VALUATION OF MARINE ECOSYSTEM SERVICES: A GAP ANALYSIS

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July 2008

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INTRODUCTION

Marine ecosystems provide numerous services to humans. Over the past decade, with the advances in application of environmental valuation techniques, a wealth of studies was conducted to quantify and monetize the services that different marine ecosystems provide. Many of these studies have focused on direct market valuation and were prepared in the context of estimating economic value from fisheries. Still, many others look at other marine ecosystem services, ecosystem features, and measure different economic values. Nevertheless, it seems there is a gap that is being created in terms of the ecosystems that are being valued, and the economic values that are being estimated.

The World Bank in collaboration with UNEP-World Monitoring Conservation Center (UNEP-WCMC) and the World Resources Institute has embarked on developing a toolkit of methods and approaches for valuing marine ecosystem services across a range of habitat types and development contexts. The Bank's initial involvement was invited by WCMC/UNEP in the context of a larger study on Strengthening Capacities for Evaluating Services Provided by Ocean and Coastal Ecosystems, a comprehensive body of research to be funded through Norwegian Government funds to UNEP. To date, however, the funding for this larger effort has not been secured. As an interim measure, the following report, attempts to identify current gaps in the measures and methods available to adequately capture the value of marine ecosystem services to society and the planet and to lay out a road map for additional research and development of the tools needed to fill these gaps. That latter research and the refinement of tools to help bring the field of marine ecosystem services valuation on a par with terrestrial efforts, will the subject of a second phase, if needed funding materializes.

The main objective of this report, therefore, is to inform the preparation of the toolkit for valuation of marine ecosystems' services. The report will also seek to achieve the following sub-objectives:

- Provide an overview of the techniques used in valuation of marine ecosystem services: marine ecosystems, valuation techniques, and values based on desktop study.
- Identify gaps in the valuation of marine ecosystems and services in terms of ecosystem services, values, and techniques.
- Identify potential applications for valuation studies of marine ecosystem services.
- Contribute to parallel discussions initiated during the International Coral Reef Initiative general meeting, in Washington DC January 2008, on valuing coral reef ecosystem services, and subsequent studies to identify the most relevant applications of such techniques to improve decision-making in trade-offs affecting the future of coral reef s.

This report draws on a desktop study of published articles and material on valuation of marine ecosystem services commissioned by WCMC in July 2007. A literature review was conducted by Federico Bernasconi at the UNEP-WCMC center, and as consequence the review results were summarized in a database presenting the different methodologies that are applied to attribute a monetary value to the ecological services provided by the various elements that belong to those ecosystems. This database forms the basis for the results in Chapters 1 and 2 of this report. Although the database includes over 200 articles that were reviewed, , the analysis in this paper reflects findings from only 128 of these articles.

In addition, this report benefited from panel discussions held at the ICRI meeting in Washington DC in January 2008 and subsequently, on the viewpoints, perceived gaps and needs from the perspective of policy decision-makers, as well as marine scientists, economists and the marine conservation community. It also benefited from review by UNEP-WCMC and additional materials supplied by WRI on their work.

The description of marine ecosystems is based upon those described in the Millennium Ecosystem Assessment report: Current State and Trends Assessment (2005), as well as reports and contributions from the UNEP-WCMC center.

Limitations of the methodology:

- The report relies on studies and research papers that are published in scientific journals, which even though it offers the advantage of peer reviewed methodologies and results decreases the numbers of considered studies by not including valuation studies performed in the grey literature that do not get published, as well as those conducted by the private sector, which do not enter the public domain[4].
- All the studies in the database are in English, though attempts were made to locate and benefit from studies in other languages. This limitation contributes towards bias of geographical extent of the conducted valuation studies.

The report starts by presenting a brief overview of the types of marine ecosystems as they are classified in the Millennium Ecosystem Assessment Report, and provides a brief description of the wide array of provisioning, regulating, cultural and supportive services that marine ecosystems provide (Chapter 2). It also looks at which ecosystems and services are more valued than others and overviews the gaps in coverage of valuation studies of the ecosystem and services valuations.

Chapter 3 analyzes the reasons behind conducting valuation studies, and will try to respond to the question: what is driving the need for valuation studies of marine ecosystem services? It then overviews the current status quo of valuation of marine ecosystem services: techniques used in valuation studies, measured economic values, geographic extent of the valuation, and finally present any identified gaps.

Chapter 4 is forward looking, and it presents the different potential applications for valuation of marine ecosystem services by scientists and decision makers. Case study of valuation of marine ecosystem services in Zanzibar is presented in Chapter 5, and Chapter 6 presents policy recommendations for bridging the identified gaps.

1. MARINE ECOSYSTEM SERVICES: OVERVIEW

1.1 Marine and coastal ecosystems

This section follows the classification that is described in the Millennium Ecosystem Assessment reports (2005) and which provide descriptions for coastal systems and subtypes (those marine systems up to 50 m depth), marine system (depths greater than 50 m). The marine system within the context of valuation studies mostly relates to the marine system.

(a) Coastal Systems and Subtypes (MA)

In classifying the marine and coastal ecosystems this paper relies on the coastal ecosystems classification presented in the Millennium Ecosystem Assessment report. The report differentiates between the coastal ecosystems (area between 50 meters below mean sea level and 50 meters above the high tide level or extending landward to a distance 100 kilometers from shore) and which includes coral reefs, intertidal zones, estuaries, coastal aquaculture, and seagrass communities, and the marine systems which is divided into four biomes and generally has depths greater than 50 m below mean sea level. Below is a brief overview of these coastal ecosystems:

[4] An effort will be made to obtain at least some of the grey literature from NGOs and the community of practice.

i. Estuaries, marshes, salt ponds, and lagoons

Estuaries are defined as partially enclosed coastal body of water which is either permanently or periodically open to the sea and within which there is a measurable variation of salinity due to the mixture of sea water with freshwater derived from land drainage. Coastal marshes and lagoons are also included within the estuaries.

Estuaries, marshes and lagoons play a key role in maintaining hydrological balance, filtering water of pollutants, and providing habitat for birds, fish, and mollusks, crustaceans, and other kinds of ecologically and commercially important organisms. The estuaries are important nursery areas for fisheries and other species and form one of the strongest linkages between coastal, marine, and freshwater systems and the ecosystem services they provide. The main threats facing estuarine systems include coastal development, pollution, changes to hydrology, as well as upstream threats.

ii. Mangroves

Mangroves are trees and shrubs that grow in intertidal zones and estuarine margins that have adapted to living in saline water, either continually or during high tides. Mangroves grow under various salinity levels ranging from fresh water to 2.5 times seawater strength (66 ppm). Mangroves are classified into three major zones based on dominant physical processes and geomorphological characters: tide dominated fringing mangroves, river-dominated riverine mangroves, and interior basin mangroves. Mangroves are also a vital source for carbon sequestration (Ong 2002).

The main ecosystem services provided by the mangroves include land stabilization, nutrient cycling, processing pollutants (including adsorption of heavy metals), supporting nursery habitats for marine organisms, and providing fuel wood, timber, fisheries resources, and serve as buffer zones from storms. The main threats facing mangrove forests include removal, aquaculture, forest use, and freshwater diversion.

iii. Intertidal habitats, deltas, beaches, dunes

Intertidal habitats provide ecosystem services such as food, shoreline stabilization, maintenance of biodiversity, and recreation. Mudflats are critical habitat for migrating shorebirds and many marine organisms, including commercially important species like the horseshoe crab and a variety of clam species. Coastal deltas are important microcosms where many dynamic processes and human activity converge. Beaches and sandy shores also provide ecological services and are being altered worldwide. Sandy shores have undergone massive alterations due to coastal development, pollution, erosion, storms, alteration of freshwater hydrology, sand mining, groundwater use, and harvesting of organisms. Beaches provide feeding grounds for migratory birds, provide nesting habitat, deliver land-based nutrients to the near shore coastal system, and provide both food and recreational space to humans. Removal of beach wrack near urban centers and tourism resorts also alters habitat and services.

iv. Coral reefs and atolls

Reef formations occur as barrier reefs, atolls, fringing reefs, or patch reefs, or a combination of these formations mainly in relatively nutrient poor waters of the tropics, and are known to provide a variety of provisioning, regulating, and cultural services. Among the provisioning services is their contribution to fisheries products (e.g., nutrition and livelihoods to coastal communities) as well as to pharmaceutical compounds and bio-prospecting; they also provide regulating services such as the formation of beaches (important to tourism), and buffering of coastal area again the impact of waves and storm surges. As the most diverse ecosystems in the ocean, if not the planet, and as absorbers of biological carbon, coral reefs

play an important regulatory role in nutrient and carbon cycling. However, the most well known services of this ecosystem are the cultural services with respect to tourism related activities. Although coral reefs are also a source of construction material for coastal communities, and of curios and ornamentals for the aquarium industry, these are not environmentally sustainable activities.

Human induced stress on reefs, such as coastal construction, pollution, destructive land use practices, as well as warming seawater and climate change lead directly or indirectly to coral reef degradation and have placed coral reefs on an accelerated path to ecosystem collapse in many parts of the world..

v. Seagrass beds or meadows

Seagrass is a generic term for the flowering plants that usually colonize soft-bottom areas of the oceans from the tropics to the temperate zones, and tropical Seagrass beds can occur in association with coral reefs as well as in their absence. Seagrass provides a range of ecosystem services including habitat and food services for coral reef fish and invertebrates including species that are used in traditional medicine, seafood, fodder, agar, carageenan, paper, and flour, as well as stabilizing coastal sediments and shorelines, and filtering sediment from coastal waters that might otherwise smother coral reefs. Seagrass beds are threatened by human activities in coastal areas such as construction and dredging, anchoring, habitat conversion, pollution, and are also affected by climate change (Moberg 2003).

vi. Kelp forests

Kelp forests are temperate ecosystems that have a complex biological structure organized around large brown algae, supporting a high diversity of species interactions. Kelp forests provide provisioning and regulating services as they support invertebrate and finfish fisheries and are themselves harvested for food and additives; protection against wave and storm impacts; and are nursery habits for some species. Most of the kelp forests worldwide have been degraded and there is no kelp forest in its natural condition. One of the main threats to kelp forests is the removal of predators like sea otters; this causes the proliferation of sea urchins, which in turn graze on the kelp.

vii. Other benthic communities: rock and shell reefs, mud flats, coastal surmounts, and rises

Other rock communities provide a variety of ecosystem services: rock reefs provide rich nursery habitat for fisheries; mud flats are productive habitats that exhibit high species diversity; hard-bottom habitats below the photic zone are dominated by sponges, corals, bryozoans, and compound ascidians. Most of these temperate, non-reef-building corals are found in deeper waters beyond the coastal limit, although their ecosystem dynamics and the threats facing them are similar to many coastal systems. Human induced disturbances can cause major ecological damage and compromise biodiversity, regardless of whether these communities occur more inshore of offshore. Bottom trawling and other fishing methods that rake the benthos have destroyed many of these communities already.

viii. Semi enclosed seas

The semi enclosed seas are defined as a gulf, basin or sea surrounded by two or more states and connected to another sea or the ocean by a narrow outlet or consisting entirely or primarily of the territorial seas and exclusive economic zones of two of more coastal states such as: Mediterranean Sea, Red Sea, Black Sea, and Baltic Sea. The Millennium Ecosystem Assessment report notes the high productivity of these ecosystems and high species diversity and endemism. At the same time semi enclosed seas are adversely affected by pollution and the heavy extractive use of surrounding communities and countries.

(b) Marine System

The marine system is defined as the sea that is deeper than 50 m below sea level, and is the main source of fishing (MA conceptual framework 2005). The Millennium Ecosystem Assessment classifies the marine system into four biomes: the coastal boundary zone, trade-winds, westerlies, and polar. The coastal boundary zone that surrounds the continents is the most productive part of the world ocean, yielding about 90% of marine fisheries catches, while the other three biomes are less productive, and their deep waters are exploited mainly for their large pelagic fish.

For purposes of classifying the valuation studies, those studies that provide valuation for fisheries within an identified coastal zone ecosystem, have been classified as provisioning service of that ecosystem. While those valuation studies that refer to open seas fisheries were classified under general marine provisioning service.

1.2 Ecosystem services

Ecosystem services may be divided into four categories: provisioning, regulating, cultural, and supporting services (MEA 2005). Below is a brief description of each of these services:

(a) Provisioning services are defined as those that result in products obtained from ecosystems (in some cases referred to as production services) (Beaumont 2007). These include:

i. Food: Marine ecosystems provide ample provisioning services including fish from marine and capture fisheries, marine products, and aquaculture products. Both total and per capita fish consumption have grown over the past four decades leading to over fishing and over exploitation of marine fishery resources, which in turn reflected in increases in real prices of fish products. While traditional aquaculture is generally sustainable, an increasing share of aquaculture uses carnivorous species, and this puts increased pressure on other fisheries to provide fishmeal as feed and also exacerbates waste problems. Shrimp farming often results in severe damage to mangrove ecosystems, although some countries have taken steps to reduce these harmful impacts.

ii. Fiber, timbres, and fuel: Even though marine ecosystems are not usually associated with fiber, timbres and fuel, nevertheless mangroves are an important source of these. Coastal communities rely on mangroves for mangroves for building, manufacturing, fuel, and other needs.

iii. Medicines and other resources: A wide variety of species—microbial, plant, and animal— and their genes contribute to commercial products in such industries as pharmaceuticals, botanical medicines, crop protection, cosmetics, horticulture, agricultural seeds, environmental monitoring and a variety of manufacturing and construction sectors. Several marine ecosystems provide habitat or are direct resource for medicinal resources. For example, several species of fin fishes are used in Nigeria in traditional medicinal recipes, other species such as algae are researched for use in Alzheimer's disease (Jina et al. 2006). Shrimp and crabs are two important sources of chitin and chitosan (one of chitin deliverables) that has high value-added applications in medicine and cosmetics (Rinaudo 2006); coral (which has a similar chemical composition to human bone) is used as a bone supplement; sponges and tunicates have been used to cure certain forms of cancer (Ahn 2008), and omega 3 fatty acids, derived from fish oil, are widely used as nutritional supplements.

(b) Regulating services are defined as those that regulate ecosystem processes:

i. Biological regulation: which includes regulating interactions between different trophic levels thus preserving functional diversity and interactions. An important example are the urchin barrens which

used to be kelp forests that have been reduced to mostly urchin species due to the over-fishing that reduces natural predators of urchins. Almost no kelp forest exists in its natural state today (MEA 2005).

ii. Freshwater storage and retention: storage and retention of water; provision of water for irrigation and for drinking. This ecosystem service is most relevant to freshwater estuaries and wetlands.

iii. Hydrological balance: even though this mostly concerns groundwater recharge / discharge in terrestrial ecosystems, some features of marine ecosystem also exhibit this service. For example, the coral reef carst material acts as regulator of groundwater discharge and mineral leaching.

iv. Atmospheric and climate regulation: marine ecosystems affect and are affected by atmospheric and climate conditions. For example, while marine plants fix atmospheric CO2, they return it via respiration; moreover, dead organisms, particles, and dissolved organic carbon form carbon sinks in the deep ocean, some of which remains sequestered in the sediment while the remaining is respired at depth and eventually re-circulated to the surface (the "biological pump"). At present, several sources are proposing the restoration of mangroves as use for carbon sinks. Moreover, the reduction in number of ocean vertebrate species hinders the functioning of marine ecosystems and leads to significant reduction in the ocean's carbon sink ability (Lutz 2008).

v. Human disease control: even though the Millennium Ecosystem Assessment focuses on the role of ecosystems in controlling human infectious diseases, the marine ecosystems contribute to regulating conditions that affect public health as well. An example of such is the red tide phenomenon, which results from the proliferation of certain type of algae (K. brevis) which produce powerful toxins called brevetoxins that not only result in death of millions of fish and other marine species, but also could accumulate in tissue of shellfish, which, if ingested leads to severe gastrointestinal and neurological symptoms (CDC brochure).

vi. Waste processing: marine ecosystems vary in their ability to absorb wastes and to detoxify, process, and sequester them, depending on the type of wastes, concentration, loading rates, and type of ecosystem. An example of marine ecosystem waste processing is the mangroves' ability to adsorb heavy metals and other pollutants, thus reducing their concentrations in marine environment. In addition, the bioturbation activity of faunal organisms within the seabed can bury, sequester, and process waste material through assimilation and chemical alteration (Beaumont 2007).

vii. Flood/storm protection: This function relates to the ability of ecosystems to ameliorate 'natural' hazards and disruptive natural events. For example, vegetative structure can alter potentially catastrophic effects of storms, floods and droughts through its storage capacity and surface resistance; coral reefs buffer waves and protect adjacent coastlines from storm damage. The services provided by this function relate to providing safety of human life and human constructions (De Groot et al. 2002).

viii. Erosion control: The soil retention function mainly depends on the structural aspects of ecosystems, especially vegetation cover and root system. Tree roots stabilize the soil and foliage intercepts rainfall thus preventing compaction and erosion of bare soil. Plants growing along shorelines and (submerged) vegetation in near-coastal areas contribute greatly to controlling erosion and facilitating sedimentation. The services provided by this function are very important to maintain agricultural productivity and prevent damage due to soil erosion (both from land slides and dust bowls) (De Groot et al. 2002).

(c) Cultural services are the nonmaterial benefits people obtain from ecosystems (Beaumont 2007):

Human cultures, knowledge systems, religions, social interactions, and amenity services have been influenced and shaped by the nature of ecosystems. At the same time, humankind has influenced and shaped its environment to enhance the availability of certain valued services. Recognizing that it is not possible to fully separate the different spiritual, intellectual, and physical links between human cultures and ecosystems, the MA assessed six main types of cultural and amenity services provided by ecosystems: cultural diversity and identity; cultural landscapes and heritage values; spiritual services; inspiration (such as for arts and folklore); aesthetics; and recreation and tourism. Because global aggregated information on the condition of cultural services was limited (with the partial exception of recreational and tourism benefits), the section below draws significantly on information in the MA sub-global assessments.

i. Cultural and amenity: communities impact their surrounding ecosystems, and at the same time are affected by the nature that surrounds them. Nature shapes the traditions and beliefs of the communities, and maintains the cultural value of these ecosystems in spite of advances in lifestyle. De Groot et al (2002) describe the prominence of nature in cultural attributes that surround us from books, to magazines, films, music, national symbols, and so on. Marine ecosystems also stand out in the cultures of many people such as those of the aboriginal groups in Australia lived along the Great Barrier Reef region for over 40,000 years, which resulted in the reef permeating their culture and shaping many of their traditions such as traditional hunting.

ii. Recreational: perhaps recreational value of ecosystem forms the vast share of valuation studies, which is not surprising given the growing magnitude of the tourism industry. According to Millennium Ecosystem Assessment report (2005) nature travel increased at an estimated rate of 10–30% annually in the early 1990s, and in 1997 nature tourism accounted for approximately 20% of total international travel. A number of developing countries depend on tourism as the largest contributor to their economy.

iii. Aesthetics: Many people enjoy the scenery of natural areas and landscapes. This is clearly reflected in peoples' preference to live and visit aesthetically pleasant environments. Aesthetic information has considerable economic importance, which is reflected in such sectors as the real estate where housing with ocean / sea view are usually considerably higher priced than similar housing in other areas (De Groot et al 2002).

iv. Education and research: marine ecosystems provide numerous opportunities for education and research, through excursions, field studies, and reference areas for monitoring environmental change (De Groot et al 2002).

(d) Supporting services are those services that are necessary for the production of all other ecosystem services, but do not yield direct benefits to humans (Beaumont 2007):

i. Resilience and resistance (life support): is defined in Beaumont 2007 as the extent to which ecosystems can absorb recurrent natural and human perturbations and continue to regenerate without slowly degrading or unexpectedly flipping to alternate states. Healthier ecosystems are expected to have higher resilience than are ecosystems that are weakened by external factors such as overfishing, pollution, and other human pressures.

ii. Biologically mediated habitat: is defined as habitat which is provided by living marine organisms (Beaumont 2007). Examples of such habitat are coral reefs, seagrass beds, and kelp forests which provide a habitat for numerous other marine species the survival of which depends on the health of their habitat forming species.

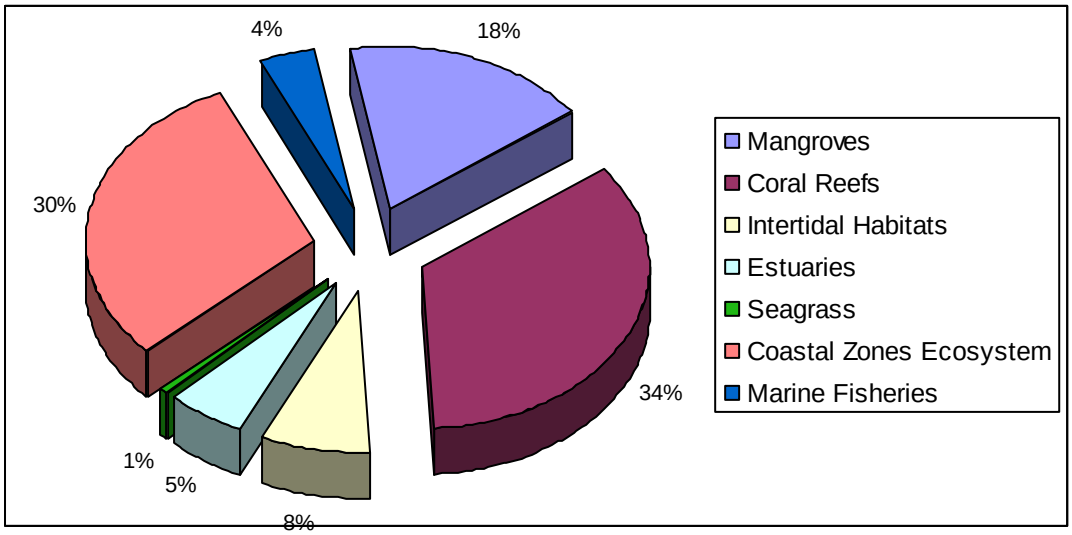
iii. Nutrient cycling and fertility: Ecosystems regulate the flows and concentrations of nutrients through a number of complex processes that allow these elements to be extracted from their mineral sources (atmosphere, hydrosphere, or lithosphere) or recycled from dead organisms. This service is supported by a diversity of different species.

2. VALUING ECOSYSTEM SERVICES: CURRENT SITUATION ANALYSIS

2.1 Valuation of marine ecosystem services

Of the ecosystems and features described above, valuation of coral reef ecosystems took a high share of all valuation studies with almost 34% of valuation instances pertaining to coral reefs, which is followed by valuation studies that pertain to coastal zone ecosystems in general without specifying the ecosystem types. The third ranking ecosystem was mangroves at 18% of all valuation instances. For other ecosystems as classified in the Millennium Ecosystem Assessment, such as, kelp, rock and shell reefs, seamounts and mid ocean ridges, there was no or limited valuation studies. Marine system – located outside of the coastal zone ecosystems - is represented only at 4%, which is due to two reasons: the first is because the study did not try to encompass all the available fisheries valuation studies, but focused on those valuations pertaining to specific ecosystems and second because those fisheries that are within coastal areas (defined up to 50 m below sea level) are classified within their respective ecosystems – in those studies where this is defined – as provisioning service of that specific ecosystem.

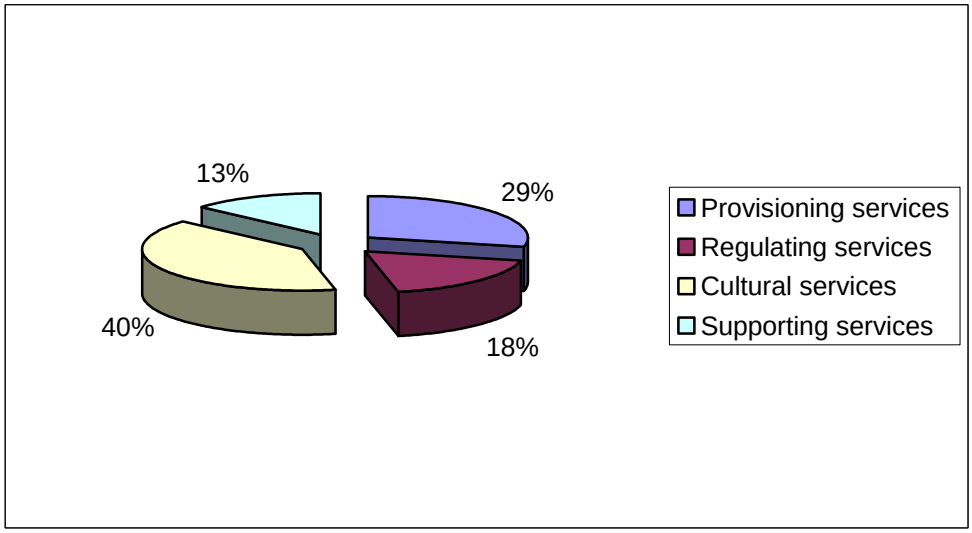
Figure 1: Distribution of valuations by ecosystem type



n=590

Quality damages: Another aspect that was given special attention in valuation studies was quality damages to various ecosystems and features, and almost 16% of all valuation instances pertained to assessing quality damages.

Figure 2: Distribution of valuations by ecosystem type



n = 590

The most commonly valued services for marine ecosystems are the cultural services (40%), followed by provisioning (29%) services, and then regulating and supporting services with 18% and 13%, respectively. The relative distribution of valuations of these services differed with ecosystems type. For example, a large proportion of valuations focus on cultural (e.g., recreational) services for intertidal habitats and for coral reefs, while in the case of mangroves the largest part is dedicated to provisioning services, as in Table 1.

Table 1: Distribution of valued ecosystem services by ecosystem type

Ecosystem Service	Mangroves	Coral Reefs	Intertidal Habitats	Estuaries*	Seagrass	Coastal Zone	Marine System
Provisioning services	41%	26%	7%	28%	50%	26%	52%
Regulating services	24%	13%	15%	28%	25%	21%	0%
Cultural services	13%	52%	72%	22%	0%	37%	48%
Supporting services	21%	9%	7%	22%	25%	16%	0%
Totals	100%	100%	100%	100%	100%	100%	100%

Highlighted cells indicate the most commonly valued ecosystem service. In case of estuaries the number of studies is limited and they consider most of the services' types. n=590

Gaps in valuation of services provided by various ecosystems

Figure 3, drawn from the MEA, shows the relative magnitude of ecosystem services by ecosystem type. The larger the circle the greater is the relative magnitude of that particular service. When comparing the importance of specific services provided by ecosystems with the valuation frequency of these services in the literature, it becomes clear that there are gaps between the relative magnitude of certain services as identified by the Millennium Ecosystem Assessment and the number of published studies that measure these significant services, i.e. in other words, some of the ecosystem services that have been identified as having large relative magnitude in the millennium ecosystem assessment have few valuation studies. Some examples of such gaps are perceived below:

- Coral reefs: the MA identifies the following services as important: biodiversity, flood / storm protection, cultural and amenity, recreational and aesthetics. Valuation studies focus however on cultural and provisioning services which together form 78% of valuation instances. The regulating services are those that are provided by the ecosystem and include in case of coral reefs biological

regulation of interactions between different trophic levels helping in preservation of functional diversity and interaction, as well as other regulating services such as flood and storm protection. These regulating services in spite of their relative magnitude gather only 13% of all valuation efforts observed. Supporting services of which nutrient cycling and fertility were identified by the millennium ecosystem assessment of moderate magnitude obtain only 9% of valuation effort. Moreover, a closer look at the cultural services reveals however that almost 76% of these refer exclusively to tourism, while 16% refer to the total economic value. This leaves approximately less than 10% of these studies that refer to heritage and educational values within the cultural services of coral reefs. Moreover, as climate change impacts progress leading to sea level rise and storms coral reefs could be natural buffers against these devastating effects – the value of which at present is not being estimated.

- Intertidal habitats: the most important ecosystem services are regulating services (biodiversity), and cultural services (cultural and amenity, and recreational). In line with its relative magnitude, review of valuation studies shows that up to 72% of valuation instances do focus on the cultural value of intertidal habitats (most of which refer to recreational value of beaches), however, to a much lesser extent on regulating, supporting and provisioning services. 15% refer to regulating services mostly relevant to flood control, while supporting and provisioning services are each represented by 7% of valuation instances.

- Estuaries: the MEA (2005) identifies cultural (cultural and amenity, and recreational) and regulatory services (waste processing) as having large relative magnitude. In line with the MEA (2005), the recreational aspect of estuaries is well studied. Another example of recreational values taking prominence over other ecosystem services is the case of the Chesapeake Bay, one of the largest Bays in the world, where tourism / recreation / cultural amenities are the most important value of the Bay, with provisioning (fisheries) lagging behind now.

- Seagrass: the main ecosystem services that are provided by seagrass ecosystems include biodiversity, waste processing, flood/storm protection, and cultural and amenity (which are basically supporting, regulating, and cultural services). Review of available studies on seagrass valuation however shows that 50% of instances refer to provisioning services, 50% to supporting and regulating services, and 0% to cultural services. It should be noted however, that a limited number of valuation studies refer to seagrass so the numbers are not conclusive.

- Mangroves: the MEA (2005) identifies the following as major services: erosion control, waste processing, biological regulation, and fiber, timber, and fuel. Valuation studies also focus on provisioning and regulating and supporting services, with clear focus on provisioning services (related to fisheries productivity) which attract almost half of all valuation instances for mangroves.

Another major gap in the valuation of marine ecosystem services is the relative absence of studies that tackle the valuation of deep sea marine ecosystems which include continental slopes, abyssal plains, seamounts, cold-water corals, deep-sea sponge fields, hydrothermal vents, and cold seeps and gas hydrates (van den Hove and Moeau 2008). These systems provide significant regulating services in terms of CO_2 uptake from the atmosphere (plankton production and food webs), and deep carbon storage by macro vertebrate fauna (whales and other marine mammals, sharks, tuna, turtles, big schools of fish) which almost no studies try to valuate. As van den Hove and Moreau (2008) note, the added difficulty with valuation of ecosystem services provided by deep sea ecosystems compared to the coastal zone ecosystems is due to the limited knowledge of deep-sea ecosystems and the complexity of the processes going on in the deep sea; the nature of deep-sea ecosystems, especially those with significant option-use values; and the limited first-hand experience of many people with deep sea ecosystems.

The absence of first hand experience of deep sea ecosystems and the complexity of processes would increase the biases that are associated with the use of stated preference techniques especially the informational biases – thus limiting the application of these methods (contingent valuation and choice modeling) in the case of deep see ecosystems. Exceptions to the above would be the valuation of fisheries and minerals extracted from deep sea ecosystems – as these could be (and are) valued through the direct market valuation.

Overall, supporting services account for almost 13% of all valuation instances, which may be explained by the difficulty to clearly define some of the supporting services that ecosystems provide, as well as limited data availability for some of these services (Beaumont 2007).

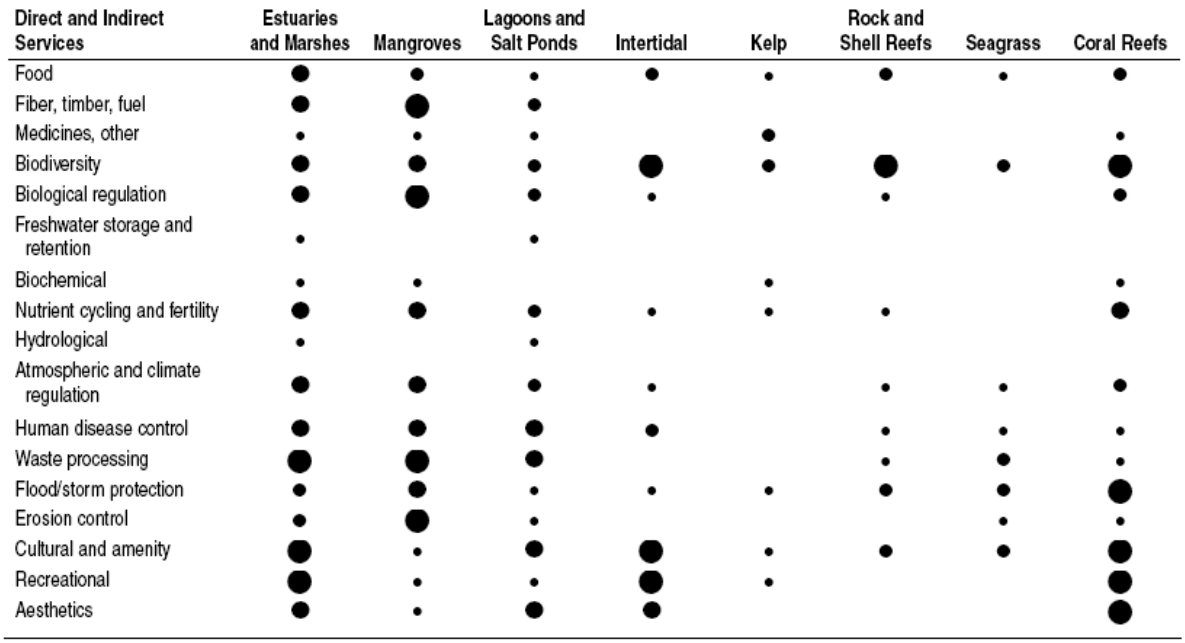


Figure 3: Relative significance of services by ecosystem type (MEA 2005)

2.2 Valuation methods and values measured

There are several valuation techniques that have been used to determine the monetary value of non-market goods, and these could be mainly differentiated by the sources of valuation data. If the source of data is based on observations of people's choices in reality – then these techniques are termed revealed preference methods and include a variety of methods such as: production function, replacement cost, travel cost, and hedonic prices. If economists rely on data that is obtained from people's responses to hypothetical questions, then these methods (e.g. contingent valuation and choice modeling) are termed stated preference methods (Maler and Vincent 2005). In addition to these, a number of methods (meta-analysis and benefit transfer) rely on information that has been collected within similar contexts and apply it to areas where there is limited information available.

The different valuation methods measure different economic values including direct use, indirect use, and non-use values. Direct use values include those that are used directly by humans and may include consumptive uses (such as harvesting food products) and non-consumptive uses (such as beach recreational activities). Indirect use values refer to those ecosystem services that provide benefits

extending outside the ecosystem itself such as the storm protection function of coastal mangrove forests, which benefits coastal properties and infrastructure; and carbon sequestration, which benefits the entire global community by abating climate change. This category of benefits corresponds broadly to the MA notion of regulating and supporting services. Non use values refer to the value people may have for knowing that a resource exists even if they never use that resource directly (existence value) such as the value that people would hold for protecting an endangered species that they do not benefit directly from. Finally, option values are derived from preserving the option to use in the future services that may not be used at present, either by the people themselves (option value) or by future generations (bequest value), often option values are considered as use values. The total economic value (TEV) incorporates the use and non-use values (MEA 2005).

Each of the valuation techniques has its strengths and weaknesses, and the choice of one technique over the other is usually a factor of what needs to be valued (use, non-use, or TEV values), the purpose of conducting the valuation study, availability of information (revealed or stated), and limitations of the different valuation methods. It should be noted that valuation is usually relatively simple in the case of direct use value, and then increasingly difficult as we try to measure indirect use value, option, and non-use values of marine ecosystem services (MEA 2005). Table 2 presents a quick overview of the valuation techniques that are used and which could be applied to different marine ecosystem services valuation needs.[5]

Table 2: Main economic valuation techniques

Methodology	**Types of Values Estimated***	**Approach**	**Applications**	**Data requirements**	**Limitations**
1. Revealed preference methods					
Change in productivity	Use	Trace impact of change in environmental services on produced goods	Any impact that affects produced goods	Change in services; impact on production; net value of produced goods	Data on change in service and consequent impact on production is often lacking
Replacement cost	Use	Use cost of replacing the lost good or service	Any loss of goods or services	Extent of loss of goods or services; cost of replacing them	Tends to overestimate actual value.
Travel cost	Use	Derive demand curve from data on actual travel costs	Recreation	Survey to collect monetary and time costs of travel to destination; distance traveled.	Limited to recreational benefits; hard to use when trips are to multiple destinations.
Hedonic prices	Use	Extract effect of environmental factors on price of goods that include those factors for example effect of environmental quality on real estate pricing.	Air quality; scenic beauty; cultural benefits.	Prices and characteristics of goods	Requires vast quantities of data; very sensitive to specification

[5] There are several available guides and references on the application of these valuation techniques, some of which are accessible online – such as the Elsevier Environmental Economics Handbook (http://www.sciencedirect.com/science/handbooks/15740099), as well as some guides published by the Joint Nature Conservancy Committee e.g. The Green Buck (http://www.jncc.gov.uk/page-4022) and Valuing the Environment in Small Islands - An Environmental Economics Toolkit (http://www.jncc.gov.uk/page-4065).

Methodology	Types of Values Estimated*	Approach	Applications	Data requirements	Limitations
2. Stated preference methods					
Contingent valuation	Use and non-use	Ask respondents directly their willingness to pay for a specified service.	Any service.	Survey that presents scenario and elicits willingness to pay for specified service.	Many potential sources of bias in responses; risk of over estimation, guidelines exist for reliable application
Choice modeling	Use and non-use	Ask respondents to choose their preferred option from a set of alternatives with particular attributes.	Any service	Survey of respondents	Similar to CV; analysis of the data generated is complex.
3. Other methods					
Benefits transfer	Use and non-use	Use results obtained in one context in a different context.	Any for which suitable comparison studies are available	Valuation exercises at another, similar site.	Can be widely inaccurate, as many factors vary even when contexts seem similar. Extrapolation is not always justified.
Meta analysis studies	Use and non-use	Combines results of several studies to explain variation in WTP	Any for which sufficient numbers of studies are available	Valuation studies for similar ecosystems and services	Loss of detail in aggregation process

Source: modified from Pagiola 2004 and Heal 2005.

An overview of the valuation studies reveals that use values are more often measured than the non-use values and the total economic value. This may be explained by the fact that use values are relatively less complicated to measure than the non-use values as explained above. As Figure 4 indicates, there is variability in values among various marine ecosystems: for example over 95% of valuation instances for fisheries value the use value (which is explained also by the fact that the ecosystem services measured are provisioning and cultural (recreational fishing), both of which are use values). The same may be said of all other ecosystems, where the bulk of valuations consider the use values of the ecosystem services provided.

A few of the ecosystems (mangroves, coral reefs, inter-tidal habitats) as well as valuations for coastal zone ecosystems in general tried to determine the non-use value of these ecosystems (existence value). The highest proportion of valuation studies looking into non-use values was shown for the coral reefs at almost 10% of valuation instances. This may be explained by the fact that people are more familiar with the coral reef ecosystem than with mangroves for example.

Several of valuation instances attempt at determining the total economic value for ecosystem services (use and non-use values). Many of these valuations are results of meta-analysis that combine the results of several analysis and several are results of stated preference methods – contingent valuation and choice modeling.

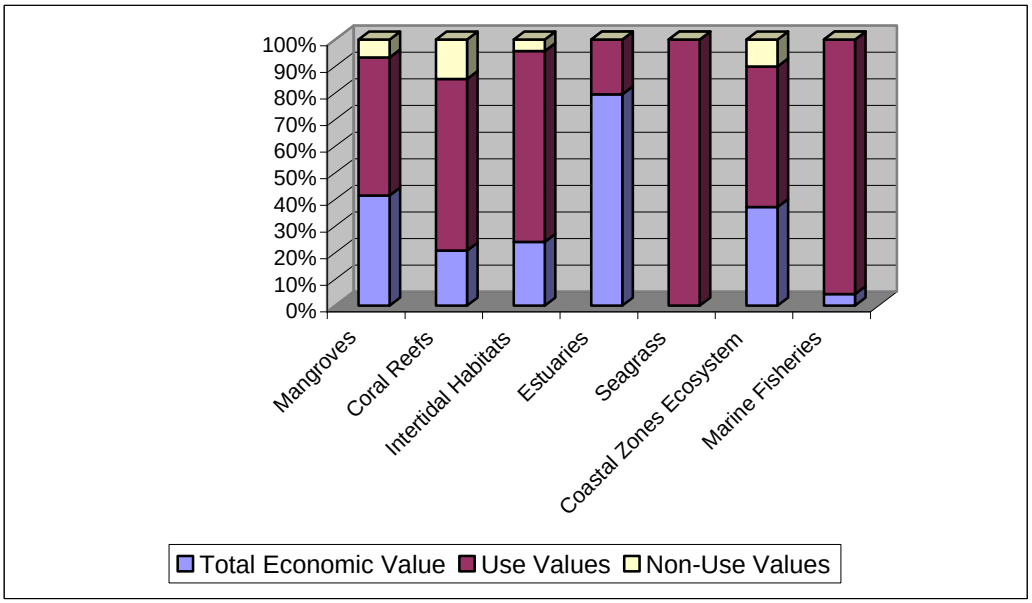
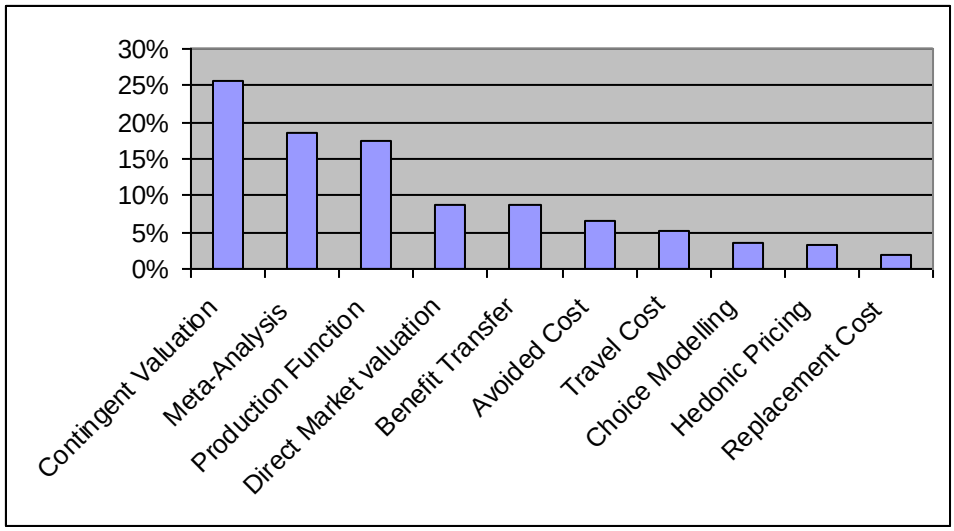


Figure 4: Distribution of measured values for marine and coastal ecosystems
**Option value is considered use value, n=592*

In terms of valuation methods used, almost 25% of valuation instances in the published papers relied on contingent valuation technique, followed by meta-analysis (18%) and production function (17%) approaches. Some of the valuation approaches were used to a lesser extent, such as the averting cost behavior that was used in 0.3% of instances, replacement cost, travel cost, hedonic pricing, and choice modeling, each of them used in less than 5% of instances. Different techniques were used to estimate value of the different services that various ecosystems provide.

Figure 5: Distribution of valuation techniques used in sample analyzed

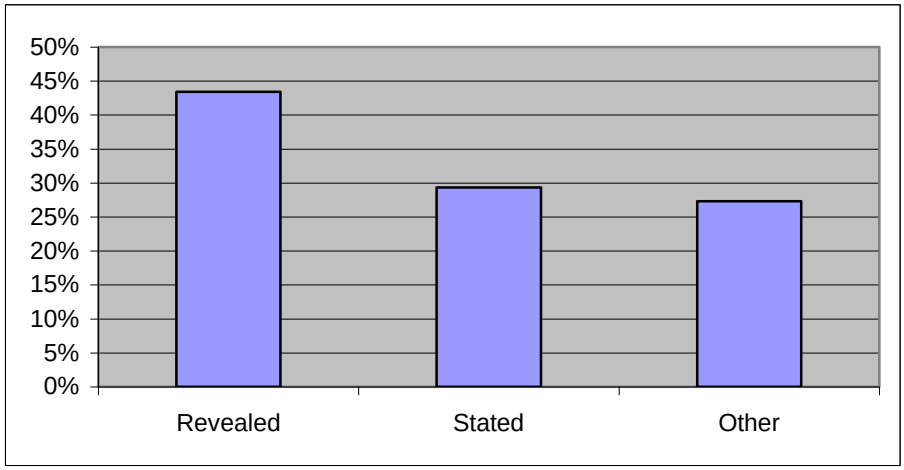


n=590

By summing the stated and revealed preferences methods, we see that 45% of valuation instances rely on stated preference methods, compared to 30% of valuations relying on revealed preferences methods. The

choice of valuation method as indicated by data availability, and required economic value tend to steer the researchers' preferences towards the stated rather than revealed valuation methods.

Figure 6: Distribution of valuation technique by source of data



n=590

Table 3 presents the details of the valuation methods that were applied for the various ecosystems, and should be looked at in contexts of the measured valued (use, non-use, or total economic value). This table also provides venue for comparing the "preferred" valuation methods across the different ecosystems. One of the observations is the relatively high proportion of contingent valuation and choice modeling within the coastal zones ecosystem (35%), intertidal habitats (53%), and coral reefs (30%).

Table 3: Valuation Method Used

Valuation Technique	Mangroves	Coral Reefs	Intertidal Habitats	Estuaries	Seagrass	Coastal Zones Ecosystem	Marine System
Direct Market valuation	13%	6%	4%	0%	0%	10%	30%
Avoided Cost	9%	11%	0%	0%	0%	3%	0%
Replacement Cost	6%	0%	0%	0%	0%	3%	0%
Production Function	22%	22%	2%	9%	100%	12%	26%
Travel Cost	1%	6%	20%	0%	0%	3%	9%
Hedonic Pricing	0%	0%	20%	6%	0%	4%	4%
Contingent Valuation	20%	29%	46%	0%	0%	28%	9%
Choice Modeling	0%	1%	7%	13%	0%	7%	0%
Benefit Transfer	13%	4%	0%	9%	0%	15%	4%
Meta-Analysis	16%	20%	2%	63%	0%	15%	17%
Total	100%	100%	100%	100%	100%	100%	100%

Note: n = 590

The table also clearly shows the high incidence of other methods (benefit transfer and meta-analysis) for several ecosystems. Direct market valuation – which measures the use values – is mostly used for ecosystems that have pronounced provisioning services such as the fisheries and mangroves, avoided cost was mostly used for mangroves and coral reefs and it mostly accounts for the measured regulating services (flood control). Travel cost method accounts for 20% of inter-tidal habitat and would refer to the mostly recreational value of these habitats (mostly beach), it also accounts for 6% of coral reefs ecosystem and marine system and also mostly is due to the recreational activities (diving, snorkeling, and

recreational fishing). The hedonic pricing method looks at property values related to ecosystems services and quality, and as expected is most prominent in the inter-tidal habitat ecosystem and to lesser extent for estuaries, coastal zones ecosystem, and marine system.

It should also be mentioned that there is substantial disagreement on the suitability of use of stated preference methods for valuation purposes – especially for ecosystem functions rather than services – as respondents tend to have limited knowledge and understanding – which tends to increase biases (Barkmann 2008). The same reasoning could be applied to ecosystem services that are more difficult to know about and understand for the respondents such as many of the regulating and supporting services, as well as the ecosystem services of deep sea ecosystems.

At the same time revealed preference methods have also their biases and limitations. For example, travel cost and hedonic pricing methods could be applied to ecosystem services that are related to tourism and housing – which also significantly limits the use of these methods.

2.3 Geographic extent of valuation

UNEP-WCMC desktop research showed that most of the published research papers pertained to East Asian Seas (South China Seas Project literature), while there were no or very few published papers on the following regions: Antarctic Ocean, Black Sea, ROPME/RECOFI Area, South-East Pacific Ocean, and South-West Atlantic Ocean, and limited studies on the Red Sea and Gulf of Aden region. However, it is possible that local universities have research on the subject that does not end up being published in English language journals.

Despite the limited studies available, there seems to be increased interest in some of the regions where to date valuation of marine ecosystem services has been under-represented. One of such initiatives is the call for action by PERSGA (the Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden) to develop a toolkit on economic valuation of marine and coastal resources in Red Sea and Gulf of Aden region. The Red Sea is home to almost 4% of the world's coral reef and is home to many endemic species. The Red Sea ecosystems however are threatened by pollution from development of surrounding coastal areas, industrial facilities, and oil spills from tankers and exploration of gas and oil.

2.4 Reasons behind conducting valuation studies for marine ecosystem services

As described in UNEP (2008), the main policy objective behind conducting valuation studies is to improve decision making and policy setting processes, through:

- Demonstrating the value of biodiversity: awareness raising;
- Land use decisions: for conservation or other uses;
- Setting priorities for biodiversity conservation (within a limited budget);
- Limiting biodiversity invasions;
- Assessing biodiversity impacts of non-biodiversity investments;
- Determining damages for loss of biodiversity: liability regimes;
- Limiting or banning trade in endangered species;
- Revising and complementing the system of national economic accounts; and
- Choosing and calibrating economic instruments for biodiversity conservation and sustainable use.

The published research that has been analyzed does not always clarify the reasons behind conducting the valuation studies. As such, only few of the published materials noted the agencies that commissioned the studies and those were mostly commissioned by governments. However, valuation studies are conducted for a number of reasons and are used within a variety of contexts.

Government agencies, especially those that are involved in spatial and development planning may use it as a tool to assist in making decisions (and tradeoffs) on most cost effective development trajectory. In this case, the valuation could be used within the context of cost-benefit analysis – in order to take into consideration the services that are provided by ecosystem within the development planning framework and to assist in choosing the most sustainable economic development trajectory. This is often however relates to coastal development decisions that involve tourism. Damage assessments due to tanker/freighter accidents, cruise ship foundering, cruise ship dumping, alien species introductions, are another venue where governments seek valuation in order to seek compensation for damages within their territorial waters and coastal areas.

Development agencies may require valuations as part of conservation and in effort to assist the different countries in achieving their sustainable development objectives, which also comes as part of the development planning. For example, the World Bank conducts country environmental analysis which includes developing a cost of environmental degradation – to assist in determining the key priority environmental issues of relevance to the country. Furthermore, as development agencies are moving further into the adaptation to climate change agenda, the need for valuation of ecosystem services pertaining to adaptation function are becoming more relevant and more needed. This implies a change in focus from recreational / cultural ecosystem services towards regulating and supporting services – such as flood control and storm protection – ecosystem services that are vital in face of rising sea levels. Moreover, marine ecosystems will in their turn be impacted by climate change – such as the detrimental impact of warmer and more acidic oceans on coral reefs – thus reducing their ability to provide all ecosystem services – which increases the need for mitigation of climate change in order to preserve the essential services that they provide and which may prove too costly to replace.

Within the context of seeking sustainable development and fighting poverty, governments and development agencies need to pay more attention to preserving the ecosystem services that are being provided – since their degradation will set back many of the local communities that are dependent on their products and the security that these ecosystems provide.

Researchers may conduct valuations for scientific and research purposes and in order to find applicable solutions and improve the valuation methodologies to facilitate its use. On the other hand, conservationist societies and non-governmental organizations may see valuation as a tool to promote conservation goal by highlighting the value of the ecosystem elements that they are trying to conserve. A publication by WWF "The Green Buck: Using Economic Tools to Deliver Conservation Goals: A WWF field guide" provides examples of use of valuation for conservation purposes. Among the objectives that the WWF publication lists are: financing conservation through payment for environmental services and access charges; creating markets that support conservation; and influencing policies and plans.

A review of the conducted studies reveals that expertise is centered within the academic institutions for conducting valuation studies. 56% of studies that are published are produced by universities, in addition to those an additional 12% of valuations are result of universities collaborating with other entities or academics working as consultants. There were also several non-governmental organizations, such as the World Conservation Union who have published work on valuation of marine ecosystems and their services. Several think tanks, such as the Resources for the Future and the World Resources Institute, conducted valuation studies of marine ecosystem services. In addition, the private sector, mainly consultancies, conduct valuations for example, those that have published their results include JacobGibb and COWI consult.

Table 4: Distribution of valuation studies by agency that conducted the valuation study

Universities	Private sector	Government & affiliated research	NGO	Collaboration *	Development agencies	Total
102	18	13	9	34	7	183
56%	10%	7%	5%	19%	4%	100%

* Different types of institutions collaborate; mostly it is collaboration between universities with either non-governmental or non-profit organizations, government or affiliated research department, as well as with development agencies. 62% of collaborations involve universities. n = 590

3. POTENTIAL APPLICATIONS FOR VALUATION OF MARINE ECOSYSTEM SERVICES

There are several potential uses for valuation of marine ecosystem services. Each of these has its difficulties and specifics for valuation. These include:

3.1 Integrating marine ecosystem services into national accounts systems[6]

It is crucial to represent ecosystem services in the System of National Accounts (SNA) because the SNA constitutes the primary source of information about the economy and is widely used in all countries for assessment of economic performance, policy analysis and decision-making[7]. However, the SNA has a number of well-known shortcomings regarding the treatment of the environment. For example, in contrast to the treatment of manufactured capital, the value of natural capital is not included and, hence the cost of depletion and degradation of marine ecosystems and their components such as fisheries and mangroves is not included. Similarly, the benefits from improvements to marine ecosystems through better management and recovery are often not recorded.

More importantly, ecosystems provide non-marketed services that are often poorly measured, wrongly attributed to other sectors, or omitted entirely from the SNA, although they may be critical to rural livelihoods in developing countries. In principle, the SNA includes products such as non-marketed fish and mangrove forest products, but measurement difficulties have limited implementation in many countries; even marketed production may be poorly recorded when products are traded in informal markets, as is usually the case in poor rural communities. Marine ecosystems services are also used as unpaid inputs to other sectors; examples include biodiversity protection and aesthetic values (for tourism), shoreline protection (for housing and all sectors with activities along the coast), or the provision of fish habitat services (for fishing) but the value of these services is not recognized and, hence, is attributed to the using sectors, rather than the ecosystem providing the services. Finally, ecosystem services such as biodiversity protection and waste water assimilation may not be represented at all. Thus the total benefits from marine ecosystems are underestimated, and many sectors of the economy are not fully aware of their dependence on healthy ecosystems.

Environmental economics has been able to estimate the value of non-market marine ecosystem services, but there are limitations to linking these values to the SNA. Many studies have been associated with integrated coastal and marine management and its variants (ICM, ICAM, ICZM)[8], coral reef valuation, or marine protected area management and are driven by the ecology of an ecosystem; economic valuation is usually added on in a secondary and much less comprehensive manner. Furthermore, the valuation

[6] This section is contributed by Glenn Marie Lange.
[7] This approach does not replace cost-benefit analysis used for projects and programs, but offers a new, additional way to reach policy-makers.
[8] ICM: Integrated Coastal Management; ICAM: Integrated Coastal Area Management; ICZM: Integrated Coastal Zone Management.

methods have largely been developed in the context of cost-benefit analysis and the measurement of total social welfare or total economic value. This is not compatible with valuation methods used for the SNA, which values products at market price[9]. Consequently, such values cannot be directly integrated with the SNA (Lange, 1999; Pagiola et al., 2004).

To overcome these gaps, the System of Environmental and Economic Accounting (SEEA) was developed as an extension, or satellite account, to the SNA. The SEEA Handbook, compiled by the UN and other international agencies, was completed in 2003 (UN et al., 2003), and further revisions are currently underway. Several specialized manuals have subsequently been compiled, including one for fisheries, the System of Environmental and Economic Accounting for Fisheries (SEEAF) (UN and FAO, in press). The SEEAF manual strongly recommends development of an ecosystem-based approach to accounting for fisheries, noting that one cannot view fisheries in isolation from the ecosystems on which they depend. However, the SEEA approach addresses individual natural resources; ecosystems are only briefly mentioned. The European Environment Agency has started to develop a framework for ecosystem accounting based mainly on land accounting (EEA, 2006; Weber, 2006), and has drafted a case study of accounting for coastal wetlands in the Mediterranean (EEA, 2008), which is relevant to marine ecosystems.

Box 1: Structure of environmental accounts

Environmental accounting has evolved since the 1970s through the efforts of individual countries and practitioners, each developing their own frameworks and methodologies to represent their environmental priorities. Since the late 1980s, a concerted effort has been under way through the United Nations Statistics Division, Eurostat, OECD, the World Bank, national statistical offices and other organizations to standardize the framework and methodologies. The United Nations published a handbook on environmental accounting the System of Integrated Economic and Environmental Accounting 2003 or SEAA-2003 (UN, et al., 2003). As satellite accounts, SEEA has a similar structure to SNA. SEEA consists of stocks and flows of environmental goods and services. It provides a set of aggregate indicators to monitor environmental-economic performance at the sectoral and macroeconomic level, as well as a detailed set of statistics to guide resource managers towards policy decisions that will improve environmental-economic performance in the future. The definition of environmental goods and services in SEEA is much broader than in SNA, in principle attempting to measure all economic values, not just market transactions. SEEA has four major components:

- Asset accounts record stocks and changes in stocks of natural resources over time, as well as items indicating the health or integrity of stocks. In a marine ecosystem accounting approach, stocks would include all major components relevant to a particular ecosystem such as coral reefs, fisheries, mangrove forests, seagrass beds, etc.
- Flow or production accounts record materials and energy generated such as fish and timber from mangroves (provisioning services), services for tourism and recreation, and regulating services such as the amount of pollution assimilated by the marine ecosystem (initially recorded at point of generation) or protection of the shoreline.
- Environmental protection and resource management expenditure accounts identify expenditures undertaken by public and private sectors to manage resources and protect the environment. These are already included in SNA but are not made explicit because they are combined with all the other expenditures of these institutions. The purpose of this part of SEEA is to make those expenditures explicit. Marine ecosystem accounts include management expenditures for the various ecosystem components and user fees and taxes paid by users of the marine ecosystem.
- Environmentally-adjusted macroeconomic aggregates include commonly used indicators of macroeconomic performance that have been adjusted to better reflect sustainability, such as environmentally-adjusted Gross domestic product (GDP), Net domestic product (NDP), Adjusted net savings, and Total national wealth.

The major distinction between the accounting approach to valuation and other approaches discussed in this report is the emphasis of the former on integration with the SNA. The ecosystem accounts achieve

[9] In actual practice, CBA often makes use of different kinds of values including some market values, but its objective is to measure social welfare, in contrast to the objective of national accounting which is to measure market values.

this by sharing structure, definitions and classifications with SNA. The advantage of this approach is that it provides a tool to overcome the tendency to divide issues along disciplinary lines, in which analyses of economic and environmental issues are carried out independently of one another. Furthermore, the accounting approach can engage policymakers outside line ministries, notably in ministries of finance or national planning agencies, by presenting the economic valuation in a framework (the SNA) and with macroeconomic indicators that are familiar to them.

For issues such as marine ecosystem management, the advantage of the SEEA approach is clear. It is not possible to promote coastal and marine management purely from the narrow perspective of individual components such as fisheries or mangrove forests, or managing them independently from the larger economy that may affect them. Rather, an approach that is ecosystem-based and economy-wide is needed to identify the benefits provided to multiple sectors and stakeholders, as well as threats arising from competition or conflicting policies within the ecosystem, as well as from without. An accounting approach does not replace other valuation method, but should be one of several tools used, with its own unique advantages. Several over-arching policy needs have motivated environmental accounting throughout the work:

- Is GDP growth sustainable, or is natural capital being depleted to fund current consumption, in other words, are we "living off our natural capital?"
- What is the true economic importance of marine ecosystems?
- Who benefits from marine ecosystems? What is the distribution of benefits among different stakeholders, especially poor households? Are there gender differences?
- What is the potential for marine ecosystems to finance their sustainable management through resource rent capture?
- What are the tradeoffs in developing one set of resources at the expense of others in terms of future option values?

This section reviews each of these policy issues below, identifying the issues in more detail and how ecosystem accounting addresses them.

3.1.1 Macroeconomic indicators of sustainable development

For all natural resources, policy analysis and decision-making take place on three relatively distinct levels: the local/enterprise/household level, the sectoral/industry level and the macroeconomic (national or regional) level. The contribution of environmental accounting to policy analysis has been primarily at the sectoral and macroeconomic levels, where environmental values are linked to the national accounts.

At the macroeconomic level, a major objective of ecosystem accounting is to help provide more accurate measures of sustainable economic growth, and more accurate assessments of the benefits of sectoral budget allocations, sectoral investments, and broad policy measures, international trade for example, that may impact marine ecosystems. The target audience is primarily ministries of finance, national planning agencies and central banks, agencies which make decisions across ministries and sectors[10]. In dealing with these agencies it is essential to present the case for marine ecosystems in terms of the indicators these agencies routinely use to evaluate the relative importance of different sectors, such as the sectoral contribution to GDP, share of exports, or the number of jobs generated; indicators that are generated by the national accounts.

Most national development plans call for sustainable economic growth, recognizing that short-term GDP growth can be obtained from depletion of resources, but that maintaining economic growth over the long

[10] Line ministries for fisheries forest, tourism and others will also find this information useful, but it is not essential for decision-making within the sector.

term is not possible unless ecosystems are managed sustainably. Gross Domestic Product (GDP) or Gross National Income (GNI) is the indicator most commonly used to assess economic growth, but it has major limitations, as described above. GDP does not account for depletion or degradation of natural capita, and GDP measures goods produced, but not the 'bads' such as beach erosion and pollution. In the case of over-fishing, GDP would appear to increase in the short run, but the economy would not be able to sustain that higher level of GDP in the future because of loss of the underlying assets.

While GDP is needed to assess economic growth, complementary macroeconomic indicators are needed to evaluate whether GDP growth is sustainable. Economic development can be viewed as a process of 'asset portfolio management' in which the objective is to build the wealth of a nation, defined to include all forms of capital—manufactured, natural and human/social capital (see WB—Where is the Wealth of Nations? And work by Dasgupta and Maler, Arrow et al., etc.). Under this approach, sustainable development requires non-declining per capita wealth over time, and the appropriate indicator of sustainability would be the *change in per capita wealth* over time. But this indicator requires data that many countries do not have so the World Bank has developed an alternative indicator known as Adjusted Net Savings (ANS) also known as Genuine Savings[11].

Box 2: Adjusted net savings (ANS)

ANS is calculated as:
Gross national saving
- Depreciation of produced capital
+ Investment in human capital (measured as spending on education)
+ Net changes in stocks of natural capital
- Cost attributed to greenhouse gas emissions
- Cost of damage to human health from PM10 emissions
ANS will be negative value when depletion and depreciation are greater than investment and additions/improvements to natural capital and positive when additions are greater than depletion.

So ANS provides a very clear and strong signal to policymakers about national wealth. ANS has the added advantage that the World Bank compiles annual estimates of this indicator for all countries, but presently it does not include fisheries, a major marine ecosystem asset. It also cannot represent changes in per capita wealth—total wealth is required for that indicator—but it provides a relatively easy way for countries to begin monitoring macroeconomic sustainability.

Another useful macroeconomic indicator for monitoring natural capital is resource rent as a share of GNI or GDP (this is reported by the Norwegian and Australian statistical offices, for example).

Resource rent is a central concept for management as well as for valuation of natural resources. Briefly, resource rent is an economic return to the resource itself above the costs of harvest or extraction. Rent potentially arises under conditions of scarcity relative to demand for the resource, and is jointly determined by two conditions a) relative scarcity and b) efficiency in harvesting.

[11] Another approach is depletion-adjusted Net National Income. There are theoretical and practical reasons to prefer the Adjusted Net Savings) over adjusted NNI (for theoretical reasons, see discussion by Heal and Kristom, 2005, also World Bank 2005). If natural capital is being liquidated, NNI will be lower than GNI, but annual growth of NNI may still be positive and may even occur at the same rate as GNI. Policymakers may respond by saying, "OK, the level of NDP is lower than GDP, but the annual rate of growth is virtually the same for both, so the economy seems to be growing at the same rate, regardless of the indicator used. What's the big deal?" The problem is that the capital part of the analysis (net investment is small as a share of NNI) is small in any given year, although it can have large long-term impacts.

Regarding the first condition, if there is no shortage of fish to catch, the rent is zero, but when fish are scarce, a resource rent can arise. If demand for fish increases (e.g. due to growing population), but allowable fish catch (supply) does not increase, then the price of fish will increase. No change in the cost of fishing has occurred; the difference between the old and new price constitutes resource rent because it is due entirely to the scarcity of fish.

One way to understand resource rent is to consider a competitive auction for fish quota. The quota price represents what it is worth to a fisher simply to have access to the resource. In deciding how much to pay for quota, a fisher would estimate net revenue from the sale of the fish after paying for all the inputs needed for fishing, including a reasonable cost for capital such as vessel and gear. Any 'extra' income remaining after paying for all other inputs is the contribution of the fish, the resource rent, as in the example for Namibia in Box 3 which shows that total resource rent in 2006 was 14% of the sales value of fisheries.

Box 3: Calculating resource rent: an example for Namibia

To calculate resource rent from national accounts data, the following formula is used for each fishery:

$$RR = TR - (IC + CE + CFC + NP)$$
$$NP = r \times K$$

Where RR is Resource rent
TR is Total revenue
IC is Intermediate consumption
CE is Compensation of employees
CFC is Consumption of fixed capital
NP is Normal profit
r is the opportunity cost of capital
K is the value of fixed capital stock invested in the industry

Note that this approach calculates rent as the difference between revenue and average cost, not marginal cost. Data about marginal cost are not generally available from national accounts data. This practice introduces an upward bias into the measure of rent when average cost is lower than marginal cost.

Resource rent for all fisheries in Namibia, 2006 (millions of Namibia $)

Output		4,969
	- Intermediate consumption	2,403
	- Compensation of employees	1,088
	- Consumption of fixed capital (depreciation)	177
	- Normal profit (20% return on fixed capital, $3140	628
= Resource Rent		673

Note: Calculations combine fishing and fish processing industries because of the high degree of vertical integration in the industry, especially for freezer trawlers whose continuous-process operation make the separation of fishing from fish processing somewhat arbitrary.

Source: (Lange 2008) and calculations based on unpublished data from the Namibian national accounts.

A critical issue here is the second condition, efficiency of harvesting which is based on technology and management of the fishery. If management promotes excess capacity, potential rent will be dissipated on paying unnecessarily high capital costs. This can happen in large industrial fleets as well as artisanal fishing under conditions of open access. A number of studies have indicated that many of the world's fisheries have the potential to generate significant rents but under current management, generate no rent, and in some cases are actually subsidized, which can be viewed as a negative rent. In the case of the Namibian hake fishery, although it receives no subsidies and contributes significantly to government

revenues from hake quota levies, it is not managed optimally. Sumaila and Marsden estimated that rent from hake fishery in 2002 generated about US$21 million, but was capable under alternative management options of generating US$112-118 million.

The value of a natural resource asset, such as the stock of fish, is the discounted sum of rents it is expected to generate over its lifetime. For renewable resources such as fisheries or mangrove forests that are sustainably managed, the lifetime of annual rents is infinite. The discussion in this section has used fisheries as an example, but in accounting for marine ecosystems, this approach should be extended to all components of a marine ecosystem, including coral reefs, mangroves, etc. (see (Dixon et al., 2000) for application of the rent concept to coastal tourism in the Caribbean). The asset value of these resources, and net depletion or additions to total nation wealth, is based on the resource rent they generate.

3.1.2 What is the true economic importance of marine ecosystems?

A primary cause for ecosystem degradation is failure to identify and internalize in decision-making the economic value of ecosystems. By quantifying the total economic contribution to GDP from marine ecosystems, the accounts help decision-makers argue more persuasively for the investments necessary for marine management and conservation. In identifying these ecosystem services, it is useful to distinguish

- Goods and services already included in the SNA and correctly attributed to the appropriate component of the ecosystem, e.g., fish or forestry (mangroves)
- Goods and services that should be in the SNA according to the *System of National Accounts* (UN et al., 1993), but which are underestimated or missing due to the difficulty of collecting accurate information, e.g., non-market (subsistence) or informal market production
- Ecosystem services whose value is already included in the SNA, but is attributed to other sectors such as tourism
- Ecosystem services not included in the SNA, e.g., biodiversity protection, assimilation of wastewater, etc.

Many ecosystem services correspond to what economists call ‘direct use values’ which have been described earlier in this report. These services are often traded in markets (formal or informal) and have market prices, which represent their economic value. For such marketed products, valuation is relatively straightforward, requiring collection of information about the volume sold and the price paid. Sometimes a portion of such products may be kept by a household for its own consumption, or bartered without going through the market. These are considered ‘near market’ products, products with an identical or closely related product which has a market price. In such cases, the market price usually represents a reasonable estimate of its value.

Other ecosystem services, however, such as habitat or shoreline protection, may not have a market price, or sometimes the observed market price is very different from the real value of the service—this may occur for, example, when entry fees to a marine protected area are far below what visitors are willing to pay, and sometimes even not sufficient to cover the costs of operating a protected area. Although the theory for non-market valuation is well developed, the techniques are not easy to implement because they require quantification of the complex, non-linear relationship between the size, composition and health of an ecosystem and the level of services provided. Due to lack of information, most studies simply assume a linear relationship between the area of the ecosystem and the level of service provided. This assumption results in sub-optimal ecosystem management. For example, a trade-off analysis between preserving a mangrove forest that provides fishing and shoreline protection and clearing the forest for shrimp ponds, would recommend doing either one or the other, when in fact the best solution may be a combination that optimizes the marginal benefits from each potential use. Barbier et al. (2008) provide a good example of how more accurate estimation of the service function can provide very different recommendations.

Box 4: Improving coastal management with more accurate values for ecological functions

In many policy analyses, it is commonly assumed that ecosystem services respond linearly to changes in habitat size. This assumption leads frequently to an "all or none" choice of either preserving coastal habitats or converting them to human use, rather than the mixed-use approach promoted by ecosystem-based management. Barbier et al. (2008) used field data to estimate relationships between habitat area and the ecosystem function of wave attenuation for mangroves, salt marshes, seagrass beds, near shore coral reefs, and sand dunes, and found them to be almost always non-linear.

They applied these non-linear relationships to a case study from Thailand for the choice of conversion of a10 km2 mangrove habitat to shrimp aquaculture or preservation for ecosystem services of coastal protection from wave attenuation, wood collection and habitat-fishery linkage. The highest value ($17.5 million) was generated by a mix of land uses and sharing of benefits: roughly 8 km2 preserved for ecosystem services ($15.6 million) that benefit local communities (communities up to 5 km inland benefit from coastal protection) and 2 km2 for shrimp farming ($1.9 million) that benefits outside investors. The small loss of mangroves converted for shrimp farming did not significantly reduce the value of coastal protection services.

By contrast, when they applied a linear value for ecosystem services, based on average rather than marginal value, a single land use—complete preservation—generated the highest value ($18.98 million). Due to a lack of ecological information, most economic studies assume linearity for ecosystem services, which typically result in 'all or none' recommendations. This study demonstrates that such an assumption is unrealistic and misleading; the use of more realistic, nonlinear values for ecosystem services support a mix of conservation and economic uses that is consistent with the goals of ecosystem-based management.

While in the strict economic sense the value of a natural resource and an ecosystem is measured by the resource rent, policymakers often use the term 'value' in a broader sense to indicate economic significance for various purposes. Policymakers in line ministries as well as ministries of finance, central banks and planning agencies want to know things such as how much do marine ecosystems contribute to:

- Trade and the balance of payments
- Wages and employment
- Potential for 'upstream' and 'downstream' linkages to other industries to spur development

In addition to direct values generated by marine ecosystem services, these services have linkages to other sectors of the economy. For example, fishing generates 'forward linkages' to industries that use fish such as fish processing, marketing and restaurants, as well as 'backward linkages' to industries that supply inputs to fishing such as boat building, gear repair, fuel depots, etc. When these forward and backward linkages are met by local business, the economic benefit from marine ecosystem services is 'multiplied' to generate employment and income throughout the rest of the economy. This is especially important in developing countries where unemployment and poverty are very high.

The multiplier effect of forward and backward linkages is commonly estimated using model based on social accounting matrices or input-output tables, which are part of the SNA. Closely related to this, but less data demanding is value-chain analysis, which has become very popular in livelihoods analysis (e.g., Gudmundssen, 2006; Roe et al., 2006). The main difference is that it doesn't try to estimate all the linkages throughout the economy, just the most important ones. Both approaches not only show the broader economic impact of marine ecosystem services, but also can identify opportunities for intervention to increase incomes and reduce poverty.

When the total economic value of marine ecosystem services is linked to the broader economy, it is much easier to integrate marine policy with national development and to monitor interactions and feedback across different industries. Thus, marine ecosystem accounts can be useful for two sets of resource

managers and stakeholders: those responsible for use and management of the marine ecosystem, and those responsible for management of the macroeconomy.

Fisheries, tourism managers, and coastal land use planners, for example, may already have good information about the total economic value of their resources. What they gain from the ecosystem accounts is the ability to put that information within the context of the national economy. This helps them to identify and address opportunities or threats that originate outside their sectors, which can improve their ability to protect and develop this resource. Policy-makers and other stakeholders outside the marine sectors gain a tool for more accurate coordination of policies across the economy, anticipating policy impacts across different sectors and designing more effective national development policies.

3.1.3 How are the benefits distributed among different stakeholders, especially the poorest households?

The question of who benefits from ecosystem services is increasingly important for management and development policy:

- *Identifying how sustainable marine ecosystem management contributes to poverty alleviation.* Poverty reduction is a priority in developing countries, so analysis of the distribution of benefits from marine ecosystems is needed to understand the level of dependence on and vulnerability to changes in marine ecosystem services, and to identify opportunities for marine ecosystems to contribute to poverty reduction.
- *Aligning costs and benefits to promote incentives for sustainable management* and, related to this, identifying who might pay for ecosystem services. Total value of ecosystem services may be high, but major beneficiaries may not be the local communities who manage or have a major impact on managing the ecosystem.

This analysis of distribution of benefits is especially important for tourism and for industrial fisheries in developing countries, two activities where it is common to find foreign businesses. There are several dimensions of the distribution issue to consider:
Private sector beneficiaries:

- Business owners. The scale of operations varies from large-scale commercial operators, artisanal users who operate commercially but on a much smaller scale, and subsistence users. In many developing countries, ecosystem services may be critical to the livelihoods of artisanal or subsistence households and thus have a high social value even when the economic value of such products is low relative to commercial operations. Large scale operations are more likely to involve foreign owners or partners, so part of the benefits accrues to stakeholders outside the country providing the ecosystem services.
- Workers. Economic activities based on marine ecosystems generate employment and wage income. The share of workers and incomes accruing to local labor force is an important issue in many cases. Workers may require specialized skills and training not found among local communities, especially in rural areas.
- Consumers and households benefit from cultural and recreational services, waste assimilation services, shoreline protection, etc.

Governments also benefit when activities based on marine ecosystems provide tax revenues. Local, regional/national or international beneficiaries: Local beneficiaries such as fishers live in close proximity and are usually aware of the direct benefits they receive from the ecosystem. Typically, the further away from the ecosystem, the lower the awareness of the value of the indirect benefits they receive. In developing countries, recreational services may be enjoyed mainly by foreign visitors but they also provide employment to local communities. In some instances, recreational services of coastal and marine parks are provided free of charge or at a cost that does not reflect its value to the beneficiary. Thus the

recreational services are undervalued and do not send an appropriate signal for sustainable management. In developing countries, this may result in transfer of benefits from the relatively poor host country to well-off foreigners. Some countries have introduced two-tiered entrance fees for national parks in order to maintain access to parks by local residents while capturing more of the willingness-to-pay by foreign visitors.

3.1.4 Potential for Marine Ecosystems to Fund Sustainable Management

There are three components to this assessment:

- Resource rent generated by marine ecosystem services: this represents the potential revenue that can be obtained
- Amount of tax and non-tax revenues collected by government from these services
- Current levels of government expenditure on managing marine ecosystems

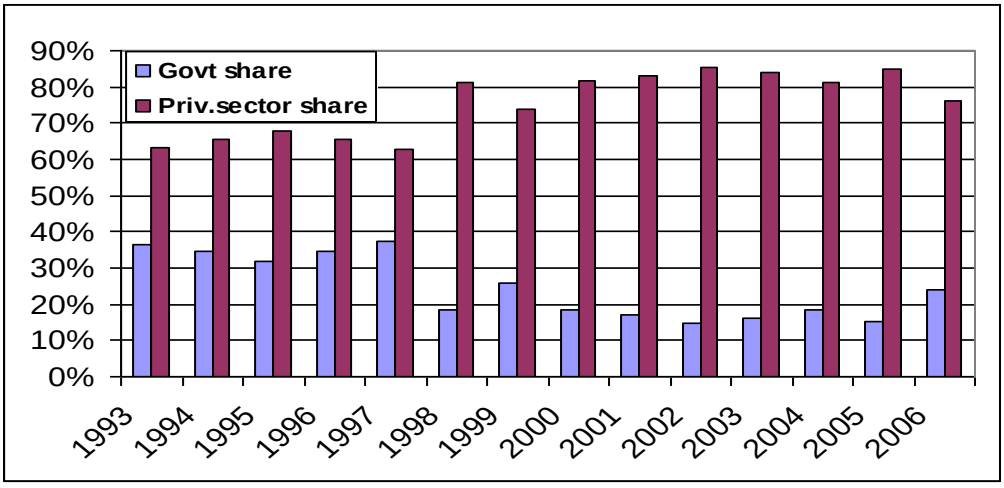
It may not initially seem that these statistics are part of environmental accounts or the SNA because these data can be collected outside the environmental accounting framework. However, they are included because it is so useful for policymakers to have this information along with the kind of information discussed in sections above.

The potential for marine ecosystems to contribute to management expenditures of their respective sectors has two components:

- The potential resource rent generated by marine ecosystems
- The efficiency of current revenue collection, given current levels of taxation and levies. Actual revenue collected may be less than potential revenue due to under-reporting of activity, catch, tourist occupancy rates, etc.

Figure 7 indicates the shares of resource rent form fishing in Namibia accruing to the public and private sectors, respectively, after independence in 1990. Most of the rent has accrued to the private operators, and their share has been increasing.

Figure 7: Shares of resource rent from Namibia's fisheries accruing to public and private sectors



Source: (Lange 2008)

Coastal tourism has the potential for generating significant incomes in developing countries and contributing to poverty reduction. However, the extent to which it does so depends on local participation in the tourism industry (Dixon et al. 2000). Under the 'pro-poor tourism' approach, a number of analyses

have been carried out to identify ways to increase local participation (Roe et al. 2004; Mitchell and Fall, 2006).

3.2 Payment for Ecosystem Services

The challenge for sustainable development is 'Who will pay for non-market ecosystem services?' Economic valuation can help to promote sustainable development by providing policymakers with information about the value of non-market marine ecosystem services, and the potential costs if these services are lost. However, recognition of the value of ecosystem services will not ensure conservation of the ecosystem if those responsible for providing the benefits (owners/managers of an ecosystem) do not themselves benefit from conservation. In the past, the solution to such a problem was mainly achieved through regulation of use. A simple, market-based alternative, Payment for Ecosystem Services (PES), is based on the idea that if people benefit from a service then they should be willing to pay for it. PES is an attractive mechanism because it makes use of economic incentives and the private sector to bring about improved management of an ecosystem. Valuation can play an important role in developing markets for of ecosystem services, helping to guide the negotiations about payments.

PES is a mechanism to promote more socially optimal management of ecosystems where there are significant non-market ecosystem services that benefit agents other than those responsible for its management (positive 'externalities'). It works by creating a market for these services to internalize benefits in the decision-making of the owner/manager of the ecosystem. Those who benefit pay for the service; those who provide the service receive the payment.

PES has been successful when the following criteria are met

- The volume and value of the service received by each beneficiary and provided by the owner/manager of an ecosystem must be clearly understood.
- Property rights must be secure so that the owner/manager of the ecosystem providing the service has the ability to enter into a contract
- Monitoring and enforcement mechanisms need to be affordable—if the value of the ecosystem service is not very high, then beneficiaries may not be willing to pay enough to compensate land owners and pay for the institutions necessary for this market
- Relatively few participants (beneficiaries and land owners) in order to keep the transaction costs low and reduce the potential for 'free riding' in which someone who cannot be excluded from a service chooses to pay less than his/her share of the benefits.

PES has been applied to terrestrial ecosystems most often for the provision of water services by upstream forest ecosystems (Engel et al., 2008). Marine ecosystems also benefit from ecosystem services provided by terrestrial ecosystems, especially clean water free of excess nutrients and sediment. Users of marine ecosystems should be willing to pay for such services, for example, providing incentives for land use that reduces erosion and agriculture that uses less fertilizer. However, there has been no example of PES for services provided by marine ecosystems so far. Marine ecosystems appear to face obstacles which terrestrial ecosystems do not.

In identifying the potential for a PES approach to marine ecosystem management, one must first identify which problems are amenable to PES solutions. PES is designed to 'internalize' services in the decision-making of ecosystem managers who provide the service, as well as the users of the service. But many problems do not arise because of externalities. The two most common direct[12] causes of marine ecosystem degradation are overfishing and excessive nutrient loading due to inadequately treated waste water from coastal settlements. The former and to some extent the latter often arise due to competition

[12] Indirect causes such as climate change are also having a major impact on marine ecosystems.

among users of the ecosystem in the absence of well defined property rights over marine waters, rather than because of an externality.

Under some circumstances, MPAs might be interpreted as a form of PES when payments are made by non-consumptive users (for example, visitors for diving and snorkeling) or consumptive users (for example, fishers whose target fisheries use MPAs as breeding or nursery grounds). A similar terrestrially based system of protected area management was recently cited as an example of PES for wildlife services (Frost and Bond, 2008).

Lack of property rights appears to play a major role in the problems of marine ecosystem management. Creation of property rights in fisheries has done a great deal to improve fisheries management, but that is only one part of the marine ecosystem. Even if property rights could be assigned, there are further challenges to using PES when it is difficult to quantify how specific users benefit from these services. For example, mangrove forests provide storm protection to coastal communities and the value of this service is the damage avoided by maintaining the mangroves. But it is extremely difficult to identify the value of this service (damage avoided) for any one individual. Without knowing how much to pay, a beneficiary cannot negotiate a contract with ecosystem users. Further complicating this situation, there are likely to be a large number of beneficiaries in marine ecosystems. In successful PES programs, there tend to be a small number of important beneficiaries in a watershed. Transactions costs are higher when there are many users, and may become too high to pay for. Existence of a large number of beneficiaries also increases the likelihood of free riding.

3.3 Damage compensation

The sources of damage to marine ecosystems could be numerous, and one of the applications of valuation techniques is to determine the right damage compensation. The amount of compensation, and whether it is pursued or not, depends to a large extent on the applicable laws within the different countries. For the marine ecosystems the main sources of damages are shipping accidents, oil spills such as those in the Red Sea, Philippines, and the Galapagos Islands (Spurgeon 2002). Spurgeon (2006) also notes the importance of taking into account the magnitude of non-use values in determining the compensation amount.

In the USA, the practice of damage assessments started in 1980's and two agencies developed procedures and rules: the US Department of Interior (US DOI) and the US Department of Commerce, National Oceanographic and Atmospheric Administration (US DOC, NOAA). In both case, damages are defined as sum of restoration costs, compensable value, and assessment cost. UNDOI identifies two types of rules for damage assessments: type A rules are designed for damages up to $100,000, and the estimate of economic damages is based on use values from the most current relevant economic studies in the published literature and adjusted to current dollars. Type B rules are designed for more complex and larger spills – over $100,000 in damages and allow flexibility in the assessment of injuries to the natural resources and its services from spills and in assessments of economic damage. Type B rules include measuring non-use values (existence and bequest) when use values cannot be determined (Ofiara 2002).

NOAA emphasizes the restoration of injured natural resources and services, and its approaches were developed to determine and assess the scale of suitable restoration projects and/or acquisition of equivalent resources and services so as to make the public and resources whole. Among these are the economic approaches of nonmarket valuation methods (travel cost method, contingent valuation) and market methods (factor income approach, demand and supply market models, hedonic price approach), benefit transfer, conjoint analysis, and habitat equivalency analysis (Ofiara 2002).

Damage assessments due to war events are also emerging, such as the damage assessment that was conducted by countries affected by the 1991 Gulf war and the damage assessment due to 2006 Israel

hostilities on Lebanon – where the World Bank assisted in preparation of environmental degradation study to estimate the damages.

3.4 Marine and coastal spatial planning

Marine and coastal spatial planning is probably one of the most common uses of valuation within the context of cost-benefit analysis. It also helps for planning for the operation of marine protected areas and there are numerous examples where valuation studies were used to determine the entry fees into marine protected areas.

In Zoppi (2007), the contingent valuation method was used to compare the results and complement the carrying out of the multi-criteria analysis (MCA) to evaluate local preferences for development of coastal areas surrounding the Arbus town in Sardinia, Italy. The study shows that contingent valuation results could be used to determine the weights in MCA, thus enhancing the MCA's objectivity and accuracy.

In New South Wales, the Economic Values of Natural Resources and Natural Environments on the NSW Coast project, demonstrated a methodology for identifying and estimating the value of natural environments and resources regionally, across the NSW coast, and locally, as applied in the Wallis Lake Study and their use in prioritizing options for resource protection and investments in coastal catchments.

3.5 Carbon finance

The ocean's ability to sequester carbon, as well as the ecosystem services provided that serve adaptation to climate change are important possible applications for valuation studies. Lutz (2008) argues that the value of carbon sequestration in the carbon finance market would allow for the provision of financial incentives towards efforts that are geared for the amelioration of marine ecosystem's health such as conservation efforts, sustainable management of fisheries, establishment of marine protected areas, improving coastal water quality, and restoration of habitats. Furthermore, with the emergence of a number of funds for climate change adaptation, the conservation and sustainable use of marine and coastal biodiversity as a mechanism to maintain livelihood options and ecosystem services in the face of changing climatic conditions may well result in increased financial investments. In fact, the expert meeting of the Nairobi work programme already identified integrated marine and coastal area management as an important tool for climate change adaptation in marine and coastal areas.

3.6 Bioprospecting and access and benefit sharing arrangements

The UN Convention on Biological Diversity (CBD) and the Bonn guidelines provide guidelines for international policy on access and benefit sharing arrangements. The CBD establishes standards for regulating access to genetic resources and the distribution of the benefits arising from biodiversity. The Bonn Guidelines provide voluntary guidance for the CBD's Contracting Parties regarding their obligations under the access and benefit sharing provisions of the CBD, as well as on guidance on incentives and accountability in implementing ABS arrangements, national monitoring and reporting, means for verification, settlement of disputes, and remedies (Laird et al. 2003).

Bioprospecting activities are also taking place in deep sea and coastal zone ecosystems. Arico (2007) provides several examples of patents which are based on deep sea genetic resources:

- Food utilizing lactic acid bacterium derived from deep sea water
- New cosmetic compositions with anti-oxidant properties comprising antiradical agents, useful for skin protection with anti ageing effects
- Method for producing wine
- Process for preparing seafood-tasting protein gel from transglutaminase

- Deep sea microbiological sampling and culturing apparatus and method.

The effective implementation of CBD provisions on access and benefit sharing requires a clear understanding of how bioprospecting is being conducted and regulated. A review of six bioprospecting projects in three countries (Aguilar-Støen 2008) revealed that bioprospectors are increasingly collecting resources in marine environments within their own countries, which facilitates the issue of access to resources, but leaves benefit sharing issues largely unresolved.

Valuation programs may assist with stressing the importance of conservation of genetic resources, also providing awareness on values of these genetic resources will help empower indigenous and local communities in negotiating contracts with collectors and developers (UNDP 2004).

3.7 Prioritization of future work on marine and coastal ecosystems

One of the often cited limitations of valuation studies is the limits imposed by complexity of interactions of ecosystems and the difficulty to pinpoint the change of flows in terms of ecosystem services. Such limitations could form the priorities for further research. Collaboration between marine ecologists and economists is important in determining areas of research that would benefit the valuation efforts of marine ecosystem services. Integration of valuation techniques and economic instruments into national and international research programs on marine and coastal ecosystems will result in research that takes several aspects into consideration.

4. RELATED INITIATIVES

There are several ongoing initiatives for valuation of marine ecosystem services and integration of valuation into the decision making process. Below are a few examples of these initiatives and projects:

- *World Resources Institute (WRI) initiatives in the Caribbean*

The WRI is working on economic valuation of tropical coastal ecosystems which aims to measure the value of coral reefs and mangroves in three main areas: tourism, fisheries, and shoreline protection, and to identify incentives for decision makers to reduce threats to these ecosystems. WRI is working with the Institute of Marine Affairs of Trinidad and Tobago to develop a method for estimating the economic value of shoreline protection using an "avoided damages" approach. Work in Trinidad and Tobago and St. Lucia using this approach is now being modified for application in Belize, where the barrier reef creates a different set of conditions related to storm surge and coastal vulnerability.

- *Atoll Ecosystem-based Conservation Project in Baa Atoll, Maldives*

This UNDP-GEF funded project, which started in 2004 and will continue till 2008, aims to ensure the long-term conservation of three protected areas in Baa Atoll—75-islands on the west side of the atoll chain. Among the project's activities is to pilot a long-term financing mechanisms for biodiversity conservation in Baa Atoll.

- *The Initiative for the Protection and Management of Coral Reefs in the Pacific (CRISP)*

CRISP program, mainly sponsored by France and implemented in partnerships with Secretariat of Pacific Regional Environment Program, University of the South Pacific and Secretariat of the Pacific Community, aims to: develop a better understanding of the biodiversity, status and functioning of coral

ecosystems; carry out coral ecosystem protection and management activities on a significant scale; develop the economic potential of coral ecosystems based on their use values and biodiversity; and disseminate information and knowledge, build capacity and foster local, national and international networking throughout the South Pacific. The programme was launched in 2005 and will continue into 2009, and is currently supporting about 30 MPAs in 10 Pacific countries and territories. As part of CRISP, a valuation study was conducted to estimate the total economic value of the coastal ecosystems within the Navakavu locally managed marine area in Vitu Levu Island in Fiji. Also as part of the Program a workshop on economics was conducted with the objectives to improve valuation methods for MPA economic impacts analysis and develop decision tools adapted to Pacific marine protected areas. The workshop also resutled in identifying a number of potential sites for which economic valuation of MPA impacts will be conducted (from September 2008 to December 2009) (CRISP 2008).

- *United Nations Environment Programme*

In 2006 the United Nations Environment Programme published a study titled 'In the Front Line: Shoreline Protection and other Ecosystem Services from Mangroves and Coral Reefs'. This study highlighted a number of values from mangroves and reefs including:

- In Malaysia, the value of mangroves for coastal protection is estimated at US$300,000 per kilometer of coast based on the cost of installing artificial coastal protection.
- Following the degradation of the reef around Malé in the Maldives, the cost of installing artificial breakwaters was US$10 million per kilometer
- In Sri Lanka, reef fisheries are worth between $15,000 and US$150,000 per square kilometer a year.

- *Integrating marine ecosystem services into national accounts in Zanzibar:*

This study's objectives are to estimate the value of the services produced by Zanzibar's marine ecosystem and compile ecosystem accounts that integrate ecosystem values with Zanzibar's national income accounts. Methodology and results of this case study are discussed below.

5. CASE STUDY[13]

5.1 Introduction

This case study reports the value of marine ecosystem services in Zanzibar, a small island archipelago off the coast of Tanzania. Zanzibar's ecosystem has global and regional significance because of its biological ecosystems (endemic species of corals, fish, seagrass, flora and fauna) and the high economic dependence of the local community on marine ecosystems for tourism, fishing (mainly artisanal), seaweed farming, mangrove harvesting, and other activities, which makes the marine ecosystem critical for Zanzibar. In addition, its rich cultural heritage makes Zanzibar a unique tourist destination.

Zanzibar's population currently is just over 1.1 million, and it is densely populated, with 428 people per square kilometer (Office of the Chief Government Statistician (OCGS), 2008). Poverty is extreme and widespread in Zanzibar, average per capita GDP $415 in 2007, with roughly 50% of the population below the basic needs poverty line and 13% below the food poverty line (OCGS, 2006). (Grootenhuis and Lopez, 2003; RGZ, 2007; Ruitenbeek *et al*., 2005).

[13] This section is contributed by Glenn Marie Lange.

This project is a joint effort of the Earth Institute at Columbia University and the Institute of Marine Sciences, University of Dar Es Salaam, funded by a Pew Fellowship in Marine Conservation and carried out from 2006-2009 with a budget of US$150,000. The project worked closely with many stakeholders in government (including all relevant line ministries[14], ministry of finance, Bank of Tanzania, and other agencies); academic[15] and NGO communities at national, local and international levels; and many private sector groups both individual companies and industry organizations.[16]

The purpose of the project is to promote sustainable development by providing stakeholders with a powerful economic tool for decision-making based on the economic value of the marine ecosystem—to understand how dependent the economy currently is on the ecosystem, and what would be lost if the ecosystem is not protected.

The study distinguishes two target audiences: i) line ministries, private sector and civil society organizations directly involved in the use and management of the marine ecosystem; and ii) agencies with responsibility at the economy-wide level like the ministry of finance. The former are often quite receptive to valuation studies like this, which can clearly help them with management. The latter have no direct responsibility for the marine ecosystem and must be convinced that they, too, have a stake in sustainable ecosystem management.

To engage decision-makers at the macroeconomic level, we must demonstrate what their stake is. We do this by integrating ecosystem values with Zanzibar's national income accounts to show the ecosystem's influence on the important indicators of macroeconomic performance, such as the contribution to GDP, employment and the balance of payments, and what can potentially be lost under mismanagement. In addition, we account for the distribution of economic benefits among different stakeholders, especially the poorest and most vulnerable.

Distribution of benefits is a critical factor for both target audiences but for slightly different reasons. At the sectoral level, information about distribution of benefits contributes to improved management; countless studies have shown that incentives for sustainable management are strongest when those who use a natural resource directly benefit from it. But in many developing countries, the local communities often lose out to other users; when local communities do not have a sufficient stake in the sustainable management of a natural resource, conservation often fails. This is a danger in Zanzibar.

At the macroeconomic level, policy-makers are not involved in sectoral or field-level decisions about how an ecosystem is managed. However, many developing countries, including Zanzibar, now have some form of poverty reduction strategy plan, in which poverty reduction joins the traditional macroeconomic objective of economic growth (Revolutionary Government of Zanzibar (RGZ), 2007). Under such plans, monitoring poverty and income distribution has become a priority for macroeconomists. Accounting for distribution of benefits from marine ecosystem services, which shows the impact on poor communities especially in the rural areas where poverty is most pervasive and extreme, is an additional way to convince macroeconomists that they have a stake in sustainable marine ecosystem management.

5.2 Approach and scope of valuation of Zanzibar's ecosystem services

[14] Notably the Department of Fisheries; Ministry of Tourism, Trade and Investment; Tourism Commission; Department of Environment, Department of Forestry, Department of Lands

[15] Notably Chumbe Island Coral Park, the Western Indian Ocean Marine Science Association based in Zanzibar, the Beijer Institute for Ecological Economics based in Stockholm, and the Center for Environmental Economic Policy in Africa at the University of Pretoria.

[16] All seaweed companies, all local airlines and airport authorities, many hotels and tourism-related businesses, the Zanzibar Association of Tourism Investors, and others.

This case study presents economic accounts for the value of the marine ecosystem services. Using the MA categories, Zanzibar's most important ecosystem services include:

1. Provisioning services
    - Fishing and fishing-related activities
    - Seaweed farming
    - Mangrove harvesting for fuel, timber, and other products
2. Education and cultural services
    - Tourism and related activities
    - Education and research related to the marine environment
3. Regulating services
    - Habitat provision for fisheries and other species:
    - Waste water assimilation
    - Natural hazard protection: storm protection and beach erosion control

A comprehensive framework for accounting for marine ecosystem services in Zanzibar (Lange, 2007) is based on the ecosystem accounting approach of UN et al. (2003) and the European Environment Agency (EEA 2006; 2008) which integrates economic accounts with physical accounts for land use and the major components of the ecosystem, such as coral reefs and mangrove forests. We report only the economic accounts here.

The accounting approach estimates economic values that are consistent with the national accounts, which are based on market prices[17] (see Section 3 for further discussion). Income in the national accounting sense is called 'value-added,' and when one speaks of a sector's contribution to GDP, it refers to that sector's value added. Value-added is calculated as gross revenue (the value of output) minus costs of intermediate inputs (goods and services) used for production. Value-added consists primarily of two components[18]:

- Compensation of employees—wages and salaries plus any benefits and in-kind payments.
- Gross operating surplus or mixed income—a residual income that remains after paying for all other production costs. This component of income is a mix of several things: the earnings of the self-employed who are not paid an explicit wage; the 'surplus' to cover the cost of capital and depreciation; and when natural resources are the basis for economic activity, gross operating surplus includes any resource rent that is generated. It is not the same as net profits, as businesses must pay taxes out of this income.

Economists make a distinction between the value of *ecosystem-based activities*, like fishing and tourism, and the value of the *ecosystem itself*. The former is the combined value of several contributing factors—the ecosystem, labor, and capital; it is total value-added, the contribution to GDP. The latter refers to the value of the ecosystem alone in a given activity, such as the value of fish stock in fishing, or the value of the coral reefs to tourism; this is resource rent (see section 3 for further discussion of rent).

The objectives of this case study are to quantify:

1. Contribution of marine ecosystem services to the macroeconomy of Zanzibar
    - Contribution to GDP,
    - foreign exchange earnings[19]
    - employment, disaggregated by gender where possible, and

[17] In contrast to many economic valuation studies, in which the objective is to measure economic welfare.

[18] A certain category of taxes, Taxes on production, is also included, but in most instances it is extremely small.

[19] As an autonomous region in the United Republic of Tanzania, Zanzibar calculates its own GDP but not a separate balance of payments (BOP); hence, we report the contribution to foreign exchange earnings but not a total BOP.

2. Distribution of income among different stakeholders and the share of that income that can be identified as resource rent.

Given Zanzibar's focus on poverty reduction and the implications for sustainable management of benefits accruing to local communities, five groups of beneficiaries are distinguished:

Beneficiaries in communities where activities based on marine ecosystem services occur:

1. Zanzibari villagers in coastal areas where most beach hotels are located and mst fishing and seaweed farming occurs
2. Urban Zanzibaris involved in businesses in Zanzibar Town and its suburbs

Beneficiaries in Zanzibar, but not in communities where activities occur:

3. Urban Zanzibaris involved in businesses in rural coastal areas, usually tourism
4. Zanzibari government

Beneficiaries outside of Zanzibar:

5. People from outside Zanzibar including mainland Tanzania and foreigners as (part-) owners of businesses, hired as workers, or the mainland government which levies its own taxes

Using the national accounting approach, we estimate for each group the components of value-added: compensation of employees and gross operating surplus / mixed income (including rent). Where data are available, we quantify taxes received by the Zanzibari government. Valuation of each ecosystem service is described in the next section. We conclude by integrating all these values with national income accounts, and discussing the policy implications and priorities for further work.

5.2.1 Recreation and Tourism

International tourism[20] was identified in the 1980's as a sector with major potential for driving economic development in Zanzibar. Since then it has grown from 19,368 visitors in 1985 to an estimated 219,047[21] in 2007 (Table 5). Similarly, hotel capacity has grown from 550 beds in 1985 to 9,430 beds in 2007, with the most rapid growth occurring in coastal areas. The majority of tourists come to Zanzibar for its beautiful tropical beaches and coral reefs, but the traditional culture is also an attraction. Roughly half of all visitors tour Zanzibar's historic Stone Town and spice farms.

Although it is one of the most important sectors of the economy, there has been little economic analysis of tourism to determine the impact on the national economy or the lives of Zanzibaris. While the potential to contribute to economic development is great (e.g., 'pro-poor tourism' (Ashley and Mitchell, 2007)), foreign tourism has also been a powerful force for social change and disruption (Gossling, 2003). The rapid expansion of tourist infrastructure on the coast, combined with a population growth rate of over 3%, has put great pressure on coastal areas. In some areas, particularly the northeast, local villages have seen their access to the beach and sea greatly restricted (Gossling, 2003; Mustelin, 2007). For example, the most recent fishing census found that the number of landing sites for fishers had declined in the previous decade, in part due to the appropriation of beach sites for tourism (Jiddawi and Khatib, 2007).

While losing access to traditional livelihoods, the coastal communities are often least able to benefit from tourism employment opportunities. Their relatively poor education makes local villagers ill-equipped to work in large hotels serving a sophisticated, mainly European clientele in all but the least skilled

[20] There is a small domestic tourism sector, but it is extremely small. International tourism dominates the sector and is the only sector discussed in this case study.

[21] This figure is 53% higher than the official tourist arrival statistics compiled by the Commission for Tourism. The official statistics do not record passengers who arrive by air from Mainland Tanzania. The figure in the text includes these 'missing' tourists; estimation is described in the annex.

positions. The majority of hotels prefer to employ people from Zanzibar Town, mainland Tanzania or foreigners in skilled jobs, especially those which involve interaction with tourists. Tourism in Zanzibar has triggered a migration from mainland Tanzania which has been socially disruptive (Gossling, 2005).

Table 5. Tourist arrivals, length of stay and expenditure by type of tourist in Zanzibar, 2007

	Budget & Mid-range tourism	Small-scale, upmarket tourism	Large-scale, upmarket tourism	All-inclusive, 'club' tourism	Total
Number of visitors	98,098	16,077	60,463	44,410	219,048
Share of total visitors	45%	7%	28%	20%	100%
Average length of stay (days)	6.6	6.0	6.0	8.4	6.8
Average daily expenditure/ person, US$	87.83	225.47	172.84	123.27	609.41
Total expenditures, million US$	54,476	21,692	62,598	46,164	184,930
Share of total expenditures	29%	12%	34%	25%	100%

Source: Based on (Lange and Jiddawi, forthcoming)

Using established methods to measure the economic value of tourism for national accounts (WTO, 2000), the following surveys were carried out: 1) a Visitors' Exit Survey of 1,840 visitors to determine how much tourists spend in the local economy, how long they stay, and what they do, and 2) a Survey of Tourism Industries including hotels, dive operators, restaurants, local tour operators and others to dtermine the costs and incomes generated from tourism activities and the share of income received by different stakeholders. To better understand the impacts of tourism, our analysis distinguishes four kinds of tourism in Zanzibar, which vary in terms of economic contribution and the relationship with local communities:

1. *Budget and Mid-range tourism:* Budget tourism consists of independent travelers staying in low-cost hotels and restaurants run mostly by local business people. This group is combined here with Mid-range tourism, targeting both package and independent tourists with a mid-range budget. It targets the same budget group as the All-inclusive 'club' tourist segment, but in contrast, businesses serving this segment are often locally owned and generate a greater share of benefits to the local community.
2. *Small-scale, up-market tourism,* based in small, mostly foreign owned hotels, including a few eco-lodges targets the high-end tourists who spend the most money. They generally operate with the greatest environmental awareness. More of these hotels see themselves in a long term partnership with local communities and are willing (and have the funds) to increase local hiring, and invest in improving local education, water and health, and other aspects of community life.
3. *Large-scale, up-market tourism* based in large, foreign-owned hotels serving mostly high-end travelers, both package and independent with mixed impact on the local economy and environment: some hotels reach out to local communities while others wall themselves off, similar to the 'club' hotels. Some operate in an environmentally sensitive manner, while many others do not.
4. *All-inclusive package tourism*, known as 'clubs,' which are based in large-scale, foreign-owned hotels targeting mainly tourists with a mid-range budget. They have little or no interaction with local communities, and do not make environmental responsibility a priority.

Tourism contribution to GDP and distribution of income

Tourists spent US$184.9 million in the Zanzibar economy in 2007[22] (Table 5; see Annex for detailed expenditures). Budget travelers spend the least, an average of $77 per day, and Mid-range tourists spend

[22] exclusive of expenditures on transportation to the island, tour agent commissions on packages and hotel reservations, and any other items that do not accrue exclusively to the Zanzibar economy.

about $119. Together they account for 45% of tourist arrivals, but only 29% of total tourism spending, both because of their low daily spending and their relatively shorter average length of stay. Tourists in the Small-scale, up-market segment spend significantly more per day than any other group, $225, but this market is not well developed yet, with realteively few visitors so they do not contribute much to the tourist economy (12%). Large-scale, up-market tourists spend less, $173/day. Most often, tourists in both up-market groups visit Zanzibar as part of a multi-destination tour, spending the last few days of their tour relaxing on Zanzibar's beaches. Although the All-inclusive market spends less per day than the Up-market segments, $123/day, they stay longer, accounting for 20% of tourist arrivals, but 25% of total spending.

The contribution of tourism to GDP is calculated by estimating the value-added generated from each industry that produces tourism goods and services; this is then distributed among the five stakeholder groups identified. Surveys were the main source of the estimates supplemented and verified by secondary data (methods are described in detail in (Lange and Jiddawi, forthcoming). Tourism accounts for 26% of GDP and a large amount of foreign exchange earnings (balance of payments is not calculated for Zanzibar independently from the United Republic of Tanzania). Employment, only calculated for hotels, is also significant and twice the number reported in official statistics.[23] Roughly 40% of jobs in hotels are filled by women.

For both poverty reduction and marine conservation, a key issue is the extent to which people living in coastal communities—who are partly responsible for its management, dependent on it for survival and often in competition with tourism—are benefiting from tourism. Overall, Zanzibaris obtain 47% of tourism GDP (Table 6; see annex for breakdown of value-added), but much of that goes to government in the form of fees and taxes (15%), and to Zanzibaris from outside the local communities (12%). Only 20% accrues to local communities. Non-Zanzibaris (from mainland Tanzania and other countries) obtain 53% of tourism GDP, mainly in the form of gross operating surplus, but this distribution varies a great deal among different kinds of tourism. Budget & mid-range tourism generates the greatest benefits to local communities; Up-market tourism benefits local communities slightly more than 'club' tourism.

Table 6. Contribution to GDP and distribution of value-added from tourism activities in Zanzibar, 2007 (values in thousand US$)

	Budget & Mid-range tourism	Small-scale, upmarket tourism	Large-scale, upmarket tourism	All-inclusive, 'club' tourism	Total
Contribution to the macroeconomy					
Contribution to GDP	34,032	11,934	43,015	30,655	119,636
Percent contribution to GDP	8%	3%	9%	6%	26%
Contribution to foreign exchange earnings	54,476	21,692	62,598	46,164	184,930
Employment*	Na	Na	Na	na	9,351+
Male					5,535+
Female					3,817+
Distribution of income among beneficiaries					
1. Zanzibari villagers in rural tourism	13,056	804	1,301	472	15,633
2. Urban Zanzibaris in urban tourism	5,432	754	1,238	847	8,271
3. Urban Zanzibaris in rural tourism	6,317	2,614	3,745	2534	15,210
4. Zanzibari government	4,802	1,449	5,677	5567	17,495
Subtotal, Zanzibaris	29,606	5,621	11,961	9420	56,608
5. Non-Zanzibaris	4,425	6,313	31,054	21235	63,027

[23] Our figures are derived from a hotel survey covering more than 50% of total hotel beds.

	Budget & Mid-range tourism	Small-scale, upmarket tourism	Large-scale, upmarket tourism	All-inclusive, 'club' tourism	Total
Zanzibaris share of total income (rows 1-4)	87%	47%	28%	31%	47%
Local Zanzibaris share of total income (rows 1 & 2)	54%	13%	6%	4%	20%
Resource rent (minimum estimate)					3,077
Resource rent as % of total income					3%

Na: not available..
**Employment estimates only for hotels at this time; distribution by type of tourism not yet available.*
Source: Based on (Lange and Jiddawi, forthcoming).

Resource rent accrues to two groups: government in the form of taxes and levies, and the private sector in the form of profits above the opportunity cost of capital. It is not possible to calculate rent accruing to the private sector without more extensive information about tourism businesses finances, particularly their capital costs and taxes. However, the government levies reported here can be viewed, at least in part, as a form of rent capture. Hotel levies, restaurant levies and tour operator levies are rent capture instruments and account for 3% of tourism value-added. This is a lower bound for rent capture by government. At the other extreme, all the taxes and fees reported here—which do not represent all the revenue government received from tourism—can be viewed as a form of rent capture; these account for 15% of tourism value-added.

Multiplier effects from tourism

So far we measure only the direct income and employment generated by tourism businesses. But tourism has the potential to generate substantial additional local benefits through the 'multiplier effect'— income and employment created when goods and services needed to run tourism businesses are produced locally instead of imported from mainland Tanzania or elsewhere. A multiplier analysis of international tourism in mainland Tanzania showed significant employment and income benefits beyond the direct impact of tourist spending (Kweka et al., 2001). It is not clear that a strong multiplier effect holds true for tourism in the Zanzibar economy. Our hotel surveys indicated that although hotels and restaurants bought most of their fish from local sources, most other food items were sourced from mainland Tanzania, a finding supported by value-chain studies of tourism by (Coles, 2007b and Ellman, 2007). However, this provides an opportunity for increasing local benefits from tourism.

5.2.2 Fishing and related activities

Fishing in Zanzibar is almost entirely a small-scale, artisanal operation for the local market[24]. The 2007 fishing census found 34,269 fishers (Jiddawi and Khatib, 2007); nearly half the vessels were dugout canoes, and only 11% of boats were motorized, so most local fishermen operate close to shore.[25] Fishing accounts for only 6% of GDP, but is an important part of coastal livelihoods (OCGS, 2006; Grootenhuis and Lopez, 2003). In 2007, the catch was nearly 26,000 tons (OCGS, 2008), for an average annual consumption of 23 kgs per person[26].

[24] Foreigners are licensed to fish the off-shore fishery within the 200-mile EEZ. Under a recent agreement, the off-shore fishery is managed jointly by the governments of Zanzibar and mainland Tanzania.
[25] With the exception of *dago*, or camping fishing expeditions which can last several months at a time.
[26] Fish catch statistics are unreliable (De la Torre, 2006), but this issue cannot be addressed here; the official catch statistics are used for analysis. Some fish is consumed by tourists, so the amount available for Zanzibari residents is less than 22.8 kg/person.

Throughout the world, fishing communities are often among the poorest, and many of Zanzibar's households are quite poor (OCGS, 2006), but the average earning of fishermen and women in 2007 was US$765 (Table 7) which is higher than the economy-wide average of $415 (OCGS, 2008). There is great variation of income among different fishers, however; 22% of fishers do not have access to any vessel and are limited to fishing by foot along the shore. The majority of foot-fishers are women who mainly glean the intertidal zone which does not generate high incomes.

The Department of Fisheries record catch and the value of catch, but very little is known about the net income of fishers and how it varies by season and location. There is no information about downstream fishing-related activities such as processing and marketing to the different market segments—local household consumption, local restaurants, and restaurants and hotels mainly serving foreign tourists. There have been concerns, for example, that middlemen supplying tourist hotels are able to extract most of the value, paying fishermen very little and charging high prices to hotels. Because all the activity is in the informal sector by the self-employed, usually operating at a very small scale with unpaid family members, there are no financial records.

Table 7. Fish catch and use in Zanzibar, 2007

Reported Catch and Value of output	23,582 tons	US$27.78 million
Total Catch and Output Including own-consumption*	25,940 tons	US$30.56 million
Contribution to GDP – Value added (Output – costs of fishing)		US$26.22 million
Per capita consumption of fish	23 kgs	$27

**Zanzibar national accounts assume that an additional 10% of reported catch is retained for own consumption.*
Note: exchange rate for 2007 is Tanzania shillings 1247 to the US$, from (OCGS, 2008)
Source: Fish catch from Department of Fisheries, 2007; contribution to GDP from (OCGS, 2008); number of fishers from (Jiddawi and Khatib, 2007).

To better understand the entire fisheries-related economy, and the distribution of income among the players, a value-chain study was undertaken in early 2008 (Coles, Lange and Jiddawi, forthcoming). The study gathered information through a survey at six fish landing sites and the two main urban markets about the number of men and women involved in the marketing, transporting and processing of fish in the market chain between the fishers and the consumers, and their average incomes. These results were scaled up to estimate the employment and earnings throughout Zanzibar (See Annex for employment and earnings in each activity).

The activities covered in the study include several stages in the selling and transport of fish:

- Auction of fish at landing sites and market in Zanzibar Town;
- Wholesale trade which is largely responsible for the purchase and transport of fish from landing site auctions to other markets or directly to consumers, including hotels; and
- Retail sales to consumers in local markets and in the main markets of Zanzibar Town (Darajani and Mwanakwerekwe)
- Primary processing, mainly just gutting and scaling of fish at local markets and
- Secondary processing, informal drying, salting, frying or smoking operations which sell in local markets.

Distribution of income, employment and resource rent

The bulk of all the income related to fishing stays in the fishing communities that have the responsibility for managing the resource: $26.2 million goes to fishers and $2.96 million goes to those involved with marketing and processing. Auctioneers, who typically represent the first step in the marketing chain after fishing, do not earn particularly high incomes compared to the average earnings of fishers or to those who work in the next stages, the wholesale and retail markets. The average incomes of retailers and

wholesalers are significantly higher than the average earnings of all other activities, while the processors have the lowest incomes. Secondary processing is an activity dominated by women and they earn more than primary processors, but their income is still quite low.

Fishing is carried out under a variety of arrangements between the owner of a boat, the captain and the crew, and payment is most often a share of the catch. Marketing and processing is carried out by self-employed operators assisted by unpaid family members. In both cases, income falls in the mixed income[27] category. In all these activities, the beneficiaries are local communities and there is little, if any, involvement of non-Zanzibaris. Government does not obtain any significant revenue from fishing. Local markets may charge a fee to sellers, but this is strictly a payment for maintenance of marketing facilities.

In the case of open access fisheries in which there are no restrictions to fishing resource rent can be dissipated on excess capacity (vessels and fishers). Zanzibar's artisanal fisheries operate under an open access regime with no effective controls[28] outside the few marine protected areas and conservation areas; anyone who wants can fish wherever he wants. There is no evidence of any resource rent being generated in fishing or further down the value-chain.

There are no taxes, fees or levies on artisanal fishing, and fishers typically work through informal markets without paying VAT or income tax. Government, on the other hand, incurs significant expenses in running the Department of Fisheries.

Table 8. Total contribution of fishing to GDP, exports and distribution of income by beneficiary and activity in Zanzibar, 2007 (thousand US$)

Beneficiaries	**Fishing**	**Processing & marketing**	**Total**
1. Zanzibari villagers	26,223	1,883	28,106
Wages & salaries	-	-	-
Mixed income, Operating surplus	26,223	1,883	28,106
2. Urban Zanzibaris in urban activities	-	1,073	1,073
Wages & salaries	-	-	-
Mixed income, Operating surplus	-	1,073	1,073
3. Urban Zanzibaris in rural coastal activities	-	-	-
4. Zanzibari government	-	-	-
5. Non-Zanzibaris	-	-	-
Total	26,223	2,956	29,179
% of GDP	5.6%	0.6%	6.2%
Foreign exchange earnings, exports	-	-	-
Employment	34,269	2,934	37,203
Male	30,091	na	
Female	4,178	na	

Na: not available, Source: Based on (Lange and Jiddawi, forthcoming).

5.2.3 Seaweed farming

Commercial seaweed farming was introduced in the late 1980s, predominantly *Euchuema denticulatum* and to a lesser extent *Kappaphycus alvarezii*, locally known as *spinosum* and *cottonii*, which provide carageenan, a thickening and gelling agent used mainly in processed food, dairy products and other products such as toothpaste (Bryceson, 2001; Jiddawi and Ngazy, 2000; Sen, 1991). It was viewed

[27] Paid workers are sometimes hired, but quite infrequently. There is no information about the amount paid to them.
[28] There are some regulations concerning gear, but these are rarely enforced.

positively as an opportunity to increase incomes of rural households, especially for women, who form the majority of seaweed farmers[29] and have few alternative sources of livelihood. Production has grown from around 1500 tons in 1991 grown by roughly 1000 farmers to 8,485 tons grown by 16,206 farmers in 2007 (Sen, 1991; Jiddawi and Khatib, 2007;OCGS, 2008). It accounts for only 1% of total agricultural production, but 23% of cash crop production in 2007 (OCGS, 2008). And herein lies the importance of seaweed farming—it is a significant source of foreign exchange earnings, averaging 13% of merchandise trade exports in recent years and, more importantly, it is one of the few sources of cash income for rural women.

Zanzibari farmers practice the 'off-bottom' method in which farmers tie seaweed cuttings to a rope suspended in the water between sticks. Farming activities take place during spring tides, the period when tides reach their maximum and minimum. These occur about two weeks out of every month, so farming does not require full-time effort; if a farmer is satisfied with relatively low productivity, she can simply tie the cuttings and leave them with no further attention until ready to harvest. The cuttings grow quickly and are ready to harvest after roughly six weeks. The seaweed is then carried to shore for drying and later sold to a buying company for export.

When commercial operations began, the rules for operation were jointly established by the government and the seaweed exporting companies: each company was allocated specific villages where they could recruit farmers and were required to 1) provide farming materials free of charge to anyone who wanted to farm regardless of the scale of farming[30] and 2) buy all the seaweed grown at a price fixed jointly by government and the companies. In addition, the companies provide training to all farmers and hire staff in each village to purchase seaweed from farmers which is stored in the company's local warehouse until moved to a central warehouse for cleaning, packing, and export to carageenan processors mainly in Europe, the USA, and, increasingly, in China. In return for free inputs and a guaranteed market and price, farmers were required to sell their seaweed only to the company that provided them with inputs. They were not free to seek higher prices from other potential buyers.

The global supply chain for Zanzibar's seaweed is short and characterized by monopsony markets at all levels—markets characterized by a large number of sellers and a small number of buyers, a condition that tends to prevent competition and favor buyers. In Zanzibar, a large number of farmers sell to a few exporting companies (initially two, currently seven). These companies in turn compete with a large number of exporters worldwide, mainly in Asia, to sell to a handful of large multinational companies that process seaweed into carageenan. Zanzibar has a very small share of the world market, producing roughly 5% of the global supply of *spinosum* and *cottonii* (FAO, 2003). Neither farmers nor exporters in Zanzibar have the capacity to influence world market prices.

Productivity is very low so, given the world market price, few farmers earn high incomes from seaweed farming. In 1991, farmers produced an average of 1.5 tons annually, which would earn a farmer nearly $200 in 2007 prices (Table 9). Over time, this has fallen to an average of half a ton per farmer, which is far lower than in Asia (Msuya et al., 2007). In 2007, more than 60% of farmers earned less than $58, and 25% earned less than $6 for the entire year (Lange and Jiddawi, forthcoming). Of the 40% earning more than $58/year, only 6% earned at least $148.

The price paid to farmers increased over time, but not enough to keep pace with inflation, so in 2006 the government increased the minimum price and released farmers from their obligation to sell only to the

[29] Initially, few men took up seaweed farming because economic activities in the intertidal zone were traditionally seen as par of women's domain. Over time, more men took up farming, especially on Pemba island.

[30] Companies provide ropes and 'tie-ties,' short plastic strips for tying cuttings onto the ropes. Farmers must provide the sticks for supporting ropes themselves.

company that supplies them with farming inputs, assuming that increased competition among buyers would result in a higher price paid to farmers[31]. But while farmers rightly complain about low incomes, there is little scope for increasing the price they are paid. Exporters are squeezed by global competition in a monopsony market and currently have extremely low profit margins (Lange and Jiddawi, forthcoming). The instability of supply under the new policy adds to their difficulties.

Table 9. Seaweed farmers, production and prices in Zanzibar, 1991 to 2007

	Number of farmers	Production, tons	Farmer's price*, $/ton	Buyer's export price, $/ton
1991	1,000	1,500	$87	$400-$450
2005	14,640	7,362	$66	$230
2007	16,206	8,485	$133	$275-$300

**Beach price paid in Unguja, the island where most seaweed is grown. The price paid in Pemba is lower because of the extra cost buyers incur in first shipping seaweed to Unguja before it can be exported.*

Source: Historical figures from Sen (1991) and discussions with one of the early seaweed exporting companies, Zascol. Figures for 2005 and 2007 obtained from (OCGS, 2008; Jiddawi and Khatib, 2007; and seaweed exporting companies)

Distribution of income, employment and resource rent

Seaweed farmers provide only labor and sticks to the production process. Virtually all labor is provided by farmers and unpaid family members[32], so the beach price received by farmers, their sales revenue, is entirely as value-added (Table 10). Value-added is treated as mixed income in the national accounts accruing to the farmer. For seaweed exporting, detailed cost and revenue data provided by two companies were used to estimate the value-added at this stage of the value chain (see Lange and Jiddawi, forthcoming). The cost of labor (staff plus casual) accounts for an average of 25% of total sales revenue. Purchase of materials, transportation, government levies and other production costs account for the remaining 75% of revenue. In the past two years, companies barely earned anything beyond these costs, even experienced losses at times. We assume zero gross operating surplus at this time.

Farmers pay no fees or taxes on their products or income from seaweed farming. There is no resource rent generated by seaweed farming; the price received barely covers the opportunity cost of a farmer's time. There is no evidence that seaweed exporters currently capture any resource rent. Rent would be indicated by profits above the opportunity cost of manufactured capital, but exporters are barely covering their capital costs at present. However, the government levies on seaweed farming are a form of rent capture. Seaweed exporters pay a 1% royalty on the value of seaweed they purchase from farmers plus a 1.5% excise tax on the invoiced value of seaweed exports, for a total of US$46,129 in 2007, or 3% of income generated (value-added). Whether there is additional rent captured by the multinational companies cannot be determined within the scope of this project.

Table 10. Total contribution of seaweed farming and export to GDP and distribution of income by beneficiary and activity in Zanzibar, 2007 (thousand US$)

Beneficiaries	Farming	Processing & export	Total
1. Zanzibari villagers	1,017	90	1,107
Wages & salaries	-	90	90

[31] This policy has not been successful for a variety of reasons described in (Lange and Jiddawi forthcoming).

[32]Farmers occasionally hire labor, especially for tasks like tying the cuttings to ropes and harvesting, and sometimes purchase sticks. The costs are very small, but there is no precise estimate. Because hired labor and purchased sticks are from the village, income remains in the village, and treating it all as Mixed income does not distort the distribution of income between major stakeholders, that is, local community and outsiders..

Mixed income, Operating surplus	1,017	-	1,017
2. Urban Zanzibaris in urban activities	-	509	509
Wages & salaries	-	509	509
Mixed income, Operating surplus	-	-	-
3. Urban Zanzibaris in rural coastal activities	-	-	-
4. Zanzibari government	-	46	46
5. Non-Zanzibaris	-	-	-
Total	1,017	645	1,663
Resource rent as share of Value-added	-	3%	3%
Seaweed % of GDP	0.2%	0.1%	0.4%
Foreign exchange earnings from exports	-	2,397	2,397
Employment	16,206	216	16,422
Most seaweed farmers are women, but exact figures are not known Most workers in exporting are men, and exact figures are not known but there are far fewer workers in exporting than farmers.			

Na: not available / Source: Adapted from (Lange and Jiddawi, forthcoming)
Notes: Income to seaweed farmers includes the small amount paid to hired laborers; it is not possible to determine how much is paid out at this time. Operating surplus for seaweed exporting companies is assumed to be near zero in 2007

5.2.4 Other ecosystem services

There are a number of ecosystem services which are important but could not be valued given the limited resources available for this study. They are important areas of future work and include mangrove harvesting, control of beach erosion, wastewater assimilation and education and research in to the marine environment. Although locally significant, mangrove harvesting is presently a minor activity because of the massive loss of mangrove forests, particularly on the main island of Unguja. Rough estimates indicate that the value of mangrove harvesting in 2007 was in the range of $28,000 (Lange and Jiddawi, forthcoming).

5.3 Policy implications

In the Zanzibari economy of 25 years ago, local communities had virtually all the responsibility for, and the benefits from, managing the marine ecosystem. Ecosystem services were limited to provision of fish and other marine products; tourism was just beginning. The economy was much more dependent on crop agriculture, especially cloves. Today the story is quite different. Marine ecosystem services account for 30% of GDP, 77% of investment, and a large amount of foreign exchange and employment (Table 11). These figures would be even higher if the indirect ecosystem services were included. Resource rent, the value of the ecosystem itself, appears very low, but that mostly reflects the difficulty of estimating resource rent, discussed in the previous section. Despite its clear economic importance, the marine ecosystem is seriously degraded due to both human and natural causes[33]. Why has this happened?

Part of the answer lies in the fragmentation of decision-making and management. Ecosystems cut across conventional sectoral definitions but management is divided among many government agencies and private sector groups, a problem common to many countries. No single agency has responsibility for the entire ecosystem, and there has been no comprehensive, economy-wide assessment of the economic value, so there is no basis for assessing trade-offs and development options. In addition, incentives for marine conservation vary a great deal among different stakeholders. Unless there are shared incentives for sustainable management, the future of Zanzibar's marine ecosystem is not promising.

[33]Periodic coral bleaching has damaged some of the reefs and increased their vulnerability to other threats.

The economic importance of tourism surpasses the value of other ecosystem services in terms of most macroeconomic indicators. But tourism has largely excluded local communities, even as it claims more and more of coastal and marine resources. Local communities do not have much economic stake in tourism activities—as a whole, they obtain more income from fishing and seaweed than from tourism. In the short-term it is possible to increase incomes from these activities by, for example, increasing productivity of seaweed farming, increasing cold storage and transport facilities for fish to reduce spoilage and loss, or developing aquaculture. However, in the long-term incomes can be significantly increased only by greater participation in the tourism economy, either through investment and employment[34] in tourism, or by supplying inputs to tourism such as high-value fruits and vegetables.[35]

Overfishing and destructive fishing practices are one of the major reasons for the decline of Zanzibar's marine ecosystem. But even though local communities bear the benefits from fishing and the consequences for overfishing, at low levels of income and open access fishing grounds, they have little incentive to change their fishing practices (Silva, 2006). Without greater involvement in activities that depend on a healthy ecosystem, this is unlikely to change. Tourism offers an alternative livelihood, and in principle should promote marine conservation, but not all segments of the tourism industry have the same incentives.

Large hotels, both 'club' and mid- to up-market, dominate tourism in Zanzibar. This is problematic for two reasons: it generates the least benefits for local communities, and it does not have a strong incentive to promote the health of the marine ecosystem. Many of these tourists do not participate in any marine activities beyond a boat ride and spend much of their time on the beach but not diving or snorkeling where the health of the reef and fisheries is essential. Consequently, this segment of the tourism industry has relatively little economic incentive to promote marine conservation.

Table 11. Contribution of marine ecosystem services to the macro-economy and distribution of income by beneficiary and activity in Zanzibar, 2007 (thousand US$)

A. Macroeconomic indicators

	Seaweed farming & export	Fishing & marketing	Tourism	Total
Contribution to GDP	1,663	29,179	119,636	150,478
Share of GDP	0.4%	6.2%	23.6%	30.2%
Foreign exchange earnings	2,397	-	184,929	187,326
Employment	16,422	37,203	9,351+	62,976 +
Share of investment projects, 2003-2007*	-	1%	76%	77%

B. Distribution of income among beneficiaries

	Seaweed farming & export	Fishing & marketing	Tourism	Total
Zanzibaris, subtotal of which:	**1,663**	**29,179**	**56,610**	**87,451**
1. Zanzibari villagers in coastal areas	1,107	28,106	15,633	44,846

[34] Greater employment in tourism will require much more investment by government in general education, so that it is equivalent to education obtained in mainland Tanzania, where many tourism workers come from.

[35] There are several projects underway to increase Zanzibar involvement in the tourism value-chain, especially the production of agricultural products.

2. Urban Zanzibaris in urban activities	509	1,073	8,271	9,853
3. Urban Zanzibaris in rural activities	-	-	15,211	15,211
4. Zanzibari government	46	-	17,495	17,541
5. Non-Zanzibari	**-**	**-**	63,028	63,028
Total	**1,663**	**29,179**	119,638	150,478
Zanzibari share as % of total income (rows 1-4)	100%	100%	47%	58%
Local Zanzibari share as % of total income (rows 1-2)	97%	100%	20%	36%
Resource rent as % of Value-added (minimum)	3%	0%	3%**	3%**

**Cumulative value of investment projects approved by the Zanzibar Investment Promotion Authority.*
*** Lower bound on estimate of rent*
Source: Tables in text, except for share of investment projects obtained from (OCGS, 2008).

Government obtains most of its revenue from large-scale tourism so it also has less incentive to make marine conservation a priority. Tourism that depends on a healthy marine environment—Small-scale, up-market tourism which promotes eco-tourism and Budget tourism—has not been driving the tourism industry in Zanzibar. There is, however, a trade-off between smaller numbers of higher-paying tourists at eco-lodges and large numbers of tourists who spend much less. Many countries set their goal for tourism development in terms of a target number of visitors. A better approach would be to set a target revenue stream and decide what type of tourism can meet that goal with the least impact on the environment and society. On Unguja, Zanzibar's main island it may be too late to change tourism policy radically because of the large, and still growing, number of big hotels. But tourism is just developing on Pemba, a relatively pristine island with great ecotourism potential, and it is not too late to reconsider tourism development policy for Pemba.

Several MPAs and Conservation Areas have been established in Zanzibar to promote marine conservation, but they have had a mixed history. As in the rest of the world, MPAs work best when there is local benefit and cooperation; when local communities feel they bear the cost of reduced access to fisheries but do not see much benefit, there is little cooperation and MPAs fail to protect the ecosystem. The most successful on Zanzibar are Chumbe Island Coral Park, a privately managed MPA that supports its activities through eco-tourism on the island, and Misali Island Conservation Area, managed by local communities with external support from NGOs and the Department of Fisheries. Two others have not been very successful. Mnemba Island MPA is managed by the Department of Fisheries which collects an entry fee from tourists who dive and snorkel there. Part of that fee is supposed to be given as compensation to the community that traditionally used the fishing area, but the community has not received any payments for a long time. Consequently, they have returned to fish there, often while tourists are diving in the same location. Menai Bay Conservation Area has suffered from a lack of resources to monitor and enforce regulations; there is no compensation to communities to restrict fishing. Smaller projects establishing local no-take zones in villages are being tried, and may have more success.

6. RECOMMENDATIONS

In order to improve the use of valuation techniques it is important that there is increased awareness among the public on the ecosystem services that marine ecosystems provide, whether coastal or deep sea ecosystems.

An increase in dialogue between the marine scientists and managers of protected areas and social scientists and economists would assist in fostering understanding of the needs of what is required and what could be achieved through the use of valuation techniques, and how the results of valuation could be applied.

Many countries are aware of the benefits of valuation studies in achieving policy goals, however, they are limited by weak valuation resources. A database of valuation studies that have been conducted will facilitate the use of results of valuation especially in countries that to date have limited valuation experiences. Similarly, a database of environmental economists and centers who conducted these studies would facilitate access to them by these countries. It would be helpful to include the purpose for conducting the valuation in any such database, as well as how it was used in decision making process.

Similarly, valuation of ecosystem services should be better integrated with the potential use of the results of the analysis, to tailor valuation methods to user needs and facilitate integration of results into the decision making processes.

Funds should be geared towards carrying out research on marine ecosystem services especially those that are currently under-represented, such as the deep water ecosystems, since understanding the linkages between the various elements of ecosystems will facilitate their valuation.

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8. ANNEXES

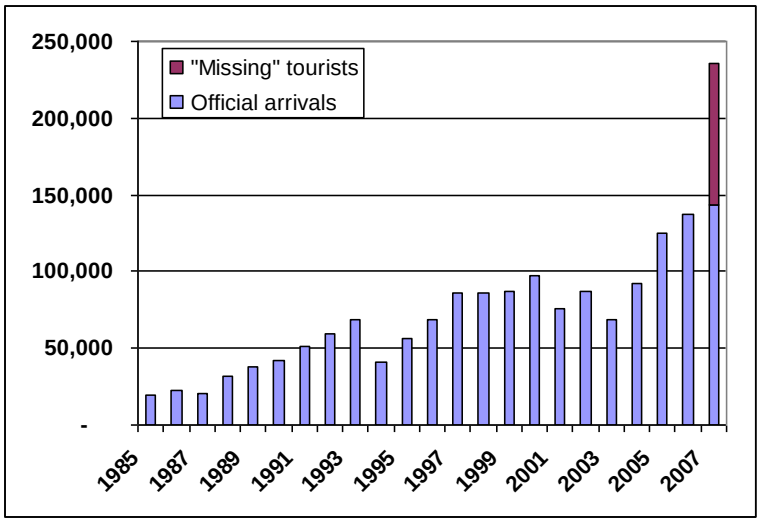
8.1 Annex 1: Tourism in the Zanzibar economy

Tourist arrivals

It is difficult to determine exactly how many foreign tourists visit Zanzibar because of the way in which visitor statistics are compiled. There are two ports of entry, the seaport and the airport. All foreigners arriving at the seaport are required to register with immigration officials. While there are bound to be some discrepancies, a procedure is in place to count everyone. Visitors arriving by air face a different situation: those arriving directly from another country are required to obtain a visa and register with the immigration authority, but those arriving on flights from mainland Tanzania, where they have already obtained a visa, are not required to register. Consequently, official statistics underestimate the true number of foreign visitors because they do not include those arriving from mainland Tanzania. Many tourists travel on a multi-destination tour of Tanzania (or East Africa) that ends with a few days in Zanzibar, so this omission is significant.

A survey of the five major airlines serving the routes between mainland Tanzania and Zanzibar was carried out to identify these tourists. Foreign visitors were defined as those who either purchased a non-resident ticket or paid for their ticket in US dollars rather than local currency.[36] The official figure for foreign tourists arrivals to Zanzibar in 2007 was 143,283; the additional 'missing tourists' obtained from the airline survey were 75,764 for a total of 219,047, about 53% higher than the official statistics.

Figure A1. International tourist arrivals in Zanzibar, 1985 to 2007



Note: 'Missing tourists' are those arriving by air from mainland Tanzania, who are not included in the official tourist statistics, as explained in the text. Estimates are not available prior to 2007.
Source: as described in text.

[36] Three airlines charge different rates for residents and non-residents; the other airlines do not charge different rates but keep separate records for tickets paid for in local currency and in US dollars.

Tourist expenditures

Table A1. Detailed expenditure by type of tourist in Zanzibar, 2007 (thousand US$)

	Budget & Mid-range tourism	Small-scale, upmarket tourism	Large-scale, upmarket tourism	All-inclusive, 'club' tourism	Total
Total expenditures	54,476	21,692	62,598	46,164	184,929
Hotels	38,252	17,110	50,541	32,326	138,229
Local transport	2,728	842	1,367	830	5,767
Shopping	5,862	1,831	4,413	5,874	17,979
Activities & tours, of which:	5,640	1,510	3,973	3,733	14,857
Marine related*	4,831	1,381	3,192	3,054	12,459
Non-marine**	809	129	781	679	2,398
Visas & departure fees	1,994	399	2,305	3,399	8,097

*Marine related activities include diving, snorkeling, boat trips, dolphin & whale watching, visits to a forest protected area with mangroves, and sport fishing.
**Non-marine activities include visits to spice farms, tours of Stone Town, and other cultural activities.
Source: Based on (Lange and Jiddawi, forthcoming)

The contribution of tourism to GDP is calculated by estimating the income generated from each industry that produces the goods and services which tourists bought in Zanzibar, based on data collected from a Survey of Tourism Industries. The survey covered hotels, restaurants, tour operators, dive operators and others, with heavy focus on hotels, which is the main component of spending. The long version of the hotel survey with face-to-face interviews covered 20% of hotels measured by capacity; a shorter version covered an additional 30%. All segments of the tourism industry were surveyed. The surveys asked for detailed information about ownership and other characteristics of the hotel, revenue & cost structure[37], occupancy rates, sourcing of food and other purchases, employment & wages, and several environmental issues (water, wastewater and beach erosion). Most of the dive operators were interviewed for similar information, as well as local tour operators for non-marine activities. Tour operators specializing in international package tours from each major market were interviewed to determine how to breakdown the cost of package tours into those components spent in Zanzibar and those outside (e.g., airfare, tour company commissions). There was no information about the cost structure of local transportation (taxis, car & scooter hire, and minibuses) or retail trade (for shopping expenditures[38]), which are mainly provided by informal operators. For these sectors, value-added was calculated using figures from the Tanzania national accounts for the percentage of value-added as a share of gross output.

Table A2. Incomes (value-added) generated from tourism by type of expenditure in Zanzibar, 2007 (thousand US$)

[37] A few hotels were willing to give actual figures for revenues and costs; the other hotels were willing to identify the shares of turnover for major categories: employment, purchases of goods & services, and gross margin.

[38] Few of the items purchased are produced locally—only spices, locally bottled drinking water, carved wooden items (often from imported wood), CDs of local music, shells, woven baskets & mats, and a very small amount of local textile goods, as well as services such as internet services, henna painting, and hair braiding. The famous Swahili khangas are imported from mainland or Asia. So the main contribution of the purchase of goods is the trade margin, the amount of labor and capital required for the selling process itself.

	Hotels & restaurants	Transport	Shopping	Marine Activities	Non-Marine Activities	Total
Total Value-added	**97,413**	**2,732**	**3,596**	**6,441**	**1,357**	**111,539**
Zanzibaris villagers on coast	15,031	0	91	1,570	217	16,908
Zanzibaris in urban tourism	5,641	228	1,402	966	660	8,898
Urban Zanzibaris in rural tourism	10,201	2,053	817	2,711	394	16,176
Non-Zanzibaris	66,540	451	1,286	1,194	86	69,557
Compensation of employees	**34,781**	**1,229**	**1,618**	**2,773**	**995**	**41,396**
Zanzibaris villagers on coast	5,475	0	81	1,386	199	7,141
Zanzibaris in urban tourism	2,237	123	809	416	497	4,083
Urban Zanzibaris in rural tourism	5,983	1,106	728	693	249	8,760
Non-Zanzibaris	21,085	0	0	277	50	21,412
Gross operating surplus	**62,632**	**1,503**	**1,978**	**3,668**	**362**	**70,143**
Zanzibaris villagers on coast	9,556	0	10	183	18	9,767
Zanzibaris in urban tourism	3,404	105	593	550	163	4,816
Urban Zanzibaris in rural tourism	4,218	947	89	2,017	145	7,416
Non-Zanzibaris	45,455	451	1,286	917	36	48,145

Note: these figures do not include taxes and fees paid to government out of Gross operating surplus, or the payments for visas & departure fees.
Source: (Lange and Jiddawi, forthcoming)

8.2 Annex 2: Fisheries in Zanzibar

Table A3. Fish catch in Zanzibar by major fish group, 2007

	(Latin)	(Fish Groups)	(Swahili)	Tons	Thousand US$
1	Siganidae	Spine foot	Tasi	932	1,780
2	Scaridae	Parrot fish	Pono	1,226	1,486
3	Lethrinidae	Emperors	Changu	2,496	1,793
4	Serranidae	Groupers	Chewa	574	821
5	Mullidae	Goat fish	Mkundaji	834	894
6	Lutjanidae	Surgeon fishes	Puju/Kangaja	578	819
7	Mugilidae	Mullets	Mkizi	855	1,029
8	Clupidae	Anchovies	Dagaa	2,374	2,045
9	Sardinella	Sardin	Sardini	973	1,485
10	Englaulidae	Mackerels	Vibua	1,164	1,983
11	Carangidae	Travellys	Kole/Karambisi	1,185	1,549
12	Scrombidae	Yellow fin tuna	Jodari/Sehewa	1,428	1,723
13	Scrombidae	Sword fish	Nduaro/Mbasi	1,041	1,262
14	Hemiramphidae	King Fish	Nguru/Kanadi	1,002	1,311
15	Sphyraenidae	Barracuda	Mzia	1,254	1,577
16	Elasmobranchia	Sharks/Rays	Papa/Taa	1,339	1,019
17	Molluscs	Octopus/Squid	Pweza/Ngisi	922	1,470
18	Palinura	Lobsters	Kamba	463	769
19	Demersals/Pelagics	Others	Wengineo	2,940	2,963
Total Gross output				23,582	27,778
Gross Output Including own-consumption*				25,940	30,556
Contribution to GDP (Gross output – costs of fishing)**				26,223	26,223
Number of fishers				34,269	
Average income per fisher, US$					765

*Zanzibar national accounts assume that an additional 10% of reported catch is retained for own consumption.

** Zanzibar national accounts assume that intermediate inputs for fishing accounts for about 14% of gross output; the remainder is value-added, the contribution to GDP.

Source: Fish catch from Department of Fisheries, 2007; contribution to GDP from (OCGS, 2008); number of fishers from (Jiddawi and Khatib, 2007).

Table A4. Employment and earnings (value-added) from fishing and related activities in Zanzibar, 2007

	Employment	Average annual earnings, US$	Total value-added/earnings, thousand US$
Total fishers	34,269	765	26,223
Fishing-related workers			
Auctioneers	260	560	145
Retailers	946	1073	1,014
Wholesalers & wholesaler/retailers*	752	1809	1,360
Primary Processors	206	259	53
Secondary Processors	770	498	383
Subtotal fishing-related	2,934		2,956

* Many wholesalers also act as retailers.

Notes: Earnings represent revenues net of all costs including purchase of fish, equipment, transportation costs, etc.

Source: Adapted from (Coles et al. forthcoming)

8.3 Annex 3: Ecosystem Services in Zanzibar

- **Mangrove Harvesting:** Mangrove forests provide timber for construction, fire wood and charcoal. However, very little information is available about wood use. Although locally significant, mangrove harvesting is presently a minor activity because of the massive loss of mangrove forests, particularly on the main island of Unguja. Only an estimated 20,000 hectares of mangroves remain, 4,000 hectares on Unguja and 16,000 hectares on Pemba, which is much less developed. Mangrove forests also provide significant indirect ecosystem services: habitat for fisheries and shore protection. Recent examples of valuation of these services include (Barbier et al., 2008) and (Aburto et al., 2008). There is some information about certain fish populations (notably mud crab) that could be used to estimate habitat value in future work.

- **Control of beach erosion:** There is a natural, annual cycle of erosion followed by build-up of sand beaches that was roughly in balance until the mid-1990s. However, since that time, many hotels and villages have observed that erosion is more severe and the lost sand is not fully replaced during the build-up phase, resulting in serious damage to infrastructure and loss of valuable palm trees for agriculture. Scientists monitoring this problem are not certain what has caused the acceleration of beach erosion. Several components of the ecosystem can provide protection from storm damage—coral reefs, mangroves and seagrass beds, and it may be that changes in the ecosystem have affected storm protection services. The other hypothesis is that increased severity of erosion is resulting from changing wind patterns, which could have many causes, including climate change. If it is determined that it is related to changes in the ecosystem (status of coral reefs, mangroves, seagrass beds, etc.) a value for the services provided by the ecosystem can be estimated.

- **Waste water assimilation:** Sea water quality is, so far, only a serious concern for the one large city on the island of Unguja, Zanzibar town, which dumps untreated waste water directly into the sea off through about 20 long pipes.[39] The coral reefs off Zanzibar Town are experiencing high incidences of death and disease, and there are large outbreaks of crown-of-thorns starfish that prey on the coral

[39] Hotels are required to treat all their wastewater in septic systems. Although there is no monitoring, hotels have an incentive to treat their wastewater, since their guests use the beach and swim in the water in front of the hotels.

reefs. Many factors contribute to the poor state of the coral reefs including bleaching from sea warming events, physical damage from tourist and fishing boats, and overfishing, but the deterioration of water quality also contributes to their decline. The damages include loss of fish, loss of tourism value because the coral reefs are no longer attractive, and potential damage to human health. Valuation of waste water assimilation is based on the economic benefits of avoided damage achieved by reducing effluent. This will require quantifying the decline in ecosystem services and an understanding of the role waste water has played in this decline.

- **Education and research in to the marine environment:** Zanzibar is the site of two important centers that collaborate and support an active program of research and graduate study in marine science related mainly to Zanzibar—the Institute of Marine Sciences (IMS), which is part of the University of Dar-es-Salaam and Chumbe Island Coral Park, a private organization. Both institutions regularly host students and researchers from Stockholm University, the School for International Training (USA) and other institutions for higher education.