A MULTIDISCIPLINARY CRITIQUE OF THE ECOSYSTEM SERVICES-BASED COST-BENEFIT ANALYSIS FOR ENVIRONMENTAL POLICY EVALUATION

G Wegner1 and U Pascual2

1Wildlife Conservation Research Unit (WildCRU), University of Oxford, Tubney House, Abingdon Road, Tubney, Abingdon, OX13 5QL, UK, E-mail: giulia_wegner@yahoo.com ; 2Department of Land Economy, University of Cambridge, 19 Silver Street, Cambridge, CB39EP, UK

SUMMARY

This paper provides a critique of the cost-benefit analysis tool for ecosystem services policy evaluation. We argue that when applied to public ecosystem services, the theoretical assumptions that underlie economic valuation and cost-benefit analysis fail to fully acknowledge the multiple dimensions of human well-being, the plural forms of value articulation, the complex nature of ecosystems, the distributional biases of markets and the fairness implications of spatio-temporal framing. The current monistic utilitarian approach to ecosystem services policy evaluation should therefore be replaced by a pluralist framework composed of a heterogeneous set of value-articulating instruments that are appropriate to the specific context within which decision-making takes place. It is argued that within this pluralist framework cost-benefit analysis may remain an appropriate tool to examine the contingent trade-offs of local policies that have limited impacts on ecosystems and their services.

INTRODUCTION

Ecosystem services are the tangible and intangible benefits that human beings derive from their interaction with nature. As the scale of most economies continues to grow, demands on ecosystems increase too, so that all demands cannot always be fulfilled simultaneously, and trade-offs across ecosystem services, among beneficiaries and between time periods are expected. To choose among policies that involve such trade-offs can be a complex and daunting task. Cost-benefit analysis is often considered an effective tool to guide this choice (Carpenter et al., 2009).

Cost-benefit analysis compares alternative policy options by quantifying all impacts on ecosystem service flow through a monetary metric, and by aggregating the obtained monetary values so as to calculate the total net benefits of each policy option. Policies are then selected in terms of their capacity to maximise total net benefits or social welfare (Pearce et al., 2006). That is, at the basis of CBA is the normative view that individual values and net benefit maximisation are of prime importance (Accocella, 1998), and that personal values are revealed through choices in the market place (Vatn, 2005).

Here we aim to bring clarity and synthesis to the rich and often disconnected set of criticisms made to cost-benefit analysis and to review the arguments advanced in its defence, in order to facilitate a consensus about the applicability of cost-benefit analysis to ecosystem service policy evaluation. On the basis of this review we conclude that cost-benefit analysis should be used with judgement, as only one potential component of a richer framework for environmental decision-making. The main argument is that public ecosystem services such as
watershed regulation, climate stabilisation and pest/disease control have characteristics that challenge the economic theories of value articulation and value aggregation that underlie cost-benefit analysis. Here we summarise some of these key challenges.

ECOSYSTEM SERVICES AND VALUE ARTICULATION

The use of cost-benefit analysis in the context of ecosystem services poses considerable challenges, since public ecosystem services have characteristics that challenge the theory of value articulation through willingness to pay that underlies this policy evaluation approach. We argue that due to the characteristics of public ecosystem services, willingness to pay may represent an invalid measure of the values that people hold towards many of these services. We discuss each of these characteristics in turn.

- **Intangible values:** Cost-benefit analysis uses monetary values in its calculation of policy impacts upon ecosystem services. However, public ecosystem services impact on human well-being also through intangible psychological, social and cultural benefits that are hardly quantifiable in monetary terms (Chiesura and de Groot, 2003). As a consequence these benefits of nature fail to be accounted for in cost-benefit analysis.

- **Altruistic and intrinsic values:** Human behaviour towards ecosystem services can encompass altruistic concerns for the well-being of other human and non-human beings (Sagoff, 1988), as well as intrinsic motivations without regard to any of the consequences (Paavola and Adger, 2005). Again, individuals find it difficult to measure these altruistic and intrinsic values of nature in monetary terms (O’Neill et al., 2008), and therefore these values tend to remain excluded from cost-benefit analysis.

- **Collective value formation:** Cost-benefit analysis assumes that individuals can elicit their values for ecosystem services in isolation (Accocella, 1998). However, the benefits of ecosystem services and their anthropogenic change are complex and collective processes that cannot be comprehended and valued individually (Sagoff, 1988). Instead, environmental values need to be socially constructed through some form of deliberative communication (Dryzek, 2000).

- **Non-linearity and irreversibility:** As conceived by cost-benefit analysis, the value that people attach to an object is ‘marginal’ and ‘relative’, that is, determined by the value of the last unit used and by its relative scarcity compared to other substitutable commodities or income (Baumgärtner et al., 2006). But ecosystem services are not typical commodities, as they are characterised by limited degrees of substitutability, non-linearities and critical thresholds. When an ecosystem is approaching a critical threshold, only minor disturbance may alter the ecosystem in a dramatic and often irreversible manner, so that some of the services it provides may become scarce in absolute rather than relative terms (Farber et al., 2002). In such circumstances economic valuation becomes meaningless and cost-benefit analysis faces a formidable challenge.

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• **Complexity and resilience**: Ecosystems are complex and highly interconnected, which implies that even minor changes in one component of an ecosystem can have large impacts on other components and change the provision and thus relative value of its services (Daily *et al*., 2000). Accounting for these interdependencies would require the use of general equilibrium models that necessitate a large amount of data and rely on highly questionable theoretical assumptions (Neumayer, 2003). Hence, in practice, partial equilibrium models remain the norm in CBA and ecological interdependency tends to be ignored (Norgaard, 2010). Ecosystems are also endowed with some degree of in-built resilience that affects the level of provision of ecosystem services and therefore their marginal value. However, accounting for changes in this crucial property when measuring and valuing ecosystem services is still arduous (Arrow *et al*., 2008).

• **Ignorance and uncertainty**: Cost-benefit analysis is practised under the assumption that humans are omniscient actors; i.e., we have complete information and perfect understanding of our set of choices, and hence we can always form values over goods and services. In reality, decisions regarding ecosystem services are often afflicted by ignorance or uncertainty. These can characterize both stages of biophysical quantification by scientists, due to the high complexity of ecosystem functions (Daily *et al*., 2000; Carpenter *et al*., 2009), and economic valuation by citizens, due to the fact that people may not have sufficient understanding of and experience with ecosystem services (Spash and Hanley, 1995). Some cost-benefit analysis practitioners deal with uncertainty about biophysical processes through the use of probabilistic methods (Pascual *et al*., 2010). However, probabilistic methods are not helpful when we deal with structural uncertainty or ignorance, especially when the studied ecosystem approaches an ecological threshold.

• **Market prices and inequality**: Market prices may not be considered a neutral and accurate reflection of consumer values for ecosystem services, because they are significantly influenced by the distribution of wealth in society (Martínez-Alier, 2002). In fact, the budget constraints of the poor may result in an underestimation of those ecosystem services that are crucial to the long-term sustainability of their livelihoods. The unequal capacity of poor and rich people to express their values for ecosystem services through prices can be further exacerbated by ‘resigned adaptation’ (Sen, 1999) and ‘status seeking’ behaviour (Brekke *et al*., 2003). While distributionally weighted cost and benefit calculations have been advocated as a potential way to address equity distortions in cost-benefit analysis (Pascual *et al*., 2010), so far it has proved difficult to develop a consensus for their formulation, quantification and application (Kriström, 2006).

**ECOSYSTEM SERVICES AND VALUE AGGREGATION**

In order to carry out net benefit calculations, cost-benefit analysis aggregates the values of ecosystem services on a single monetary scale of measurement. In this respect, the assumptions that all values that people hold towards ecosystem services are exogenous (i.e., context-independent) and continuous (i.e., commensurable with each other through a single unit of measure) are essential, because they make the aggregation of values on a single scale of measure possible (Vatn, 2005). However, in the case of public ecosystem services people often hold values that are endogenous (i.e., context-dependent) and lexicographic (i.e., non
commensurable with each other through money), and this makes value aggregation highly problematic.

- **Endogenous values.** Individuals tend to assign different values to an ecosystem service depending on the context, i.e. depending on whether they act in the role of self-interested consumers or in the role of citizens interested in the common good (Brekke and Howarth, 2000). Such multiple and possibly conflicting processes of valuation precludes the aggregation of all values of ecosystem services on a single scale of measure (O’Neill *et al*., 2008).

- **Lexicographic values.** These are intrinsic values that may be held towards ecosystem services for deontological, cultural and religious reasons, and that due to their nature cannot be measured in monetary terms and compared with other values (Spash and Hanley, 1995; Gowdy, 2004).

**SPATIO-TEMPORAL FRAMES IN COST-BENEFIT ANALYSIS**

Cost-benefit analysis is highly sensitive to spatial and temporal framing – a slight change in the spatial and temporal frames can lead to a change in the range of consequences and stakeholders that are included in the analysis. Unfortunately, no consensus has been reached yet on how the spatial and temporal boundaries of analysis should be selected.

- **Spatial framing:** The method for spatial framing suggested by the Millennium Ecosystem Assessment (MA, 2003) is arduous to undertake when dealing with large-scale ecosystem change, in which case our knowledge of how and where ecosystem services are generated, altered and experienced is often insufficiently detailed. Large-scale cost-benefit analysis therefore risks adopting spatial boundaries that do not encompass all the impacts of a planned change.

- **Temporal framing:** The choice of the temporal scale of analysis in cost-benefit analysis is critical, since it determines to what extent the interests of future generations are included in the analysis. This choice is arduous because the co-evolution of social-ecological systems is not predictable, and consequently the more we extend our analysis into the future the less accurate our predictions become (Winkler, 2006). This choice is complicated also by the need to select an appropriate discount rate. No conclusive argument in favour of either positive or zero discounting of future ecosystem services has been advanced yet – the former leads to biases against future generations, while the latter leads to similar biases against present generations (Chichilnisky, 1996). The use of hyperbolic (or declining) discount rates, on the other hand, is afflicted by problems of time-inconsistency (Li and Löfgren, 2000). Since the use of any discount rate entails potential problems of intergenerational justice, the use of cost-benefit analysis to assess projects whose impacts extend far into the future risks generating controversial results.
WHY DOES COST-BENEFIT ANALYSIS PERSIST DESPITE ITS PREDICAMENTS?

Despite the shortcomings listed above, cost-benefit analysis continues to receive support in academic and policy-making circles on the basis of four postulated merits:

- **Expediency:** It is often claimed that the market is nowadays a ubiquitous institution for the satisfaction of human needs and wants, and that consequently the couching of ecosystem services in economic terms is the best guarantee to their contemplation in public decisions (Heal et al., 2005). This claim is contradicted by evidence from the real world of politics – even when governments recommend the use of CBA to guide policy-making, public decisions are often based on goals other than economic efficiency, such as the need to align with the prevalent public opinion or to co-opt interest groups and lobbies (Kalt and Zupan, 1984). Hence, the contemplation of public ecosystem services in decision-making may be better guaranteed by deliberative procedures that increase participation and transparency, rather than by cost-benefit analysis. Further, the expediency argument collapses when the theoretical assumptions that underlie cost-benefit analysis appear to be inadequate, as there is nothing pragmatic about using a policy evaluation tool that can result in inaccurate estimates and hence misguided decisions (Gowdy, 2004; Norgaard, 2010).

- **Democracy:** Cost-benefit analysis is often assumed to be a democratic approach to decision-making because it treats the values of all individuals equally, and because its goal is the maximisation of social welfare. However, this argument is based on a reductive interpretation of democracy as the aggregation of isolated values, and on a reductive definition of the social goal in terms of economic efficiency. Instead, democracy may be interpreted more broadly as ‘deliberative governance’ (Dryzek, 2003), and the social goal as the creation of opportunities for individuals to identify and pursue a broader set of capabilities (Sen, 1999). Further, the unequal distribution of wealth in society means that the values of wealthier groups tend to be disproportionately represented in cost-benefit analysis (Bromley, 1991; Spash, 2008). Finally, cost-benefit analysis can lead to a politics of exclusion, because stakeholders who are not used to define nature’s benefits in economic terms may be left out of the decision process (Martínez-Alier, 2002).

- **Value-neutrality:** This might be a naive postulation, because on the contrary cost-benefit analysis requires numerous normative judgments, from the choice of the geographical boundaries of analysis, to the use of distributional-equity weights, to the setting of a temporal discount rate (Spash, 2008).

- **Inescapability of trade-offs:** The preservation of elements of nature that are intrinsically valued often entails opportunity costs that also embrace other intrinsic values, in which case people are eventually forced to allow their trade-off (Beckerman and Pasek, 1997). On the basis of this inescapability of trade-offs among intrinsic values, it is often argued, people may as well accept the monetary valuation and comparison of the intrinsic values that they hold towards nature. However, while it cannot be denied that at high opportunity costs the trade-off of intrinsic values may be unavoidable, it is arguable whether such conflicting ethical choices can be properly dealt with through cost-benefit analysis (Martínez-Alier, 2002). Instead, their
resolution requires open deliberation over the interests, motivations and values that underlie such arduous decisions.

CONCLUSIONS: TOWARDS A PLURALIST FRAMEWORK FOR ECOSYSTEM SERVICE DECISION-MAKING

Cost-benefit analysis may largely fail to identify socially desirable solutions with regard to ecosystem services when they (i) affect intangible dimensions of human well-being; (ii) are intrinsically and collectively valued; (iii) are characterized by ecological thresholds, complexity and uncertainty; (iv) differently affect poor and wealthy groups in society; and (v) are valued in different ways depending on the context. In these circumstances cost-benefit analysis can result in inaccurate estimates and therefore constitute an unreliable guide to decision-making. In addition, the margin of error in cost-benefit analysis can further increase when this tool is used to evaluate ecological change over spatially and temporally extensive scales.

In order to mediate to the limitations of cost-benefit analysis reviewed in this paper, rather than restrict policy decisions to this approach alone, we argue in favour of the adoption of a pluralist framework instead. Such a framework would be composed of a heterogeneous set of value-articulating and decision-making instruments that better account for the characteristics of public ecosystem services, and for the multiple ways in which people value and make decisions about the environment. Cost-benefit analysis may remain a component of this pluralist framework, since it may be suitable to examine local projects that have marginal and spatio-temporally limited impacts on ecosystem services (Gowdy, 2007), but its applicability should be carefully assessed on a case by case basis.

Emerging tools for a pluralist framework for decision-making include multi-criteria assessment and deliberative valuation approaches. While both cost-benefit analysis and multi-criteria assessment are based on a calculative logic, deliberative methods (e.g., focus groups, citizens’ juries, consensus conferences and deliberative polls) are based on discursive interactions between lay people, scientists and decision makers about how to address collective environmental issues. Multi-criteria assessment shares technical problems of value aggregation with cost-benefit analysis, and also suffers from significant power asymmetries among participating stakeholders (Munda, 2004). For what concerns deliberative methods, problems of inclusiveness, representation, manipulation and competence have not been fully resolved yet (Carter et al., 2007). Nonetheless, the standard defence of cost-benefit analysis that it shouldn’t be criticized unless a full-blown alternative exists is now less valid than ever, as a number of alternative approaches for decision-making are being refined. Our view is that the main limitations of cost-benefit analysis need to be recognised, and emergent alternatives for decision-making acknowledged and invested upon.

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