Ecosystem Services and their Economic and Social Value

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Introduction

The concept of "ecosystem services valuation" has become an important theoretical construct for linking ecosystem functions to human well-being, using basic principles of natural science combined with welfare economics (as well as contributions from psychology, sociology, and even more recently, neuroscience). It is important to recognize that ecosystem services are valued using inherently anthropocentric methods— nature is afforded no intrinsic value. The socioeconomic value of an ecological resource depends solely on the value humans derive from that resource. This value may be direct—in the case of fish harvested from the sea—or indirect—in the case of water filtration provided by wetlands. It is the indirect ecosystem services that are frequently overlooked in planning and decision-making since they often require sophisticated scientific understanding, and provide value to human society through complex mechanisms and interactions.

Understanding these links is becoming increasingly critical in a wide range of policy and management contexts, because when ecosystem services are degraded or destroyed the costs to society can be great, oftentimes eclipsing the benefits that are conveyed through the degrading activity. For example, in the wake of Hurricane Katrina in New Orleans in 2005 it has become apparent that the economic benefits that accrued over the decades from destroying the wetlands surrounding the city (for ports, canals, and other forms of industrial development), were less than the costs of the lost storm mitigation services that the wetlands naturally provided.[1] In other words, when accounting for the full value of the benefits derived from New Orleans' wetlands' ecosystem services, the decision to remove them in favor of industrial uses was uneconomic, and would not have passed a cost-benefit test.

It is vital to establish a consistent definition for ecosystem services, even if the concept can never be perfectly defined. The most recent attempt to standardize both a definition and to create categories of ecosystems services came out of the United Nations' Millennium Assessment in 2005[2]: ''ecosystem services are the benefits people obtain from ecosystems.'' While a very simple definition, this has become the standard for many studies today. The Millennium Assessment goes on to describe specific categories of services, which include provisioning services, such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; supporting services, such as nutrient cycling that maintains the conditions for life on Earth, and biodiversity. [3]

Although the Millennium Assessment helped to clarify current thinking about ecosystem services, this definition has not been universally accepted. After surveying many competing definitions of ecosystem services across many studies, Boyd and Banzhaf [4](2006) concluded that "ecology and economics have failed to standardize the definition and measurement of ecosystem service." They proposed the creation of a consistent definition that can be easily integrated into market accounting systems. To this end, they focus on defining "final" ecosystem services, which are components of nature, directly enjoyed, consumed, or used to yield human well-being."[5]

Their definition makes a distinction between final ecosystem services and final economic goods.

Ecosystem services can be thought of as inputs in a manufacturing process, which contribute to the production of final goods enjoyed by people. Boyd and Banzhaf point out that much of the value of ecosystem services is already captured in economic models through normal measures of GDP, to the extent that ecosystem services contribute to the final value of many market goods (i.e. crop production or fisheries).

This is an important distinction because it is the "non-market" goods provided by ecosystem services that are almost completely ignored in traditional measures of GDP. Non-market values refer mostly to the indirect benefits of ecosystem services that are not currently priced in market systems, and include, everything from climate regulation to the quality of life benefits from clean air, water, open space, and the existence value of abundant wildlife. In order to make more rational decisions about how we use and manage our resources—and attempt to maximize their social and economic value—these non-market values must be captured in new models and incorporated into all levels of decision-making.

The reality is that markets will never account for the full range of ecosystem services unless they are forced to. This point cannot be emphasized strongly enough. Even though measuring ecosystem services and the values they provide is a challenge—both methodologically and practically—the much greater challenge is using this information to change behavior and produce better societal outcomes.

It is likely that under our current regulatory systems, the lack of proper accounting for ecosystem services is leading to many uneconomic decisions from the local level all the way to the international level, especially when longer time frames are considered and proper discount rates are used[6]. Climate change will likely prove the largest "meta" example of our collective market failure—the damages we will suffer due to the warming of the planet and the acidification of the oceans will eventually eclipse the benefits we accrued by burning excess quantities of fossil fuel.[7]

But there are many more examples at a smaller scale as well, whether they are areas such as New Orleans where wetlands destruction ultimately proves disastrous, offshore mining that ends up fouling beaches and depressing tourism values, or the decimation of pelagic fisheries and excessive marine mammal by-catch that ultimately impoverish nations rather than enrich them.

Though a detailed discussion of why markets fail to account for ecosystem services is beyond the scope of this paper,[8] the primary reasons are relatively straightforward:

1. Externalities—pollution costs are not borne by those who cause the pollution, which leads to the underpricing of polluting goods. This distorts the entire economy in favor of resource-intensive production.

2. Lack of property rights—where there are no property rights, resources are exploited in a "free-for-all" manner. This is especially true in the open oceans, but also has implications near the shore.

3. Imperfect information—the complexity of ecosystem services and the fact that many are poorly understood leads to a bias in favor of what is known and easily quantifiable (i.e. direct market benefits over non-market ecosystem services).

4. Discounting—people value the future a lot less than the present and this creates a bias in favor of

short-term planning that is very difficult to overcome; this is partially driven by two-six year election cycles, but also corporate quarterly reports which cause publicly held companies to invest for short term gains to the detriment of long term sustainability.

The field of environmental and natural resource economics has an extensive literature on how to "correct" these market failures that has been developed over many decades. But throughout much of the world we continue to ignore the bulk of this work because of very powerful socio-political forces that favor the status quo, rather than a collective lack of knowledge of how to make markets function more effectively for society.

The Economic Value of Ecosystem Services

Much of the market value of ecosystem services is derived through biological productivity that produces goods directly exploited for human use and consumption (i.e. fish, kelp, coral, or even shark fins), but there is also tremendous market value derived indirectly through all sorts of non-consumptive activities, with tourism being the most prominent. In many coastal areas and island nations, the natural beauty, coral reefs, beaches, surf breaks, and wildlife provide an important source of economic value that is directly measureable through market prices (i.e. hotel, travel, restaurant, and diving revenue).

Non-market values exist on a continuum, with some that are completely divorced from market prices and others that are actually embedded in them. For example, the ecosystem value of carbon cycling through the oceans and atmosphere is not something that is recognizable in market prices (although it is critical for life), whereas homes adjacent to beaches are much more expensive than equivalent homes inland due to their proximity to the natural beauty of the coasts. In essence, what at first appears to be a non-market value—an ocean view or a nearby beach entrance—is actually incorporated into real estate prices in the market.

There is also a category of non-market value that is derived from the benefits that individuals receive freely (or for very low cost) from ecosystem services, but for which they would be willing to pay. Economists refer to this type of value as "consumer surplus," and contend that it should be considered when assessing a resource's overall value. The logic is that if taking a walk on the beach on a sunny day provides an individual with the equivalent of $10 in value (perhaps akin to the value of going to a movie on a rainy day), then just because the beach has free access doesn't mean that it's value should be counted as zero; the $10 in value that individual receives "internally" (since no actual dollars are exchanged) should be considered as real as if they had paid an admissions ticket to enter the beach.

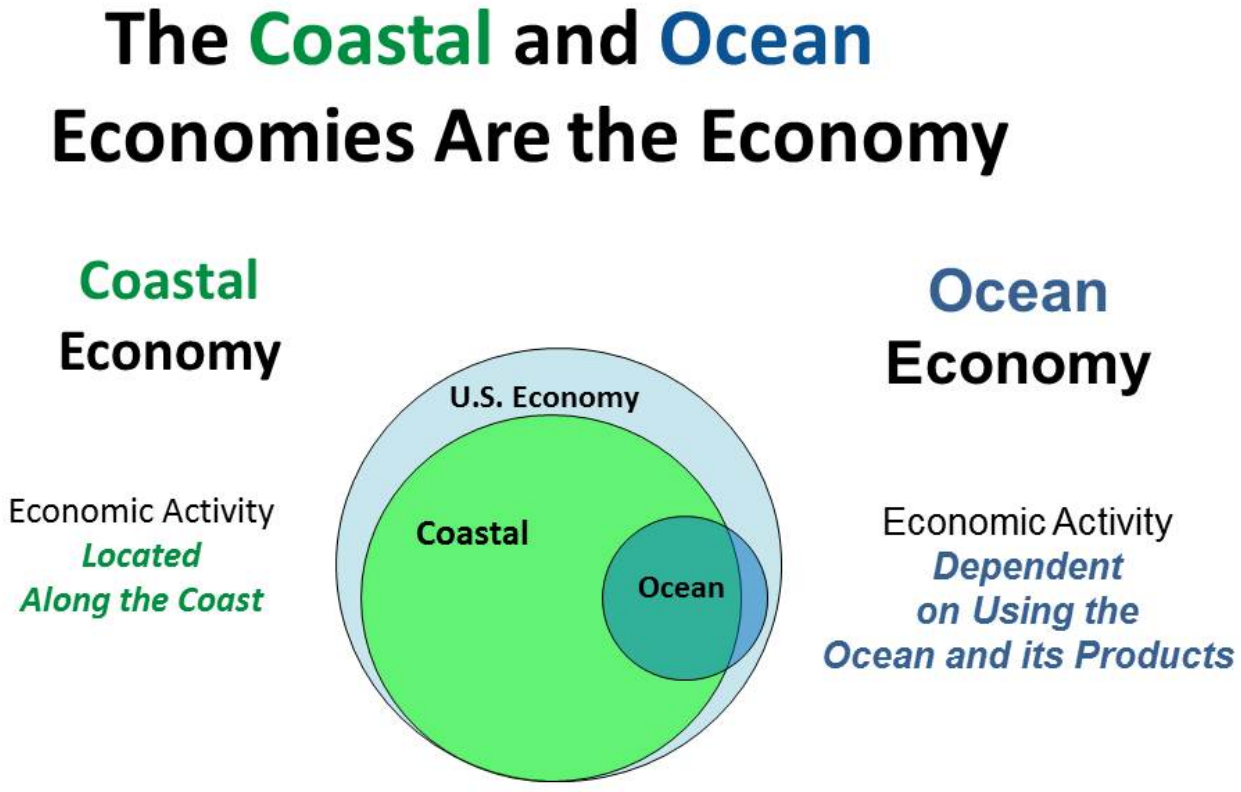
This example illustrates that many ecosystem services have both market and non-market values. Coastal zones are the prime example; they contain market values from the fish that is harvested, the tourist revenue, and also a portion of nearby home values, but they also provide consumer surplus to many millions around the world just by their very existence, which is not captured by market systems or traditional means.

In the U.S. we have reasonably good data that measures the market values of our ocean and coastal resources. Since 1933, the U.S. has kept national income and product accounts (NIPA), which measure total income and output of the nation, and provide a comprehensive picture of the nation's economy (NRC 1999). These accounts measure production and income that arise primarily from the market

economy, where goods and services are traded openly through the interaction of supply and demand. With the NIPA datasets it is possible to ascertain the value the oceans and coasts generate for national, regional, state, and local economies. The national accounts are divided into sectors, such as shipbuilding and repair, coastal construction, marine transportation, fishing, offshore minerals, and coastal tourism and recreation. They provide a reasonably accurate estimate of wages, employment, number of establishments and GDP for the ocean economy.

In 1999, the National Ocean Economics Program (NOEP) was launched at the Massachusetts Institute of Technology. Its mission has been to produce time series data using NIPA on the value of the oceans and coasts to the U.S. economy. The first of its kind, NOEP data provide both snapshots in time as well as trends in ocean-dependent economic activities by county, state, and the nation as a whole.[9] The NOEP data has revealed that marine transportation and coastal tourism and recreation generate far more jobs and revenue for the U.S. economy than other ocean industries such as fishing, offshore minerals, construction, and ship building. The NOEP also provides marine natural resource production and value estimates, with data on annual production of offshore oil and gas in state and federal waters, and fisheries for more than 50 years (which shine a light on which species have declined and which are stable).

Figure 1: The Ocean and Coastal Economy



The NOEP data has been cited hundreds of times by government, NGOs, and business, as it has become the premier source for economic statistics on the status of and trends in the ocean and coastal economy. The NOEP produces state-level multipliers which can be used to determine the overall wage and employment impacts of a dollar spent in an ocean industry after it percolates through the rest of the economy. The NOEP also produces estimates of the size of the coastal economy using shore adjacency criteria. In the U.S. in 2010 the total coastal economy generated 83 percent of total U.S. GDP, while only representing about 20 percent of the land mass. Coastal counties produced more than 50% of all jobs and wages.

The NOEP not only pioneered the use of ocean and coastal accounts in the U.S., but its methodology has become the international standard, although each nation has customized the basic categories for their own economies. Studies in Canada have been undertaken at the national level (Roger A.Stacey Consultants 2003) and provincial levels (Gardner et al. 2005), while ocean economy estimates have been undertaken for the United Kingdom (Pugh 2008, EDA, 2011), France (Kaladjian 2007, 2009), Australia (Allen Consulting Group 2004), New Zealand (2007),[10] and China (2006-2012)[11]. Kildow and McIlgorm (2010) compare some of these international programs.[12]

Non-market values are understandably much more difficult to measure than market values. Over many decades, however, economists have refined numerous statistical methods for estimating them. The two primary methodological categories for assessing non-market values can be divided into “revealed preference” techniques and “stated-preference” techniques.

Revealed preference methodologies examine observable human behavior that can be used to estimate values derived from ecosystem services. For example, the Travel Cost Method (TCM) uses data on how much time and money people spend to visit natural resources, such as beaches, lakes, rivers, or national parks, to determine their consumer surplus from the public provision of these goods.

The Hedonic Price Method (HPM) relies on real estate values to separate out from final home prices the incremental contribution of environmental amenities, such as nearby air quality, proximity to natural resources, and scenic views[13], as a means to directly assign monetary values to these ecosystem services (in some ways HPM can be viewed as a “quasi-non-market” valuation method since it relies on market prices to estimate what are normally considered non-market values).

It is worth noting the magnitude of many of these non-market values in the coastal zones and the associated policy implications. The value of an ocean view that is capitalized into a single home can be worth upwards of a million dollars in California (and in this range in many other parts of the world).[14] This means that any attempts to diminish these views with offshore oil rigs could potentially lead to large decreases in property values. In the same manner, proximity to clean beaches with abundant wildlife can be capitalized at hundreds of thousands of dollars per home, and therefore, anything that could potentially despoil the beaches and the surrounding coastal areas could also greatly impact real estate prices.[15] There is new research underway that links home prices to the proximity to surf breaks and suggests that this ecosystem service significantly increases nearby property values as well.

These ecological services generate a relatively stable stream of revenue to local governments through property taxes, which can be sustained indefinitely if the resources are protected. Since many

communities and states rely on property tax as a major source of overall revenue, it is critically important to understand the extent to which property values are impacted by changes in nearby ecosystem services, for better and worse.[16,17]

Stated preference methods are used to estimate the most controversial elements of non-market value: non-use value. Non-use value includes three sources of value—the pure **existence value** of knowing ecosystems (or parts of ecosystems) are being protected, the **option value** of wanting to reserve the right to visit these natural systems sometime in the future, and the **bequest value** of wanting to ensure that our descendants have the option of enjoying these ecosystems. Non-use values are most easily understood in the context of a remote area like the Arctic or the middle of the Brazilian rainforest, which few of us are ever likely going to visit, but from which we derive some value from simply knowing that they are being protected and sustained.

The non-market value of ecosystem services for natural processes such as beach nourishment or storm protection can be estimated using "replacement or avoided cost" methods. For example, if a new jetty disrupts natural sand dispersal and reduces the width of down-current beaches, the cost of replacing the sand can be imputed as an added cost of building the jetty—a non-market impact. Similarly, if mangroves provide storm protection that reduces average annual damages to life and property of $100 million that value can be imputed to the mangroves. (In the wake of the 2004 Asian tsunami, significant attention has been paid to the differences in wave impacts in areas where there were relatively intact mangrove systems versus those where they were largely removed in favor of coastal development, and it can be shown that the former fared much better overall.[18])

Mangroves are also being studied for their carbon sequestration potential. Recent research posits that even at relatively modest CO_2 prices, this "blue carbon" may be extremely valuable.[19] Increasing attention is also being paid to the potential value of rare deep-sea creatures for use in medical research or materials innovation.[20] With deep-sea mining operations expanding exponentially around the world,[21] it is critical to document the non-market values of deep-sea life and the threats they face. Even though the profits from deep-sea oil and mineral operations are often great, the costs and risks they impose on marine systems and on society can be great as well in terms of lost opportunities; only a comprehensive accounting can inform policymakers and the public as to whether the net benefits are positive and worthwhile.

An illustrative example of the power of non-market valuation comes from a recent decision by the government of the small island nation of Palau, which is extremely dependent on tourist revenue for its economy. After careful analysis, the government concluded that the value of keeping their sharks alive is orders of magnitude greater than selling them for shark fin soup; research conducted by the Australian Institute of Marine Science indicates that over the course of their lifetime each shark off the coast of Palau provides on average of $1.9 million in tourist dollars.[22]

Many of the dozens of nations that have robust whale-watching industries have also estimated the economic benefits these (and other) cetaceans provide, and assessed ways to augment this industry.[23] While hunting whales is not allowed in most parts of the world, whale mortality is often due in large part to human causes, whether through ship strikes, pollution, or underwater sonar, and efforts to mitigate these impacts can provide net benefits to regional whale watching industries.

The Social Value of Ecosystem Services

Measuring the social value of ecosystems is considerably more difficult than economic value, not only because social variables are harder to quantify, but because there is no consensus on the definition of social value to begin with.[24] In general, social values refer to issues of equity, opportunity, and vulnerability, as well as cultural benefits. For example, a coastal ecosystem can provide social value through its local maritime cultures, the sports and recreational activities that bring the community together, the variety of economic activities that provide for social cohesion and mobility, and the resilience provided against extreme climactic events. Given the complexity in measuring social value and the lack of an agreed-upon definition, it is easiest to illustrate how to think about the concept using some current case studies.

Take offshore oil and mineral development, which is expanding rapidly around the world,[25] and tends to concentrate a tremendous amount of wealth in a small number of hands. The world's oil and mining companies exert significant market power, and act much more like oligopolies than firms in a competitive market.[26] This means that they often have the ability to set very favorable terms in the areas where they operate, and when then collude they can both move market prices and restrict access (case in point are the Chinese companies that currently control much of the world's "rare earth" minerals)[27].

While the majority of the profits (benefits) of offshore oil and mineral extraction go to the few, the risks of their activities are often spread out over large populations. A major oil spill can decimate the livelihoods of literally millions of inhabitants in nearby coastal areas, and the lost non-use values from degraded marine ecosystems will be felt way beyond the shores where the spill occurred. This asymmetry between concentrated benefits and widespread social costs is endemic in many areas around the world. The situation in the Niger Delta in Nigeria is particularly extreme, where the environmental and social costs of oil production are externalized onto a large and mostly poor population with very few mechanisms for redress[28]. But one doesn't have to travel to the less-developed parts of the world to witness such power and equity imbalances; in the U.S. the Alaskan natives are under constant threat from oil and mineral companies seeking to exploit the state's rich natural resources that threaten ocean and coastal ecosystems, and the natives' traditional way of life.[29]

From a social value perspective, such unequal power dynamics increase vulnerability for local populations, and can greatly increase inequality and poverty in the event of an accident. They also present a more fundamental problem in that the local people are often at the mercy of the environmental and safety policies of companies that are not held accountable for their misdeeds.

There are ways for governments to address the social inequities inherent in this type of industrial activity, even if it is very difficult to do. First, they can insist on high royalty payments for the energy and minerals, and either funnel this revenue directly back to the communities or use it for social ends, such as education, infrastructure, and healthcare (too often, corrupt governments actually embezzle the money[30]). Governments can also not only require strong environmental and safety protections from firms, but mandate environmental insurance bonds as a precondition for approving offshore operations. These bonds must be high enough to cover clean-up and compensation costs in the event of an accident. The companies get the money returned (with interest) based on environmental and safety performance

metrics that must be met not only during operations, but during any decommissioning and remedial phase of the energy and mining projects.

The example of offshore mining presents a case where the diminishment of social value is often imposed on communities through intensive natural resource exploitation in the coastal zones, unless strong government negotiations can tip the scale in favor of greater social benefits and protections. But what if communities want affirmative models for producing strong social values?

The natural sciences have demonstrated that more diverse ecosystems are the most resilient,[31]and new social science research points to economic diversity as a key indicator of social resilience as well.[32] Communities that derive employment and economic value through a variety of activities are better suited to weather economic crises as well as environmental change. They also provide greater opportunity and mobility to a wider class of the citizenry.

Monterey, California is a good illustration of a community that has evolved from an economy predominantly based on natural resource-intensive industries (fishing and agriculture) to a much more diverse economy. While fishing and agriculture still account for a large share of employment and GDP, the development of very robust tourism, research, and education sectors—based on the very ecological systems that have been under pressure for so long—has produced a much more vibrant economy overall.[33]

Monterey is now home to many of the premier marine science and policy institutions, which attract highly-educated students and workers, and Monterey Bay Aquarium is world famous. Wildlife viewing, other forms of coastal tourism and coastal recreation are now huge industries, employing more than 12,000 people and generating over $650 million dollars in 2009.[34] The much greater variety of economic activity supports a large service, tech, and construction sector.

Tensions remain between the natural resource sectors and the larger community due to continued threats to marine life, and very serious water and water quality issues. But whereas in the past, fishermen and farmers controlled most of the levers of power, there are increasing pressures in this more diversified economy to balance needs and promote activities with less of an ecological footprint and more dependence on ecological health.

Florida is an example of a state that has also realized that diversification is a key to economic strength and resilience. Over the past decade, the state has attracted a number of highly prestigious marine and medical research institutions that provide stability, high wages, and an alternative to dependence on tourism, which is volatile given the frequency of extreme weather events in Florida. Scripps Research Institute and Mayo Clinic have been enticed to Florida with generous incentives. The Hubbs Research Institute complements Sea World and its program in Orlando, and numerous other world class research centers have established satellite operations in Florida.[35] In addition, the government of Florida has increased its own ocean research programs at its universities; marine research budgets in Florida in 2008 were more than $300 million (with only a little more than half of the institutions reporting precise figures)[36]

Any discussion of social value from ocean and coastal ecosystems would be incomplete without mentioning the fascinating new neuroscience research[37] that has shown that the proximity to the

oceans, with their miles of beaches, dramatic sunsets, and abundant wildlife provide tremendous psychological value to humans. Coastal zones make us happier, healthier, and reduce stress through a number of channels. This tremendous social value is not captured by any of our current models, but is potentially very large. The policy implications are large as well. It is good for people to live near the oceans and this should be encouraged. The key, as always, is how to integrate human societies into the coastal zones in ways that don't threaten the very ecological systems that make them so attractive; and also to generate diverse streams of economic activity to maximize resilience and opportunity.

Incorporating Ecological Services into National Accounts

Environmental accounts provide a framework for collecting and organizing information on the status, use, and value of a nation's natural resources and environmental assets, as well as on expenditures on environmental protection and resource management.[38]

Creating "green" national accounts that incorporate changes in ecosystem services and natural capital into current measures of GDP has been an overarching goal of the environmental movement for decades. The logic is simple: by incorporating the full range of environmental values into our economic accounts we can identify areas where certain industrial activities actually make society worse off, and also the areas where investments in natural capital can provide the greatest returns to society.

The United Nations Conference on the Environment in Rio de Janeiro in 1992 produced Agenda 21, which called for the UN to begin work on a handbook for green accounting. The finished product was based on numerous approaches to environmental accounting, pioneered in a series of workshops by the United Nations Environment Programme (UNEP) in collaboration with the World Bank. Because of the embryonic nature of this work, the discussion of concepts and methods never reached any final conclusions, and the UN handbook and its System of integrated Environmental and Economic Accounting (SEEA) were therefore issued as an interim version of work in progress.[39] However, the SEEA was subsequently tested in Canada, Colombia, Ghana, Indonesia, Japan, Mexico, Papua New Guinea, the Philippines, the Republic of Korea, Thailand, and the U.S.

In response to the issuance of the UN handbook, the U.S. Bureau of Economic Analysis (BEA) in the Department of Commerce began to develop a system for extending NIPA to include both market and non-market estimates of ecosystem values. Members of Congress were tipped off about this work in 1995 and held hearings. Some in Congress believed that the methods for valuing the environment were still immature and not ready to be institutionalized; they were also responding to pressures from the coal and other extraction industries, who feared that their activities would show up negatively in the new green accounts. Other members felt that it was inappropriate to change an economic accounting system that everyone trusted.

The result of the hearings was that Congress withdrew funding for this BEA experiment, imposed a ban on any additional work until further notice, and asked the National Academy of Sciences National Research Council to review the BEA strategies and report back to them. The resulting report entitled, "Nature's Numbers" (NRC 1999), provided an unequivocal endorsement of green accounts and a call for a comprehensive assessment of market and non-market values of ecosystem services. The authors expressed concern that the U.S. might lag behind other nations if a system of green accounts wasn't

developed quickly, and that it was in the best interests for U.S. investors and policymakers to have this information.

In 2006, sufficient progress towards a system of green accounts internationally prompted a major interagency meeting between the U.S. Government Accounting Office (USGAO) and the National Academy of Sciences to once again discuss the topic of environmental accounts.[40] This meeting followed the lifting of the Congressionally-imposed ban on BEA's activities that had lasted from 1995-2005.[41] In 2010, a report by the U.S. General Accounting Office described the status of environmental accounting around the world, indicating that many nations were now using some form of it and that there was a strong effort to standardize the accounts.[42] The absence of U.S. participation to date was cited negatively because it has prevented the U.S. from having a voice in the setting of international green accounting standards.

Since 2010, The European Commission has instituted regulations for the entire European Community, on green accounts,[43] which are described in detail in a report issued by the European Commission Statistical Bureau in 2012.[44] Through the UN's work and the European Community's efforts, many nations have now implemented an official system of environmental accounting as of 2012. However, the U.S. government has yet to follow suit, and there are no indications of immediate plans to do so.

Conclusion

Much of the social and economic value of ocean and coastal resources is obvious to all, as it shows up clearly in market data, for both income and employment. However, much of the value of the ecosystem services in our ocean and coastal zones is poorly understood and involve large, distant, and complex processes, the magnitude of which is likely greater than the value of what we know how to quantify.[45] A large portion of this value is conferred to society outside of market mechanisms, and in ways that are often hard to trace. But methods for estimating these non-market values do exist, and must be embraced if we ever hope to achieve long-term sustainability that guarantees widespread social and economic prosperity. It is up to natural scientists to establish and communicate the links between ecosystem services and benefits to humans, and economists to put dollar values on them. But this is only the first step.

Unfortunately, market failure is the norm, rather than the exception in the environmental realm, meaning that markets alone will almost never take into account the value of ecosystem services without some form of intervention. Governments, NGOs, and businesses, therefore, must take an active role in building institutions and mechanisms to bring the non-market values to light, as well as to incorporate them into decision-making. This is hard to do in political and economic climates dominated by short-term thinking, but it is absolutely essential. If we do not follow this path much of what we believe to be economic growth will over the medium to long-term prove illusory, and the costs that we ignore increase to the point that they overwhelm the benefits.

There has been significant progress towards an international system of green accounts, which attempts to build the full value of ecosystem services into individual national accounts, but this has yet to be fully realized, and U.S. participation has stalled. Even with the advent of national green accounts, much of the most important data on the value of ecosystem services will be needed at finer geographic scales so that cities, states, and provinces can have useful information for planning. The data requirements of

such an effort are vast, but the payoffs much larger. The value of ecosystem services will only grow over the coming decades, as population increases put ever greater pressures on natural resources, and humans around the world seek the beauty of the oceans and coasts for the high quality of life they provide.

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