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M. Vijay Kumar

PERSPECTIVES ON ECOSYSTEM SERVICES: APPROACHES, DEVELOPMENT AND VALUATION

M. Vijay Kumar[1], N. Nandini[2] and B. S. Prabhakar[3]
[1]Research Scholar, Department of Environmental Science, Bangalore University, Jnana Bharathi Campus, Bengaluru, Karnataka, India.

ABSTRACT

Ecosystem services originate from a functioning ecosystem and are of direct value to humans. They enter the utility function either directly, or along with labour, capital, and other produced goods as inputs in a production process resulting in consumable goods. Most ecosystem goods and services have produced although usually imperfect substitutes. It is the nature of economic and population growth that some ecosystem goods and services become depleted and that humans use inputs including plentiful ecosystem goods and services to produce new capital and goods that compensate for such depletion. An economic question is whether the substitutes for ecosystem services cost society more to produce than the opportunity cost of protecting the original ecosystem services. Many ecosystem services and some ecosystem goods are commonly received for free. The marketing of ecosystem goods and services is basically an effort to turn such recipients those who benefit without ownership into buyers, thereby providing market signals that serve to help protect valuable services. Some formal arrangement is needed to make this happen.

Key words: ecosystem services, valuation, payment for ecosystem services, dis-services

INTRODUCTION :

Ecosystem services are the conditions and processes through which natural ecosystems and the species that make them up, sustain and fulfil human life (Daily, 1997). Ecosystem services can be defined in myriad ways dependant on scale and perspective. The concept of ecosystem services

encompasses the delivery, provision, production, protection or maintenance of a set of goods and services that people perceive to be important. This includes goods such as food, timber, biomass fuels, natural fibre, pharmaceuticals and industrial products, services such as the maintenance of biodiversity and life-support functions including waste assimilation, cleansing, recycling and renewal (Daily, 1997; Norberg, 1999), intangible aesthetic and cultural benefits.

However, to facilitate comparative ecological economic analyses(deGrootet al., 2002) recently constructed a typology for describing, classifying and valuing ecosystem functions, goods and services. Economic theory recognizes four kinds of capital – human, financial, manufactured and natural. Ecosystem services are the equivalent of 'natural capital', developed economies have focused primarily on using the first three (which were considered limiting factors to development) to transform natural capital (which was considered 'free' and abundant) into consumer products and services (Hawken et al., 1999).

The term ecosystem services first were popularized by ecologists pointing out the wide range of natural processes and products that support human existence and enhance human well-being (Daily, 1997). This early work tended to define ecosystem services very broadly as the "biological underpinnings essential to economic prosperity and other aspects of our well-being" (Daily, 1997). The Millennium Ecosystem Assessment (2005a) followed this broad definition and distinguished between supportive services (leading to the maintenance of the conditions for life, such as nutrient cycling), provisioning services (providing direct inputs to human economy, such as food and water), regulating services (such as flood and disease control), and cultural services (such as provision of opportunities for recreation and spiritual or historical purposes).

The ecological and economics literature provides several definitions of ecosystem services not all of which are compatible or equally useful from an economic perspective. As Boyd and Banzhaf (2006) point out, such broad definitions of ecosystem services are not very useful from an economic perspective, because they lump together ecosystem products (such as food, fiber, or water), ecosystem functions or processes (such as nutrient cycling or habitat provision), and benefits (the economic value of a service, such as flood control or aesthetic beauty). They emphasize, as have others (deGrootet al., 2002; National Research Council, 2005; Chan et al., 2006) thatfor valuation purposes one needs to distinguish clearly between ecosystem functions and services, the crucial distinction being that services require the explicit involvement of human beneficiaries. While ecosystem functions constitute the biogeochemical flows that connect the different constituent parts of ecosystems (Odum, 1962), ecosystem services are "flows from an ecosystem that are of relatively immediate benefit to humans". To ensure that services can be quantified, (Boyd and Banzhaf, 2006) suggest narrowing the definition of ecosystem services further to include only end products - "components of nature, directly enjoyed, consumed, or used to yield human well-being".

By defining ecosystem services as things or characteristics of nature directly valued by humans, ecosystem functions and processes like nutrient cycling are not considered services because they are intermediate to the production of the final services or ecosystem components, such as surface water, oceans, vegetation types, and species. This definition of services as end-products avoids the problem of double-counting that would result from counting both intermediate inputs, such as hydrological cycling and water filtration by soils, and endproducts, such as drinking water. From a human welfare perspective, it is only the end products that matterhumans do not care about hydrological cycling or water, but about the resulting end-product the amount of available water of a certain quality.

Ecosystem Services

Defining ecosystem services as discrete and identifiable end products is necessary for quantification, which in turn is a prerequisite for the establishment of ecosystem service markets. It is not surprising that all such markets or market-like arrangements that have developed are for what Boyd and Banzhaf refer to as services, that is, for end such as water, forests, or species. Not counting ecosystem functions as services does not imply that the former do not have value, but they certainly do. However, this value is reflected in the value of the resulting services. These services are benefits-specific, that is, they are tied to particular human activities or desires, and are spatially and temporally explicit (Salzman and Ruhl, 2000; Boyd and Banzhaf, 2006). By focusing on end-products only, some services commonly identified in the literature are not considered services under Boyd and Banzhaf's definition. For example, carbon sequestration is not an end-product and hence not a service; rather, it is an intermediate input into services such as beaches, wetlands, or forests directly used by humans, and its value is already accounted for through the benefits provided by those services, such as avoided health and property damages, recreation, or provision of timber, among others.

A broader version, which developed in parallel, included all aspects of human dependence on the environment, and was driven by the concern that human actions leading to 'resource depletion, pollution, and extinction' could have significant negative consequences for human well-being (deGroot, 1987). Ecosystem services tend to fall into the categories of open access and pure public services. This means that they tend to have no producer property rights, ambiguous entitlement structures and prohibitive transaction costs (Sternberg, 1996). As no one ''owns'' or has ''rights'' to these services and others cannot be excluded from using or benefiting from them, little incentive exists for beneficiaries to manage ecosystem services sustainably (Dasguptaetal., 2000). Additionally, it is difficult to extract compensation payment from beneficiaries for redistribution among intraand intergenerational parties that might be affected by negative outcomes such as loss of biodiversity, pollution or irreversible degradation and depletion of ecosystem services (Sternberg, 1996). In effect, ecosystem services fall outside the sphere of markets and tend to be 'invisible' in economic analyses. Costanzaet al., (1997) states the value of the world's ecosystem services and natural capital, asserted that ''because ecosystem services are not fully 'captured' in commercial markets or adequately quantified in terms comparable with economic services and manufactured capital, they are often given too little weight in policy decisions''. Conversely, it has been argued that decisions about ecosystem conservation and restoration incur costs (or forgone benefits) and can lead to misuse of resources if not guided by some concept of value or trade-off (Pearce, 1998a; Howarth and Farber, 2002).

Development In Ecosystem Services In Recent Years

Humans have brought about massive changes in the structure and functioning of the Earth's ecosystems, significantly altering many biogeochemical flows on scales ranging from local to global (Vitouseket al., 1997a; 1997b). These changes have affected the volume of ecosystem service flows in every region of the globe (Millennium Ecosystem Assessment, 2005b). Removal or modification of "natural" ecosystems for purposes of agricultural production and application of new technologies hadbeen the principal drivers of humanity's impacts on ecosystems and biochemical cycles (Millennium Ecosystem Assessment, 2005a). Overall, human appropriation of most services has increased substantially during the past 50 years. The Millennium Ecosystem Assessment (2005b) concluded that a large number of provisioning services (the supply of biotic matter) have been degraded, with the notable exception of crop and livestock production. Regulating services have fared

even worse, with marked degradations in crucial services such as erosion regulation, water purification, pest regulation, pollination, and natural hazard regulation. The degradation of ecosystems and the resulting impacts on the quantity and quality of the services they provide to humans are expected to continue over the next several decades (MEA, 2005b). This is of concern to the extent that many of the services undergoing decline are essential for sustaining the long-term well-being of societies (Foley et al., 2005). Trade-offs between the preservation of "nature" and the satisfaction of human needs and desires make unavoidable the conversion of some lands to accommodate incentive to take the services value into account in their decision making. The large human population increase during the last 50 years, coupled with increasing average per capita resource consumption, has dramatically increased the scale of ecosystem transformation (Millennium Ecosystem Assessment, 2005b). Accounting systems that predate the recent period of increasing scarcity of many services and widespread awareness thereof have prevented the incorporation of environmental considerations into decision making at both macro (Hecht, 2005; Hamilton and Lutz, 1996; Repetto et al., 1989) and micro scales (Bennett and James, 1998). Finally, perverse incentives actively encourage environmentally degrading behaviours (Myers and Kent, 2001).

Natural ecosystems play an essential role in the regulation and maintenance of ecological processes and life support systems on earth. The maintenance of the earth's biosphere as humanity's only life support system in an otherwise hostile cosmic environment depends on a very delicate balance between many ecological processes. Some of the most important processes include the transformation of energy, mainly from solar radiation, into biomass (primary productivity); storage and transfer of minerals and energy in food chains (secondary productivity); biogeochemical cycles (e.g. the cycling of nitrogen and other nutrients through the biosphere); mineralization of organic matter in soils and sediments; and regulation of the physical climate system. All these processes, in turn, are regulated by the interplay of abiotic factors (i.e. climate) with living organisms through evolution and control mechanisms. In order for humans to continue to benefit from these functions, we need to ensure the continued existence and integrity of these natural ecosystems and processes. Because of the indirect benefits of regulation functions, they are often not recognized until they are lost or disturbed, but they are nevertheless essential to human existence on earth.

Frame Work For Ecosystem Services

The Millennium Ecosystem Assessment (MEA) derived a framework that is close to the environmental economics approach, except that

1) It broadened the term 'services' to include products and existence values as 'provisioning services' and 'cultural services' respectively;

2) It limited the concept of natural capital to 'life on Earth' or 'biodiversity', thereby excluding purely abiotic resources such as minerals or abiotic energy sources; and

3) It introduced a confusing category called 'supporting services' that covers what were seen as functions (Figure 1). Subsequent assessments, most notably the United Kingdom National Ecosystem Assessment framework (Mace and Bateman, 2011), have modified this framework somewhat while retaining the above core elements.

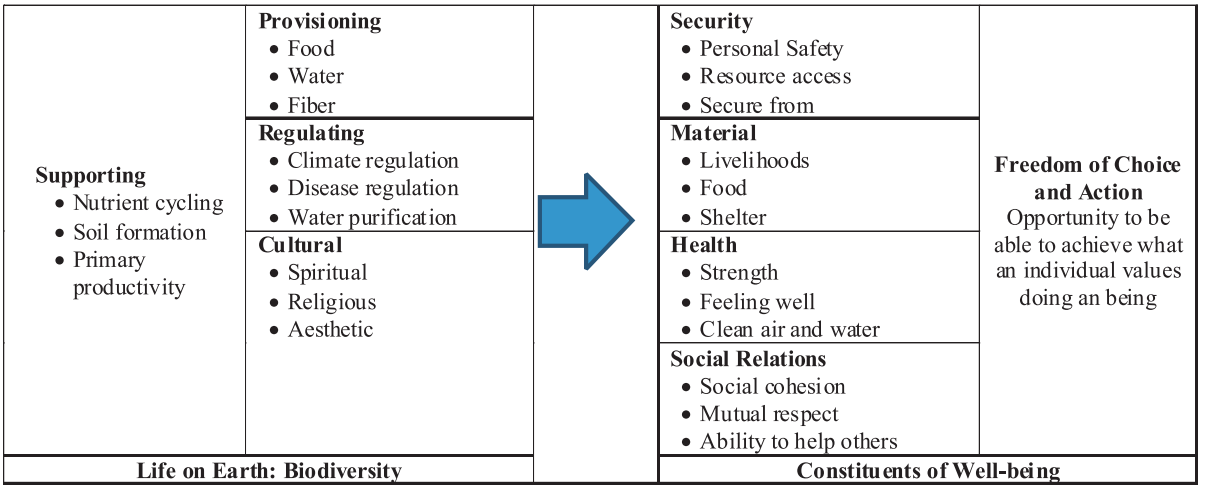

Figure 1: The Millennium Ecosystem Assessment (MEA) framework
Source: MEA 2005a

Valuation Of Ecosystem Services

The economic value of something is a measure of its contribution to human well-being (Freeman, 2003). Economic values reflect the preferences and actions of people in a society, who are assumed to behave so as to maximize their well-being given the constraints that they face. Clearly such values are based on an instrumental view of nature and on the assumption that individuals are competent judges of what is in their best interests. These premises are arguable, and much has been written about alternative approaches to value and about the inadequacies of human decision making. However, even with its flaws, quantification of economic values can, and regularly does, provide useful information for public decisions, especially when the limitations as well as the strengths of the values are recognized.

Proponents of ecosystem service valuation believe that valuations can:
(I) improve understanding of problems and trade-offs;
(ii) be used directly to make decisions;
(iii) illustrate the distribution of benefits and thus facilitate cost-sharing for management initiatives and (iv) the creation of innovative institutional and market instruments that promote sustainable ecosystem management (Alyward and Barbier, 1992; Sinden, 1994; Daily, 1997; Dasguptaet al., 2000; Armsworth and Roughgarden, 2001; Salzmanet al., 2001). For instance, Van Wilgen et al., (1996) compared the cost of alien plant management in South African fynbos ecosystems with that of developing additional water supply facilities and demonstrated that alien plant clearing and management was a more cost-effective approach to ensuring water production and delivery than alternative supply options such as dam construction, effluent treatment and desalinization. Valuation of additional fynbos ecosystem services such as wildflower harvest, genetic storage and tourism opportunities further strengthened the argument for continued investment in alien plant clearing programs (Higgins et al., 1997).

Similarly, New York cityadministrators decided that investment in restoring the ecological integrity of the Catskills Mountains watershed would be less costly in the long-run than constructing a new water filtration plant (PCAST, 1998). Watershed restoration would also provide additional ecosystem services such as flood and erosion control, carbon storage and visual amenity benefits. To

finance initiatives for restoration Environmental Bonds were issued to raise funds which were then used to purchase land, halt development in the watershed, compensate landowners for restrictions on private development and subsidize improvement of septic systems (PCAST, 1998). These case studies are compelling examples of how valuation of previously overlooked ecosystem services have been useful for re-framing decisions and prompting improved management of natural capital. Ecosystem service valuation is thus being developed as a means of putting natural capital into the equation of economic 'development' and on the agenda of policy-making (Munda, 2000). The aims of this paper are to:

(I) critically review the neoclassical economic framework and principal methods used to value ecosystem services from an ecological perspective;

(ii) assess the economic welfare approach to decision-making and

(iii) present alternative approaches for collective decision-making concerning ecosystem service management.

Ecological Value: Markets And Payments For The Provision Of Ecosystem Services

Although today one constantly encounters references to "the market", there is of course, as Bromley (1997) reminds us, no such thing. Markets are socially constructed, ordered domains of exchange through which individuals can arrange the transaction of goods and services (Polanyi, 1944; Bromley, 1997), and the vast diversity of existing markets reflects the diversity in the underlying "prior collective notions and expressions of who counts, and what is valuable and useful".

An even more misleading notion is that of the "free market." Markets, especially efficient ones characterized by low transaction costs, require supporting institutions that facilitate information flows about exchange opportunities, reduce negotiating costs among market participants, and ensure the enforceability of contracts (Bromley, 1997). All of these require some form of community or government involvement. Markets are embedded in a larger institutional context that both enables and restricts the behaviour of participants. In many cases where ecosystem services are exchanged, the exchanges do not occur in what economists would consider a market. One important reason for this is that the economic value of many ecosystem services is highly location-specific (Salzman and Ruhl, 2000). The resulting spatial non-fungibility of ecosystem services restricts the geographic scale of the potential market and creates many small, discrete exchanges, all characterized by a small number of service suppliers and/or buyers. The resulting oligo- or monopolistic exchange regimes still are markets in the basic sense that they involve voluntary exchanges, but they do not conform to what economists refer to as competitive markets. Importantly, a non-competitive market loses much or all of the theoretical efficiency advantage competitive markets might have over alternative resource allocation strategies. Because the structure of an ecosystem service market is a function of, among other things, the characteristics of the particular service

(i) its temporal and spatial fungibility, its rivalness and exclusiveness, and its physical or economic quantifiability

(ii) efforts to establish service markets must be preceded by a careful analysis of these characteristics and their implications on supply and demand. The crucial question to consider is why are markets for many ecosystem services lacking? Answering this question will identify the obstacles to be overcome for ecosystem service markets to become a widespread reality.

The three main reasons for the widespread absence of ecosystem service markets are

1) the lack of widely available, easily applicable, and low-cost approaches to quantifying ecosystem service flows;

2) the difficulty of attaching to those flows reliable and low-cost estimates of their economic value (Boyd and Banzhaf, 2006; Boyd et al., 2001; Waingeret al., 2001; Troy and Wilson, 2006);
3) the public goods nature of many of these service flows, or more specifically, their non-exclusiveness. While technical difficulties and limits to our scientific understanding may be the proximate causes for the first two reasons, the ultimate cause more likely is the fact that in most places, most ecosystem services have not become scarce until fairly recently (Millennium Ecosystem Assessment, 2005a). Since absence of scarcity by itself is a sufficient reason to prevent markets from developing, the increasing scarcity, present and projected, of many ecosystem services, and the increasing awareness of this scarcity, will by themselves favour the establishment of economic incentives for the provision of ecosystem services. However, measurability and exclusiveness remain necessary conditions for the development of private service markets. In fact, measurability remains a necessary condition for any kind of market-based approach, private or government created. In any case, markets are not the only approach that allows the utilization of economic incentives. Rather, a variety of economic incentive approaches have been utilized to encourage the production of ecosystem services.

The approaches can be distinguished into three principal types. Some payment systems have taken the form of business to business deals, where individual companies contract for the provision of services with landowners in what are essentially one-off, special arrangements driven by self-interest and worked out directly between the parties. These arrangements are close to “real” markets in the sense that the only role for government is that of an enforcer of contracts. However, they are relatively rare due to the lack of excludability of many ecosystem services that prevents suppliers from reaping the full value of the services. A second type of payment system is direct government payments in the form of a competitive program, a subsidy, or hybrids. A third approach is mitigation markets, which are based on compensatory mitigation requirements. These markets are entirely government created, since both demand and supply are the result only of environmental regulations coupled with monitoring and the credible threat of sanctions for non-compliance. In other words, they did not develop spontaneously from the profit motive of self-interested individuals. Rather, they are created through regulation and function well only to the extent that they are well-designed and implemented.

In the U.S., mitigation markets for ecosystem services have been employed only in the case of wetlands and endangered species banking (Shabman and Scodari, 2004; Fox and Nino- Murcia, 2005). Even in those cases, however, markets are relatively new and often thin. Of these three types of arrangements i.e., business to business deals, government payment programs, and mitigation markets & the last is the only one that can be characterized as a market.

Payment For Ecosystem Services

By contrast, the business to business deals and government payment programs in existence so far all involve unique, tailor-made arrangements with products tailored to the buyer's needs, characterized by large requirements of highly specific information, resulting in intense negotiations and concomitant high transaction costs for buyers and sellers (Zilberman, 2005). Because of their lower transaction costs, markets in theory are superior to payment schemes as a tool for achieving largescale and broad-based private investment in ecosystem services. Of course, payment schemes and markets are not mutually exclusive. However, the presence of large-scale government payments for ecosystem services could crowd out some private investment in services. In general, which approach is preferable depends on the characteristics of the ecosystem service in question. Specifically, because of market failure, there is a role for public financing of service provision for services that have public good aspects

and that cannot be bundled effectively with (i.e., that are not co-products of) private good type ecosystem services. For example, a given quantity of water of a given quality is a private good to the extent that its use is rivalrous and exclusive. Hence, the provision of this service (the water) is generally amenable to being marketed, and can be arranged through private interactions among self-interested individuals. In contrast, the biological resources found on that land to some extent may constitute public goods, and as such are not amenable to being marketed. If water quality and quantity and biodiversity were perfect joint products, then biodiversity could be "bundled" with water, and the market-based conservation of water would also achieve biodiversity conservation. Evidence suggests that in many cases such bundling will be imperfect (Chan et al., 2006).

Though the geographic scale and comprehensiveness of existing ecosystem service markets and payment schemes is still limited, the number of such schemes is rapidly increasing and large-scale, national-level payment schemes now exist in many countries. For example, in most European Union countries agri-environment schemes with a biodiversity component are in place (Kleijn and Sutherland, 2003). In the U.S., federal programs such as the Department of Agriculture's Conservation Security Program, Wildlife Habitat Incentives Program, and Environmental Quality Incentives Program or the U.S. Fish and Wildlife Service's Partners for Fish and Wildlife and Landowner Incentive Programs provide incentives to farmers and ranchers to implement voluntary conservation measures (Casey et al., 2006), and the majority of states have public payment programs for the restoration or conservation of wildlife habitat (George, 2002). Despite the rapid growth of markets and payment schemes aimed at ecosystem services to and from agricultural lands, substantial challenges remain to integrate the value of many ecosystemservices into the broader economy. What needs to be explored is the suitability of the different approaches to the efficient allocation of various ecosystem services, their associated design requirements, and the feasibility of implementing these requirements given the current structure of resource conservation incentive programs in the agricultural sector. Importantly, the proposed 2007 Farm Bill legislation expressly calls for the increased application of market-based approaches for ecosystem services and the exploration of the above questions.

Ecosystem Services As Public Good

Market transactions occur when the participating individuals perceive an opportunity to realize net benefits. The quality of a good or service is one of the features that determine its utility (demand) and its production cost (supply). This immediately highlights the main challenge ecosystem service markets face: In many cases, private interest in the quality of ecosystem services is lacking or is weak due to a lack of the service's exclusiveness. For this reason, many ecosystem service markets currently operating are government constructed, existing only as a result of regulations backed by credible monitoring and enforcement. Examples are habitat and wetlands banking. Such public or quasi-public goods markets are intrinsically problematic because there is no inherent incentive to ensure service quality beyond what is required by regulation (Salzman and Ruhl, 2000): The problem with ecosystem service markets is that the market itself does not define the units of trade (whereas conventional markets do). Instead, units of trade and compensation have to be defined by governments, governments being the trustees of environmental quality. This is a point often missed by advocates of trade in ecosystem services. In a conventional market, the buyer is concerned selfishly about the quality of the 'unit' they buy. In an ecosystem market, the environmental good is a public good and the buyer is therefore indifferent to its quality. The buyer is concerned only about satisfying the regulator's definition of an adequate unit. (Boyd and Banzhaf, 2006) As a result, the appropriate institutional

framework becomes important for achieving the desired quality of the services in question. For the case of credit trading in mitigation banking, Salzman and Ruhl (2000) identify the requirements the framework must fulfil as currency, exchange, and review adequacy. A currency, or unit, is adequate if it does not lead to non fungibilities, that is, if it captures the variations in environmental service values across time and space. Exchange adequacy is achieved if all trades in environmental goods and services are of equal total economic value. It is automatically achieved by an adequate currency; lacking such currency, exchange adequacy.

Dis-services Of Ecosystem Services

The relationship between nature and society is not all positive. Nature imposes several kinds of hardships on human beings. Biotically, pests and diseases are obvious examples. Abiotically, rain brings both life-giving water but also life threatening floods. Human history is a history of a constant struggle to adapt to this munificent-cum-hostile nature. But by focusing on services, a term with positive connotations, the Ecosystem Service discourse automatically conceals the hostile side of the relationship. Some ecologists have begun to question this omission, pointing to 'dis-services', such as pathogens (Willott 2004; O'Farrell et al., 2007; Dunn 2010). Another example would be wildlife, which affects local human populations negatively through crop damage by large herbivores, predation on livestock by carnivores, and direct injury to and loss of human lives. Clearly, increases in natural capital do not always result in increases in well-being. But neither the Millennium Ecosystem Assessmentreport nor any of the hundreds of Ecosystem Serviceassessments that followed contain any mention of negative relationships. The problem precedes the Millennium Ecosystem Assessmentor the Ecosystem Serviceliterature: the literature on Total Economic Valuealso mentions only positive benefits. As the literature on problem framing points out, particular terms predispose our thinking in particular ways (Bardwell 1991), and the positive connotation of the words 'service' and 'benefit' predisposes the Ecosystem Servicediscourse towards focusing on positive relationships only.

CONCLUSION

This paper has attempted to define ecosystem goods and services, describe why they are of economic value to people, briefly explain how to quantify that economic value, and examine the prospects for provision and marketing of ecosystem goods and services. It was also stressed that ecosystem goods and services are those that arise "naturally" from natural capital, with little human input. Given the growing scarcity and recognition of the importance of ecosystem services to maintain our quality of life, ecosystem system goods and services will likely rise in value over time. Ecosystem services improve human well-being by either directly affecting our utility or indirectly as inputs to producing other goods or services of value to humans. The idea of Ecosystem Servicewas coined as a way of combating a perceived blindness of policy-makers to the importance of biotic nature. But convincing policy makers to change presumes that one knows what change is required. This makes Ecosystem Servicea policy advocacy tool. Conceptual completeness and consistency are then not critical. If, however, it is to be a framework for scientific enquiry, then it has to be much more consistent in its philosophical framework, inclusive in its normative concerns, open-minded about how biotic and abiotic stocks and processes may or may not produce well-being, and inclusive in the social science perspectives it invokes. It is believe that such an approach, albeit more challenging to implement, will yield dividends in the long run in terms of more nuanced insights and more usable knowledge.

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