Framing the valuation of ecosystem services: a theoretical discussion of the challenges and opportunities associated with articulating values that reflect the economic contributions of ecological phenomena

Katharine N. Farrell
katharine.farrell@agrar.hu-berlin.de
+49 30 20 93 6235
Division of Resource Economics,
Faculty of Agriculture and Horticulture,
Humboldt-Universität zu Berlin,
Unter den Linden 6, 10099 Berlin, Germany

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Abstract

This paper presents a theoretical discussion concerning possibilities for designing environmental value articulation procedures that respect the basic non-economic character of ecological phenomena. The question of how to estimate the economic value of ecosystem services contributions is a particularly important issue for agricultural economics because of the dependence of agricultural production on the life cycles and biological viability of ecosystems (sic Georgescu-Roegen, 1966). Distinguishing between two basic types of ecosystem services values – demand vs supply based – this paper aims to describe a theoretical context within which it may be possible to develop recommendations regarding procedures and associated institutional structures that can support the expression of economically relevant measures of *the economic worth* of a given *ecological phenomena* that are also ecologically sound. Finally it is proposed that there are strong synergies between the problem structure of this issue and the theoretical contributions of Herbert Simon, concerning bounded rationality and further work on the details of these links is recommended.

1. Introduction

This paper presents a theoretical discussion concerning possibilities for designing environmental value articulation procedures that respect the basic non-economic character of ecological phenomena, including the irreducible uncertainty of their stochastic change dynamics, while still producing value estimates that are operationally useful for conducting economic analyses. While the generation of such estimates is often viewed as a topic for environmental as opposed to agricultural

economics, the question of how to estimate the economic value of ecosystem services contributions is a particularly important issue for agricultural economics because of the dependence of agricultural production on the life cycles and biological viability of ecosystems (sic Georgescu-Roegen, 1966). Distinguishing between two basic types of ecosystem services values – demand vs supply based – this paper aims to describe a theoretical context within which it may be possible to develop recommendations regarding procedures and associated institutional structures that can support the expression of economically relevant measures of *the economic worth* of a given *ecological phenomena* that are also ecologically sound. This problematique has, in recent years, come to be labelled 'ecosystem services valuation' (sic Suhkdev, 2008) and we will adopt that term here, for convenience and clarity, while keeping in mind that the term 'services' presumes an instrumental relationship between economic and ecological processes.

2. Opening propositions

We may begin from the presumption that all values must, by definition, relate back to some system of human judgement. Economic values or judgements of worth can then be defined as those values that relate back to systems of human judgements that structure and regulate economic production and consumption. Some economic values deriving from the services of ecological phenomena are relatively easy to observe and estimate. For example, an annual drop in the productivity of an agricultural field, due to deterioration of the soil ecology, as a result of over-irrigation, can be measured in terms of reduced productivity or increased fertilisation costs. A minimum ecosystem service value can thus be observed, either as the cost of maintaining production steady, under deteriorating conditions, or as lost income. Such shadow price estimates provide more or less plausible base line value estimates of the minimum economic worth directly provided an ecosystem's services. However there is another set of economic values, referred to variously as indirect, non-use, intrinsic or existence values, which are considerably more difficult to estimate. It is these values that will occupy our attention in the following pages.

Within this sub-category of indirect values, we can further distinguish between demand-based ecosystem services values – which are related to preferences and willingness and ability to "pay" and supply based values – which are related to the

ecosystems production and willingness and ability to "sell".[iii] While demand based ecosystem services values can be estimated through exclusive reference to the system of human judgements that structure and regulate economic production and consumption, supply based values must *also* include reference to a second system of human judgements, one that provides understanding regarding how ecosystems generate and maintain supplies of the goods and services that are economically useful to humans. It can be expected that lack of reliable data regarding supply-based value contributions of ecosystem services leads at the very least to their inefficient use and at worst to their systematic over consumption and the eventual collapse of the ecosystem. While demand-based values can be estimated by consulting economic actors regarding their preferences, estimating supply-based values requires the deployment of a complex array of often uncertain information that bridges the analytical divide between social and physical sciences.

3. The Problem:

Since the advent of mainstream environmental economics, in the 1970s, efforts to develop appropriate methods for articulating the economic worth of what have been called here above 'supply-based" or complex intrinsic values have been ongoing.[iv] They have usually taken the form of price estimates and have been accompanied by a constant critique (Kapp, 1971; Kneese, 1977; Vatn and Bromley, 1994; Costanza 1998), with it being generally agreed that efforts to reduce such economic worth to monetary values is fundamentally flawed and inevitably unsatisfactory.

In recent years, some scholars have responded to this critique by turning their attention to institutional (Faber et al, 1996; Sagoff, 1998; Wilson and Howarth, 2002: Jacobs, 1997; Farrell, 2005; 2007; Vatn, 2005), methodological (Funtowicz and Ravetz, 1991; Martinez-Alier et al, 1998) and cognitive / epistemological (Siebenhuner, 2002: Stagl, 2003; Mayumi and Giampietro, 2006; Sneddona et al, 2006) aspects of environmental value articulation. As a constructive response to the long standing critique of monetary valuation, this newer approach identifies not only the problems at hand but also possible strategies for their resolution. In the following pages it is argued that formal attention to the epistemological problem of construing the economic contribution of ecological phenomena could help to advance this emerging alternative discourse.

We can begin by setting out the structure of the problem of ecosystem services valuation by reviewing some basic principles. Next we may review some important links between this problem and arguments first presented by Kenneth Boulding and Nicholas Georgescu-Roegen in the 1950s regarding the ecological embeddedness of all economic activity and the need to fundamentally revise economic theory in order to take this into account. Finally, based on this review, it will be argued that it is *both appropriate and necessary* for studies of ecosystem services valuation to address, in the first instance, epistemological problems associated with construing the wealth generating processes that give rise to the economic worth that may or may not be of value to one or another economic actor. Perceiving and articulating the economic worth of ecological phenomena requires epistemologically complex environmental valuation procedures because multiple ways of knowing simultaneously co-operate in the articulation of an ecosystem service's value. Drawing here upon Herbert Simon's (1955; 1959) theory of bounded rationality it is possible to describe practices through which organisations of people can simultaneously make reference to multiple epistemological perspectives concerning the overall economic worth of a given object, in this case and ecosystem service. Here we can imagine a community of differently oriented individuals, each offering some information regarding what about the service is valuable and to whom. In the end, there are bound to be overlaps in the valuations, which can be balanced as double counts, and there will be gaps. However, there will also be a more or less operational rough picture of the general economic contributions of the ecosystem service, which provides not perfect but sufficient information upon which to proceed.

The problem of ecosystem services valuation can be understood in terms of some basic principles regarding the institutional context in which environmental values are articulated; methodological challenges and problems associated with construing ecosystem services values; and the role of epistemology in the formulation and articulation of environmental values.

Critiques of monetary valuation are well rehearsed and we need not revisit them here. Instead, it is proposed here that the method can only ever, at best, refer to demand-based ecosystem services values, because its only frame of reference is the system of

human judgement concerning the economic worth of the phenomenon in question. Estimating supply-based ecosystem services requires an approach that can also make reference to human systems of judgement concerning how an ecosystem produces valuable goods and services.

Here we can define two basics characteristics of supply-based ecosystem service values, which make them particularly ill suited for representation through monetary valuations: (1) they are fundamentally non-market values, produced according to the laws of physics, not the laws of man, this means that their productivity cannot be directly regulated through economic controls; and (2) they are components of living systems that are fundamentally irreducible, so they cannot be meaningfully represented through recourse to single numeric metrics. Nonetheless, these are economically (as opposed to purely ecologically) relevant values, because they produce outputs that eventually support economic activities. In order to capture and represent the economic value of these processes and their products, methods of value articulation are required that can make reference to data that is organised according to the laws of physics and biology, while retaining an analytic that is organised according to the principles of economics. That is to say, two ways of thinking need to be applied at the same time to the same problematique.

This presents two fundamental problems for economists: (1) economic worth is always specified with respect to what is useful for one or another specific economic purpose (GR, 1971: 282). However, because ecological phenomena are non-excludable, one phenomenon (a forest, the global climate) may serve many purposes. While this is a problem common to all non-excludable goods and services, *it is a basic attribute of ecological phenomena*. This means that the economic worth of these phenomena *can only be correctly construed as a complex value*. That is to say, as a value able to take into account a range of differently oriented economic contributions made toward the fulfilment of a range of different economic purposes; (2) Although ecological phenomena clearly contribute to economic production, their dynamics are regulated by the laws of physics and not by the laws of humans. This means that the economic worth of their contributions includes activities and outputs that cannot be described *solely* through recourse to economic analysis. The problem

here is not simply one of construing the information correctly but also of coping with epistemological complexity and uncertainty (sic Funtowicz and Ravetz, 1990; 1994).

4. New Discourses

Empirically, the economic worth of an ecological phenomenon is always comprised of multiple and potentially incommensurable values (O'Neill, 2001; Munda, 1996; Smith, 2003), associated with multiple ecosystem functions, which may serve different users and different use specifications: i.e. a river might be valuable for its beauty, as a clean water supply, as a means for goods transport, as a cooling systems for a microclimate with local agricultural value, as nutrient transport for a far away delta fishery, etc.

Discussing economic valuation of forest ecosystems, Vatn (2003) points out that while ecosystem goods and services clearly have economic values, these are not unitary, discrete values. Instead, ecosystem values are complex, procedural values, defined precisely in the context of our interaction with and participation in the environment, through, for example, our use of ecosystems "to produce food and restructure waste" (Ibid).

If we are to articulate values for these ecosystem goods and services without excluding from our description the very attributes we purport to value, then we shall require non-reductive valuation procedures that allow us to describe and honour the full complexity of these phenomena. However, honouring such complexity still entails making decisions regarding which perspectives count, so to speak, and which do not. This governance question of 'who decides who decides?' (Farrell, 2004) has been raised, in one form or another by a number of scholars considering the problems of environmental valuation, however Luks (2000), Martinez-Alier (2002) and O'Hara (1996) each make explicit reference to a set of living systems criteria for deciding this that call upon us to formally consider the question of how a society determines who has standing to pronounce the economic worth of one or another ecological phenomenon. This proposition, which constitutes the focus of the remainder of this paper, fits closely with arguments presented in the early works of Boulding and Georgescu-Roegen. The case for formally considering the question of who decides who decides about the criteria for environmental valuation has been well made. What

is still lacking is the development of explicit theoretical explorations concerning what new institutional decision making and governance structures might help to make this implicit question a topic for regular debate within economic resource management and decision-making processes.[v]

4.1. epistemological complexity / post-normal science intrinsic value

Methodologically, the multiple attributes that contribute to complex ecosystems services values are functionally distinct from one and other, are understanding of them is based on different descriptive domains (Giampietro, 2004; Giampietro and Mayumi, 2001; 2006) and by extension a variety of analytical structures are required to measure and evaluate their qualities. Any associated value articulations will necessarily be expressed in language specific to the respective descriptive and analytical domains and may well be incommensurable. While epistemology is traditionally understood as the theoretical treatment of 'truth' apprehension, this definition is dependant upon the presumption that there is only one truth to be apprehended. However, the truth of what ecological phenomena contribute to economic processes is complex. Ecosystem valuation must contend with 'non-unitary' truth. Developing a single but nonetheless non-reductive picture of the economic worth of these phenomena can only be supported by an epistemology that can describe the apprehension of complex truth.

Working within the post-normal science discourse Giampietro (2004) uses the metaphor of a mosaic to describe how non-reductive descriptions of complex problems may be put together, from individual pieces that maintain their individuality, while nonetheless contributing to the construction of a bigger picture. Similarly, Healy describes what he calls 'epistemological pluralism' (Healy, 2003) – where multiple incommensurable epistemological perspectives are all deployed to contend with a single practical problem. He proposes that this can lead to the discovery of solutions that are beyond the conception of any one single perspective, because orientation around a common practical problem provides the coherence that is at risk when multiple versions of truth are deemed equally valid.

4.2. the role of cognition in value articulation / complex discourse

While environmental valuation is intended to provide economic data regarding the worth of ecological phenomena, it is nonetheless, a human cognitive activity. Whether we are concerned with the stage where economic purpose is defined or with the collecting, ordering and analysing of data regarding economic contributions, the capacities *and limitations* of human cognitive faculties are always part of the process at hand. In recent years, the role of cognition and learning in the formulation and articulation of values has been discussed by Siebenhuner (2002), Stagl (2003) and Hukkinan (2001). With respect to delimiting and combining different forms of information in environmental valuations, Giampietro and Mayumi (2006), Norgaard (2004) and Sneddona et al (2006) have all argued that a new view of epistemology, which regards truth as multi-dimensional, is required. What is common across both lines of argument is a recognition that the cognitive and perceptual capacities (and limitations) of the human brain are factors that should be taken into account when describing environmental value articulation processes.

5. New Valuation Methods

As has been pointed out above, the aim of this paper is not to critique monetary valuation but to identify new procedures for articulating intrinsic, supply based, economic values associated with ecosystem services. Toward that end, two methodological discourses, arising from the theoretical discourses presented above, seem to offer a basic theoretical framework from which to begin: deliberative valuation and post-normal science extended peer review.

5.1. Deliberative valuation

Use of deliberative consultation as a valuation methodology draws on political theory concerning deliberative democracy and typically takes the form of participatory stakeholder consultations, such as collaborative modelling and multi-criteria analysis (Munda, 2004; DeMarchi et al, 2000; UFZ, 2002; Videira et al, 2003), where stakeholders participate in setting the analytical parameters for an economic model or deliberative valuation exercises (Wilson and Howarth, 2002; Niemeyer and Spash, 2001) and groups of individuals discuss and decide contingent monetary values for ecological phenomena. The basic concept is Kantian (1787) in origin and relies on the Habermasian theory of communicative rationality (Habermas, 1984; 1987; 1996) and the ‘ideal speech’ setting, where small groups employ rational discourse, allowing

the ‘best argument’ to lead to a consensus. Common forms of deliberative democracy include citizens’ juries, consensus conferences and stakeholder consultation.

O’Hara (1996) offers one of the more concrete explorations of the relationship between deliberative democratic theory the problem of complex values, proposing that discourse ethics could serve as basis for the kind of complex decision making procedures that could include value data from disparate sources. Dryzek (1987; 1994) has also argued that deliberative democracy is particularly useful as an institutional setting for the articulation of environmental values, both because it provides a forum in which a society of individuals can formulate a shared position on the worth of a common good, like an ecosystem, and because this shared position is inherently mutable, enabling adaptations in social choice that are responsive to spatial, temporal and evolutionary changes in the nature of the ‘common or public good’ at issue.

However, as Stagl (2003) notes, while experiments with public participation may be promising in their results they are not yet supported by firm theoretical foundations, although work in this direction is certainly underway (Munda, 2004; Kasemir et al, 2003; Milan Book, 200?). While the model of deliberative democracy holds promise for accommodating epistemologically complex value articulation (see Dryzek, 1987; Young, 2000), the arguments justifying the usefulness of the method are currently coming under heavy critique within their home discipline of political theory regarding its claim to political legitimacy (Dryzek, 2001, O’Neill, 2001, Shapiro, 2003, Parkinson, 2003; Smith, 2003; Farrell, 2008; 2010). While it is certainly not necessary for a method of economic valuation to be democratically legitimate, there is one aspect of this critique that is, nonetheless, of concern here.

Following Parkinson (2003) we may refer to this as the problem of scope. It is related to difficulties that arise where there are a range of equally valid conflicting views regarding a single problem, such that it is not possible to reach an agreement. In the environmental politics discourse it is also referred to as a problem of value conflicts. Weale (2001), in evaluating recommendations on the setting of environmental standards, which were made by the British Royal Commission on Environmental Pollution, argues that if we propose to consider deliberative democracy as a potential institutional framework for governance then, “[w]hen theorist of deliberative

democracy reject an understanding of democracy in terms of the aggregation of interest, they need at least to show how conflicts of value and opinion, as well as of legitimate interest, will be dealt with under some alternative regime" (Weale, 2001:371). Here there is a need to critically consider the appropriateness of mainstream deliberative democracy tools for the task of ecosystem services valuation.

This inadequacy of deliberative democracy theory for managing conflicts, to which Weale refers, has been pointed out by many scholars and it is precisely this weakness that we find problematic: not on political theory but on epistemological grounds. The basic problem is that deliberative democracy presumes that agreement can be reached through deference to the 'best argument'. If deliberative democracy is to be used as a method for articulating living systems values – which are epistemologically complex values – then the concept of 'best argument,' which presumes one truth, is problematic. While the presumption that a range of views can all be 'right' (Young, 2000) seems unavoidable, the standard 'difference democrat' response to this 'best argument' form of authority – veto power / the right to reject an argument without explaining why – seems an unhelpful alternative where combinations of meanings play a central role in building a complex picture of an irreducible whole.[vi]

However, somehow, in real life situations, groups of people we do reach decisions and make agreements regarding the value of ecosystem services, if only implicitly. If, in the end we are able to agree with others or ourselves, without having resolved our personal or collective value conflicts, then there must exist some system of meta-ordering that can supports this kind of discourse and decision-making. Here we propose that the work of Herbert Simon (YYYY; YYYY), concerning bounded rationality, holds out particular promise as a guide for considering how epistemologically complex ecosystem services value articulation procedures might be designed and operated. In particular, it provides a clear link between the epistemological complexity of the valuation problem and the operational dexterity of real economic actors, making complex decisions in complex situations.

The project of putting together the existing discourse on ecosystem services valuation with the principles of bounded rationality is a project beyond the scope of this paper. Instead, in the final pages here below, a few points of potential links are highlighted,

where it seems reasonable to begin the work of weaving these two discourses together, to see if they can indeed be used to build a bridge from the ecological functions of the biological systems upon and within which human economic activity is embedded and the decision-making processes that we use to structure and operate these activities.

5.2. extended peer review

In order to articulate the economic worth of a given ecological phenomenon it is necessary to understand the dynamics of that phenomenon. The usefulness of a given analysis regarding the ecological functions of a given ecological phenomenon, need to be evaluated through reference to what is required in order to conduct good economic analysis. However, the productivity of these same ecological phenomena can only be evaluated through reference to ecological analysis referents. Somehow, the two must be combined, not side by side or consecutively but dynamically. Combination of multiple epistemological perspectives in such a manner is a task addressed by Funtowicz and Ravetz (1991), through the introduction of the concept of 'extended peer review'. Extended peer review is a broad concept and we do not propose to define it here. Instead, drawing from Funtowicz and Ravetz (1991; 1993; 1994) and Ravetz (1971) we adopt the following working definition: critical evaluation of science related problem formulations and scientific analysis by individuals who are not expert in the specific field of scientific enquiry being subjected to that critical evaluation. Here there seems to be good potential to use insights from Simon's work to inform the design of rules regarding how groups of discussants are constituted and how their contributions are fit together into complex bigger pictures. Munda (2004) has already lead the work in this direction a bit but much more could be done, if the theory from Simon were to be engaged as a primary as opposed to instrumental object of discussion.

6. Enter Simon

While the introduction of arguments concerning institutions/politics and epistemology/cognition into the environmental valuation discourse is relatively recent, this approach, which is largely consistent with early ecological economics positions presented by Boulding and Georgescu-Roegen is also well in keeping with Simon, who was one of the key thinkers opening up the modern discourse on institutions and economics. The need to take institutional factors into account, as

empirical data that are relevant for understanding how ecosystem values are construed and articulated (O'Neill, 1993; 2001; Vatn, 2005) was raised by Boulding in 1950 and reiterated by him again in 1991. In concluding his contribution to the first book reporting the papers presented at the first ISEE conference (Costanza, 1991) Boulding asked "[c]an the human race adapt to the changes that it is producing so rapidly?" (Boulding, 1991:25) and encouraged ecological economists to consider the direct relationship between his theories of evolutionary economics and the need for careful study of "the structure of power in the human race over the future… decisions…[and] overall images of the world in the minds of the decision makers, and the learning process by which these images are created" (Boulding, 1991:28) including "asking what new institutions might be necessary" (ibid:22) if the human race is to successfully adapt.

This approach is based on a set of epistemological presumptions that can be traced back to specific observations made by Kenneth Boulding (1950; 1981) and Nicholas Georgescu-Roegen (1955; 1971) regarding the structure of ecology related economics problems and appropriate ways of construing them. Their arguments are remarkably consistent with more recent contributions which, again, argue that epistemologically complex problem definition and decision making procedures are required, if we are to even begin the process of discussing the substantive problems associated with ecosystem valuation (sic Norgaard, 1989; 2004). As early as 1955 Georgescu-Roegen identified human perspective and political structures as empirically relevant object that need to be described and understood if we are to engage with the kinds of problems that arise at the interfaces between economic and ecological processes.[vii] Recalling his return to his home country of Romania in the late 1930s, reflecting on his "training in the Western schools with a formidable armamentarium of mathematical standard economics", Georgescu-Roegen found that "Romania's institutions were not adapted to the Walrasian principle of profit maximisation" (GR, 1976:xi) but "[o]ne certainly would not expect a society that cannot live according to the Walrasian distribution theory – i.e., according to the marginal productivity theory – to commit suicide rather than adopt another system" (GR, 1966[1955]:339).

7. Conclusions

Ecosystem biology and complexity theory have both moved on considerably since the 1950s, revealing some of Boulding's assertions as naïve (see Levin, 2000) and some of Georgescu-Roegen's views concerning thermodynamics have been demonstrated be incomplete and/or incorrect (see Mayumi, 1992; Tsuchida and Murota, 1987). Nonetheless, their core presumptions continue to hold salience for economic analysis concerning the ecosystem services valuation and point us in a direction that has been worked through in forensic detail by Simon, who took these operational problems as his main object of study. Using Simon's work as a bridge, it may be possible to make explicit and operational the epistemological complexity that seems to be limiting progress in the design of valuation methods that speak in meaningful ways about the supply, as opposed to demand based economic worth of ecosystem services. In this paper the prospect that this might be a useful avenue of enquiry has been considered and endorsed. The work of putting this suggestion into practice seems justified, albeit with the caveat that is seems unlikely to be an easy road, through the fruits it may bear seem promising.

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[i] This paper draws from and elaborates upon several points originally presented in the paper "More than Rational Decision Making: an ecological economics based approach to ecosystem services valuation", which was written in collaboration with Arild Vatn of the Norwegian University of Life Sciences, Aas, Norway and presented at the 2004 conference of the International Society for Ecological Economics, in Montreal, Canada. In addition, the topic of demand vs supply-based ecosystem services has been discussed at length with George Hutchinson of the Queens University of Belfast and his contribution to the ideas presented here is gratefully acknowledged.

[ii] katharine.farrell@agrar.hu-berlin.de | Humboldt University Berlin, Department of Agricultural Economics, Division of Resource Economics, Philippstr. 13 - D-10099 Berlin – Germany.

[iii] see also Martinez-Alier, 2002: 269.

[iv] see Farrell, 2005; 2007 for an overview of the debate and references to explore its the background.

[v] Indeed the ISEE2004 conference: "Challenging Boundaries: Economics, Ecology and Governance" provides a venue for such exploration, which is demonstrated also in recent contributions such as Costanza, 2003; Norgaard, 2004 and Shi, 2004.

[vi] see Shapiro, 2003 for a discussion of the state-of-the-art debates in democratic theory

[vii] While we have chosen Boulding and Georgescu-Roegen as our referents, it is important to note Martinez Alier's (1987) observation of differences between these authors during this period: "[t]hat there was no concerted action to create a school of ecological economics is made clear by Boulding's inane critique of Georgescu-Roegen (Boulding 1972)" (Martinez Alier, 1987:2). However, our interest here is epistemological foundations and these can exist without a school and even where disagreements on detail remain unresolved.