Assessing, demonstrating and capturing the economic value of marine & coastal ecosystem services in the Bay of Bengal Large Marine Ecosystem

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List of Acronyms

BDT	Bangladesh Taka (at the time of the study USD 1 = BDT 77.72)
BOBLME	Bay of Bengal Large Marine Ecosystem
EEPSEA	Environment and Economics Programme for South East Asia
FAO	Food and Agriculture Organisation of the United Nations
GDP	Gross domestic product
GEF	Global Environment Facility
IDR	Indonesia Rupiah (at the time of the study USD 1 = IDR 11,689.18)
INR	India Rupee (at the time of the study USD 1 = INR 60.08)
LKR	Sri Lanka Rupee (at the time of the study USD 1 = LKR 130.20)
LME	Large marine ecosystem
MMK	Myanmar Kyat (at the time of the study USD 1 = MMK 971.99)
Mt	Megatonne (10^6 tonnes)
MVR	Maldives Rufiyaa (at the time of the study USD 1 = MVR 15.42)
MYR	Malaysia Ringgit (at the time of the study USD 1 = MYR 3.19)
NPV	Net present value
PPP	Purchasing power parity
SANDEE	South Asia Network of Development and Environmental Economics
SAP	Strategic Action Programme
tC	Tonnes of carbon
tCO_2e	Tonnes of carbon dioxide equivalent (1 tC = 3.67 tCO_2e)
TDA	Transboundary Diagnostic Analysis
TEEB	The Economics of Ecosystems and Biodiversity
TEV	Total economic value
THB	Thailand Baht (at the time of the study USD 1 = THB 32.16)
USD	United States Dollar

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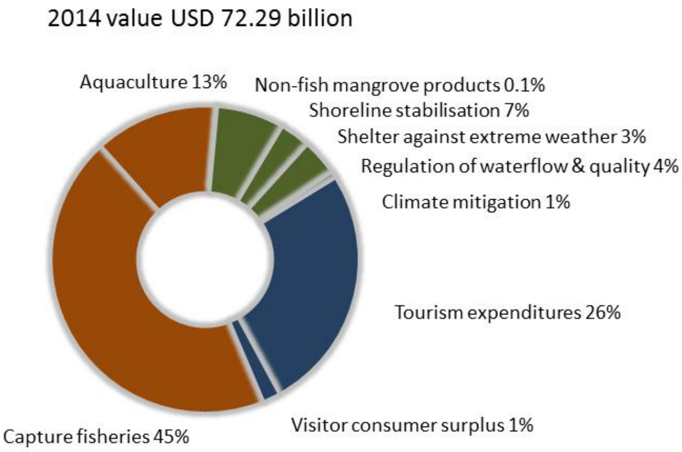
Executive summary

Background and aims of the valuation study

This document reports on a study carried out under the auspices of the Bay of Bengal Large Marine Ecosystem (BOBLME) Project. Its objective was to assess the economic value of marine and coastal ecosystem services in the Bay of Bengal. By so doing, it sought to demonstrate both the economic benefits provided by healthy marine and coastal ecosystems and the potential economic losses/damages resulting from the loss of these services, as well as to identify economic instruments that can be used to strengthen the sustainable management of marine and coastal natural resources. The main aim was to generate information that will support the development of the Strategic Action Programme (SAP): a coordinated programme of action designed to better the lives of the coastal populations through improved regional management of the Bay of Bengal environment and its fisheries.

Estimate of the value of marine & coastal ecosystem services

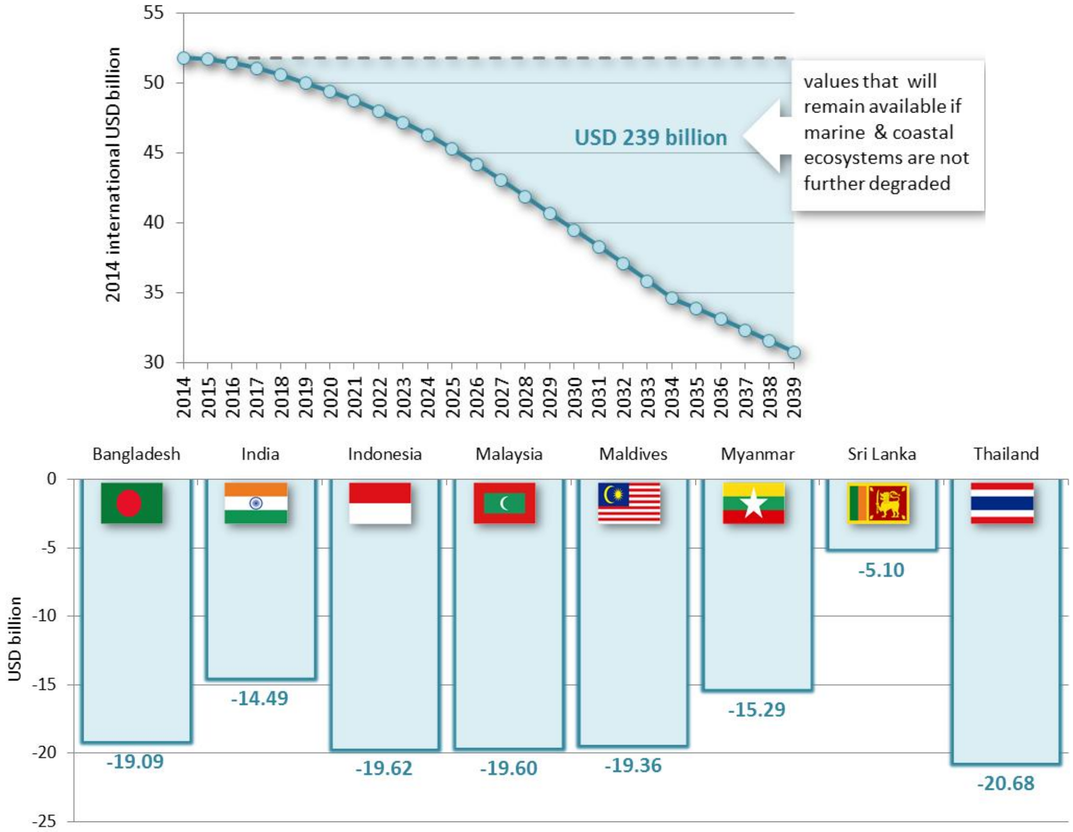
Around 185 million people or 44 million households live in the coastal zone of Bay of Bengal countries, the vast majority of whom depend in some way on marine and coastal resources for their livelihoods and economic wellbeing. The study found that, in total, marine and coastal ecosystem services in the BOBLME may currently be worth more than USD 72 billion a year. Direct income generated in the fisheries and tourism sectors accounts for only two thirds of this value. The remainder, almost USD 24 billion a year, is comprised of non-commercial and non-use values and multiplier effects that would conventionally be excluded from economic estimates of income and GDP.



Findings on the economic consequences of ecosystem change

Of this baseline ecosystem value, economic benefits worth an estimated USD 52 billion are contributed by mangrove and coral reef ecosystems. If no action is taken to halt the degradation of marine and coastal habitats and resources, it is estimated that mangrove cover will reduce by almost a half over the next 25 years to just under 8,800 km^2 and coral reef area will contract by 40% to 5,000 km^2. The annual value of marine and coastal ecosystem services will progressively decline over the next 25 years, from today's value of just under USD 52 billion to a value of USD 30 billion by 2039. This pattern of decreasing ecosystem service values is repeated across all of the BOBLME countries.

In contrast, the SAP will provide a means of addressing the current threats to coastal and marine resources and habitats, and halting further environmental degradation and loss. At a minimum, it is assumed that the SAP will serve to maintain the value of ecosystem services at current levels (and, in reality, it is to be hoped that it will have the effect of not just sustaining ecosystem services and values over time, but improving and increasing them considerably). Under this conservative scenario, for the BOBLME region as a whole, setting in place the SAP will help to secure ecosystem values worth USD 1.3 trillion in total over the next 25 years. The annual value of economic benefits and costs avoided from the maintenance of biodiversity and ecosystem, services translates to a value of some USD 280 per capita of the coastal zone population, equivalent to over 6% of average per capita GDP.



Potential economic instruments to strengthen sustainable management

Economic forces and factors have been identified as underlying many of the threats to the BOBLME's marine and coastal environments. Economic instruments provide a potentially powerful means of addressing these threats, overcoming the policy, market and livelihood factors that currently result in ecosystem degradation and loss, and setting in place positive financial and economic inducements and enabling conditions for people to conserve and sustainably manage natural resources and habitats in the course of their economic activities. A variety of economic instruments are identified as having potential to enhance the sustainable management of marine and coastal habitats and resources in the BOBLME, which could be used to secure incentives and finance to support the implementation of the SAP, including:

- <u>Charge and fee systems</u> which can serve to generate income, recover costs, compensate losses, reward compliance, penalise non-compliance, manage or control use, such as user fees, product charges, deposits and bonds, fines, penalties and non-compliance fees, liability payments and compensation;
- <u>Fiscal Instruments</u> which can serve to generate revenues, recover costs, redistribute income and budgets, en/discourage particular production and consumption activities, such as taxes and charges, subsidies, budget allocations, extra-budgetary earmarking and funds, and environmental-fiscal transfers;

- Market creation and development which can serve to enhance value-added, reward conservation, promote more efficient / equitable resource allocation, stimulate green production and consumption, such as tradable permits, rights and quotas, tradable offsets and credits, payments for ecosystem services, new products and markets, eco-labelling and certification; and
- Financial mechanisms which can serve to earmark, retain, administer and allocate funding for particular purposes, sites or target groups, mobilise capital and investment resources for green business, such as grants and funds, credit and loans, green investment and capital facilities, cost-sharing and devolved management, revenue-sharing and livelihood support,.

Recommendations on next steps in using economic valuation

The report concludes by recommending possible next steps for incorporating the results of the valuation study into the implementation of the BOBLME Project and Strategic Action Programme. These conclusions and recommendations draw on the findings of a regional workshop to present and validate the draft results of the valuation study and discuss ways forward, next steps and possible future work in biodiversity and ecosystem valuation, and include:

- Future work to improve the precision of ecosystem valuation, including:
  - Identifying identify strategic needs, niches and entry points for using ecosystem valuation to influence decision-making;
  - Identifying key knowledge gaps as regards biophysical aspects of on ecosystem services for key habitats sectors, services and locations, and developing a strategy for undertaking the research and data collection to fill these gaps; and
  - Carrying out a systematic and participatory process to vision, describe and model the socio-economic and biophysical consequences of likely management "futures" for the BOBLME.
- Advice for incorporating valuation results into the implementation of the BOBLME Project and the SAP, including:
  - Developing a strategy for communicating the economic value of marine and coastal ecosystem services to decision-makers, budget-holders, potential investors and other key stakeholders;
  - Making efforts to articulate and convey a clear economic and business case for the SAP;
  - Developing a sustainable financing strategy or business plan which would accompany, and form an integral part of, the SAP; and
  - Facilitating the exchange and sharing of technical expertise in ecosystem valuation between BOBLME countries and institutions.
- Ways forward in operationalising selected economic instruments, including:
  - Undertaking an institution, context and stakeholder analysis to identify strategic needs, niches and entry points for introducing and using economic instruments for the sustainable management of marine and coastal resources;
  - Integrating goals, milestones and budgets for the selection, design and implementation of economic instruments in the SAP; and
  - Making explicit efforts to work to get Ministries of Finance and Economic Planning and other line agencies on board as regards the development of economic instruments for the marine and coastal environment.

1 Background: study context and aims

Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka and Thailand are working together through the Bay of Bengal Large Marine Ecosystem (BOBLME) Project to lay the foundations for a coordinated programme of action designed to better the lives of the coastal populations through improved regional management of the Bay of Bengal environment and its fisheries.

In 2012 the project completed a Transboundary Diagnostic Analysis (TDA). This identified and prioritised the region's major transboundary environmental and fisheries concerns. The TDA in turn feeds into the other major output expected from the project – a Strategic Action Programme (SAP) to address and remediate these threats, and ensure the long-term institutional and financial sustainability of the BOBLME Programme. The SAP is currently under development.

The current study aims to generate information that will support the development of the SAP. Its objective is to assess the economic value of marine and coastal ecosystem services in the Bay of Bengal. By so doing, it seeks to demonstrate both the economic benefits provided by healthy marine and coastal ecosystems and the potential economic losses/damages resulting from the loss of these services, as well as to identify economic instruments that can be used to strengthen the sustainable management of marine and coastal natural resources.

To these ends, the report contains eight chapters and two annexes:

- Chapter 2 describes the **conceptual frameworks and approaches** which underpin marine and coastal ecosystem valuation, and introduces the methods used in the current study;
- Chapter 3 specifies the **key questions** that the study seeks to answer, elaborates its **scope and coverage**, and explains the **valuation techniques, data sources and assumptions** that have been applied;
- Chapter 4 describes the **stakeholders and economic linkages** associated with the BOBLME's biological resources and natural habitats;
- Chapter 5 estimates the **current value of marine and coastal ecosystem services** at the regional level, for each of Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka and Thailand, and for key sectors and beneficiary groups;
- Chapter 6 assesses the **economic losses and damages** that might arise should the natural environment in the BOBLME continue to be degraded and over-exploited, with a view to identifying the **value-added and costs avoided** from implementing a SAP;
- Chapter 7 presents a generic list of **economic instruments** to enhance the sustainable management of marine and coastal habitats and resources, that could be used to secure incentives and finance to support the implementation of the SAP;
- Chapter 8 lays out **brief recommendations and possible next steps** in incorporating the results of the ecosystem services valuation study into in the implementation of the BOBLME Project and SAP;
- Annex I presents a **bibliography of marine & coastal valuation studies** carried out in BOBLME countries; and
- Annex II lists the **Atolls, Cities, Districts, Divisions, inhabited Islands, Provinces, Regencies, Regions, States, Townships and Union Territories** in the BOBLME coastal zone.

2 Introduction to marine & coastal ecosystem valuation: rationale, concepts and practical applications

The basic aim of ecosystem valuation to facilitate more equitable, sustainable, inclusive and informed decision-making, by articulating in monetary terms the economic importance of ecosystem services for human wellbeing. This chapter identifies the economic and development challenges that arise from the undervaluation of the natural environment. It describes the conceptual frameworks and approaches that can be used to understand and trace ecosystem-economic linkages, and introduces the methods, techniques and instruments to be applied in the current study.

Why marine and coastal undervaluation is a problem

It is estimated that more than two billion people (Brown et al. 2008) and nearly half of major cities (Millennium Ecosystem Assessment 2005) are found within 50 km of the world's coastlines, with population densities that are on average two and a half times higher than those of inland areas (Agardy et al. 2005).

Much of this human population, industry and infrastructure has been attracted by the rich natural resources and economic opportunities that are found in these areas. The livelihoods of at least three billion people or almost half the global population are thought to depend on marine and coastal biodiversity (SCBD 2009), which plays a substantial role in global, national and local economies. Fish has for instance become the most valuable agricultural commodity that is traded internationally: its export revenues are now worth more than coffee, cocoa, sugar and tea combined (OECD 2008). Coastal tourism is currently one of the fastest growing components of the international leisure and recreation industry: World Tourism Organisation statistics show that twelve of the world's fifteen top tourist destinations are countries with coastlines (UNEP 2009).

The economy-wide impact of marine and coastal-based activities is immense, and extends far beyond the immediate income they generate. Marine fisheries for example generate income in excess of €60 billion a year, provide for around 35 million jobs and support the livelihoods of more than 300 million people (Beaudoin and Pendleton 2012). In Sri Lanka, the fisheries sector comprises around 10% of all agricultural export earnings, provides employment to just under four% of the economically active population and contributes over 70% of animal protein intake (MFARD 2013). Coastal tourism directly accounts for a fifth of the Maldives' GDP, while its wider effects generate more than sixty% of foreign exchange receipts, over ninety% of government tax revenues and almost half of employment opportunities (Emerton et al. 2008).

Together with this striking concentration of human settlement and industry, and alongside high levels of affluence, rates of poverty however remain high in coastal areas. Worldwide, there are thought to be more than 250 million coastal poor (Brown et al. 2008), many of whom are living at the margins of society and the economy. The coastal poor are especially reliant on biodiversity and ecosystem services – because they lack access to alternative products and services, or simply cannot afford to procure them through the market. Mangrove forests have, for example, been shown to sustain more than 70 direct human activities, ranging from fuelwood collection and medicinal products to house-building and artisanal fisheries (Dixon 1989). Studies carried out in Southern Thailand indicate that they are worth around USD 1,500 a year to household income (Sathirathai 1998), equivalent to almost a quarter of per capita GDP. In West Papua, mangrove goods and services are worth more than USD 3,000/hectare/year, contributing up to half of income among the poorest households: more than the returns from either cultivated crops or wage earnings (Ruitenbeek 1992). Around Wakatobi National Park in Indonesia, marine and coastal resources together account for around 60% of net primary income: all residents name seafood as their main (and in many cases their only) source of protein, half or more have built their houses from natural materials, and over 40% utilise mangroves for fuel (Cullen 2007).

Given this juxtaposition of wealth and poverty, combined with a rapidly growing human population, it is hardly surprising that coastal zones have long been the focus of intense development processes. It would be extremely naïve to deny that an inherent tension exists between economic development and natural resource conservation, and that trade-offs must be achieved which balance how, where and what to produce, consume and invest. Although coastal ecosystems are among the most productive systems in the world they are also the most highly threatened; the single greatest threat is development-related loss of habitats and services (Agardy et al. 2005).

It is not just resource-based production and consumption (such as fisheries, tourism or forest products) that suffers when marine and coastal ecosystems are degraded. A wide variety of essential life support functions are also lost – often with devastating economic consequences. The avoided damage costs associated with the protective functions of marine and coastal ecosystems have received particular attention over recent years in South and South East Asia, in the wake of a series of major natural disasters and in relation to growing concerns about the effects of climate change. The storm protection services provided by mangroves in Sri Lanka were for example estimated at almost USD 8,000/km^2/year just before the 2004 Indian Ocean tsunami (Batagoda 2003), while studies carried out in the south of Viet Nam show net present values of USD 5,000/km^2 or more in guarding against extreme weather events (Tri et al. 1998). In Southern Thailand, mangrove coastline protection and stabilization services are thought to be worth up to USD 3,000/ha/year (Sathirathai 1998). In Indonesia, the value of coral reefs in protecting coastlines against the effects of storms, waves and tidal surges has been calculated to range between USD 829 and USD 1 million per kilometre in terms of costs and losses foregone (Cesar 1996).

We might ask why, if marine and coastal ecosystems are so valuable, do they continue to be degraded and lost? The reason is not that they have no economic importance, but rather that their value is poorly understood, rarely articulated, and as a result is frequently not considered in decision-making. The sum of economic benefits associated with marine and coastal biodiversity and the full economic costs associated with its degradation and loss tend to be under-estimated, or omitted altogether, in the economic calculations that inform how policies are formulated, prices are set, markets are developed and investments are made (Emerton 2006, 2013b). As a consequence, at the worst, a substantial misallocation of resources has occurred and gone unrecognised, and immense economic costs have often been incurred (James 1991) – often to the particular detriment of the poorest and most vulnerable groups.

Given the undervaluation of marine and coastal ecosystem services, it is hardly surprising that the most "productive" or "economic" activities in coastal areas have frequently been seen as those which over-exploit, replace or otherwise degrade natural ecosystems. In many parts of the world, the expansion of agriculture, aquaculture, urban and tourist infrastructure has resulted in the conversion and reclamation of coastal habitats. Intensive resource harvesting has often been promoted as a means of generating income, employment and foreign exchange earnings, placing high and often unsustainable demands on the natural environment. Ample evidence exists to suggest that these activities have weakened the resilience of coastal ecosystems and undermined their ability to provide goods and services. Most of the stocks of the world's top ten marine fish species (which account for around a third of capture fisheries production) are now considered to be to be fully exploited and have no potential for further increases (FAO 2013), and it is thought that more than a third of mangrove area has been lost or converted in the last few decades and a fifth of coral reefs have been destroyed (Agardy et al. 2005).

The effects of marine and coastal undervaluation are also manifested at the policy level. Economic policies which aim to stimulate production and growth have often hastened the process of ecosystem degradation and loss. At the worst, prices and markets may be distorted so as to present "perverse incentives" which actually encourage people to degrade, deplete and convert forests in the course of their economic activities, because it is more profitable for them to do so. For example fisheries subsidies, estimated to be worth between €23-26 billion a year worldwide (MRAG 2009) have, by artificially increasing the capacity of fishing fleets, resulted in the over-exploitation (and in some cases collapse) of fish stocks (UNEP 2004a). The loss of potential economic benefits in the global fishery due to fish stock depletion and over-capacity is estimated at €40 billion per year (World Bank and FAO 2009).

In many countries there exist various fiscal inducements (often combined with low or non-existent environmental penalties and fines) which provide a powerful incentive to modify and reclaim coastal habitats for more 'productive' commercial uses. One example is the generous tax breaks, import duty exemptions, export credits and preferential loans offered to shrimp farming across Asia (Bailly and Willmann 2001; Primavera 1997). Another example is when the incentives applied to other sectors of the economy are not offered to 'ecosystem-friendly' products, technologies and activities. In the Maldives, for instance, import duty reductions focus almost entirely on the products that are required for construction and expansion of the tourism, fisheries and industrial sectors in coastal zones, and make no explicit effort to encourage 'green' products or technologies: the relatively higher import duty levied on solar panels (25%) as compared to that for diesel-based electricity generation equipment (20%) is one example of this (Emerton et al. 2008).

The net result of biodiversity under-valuation is that prevailing prices and market opportunities create a situation where it remains more profitable for people to engage in economic activities that overexploit, convert and otherwise degrade natural ecosystems – even if the costs and losses that arise for other groups, or to the economy as a whole, outweigh the immediate gains to the individual or group which is causing the damage. Work carried out in the Togean Islands in Indonesia for example shows that while the costs associated with the loss of ecosystem services caused by commercial logging and agriculture in coastal areas outweigh the income they generate by a factor of more than four, it is still more profitable for households and businesses to clear and reclaim coastal habitats than to engage in other more sustainable land and resource uses (Cannon 1999; Emerton 2009). Similarly, in Sri Lanka, it is possible to gain high market returns from clearing mangroves for shrimp farming; however, if the costs and negative externalities associated with ecosystem service loss were factored into prices and markets, shrimp farming would cease to be a financially viable land use option (Gunawardena and Rowan 2006).

A stepwise approach to identifying, estimating and capturing marine & coastal ecosystem values

If marine and coastal ecosystems have no value, then economic policies and decisions that result in the degradation, depletion and modification of the natural environment would be perfectly rational ones. This, however, is clearly not the case. A key question is therefore: how do we overcome the problems associated with the under-valuation of marine and coastal biodiversity? Clearly, there is an urgent need is to find ways of better demonstrating the value of biodiversity and ecosystems, communicating this information to decision-makers, and, ultimately, taking action to ensure that these costs and benefits are properly reflected in the policies, prices and markets that shape people's day-to-day economic behaviour.

This is what the current study aims to do. It however goes beyond just estimating the monetary value of marine and coastal ecosystem services in the BOBLME. The study also seeks to work towards better integrating these values into real-world decision-making, by identifying economic instruments that might be used to support and strengthen the implementation of the Strategic Action Plan (SAP).

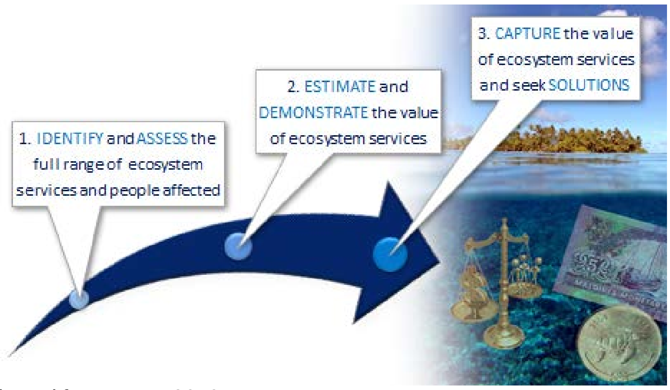
To these ends, the study adopts the stepwise scheme proposed by the global initiative The Economics of Ecosystems and Biodiversity (TEEB). TEEB offers a simple framework for linking economic valuation to the identification of policy instruments to strengthen the conservation and sustainable use of natural resources in the real world. Over recent years this framework has become an increasingly popular way of organising biodiversity and ecosystem valuation studies – including those being carried out in marine and coastal environments, and in the Asia region. For example, the "TEEB for Oceans & Coasts" study is currently ongoing at the global level, seeking to draw attention to the economic benefits of ocean and coastal biodiversity and healthy ecosystems (see Beaudoin and Pendleton 2012, http://teeboceans.org/). National TEEB studies are also being carried out in several Bay of Bengal countries (for example India, Indonesia, Malaysia and Thailand), and an ASEAN TEEB scoping study was recently undertaken (ACB 2012).

By drawing on the TEEB framework, the BOBLME study therefore aims to reflect what is currently considered to be international best practice in biodiversity and ecosystem valuation, and to use an approach that has already gained some level of traction and credibility with researchers and decision-makers. It also seeks to ensure consistency between the current study and various other ecosystem service valuation initiatives within the region and elsewhere.

TEEB proposes a three-tiered approach to valuation (TEEB 2008, 2010; Figure 1), which is applied in the current study:

- First of all, it is necessary to **identify and assess** the full range of ecosystem services affected and the implications for different groups in society. This requires considering the variety of stakeholders and economic processes that influence and/or benefit from biodiversity and ecosystem services (step 1 of the current study);
- Second the value of ecosystem services should be **estimated and demonstrated**, using appropriate methods. This involves both looking at the present situation (step 2) and analysing the linkages over scale and time that affect when and where the costs and benefits of biodiversity and ecosystems are realised (step 3), so as to help frame the distributive impacts of decisions (step 4); and
- Last, but not least, comes the step of **capturing the value of ecosystem services and seeking solutions**: to overcome their undervaluation using economically-informed policy instruments (step 5).

Figure 1: Three-tiered approach to identifying, estimating and capturing ecosystem service values

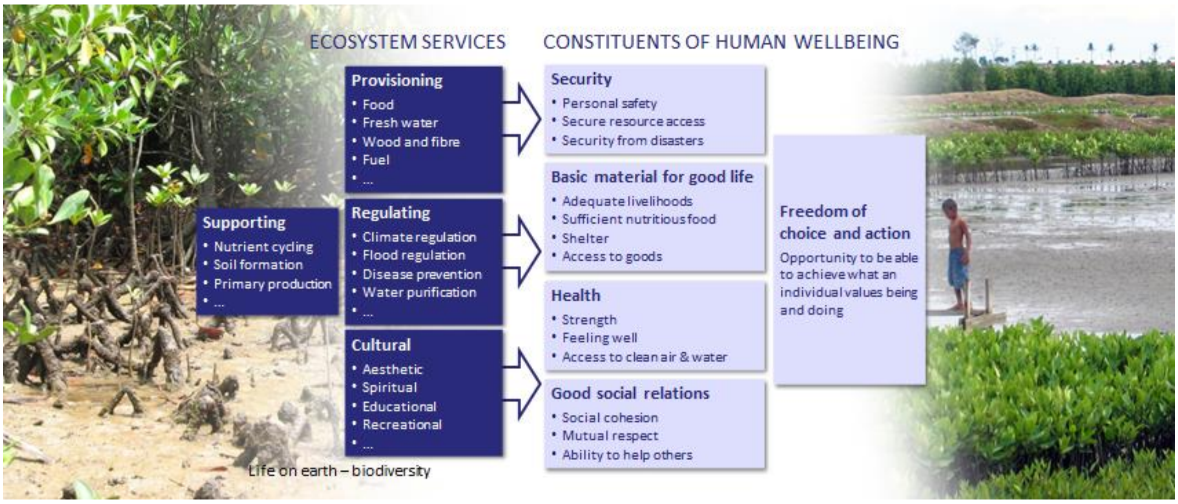


Adapted from TEEB 2010

The paragraphs below present the conceptual frameworks and approaches which underpin each stage of this three-tiered approach, and are used in the current study.

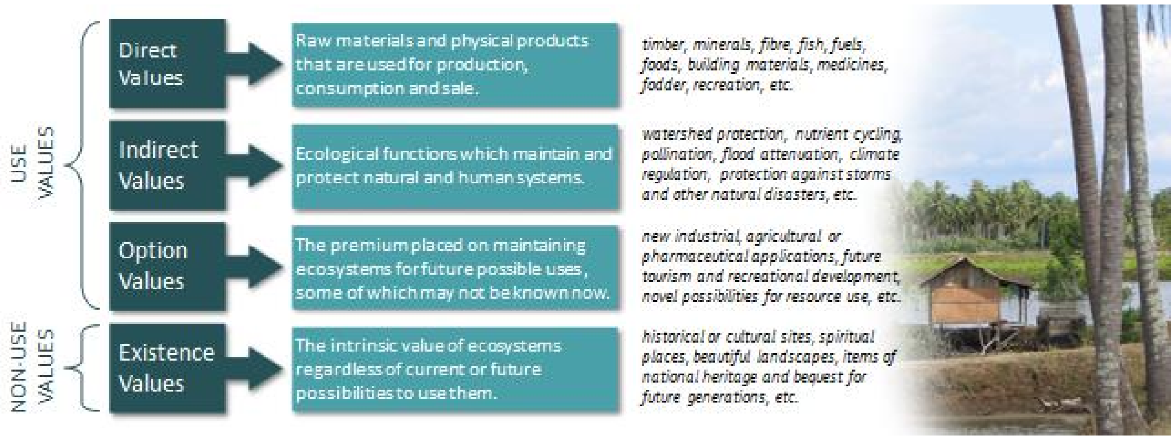
The valuation study characterises the BOBLME's marine and coastal ecosystem services according to the four basic categories suggested in the **Millennium Ecosystem Assessment** (MEA) – provisioning, regulating, supporting and cultural services (Millennium Ecosystem Assessment 2005). As elaborated in Chapter 4, together these generate not just products and raw materials, but also provide the primary productivity and vital life support services that are critical to human wellbeing in the BOBLME region (Figure 2).

Figure 2: Marine and coastal ecosystem services and human wellbeing



Adapted from MEA 2005

Figure 3: The total economic value of marine and coastal ecosystems



Adapted from Emerton 2014

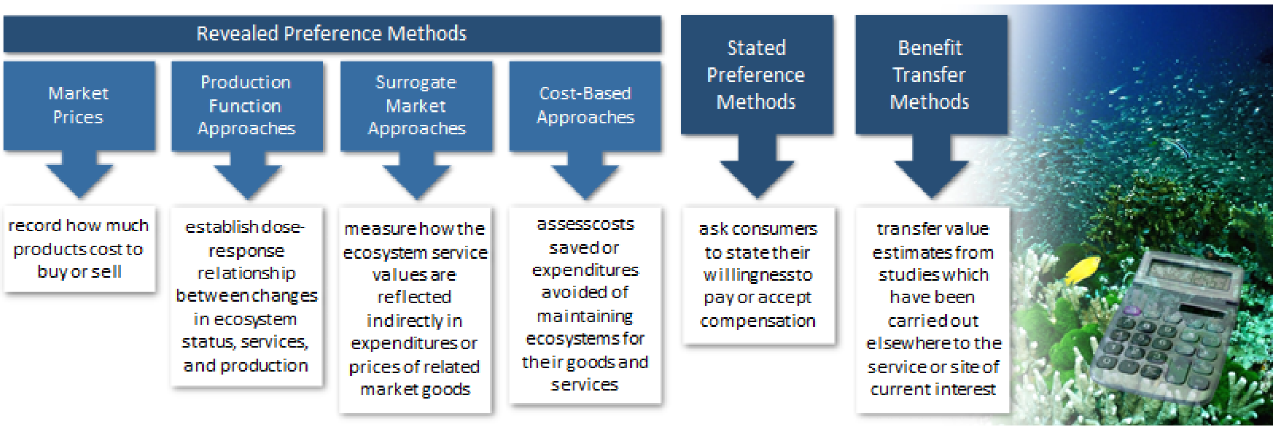
The MEA ecosystem service framework is overlaid with the concept of **Total Economic Value** (TEV). Over the last two decades, TEV has become the most widely-applied framework for identifying and categorising ecosystem values. Its major innovation of TEV is that it extends beyond the marketed and priced commodities to which economists have conventionally limited their analysis. It values the full gamut of economically important goods and services associated with ecosystems (Figure 2), and considers their complete range of characteristics as integrated systems – resource stocks, flows of services, and the attributes of the ecosystem as a whole. Each of the categories of TEV correspond to a different component of the MEA ecosystem services framework: direct values to provisioning services, indirect values to supporting and regulating services, existence values to cultural services, and option values potentially cross-cutting all four categories of MEA ecosystem service.

Techniques for estimating and demonstrating the value of ecosystem services

Although it is usually relatively easy to identify how and for whom marine and coastal ecosystems have economic significance, the question of how to place a monetary value on these services has long posed something of a challenge to economists. The easiest and most straightforward way to value goods and services, and the method used conventionally, is to look at their market price: what they cost to buy or are worth to sell. However, as ecosystem services very often have no market price (or are subject to market prices which are highly distorted), these techniques obviously only have very limited application.

Parallel to the advances made in the definition and conceptualization of the economic value of ecosystem services, techniques for quantifying ecosystem values and expressing them in monetary terms have also moved forward over the last twenty years or so. Today a suite of methods is available for valuing marine and coastal ecosystem services that cannot be calculated accurately via the use of market prices (Figure 4.

Figure 4: Commonly-accepted ecosystem valuation methods



Adapted from Emerton 2014

This ecosystem valuation toolbox is now commonly-accepted and widely-used in conservation and development planning, including in marine and coastal environments (see, for example, van Beukering et al., 2007; UNEP-WCMC, 2011; Wattage, 2011). Various valuation methods are applied in the current study to estimate the value of marine and coastal ecosystem services in the BOBLME. A detailed description of the valuation techniques, indicators, data sources and assumptions used is provided in Chapter 3, and further information is provided for each of the ecosystem services valued in Chapters 5 and 6.

Instruments for capturing the value of ecosystem services and seeking solutions

The frameworks and techniques described above enable a wide range of formerly unvalued or undervalued components of biodiversity and ecosystem services to be calculated. A large, and growing, body of literature on the economic value of marine and coastal ecosystems now exists, covering most regions of the world – in BOBLME countries almost a hundred such studies have been published (see Annex 1 for a list of these). Over the last decade, ecosystem valuation has gained currency as a convincing (and usually much-needed) way of demonstrating the economic gains and value-added associated with marine and coastal conservation.

As useful as this kind of information on costs and benefits is for advocacy and awareness purposes, it is, nevertheless, important to underline that economic valuation is not an end in itself. Rather, it should be seen as a means to an end – better and more informed decision-making (Emerton 2006, 2013b). Even if information on ecosystem values is a necessary condition for changing the way in which economic trade-offs are calculated and development decisions are made, by itself it is rarely sufficient. The point is that, however high the value of marine and coastal ecosystem services is demonstrated to be on paper, this means little in practice unless it translates into tangible changes in the markets, prices and profits prices that drive people's economic decisions in the real world. Along similar lines, as much as conservation and development decision-makers may be convinced that it is in the public interest to conserve marine and coastal resources and habitats, this will have little impact unless the people who depend and impact on natural ecosystems also perceive there to be concrete gains from doing so.

The key challenge thus becomes one of moving beyond merely estimating the value of marine and coastal ecosystem services, and going on to identify where there are needs and niches to change the economic conditions and circumstances that people face as they go about their day-to-day economic business. The basic intention is to ensure that biodiversity and ecosystem values are properly reflected in people's economic decisions. A variety of economic policy instruments are available which can be used to balance or reverse the price, market, business and livelihood factors that cause people to convert or degrade marine and coastal ecosystems in the course of their economic activities, and instead set in place the economic opportunities and rewards that will stimulate the investments which are required to encourage, enable and motivate conservation by making it more profitable (or less costly) for them to do so (see Essam 2013).

TEEB provides some guidance about the types of policies and instruments which have proved successful in practice. It mentions those which lead to environmentally damaging subsidies being rethought, unrecognised benefits being rewarded and uncaptured costs penalised, the benefits of conservation being shared more equally, and the costs and benefits of ecosystem services measured. A generic list of economic instruments that can be used to enhance the sustainable management of marine and coastal natural resources in the BOBLME and to secure incentives and finance to support the implementation of the SAP is presented in Chapter 7.

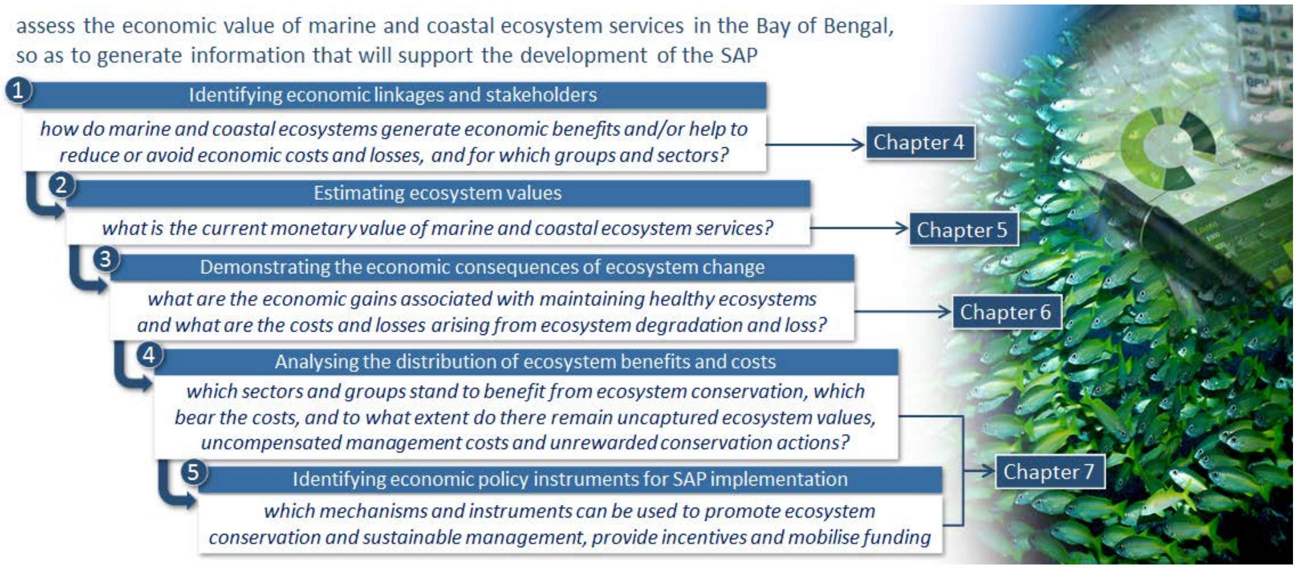
3 Scope, methodology & assumptions: how ecosystem services were valued

This chapter describes how the study was approached. It specifies the key questions that the economic analysis sought to answer, and elaborates its coverage in geographical, socio-economic and ecosystem service terms. The methods, indicators, data sources and assumptions used to quantify marine and coastal values and model the economic consequences of ecosystem change in the BOBLME are also explained.

Study steps and questions

Building on the conceptual frameworks and the three-tiered approach outlined in the previous chapter, the current study involved five steps, each of which seeks to answer a key question (Figure 5). The subsequent chapters of this report elaborate on one or more of these steps and questions. The basic aim was to follow a logical and iterative economic assessment process which moves from the identification of ecosystem service stakeholders and linkages, through their monetary valuation and analysis of how costs and benefits are distributed between different groups and sectors, to the identification of needs, niches and opportunities to use economic policy instruments to encourage and enable more sustainable natural resource management in the BOBLME, in support of the SAP.

Figure 5: Study steps and questions



Defining the study boundaries and coverage

The valuation study is concerned with marine and coastal ecosystem values in the Bay of Bengal Large Marine Ecosystem (Figure 6). Its geographical scope extends across the BOBLME as defined by the project: the Bay of Bengal itself, Andaman Sea, Straits of Malacca and Indian Ocean to 2°S (BOBLME 2012b). As well as high seas, this comprises the coastal areas, islands, reefs, continental shelves and marine and coastal waters of the northern part of the Island of Sumatra in Indonesia, the west coast of Peninsular Malaysia, the west coast of Thailand, India's east coast and Andaman and Nicobar Islands, and the entire coastlines of Myanmar, Bangladesh, Sri Lanka and the Maldives (BOBLME 2012b).

Several estimates have been made of the human population that occupies the BOBLME's coastal zone. Project documents cite figures of 450 million people spread over a coastal strip of something around 1.2 million km^2 (BOBLME 2012b, 2012c; Townsley 2004). These figures correspond to the area and population of the Atolls, Divisions, Provinces, Regions, States & Union Territories that have a coastline on the Bay of Bengal (Table 1). They however likely represent a significant overestimate, because they cover a zone that extends a long distance inland (in many cases a hundred kilometres or more). Much of this area and population cannot strictly be considered to have meaningful cultural, economic or ecological linkages to marine and coastal resources and habitats.

Figure 6: Map of Bay of Bengal Large Marine Ecosystem

From http://www.boblme.org/

The study therefore confines itself to a much smaller area: the 399 coastal Cities, Districts, Divisions, inhabited Islands, Regencies, Townships and Zilas that abut the Bay of Bengal (Table 2; also see Annex 2). Most of these administrative units extend only tens of kilometres inland. This is considered to be the maximum[1] area that can be realistically defined as being "coastal", in the sense that human economic livelihoods, wellbeing and security depend to a significant extent on marine and coastal ecosystem services.

Table 1: Population of coastal Atolls, Divisions, Provinces, Regions, States & Union Territories, 2014

Country	Administrative units	Area ('000 km^2)	Persons (millions)	Households (millions)
Bangladesh	Barisal, Chittagong, Khulna Divisions	69.42	54.39	11.52
India	Andhra Pradesh, Odisha, Tamil Nadu, West Bengal States; Andaman & Nicobar, Puducherry Union Territories.	658.30	302.89	72.67
Indonesia	Aceh, Riau, Sumatera Barat, Sumatera Utara Provinces.	259.97	29.28	6.92
Malaysia	Johor (partial), Kedah, Melaka, Negeri Sembilan, Perak, Perlis, Pulau Pinang, Selangor States.	68.04	18.02	4.41
Maldives	Addu, Faadhippolhu, Felidhu, Fuvahmulah, Hadhdhunmathi, Kolhumadulu, Male', Mulakatholhu, North Ari, North Huvadhu, North Maalhosmadulu, North Miladhunmadulu, North Nilandhe, North Thiladhunmathi, South Ari, South Huvadhu, South Maalhosmadulu, South Miladhunmadulu, South Nilandhe Atoll, South Thiladhunmathi Atolls	18.59	0.36	0.05
Myanmar	Ayeyarwady, Bago, Tanintharyi, Yangon Regions; Mon, Rakhine States.	154.91	22.39	4.53
Sri Lanka	Eastern, Northern, North Western, Southern, Western Provinces	28.47	13.49	3.43
Thailand	Krabi, Phang Nga, Phuket. Ranong, Satun, Trang Provinces	20.14	2.24	0.57
Total		1,277.84	443.05	104.10

Calculated from BBS 2012; BPS 2010; DCS 2012; DNP 2007, 2013; JPM 2011; MHA 2011; MOH 2012; NSO 2010; UNDP 2011.

Focusing on these units yields a substantially smaller estimate of coastal area and population than those used in earlier project reports: around 185 million people or 44 million households, occupying some 0.83 million km^2. The study defines this area as the BOBLME "coastal zone", and takes this population to represent the primary stakeholders in the Bay of Bengal's marine and coastal ecosystem services. It should however be noted that economic multiplier and linkage effects mean that a much larger number of producers, consumers, investors and employees, which are spatially dispersed across (and outside) BOBLME countries, depend on or benefit in some way from marine and coastal resources and services.

[1] Although ideally an even smaller area would be considered, extending only 5-10 km inland, fine grain data are not available at this level of detail. The current study therefore narrows in on the lowest-level administrative units for which comprehensive data are collected and published.

Table 2: Population of coastal Cities, Districts, inhabited Islands, Regencies & Townships, 2014

Country	Coastal administrative nits	Area ('000 km^2)	Persons (millions)	Households (millions)
Bangladesh	11 Districts	34.52	26.96	5.62
India	37 Districts	191.78	108.10	26.60
Indonesia	45 Cities & Regencies	460.19	19.24	4.50
Malaysia	29 Districts	23.67	7.77	1.86
Maldives	190 inhabited Islands	0.14	0.36	3.25
Myanmar	47 Divisions & Townships	80.77	9.51	1.87
Sri Lanka	14 Districts	27.65	11.67	2.94
Thailand	26 Districts	13.05	1.48	0.37
Total		831.76	185.10	43.81

Calculated from BBS 2012; BPS 2010; DCS 2012; DNP 2007, 2013; JPM 2011; MHA 2011; MOH 2012; NSO 2010; UNDP 2011.

The study draws on the categorisation of marine and coastal realm habitats and ecosystem services suggested in the Millennium Ecosystem Assessment (UNEP 2006; Table 3). This defines marine systems as waters from the low water mark (50m depth) to the high seas, and coastal systems as <50m depth to the coastline and inland from the coastline to a maximum of 100 km or 50-metre elevation (whichever is closer to the sea) (UNEP 2006). Three major marine habitat types are described (outer shelves edges slopes; seamounts & mid-ocean ridges; and deep sea & central gyres), and eight coastal ones (estuaries & marshes; mangroves; lagoons & salt ponds; intertidal; kelp; rock & shell reefs; seagrass; coral reefs; and inner shelf).

Table 3: Summary of ecosystem services provided by different marine and coastal habitats

	Coastal habitats									Marine habitats		
Ecosystem services	Estuaries & marshes	Mangroves	Lagoons & salt ponds	Intertidal	Kelp	Rock & shell reefs	Seagrass	Coral reefs	Inner shelf	Outer shelves edges slopes	Seamounts & mid-ocean ridges	Deep sea & central gyres
Provisioning services												
Food	■	■	■	■	■	■	■	■		■	■	■
Fibre, timber, fuel	■	■	■						■	■		■
Medicines, other resources	■	■	■		■			■	■			
Regulating services												
Biological regulation	■	■	■	■		■		■				
Freshwater storage & retention	■		■									
Hydrological balance	■		■									
Atmospheric & climate regulation	■	■	■	■		■	■	■	■	■		■
Human disease control	■	■	■	■		■	■	■				
Waste processing	■	■	■				■	■				
Flood/storm protection	■	■	■	■	■	■	■	■				
Erosion control							■	■				
Supporting services												
Biochemical	■	■			■			■				
Nutrient cycling & fertility	■	■	■	■	■	■		■	■	■	■	■
Cultural services												
Cultural & amenity	■	■	■	■	■	■	■	■	■			
Recreational	■	■	■	■	■			■				
Aesthetics	■	■	■	■				■				
Education & research	■	■	■	■	■	■	■	■	■	■	■	■

Adapted from UNEP 2006.

The valuation study has a particular focus on assessing the economic significance of the ecosystem services associated with the "critical habitats" of the BOBLME, as defined by the project: seagrass, mangroves and coral reefs (Angell 2004). There are currently recorded to be just under 16,000 km^2 of mangroves and 8,500 km^2 of coral reefs in the BOBLME region (Table 4). Unfortunately no estimates are available of the area of seagrass. Data on mangroves and coral reefs come mainly from BOBLME countries' own estimates and statistics, disaggregated to the level of Atolls, Divisions, Provinces, Regions, States & Union Territories. It should be noted that these sources yields quite different figures to those suggested in the TDA and its supporting technical studies (see BOBLME 2012c; Angell 2004). The reasons for this variation are unclear.

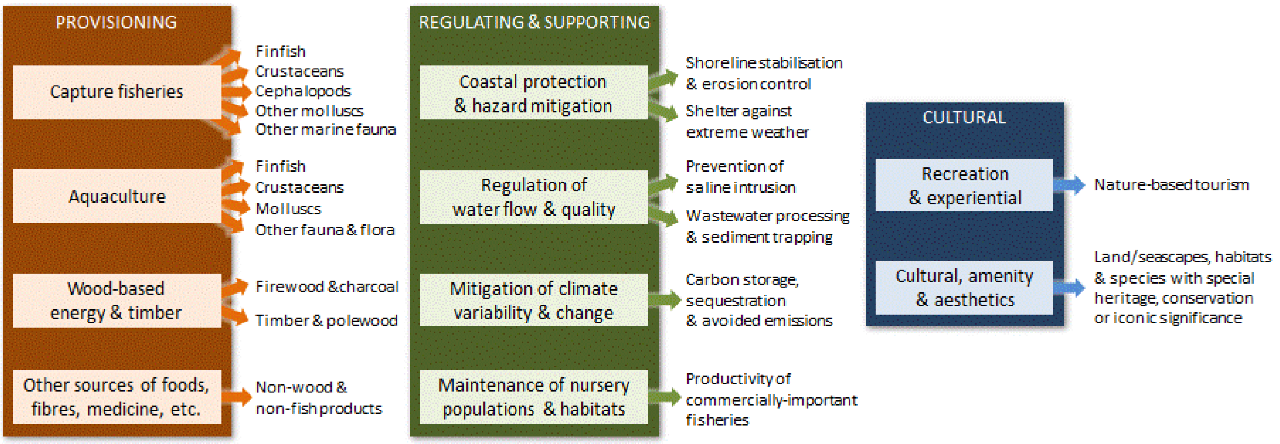
Table 4: Area of mangroves and coral reefs in BOBLME, 2014 (km^2)

	Mangroves	Coral Reefs
Bangladesh	4,252	8
India	3,310	1,097
Indonesia	2,457	1,586
Malaysia	802	284
Maldives		2,840
Myanmar	3,119	1,870
Sri Lanka	84	680
Thailand	1,768	105
Total	15,792	8,471

**inhabited islands only. Mangrove area from DMCR 2013; FSI 2011;Hasan* et al. *2013; JPM 2013; MFARD 2013; MOECAF 2014; Saputro* et al. *2009. Coral reef area from Bhatt* et al. *2012; BPS 2013; DMCR 2013; DNP 2013; Spalding* et al. *2001.*

The study focuses on ten categories of ecosystem services that are considered to be of the greatest importance in economic and human wellbeing terms in the BOBLME, and for which sufficient data are available to enable monetary valuation. These are: capture fisheries; aquaculture; wood-based energy & timber, other sources of foods, fibres, medicines, etc.; coastal protection and hazard mitigation; regulation of waterflow & quality; mitigation of climate variability & change; maintenance of nursery populations & habitats; recreational and experiential; and cultural, amenity & aesthetics (Figure 7).

Figure 7: Marine and coastal ecosystem services considered in the valuation study



The study is a partial valuation exercise. As elaborated further below, the lack of data on both socioeconomic and biophysical aspects of marine and coastal ecosystem services in the BOBLME constrained which ecosystem services could be included. It should also be noted that the study is concerned only with the ecosystem services associated with living marine resources, wild species and natural habitats. This means that no attempt has been made to value marine shipping and transport, tidal/wave and wind-based energy production, salt production, sand and coral mining, or mineral, oil and gas exploitation. Aquaculture production is included only in baseline calculations. Due to the considerable ethical and data issues involved, most of the spiritual, cultural and non-use values associated with marine and coastal ecosystems are not valued, except for those that are linked to tourism and recreation.

Measuring the current economic value of ecosystem services

The techniques used to value ecosystem services are drawn from the toolbox of methods described above in Chapter 2. The methods and associated indicators of value were selected according to which were considered to be the most technically appropriate for a given ecosystem service, realistic for the BOBLME context, and feasible given the availability and quality of data (Table 5).

Table 5: Ecosystem service valuation methods and indicators

Ecosystem service	Component	Valuation method	Indicator of value
Capture fisheries	Finfish, crustaceans, cephalopods, otjher molluscs, other fauna & flora	Market prices	Value of marketed & non-marketed production
Aquaculture			
Wood-based energy & timber	Fuelwood, timber		
Other sources of foods, fibres, medicine, etc.	Non-wood & non-fish products	Market prices (benefit transfer)	
Coastal protection & hazard mitigation	Shoreline stabilisation & erosion control	Mitigative & avertive expenditure (benefit transfer)	Avoided expenditures on physical reclamation and replenishment
	Shelter against extreme weather	Replacement cost (benefit transfer)	Costs of equivalent engineered storm protection defences
Regulation of water flow & quality	Prevention of saline intrusion	Mitigative & avertive expenditure (benefit transfer)	Expenditures saved on alternative fresh water sources
	Wastewater processing & sediment trapping	Replacement cost (benefit transfer)	Reduced costs of wastewater treatment and sediment trapping
Mitigation of climate change	Carbon storage, sequestration & avoided emissions	Market prices	Potential value of carbon emissions reductions offset sales
Maintenance of nursery populations & habitat	Productivity of commercially-important fisheries	Effects on production	Contribution to on-site and off-site capture fisheries
Recreation & experiential	Nature-based tourism	Market prices	Tourism expenditures & earnings
		Contingent valuation & travel cost (benefit transfer)	Domestic & international visitor willingness to pay
Cultural, amenity & aesthetics	Land/seascapes, habitats & species with special significance to humans		

Although it was originally intended that all figures would be expressed as net values (i.e. with harvesting, production, processing, marketing and other costs deducted), in the event insufficient data were available to do this. The ecosystem service value estimates presented below in Chapters 5 and 6 are therefore gross figures. Resource use values (such as fisheries, fuelwood, timber, non-wood and non-fish products) are expressed at "habitat's edge" price: the price received by the primary harvester or producer. Regulating and supporting service values reflect value-added or costs avoided to beneficiaries. The values associated with recreational expenditures and earnings represent the prices paid by visitors to service providers.

As the limited scope and short time frame for the study did not permit any primary data collection or detailed modelling to be carried out, it was necessary to rely on pre-existing statistics. There however remain major data gaps relating to both socioeconomic and (in particular) biophysical aspects of ecosystem services in the Bay of Bengal. For this reason, the current study relies heavily on benefit transfer techniques – the transferral of value estimates from studies which have been carried out elsewhere to the service or site that is of interest. They are commonly used in cases where site-specific data are lacking. For example, the valuation studies carried out for the Agulhas & Somali, Benguela and Guinea Currents, South China Sea/Gulf of Thailand, Caribbean and Mediterranean LMEs relied almost wholly on benefit transfer (see Interwies 2010; Lokina 2011; Mangos et al. 2010; Schuhmann 2012; South China Sea Project 2003; Sumaila et al. 2006; Turpie and Wilson 2011; UNEP/GEF 2007). In the current study, a "value function transfer" approach is used (see Brander 2013). This uses ecosystem value estimates that are expressed as a value per unit (for example per hectare of mangrove, per tourist, or per coastal resident). These figures are then applied to the appropriate areas or populations in the BOBLME coastal zone.

It is worth noting that extreme caution must always be exercised when using benefit transfer techniques, due to the dangers of extrapolating data about one site to another context which might have very different biological, ecological and socio-economic characteristics. The current study therefore takes a conservative approach. It draws only on studies carried out in other Bay of Bengal countries or in neighbouring Indian Ocean and Coral Triangle regions. A database of around 200 value estimates was compiled for this purpose, just under half of which refer specifically to BOBLME sites and countries (see Annex 1 for a list of these).

All of the figures in the current study are expressed at 2014 US Dollar (USD) rates. For estimates which refer to studies carried out in the past, deflators based on the consumer price index in each country have been used to account for inflation and bring values to 2014 levels. In cases where benefit transfer techniques are used, weights based on relative Purchasing Power Parity (PPP) valuations of per capita Gross Domestic Product (GDP) have also been applied to adjust for the differences in real prices and values between the country in which the estimate was generated and that in which it is being applied (Table 6). PPP deflators are applied to all transferred values except for international tourist willingness to pay and carbon prices, which are assumed to already reflect "international" values.

Table 6: Cross-country deflators applied to benefit transfer estimates used in the study

Countries which provide reference estimates of ecosystem values used in the study	PPP valuation of GDP per capita (current int'l dollar)	Deflator used when applying benefit transfer estimates to BOBLME countries							
		Bangladesh	India	Indonesia	Malaysia	Maldives	Myanmar	Sri Lanka	Thailand
Bangladesh	2,216	1.00	0.51	0.40	0.12	0.23	1.19	0.31	0.22
Cambodia	2,777	1.25	0.64	0.51	0.15	0.29	1.49	0.39	0.27
India	4,307	1.94	1.00	0.78	0.23	0.45	2.31	0.61	0.42
Indonesia	5,499	2.48	1.28	1.00	0.30	0.58	2.95	0.78	0.54
Kenya	1,903	0.86	0.44	0.35	0.10	0.20	1.02	0.27	0.19
Malaysia	18,639	8.41	4.33	3.39	1.00	1.95	9.98	2.65	1.82
Maldives	9,543	4.31	2.22	1.74	0.51	1.00	5.11	1.35	0.93
Myanmar	1,867	0.84	0.43	0.34	0.10	0.20	1.00	0.26	0.18
Pakistan	3,231	1.46	0.75	0.59	0.17	0.34	1.73	0.46	0.32
Philippines	4,962	2.24	1.15	0.90	0.27	0.52	2.66	0.70	0.49
Seychelles	15,848	7.15	3.68	2.88	0.85	1.66	8.49	2.25	1.55
Sri Lanka	7,046	3.18	1.64	1.28	0.38	0.74	3.77	1.00	0.69
Thailand	10,227	4.62	2.37	1.86	0.55	1.07	5.48	1.45	1.00
Viet Nam	4,256	1.92	0.99	0.77	0.23	0.45	2.28	0.60	0.42

From IMF World Economic Outlook Database, July 2014 http://www.imf.org/external/pubs/ft/weo/2014/01/weodata/weoselgr.aspx

Even though both national-level and regional-level values are expressed in USD, they cannot be directly aggregated or compared with each other. Country estimates refer to "domestic USD", which have been converted from the currency of that country using the market exchange rate. This indicates how much marine and coastal ecosystem services are worth according to the prevailing costs and prices in that country. They thus have relevance only in the context of the country for which they have been calculated.

It follows that these "domestic USD" country values cannot simply be added up in order to come up with the value of marine and coastal ecosystem services in the BOBLME region as a whole. Along similar lines, "domestic USD" estimates cannot be directly compared between different countries. This is because real price levels differ between countries. For example, the local market price of fish will be very different in Bangladesh as compared to Thailand, and the cost of mitigating coastal erosion damages will vary considerably between Malaysia and the Maldives. At the same time, the exchange rates that prevail in some BOBLME countries do not reflect the real value of the local currency as compared to other currencies.

To come up with regional estimates of marine and coastal ecosystem service values for the BOBLME as a whole, it is therefore necessary to express all values in terms of a common numéraire that can be directly compared, combined and aggregated between countries. In order to do this, the study converts national-level "domestic USD" figures to "international USD". An international USD has the same purchasing power as the USD has in the United States, and is a commonly-accepted numéraire for cross-country comparisons or aggregations of economic statistics. This is done by applying a weight which accounts for the difference between the prevailing market exchange rate to the "domestic dollar" and the implied PPP conversion rate to the "international USD" (Table 7). International USD figures are then aggregated to give regional-level value estimates for the BOBLME as a whole.

Table 7: Weights used to convert "domestic USD" to "international USD"

	Market exchange rate (local currency: "domestic" USD)	Implied PPP conversion rate (local currency: "international" USD)	Weight ("domestic": "international" USD)
Bangladesh	77.72	36.36	2.14
India	60.08	23.58	2.55
Indonesia	11,689.18	7,301.27	1.60
Malaysia	3.19	1.93	1.65
Maldives	15.42	11.95	1.29
Myanmar	971.99	506.07	1.92
Sri Lanka	130.20	64.91	2.01
Thailand	32.16	17.74	1.81

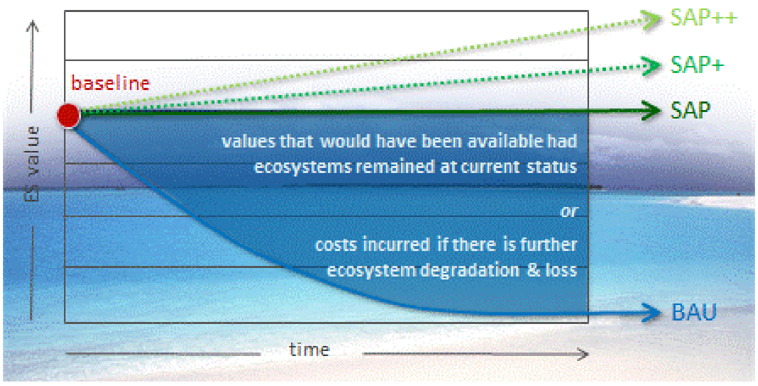
From IMF World Economic Outlook Database, July 2014 http://www.imf.org/external/pubs/ft/weo/2014/01/weodata/weoselgr.aspx

Modelling the economic consequences of ecosystem change

The study first assesses the baseline situation: it identifies the marine and coastal services that are currently being provided by the BOBLME, and estimates their economic value in the year 2014. However, rather than just giving a static view of the present situation (as most of the other LME valuation studies confine themselves to), it goes on to carry out a dynamic analysis of ecosystem service values over time. This is because coming up with a single, snapshot estimate has little meaning in management and policy terms. It is the changes in economic values that result from shifts in ecosystem status that have relevance. In the current study the main interest is in the benefits that can be ascribed to the maintenance of healthy marine and coastal ecosystems in the BOBLME, and, conversely, the costs that might be incurred should marine and coastal biodiversity be degraded and lost.

In order to generate these figures, the study compares two possible policy and management scenarios (Figure 8). One is "Business as Usual (BAU)", under which marine and coastal ecosystems continue to be degraded and over-exploited. The other is the "Strategic Action Programme (SAP)", designed to better the lives of coastal population through improved regional management of the Bay of Bengal environment. The scenarios are modelled over a 25-year period.

Figure 8: Baseline, Business as Usual (BAU) and Strategic Action Programme (SAP) scenarios



The BAU scenario is based largely on the results of the Transboundary Diagnostic Analysis (TDA) carried out by the BOBLME Project, combined with an analysis of the current status and past trends in resource utilisation and ecosystem change in the region. It extrapolates a continuation and escalation of the three main transboundary issues identified in the TDA (as described in BOBLME 2012b), namely: overexploitation of living marine resources, degradation of critical habitats, and worsening of pollution and water quality.

Although a draft SAP has been prepared, it does not yet contain detailed or quantified targets. This means that it is not known which specific policies, measures and management activities are envisaged, or what improvements in ecosystem status and integrity are anticipated. In the absence of such information, it is not possible to model the SAP scenario in any detail. The current study therefore takes a conservative view, and equates the SAP to a continuation of the baseline. This assumes that, at a minimum, current threats to the natural environment will be addressed and there will be no further degradation of marine and coastal ecosystems. In reality, it is of course to be hoped that the SAP will actually serve to improve the status of marine and coastal environments (as depicted by SAP+ or SAP++ trends in Figure 8). Once the SAP is developed, these projections can be incorporated into the economic model.

The 2014 baseline thus serves as the reference case against which the both the economic benefits provided by healthy marine and coastal ecosystems (under the SAP scenario) and the potential economic losses/damages resulting from the loss of these services (under BAU) are measured. The analysis shows the incremental costs of the BAU (the loss of economic values that would have been available had marine and coastal ecosystems remained at their current status). Alternatively, it can be taken as an indication of the marginal value-added by the SAP in terms of avoided economic costs and damages – it looks at the changes in ecosystem service values that would result from a decline in the area and quality of mangroves and coral reefs (the "critical habitats" identified in BOBLME 2012c; Angell 2004). Under BAU, past rates of habitat loss and threat in each country (Table 8) are assumed to continue for the next five years (2015-19). Mangrove and coral reef degradation is then assumed to escalate over the subsequent decade before slowing again between 2030-35. To reflect variation in the rate of habitat degradation and conversion, and to indicate threshold effects, a curvilinear trajectory of change is assumed. A 10% discount rate is applied to future costs and benefits (reflecting the prevailing opportunity cost of capital in BOBLME countries).

Table 8: Current rates of habitat loss and threat

	Mangroves average annual area loss (%)	Coral reef average annual area loss (%)	% coral reefs low integrated local threat	% coral reefs medium integrated local threat	% coral reefs high integrated local threat	% coral reefs very high integrated local threat
Bangladesh	-0.9%	-0.7%	34%	32%	21%	13%
India	-0.8%	-0.7%	34%	32%	21%	13%
Indonesia	-1.7%	-0.7%	7%	55%	26%	12%
Malaysia	-0.8%	-0.7%	1%	56%	34%	9%
Maldives	0.0%	-0.7%	34%	32%	21%	13%
Myanmar	-0.4%	-0.7%	34%	32%	21%	13%
Sri Lanka	-0.4%	-0.7%	34%	32%	21%	13%
Thailand	-0.7%	-0.7%	10%	47%	28%	15%

From figures presented in BPS 2013; Bruno and Selig 2007; Burke et al. 2011, 2012; DNP 2013; FAO 2007; FSI 2011;Hasan et al. 2013; JPM 2013; MFARD 2013; MOECAF 2014; NSO 2013; Saputro et al. 2009.

The coastal zone population is assumed to grow in line with the latest census projections for coastal Cities, Districts, inhabited Islands, Regencies & Townships (see BBS 2012; BPS 2010; DCS 2012; DNP 2007, 2013; JPM 2011; MHA 2011; MOH 2012; NSO 2010; UNDP 2011). Under the BAU scenario, this has an effect on the absolute number of people using mangrove products − although these rising use levels are, obviously, counterbalanced by the declining product availability that results from progressive habitat loss. All factors other than habitat loss and population growth are held constant in both scenarios. This implies that ecosystem service values vary in direct proportion to changes in mangrove and coral reef area, with absolute levels of mangrove product utilisation also being influenced by population growth.

It is important to emphasise that, while this type of simplified economic model and *ceteris paribus* assumptions are justifiable given the time and data constraints facing the current study, they represent a considerable oversimplification of the actual situation. In this kind of valuation exercise, it would usually be expected either that a separate process would already have been carried out to specify future ecosystem management scenarios for the study site, or that they would be built up with the active participation of key regional experts and stakeholders as part of the valuation study itself. This would enable the assumptions and hypotheses used to model changes in key variables to be carefully researched and thought through, and a detailed set of quantified change estimates to be built up, which would then be reflected in the economic scenario model.

This was clearly not possible in the current study, which was undertaken as a rapid, desk exercise and which relies on a TDA which is qualitative and retrospective, not quantitative or prospective, in its focus. There was insufficient information to predict with any accuracy what any of these relationships or trends will be. It is to be hoped that any future valuation study would allow for a more considered and detailed scenario development exercise to be undertaken, permitting these trends to be projected, quantified and modelled.

Constraints and data limitations

The valuation study is an extremely ambitious one, given that it is based only on pre-existing information (no primary data collection was undertaken) and has been carried out over an extremely limited time frame. Perhaps the greatest constraint is the accessibility and quality of information on which to base the ecosystem service valuation calculations. In many cases the socioeconomic and (especially) biophysical data that are available for BOBLME countries contain major gaps, are of doubtful quality and accuracy, and show significant inconsistencies (and even contradictions) between different sources.

As well as the limitations to the study that arise from poor data quality and coverage, it should be stressed that extrapolating current ecosystem values into the future is also both imprecise and risky, and involves many unknowns. As interesting (and hopefully useful) as the aggregate numbers generated by this study will be, these figures will inevitably mask some important elements of ecosystem service values, and over-simplify the complex dynamics and relationships at play when looking at the impacts of ecosystem change on ecosystem service provision and economic values.

In particular, the assumption that ecosystem service values will vary in direct proportion to changes in mangrove and coral reef area represents a massive oversimplification. The almost complete absence of quantitative data on the biophysical linkages and dose-response/causal relationships that link changes in habitat area or quality, associated shifts in ecosystem service provision, and consequent effects on economic production and consumption poses a major constraint to the study. This is a particular concern in relation to the modelling the impacts of changes in mangrove and coral reef area on fish breeding and nursery habitats, shoreline stabilisation and erosion control, shelter against extreme weather, regulation of waterflow and quality, and marine and coastal tourism values under BAU. In reality, none of these values would decline in direct proportion to the decrease in mangrove and coral reef cover. However, without accurate quantified information as to what the relationships between changes in habitat and changes in the generation of ecosystem services, it is not possible to present a more sophisticated analysis.

A related concern is the lack of information on the sustainability of current ecosystem management and resource use, and about what future levels might be supportable in different sites and for different ecosystems. Another important issue is that the calculations in the current study are not able to account for non-linearities and threshold effects in ecosystem functioning. As already mentioned above, many parameters other than area affect ecosystem values, but cannot be defined or predicted with any certainty in the current study – for example the degree of human dependence on ecosystem services, the real value of these services over time, and changes in population, demography, income levels and societal preferences. These factors are especially important given the rapid livelihood, economic, social and institutional changes that are currently taking place in Bay of Bengal countries. Gaps in knowledge are a particular concern in relation to capture fisheries − and would require considerable new bioeconomic data, research and modelling to fill. It would be reasonable to expect that, as fisheries become more degraded and fishing levels reach (or even exceeds) sustainable limits, major changes will be registered in both the overall volume and the composition of catch, as well as catch per unit effort (and thus in the value of fisheries). At the time of the study information was not however available on fishing sustainability (overall or for particular species and/or methods), or on future projections of catch, fishing techniques/technologies, costs, prices, disposition of catch, and other key parameters.

Ideally, changes in all of these variables would also be incorporated into the scenario models. For example, it has already been noted that the regional fishery is overexploited, and that catch in five of the eight BOBLME countries has either remained static or declined over the past decade (BOBLME 2011f, 2012c). To project these trends into the future would however require that a detailed fisheries model be constructed, which is clearly beyond the scope of the current study. Likewise, although ambitious projections of future growth in tourist numbers and spending have been made in all of the BOBLME countries, current information does not allow these estimates to be translated into a coherent forecast for marine and coastal recreation in the BOBLME region.

It would also be desirable for estimates of ecosystem dependence and values to reflect future shifts in people's socioeconomic status and conditions. For example, it is almost certain that both the percentage of households that utilise mangrove products and average harvest levels per household will decline considerably over the next 25 years because of the increased availability of and preferences for purchased alternatives (for example bricks rather than building poles, electricity or gas rather than woodfuel), and in response to the reduced supply of these products that will result from habitat loss. At the same time, the rapid processes of urbanisation, industrialisation and infrastructure development that characterise the BOBLME region might be expected to increase the real value of mangrove and coral reef protection functions and regulating services (due to infrastructure development, higher concentrations of human settlements and industry, and more costly buildings and assets). Climate variability and change present another critical – although highly uncertain – influence on ecosystem service demands and values.

The study represents a first attempt to value and model marine and coastal ecosystem services in the BOBLME. Its findings should be understood within these limitations – they are partial, indicative estimates, generated for communication, awareness and policy/management support purposes. They should thus be seen as a broad indication of what *might* occur under different fisheries and environment management futures in the Bay of Bengal, rather than a definitive statement of what *will* happen. It is to be hoped that as better and more accurate information becomes available, these value estimates can be updated and improved. A more comprehensive valuation, using a fuller national data set and carried out with involvement of relevant government departments, is already envisaged to be a key component of the second phase of the BOBLME programme.

4 Ecosystem-economic linkages & stakeholders: who and what depends on ecosystem services

This chapter describes the stakeholders and economic linkages associated with the biological resources and natural habitats of the BOBLME. It describes the ways in which marine and coastal ecosystem services generate economic benefits and/or help to reduce or avoid economic costs and losses for different groups and sectors.

Summary of ecosystem-economic linkages and stakeholders

A wide array of reports has already been published by the project; these provide detailed information on the prevailing socio-economic, environmental, policy and management conditions in the BOBLME region (see Ali 2004; Angell 2004; BOBLME 2011a-j, 2012a-c, 2013a-b; Joseph 2003; Myint Pe 2003; Omar 2004; Purnomohadi 2003; Townsley 2004). The following paragraphs do not seek to repeat this information. Rather, they aim to present new and updated quantitative data and to provide a slightly different perspective which focuses specifically on ecosystem-economic linkages and stakeholders (Table 9).

Table 9: Summary of BOBLME ecosystem-economic linkages and stakeholders

BOBLME coastal zone population	187 million people or 44 million households	
Ecosystem services	**Economic linkages**	**Key stakeholders**
Capture fisheries & aquaculture	Local and national nutrition, income, foreign exchange & employment	≈ 3.7 million people, 6.1% of the economically-active rural population or 10.9% of rural households depend on fishing as a primary source of income and/or employment ≈ 7.5 million people employed in other fisheries-related primary production activities ≈ 15 million people involved in ancillary occupations
Non-fish mangrove products	Local subsistence & income, costs saved on purchased alternatives	≈ 200,000 households or 40% of rural mangrove-adjacent households harvest mangrove tree products for household energy, shelter, dyes, fodder or traditional medicines.
Coastal protection & hazard mitigation	Household, commercial & public costs and damages avoided to human life, health, production, property & infrastructure	≈1.5 million people protected against the effects of storms, cyclones, tidal surges, erosion and other natural hazards by mangroves and ≈0.7 million protected by coral reefs
Regulation of waterflow & quality		≈ 1.5 million people protected against the effects of saltwater intrusion, water pollution and siltation by mangroves
Mitigation of climate variability & change	Local income; local, national and global expenditures & damage costs avoided	> 1,600 MtC stored in mangrove forests and soils, ≈ 11 MtC a year sequestered , ≈ 8 MtC a year emissions avoided.
Recreation, cultural, amenity & aesthetics	Local, national and global income & employment; local, national and global non-use values	> 40 million visitor days spent on marine and coastal tourism activities ≈ 0.4 million direct jobs and 0.9 million indirect and induced jobs partly or wholly supported by BOBLME marine and coastal leisure tourism

Around 15,800 km^2 of mangroves and 8,500 km^2 of coral reefs are found within the BOBLME (Figure 9). Meanwhile, as described in Chapter 3 and elaborated in Annex 2, around 185 million people or 44 million households live in the coastal zone (defined as the residents of the 399 coastal Cities, Districts, Divisions, inhabited Islands, Regencies, Townships and Zilas that abut the Bay of Bengal; see Figure 10). Just under two thirds of this population (121 million people or 28 million households) is rural. The vast majority depend in some way on marine and coastal resources for their livelihoods and economic wellbeing.

Figure 9: Distribution of mangrove and coral reef cover between BOBLME countries

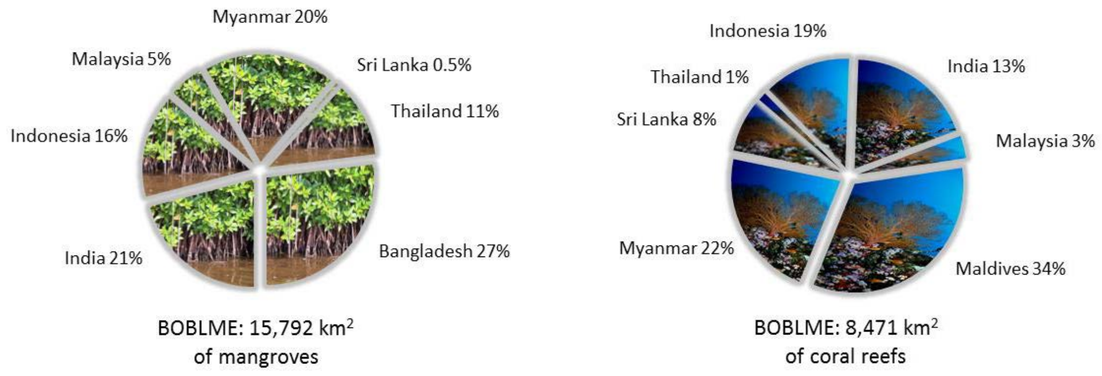
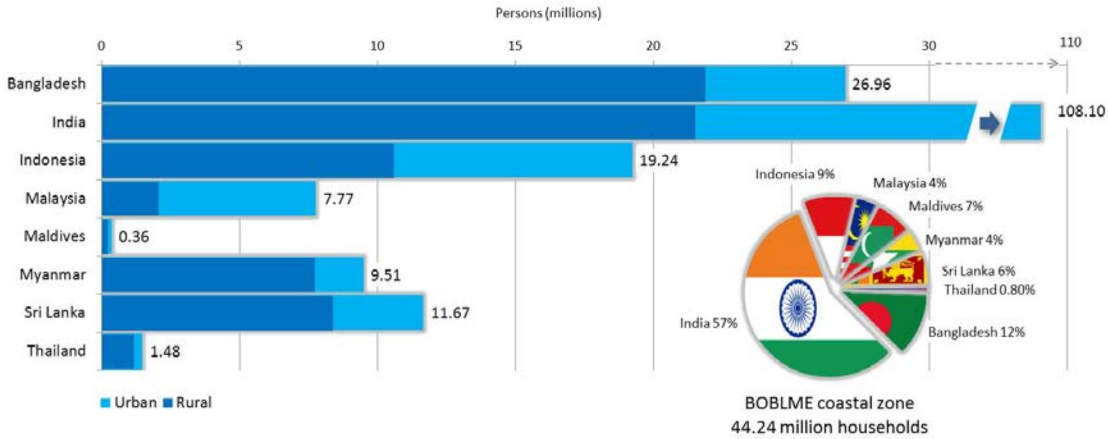


Figure 10: Distribution of coastal population between BOBLME countries



Fisheries

Fish and other aquatic living resources is one very obvious – and clearly valuable – category of products that is obtained from the marine and coastal environment. According to national statistics, the annual output from BOBLME marine and coastal waters is just under seven million tonnes from capture fisheries and 1.4 million tonnes from aquaculture production (Table 10).

Table 10: Marine and coastal capture fisheries and aquaculture production

	Capture fisheries ('000 tonnes)				Aquaculture ('000 tonnes)			
	Finfish	Crustaceans	Other	Total	Finfish	Crustaceans	Other	Total
Bangladesh	558.43	20.19	-	578.62	63.22	87.54	-	150.76
India	921.62	154.18	15.78	1,091.57	84.16	214.08	17.41	315.65
Indonesia	733.03	99.04	61.64	893.71	580.47	32.72	5.66	618.86
Malaysia	589.11	93.55	44.45	727.12	38.80	27.60	0.10	66.50
Maldives	120.00	-	-	120.00	-	-	-	-
Myanmar	1,269.64	264.96	953.48	2,488.08	1.87	54.63	2.13	58.63
Sri Lanka	377.91	39.31	-	417.22	0.01	3.31	0.03	3.35
Thailand	394.48	26.37	124.79	545.65	3.95	141.66	1.92	147.54
Total BOBLME	4,964.23	697.60	1,200.14	6,861.97	772.48	561.54	27.25	1,361.28

*From data presented in FUNGE-SMITH ET AL. 2012, 2014; DOF 2012A; FAO 2014; FRSS 2013; KKP 2012, 2014; MAC 2011a,b; MFA 2012; MFARD 2012; MLF 2012; MOA 2012; MOF 2012a,b. "Other" includes cephalopods and other molluscs, sea cucumbers, shells, seaweed and other marine products. *Reflected in other categories: aggregated category of "other marine fish" given in national statistics have been included under finfish.*

As mentioned repeatedly in the literature, these figures almost certainly underestimate actual production levels. There tends to be massive under-reporting, with statistics typically excluding a large proportion of subsistence-level and unlicensed activities. In addition, data often omit key categories such as ornamental fish, and frequently do not account for foreign vessels. It should also be noted that in several cases the figures presented are quite different to the estimates found in project reports (see BOBLME 2011f, 2012b,c). While it is to be expected that there will be a small margin of variation due to the six-year time period that has elapsed since the project estimates were calculated, this does not explain the much higher production recorded in Indonesia's, Malaysia's and Sri Lanka's national statistics, or the complete absence of the Maldives from project figures.

The fisheries sector is a key part of the economy in all of the BOBLME countries. It makes a significant contribution to income, employment, exports and foreign exchange earnings as well as providing an important source of dietary protein for a large proportion of the population. Overall, the sector is recorded as contributing 4.4% of GDP in Bangladesh (FRSS 2013), 0.9% in India (MOA 2012), 3.1% in Indonesia (KKP 2011), 1.2% in Malaysia (DOF 2009), 6.1% in the Maldives (DNP 2013), 9.1% in Myanmar (Khin Maung Soe 2008), 1.8% in Sri Lanka (MFARD 2013) and 0.9% in Thailand (NSO 2013).

Sectoral statistics also show that there are currently around 3.7 million active marine fishers in the BOBLME coastal zone (Table 11). This corresponds to approximately 6% of the economically-active rural population, and suggests that just under 11% of rural households depend directly on fishing for income and/or employment. Project reports suggest a 2:1 ratio between fishers and people engaged in other fisheries-related primary production activities, and estimate that around four times as many are involved in ancillary occupations such as net and gear making, boat construction and maintenance, almost a half of the rural population in the BOBLME coastal zone may benefit from the income and employment opportunities afforded by marine fisheries.

Table 11: No domestic marine fishing vessels and fishers

	No marine fishing vessels	No active marine fishers	% of economically-active rural coastal population(b)	% of rural coastal households(c)
Bangladesh	45,851	780,000(a)	7.1%	14.2%
India	111,767	1,186,292	3.5%	5.9%
Indonesia	28,763	113,297	2.1%	3.7%
Malaysia	21,798	41,373	4.0%	7.1%
Maldives	984	10,264	9.0%	22.9%
Myanmar	29,981	1,300,000	33.7%	71.3%
Sri Lanka	53,270	222,160	5.3%	8.7%
Thailand	16,329	35,000(a)	6.1%	10.1%
Total BOBLME	308,743	3,688,386	6.1%	10.9%

From figures presented in DOF 2012A; FRSS 2013; Khin Maung Soe 2008; KKP 2012, 2014; MAC 2011b,c, 2014; MFA 2012; MFARD 2013; MLF 2012; MOA 2012; MOF 2012; ietze et al. *2000; (a) 1994-5 Bangladesh and 2000 Thailand figures updated to 2014 levels in line with population growth; (b) based on average proportion of 50% economically active persons aged 15-64 years; (c) based on average 1.2 fishers per household.*

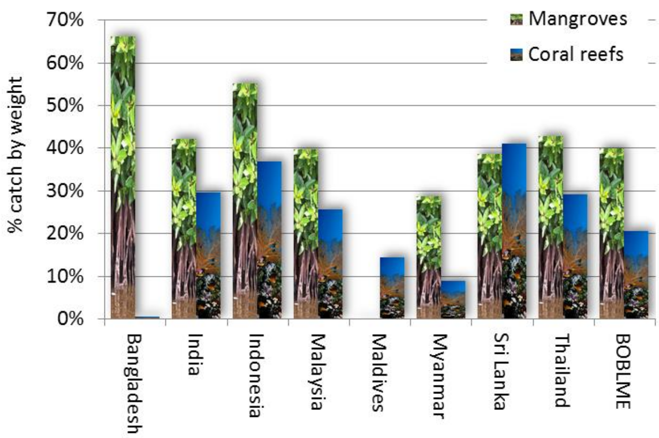
Along with other natural habitats (such as estuaries, seagrass beds, mudflats, marshes and other coastal wetlands), the 15,800 km^2 of mangroves and 8,500 km^2 of coral reefs that are found within the BOBLME provide breeding, nursery, feeding and living habitat for different life cycle stages of nearshore and offshore finfish, crustaceans, cephalopods and other molluscs (BOBLME 2012b, c; Rönnbäck 1999). There are a number of (sometimes monetised) references in the literature to mangrove/coral reef-fisheries linkages in the BOBLME and surrounding Indian Ocean and Coral Triangle regions. Most indicate that natural habitat loss reduces fisheries productivity (Islam and Haque 2003; Adhikari et al. 2010; Nguyen Thi Minh Huyen 2010; Foley et al. 2012; Kimirei et al. 2013) and that, conversely, improved conservation and sustainable management leads to discernible improvements/recovery of catch (McAllister 1988; Russ and Alcala 1996; Putra 2001; Cesar 2002; Maypa et al. 2002; Gell and Roberts in press).

The exact nature of the impact of changes in habitat area and quality on fisheries catch however remains unclear: such relationships tend to be highly variable and site specific (Barbier et al. 2003), rarely respond linearly to changes in habitat size (Pauly and Ingles 1986), and are thus extremely difficult to specify or predict. As a result, there is a critical lack of reliable biophysical information upon which to base valuation estimates (Baran 1999; Rönnbäck and Primavera 2000). Even where empirical data do exist, the literature offers a widely differing (and sometimes contradictory) set of figures (see, for example, the disparities in the amount of fisheries production stated to be associated with one hectare of mangroves in BOBLME countries in Pauly and Ingles 1986 as compared to Rönnbäck 1999, or the variation between figures in different study sites on the Gulf of Thailand in Sathirathai 1998 and Pongkijvorasin 2009).

Considerable caution must therefore be exercised in specifying quantitative or biophysical relationships between habitat status and fisheries output or productivity. There remain serious concerns that the role mangroves, seagrass and other natural habitats in fisheries production are frequently be overstated or incorrectly interpreted (Saenger et al. 2013). This bias is discernible in many of the valuation studies which have been carried out in Bay of Bengal countries (and elsewhere), which mistakenly assume that the entire value of inshore and offshore fisheries can be attributed to the existence of mangroves and coral reefs, and that the destruction of these habitats means total loss of catch.

As the current study did not have access to sufficient reliable or comprehensive data to enable bioeconomic modelling of fisheries-habitat linkages, and in the absence of any reliable empirical estimate of the links between changes in mangrove/reef status and catch, a simplified approach was taken. The marine fisheries catches in each BOBLME country was disaggregated, and the percentage reliance of each component species on mangroves and/or coral reefs for part or all of its life cycle and productivity was quantified based on expert opinion. According to these dependency ratios, it was assumed that the mangrove/reef-associated portion of fisheries catch would decline in direct proportion to habitat loss. While this is recognised to constitute a gross oversimplification, as it takes no account of actual dose-response relationships, of the non-linearity of such relationships or of the threshold effects of habitat changes, it is used as a rough proxy of the value of mangrove and coral reef services for fish breeding and nursery habitat. It is hoped that in the future, reliable biophysical data on these linkages will become available for the BOBLME, at which point these value estimates can be updated and improved.

Figure 11: Mangrove and coral-dependent species contribution to fisheries catch



Analysis of the catch composition an dependency rations for BOBLME countries suggests that, overall, mangrove-dependent species contribute around forty per cent of catch by weight in the region, and coral reef-associated species 21% (Figure 11). The share of mangrove-dependent species is particularly high in

Bangladesh and Indonesia, while reef-associated species contribute a relatively high proportion of catch in Indonesia, Sri Lanka and Thailand. It should be noted that these figures are consistent with the dependency ratios given in a number of recent studies carried out in other South and Southeast Asian which suggest that mangrove-dependent species contribute an average of 90% of inshore and offshore prawn and crustacean catch, 60% of inshore fish catch and 30% of offshore fish catch (see Gunawardena and Rowan 2005, Rönnback 1999, Singh *et al* 2004, Untawale 1986),

It is worth noting that, in addition to the obvious income and trade benefits, the mangrove/coral-reef dependent fishery makes a substantial contribution to food security in the BOBLME region. Human populations are heavily dependent on fisheries for direct consumption and for generating income to purchase other food supplies (Foale et al. 2013). For example, in Indonesia fish represents around 20% of protein supply per capita (del Pozo 2013), with similar figures in Myanmar, Malaysia and Thailand (HLPE 2014), while in the Maldives it contributes more than a half of household protein (Huelsenbeck 2012). Especially for the poorest coastal families, mangrove fisheries typically have an emergency food provision function and may constitute the only source of protein in their diet that is accessible and/or affordable on a regular basis (Walters et al. 2008).

Non-fish mangrove products

Almost 4,500 km or just over a quarter of the BOBLME coastline is fringed by mangroves (Table 12). A wide variety of mangrove products other than fish are utilised, including the use of mangrove bark, buds, leaves and wood for firewood and charcoal, building poles, tannins and dyes, rayon and paper, vegetables, fruits, algae, fodder, honey, traditional medicines and pesticides as well as a wide range of other products. Many households rely on these products to meet their day-to-day needs for subsistence and income (Walters et al. 2008). As is the case with fish (see above), the non-fish plant and animal products harvested from mangroves can make a substantial contribution to household food security as well as acting as a fallback or emergency supply of nutrition when other sources fail or become unaffordable (FAO 1996). They also contribute towards other basic needs such as domestic energy, shelter and healthcare.

Table 12: Population living on mangrove and coral reef coastlines

	Population living by mangroves						Population living by coral reefs			
	Length of mangrove coastline (km) (a)	% of total coastline length (b)	Persons within 1 km ('000) (c)	% of coastal zone population	Rural hholds within 2.5 km ('000) (c)	% of rural coastal population	Length of coral reef coastline (km) (d)	% of total coastline length (b)	Persons within 1 km ('000) (c)	% of coastal zone population
Bangladesh	500	62%	345	1.3%	150	3.3%	3	0%	3	0.0%
India	863	17%	482	0.4%	182	1.1%	1,376	27%	220	0.2%
Indonesia	1,002	35%	143	0.7%	36	1.5%	1,315	46%	155	0.8%
Malaysia	724	52%	271	3.5%	40	8.2%	10	1%	10	0.1%
Maldives	-	0%	-	0.0%	-	0.0%	644	100%	-	0.0%
Myanmar	587	23%	82	0.9%	38	2.5%	793	31%	96	1.0%
Sri Lanka	255	21%	61	0.5%	32	1.5%	270	23%	96	0.8%
Thailand	536	49%	64	4.3%	32	11.0%	294	27%	79	5.4%
BOBLME	4,467	28%	1,448	0.8%	509	1.8%	4,705	30%	659	0.4%

(a) measured from data provided in Spalding et al. *2010a,b; (b) coastline length from data provided in BPS 2013, DID 1987, DNP 2013, Joseph 2003, MSPI 2013, Myint Pe 2003, NSO 2012; (c) from population density figures provided in BBS 2012; BPS 2010; DCS 2012; DNP 2007, 2013; JPM 2011; MHA 2011; MOH 2012; NSO 2010; UNDP 2011; (d) measured from data provided in Spalding* et al. *2001, IMaRS-USF 2005, IMaRS-USF and IRD 2005; Note: mainland areas only; Maldives figures refer only to inhabited islands.*

Between 30-40% of the half a million rural households that live within 2.5 km of mangrove areas are thought to be engaged in harvesting non-fish mangrove products (Figure 12, based on data presented in BBS 2012; BPS 2010; DCS 2012; DNP 2013; Emerton 2014; Emerton and Yan Min Aung 2013; MSPI 2007). Mangrove products play a particularly important role in the livelihoods of coastal communities in Myanmar (see Emerton and Yan Min Aung 2013), and in parts of Bangladesh (see Getzner and Islam 2013; Sarker et al. 2010; Singh et al. 2010), India (see Badola et al. 2012; Dahdouh-Guebas et al. 2006; Pattanaik et al. 2008), Indonesia (see ADB 2014; Emerton 2009; Tantu et al. 2012) and Sri Lanka (see Ranasinghe and Kallesoe 2006; IUCN 2003, 2006). While the bulk of harvesting is undertaken by local households in natural areas, in Bangladesh, India, Indonesia and Malaysia mangrove plantations are harvested under a selective cutting regime.

Figure 12: Percentage of households harvesting other mangrove products

Land and water protection

Around 1.5 million people in the BOBLME coastal zone live within 1 km of a mangrove-fringed coastline and 0.65 million people live within 1 km of a coral reef-fringed coastline, and are protected in some way against the effects of storms, cyclones, tidal surges, erosion and other natural hazards (Table 12). The low-lying areas surrounding the BOBLME, which contain a striking concentration of settlements, industries and infrastructure, are particularly vulnerable to these risks.

The Asia-Pacific region is the most disaster-prone area of the world (Velasquez et al. 2012): between 1985 and 2006, more than 1.7 billion people living in the coastal zones of South and Southeast Asia were affected by natural disasters, almost all of which were related to hydro-meteorological events (Zou and Thomalla 2008). Over the last seven years, just under 80 climatological and meteorological natural disasters have been recorded in BOBLME countries, affecting almost 60 million people and incurring total damages in excess of USD 8.3 billion (calculated from data accessed in EM-DAT 2014).

Worsening water quality poses a serious, and growing, problem in the BOBLME. Rapidly increasing silt and pollution loads are being registered in the rivers that enter the sea. Many large and small rivers flow into the Bay of Bengal, including the Ganges, Brahmaputra and Meghna in the north that drain across Bangladesh and India; the Ayeryawady and Thanlwin in the east from Myanmar; and the Mahanadi, Godavari, Krishna and Cauvery in the west from India (BOBLME 2012b). Mangroves play an appreciable role in trapping silts and sediments, and in physically, biologically and chemically treating the water that enters the Bay of Bengal. As well as upholding the quality of domestic water supplies for the 1.5 million people that live within 1 km of a mangrove-fringed coastline, ecosystem water regulation services are of immense benefit to the industries and large-scale water users that are located in the coastal zone. Mangroves also help to maintain the quality and flow of freshwater entering the region's fishing grounds.

Climate adaptation and mitigation

It is thought that current processes of climate variability and change are increasing both the incidence and severity of natural disaster and extreme weather events in coastal zones of South and Southeast Asia, as well as undermining the resilience of both human and natural systems (Fuchs 2010, IPCC 2014). These changes are expected to affect the ecology and biodiversity of the BOBLME, as well as the economy (BOBLME 2012b). Coastal habitats such as mangroves play a key role in reducing vulnerability and strengthening the resilience of coastal livelihoods, settlements and infrastructure to these effects.

The potential of ecosystem-based or 'green' options for climate adaptation and disaster risk reduction has rapidly been gaining in popularity in the region over recent years (Emerton 2014). One particularly valuable set of insights concerns the ability to demonstrate that managing ecosystems for their services is frequently a far cheaper and more cost-effective option than employing artificial technologies or taking remedial or mitigative measures when these essential functions are lost. Every dollar invested in ecosystem-based mitigation in coastal communities is, for example, estimated to save the US taxpayer four dollars in losses from storm-surge effects and other natural hazards (MMC, 2005). In Vietnam, it was calculated that planting 12,000 hectares of mangroves cost $1.1 million but saved an estimated $7.3 million/year in dyke maintenance (Powell et al*.,* 2010). In a Sri Lanka, long-term climate adaptation benefits and costs saved were found to be more than twice as high of the costs of rehabilitating and conserving coastal ecosystems (De Mel and Weerathunge, 2011). Another key making explicit the foregone benefits, or opportunity costs, that occur when ecosystems are converted, modified or replaced to make way for other land uses and economic activities.

In addition to playing a key role in climate adaptation, marine and coastal ecosystems also provide important services in terms of climate mitigation. Data are available which enable these benefits to be quantified in relation to mangrove habitats. The carbon benefits of mangroves can be categorised in three ways: the total stock of carbon that is locked up in mangrove forest and soils, the additional carbon sequestered annually by existing and new forest areas (as compared to alternative land uses), and the emissions avoided by maintaining forest cover and quality rather than allowing it to degrade or be converted to alternative land uses.

The amount of above-ground carbon stored by mangroves is thought to average 231 $tC^{-1}ha^{-1}$ in Southeast Asia and 107 $tC^{-1}ha^{-1}$ in South Asia (Hutchison et al. 2013), while whole-ecosystem stocks (including living and dead wood biomass as well as soil carbon) are estimated to be 1,023 $tC^{-1}ha^{-1}$ in the Indo-Pacific region (Donato et al. 2011). This means that the total amount of above and below-ground carbon stored in BOBLME mangrove forests and soils may exceed 1,6000 MtC (Table 13).

Work carried out in the Western Indian Ocean region suggests that the carbon sequestered by mature mangrove forests (above and below-ground, and in sediments) may be in the region of 6.85 tC $ha^{-1}yr^{-1}$ and that annual avoided emissions can be approximated at 4.85 tC $ha^{-1}yr^{-1}$ (Langat et al. 2013, Githaiga 2013, Huxham et al. in prep.). BOBLME mangroves may thus contribute up to 11 MtC a year in sequestration, and almost 8 MtC in avoided emissions.

Table 13: Mangroves - carbon storage, sequestration and avoided emissions

	Mangrove area (km^2)	Whole-ecosystem carbon stock (MtC)	Carbon sequestration (tC ha-1yr-1)	Avoided emissions (tC ha-1yr-1)
Bangladesh	4,252	435.02	2.91	2.06
India	3,310	338.59	2.27	1.61
Indonesia	2,457	251.36	1.68	1.19
Malaysia	802	82.09	0.55	0.39
Myanmar	3,119	319.02	2.14	1.51
Sri Lanka	84	8.63	0.06	0.04
Thailand	1,768	180.85	1.21	0.86
BOBLME	15,792	1,615.55	10.82	7.66

Based on data presented in Donato et al. *2011; Githaiga 2013; Huxham* et al. *in prep.;Langat* et al. *2013. Mangrove area calculated from FSI 2011;Hasan* et al. *2013; JPM 2013; MFARD 2013; MOECAF 2014; NSO 2013; Saputro* et al. *2009.*

Tourism and recreation

National statistics suggest that the travel and tourism sector directly contributes around 2% of GDP in Bangladesh, India and Myanmar, 3-4% in Indonesia and Sri Lanka, 7-9% in Malaysia and Thailand, and almost 50% in the Maldives (BTB 2013; DOT 2014; KPEK 2014; MHT 2012; MOT 2012; MTAC 2013; SLTDA 2012; Tourism Malaysia 2014). Taking into account indirect and induced impacts in terms of capital investments, private and government spending and supply-chain effects almost triples this share (WTTC 2014a-h).

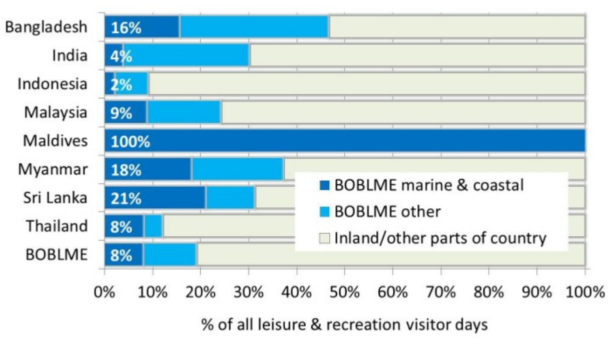
Marine and coastal recreation in the BOBLME is an important segment of the leisure travel market. Of the 65 million international and 0.9 billion domestic tourists and excursionists that visit Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka and Thailand each year, around a quarter of recreational trips are spent in Atolls, Divisions, Provinces, Regions, States & Union Territories abutting the Bay of Bengal (Figure 13). Marine and coastal sea/landscapes remain a popular attraction for both foreign and domestic visitors alike, offering a wide range of activities such as sunbathing, swimming, snorkelling, diving, surfing, boating and other water sports, as well as mass-market beach tourism (Crabtree 2007).

Calculated on the basis of tourists' stated interests and itineraries and using the average trip durations recorded in national statistics, marine and coastal trips account for just under a half of the leisure and recreational time spent in the BOBLME coastal zone – a total of more than 42 million visitor days (Table 14). On a *pro rata* basis, they may support up to 394,000 direct jobs, and almost a million indirect and induced positions.

Table 14: Marine and coastal tourism leisure visitor days and employment impact

	International leisure visitor days (million/year)	Domestic leisure visitor days (million/year)	Employment impact ('000 jobs)
Bangladesh	0.18	1.08	88
India	1.22	0.60	61
Indonesia	0.15	2.79	23
Malaysia	10.37	5.58	36
Maldives	6.10	-	59
Myanmar	0.49	-	40
Sri Lanka	1.54	0.42	33
Thailand	9.97	2.04	55
BOBLME	30.02	12.50	394

Figure 13: Share of BOBLME and marine & coastal tourism in national leisure and recreation numbers



Based on data presented in BTB 2013; DOT 2014; JPM 2012A; KPEK 2014; KPMG 2013; MHT 2012; MOT 2003, 2012; MSPI 2010; MTAC 2013; Parveen 2013; SLTDA 2012; Tourism Malaysia 2014; WTTC 2014a-h.

5 The current economic value of ecosystem services: what natural resources & habitats are worth

This chapter estimates the current value of BOBLME marine and coastal ecosystem services at the regional level, for each of Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka and Thailand, and for key sectors and beneficiary groups.

Summary of baseline ecosystem service values

This following sections of this chapter provide estimates of the current or baseline value of each of the categories of ecosystem services that were identified to be of the greatest importance in economic and human wellbeing terms in the BOBLME, and for which sufficient data were available to enable monetary valuation (as described above in Chapter 3).

Putting together these value estimates suggests that, in total, marine and coastal ecosystem services in the BOBLME may currently be worth more than USD 72 billion a year (Figure 14, Table 15).

It is interesting to note that direct income generated in the fisheries and tourism sectors accounts for only two thirds of this value. The remainder, almost USD 24 billion a year, is comprised of non-commercial and non-use values, and multiplier effects across the economy, including the regulating, supporting, cultural and local-level provisioning services that would conventionally be excluded from economic estimates of the value of marine and coastal resources and habitats.

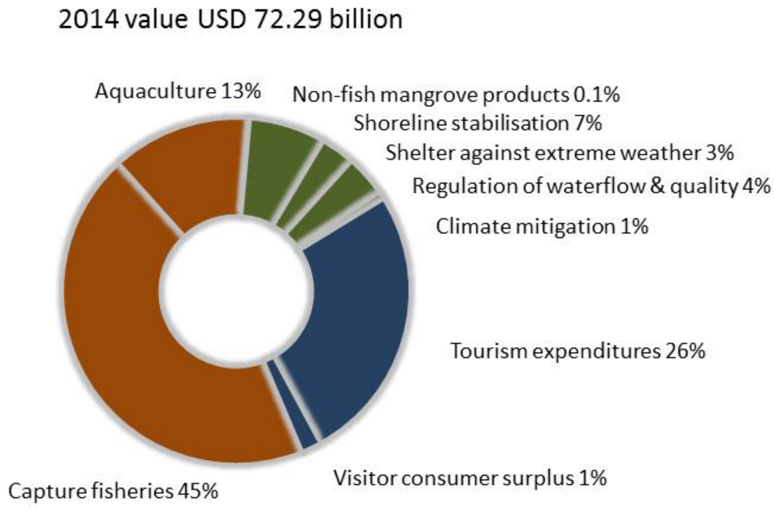


Figure 14: Baseline value of marine and coastal ecosystem services

Table 15: Baseline value of marine and coastal ecosystem services (2014 USD million)

	Bangladesh	India	Indonesia	Malaysia	Maldives	Myanmar	Thailand	Sri Lanka	BOBLME
Capture fisheries	2,937	1,803	1,493	1,185	630	6,881	1,109	485	32,355
Aquaculture	718	1,399	1,381	331	-	295	20	515	9,399
Non-fish mangrove products	8	12	2	0	-	3	3	2	67
Shoreline stabilisation	539	395	515	148	221	537	45	270	5,125
Shelter against extreme weather	138	150	246	58	311	250	51	75	2,286
Regulation of waterflow & quality	351	229	271	86	-	286	7	172	2,785
Climate mitigation	133	104	77	25	-	98	3	55	495
Tourism expenditures	33	660	239	2,925	3,611	153	404	3,297	18,717
Visitor consumer surplus	15	118	51	271	40	9	22	317	1,065
Total	4,872	4,869	4,275	5,029	4,813	8,512	1,664	5,189	72,293

Country figures converted to USD using market exchange rates; BOBLME regional figures expressed in international USD.

Capture fisheries and aquaculture

Table 16: Baseline value of marine and coastal capture fisheries (2014 USD million)

	Finfish (USD million)	Crustaceans (USD million)	Other products (USD million)	Total (USD million)
Bangladesh	2,841	96	-	2,937
India	1,079	690	33	1,803
Indonesia	1,129	278	86	1,493
Malaysia	751	310	125	1,185
Maldives	630	-	-	630
Myanmar	4,077	1,476	1,328	6,881
Sri Lanka	878	231	-	1,109
Thailand	310	105	69	485
Total BOBLME	22,838	6,412	3,105	32,355

Country figures converted to USD using market exchange rates; BOBLME regional figures expressed in international USD. From data presented in DOF 2012; FAO 2014; FRSS 2013; KKP 2012, 2014; MAC 2011a,b; MFA 2012; MFARD 2012; MLF 2012; MOA 2012. "Other products" includes cephalopods and other molluscs, sea cucumbers, shells, seaweed and other marine products.

National statistics indicate that marine and coastal capture fisheries in the BOBLME are worth some USD 32.4 billion a year (Table 16). Finfish contribute the major share of income (just over 70% or USD 22.8 billion), followed by crustaceans (20% or USD 6.4 billion) and then other marine products such as cephalopods and other molluscs, sea cucumbers, shells and seaweed (10% or USD 3.1 billion). As described above, these figures likely represent a significant underestimate of the full value of production, and should therefore be taken as a minimum estimate.

The annual value of marine and coastal aquaculture in BOBLME waters is recorded as being something just under a third that of capture fisheries: just under USD 9.4 billion a year (Table 17). Around two thirds of this value comes from crustaceans (mainly prawns and shrimps), while a third is contributed by finfish.

Table 17: Baseline value of marine and coastal aquaculture (2014 USD million)

	Finfish (USD million)	Crustaceans (USD million)	Other products (USD million)	Total (USD million)
Bangladesh	155	563	-	718
India	325	1,033	41	1,399
Indonesia	1,189	181	11	1,381
Malaysia	214	117	0	331
Maldives	-	-	-	-
Myanmar	7.96	285	2	295
Sri Lanka	0.03	20	0.05	20
Thailand	26	487	2	515
Total BOBLME	3,480	5,788	130	9,399

Country figures converted to USD using market exchange rates; BOBLME regional figures expressed in international USD. From data presented in DOF 2012A; FAO 2014; FRSS 2013; JPM 2012A; KKP 2012, 2014; MAC 2011a,b; MFA 2012; MFARD 2012; MLF 2012; MOA 2012; MOF 2012b. "Other products" includes cephalopods and other molluscs, sea cucumbers, shells, seaweed and other marine products.

Fish breeding and nursery habitats

As described above, a significant proportion of commercial fish species and other marine fauna found in the BOBLME depend on or are associated with mangroves and/or coral reefs for some or all of their life cycle. The current study sought expert advice to estimate the proportion of production for each mangrove/reef-dependent species which can be attributed to the presence of mangroves and/or coral reefs. The results of these calculations indicate that, overall, half of BOBLME fisheries income or USD 16.3 billion is accounted for by mangrove-dependent species, and 15% or USD 5 billion by reef-dependent species (Table 18).

Table 18: Baseline contribution of mangroves and coral reefs to fisheries production (2014 USD million)

	Mangrove-dependent species			Coral reef-dependent species		
	Production ('000 tonnes)	% income	Value (USD million)	Production ('000 tonnes)	% income	Value (USD million)
Bangladesh	382	75%	2,191	4	0.5%	13
India	461	53%	960	324	28%	505
Indonesia	493	55%	825	330	35%	521
Malaysia	290	45%	528	187	19%	221
Maldives	-	0%	-	17	14%	89
Myanmar	716	42%	2,924	221	10%	709
Sri Lanka	161	39%	436	171	31%	347
Thailand	233	51%	246	159	35%	169
Total BOBLME	2,736	50%	16,259	1,412	15%	4,990

Country figures converted to USD using market exchange rates; BOBLME regional figures expressed in international USD. Includes finfish, crustaceans and other marine products.

Household-level harvests of non-fish mangrove products

Data on the incidence and average values of mangrove product utilisation for fuelwood, timber and non-wood products was obtained from a variety of studies carried out in Indian Ocean countries, and applied to rural households living within 2.5 km of mangroves in the BOBLME coastal zone. These calculations suggest that non-commercial harvests of non-fish mangrove products are worth almost USD 70 million a year in the BOBLME region (Table 19). Fuelwood comprises just over half of this value, and timber/polewood and non-wood products each around a quarter.

Table 19: Baseline value of non-fish mangrove products (2014 USD million)

	% hholds harvesting		Average value (USD/user/year)			Gross value (USD million)		
	Fuelwood, poles & timber	Non-wood products	Fuelwood	Poles & timber	Non-wood products	Fuelwood	Poles & timber	Non-wood products
Bangladesh	27%	34%	111	46	36	4.44	1.85	1.82
India	38%	48%	93	39	30	6.48	2.69	2.66
Indonesia	25%	35%	148	62	48	1.33	0.55	0.61
Malaysia	3%	4%	144	60	47	0.17	0.07	0.07
Myanmar	35%	61%	124	51	40	1.64	0.68	0.93
Sri Lanka	40%	50%	119	49	39	1.51	0.63	0.62
Thailand	20%	37%	131	55	43	0.83	0.35	0.50
Total BOBLME	30%	40%	238	99	77	36.08	15.00	15.69

Country figures converted to USD using market exchange rates; BOBLME regional figures expressed in international USD. Incidence of use from BBS 2012; BPS 2010; DCS 2012; DNP 2013; Emerton 2014; Emerton and Yan Min Aung 2013; MSPI 2007. Average household use values from IUCN 2003; Bann 2002; Batagoda 2003; Chand et al. *2013; Chow 2012; Emerton 2014; Gunawardena and Rowan 2005; Islam 2011; IUCN 2006, 2007; Ranasinghe and Kallesoe 2006; Tantu* et al. *2012; UNEP 2011.*

Shoreline stabilisation and erosion control

The shoreline stabilisation and erosion control services provided by mangroves and coral reefs were valued using benefit transfer techniques. The literature review yielded a variety of estimates from studies carried out in BOBLME countries, mostly based on avoided coastal reclamation expenditures. These estimates were expressed both in terms of area (i.e. per hectare of mangrove/reef) and length (i.e. per km of protected coastline). Length-based values however displayed such a high degree of variance between different studies that they were not used. Applying average per hectare values yielded estimates of USD 4.3 billion and USD 0.9 billion for the shoreline stabilisation and erosion control services of mangroves and coral reefs respectively (Table 20).

Table 20: Baseline value of shoreline stabilisation & erosion control (2014 USD million)

	Mangroves		Coral reefs	
	Value per unit area (USD/ha)	Total value (USD million)	Value per unit area (USD/ha)	Total value (USD million)
Bangladesh	1,266	538	470	0.38
India	1,062	352	394	43
Indonesia	1,690	415	628	100
Malaysia	1,635	131	607	17
Maldives	2,096	-	778	221
Myanmar	1,409	439	523	98
Sri Lanka	1,349	11	501	34
Thailand	1,493	264	554	6
Total BOBLME	2,706	4,273	1,005	851

Country figures converted to USD using market exchange rates; BOBLME regional figures expressed in international USD. From Burke et al. *2002; Cesar* et al. *2003; De Mel and Weerathinga 2011; Emerton 2005, 2014; Riopelle 1995; Ruitenbeek 1994; Samonte-Tan* et al. *2007; Phuviriyakul 2007; Sathirathai 1998; Wilkinson* et al. *1999.*

Shelter against extreme weather

The role of mangroves and coral reefs in providing shelter against extreme weather was also valued using benefit transfer, based on studies carried out in other BOBLME and other Coral Triangle countries. Most of the estimates found in the literature are based on the replacement cost techniques, and look at engineered storm protection defences. As was the case with shoreline stabilisation and erosion control, length-based values (i.e. value per km of protected coastline) displayed such a high degree of variability between different sources that they were not used in the current study. Applying average per hectare values yielded estimates of USD 1.1 billion and USD 1.2 billion for the services provided by mangroves and coral reefs respectively in providing shelter against extreme weather (Table 21).

Table 21: Baseline value of shelter against extreme weather (2014 USD million)

	Mangroves		Coral reefs	
	Value per unit area (USD/ha)	Total value (USD million)	Value per unit area (USD/ha)	Total value (USD million)
Bangladesh	323	137	661	0.53
India	271	90	554	61
Indonesia	431	106	882	140
Malaysia	417	33	854	24
Maldives	534	-	1,094	311
Myanmar	359	112	736	138
Sri Lanka	344	3	704	48
Thailand	380	67	779	8
Total BOBLME	690	1,089	1,413	1,197

Country figures converted to USD using market exchange rates; BOBLME regional figures expressed in international USD. Average protective values from data presented in Badola and Hussain 2005; Bann 1997, Batagoda 2003; 1999; Burke et al. *2002; Cesar* et al. *2003; Emerton 2005, 2014; Hargreaves-Allen 2004; McAllister 1991; Seenprachawong 2003; Spurgeon1992; Tri* et al. *1998; UNEP 2011; White and Cruz-Trinidad 1998.*

Regulation of waterflow & quality

Benefit-transfer techniques were used to value mangrove waterflow and quality regulation services. They drew on a studies carried out in three mangrove areas of Sri Lanka which calculated avoided expenditures on sourcing alternative freshwater supplies (for prevention of saline intrusion) and replacement costs of engineered wastewater treatment and sediment trapping processes. Applying average per hectare values yielded estimates of USD 860 million and USD 1.9 billion for protection against saline intrusion and wastewater processing/sediment trapping respectively (Table 22).

Table 22: Baseline value of regulation of waterflow & quality (2014 USD million)

	Protection against saline intrusion		Wastewater processing & sediment trapping	
	Value per unit area (USD/ha)	Total value (USD million)	Value per unit area (USD/ha)	Total value (USD million)
Bangladesh	254	108	571	243
India	214	71	479	158
Indonesia	340	83	762	187
Malaysia	329	26	737	59
Maldives	421	-	945	-
Myanmar	283	88	635	198
Sri Lanka	271	2	608	5
Thailand	300	53	673	119
Total BOBLME	544	859	1,220	1,926

Country figures converted to USD using market exchange rates; BOBLME regional figures expressed in international USD. Average protective values from data presented in Emerton 2014; Emerton and Kekulandala 2003; IUCN 2003.

Climate mitigation

Mangrove climate mitigation services were valued using the prevailing voluntary carbon market price of USD 7.03/tCO_2e for issued credits from Climate, Community and Biodiversity Standard (CCBA), Verified Carbon Standard (VCS) and Reduced Emissions from Deforestation and Forest Degradation (REDD+) projects. This price was applied to the carbon stock and annual carbon sequestration/avoided emissions that had been calculated for BOBLME mangroves (see Chapter 4). These calculations suggest that the carbon stored in BOBLME mangroves is worth just over USD 43 billion, while the annual value of carbon sequestration and avoided emissions totals USD 700 million a year (Table 23).

Table 23: Baseline value of carbon storage, sequestration & avoided emissions (2014 USD million)

	Stock (USD million)	Sequestration (USD million/year)	Avoided emissions (USD million/year)	Annual carbon value (USD million/year)
Bangladesh	11,655	78	55	133
India	9,071	61	43	104
Indonesia	6,734	45	32	77
Malaysia	2,199	15	10	25
Myanmar	8,547	57	41	98
Sri Lanka	231	2	1	3
Thailand	4,845	32	23	55
Total BOBLME	43,282	290	205	495

Country figures converted to USD using market exchange rates; BOBLME regional figures expressed in international USD. Carbon stock, sequestration and avoided emissions calculated from Donato et al. *2011; Githaiga 2013; Huxham* et al. *in prep.; Langat* et al. *2013. Mangrove area calculated from FSI 2011;Hasan* et al. *2013; JPM 2013; MFARD 2013; MOECAF 2014; NSO 2013; Saputro* et al. *2009.Carbon price from Ecosystem Marketplace 2013; factor of 3.67 used to convert from tC to tCO_2e.*

Marine & coastal tourism and recreation

As already described above (see Chapter 4), it is estimated that around 42 million leisure visitor days are spent in marine and coastal areas of the BOBLME portion of Bay of Bengal countries. Using national statistics on average daily expenditures for international and domestic leisure visitors, this is activities are estimated to generate direct income worth just under USD 8.4 billion a year (Table 24).

Table 24: Tourism expenditures (2014 USD million)

	International visitors			Domestic visitors			
	Tourist leisure trips (million/year)	Average length of trip (days)	% visitors marine & coastal	Tourist leisure trips (million/year)	Excursionist leisure trips (million/year)	Tourists average length of trip	% visitors marine & coastal
Bangladesh	0.10	2.3	74%	1.04	1.04	2.3	31%
India	0.46	3.4	79%	1.24	7.73	3.4	5%
Indonesia	0.24	2.6	25%	2.78	5.65	2.0	25%
Malaysia	5.92	3.5	50%	6.14	6.78	2.5	25%
Maldives	0.91	6.7	100%		-	-	0%
Myanmar	0.28	3.5	49%		-	-	0%
Sri Lanka	0.41	5.0	75%	0.26	0.18	2.5	50%
Thailand	3.40	3.9	75%	1.22	0.26	3.1	50%
Total BOBLME	11.72	3.9	66%	12.70	21.64	2.5	26%

	Expenditure (average USD/day)			Total direct expenditures (USD million	Indirect & induced spending multiplier	Total expenditures (USD million
	international tourists	Domestic tourists	Domestic excursionists			
Bangladesh	39	11	3	15.99	2.07	33.07
India	174	11	5	216.70	3.04	659.77
Indonesia	147	38	4	79.96	2.99	238.88
Malaysia	98	70	7	1,301.79	2.25	2,925.34
Maldives	301	-	-	1,834.17	1.97	3,610.68
Myanmar	135	-	-	65.85	2.32	152.72
Sri Lanka	103	34	3	169.72	2.38	403.73
Thailand	134	71	35	1,474.89	2.24	3,297.36
Total BOBLME	250	97	8	8,377	2.62	21,945

Country figures converted to USD using market exchange rates; BOBLME regional figures expressed in international USD. Tourist numbers, length of stay and average expenditures based on data presented in BTB 2013; DOT 2014; JPM 2012A; KPEK 2014; KPMG 2013; MHT 2012; MOT 2003, 2012; MSPI 2010; MTAC 2013; Parveen 2013; SLTDA 2012; Tourism Malaysia 2014.

As well as its direct economic impact, tourism and recreation has significant indirect and induced impacts. The indirect contribution includes the income and jobs supported by investment spending, government 'collective' spending and domestic purchases of goods and services by the sectors dealing directly with tourists, while the induced contribution measures the income and employment supported by the spending of those who are directly or indirectly employed in the travel and tourism industry. Applying a multiplier based on country statistics generated via the use of the Tourism Satellite Accounting methodology (see JPM 2012a; WTTC 2014b-h) suggests that the total contribution of marine and coastal tourism and recreation to the economy is around two and a half times higher than its direct effects: almost USD 22 billion a year.

Table 25: Visitor consumer surplus (2014 USD million)

	International visitors			Domestic visitors		
	% international visitors willing to pay	Average stated consumer surplus (USD/trip)	Total value (USD million)	% domestic visitors willing to pay	Average stated consumer surplus (USD/trip)	Total value (USD million)
Bangladesh	50%	84	8	33%	14	7
India	50%	84	56	33%	12	62
Indonesia	50%	84	4	33%	19	47
Malaysia	50%	84	167	33%	18	103
Maldives	50%	84	40	33%	23	-
Myanmar	50%	84	9	33%	16	-
Sri Lanka	50%	84	17	33%	15	4
Thailand	50%	84	295	33%	16	22
Total BOBLME	50%	84	597	33%	30	468

Country figures converted to USD using market exchange rates; BOBLME regional figures expressed in international USD. Visitor willingness to pay based on data presented in Ahmed et al. *2005, 2007; Arin and Kramer 2002; Asafu-Adjaye and Tapsuwan 2008; Aungsuviriya 2010; Chanrawong 2002; Ibrahim* et al. *2012; Luangchosiri 2003; Mathieu 2003; Othman and Rahajeng ; Piriyapada and Wang 2014; Suwanrattanasri 2002; Yeo 2005;* สุมาลี สรงอุบล *2550;* ณัฐพร กิจสืบ *2549;* ณัฐพร กิจสืบ *2549;* อุษา ลานแดง *2548.*

Looking only at visitor spending would however underestimate the value of marine and coastal tourism. The total value of marine and coastal sea/landscapes and species to leisure visitors is typically far higher than the price that they pay for their trips. Consumer surplus[2] was calculated using benefit transfer techniques, drawing on the large volume of travel cost and contingent valuation studies that has been carried out in snorkelling, dive and marine protected area sites in BOBLME, Indian Ocean and Coral Triangle countries. Visitor expenditures (as shown above in Table 24) were deducted from these estimates, so as to avoid double counting. This yields an estimate for marine and coastal visitor consumer surplus of USD 1.1 billion a year (Table 25): around an eighth as much again as direct trip expenditures.

[2] Consumer surplus can be defined as a measure of consumer satisfaction or benefit which is based on the difference between people's willingness to pay for a commodity and the actual price paid by them

6 The economic consequences of ecosystem change: weighing up the gains & losses

This chapter assesses the economic losses and damages that might arise should the BOBLME natural environment continue to be degraded and over-exploited, with a view to identifying the value-added and costs avoided from implementing a Strategic Action Programme designed to better the lives of coastal population through improved regional management of the Bay of Bengal environment.

Economic costs, losses and damages from continuing business as usual

According to national census projections, by the year 2039 the BOBLME coastal zone population will have increased by 22%, to almost 230 million people or 54 million households (Figure 15). Meanwhile, under the business as usual (BAU) scenario, mangrove cover is anticipated to decline by almost a half over the next 25 years to just under 8,800 km^2 and coral reef area will contract by 40% to 5,000 km^2, while the length of mangrove and coral protected coastline will reduce by 27% and 23% respectively[3] (Figure 17).

Figure 15: Coastal zone population growth 2014-39

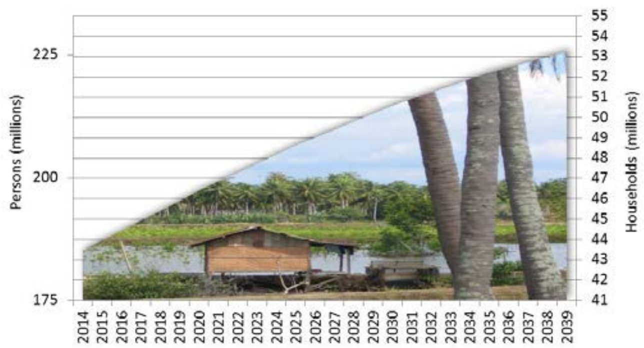
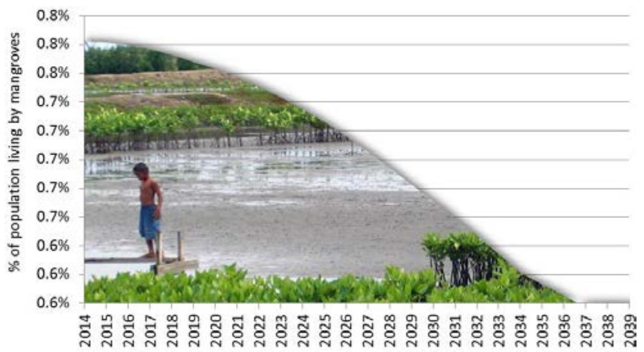
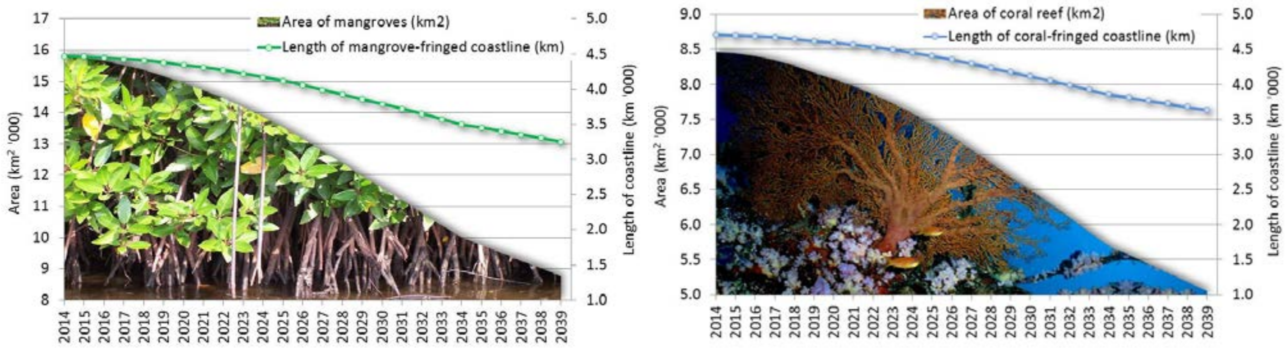


Figure 16: Mangrove-adjacent population under BAU 2014-39



Based on data in BBS 2012; BPS 2010; DCS 2012; DNP 2007, 2013; JPM 2011; MHA 2011; MOH 2012; NSO 2010; UNDP 2011.

Figure 17: Change in mangrove and coral reef area and coastline under BAU 2014-39



From data presented in BPS 2013; Bruno and Selig 2007; Burke et al. *2011, 2012; DNP 2013; FAO 2007; FSI 2011;Hasan* et al. *2013; JPM 2013; MFARD 2013; MOECAF 2014; NSO 2013; Saputro* et al. *2009.*

[3] To estimate the impact of changes in mangrove and coral reef cover on the length of protected coastline, a simple calculation was carried out which assumed that annual area losses are evenly distributed around three sides of a rectangular mangrove/coral reef patch (the fourth side is the coastline). The length of protected coastline lost each year is calculated by deducting a length equivalent to the square root of the area for that year divided by the ratio of habitat length to breadth, multiplied by the ratio of habitat length to breadth.

Under the BAU scenario the value of mangrove and coral reef ecosystem services will decrease, in line with the reduction in natural habitats. The annual value of marine and coastal ecosystem services will progressively decline over the next 25 years, from today's value of just under USD 52 billion[4] to a value of USD 30 billion by 2039 (Figure 18). This pattern of decreasing ecosystem service values is repeated across all of the BOBLME countries (Figure 19).

Figure 18: Marine and coastal ecosystem values for the BOBLME region 2014-39 (2014 international USD billion)

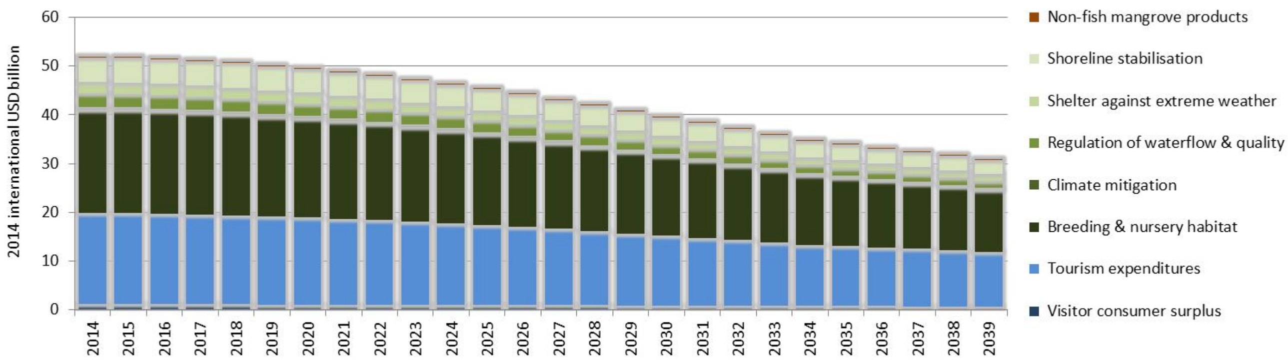
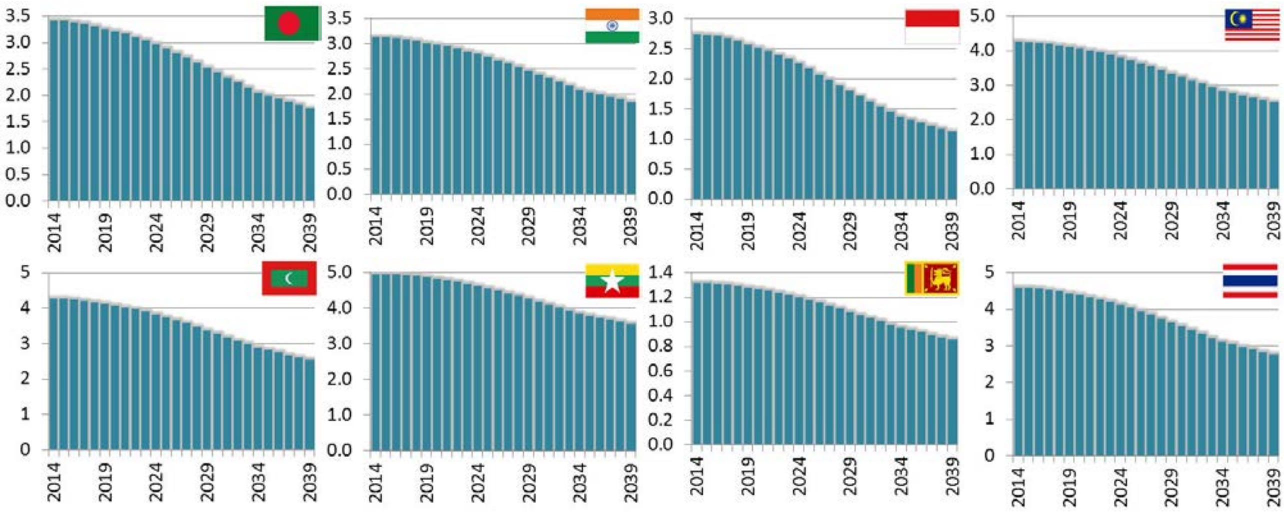


Figure 19: Marine and coastal ecosystem values for BOBLME countries 2014-39 (2014 USD billion)



Modelling the business as usual scenario therefore indicates that BOBLME mangrove and coral reef habitats will generate ecosystem services worth just over USD 1.1 trillion up to 2039, with a net present value (NPV) of USD 430 billion (Table 26, Table 27). This is considerably lower than the values generated for the SAP scenario, under which baseline ecosystem services are maintained. The annual loss of ecosystem service values will increase progressively over the next 25 years, as natural habitats become more and more degraded (Figure 20), to a cumulative loss of almost USD 240 billion by 2039 (Figure 21). This loss is felt across all the BOBLME countries (Figure 22). The incremental costs, losses and damages from BAU are particularly pronounced for regulating services (shoreline stabilisation, shelter against extreme weather and regulation of waterflow and quality) and for income generated in the fisheries and tourism sectors.

[4] This is a smaller figure that the baseline value referred to in Chapter 4 of USD 72.29 billion, which includes the total value of capture fisheries and aquaculture. Because the modelling of BAU and SAP scenarios focuses on marginal changes in mangrove and coral reef-related services, it looks only at the portion of (capture) fisheries income that can be attributed to mangrove and coral reef dependent/associated species.

Table 26: Total value of ecosystem services 2014-39 under SAP and BAU scenarios (2014 USD billion)

	BD	IN	ID	MY	MV	MM	SL	TH	BOBLME
Business as Usual (BAU)									
Non-fish mangrove products	0.21	0.31	0.06	0.01	-	0.09	0.07	0.02	1.69
Shoreline stabilisation	10.98	8.41	9.29	3.14	4.75	12.35	1.00	5.86	107.45
Shelter against extreme weather	2.81	3.21	4.83	1.23	6.67	5.57	1.10	1.64	48.42
Regulation of waterflow & quality	7.15	4.87	4.66	1.81	-	6.68	0.17	3.74	58.12
Climate mitigation	2.72	2.21	1.33	0.53	-	2.28	0.06	1.20	10.33
Breeding & nursery habitat	44.95	31.25	25.38	15.89	1.91	83.45	17.61	8.98	456.96
Tourism expenditures	0.71	14.16	5.13	62.80	77.52	3.28	8.67	70.77	401.77
Visitor consumer surplus	0.32	2.52	1.11	5.81	0.86	0.20	0.46	6.81	22.86
Total	69.84	66.94	51.79	91.21	91.71	113.89	29.14	99.02	1,107.59
Maintenance of baseline/Strategic Action Programme (SAP)									
Non-fish mangrove products	0.21	0.31	0.06	0.01	-	0.08	0.07	0.04	1.74
Shoreline stabilisation	14.01	10.26	13.39	3.86	5.75	13.97	1.18	7.01	133.24
Shelter against extreme weather	3.58	3.91	6.39	1.50	8.08	6.49	1.32	1.96	59.43
Regulation of waterflow & quality	9.12	5.96	7.04	2.22	-	7.44	0.19	4.47	72.41
Climate mitigation	3.47	2.70	2.00	0.65	-	2.54	0.07	1.44	12.87
Breeding & nursery habitat	57.30	38.08	34.97	19.47	2.31	94.45	20.34	10.79	552.48
Tourism expenditures	0.86	17.15	6.21	76.06	93.88	3.97	10.50	85.73	486.64
Visitor consumer surplus	0.39	3.06	1.34	7.03	1.05	0.24	0.56	8.25	27.69
Total	88.94	81.43	71.40	110.81	111.06	129.18	34.24	119.71	1,346.50
Incremental economic costs, losses and damages from BAU									
Non-fish mangrove products	-0.00	0.00	-0.01	-0.00	-	0.00	0.00	-0.02	-0.04
Shoreline stabilisation	-3.02	-1.86	-4.09	-0.72	-1.00	-1.61	-0.18	-1.15	-25.79
Shelter against extreme weather	-0.77	-0.70	-1.56	-0.27	-1.41	-0.92	-0.22	-0.32	-11.02
Regulation of waterflow & quality	-1.97	-1.08	-2.37	-0.42	-	-0.76	-0.02	-0.73	-14.29
Climate mitigation	-0.75	-0.49	-0.68	-0.12	-	-0.26	-0.01	-0.24	-2.54
Breeding & nursery habitat	-12.36	-6.83	-9.59	-3.59	-0.40	-11.00	-2.73	-1.82	-95.52
Tourism expenditures	-0.15	-3.00	-1.08	-13.26	-16.36	-0.69	-1.83	-14.96	-84.87
Visitor consumer surplus	-0.07	-0.53	-0.23	-1.23	-0.18	-0.04	-0.10	-1.44	-4.83
Total	-19.09	-14.49	-19.62	-19.60	-19.36	-15.29	-5.10	-20.68	-238.90

Country figures converted to USD using market exchange rates; BOBLME regional figures expressed in international USD.

Table 27: NPV of ecosystem services 2014-39 under SAP and BAU scenarios (2014 USD billion)

	BD	IN	ID	MY	MV	MM	SL	TH	BOBLME
Business as Usual (BAU)ju									
Non-fish mangrove products	0.08	0.11	0.02	0.00	-	0.03	0.03	0.01	0.61
Shoreline stabilisation	4.37	3.27	3.93	1.23	1.84	4.63	0.38	2.26	42.17
Shelter against extreme weather	1.12	1.25	1.96	0.48	2.59	2.12	0.42	0.63	18.91
Regulation of waterflow & quality	2.85	1.90	2.02	0.71	-	2.49	0.06	1.44	22.86
Climate mitigation	1.08	0.86	0.58	0.21	-	0.85	0.02	0.46	4.06
Breeding & nursery habitat	17.90	12.16	10.50	6.21	0.74	31.31	6.67	3.47	177.10
Tourism expenditures	0.28	5.49	1.99	24.36	30.07	1.27	3.36	27.46	155.87
Visitor consumer surplus	0.12	0.98	0.43	2.25	0.33	0.08	0.18	2.64	8.87
Total	27.80	26.03	21.43	35.46	35.58	42.78	11.13	38.38	430.45
Maintenance of baseline/Strategic Action Programme (SAP)									
Non-fish mangrove products	0.07	0.11	0.02	0.00	-	0.03	0.03	0.02	0.61
Shoreline stabilisation	4.93	3.62	4.72	1.36	2.03	4.92	0.42	2.47	46.95
Shelter against extreme weather	1.26	1.38	2.25	0.53	2.85	2.29	0.47	0.69	20.94
Regulation of waterflow & quality	3.21	2.10	2.48	0.78	-	2.62	0.07	1.58	25.51
Climate mitigation	1.22	0.95	0.71	0.23	-	0.90	0.02	0.51	4.53
Breeding & nursery habitat	20.19	13.42	12.32	6.86	0.81	33.28	7.17	3.80	194.66
Tourism expenditures	0.30	6.04	2.19	26.80	33.08	1.40	3.70	30.21	171.46
Visitor consumer surplus	0.14	1.08	0.47	2.48	0.37	0.08	0.20	2.91	9.76
Total	31.34	28.69	25.16	39.04	39.13	45.52	12.06	42.18	474.43
Incremental economic costs, losses and damages from BAU									
Non-fish mangrove products	0.00	0.00	-0.00	0.00	-	0.00	0.00	-0.01	-0.00
Shoreline stabilisation	-0.56	-0.34	-0.78	-0.13	-0.18	-0.29	-0.03	-0.21	-4.78
Shelter against extreme weather	-0.14	-0.13	-0.29	-0.05	-0.26	-0.17	-0.04	-0.06	-2.03
Regulation of waterflow & quality	-0.37	-0.20	-0.46	-0.08	-	-0.13	-0.00	-0.13	-2.65
Climate mitigation	-0.14	-0.09	-0.13	-0.02	-	-0.05	-0.00	-0.04	-0.47
Breeding & nursery habitat	-2.29	-1.26	-1.82	-0.65	-0.07	-1.96	-0.50	-0.33	-17.56
Tourism expenditures	-0.03	-0.55	-0.20	-2.43	-3.01	-0.13	-0.34	-2.75	-15.59
Visitor consumer surplus	-0.01	-0.10	-0.04	-0.23	-0.03	-0.01	-0.02	-0.26	-0.89
Total	-3.54	-2.66	-3.73	-3.59	-3.56	-2.74	-0.93	-3.80	-43.98

Country figures converted to USD using market exchange rates; BOBLME regional figures expressed in international USD.

Figure 20: Annual loss of ecosystem service values under business as usual for the BOBLME region 2014-39 (2014 international USD billion)

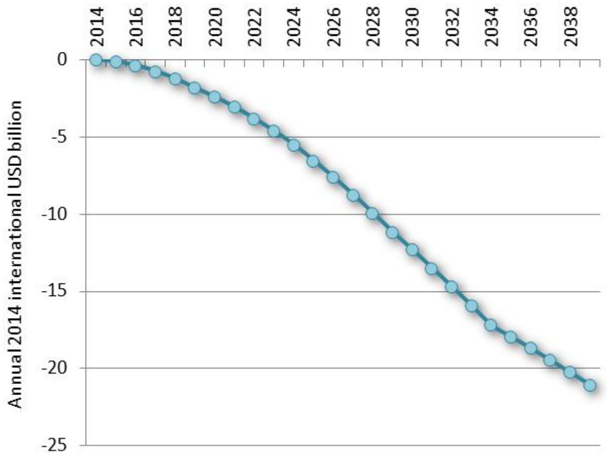


Figure 21: Cumulative loss of ecosystem service values under business as usual for the BOBLME region 2014-39 (2014 international USD billion)

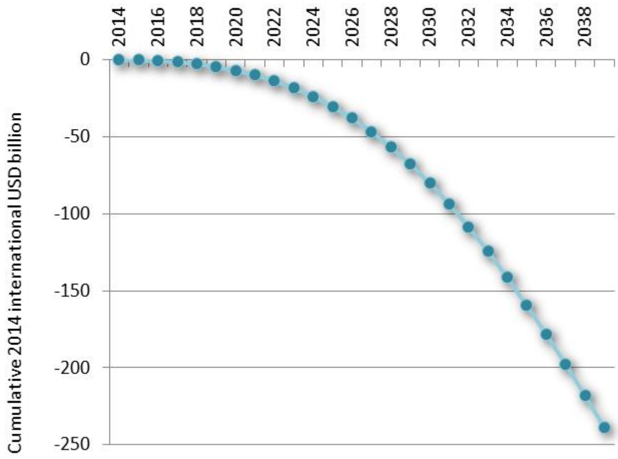
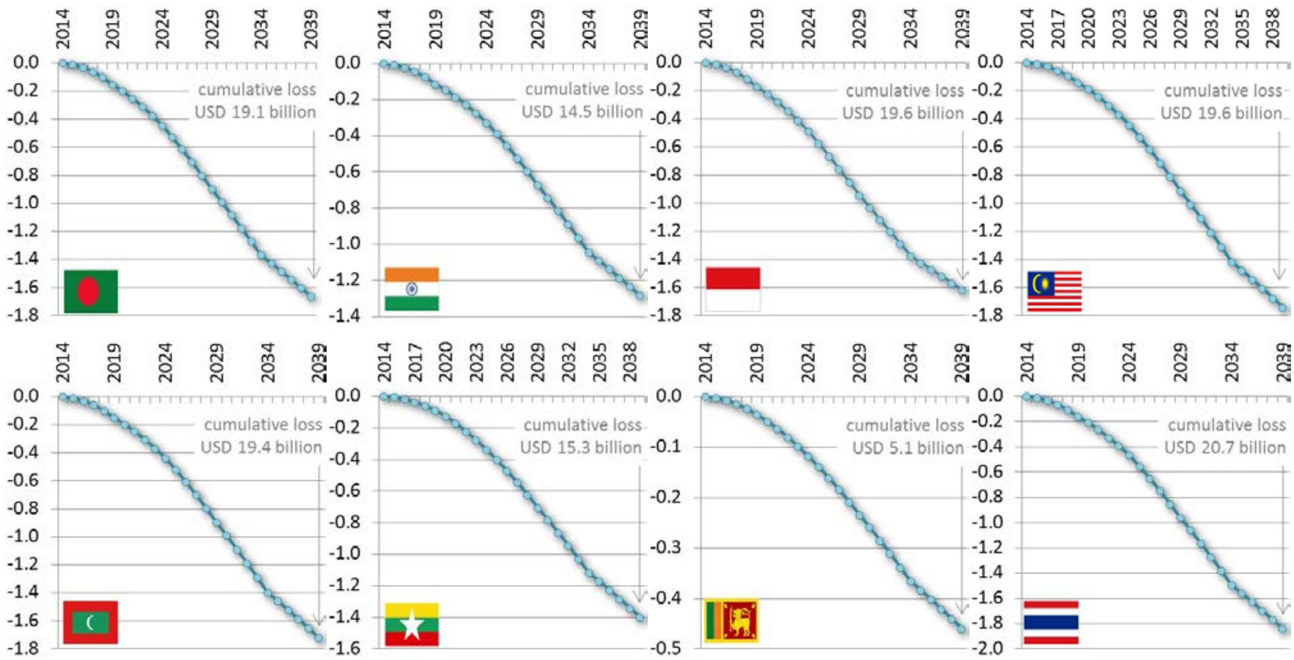


Figure 22: Annual and cumulative loss of ecosystem service values under business as usual for BOBLME countries 2014-39 (2014 USD billion)



Making the economic case for the BOBLME Strategic Action Programme

Not only does the comparison of marine and coastal ecosystem values under BAU and SAP scenarios underline the high economic costs, losses and damages from failing to take action to halt marine and coastal biodiversity loss and ecosystem degradation in the BOBLME, but it also presents a strong economic argument for investing in a Strategic Action Programme for the Bay of Bengal. The value-added and costs avoided from the SAP are substantial. This is the case even under the very conservative or minimal scenario modelled in the current study (that the SAP will serve only to halt any further degradation of mangrove and coral reef habitats). As mentioned above, it is to be hoped that the SAP would in reality serve to improve the status – and thus economic value – of marine and coastal ecosystems considerably above the current baseline.

For the BOBLME region as a whole, setting in place the SAP will help to secure ecosystem values worth USD 1.3 trillion in total over the next 25 years. The annual value of economic benefits and costs avoided from the maintenance of biodiversity and ecosystem, services translates to a value of some USD 280 per capita of the coastal zone population, equivalent to over 6% of average per capita GDP (Table 28). In the Maldives this figure rises to more than one and a half times per capita GDP (indicating the extremely high value of ecosystem services which remain unaccounted for in official GDP estimates), in Myanmar and Sri Lanka 57%, and in Bangladesh more than 12%.

Table 28: Summary of marine and coastal ecosystem service values (2014 USD million/year)

	Bangladesh	India	Indonesia	Malaysia	Maldives	Myanmar	Thailand	Sri Lanka	BOBLME
Total value (USD billion over 25 years)	85.52	78.29	68.66	106.55	106.79	124.22	32.92	115.10	1,294.71
Annual value (USD million/year)	3,421	3,132	2,746	4,262	4,272	4,969	1,317	4,604	51,788
Value per capita of coastal zone population (USD/year)	127	29	143	548	11,880	523	113	3,109	280
As % of per capita GDP	12.5%	1.8%	4.2%	4.8%	160.5%	57.4%	3.3%	57.0%	6.0%

Country figures converted to USD using market exchange rates; BOBLME regional figures expressed in international USD.

Overall, investing in the SAP therefore stands to safeguard USD 239 billion of ecosystem service values that will remain available if natural resources and habitats are not further degraded, but would be lost if action is not undertaken to foster improved regional management of the Bay of Bengal environment and its fisheries (Figure 23). This value-added accrues in all of the Bay of Bengal countries (Figure 24).

Figure 23: Ecosystem service values that will remain available under the SAP 2014-39 (2014 international USD billion)

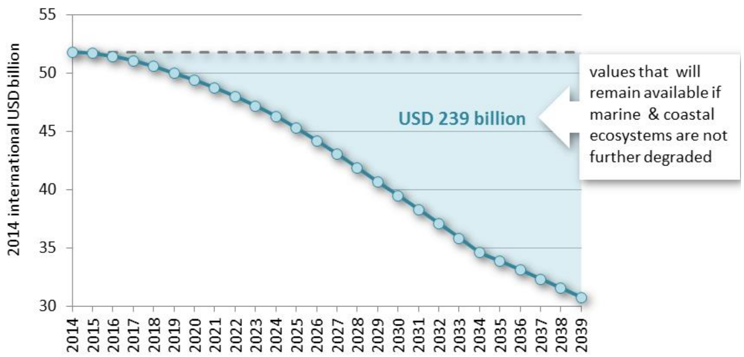


Figure 24: Costs and losses avoided from investing in the SAP 2014-39 (2014 USD billion)

Country figures converted to USD using market exchange rates; BOBLME regional figures expressed in international USD.

7 Needs, niches & options for economic instruments: securing incentives an d finance for conservation

This chapter presents a generic list of economic instruments to enhance the sustainable management of marine and coastal habitats and resources, that could be used to secure incentives and finance to support the implementation of the Strategic Action Programme.

How ecosystem benefits and costs are distributed and captured

The Transboundary Diagnostic Analysis (TDA) identifies three main transboundary environmental issues in the Bay of Bengal:

- **Overexploitation of living marine resources**, including a decline in the overall availability of fish resources, changes in species composition of catches, high proportion of juvenile fish in the catch, and changes in marine biodiversity especially through loss of vulnerable and endangered species;
- **Degradation of critical habitats**, including the loss and degradation of mangrove habitats, degradation of coral reefs and loss of, and damage to, seagrass; and
- **Worsening pollution and water quality**, including solid waste/marine litter, increasing nutrient inputs, oil pollution, persistent organic pollutants and persistent toxic substances, sedimentation and heavy metals.

Economic forces and factors underlie many of these threats. According to the TDA, the drivers of environmental degradation range from widespread poverty, insecure livelihoods and a lack of alternative business, income and employment opportunities, through the provision of subsidies and other economic stimuli to increase resource exploitation and expand production as well as low or ineffective penalties against unsustainable or illegal activities, to insufficient funding for environmental management and enforcement (BOBLME 2012a, 2012b).

The TDA concludes that action is required both to improve the management of living and renewable resources, and to reduce and abate pollution. This includes addressing the economic forces and conditions that drive resource overexploitation, habitat degradation and pollution.

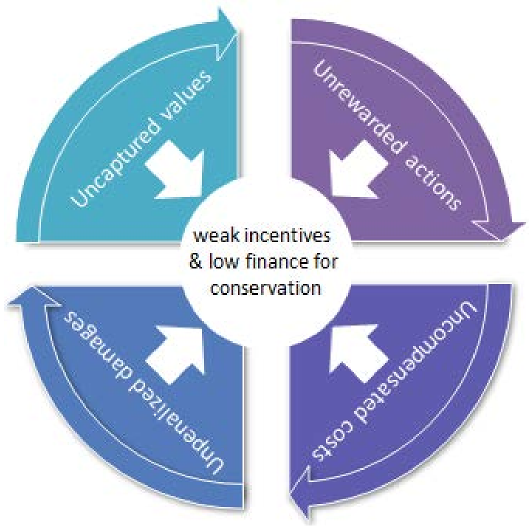
The foregoing analysis of ecosystem-economic linkages and values provides important background information with which to better understand the causes of environmental degradation and loss, and inform the responses and solutions that will be developed as part of the Strategic Action Programme (SAP). The valuation study shows that, even though a wide range of groups depend or impact on biodiversity and ecosystem services in the BOBLME, many of these values are not fully captured: they accrue outside formal markets, or are delivered as externalities to other actors, sectors or sites. Environmental costs and benefits therefore tend to be distributed unevenly across different stakeholders and economic activities.

This uneven distribution and capture of costs and benefits has implications for which activities are perceived to be the most attractive, feasible and profitable in economic terms, and exerts a strong influence over how people use and manage the natural environment in the course of carrying out their day-to-day economic activities. Ultimately it leads to a vicious cycle of unrewarded conservation actions, uncompensated conservation costs, unpenalized environmental damages and uncaptured ecosystem values, which, together, act to perpetuate a situation of weak incentives and low finance for biodiversity and ecosystem conservation (Figure 25):

- **Unrewarded conservation actions.** The groups that conserve biodiversity and secure the continued provision of ecosystem services do not necessarily gain in material terms from their actions. There are relatively few price, market or income advantages to be gained from shifting to more sustainable production and consumption practices. This means that the products, investments and actions that might contribute to biodiversity and ecosystem conservation in the BOBLME continue to go largely unrewarded – even if they result in significant gains or costs avoided for other stakeholders and economic activities;
- **Uncompensated conservation costs.** Meanwhile, many of the costs of biodiversity and ecosystem conservation remain uncompensated. For instance, the government agencies charged with environmental management in the BOBLME tend to receive extremely low budgets, and little funding or investment capital is available to support community-led or corporate initiatives. As a result both the direct and the opportunity costs of conservation tend to be chronically underfunded – in many cases people are unwilling (and frequently also economically unable) to bear these costs;
- **Unpenalized environmental damages.** Both the price of environmentally-harmful products and activities, and the penalties for causing environmental harm, tend to be low or non-existent. For the most part, the fees, charges and taxes levied on natural resources use, pollution and environmental damage do not adequately reflect either the losses associated with biodiversity loss and ecosystem degradation or the costs required to mitigate, remediate and clean up any environmental damages caused. In consequence, there are few economic motivations for people to produce, consume or invest in environmentally-sustainable ways and levels; and
- **Uncaptured ecosystem values.** Prices and markets for most ecosystem services simply do not exist. There has been relatively little attention paid to identifying, researching and developing "green" production, consumption and investment opportunities, or to mobilising the credit, funding and other support that is required to bring them into the mainstream. Much of the economic potential of ecosystem services is not being captured, meaning that potentially valuable income, employment and business opportunities remain as yet unavailable and untapped.

It is clear that what are essentially the underlying economic causes of environmental degradation also require economic responses. In the context of working towards improved regional management of the Bay of Bengal environment and its fisheries, the gaps and opportunities listed above need to be addressed if the SAP is to be economically viable, acceptable and sustainable over the long term. Of overriding importance is the need to secure adequate funding for biodiversity and ecosystem conservation, to provide economic incentives for people to use and manage natural habitats and resources sustainably, and to ensure that effective economic controls and sanctions are in place to regulate the activities that result in pollution and environmental degradation.

Figure 25: Uneven distribution and capture of environmental benefits & costs



Potential economic instruments for the sustainable management of marine and coastal resources

Approaches to environmental management in the BOBLME region have, traditionally, relied heavily, on command and control measures which use laws and regulations to restrict economic activities and impose penalties for non-compliance. Most countries in the Bay of Bengal have a comprehensive framework of laws and regulations to govern the management and use of marine and coastal resources and habitats. Examples include the gazettment of protected areas, the imposition of quotas, allocations or bans on particular land and resource uses, and binding environmental quality standards. Another common response has been to take action to mitigate, remedy or replace the loss of biodiversity and ecosystem services, once environmental damage has occurred. Examples include installing additional water treatment and purification technologies to deal with industrial pollution, building constructing shoreline protection and flood control works as a response to the conversion and degradation of coastal habitats, cleaning up oil spills and eradicating alien invasive species.

Neither approach, by itself, has proved wholly effective – either in reducing current and future environmental threats, or in remedying past environmental damages. Regulations have proved to be expensive and difficult to enforce, are often politically unpopular, and can impose significant costs on people by limiting their economic activities. Environmental mitigation also demands substantial public and private expenditures, and is rarely ever more than a temporary, partial solution.

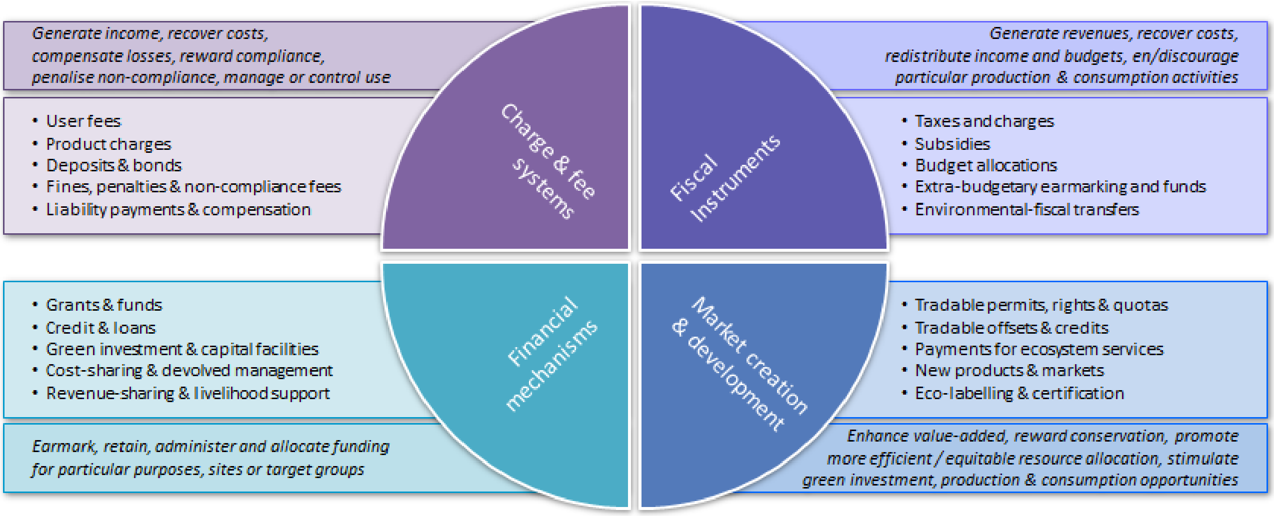
One critical problem is that conservation funding is extremely scarce in most BOBLME countries, and few governments in the region are able to afford the high levels of spending that are required to effectively enforce environmental regulations or alleviate the effects of environmental damage. Another issue is that neither the gains associated with sustainable environmental management nor the damages and losses arising from resource degradation are fully reflected in the policies, prices and markets that drive people's production and consumption decisions. As a consequence, there is perceived to be little private gain or value-added from using and managing natural resources and habitats more sustainably, and few costs from degrading, depleting or converting them.

It has now become apparent that command and control measures need to be balanced and reinforced by the provision of direct incentives (and disincentives) to the groups and sectors that depend and impact on the natural environment. It is also increasingly recognised that in most cases it is far cheaper and more cost-effective, as well as more equitable, to invest in measures that will encourage people to consume, produce and invest in ways which will avoid biodiversity and ecosystems being degraded in the first place. Unless there are clear gains from conserving the environment, few people will be willing to so – and, in most BOBLME countries, many will also be economically unable to do so.

A wide variety of economic instruments can be used to correct for the policy, price and market distortions and failures which lead to biodiversity and ecosystem degradation. There is now considerable experience in their application in marine and coastal environments. The basic aim of economic instruments is to motivate people to use and manage environmental resources sustainably, by making it more profitable (or less costly) for them to do so. This is achieved by setting in place the conditions under which people will "internalise" the broader environmental consequences of their actions into their own private economic decisions. To these ends, most economic instruments for the environment are based on "polluter pays", "user pays" and "conserver benefits" principles, namely that those who are responsible for causing environmental damage should bear the costs that their actions give rise to, and those who act to safeguard the environment should be compensated for the conservation-related costs they bear and rewarded for the environmental benefits they generate. They therefore tend to have a strong focus on sharing biodiversity and ecosystem benefits and costs more equitably (from a social viewpoint), efficiently (from an economic perspective) and effectively (from a conservation outlook).

The paragraphs below present a generic list of economic instruments applicable for the sustainable management of marine and coastal natural resources in the Bay of Bengal which address both the management of living and renewable resources and the reduction and abatement of pollution, according to the regional environmental issues laid out in the TDA. These are organised into four functional categories (Figure 26): charge and fee systems, fiscal instruments, market creation & development, and financial mechanisms. To a large extent these categories are overlapping. Economic instruments are rarely used in isolation but rather are designed as "packages" of mutually reinforcing measures which target a variety of goals, sectors, groups, and respond to different threats and opportunities. Most also fulfil a range of roles, and can potentially raise revenues, act as incentives, and serve as redistributive mechanisms. Several of the economic instruments listed below are therefore found in more than one category, showing a slight variation in their form or manifestation, depending on the purposes for which they are being used or the target audience they are addressing.

Figure 26: economic instruments for the sustainable management of marine & coastal habitats and resources



Charge and fee systems

A wide variety of charges, fees, fines and penalties can be levied on the use of marine and coastal resources and habitats, or on the products and activities which cause environmental harm. These typically serve a number of purposes. The income generated can be used to cover the costs of managing the resource or generating the service, and/or to remedy or compensate the losses incurred as a result of environmental degradation. Charges and fees provide effective mechanisms for rewarding compliance and penalising non-compliance. In addition, they are commonly used as a means of regulating or managing the demand for biological resources, and encouraging users to reduce pressures on (or shift between) particular species, stocks or sites. It is worth noting that charge and fee systems are usually associated with some form of property right over the resource or the habitat in question, as well as a recognised, agreed or legally-defined requirement (and sometimes also rate) for payment (UNEP 2004b).

Examples of charge and fee systems that have been used elsewhere for the sustainable management of marine and coastal resources and habitats, and might be applicable in BOBLME countries, include:

- **User fees:** are charges levied directly on the consumption of particular goods or services, or on the generation of waste and pollution. Examples include resource use fees (such as for fishing, hunting or mangrove products collection), access fees (such as marine protected area entry fees), pollution or emissions charges (payments based on the quantity, quality and type of pollutant or waste generated) and waste management fees (flat-rate or per-unit service charges for the collection and clean-up of solid and liquid wastes);
- **Product charges:** are applied to goods and services that create pollution or otherwise cause environmental damage through their manufacture, consumption or disposal (such as fertilisers, pesticides, batteries or industrial chemicals). These are usually intended to modify the relative prices of the products (and thus reduce consumption and/or discourage non-compliance) or to finance collection and treatment systems;
- **Deposits and bonds:** involve the provision of monetary security when economic activities are carried out which run the risk of causing environmental harm. They are usually (although not always) refundable against any damage occurring as a result of that activity. Refundable deposits are often charged at the time of product purchase (such as on batteries, bottles or chemicals), and then fully or partially reimbursed when the used item is returned to the dealer or a specialised treatment facility. Performance bonds are commonly imposed when a natural resource-based or potentially environmental harmful economic activity is initiated (for example when issuing fishing licenses or timber concessions, at the commencement of mining and other extractive industries, or as part of the approval process for construction, tourism or industrial operations in ecologically sensitive areas). They are used to encourage compliance with environmental or natural resources requirements (such as land reclamation, forest management, environmental clean-up, waste delivery or pollution control) and/or to ensure that sufficient funds are mobilised to cover the costs of mitigating, remediating and compensating any damage that may occur in the course of carrying out the activity;
- **Fines, penalties and non-compliance fees:** can be imposed on prohibited or illegal activities (such as logging of protected forests, use of banned fishing gear, littering or release of untreated wastes and pollutants into the environment), or when activities transgress or exceed agreed standards or use levels (such as a specified quantity of timber or fish harvest, or permitted levels of air or water pollution). They commonly serve both as a means of discouraging users from causing environmental harm in the first place, and as a mechanism for generating funds to compensate, remediate or mitigate such costs should they arise; and
- **Liability payments and compensation:** are made to reimburse the damages caused by environmentally harmful or polluting activities. Payments can be made directly to affected parties, or to the government or another intermediary (as a third party agent or steward acting on behalf of the general public). They can operate in the context of specific liability rules and compensation schemes, or via compensation funds financed by contributions from potential or actual polluters (such as funds for oil spills, mining disasters or industrial pollution).

Fiscal instruments

Fiscal instruments work through the government budget, and comprise various forms of taxes, subsidies and fund allocation mechanisms. They serve primarily to generate and/or (re)allocate public revenues. On the one hand fiscal instruments can be used to direct funding to environmental activities by generating new income or reallocating existing revenue sources. Because fiscal instruments also serve to modify the price of different products or activities, they can also serve to motivate environmental conservation (or, conversely, discourage degrading production, consumption and investment). In addition to the introduction of fiscal instruments that are targeted specifically at the environment, there has been increasing attention paid over recent years to dismantling the perverse subsidies and disincentives that act to encourage environmentally-damaging activities.

Examples of fiscal instruments that have been used elsewhere for the sustainable management of marine and coastal resources and habitats, and might be applicable in BOBLME countries, include:

- **Taxes and charges:** include a wide variety of mechanisms which levy an additional fee on particular products or economic activities (such as through taxes, cess, tariffs and duties) or charge for the consumption or use of government land and resources (such as through royalties and other user fees). Environmental taxes and charges may be used to generate revenue from natural resources and habitats (such as from fishing licenses, mining royalties, shipping fees, or from sales and profit taxes levied on particular products or sectors) or to finance environmental management and clean up (such as from taxes on pollution, emissions and waste generation). They are also commonly used to regulate demand, or to encourage and discourage particular forms or levels of production, consumption and investment (such as by the use of progressive or differential tax rates, or via selectively-applied tax credits, exemptions, deductions and holidays);
- **Subsidies:** may be offered in number of ways to encourage producers, consumers and investors to favour particular products, engage in particular activities or adopt particular practices or technologies which benefit the environment (or reduce environmental risk and damage). Price-based subsidies involve the government intervening to stabilise market prices or maintain them at a particular level, or even paying producers directly for generating a particular product or service. Payment-based subsidies include the transfer of public funds to the individual or company via such mechanisms as soft loans, direct funding, or provision of hard currency at below market rates. Financing-based subsidies include measures such as soft loans, revolving funds, sectoral funds, green funds, preferential interest rates or loan guarantees. Risk-based subsidies include subsidized insurance or reinsurance, liability caps, public sector indemnification or government guarantees;
- **Budget allocations:** remain the primary form of public funding to environmental activities. Annual capital and recurrent budget allocations ensure that finance is available to the government agencies and organisations that are mandated to manage the environment, and for environment-related budget lines in other sectors;
- **Budgetary earmarking and funds:** provide a means of setting aside particular revenue streams or funding sources for particular purposes, products, sectors, sites or target groups. They are often financed through a combination of the public budget, corporate or private donations and donor assistance (such as fuel taxes, transport charges, protected area fees, tourist levies or taxes on goods and services that depend or impact on biodiversity). They are commonly employed as a means of supplementing routine annual budget allocations (such as through a dedicated protected area trust fund, forestry fund or oil spill remediation fund). Budgetary and earmarked funds are also often used to mobilise public funding for corporate, private or community initiatives (such as to support the grant, financing and risk-based subsidies described above); and
- **Environmental-fiscal transfers:** are a subset of budgetary earmarking and allocation, and refer to the redistribution of public revenues between sectors, or between national and local government. They usually involve linking the provision of budget to the existence of particular environmental assets (such as critical landscapes or protected species), achievement of particular environmental goals (for example water quality standards or watershed protection), or to making particular expenditures or foregoing other sources of production and revenues in order to conserve or maintain environmental resources (such as through the protected area network). Environmental-fiscal transfers usually have a strong

element of distributive fairness and fiscal equalisation, as well as aiming to improve conservation funding and incentives.

Market creation and development

While often accompanied by, or building on, fiscal instruments, charges and fee systems, this category of economic instruments is concerned specifically with creating new markets for environmental goods and services where none previously existed, and/or with improving existing prices and markets so that they better reflect the benefits of environmental conservation and the costs of environmental degradation. Market creation and development focuses on improving the value-added, price premiums and terms of exchange of goods and services, so as to favour more environmentally-sustainable or "greener" options for production and consumption. As is the case with charge and fee systems, the creation and development of markets almost always requires that some form of property right is first established over the resource or habitat that is being targeted (UNEP 2004b). Ownership, use or management rights must be equitably and transparently devolved to the individual, household, company or community level, and fairly and effectively secured and enforced in such a way that the benefits to the holders of the rights are linked to the productivity and value of the resource or habitat (FAO 2003).

Examples of market creation and development that have been used elsewhere for the sustainable management of marine and coastal resources and habitats, and might be applicable in BOBLME countries, include:

- **Tradable permits, rights & quotas:** allow a price and market to emerge in quantitatively-assigned rights to environmental resources, land or quality (such as fishing quotas, emissions/effluent permits, hunting licenses or land concessions). They typically serve to manage demand and ration access between different users to a particular resource or productive asset (which has already been set at a specified level by the allocation of a finite quantity of permits, licenses or quotas). They can also generate revenues and income for the holders of the assigned rights. In principle this should allow the market to reach a natural price equilibrium which reflects demand, supply and relative value;
- **Tradable offsets & credits:** are a special category of tradable permits, rights and quotas. This terminology is usually applied to payments made for the exchange of obligations and claims over non-conventional environmental products and services (such as habitats, biodiversity or carbon). It encompasses schemes which have emerged in the context of liability regimes (such as compliance markets for carbon, emissions trading schemes or tradable development rights) as well as those which involve voluntary actions on the part of producers and consumers or are targeted at securing reputational gains on the part of the buyer or the seller (such as wetland or habitat banking, voluntary carbon markets or biodiversity offsets). Offsets and credits are usually based on the principle of no net loss of biodiversity or ecosystem services, and involve a land or resource user, producer or investor whose activity risks impacting on the natural environment paying to secure the conservation of equivalent biodiversity or the generation of an equivalent amount of ecosystem service elsewhere;
- **New products & markets:** encompass a wide variety of efforts to tap into (or attempt to create) peoples' demand for environmentally-friendly products and services. The aim is both to ensure that consumers have access to less environmentally-damaging (or environmentally-conserving) alternatives, and to set in place the conditions under which producers can enhance their earnings by switching to greener products and outlets. Green markets have emerged across a diverse range of products and services, ranging from natural resource-based products (such as organic agriculture, ecotourism or sustainably-sourced seafood), through environment-impacting technologies (such as hybrid cars, solar panels or low-energy appliances) to financial services (such as green pensions and investment funds);

- **Payments for ecosystem services:** are a special category of environmental markets which are rapidly gaining currency worldwide, and in the BOBLME region. They introduce payments for (mainly land use-based) ecosystem services which have traditionally had no market or price but which generate economically valuable services (mainly for off-site or downstream beneficiaries) – such as forest watershed protection, wetland flood control, mangrove storm protection, or forest landscape and biodiversity. Payments for ecosystem services charge the beneficiaries (such as tourism operators, the fishing industry, hydropower producers or water consumers), and channel the funds to the government agencies or land and resource users (often local communities) whose actions serve to secure the ecosystem services; and
- **Eco-labelling & certification:** are voluntary trademarks awarded to products or services which are deemed to have been harvested, produced and traded in an environmentally sustainable manner. Although eco-labelling and certification has some effect on the quality, availability and choice of products for consumers, the main aim is to allow producers to benefit from premium prices and markets for green goods and services (such as by adding value, capturing new markets, expanding sales and improving their image and reputation. A wide variety of eco-labelling and certification schemes have now been developed for the goods and services that depend and impact on biodiversity and ecosystem services (for example tourism, tea and coffee, fruit and vegetables, seafood) or are produced in ecologically sensitive areas (such as in or near protected areas).

Financial mechanisms

Financial mechanisms serve to attract. earmark, retain, target and administer funds for environmental activities. They are thus usually operated in in combination with (and capitalised or funded by other) other revenue-generating economic instruments. The primary aim of financial mechanisms is to make sure that funding is allocated to environmental goals, and used for specific activities, sites, sectors or groups.

Examples of financial mechanisms that have been used elsewhere for the sustainable management of marine and coastal resources and habitats, and might be applicable in BOBLME countries, include:

- **Grants & funds:** various types of grant and fund mechanisms can be used to administer financing for environmental activities. These may operate within government, the private sector, civil society or (most commonly) for a combination of sources and targets. Most funds either invest the capital and allocate the interest earned (endowment funds), draw down funds over a specified time period (sinking funds), act as a replenishable credit fund (revolving funds), or operate as a combination of the above. Funds are often capitalised through large one-off inflows of money (for example debt-for-nature swaps, major donor projects or corporate donations), dedicated revenue streams (such as payments for ecosystem services, or from the introduction of a new charge, fee or tax) or environmental mitigation and compensation payments;
- **Green investment & capital facilities:** a wide range of instruments now exist which aim to mobilise private and public capital (often also combined with technical advice) to commercial ventures which are based on the conservation or sustainable use of biodiversity. These also aim to provide financial returns to the investors. Green investment and capital facilities include mutual funds and venture capital funds which are targeted towards environmental investments, green bonds (such as forest and climate bonds) and various other capital market instruments issued by government or corporate entities to fund sustainable development or conservation businesses;
- **Credit & loans:** provide a way of administering funds which are specifically targeted at supporting environmental enterprises, but which are expected to be paid back. In addition to the credit and loan arrangements which are run with government backing or support (see above), various forms of green

loan facilities are beginning to be offered through commercial financial institutions (such as banks, building societies or credit and loan societies) or as part of corporate environmental and social responsibility activities;

- **Cost-sharing and devolved management:** over recent years there has been a growing devolution to the private sector or local communities of certain environment management functions and responsibilities that were formerly the preserve of government (such as the operation of protected area tourism facilities, running of natural resource harvesting and marketing operations, or provision of biodiversity monitoring and enforcement services). These typically involve a formal contract, lease, concession, franchise or some form of co-management or joint management agreement. As well as generating funds, freeing up government budget and increasing private and local participation in biodiversity conservation, cost-sharing and devolved management provide an important opportunity to promote the development of new market and income opportunities, as well as to enhance private investment flows into environmental management; and
- **Revenue-sharing and livelihood support:** many conservation initiatives and enterprises now make explicit efforts to involve and benefit adjacent communities. Examples include making efforts to ensure that local people are offered employment or that services and products are sourced locally, through contracting out the operation of particular facilities to local residents as commercial enterprises, to the provision of training, equipment or other support required to enable people to move into new businesses and markets, and even the operation of businesses as joint ventures or social enterprises. When fees or user charges are collected (such as is the case in many protected areas, or in ecotourism ventures) it is becoming more and more common for a certain percentage of these revenues to be shared with local residents. Sometimes payments are made directly as cash dividends, but more often a proportion of the income is remitted to local authorities or municipalities to spend on development activities. One common aim of revenue-sharing and livelihood support activities is to provide income and employment alternatives which will substitute for unsustainable activities, or encourage people to shift to more environmentally-friendly methods of production and consumption. Another motivation is often to secure reputational gains, improve relations with the local community, or extend corporate environmental and social responsibility concepts.

8 Recommendations & next steps: using valuation to support SAP implementation

This chapter lays out possible next steps in incorporating the results of the valuation study into the implementation of the BOBLME Project and Strategic Action Programme, including taking forward the most promising economic instruments for the sustainable management of marine & coastal resources. These conclusions and recommendations draw on the findings of a regional workshop to present and validate the draft results of the valuation study and discuss ways forward, next steps and possible future work in biodiversity and ecosystem valuation in the BOBLME.

Future work to improve the precision of ecosystem valuation

It is clear that there remains considerable scope to improve the precision of ecosystem valuation. Very few accurate data are available on the economic value of marine and coastal ecosystem services in the BOBLME. What is presented in this report represents a first, incomplete attempt to estimate ecosystem values for the BOBLME. Yet, while there are undoubtedly glaring gaps in knowledge about the value of key services, the accuracy of these economic estimates may not be the main, or most important, issue to be addressed in relation to improving the precision of ecosystem valuation. The conclusions of the current study are, rather, that:

- The primary need is to improve the **practicality and policy relevance of the information that is generated on the value of marine and coastal resources**, especially with regard to the economic case for their conservation and sustainable use; and
- The greatest informational constraint to ecosystem valuation is not so much the quality of socio-economic information – although there does remain some room for improvement, particularly as regards the level of human dependency on marine and coastal ecosystem goods and services. The most binding data gaps and weaknesses concern a critical lack of information on the **biophysical links between ecosystem status and the provision of ecosystem services, and the impacts on habitat change on the delivery of ecosystem services**. For example, there is currently little or no information about the sustainability of past, current or future land and resource uses and the threshold effects of ecosystem loss. One important example is changes in fisheries catch composition and catch per unit effort over time. There also remains a paucity of data on the biological, ecological and other relationships which underlie many of the regulating and supporting services that are provided by marine and coastal ecosystems. Data on the links between mangrove/coral reefs and fisheries productivity have, for example, emerged as a particular gap. This means that it is currently difficult – and in some cases impossible – to make any credible estimates of either the environmental or the economic value of marine and coastal ecosystem services in the BOBLME.

In the light of these findings, three main areas of future work to improve the precision of ecosystem valuation are recommended:

1. Making a proper investigation of the processes, stakeholders and interests that influence and drive decision-making in the sectors and by the groups that manage, depend, impact on marine and coastal resources and habitats. This process of consultation, analysis and dialogue should involve efforts to ascertain whether valuation can and should provide a way of helping to leverage change

and, if so, how and in which ways. The aim would be to identify strategic needs, niches and entry points for using ecosystem valuation to influence decision-making;

2. Identifying key knowledge gaps as regards biophysical aspects of on ecosystem services for key habitats sectors, services and locations, and developing a strategy for undertaking the research and data collection to fill these gaps. Support could, simultaneously, be provided to undertake case studies of ecosystem valuation which could help to translate these physical measures into economic and monetary indicators; and

3. Carrying out a systematic and participatory process to vision, describe and model the socio-economic and biophysical consequences of likely management "futures" for the BOBLME. It would be extremely useful to develop a set of consolidated scenarios, hypotheses and assumptions of change about possible future development trajectories for the BOBLME region, associated marine and coastal management approaches and options, and shifts in ecosystem service provision. The could be carried out in parallel with efforts to improve the availability of information on the biophysical processes underlying ecosystem services and their economic value.

Advice for incorporating valuation results into the implementation of the BOBLME Project and the SAP

The study serves to confirm that valuation is not an end in itself, but rather a means to an end: better-informed decision-making. In the context of the BOBLME Project, it is the Strategic Action Programme (SAP) that is the primary concern. The main challenge now is to ensure that the valuation results are used to strengthen and advance the implementation of the SAP. A number of key areas emerge in which information about ecosystem values can inform (and hopefully strengthen) future SAP planning and implementation:

- **Communicating the economic and business case** for the SAP. Unless a convincing and credible rationale can be provided to economic and development policy-makers, planners and budget-holders (including those in the sectors that depend and impact on marine and coastal ecosystem services) the SAP is unlikely to garner adequate support;
- Ensuring that there is **sufficient and sustainable financing** to cover the costs of implementing the SAP. While the SAP activities are yet to be costed or budgeted for in detail, it is extremely unlikely that funding needs can be met wholly from existing sources (primarily government budgets and donor funds). It is inevitable that efforts will need to be made to identify and attract new funding, develop new financing mechanisms, and engage new investors and donors; and
- **Mobilising and enhancing regional technical capacity** in ecosystem valuation. Ultimately, the continuation and further development of ecosystem valuation will depend on harnessing the experience and knowhow that already exists in BOBLME countries. This capacity is already considerable, although is unevenly distributed between institutions and countries.

To these ends, four main areas of future work to incorporate valuation results into the implementation of the BOBLME Project and the SAP are recommended:

1. Developing a strategy for communicating the economic value of marine and coastal ecosystem services to decision-makers, budget-holders, potential investors and other key stakeholders. This should be closely informed by the institution, context and stakeholder analysis recommended above as part of the future work to improve the precision of ecosystem valuation;

2. Guided by the communication strategy, making efforts to articulate and convey a clear economic and business case for the SAP. This would be targeted to the needs and interests of key stakeholder groups, including potential donors and investors;
3. Developing a sustainable financing strategy or business plan which would accompany, and form an integral part of, the SAP. The intention would be to outline clearly financing needs, gaps and means of filling them. This could also potentially serve as a means of communicating these needs and marketing the SAP to potential donors and investors; and
4. Facilitating the exchange and sharing of technical expertise in ecosystem valuation between BOBLME countries and institutions, including formal and informal training opportunities as well as technical research and studies. It should be noted that several agencies and institutions, and a small pool of experts, exist which already have considerable expertise in ecosystem valuation including, at the regional level, the South Asia Network of Development and Environmental Economics (SANDEE) and the Environment and Economics Programme for South East Asia (EEPSEA).

Ways forward in operationalising selected economic instruments

A generic list of economic instruments for the sustainable management of marine and coastal resources in the BOBLME is provided above in Chapter 7. A key question is how to actually set these instruments in motion, so that they can begin to generate finance and incentives in support of the SAP. Attention will likely be required in a number of areas, including ensuring that the selected instruments are:

- **Consistent with, and build on, existing conservation and development policies, strategies and plans.** The most successful economic instruments are usually those which attempt to use existing policies and measures more “intelligently” or in a more “joined up” manner to better achieve (or be more oriented towards) the sustainable management of marine and coastal resources;
- **Realistic and achievable within the context of existing institutional, staffing and budget availability** as well as in the light of social and political considerations. Just because an economic instrument has been successful in other parts of the world, or is technically sound, does not mean that it will be implementable in practice. The most viable instruments will likely be those which can be implemented using existing resources, and which reflect principles, procedures and practices which have already gained some level of currency and acceptance among decision-makers; and
- **Acceptable and appealing to the sectors and stakeholders at which they are directed**, or upon which they rely for their implementation. Ultimately, unless the instruments are convincing to their intended targets, they are unlikely to stimulate changes in behaviour and attitudes towards marine and coastal resource and habitat use, management and impacts.

Three main actions are recommended to assist in operationalising selected economic instruments:

1. Undertaking an institution, context and stakeholder analysis similar to that proposed as a means of improving the precision of ecosystem valuation. Here, the aim would to be identify strategic needs, niches and entry points for introducing and using economic instruments for the sustainable management of marine and coastal resources. It will be particularly important to investigate how existing strategies, plans and ongoing policy reforms in BOBLME countries (for instance the current moves to ‘green’ of national and sub-national development plans that is taking place across the region, or to update National Biodiversity Strategies and Action Plans in line with the Convention on Biological Diversity’s the CBD’s Strategic Plan for 2011-2020 and the Aichi targets), provide opportunities for economic instruments in support of the marine and coastal environment;

2. Integrating goals, milestones and budgets for the selection, design and implementation of economic instruments in the SAP. Economic instruments should be considered as a discrete programme of work, alongside other categories of actions and investments in the SAP; and
3. Making explicit efforts to work to get Ministries of Finance and Economic Planning on board as regards the development of economic instruments for the marine and coastal environment, as well as the other line agencies that they target and involve.

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Annex 2:
List of administrative units in the BOBLME coastal zone

Table 29: Bangladesh administrative units in the BOBLME coastal zone

Divisions	Zilas
Barisal	Barguna
	Patuakhali
	Bhola
Chittagong	Lakshmipur
	Noakhali
	Feni
	Chittagong
	Cox's Bazaar
Khulna	Satkhira
	Khulna
	Bagerhat

Table 30: India administrative units in the BOBLME coastal zone

States & Union Territories	Districts
Andaman and Nicobar	Nicobar
	North & Middle Andaman
	South Andaman
Andhra Pradesh	Sri Potti Sriramulu Nellore
	Prakasam
	Guntur
	Krishna
	West Godavari
	East Godavari
	Vishakapatnam
	Vizhianagaram

States & Union Territories	Districts
	Srikakulam
Odisha	Ganjam
	Puri
	Jagatsinghpur
	Kendrapara
	Bhadrak
	Baleshwar
Puducherry	Puducherry
	Karaikal
	Yanam
Tamil Nadu	Kanyakumari
	Tirunelveli
	Thoothukudi

States & Union Territories	Districts
	Ramanathapuram
	Pudukottai
	Thanjavur
	Thiruvarur
	Nagapattinam
	Cuddalore
	Villupuram
	Kancheepuram
	Chennai
	Thiruvallur
West Bengal	Purba Medinipur
	South 24 Parganas
	North 24 Parganas

Table 31: Indonesia coastal administrative units in the BOBLME coastal zone

Provinces	Regencies & Cities
Aceh	Aceh Singkil
	Simeulue
	Aceh Selatan
	Aceh Barat Daya
	Nagan Raya
	Aceh Barat
	Aceh Jaya
	Bandar Aceh
	Aceh Besar
	Kota Sabang
	Pidie
	Pidie Jaya
	Bireuen
	Aceh Utara
	Kota Lhokseumawe
	Aceh Timur

Provinces	Regencies & Cities
	Kota Langsa
	Aceh Tamiang
Riau	Indragiri Hilir
	Pelalawan
	Siak
	Bengkalis
	Rokan Hilir
	Kota Dumai
	Kepulauan Meranti
Sumatera Barat	Kepulauan Mentawai
	Pesisir Selatan
	Padang
	Padang Pariaman
	Pariaman
	Agam

Provinces	Regencies & Cities
	Pasaman Barat
Sumatera Utara	Nias Utara
	Nias & Nias Barat
	Nias Selatan
	Mandailing Natal
	Tapanuli Selatan
	Sibolga
	Central Tapanuli
	Medan
	Deli Serdang
	Langkat
	Serdang Bedagai
	Asahan & Tanjung Balai
	Labuhan Batu / Selatan / Utara

Table 32: Malaysia administrative units in the BOBLME coastal zone

States	Districts
Johor	Ledang
	Muar
	Batu Pahat
	Pontian
Kedah	Kuala Muda
	Yan
	Kota Setar
	Kubang Pasu
	Pulau Langkawi
	Pulau Pinang
	Seberang Perai
	Selatan
	Seberang Perai Tengah
	Seberang Perai Utara
	Timur Laut
	Barat Daya
Melaka	Jasin
	Melaka Tengah
	Alor Gajar
Negeri Sembilan	Port Dickson
Perak	Manjung
	Kerian
	Larut, Matang & Selama
	Hilir Perak
Perlis	Perlis
Selangor	Klang
	Kuala Langat
	Kuala Selangor
	Sabak Bernam
	Sepang

Table 33: Maldives administrative units in the BOBLME coastal zone

Atolls	Inhabited Islands
North Thiladhunmathi	Baarah
	Dhiddhoo
	Filladhoo
	Hoarafushi
	Ihavandhoo
	Kelaa
	Maarandhoo
	Mulhadhoo
	Muraidhoo
	Thakandhoo
	Thuraakunu
	Uligamu
	Utheemu
	Vashafaru
South Thiladhunmathi	Finey
	Hanimaadhoo
	Hirimaradhoo
	Kulhudhuffushi
	Kumundhoo
	Kunburudhoo
	Makunudhoo
	Naivaadhoo
	Nellaidhoo
	Neykurendhoo
	Nolhivaram
	Nolhivaranfaru
	Vaikaradhoo
North Miladhunmadulu	Bileffahi
	Feevah
	Feydhoo
	Foakaidhoo
	Funadhoo
	Goidhoo
	Kanditheemu
	Komandoo
	Lhaimagu
	Maaungoodhoo
	Maroshi
	Milandhoo
	Narudhoo
	Noomaraa
South Miladhunmadulu	Foddhoo
	Henbandhoo
	Holhudhoo
	Kendhikolhudhoo
	Kudafaree
	Landhoo
	Lhohi
	Maafaru
	Maalhendhoo
	Magoodhoo
	Manadhoo
	Miladhoo
	Velidhoo
North Maalhosmadulu	Alifushi
	Angolhitheemu
	Fainu
	Hulhudhuffaaru
	Inguraidhoo
	Innamaadhoo
	Dhuvaafaru
	Kinolhas
	Maakurathu
	Maduvvaree
	Meedhoo
	Rasgetheemu
	Rasmaadhoo
	Ungoofaaru
	Vaadhoo
South Maalhosmadulu	Dharavandhoo
	Dhonfanu
	Eydhafushi
	Fehendhoo
	Fulhadhoo
	Goidhoo
	Hithaadhoo
	Kamadhoo
	Kendhoo
	Kihaadhoo
	Kudarikilu
	Maalhos
	Thulhaadhoo
Faadhippolhu	Hinnavaru
	Kurendhoo
	Naifaru
	Olhuvelifushi
Male'	Dhiffushi
	Gaafaru
	Gulhi
	Guraidhoo
	Himmafushi
	Huraa
	Kaashidhoo
	Malé
	Maafushi
	Thulusdhoo
North Ari	Bodufulhadhoo
	Feridhoo
	Himandhoo
	Maalhos
	Mathiveri
	Rasdhoo
	Thoddoo
	Ukulhas
	Fesdhoo
South Ari	Dhangethi
	Dhiddhoo
	Dhigurah
	Fenfushi
	Haggnaameedhoo
	Kunburudhoo
	Maamingili
	Mahibadhoo
	Mandhoo
	Omadhoo
Felidhu	Felidhoo
	Fulidhoo
	Keyodhoo
	Rakeedhoo
	Thinadhoo
Mulakatholhu	BoliMulah
	Dhiggaru
	Kolhufushi
	Madifushi
	Maduvvaree
	Muli
	Naalaafushi
	Raimmandhoo
	Veyvah
North Nilandhe	Bileddhoo
	Dharanboodhoo
	Feeali
	Magoodhoo
	Nilandhoo
South Nilandhe	Bandidhoo

Atolls	Inhabited Islands
	Gemendhoo
	Hulhudheli
	Kudahuvadhoo
	Maaenboodhoo
	Meedhoo
	Rinbudhoo
Kolhumadulu	Burunee
	Vilufushi
	Madifushi
	Dhiyamingili
	Guraidhoo
	Gaadhiffushi
	Thimarafushi
	Veymandoo
	Kinbidhoo
	Omadhoo
	Hirilandhoo
	Kandoodhoo
	Vandhoo
Hadhdhunmathi	Dhanbidhoo
	Fonadhoo
	Gaadhoo
	Gan
	Hithadhoo
	Isdhoo
	Kunahandhoo
	Maabaidhoo
	Maamendhoo
	Maavah
	Mundoo
North Huvadhu	Dhaandhoo
	Dhevvadhoo
	Gemanafushi
	Kanduhulhudhoo
	Kolamaafushi
	Kondey
	Maamendhoo
	Nilandhoo
	Vilingili
South Huvadhu	Fares-Maathodaa
	Fiyoaree
	Gaddhoo
	Hoandeddhoo
	Madaveli
	Nadellaa
	Rathafandhoo
	Thinadhoo
	Vaadhoo
Fuvahmulah	Fuvahmulah
Addu	Hithadhoo
	Maradhoo
	Maradhoo-Feydhoo
	Feydhoo
	Hulhudhoo
	Meedhoo

Table 34: Myanmar administrative units in the BOBLME coastal zone

States & Regions	Divisions & Townships
Ayeyarwady	Pathein
	Kangyidaunt
	Thabaung
	Ngapudaw
	Myaungmya
	Labutta
	Mawlamyinegyun
	Pyapon
	Bogale
Bago	Thanatpin
	Kawa
	Waw
Mon	Mawlamyine
	Chaungzon
	Thanbyuzayat
	Mudon
	Ye
	Thaton
	Paung
	Kyaikto
	Bilin
Rakhine	Sittwe
	Myebon
	Pauktaw
	Maungdaw
	Kyaukpyu
	Munaung
	Ramree
	Ann
	Thandwe
	Toungup
	Gwa
Tanintharyi	Launglon
	Thayetchaung
	Yebyu
	Myeik
	Kyunsu
	Palaw
	Kawthoung
	Bokpyin
Yangon	Thanlyin
	Kyauktan
	Thongwa
	Kayan
	Twantay
	Kawhmu
	Kungyangon

Table 35: Sri Lanka administrative units in the BOBLME coastal zone

Provinces	Districts
Eastern	Ampara
	Batticaloa
	Trincomalee
Northern	Jaffna
	Kilinochchi
	Mullaitivu
	Mannar
North Western	Puttalam
Southern	Galle
	Matara
	Hambantota
Western	Gampaha
	Colombo
	Kalutara

Table 36: Thailand administrative units in the BOBLME coastal zone

Provinces	Districts
Krabi	Khlong Thom
	Nuea Khlong
	Ko Lanta
	Mueang Krabi
	Ao Luek
Phang Nga	Ko Yai
	Takua Thung
	Thap Put
	Mueang Phang Nga
	Thai Mueang
	Takua Pa
	Khura Buri
Phuket	Mueang Phuket
	Kathu
	Thalang
Ranong	Suk Samran
	Kapoe
	Mueang Ranong
Satun	Mueang Satun
	Tha Phae
	Langu
	Thung Wa
Trang	Palian
	Hat Samran
	Kantang
	Sikao

Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka and Thailand are working together through the Bay of Bengal Large Marine Ecosystem (BOBLME) Project to lay the foundations for a coordinated programme of action designed to better the lives of the coastal populations through improved regional management of the Bay of Bengal environment and its fisheries.

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