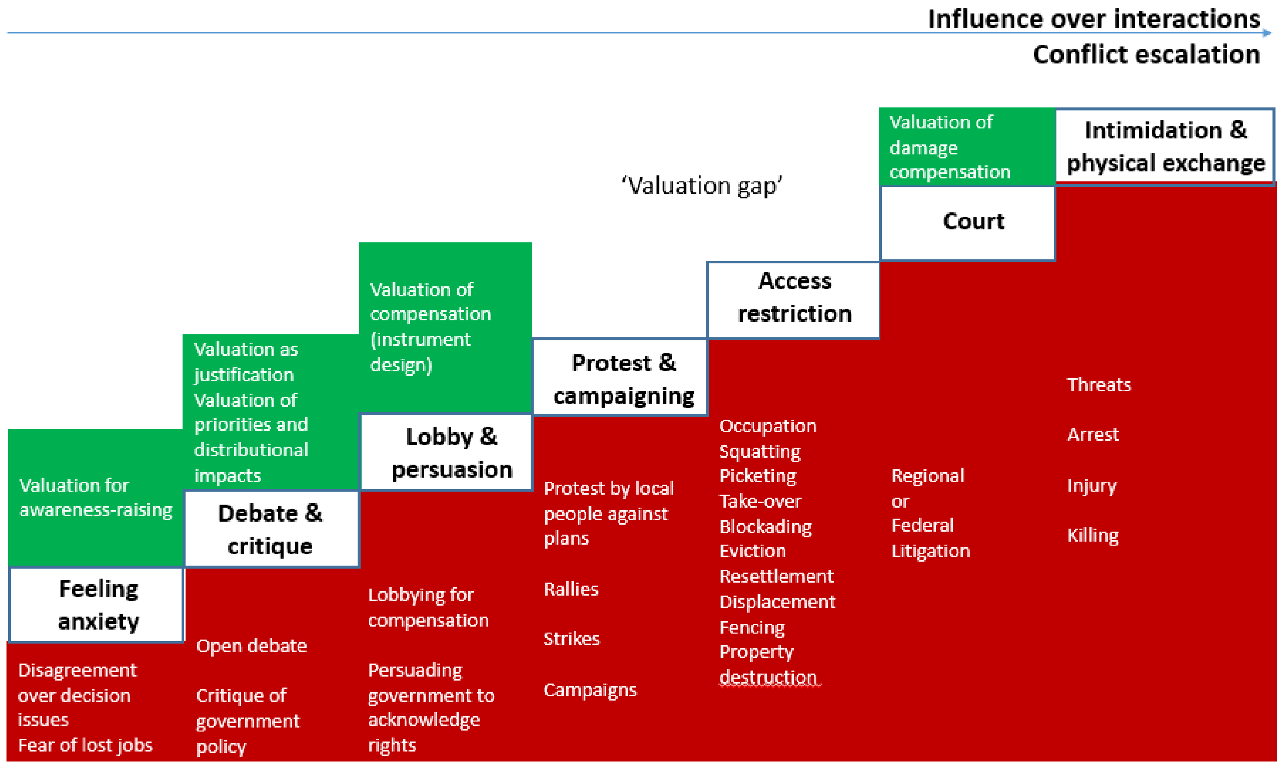


Figure 7.12. Conflict escalation in natural resource management. Source: adapted from Yasmi et al. (2006)

”**Feeling anxiety**” – in this stage valuation for awareness raising may be able to highlight the importance of decision issues, or for example allay fears about economic impacts in aggregate.

”**Debate & critique**” – valuation may be used to provide justification for plans, document priorities or counter arguments about distributional impacts.

”**Lobby & persuasion**” – where rights are negatively affected, lobbying may focus on rights to compensation by impacted stakeholders. Monetary valuation can have a limited role to play in setting compensation levels.

As conflict escalates beyond ”**lobby & persuasion**” to ”**protesting & campaigning**” and ”access restrictions” we think that monetary valuation methods have little to contribute in uncovering interests. Differences of interests are evident through stakeholder actions. This may be a ’valuation gap’ for all formal assessment methods – also socio-cultural valuation.

”**Court**” – in a litigation setting monetary valuation may be used to calculate economic damages. The use of valuation methods for this purpose is limited. Valuation is not used for conflict management, rather focusing on making the damaged party whole after a conflict has escalated or an accident taken place.

”**Intimidation & physical exchange**” – at the extreme end of the conflict escalation scale, valuation methods are inappropriate because basic rights are being violated.

Deliberative valuation methods are appropriate in the initial stages of conflict escalation, and increasingly useful the more conflicts of interest there are and the less well-defined they are. However, Figure 7.12. suggests that there is also an upper limit where formal deliberative valuation methods may be relevant. Further work should clarify which types of conflict situation deliberative valuation methods are meant to address.

Conflict and decision contexts

Yasmi et al. (2006) identify a final level of conflict escalation called ’nationalization & internationalization’. We suggest that conflicts may be lifted from local to national or international level in at all stages of conflict escalation. More generally, Jehn (1997) states that perception of conflict levels depend on the numbers of people involved, the number of conflict events, and in terms of influence over future interactions.

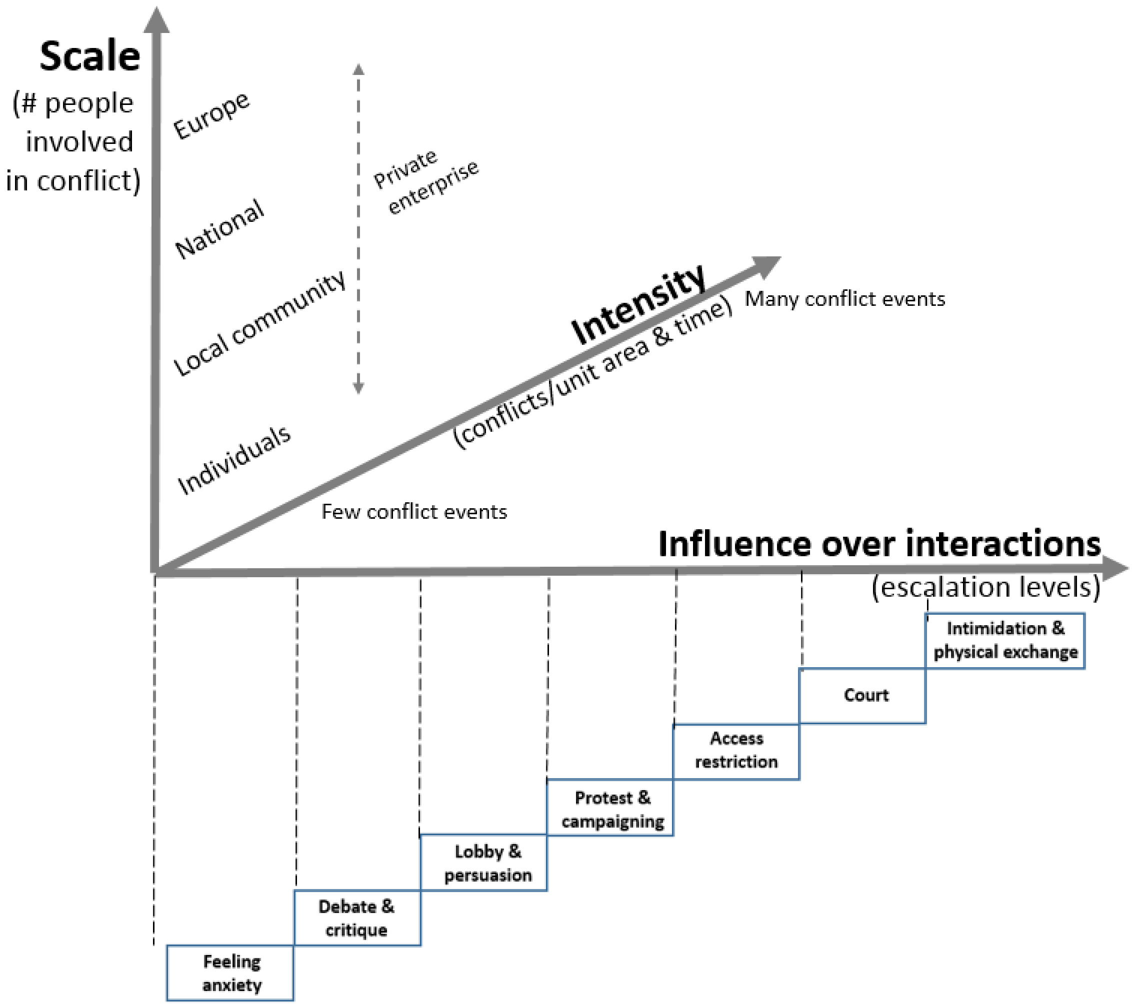


Figure 7.13. Conflict escalation at different spatial scales and resolutions

Figure 7.13. interprets conflict escalation categories as a measure of the degree of influence over interactions, and that these can be found at any spatial scales. The number of people involved in a conflict is

related to spatial scale and governance scale. Private enterprise spans all governance and spatial scales and is difficult to classify. Conflict event intensity could be indicated in terms of conflicts per unit area and time period (which in mapping terms is the same as ’resolution’ or ’spatial and temporal grain’). Similarly to the decision context framework for monetary valuation (Figure 7.7.) this provides a framework for linking conflict contexts to qualitative mapping of ecosystem service values and in what contexts deliberative socio-cultural methods may contribute (and where valuation methods in general are hard to operationalise). Defining the constraints on valuation is aimed at better use of scarce research resources, and avoiding false expectations by decision-makers and stakeholders to what valuation methods can deliver.