Valuation tools: a literature review

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1. Introduction

This section introduces tools that are used, or have a high potential, to value ecosystem services and to implement such values in decision-making processes. However, the boundaries of 'valuation tools' are permeable: many tools have attributes similar to those of other areas of our typology, and *vice versa*. This review covers primary valuation tools, which aim to make the value of ecosystem services explicit, and decision-making tools, where such values are integrated and applied to support 'real-world' decisions. We start with a brief introduction to the 'value of valuing' and recent developments within relevant academic literature.

2. The value of valuation

What is the value of valuing ecosystem services? Decisions are generally conceived of as choices and trade-offs between competing alternatives across environmental, social and economic goals. Such choices often imply (implicit or explicit) valuation to reveal the relative weights given to aspects of a decision. This makes valuation a basic need of human beings (Costanza 2000). One of the main aims of valuing ecosystem services is to make historically overlooked and 'hidden' values explicit: especially when decisions affect ecologies, the benefits of ecosystem services have often been undervalued or not considered at all in the past (Costanza et al. 1997; Daily et al. 2009). Valuing non-market ecosystem services is recognised to allow better informed and more rational decision-making by revealing such 'hidden' values (Bingham et al. 1995; Turner and Daily 2008; Fisher et al. 2009; Wainger et al. 2010; Lundy and Wade 2011; Bastian et al. 2012).

The UK NEA continually emphasises the point that non-market ecosystem services need to be made clear in decision-making, given that their inclusion can radically alter the outcome (UK NEA 2011). Therefore, implementing such advanced scientific evidence and measures into decision-making processes has great potential to improve decisions affecting ecosystems and ultimately to enhance human well-being.

One has to acknowledge that ecosystem processes and the links to human well-being are often very complex and decisions affecting ecologies are frequently not made by ecological experts. Therefore, it is important that an interdisciplinary scientific community provides decision-makers with values and tools that can be used and applied by practitioners. This also necessitates that findings are communicated adequately to such audiences, which is still deficient (Turner et al. 2003; Fisher et al. 2009).

3. Recent developments of valuation methods and tools

Within the past 60 years, the literature on valuing non-market goods and services has risen constantly; recently with almost exponential rates and a focus on ecosystem services (Fisher et al. 2009; Atkinson et al. 2012). During past decades, scientists have developed a set of valuation tools and methods to value non-market ecosystem services in monetary terms. Key

publications outlining methods and applications of such tools include: Costanza et al. (1997), Millennium Ecosystem Assessment (2005), and The Economics of Ecosystems and Biodiversity (TEEB) study (2010). Whilst earlier attempts to value ecosystem services focused on the 'total value', more recent developments value the marginal changes in the provision of ecosystem services, depending on policy options (UK NEA 2011; Atkinson et al. 2012).

Utilising the total value of ecosystem services is acknowledged to promote the services and benefits healthy ecosystems provide to human well-being to a broader audience (Fisher et al. 2009), but it can be argued that valuing marginal changes depending on the management of ecosystems reveals better means to inform real-world decisions. The UK National Ecosystem Assessment contends that where real-world decisions are concerned, there will be choices between options, with values assessed in the dimensions of relative costs and benefits of marginal changes in the provision of ecosystem services. Methods now exist that can unite natural sciences with economic assessment to estimate the relative value of changes under different scenarios and which thereby inform decision-making (UK NEA 2011).

Another recent development that can be observed is that methods evolve that are not based on aggregated individual preferences; but on shared social values and principles of deliberative democracy. This includes value domains like fairness, social equity and sustainability (de Groot et al. 2002; Hermann 2011). Such new approaches offer an alternative to valuation methods that are mainly based on aggregated individual preferences.

Furthermore, valuation focuses more and more on the valuation of 'final ecosystem services' which can directly be 'consumed' by humans rather than ecological processes benefiting or underpinning other ecosystem services such as regulating services (Atkinson et al. 2012). This is especially important to avoid double-counting when valuing ecosystem services.

4. Dimensions of valuation tools and their application

Considering the broad definition of 'tools' within the scope of this review, it is feasible to make a distinction between primary valuation tools (or methods) and decision-making tools that can be directly operationalized and implemented in decision-making processes. The aim of primary valuation tools is to reveal human and social preferences for ecosystem services. Decision-making tools can be applied directly to inform real-world decisions by integrating and comparing other value attributes such as, for example, the economic costs of projects or policies. Such 'fit-for-purpose' tools usually integrate or make demands from the outcomes of primary valuation tools.

Another distinction can be drawn between monetary and non-monetary valuation tools. Whilst monetary valuation tools reveal values given in £s, non-monetary valuation tools reveal values such as 'scores' or 'weightings'. The main advance of monetary valuation is that outcomes are given in a common metric which allows to derive 'net' benefits and costs (Fisher et al. 2011). However, monetary valuation is complex and demands robust primary valuation studies that cover ecosystem services relevant to the decision-context. Conducting such studies can be very expensive. One also has to deal with uncertainty and knowledge gaps. This means that usually not all ecosystem services and all attributes of such services can be valued in monetary terms to a sufficient degree which especially applies for cultural and non-use values (Atkinson et al. 2012).

Because of the limited evidence, applying exclusively monetary valuation methods has a danger that specific values, but also data gaps and uncertainties and risks, as well as distributional issues remain 'hidden'. Therefore, economic valuation without sufficient interpretation of the findings can hide more than it reveals. It can also simulate certainty where this is not the fact. Monetary valuation using contingent valuation is restricted to relatively simple scenarios that are conceptually manageable for participants. This makes it challenging to incorporate issues of risk, uncertainty and complexity. In addition, it is often unclear exactly how changes in ecosystems lead to changes in final benefits. In the case of cultural services, it is also challenging to conceptualise 'subtle' cultural benefits of environmental settings such as sense of place and sense of connectedness in a way that fits a monetary valuation framework. Furthermore it may be arguable whether it is always appropriate to place £s values on ecosystem services, for example in case where no acceptable substitute exists (Turner et al. 2003). Therefore, in many cases non-monetary valuation or the combination of monetary and non-monetary valuation tools is beneficial.

One option for non-monetary valuation is to collect relevant information from the literature. However, such information for a specific decision context is not always available. An alternative is to base values on expert judgement. For example, experts can assign 'weightings' to specific ecosystem services impacts. Even if evidence is limited, experts may still be able to judge values based on their knowledge and experience. Alternatively, values can be elicited from focus groups or citizens' juries. This latter technique is designed to obtain public opinion on different policy options and their impacts on society; usually informed by experts or relevant evidence (Spash 2007). As a general rule, a critical interpretation of findings should be mandatory whenever valuation tools are applied.

5. Valuation tools: Primary valuation stage

If ecosystem services are traded on markets (e.g. harvested products) the value can often be derived from (adjusted) market prices. But many ecosystem services are not traded on markets; they occur as (positive or negative) external effects. An external effect or externality describes a 'spillover', which is incurred by a party that is not directly involved in the market transaction. For example, a party might benefit from water quality improvements upstream without paying for such improvements. In such cases, the market price does not reflect the full benefits (costs) of a transaction. Sometimes, it is possible to derive such values indirectly from market prices. Applying the revealed preferences method, one derives the ecosystem services value from market goods and services which contain environmental attributes. One example is the hedonic price method where differences in property prices dependent on environmental surroundings are used as indicators for the value of such externalities. On the other hand, stated preference techniques may be used to elicit the value of ecosystem services by asking people their willingness-to-pay (WTP) for ecosystem services if there were a market. This latter technique can be applied to a wide range of ecosystem services, including cultural and intangible ones.

An emerging tool is **Deliberative Monetary Valuation** (DMV). DMV of the environment encapsulates a wide range of approaches incorporating participatory, deliberative, political and/or social learning processes, to establish a monetary value for the benefits of environmental goods. In DMV, small groups of participants explore the values that should guide their group decisions through a process of reasoned discourse (Howarth and Wilson 2006). DMV has developed as a response to critique of more established valuation methods, particularly contingent valuation: that these methods are not able to capture assessments of

risk and uncertainty properly, in the face of social-ecological complexity; that they are not able to capture the intricacies of human values; that preference utilitarian assumptions are not always empirically or ethically justified; and that values cannot be assumed to be pre-formed (Sagoff 1986; McCauley 2006; Spash 2007; Spash 2008; Norgaard 2010; Kenter et al. 2011).

All of these tools have their own inherent imperfections and caveats which cannot be outlined in full detail within scope of this review (see also Spash 2007; Hermann 2011). As a general note, such methods will always be approximations of the 'real' value, but "it is better to be approximately right, than precisely wrong" (Helm & Hepburn 2012: 17). For a more extensive review of primary valuation methods, see (de Groot et al. 2002; Freeman 2003; Hanley and Barbier 2009; Fish et al. 2011; Atkinson et al. 2012).

6. Benefit transfer

Applying primary valuation tools is usually comparatively cost-intensive, which limits their efficient applicability; especially to support smaller-scale and 'everyday' decisions. The benefit transfer approach offers an alternative by transferring values from primary valuation studies (the 'study site') to the relevant decision-making context (the 'policy site'). The application of the benefit transfer approach can be seen as a practicable and cost-effective way to implement the ecosystem services approach in decision-making, even if the accuracy of the outcomes declines (Troy and Wilson 2006; Hermann 2011). It is also recommended by the Department for Environment, Food and Rural Affairs for making more practical use of environmental values in policy-making (Defra 2007). However, even if applying the benefit transfer approach sometimes seems to be the simple alternative, its appropriate application is challenging as well and demands expertise. If not applied appropriately, the outcomes can be strongly biased (Brouwer and Bateman 2005; Spash and Vatn 2006; Bateman et al. 2011). This leads to poor decisions, and also undermines the credibility of ecosystem valuation in general.

7. Valuation tools: operational stage

At the operational stage, it is common that different primary valuation studies and methods inform 'fit-for purpose' tools because former studies often value a single ecosystem service whilst decisions affecting ecologies usually impact several ecosystem services. The UK NEA divides economic analyses for ecosystem service assessments into two types: (1) sustainability analyses, which commonly assess stocks of natural assets; and (2) programme evaluation analyses, which seek to determine the value of the flow of services provided by these natural assets (UK NEA 2011).

Within this review only a selection of tools are evaluated. Tools have been selected depending on their ability to integrate the ecosystem services framework; but also depending on their prominence and present implementation within decision-making processes.

One of the most popular valuation tools in this context is **Cost-Benefit Analysis** (CBA). CBA is a systematic process where expected costs and benefits of a project or policy are compared. It can be used to determine whether an investment is efficient, or to compare different investments to identify the most efficient application of funds. For the latter case, the related Cost-Effectiveness Analysis (CEA) might also be applied. Here, the challenge is to ascertain how an intended outcome can be achieved for the lowest cost, rather than 'policy on or off'. For both tools, monetary valuation is necessary, which means that some

ecosystem services usually remain un- or under-valued. Another unresolved problem is how equity issues can be better integrated (Sáez and Requena 2007). Therefore, outcomes should be considered with care.

Another commonly used tool that builds upon the principles of CBA is **Social Return on Investment** (SROI). In contrast to CBA, SROI aims to optimise social and environmental impacts and necessitates the involvement of stakeholders, for example to determine which impacts of a decision or organisation should be valued and to ascertain monetary 'proxy-values' to such impacts[1]. SROI may therefore be able to incorporate a broader set of non-market values but the accuracy of such proxy-values is usually less precise.

For more complex problems, or if relevant monetary valuation evidence is not available to a sufficient degree, conducting a **Multi-Criteria Decision Analysis** (MCDA) might be more appropriate. MCDA is a structural approach that explicitly considers and integrates multiple and heterogeneous dimensions and criteria. It allows economic, social and environmental criteria, including competing priorities, to be systematically evaluated. One main advance of this structural approach is that it prevents losing or hiding important information or uncertainty throughout the decision-making process (Kiker et al. 2005). MCDA allows the integration of information from other tools such as CBA (Barfod et al. 2011), or valuation evidence can be evaluated directly. It is common to assign 'scores' or 'weightings' to different attributes and impacts of policy options to make them comparable across diverse indicators, metrics, and stakeholder groups. In addition to being used as a decision-support tool, MCDA can also be used as a non-monetary valuation tool in its own right.

Corporate Ecosystem Valuation (CEV) is a new tool which has been introduced by the World Business Council for Sustainable Development (WBCSD 2011). CEV serves corporate decision-making by identifying and valuing ecosystem impacts by businesses; but also risks and opportunities businesses face from changing ecosystem services. It aims to improve corporate performance, including social and environmental goals. In general, CEV can be applied to a business as a whole, but it can also be applied to products, services, projects, assets, or an incident. CEV is flexible and allows the incorporation of monetary and non-monetary valuation as well as different tools envisaged above. However, such high flexibility also presents the danger that the tools may be used inappropriately, for example for 'green washing'.

For spatially explicit assessments and to explore impacts of decisions on land use or management changes, the tools **LUCI** (formerly Polyscape) and **InVEST** can be applied. LUCI is a visualisation tool for determining trade-offs in different ecosystem service provision at the landscape scale, with a strong focus on agricultural landscapes. The tool is designed to explore spatially explicit synergies and trade-offs amongst ecosystem services to support landscape management. LUCI is based on MCDA and allows the incorporation of local requirements and knowledge.

InVEST is a tool which incorporates models for ecosystem services. The tool allows valuation of those services and also provides some measure of risk assessment and trade-offs. It can handle scenarios and it can be applied across a wide range of decision-making needs. InVEST models are spatially-explicit, using maps as information sources and producing maps as outputs. InVEST returns results in either biophysical or economic terms.

[1] SROI does not necessarily require monetary valuation; the application of quantitative 'weightings' or 'scores' might also be appropriate.

One main limitation of both tools is that values for environmental costs and benefits are already integrated, applying the benefit transfer approach. However, transferring such values without appropriate adjustments can be problematic. Issues like cultural differences or variations of other socio-economic variables such as income level are difficult to integrate in such tools. More extensive reviews for valuation tools relevant at the operational stage are available in individual tool reviews written for the TABLES project[2].

8. Valuation within housing markets

The Royal Institution of Chartered Surveyors (RICS) has been regulating the valuation activity of its members since its foundation in the 19th century. Since 1974, the procedures which professional property valuers are expected to follow have been progressively refined through the development of the RICS 'Red Book', or Appraisal and Valuation Standards, first published in that year. This guidance is largely procedural but emphasises the qualifications and competence of the valuer, defining three elements: appropriate qualifications, membership of a professional regulatory scheme, and adequate experience of the asset concerned and the market in which it is being valued. Research has highlighted the importance of behavioural heuristics in valuation decision-making (ref to follow), and various negligence and contractual reported court cases have shed light on the expectations on valuers in terms of accuracy and responsibility. RICS has been reviewing the emergence of ecosystem valuation models in the light of its own extensive experience with the development and regulation of market valuation services, also touched on in a range of RICS Valuation Guidance Notes and Information Papers (for example …..). Early conclusions to emerge from this work include the need for very well defined bases of valuation (in a market context, these include Market Value, Worth, Fair Value and Market Rent), transparency in valuation approach and analysis, the identification and resolution of conflicts of interest and the overriding need for clear previously-agreed terms of reference. The experience of defining and refining the concept of Market Value (with the International Valuation Standards Council), since at least 1974, is particularly illuminating with regard to the definition and selection of bases of value.

9. Discounting

Because costs and benefits of decisions affecting ecologies often occur in the remote future, it is common to calculate their 'net present value'. Usually, a discount rate is applied to convert future costs and benefits to make them comparable. HM Treasury recommends applying a discount rate of 3.5% for periods of up to 30 years. Afterwards, the discount rate declines stepwise to 2.5% (HM Treasury 2003). However, consensus does not exist about the 'right' discount rate and this topic is often discussed controversial (Bingham et al. 1995; Stern 2006; Sáez and Requena 2007; German Federal Environment Agency 2008; Perino et al. 2011). One controversial aspect that is discussed is the application of the 'pure time preference rate' for decisions with inter-generational effects which may clash with intergenerational equity issues.

The outcome of many valuation tools, but also other tools, is very sensitive to the applied discount rate. Decisions affecting ecosystems often have intergenerational effects and applying a high discount rate gives benefits and costs occurring in the remote future a very low (often negligible) weight (Atkinson and Mourato 2008). The German Federal

[2] Reviews are available for Cost-Benefit Analysis, Social Return in Investment, Multi-Criteria Decision Analysis, Corporate Ecosystem Valuation, LUCI (formerly Polyscape), and InVEST.

Environment Agency (2008) recommends, for example, a discount rate of 1.5% for periods of more than 20 years with a sensitivity of 0% to account for cross-generational considerations. To clarify the sensitivity: if the discount rate recommended by HM Treasury is applied, £1000 now are taken into account with £197 in 50 years. Applying a discount rate of 1.5% would result in £475. In this light, an open discussion and potentially a revision of the discount rates recommended by HM Treasury seems to be a legitimate subject of debate.

10. Conclusion and discussion

There is no 'one fits all' valuation tool. The selection of tool(s) to support decision-making is strongly dependent on the policy context and issues like scale, scope, complexity, budget and time restrictions; but also knowledge level and expertise of the valuer and decision-maker. Many valuation tools are still in development; divergent applications, as well as hybrid forms such as 'social multi-criteria evaluation' or 'deliberative mapping', are evolving. This makes the selection of valuation tools, but also the staff that undertake such valuation, a crucial element of any decision-making process. To ensure that the application of valuation tools provides robust and reliable outcomes it should be mandatory that tools are not just applied by experts but also well written-up and reported, including a critical and transparent interpretation covering limitations and caveats which apply to all valuation tools. The definition of minimum quality standards or a mandatory review process may be beneficial.

If we want to improve decisions by making better use of valuation tools we also have to apply such tools to more relevant decision-making contexts. To date, valuation tools are almost exclusively used to inform (micro-economic) project level decisions. The influence on macro-economic, local economic strategic planning, or spatial planning is very limited. The same applies for corporate decision-making as a whole. Within the scope of this review we explored that valuation tools are available to support such decisions. However, to implement such tools within the broad range of (everyday) decisions affecting ecologies, it is not just necessary to ensure that the relevant evidence is available and that such tools are applied appropriately; it will also be necessary to change the institutional setup to enhance or make the application of valuation tools compulsory for such decisions.

A better analysis of the decision-making process and the actual demands and incentives of the decision-maker may be beneficial to develop 'fit-for-purpose' tools that will be better recognised and applied in practice. One has to acknowledge that scientific evidence and tool, even if they are applied appropriately, often have a very limited impact on the actual decision.

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