Using valuation to make the case for economic incentives: Promoting investments in marine and coastal ecosystems as development infrastructure

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Chapter 2
Valuing Ecosystems as an Economic Part of Climate-Compatible Development Infrastructure in Coastal Zones of Kenya & Sri Lanka

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Abstract Even though 'green' options for addressing the impacts of climate change have gained in currency over recent years, they are yet to be fully mainstreamed into development policy and practice. One important reason is the lack of economic evidence as to why investing in ecosystems offers a cost-effective, equitable and sustainable means of securing climate adaptation, disaster risk reduction and other development co-benefits. This chapter presents a conceptual framework for integrating ecosystem values into climate-compatible development planning. Case studies from coastal areas of Kenya and Sri Lanka illustrate how such an approach can be applied in practice to make the economic and business case for ecosystem-based measures. It is argued that, rather than posing 'grey' and 'green' options as being necessarily in opposition to each other or as mutually incompatible, from an economic perspective both should be seen as being part and parcel of the same basic infrastructure that is required to deliver essential development services in the face of climate change.

Keywords Climate-compatible development • Coastal ecosystems • Economic valuation • Mangroves

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2.1 Introduction

Several authors have noted that, even though ecosystem-based approaches are gaining in popularity, they are for the large part yet to be fully mainstreamed into development decision-making as compared to more conventional 'grey' measures (ProAct Network 2008; UN Global Compact et al. 2011; Renaud et al. 2013). It is argued that a major reason for this omission is the lack of economic evidence as to why investing in ecosystems offers a cost-effective, equitable and sustainable means of securing climate adaptation and disaster risk reduction benefits (Colls et al. 2009; UNEP 2011; Munroe et al. 2012). Intensifying competition over scarce private and public investment funds, coupled with increasing demands from shareholders and taxpayers for information about how their money has been spent, means that the need to demonstrate cost effectiveness and value for money is becoming an ever-more pressing concern (Tompkins et al. 2013; Ferrario et al. 2014). While figures are readily available on the benefits of hard engineering or built infrastructure options, and are routinely used to guide and report on investment decisions, much less information is on hand about the potential gains associated with investing in green disaster risk reduction and adaptation measures.

This chapter describes how economic valuation can assist in communicating the advantages of ecosystem-based options for climate-compatible development (CCD) in coastal areas. It contends that, rather than posing 'grey' and 'green' investments as being necessarily in opposition to each other, or as mutually incompatible, both should be seen as being part and parcel of the same basic economic infrastructure that is required to deliver essential development, adaptation and disaster risk reduction services. In turn, if CCD is to reach its full potential, decision-makers must be equipped with the tools and information that will enable them to explicitly recognise the economic values associated with ecosystem services, factor them into investment calculations, and develop policy instruments and management approaches which will better capture and harness them in support of climate adaptation and disaster risk reduction. This requires a shift in the way in which land use and development trade-offs are conceptualised and evaluated — moving from a paradigm which undervalues ecosystem services to approaches which count and invest in them as an economic part of climate-compatible development infrastructure.

2.2 The Economic Value of Coastal Ecosystem Services

On the face of it, coastal planners and decision-makers would seem to be well aware of the value of natural resources. Such figures are accorded a prominent role in most national economic statistics and indicators, and in the development decisions they inform. For example, a compilation of country-level trade accounts indicates fish to be the most valuable agricultural commodity on world markets: recorded export earnings are now worth more than coffee, cocoa, sugar and tea combined (OECD 2008). Sea fisheries, alone, are documented to generate income in excess of USD 80 billion a year, provide for around 35 million jobs and support the livelihoods of more than 300 million people (Beaudoin and Pendleton 2012).

While these kinds of statistics suggest that it is hardly a novel insight that coastal natural resources make a major contribution to local, national and even global economies, there has long been a tendency to conceptualise ecosystem values only in terms of the commodities that are traded in formal markets, such as fisheries, timber, minerals or tourism (Emerton 2006). This definition however remains an incomplete one, because it excludes the host of other goods and services that coastal ecosystems generate. In particular, the economic values associated with subsistence-level and non-market production and consumption and with the protection and regulation of natural and human systems – arguably those which are of the most importance to adaptation, disaster risk reduction and climate-compatible development – tend to be largely left out of the equation. Almost half the global population are thought to depend on marine and coastal biodiversity in some way for their basic livelihoods (SCBD 2009). In Myanmar, for example, the food, fuel, construction materials and medicinal products obtained from natural ecosystems contributes around 83 % of per capita GDP for rural populations in the coastal zone (Emerton 2014c). Meanwhile, at least 100 million people, worldwide, benefit in economic terms from the disaster risk reduction services provided by coral reefs or would incur hazard mitigation and adaptation costs should these ecosystems be degraded (Ferrario et al. 2014). Up to three times this number are thought to be vulnerable to other climate-related effects in coastal areas (ProAct Network 2008).

The economic significance of these largely uncounted ecosystem services is substantial, and often far outweighs that of the direct physical products that are obtained from coastal lands and resources (Agardy et al. 2005; UNEP-WCMC 2006; Barbier et al. 2011; Shepard et al. 2011). Recent work carried out in India and Thailand, for example, finds that mangrove coastline protection and stabilization services are worth around USD 10,000/ha/year (Das 2009; Das and Crépin 2013; Barbier et al. 2011). Similarly, the protection afforded by natural ecosystems against waves, storm surges and other extreme weather events in Indonesia, Malaysia and Singapore has been calculated at just under USD 200,000 per km of coastline (MPP-EAS 1999). In Belize, coral reefs and mangroves help to reduce beach erosion and wave-induced damages to coastal property by up to USD 250 million a year, a value that translates to more than a quarter of national GDP (Cooper et al. 2008). In Sri Lanka coastal wetlands provide flood control and water purification functions to a value in excess of USD 2500 per hectare (Emerton and Kekulandala 2003), while mangrove storm protection services were assessed to be almost USD 800,000/ha/year just before the 2004 Indian Ocean tsunami (Batagoda 2003).

Not only do these figures make the point that the value of coastal ecosystems extends far beyond that which is conventionally included in the calculations that inform development decisions, but they also serve 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 (ProAct Network 2008; Haisfield et al. 2010; Beck and Shepard 2012; Sudmeier-Rieux 2013; Temmerman et al. 2013; Spalding et al. 2014). Every dollar invested in coastal ecosystem-based mitigation is, for example, estimated to reduce the US taxpayer burden by USD 4 in terms of avoided costs, losses and damages from storm-surge effects and other natural hazards (MMC 2005). In southern Vietnam, the restoration of 12,000 ha of mangroves has saved an estimated USD 7.3 million/year in dyke maintenance, a figure that is more than six and a half times the costs of planting (Powell et al. 2010). On the west coast of Sri Lanka, long-term climate adaptation benefits and costs saved were found to be more than twice as high as the costs of conserving coastal and estuarine ecosystems (De Mel and Weerathunge 2011).

2.3 How Undervaluation Poses a Problem for Development Decision-Making

Despite these impressive figures, coastal ecosystem undervaluation remains a persistent problem. For the most part, calculations of the relative returns to different land, resource and investment choices simply do not factor in such costs and benefits. A review of past patterns of coastal development would reinforce the observation that decision makers have perceived there to be few economic benefits associated with the conservation of natural ecosystems, and few economic costs attached to their degradation and loss. The net result is that even though substantial amounts of public and private investment funds have been ploughed into establishing the built infrastructure that is required to stimulate and sustain economic development processes in coastal zones, much less attention has been paid to maintaining (or even improving) the natural capital base that underpins and protects them.

As a consequence, investments in CCD infrastructure in coastal zones tend to continue to be heavily skewed towards those hard engineering and built infrastructure options for which a monetary return can easily be calculated (Ferrario et al. 2014). Most of the cost-benefit analyses that are applied to investigate the relative desirability of different investment choices simply do not take environmental values into account (Chadburn et al. 2013; Shreve and Kelman 2014; also see Vicarelli et al. Chap. 3). The small number of cases where economic methods are used to assess ecosystem-based approaches for adaptation and disaster risk reduction tend to confine themselves to direct, physical costs and benefits – thus underestimating massively the gains and value-added that can be secured as compared to, or in combination with, 'hard' and 'grey' infrastructure options. There remain very few real-world instances where broader ecosystem values and development co-benefits are factored into calculations (also see Vicarelli et al. Chap. 3).

The effects of undervaluation are also manifested at the policy level. Across the world, there is a long history of economic policies which aim to stimulate production and growth having also hastened the process of resource and habitat, degradation and discouraged ecosystem-based investments. In coastal zones, a wide variety of tax breaks and fiscal inducements, often combined with low or non-existent environmental penalties and fines, provide a powerful incentive to intensify resource exploitation and modify and reclaim natural habitats for more 'productive' commercial uses. One obvious example is fisheries subsidies, estimated to be worth between USD 30–34 billion a year worldwide (MRAG 2009), which have led to a massive expansion in the capacity of fishing fleets and resulted in the over-exploitation (and in some cases collapse) of fish stocks (UNEP 2004). Another well-known case is the generous tax breaks, import duty exemptions, export credits and preferential loans offered to shrimp farming in many countries (Primavera 1997; Bailly and Willmann 2001).

The policy distortions and perverse incentives that result from ecosystem undervaluation mean that prevailing prices and market opportunities in many countries mean that it frequently remains more profitable for people to engage in economic activities that degrade 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 land or resource user that is causing the damage (Mohammed 2012). The loss of potential economic benefits in the global fishery due to subsidy-driven fish stock depletion and over-capacity is for example estimated to cost more USD 50 billion per year (World Bank and FAO 2009). At the local level, work carried out in the Togean Islands in Indonesia 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 2005).

In many ways undervaluation can thus be seen to have encouraged a negative investment process in coastal areas, whereby ecosystems have been destroyed, degraded and converted in the course of expanding the built environment, stimulating particular sectors or production activities, or even while attempting to take action to reduce the risk of disasters and protect against the effects of climate change (Emerton 2014a; also see Freiss and Thompson, Chap. 4). If ecosystems have no value, then such decisions would be perfectly rational ones from both a financial and an economic point of view. In a similar vein, should there be low or zero costs attached to ecosystem degradation and depletion, then there would be no particular economic advantage to be gained from considering green adaptation and disaster risk reduction measures. This is however clearly not the case. The problem is not so much that ecosystems have no economic importance, but rather that this value is poorly understood, rarely expressed in numerical or monetary terms, and as a result is frequently omitted from decision-making. A pressing question then becomes: how can we better articulate the economic opportunities, value-added and costs avoided that are associated with adopting ecosystem-based approaches, and integrate this information into climate-compatible development planning?

2.4 Frameworks for Identifying and Demonstrating Ecosystem Values

Over the last two decades, a set of useful (and increasingly widely-used) economic methods and tools have been developed which help to overcome the problems associated with ecosystem undervaluation. The concept of total economic value has now emerged as one of the most commonly-applied frameworks for identifying and categorising ecosystem values. This represents a move away from the very narrow definition of benefits that economists traditionally applied, which saw the value of ecosystems only in terms of raw materials, physical products and traded commodities. Total economic value also encompasses subsistence and non-market values, ecological functions and non-use benefits (Fig. 2.1) – in other words, the full gamut of provisioning, regulating, supporting and cultural services that ecosystems generate (Millennium Ecosystem Assessment 2005). Looking at the total economic value of an ecosystem essentially involves considering its full range of characteristics as an integrated system — its resource stocks or assets, flows of environmental services, and the attributes of the system as a whole.

The question of how to ascribe values to ecosystem services has long posed something of a challenge to economists. The easiest and most straightforward way, 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

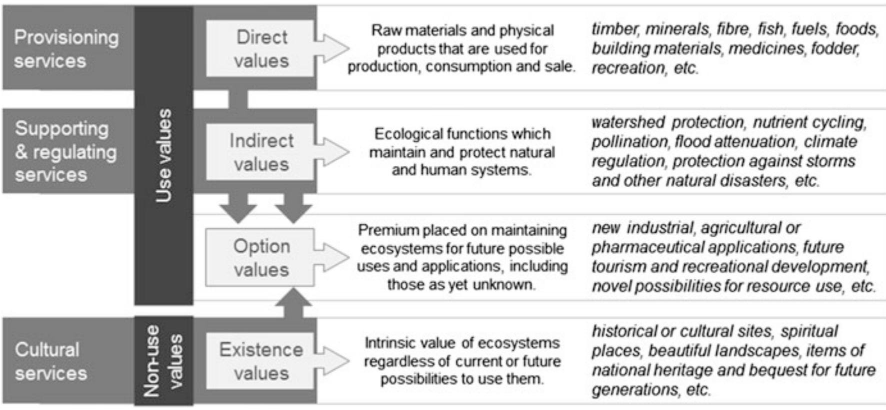

Fig. 2.1 Total economic value and ecosystem services (Adapted from Emerton 2006, 2014a)

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 defining and conceptualising the economic value of ecosystem services, techniques for quantifying ecosystem values in monetary terms have also moved forward substantially over the last 20 years or so.

Today a suite of methods is available for valuing ecosystem services that cannot be calculated accurately via the use of market prices, including in coastal environments (see, for example, van Beukering et al. 2007; UNEP-WCMC 2011; Wattage 2011; Beaudoin and Pendleton 2012). Applying these methods basically requires carrying out three interrelated steps: characterising the change in ecosystem structure, functions, and processes that gives rise to changes in ecosystem service(s); tracing how these changes influence the quantities and qualities of ecosystem service flows to people; and using valuation to assess and articulate changes in human wellbeing that result from the change in ecosystem services (see Barbier et al. 2011).

These methodological developments enable a wide range of formerly unvalued or undervalued coastal ecosystem goods and services to be expressed in monetary terms, and – in principle at least – incorporated into the calculations that are used to inform development decisions. Ecosystem valuation has for some time been a relatively well-accepted and widely-used component of environmental and biodiversity conservation research and planning. For example, a large volume of studies now exists on the economic value of coastal ecosystems, covering most major habitat types and many regions of the world. Yet, although it can in theory provide a powerful tool for placing ecosystem-based options on the agenda of development planners and decision-makers, the use of ecosystem valuation techniques in climate adaptation and disaster risk reduction still remains in its infancy and as yet there have only been a small number of real-world applications (also see Harmáčková et al. Chap. 5; Clark et al. 2012; Naumann et al. 2011; Chadburn et al. 2013; Rao et al. 2013; Emerton 2014b; Shreve and Kelman 2014).

The following sections illustrate how economic valuation approaches were applied to generate information which could be used to assist in making the case for integrating ecosystem-based options for CCD into coastal zone planning in Puttalam Lagoon, Sri Lanka and the Kwale coastline, Kenya. The objective was to demonstrate to national and local decision-makers and budget-holders the potential gains from green CCD strategies as well as the costs and losses associated with failing to factor ecosystems into coastal development planning. The studies focussed on assessing the costs, benefits and trade-offs associated with investing in mangrove rehabilitation and conservation as a means of strengthening climate adaptation and disaster risk reduction, at the same time as generating other development co-benefits for coastal populations.

2.5 Weighing up the Opportunity Costs of Land Use Change in Puttalam Lagoon, Sri Lanka

Puttalam Lagoon is located on the north-west coast of Sri Lanka, and covers a surface area of some 33 km^2. It connects to the open sea at the northern end, and is separated from the Indian Ocean on the west by a narrow strip of sand dunes and long sandy beaches. Mangroves are currently estimated to cover between 700 and 1000 ha of the lagoon's inner shoreline (Weragodatenna 2010; Kumara 2014; Bournazel et al. 2015). Tidal flats, seagrass beds, salt marshes, dry monsoon forest, coastal scrub jungles and dry thorny scrublands are also found (Kumara and Jayatissa 2013). On the eastern and southern fringes, large tracts of land have been converted to agriculture and aquaculture, including around 1500 ha of cropland, a similar area of salterns, several thousand hectares of coconut plantations and at least 1000 ha of mainly small-scale shrimp ponds (Weragodatenna 2010; Bournazel et al. 2015). Some 45,000 households or 185,000 people live in the administrative divisions abutting the lagoon.

The expansion of shrimp farming in Sri Lanka over the past three decades has dramatically changed the coastal landscape, and Puttalam has experienced some of the most destructive development in the country. It is estimated that a third or more of mangrove cover in the lagoon has been lost since the early 1990s (Bournazel et al. 2015). Meanwhile, problems with disease meant that many shrimp farms performed poorly in financial terms, leading to their being abandoned after a relatively short time, leaving denuded and unproductive landscapes (Dahdouh-Guebas et al. 2002; Westers 2012). The conversion of mangroves to aquaculture ponds and their subsequent abandonment pose potentially serious risks to development in the Puttalam Lagoon area, in terms of negative effects on local livelihoods and increased vulnerability to the impacts of climate change.

Ecosystem-based approaches have been proposed as a means of addressing the problems associated with environmental degradation, and are also being mooted as a way of strengthening the livelihoods and adaptive capacity of local communities. These are envisaged to be based around the restoration of mangroves in abandoned shrimp farms, and the promotion of environmentally sustainable aquaculture technologies and practices among functioning and developing enterprises. However, in order to have traction with local and national decision-makers (especially those in the fisheries and agricultural sectors that exert such a heavy influence on land use change patterns), the economic rationale for these green CCD options needs to be made explicit. There is still a widespread belief that mangroves and other natural habitats comprise 'uneconomic' areas, or land 'taken out' of production. There has to date been little recognition among decision-makers of the far-reaching economic costs, losses and damages that can result from the modification and conversion of coastal environments.

Against this backdrop, the valuation study assessed the trade-offs associated with alternative land use development options, with a view to demonstrating the opportunity costs of mangrove conversion in terms of climate compatible development benefits foregone.

First of all it was necessary to identify the main ecosystem services and economic processes associated with the mangroves in Puttalam Lagoon, and select the techniques that would be used to value them. Seven services relating to climate adaptation, mitigation and associated livelihood benefits were identified as being of key importance: fuelwood, timber, non-wood/non-fish products, protection against saline intrusion, water quality regulation, carbon sequestration and avoided emissions, and provision of breeding and nursery habitat for fisheries[1] (Emerton 2014b). As is so commonly the case in ecosystem valuation, conventional market price techniques only had limited applicability: for valuing wood and non-wood/non-fish products (using local farmgate prices) and carbon storage services (via the prevailing voluntary forest carbon price for Asia). The protective functions of mangroves were valued based on the replacement costs of installing and operating wastewater treatment facilities which would bring the quality of water being discharged into the lagoon to a commensurate level (for water quality regulation services), and the expenditures on alternative drinking water sources in order to mitigate or avert the effects of surface water contamination (for protection against saline intrusion). The role of mangroves in maintaining nursery populations and habitat for commercially-important fish species was assessed by tracing effects on the productivity and catch of near shore and lagoon fisheries.

The resulting analysis indicated that the 731 ha of mangroves in Puttalam Lagoon are currently providing ecosystem services worth some USD 2.8–3.0 million a year, or between USD 3800–4100 per hectare (Table 2.1).

The second step was to examine the economic impacts of mangrove degradation and loss. The analysis covered the period 1992–2012, for which mapping, land use change analysis and carbon modelling had been carried out (see Bournazel et al. 2015). This period registered a net loss of some 934 ha of mangroves, most of which were converted to shrimp farms, salt pans, coconut plantations and other agricultural land uses (Fig. 2.2).

The extent to which, or ways in which, human populations utilise or depend on mangroves in Sri Lanka is not the same today as it was 20 years ago. Thus, in addition to considering the impact of changes in mangrove area on ecosystem values, the economic model also accounted for the ways in which the real price or value of ecosystem services had altered over time. This involved tracking the considerable socio-economic changes which have occurred in and around Puttalam Lagoon since 1992 (these are well-documented in the literature: see, for example, IUCN 2012; Kumara and Jayatissa 2013). Factors such as shifts in demography and settlement patterns, fluctuations in production and demand, changes in the relative

[1]It should be noted that two 'classic' mangrove ecosystem services do not appear in Puttalam Lagoon: protection against shoreline erosion and extreme weather events. This is due to the fact that the sheltered lagoon/estuary system is not exposed directly to the sea, and mangroves are found only on the inside shores, not on the coastline abutting the Indian Ocean.

Table 2.1 Current value of mangrove ecosystem services in Puttalam Lagoon

Ecosystem services		Total value (USD '000)	Unit value (USD/ha)
Provisioning	Wood products	367.4	506
	Non-wood/non-fish products	121.3	167
Regulating	Support to fisheries productivity	1757.5	2421
	Water quality regulation	553.3	762
	Protection against saline intrusion	192.3	265
	Carbon sequestration & avoided emissions	183.9	217
Total		2808.4–2991.9	3832–4121

Note: Individual ecosystem service values cannot simply be summed to give a total, as this would result in double-counting. As some services are partially or wholly mutually exclusive, a range of values is given. Water quality regulation services are applied only to those mangrove areas which protect major freshwater inflows into the lagoon

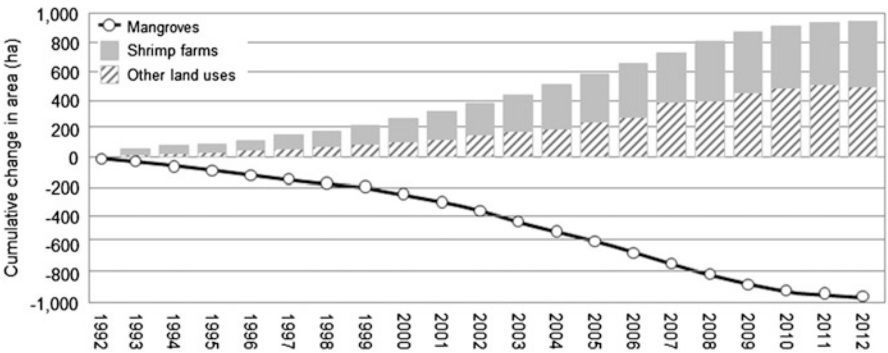

Fig. 2.2 Land use change in mangrove areas of Puttalam Lagoon 1992–2012 (Based on data presented in Bournazel et al 2015)

scarcity or abundance of natural resources, varying human dependence on (and preference for) mangrove products, and the price and availability of substitutes have all affected ecosystem service values.

The resulting analysis showed that the loss of mangroves in Puttalam Lagoon has been accompanied by a progressive decline in the value of ecosystem services[2] (Fig. 2.3). Overall, the value of mangrove services today is around USD 4 million lower than that which was available in 1992. This is even though in many cases the per hectare value of mangrove regulating services has actually shown a steady

[2]There are two exceptions to these general trends – carbon and fisheries. The slight improvement in carbon sequestration and avoided emissions values after 2007 is accounted for by the slowed pace of mangrove conversion. The dip in fisheries productivity values in 2005 and 2006 can be attributed to the sharp drop and then slow recovery of fish catch resulting from the impacts of the 2004 Indian Ocean tsunami.

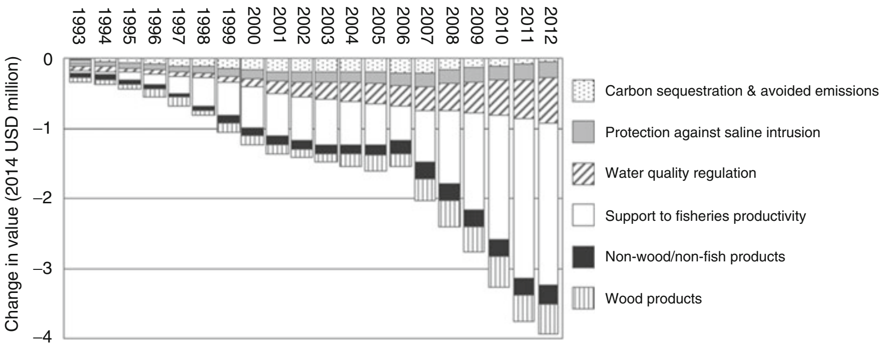

Fig. 2.3 Puttalam Lagoon: change in mangrove ecosystem service values 1992–2012 (Based on data presented in Emerton 2014b)

Table 2.2 Financial and economic impacts of land use change in Puttalam Lagoon 1992–2012 (based on data presented in Emerton 2014b)

	Value (USD mill)
Added income from shrimp farms	12.43
Added income from salterns	0.04
Added income from coconut plantations	0.17
Total added income from mangrove conversion	12.63
Foregone value of mangrove ecosystem services	−32.29
Net economic gain/loss from land use change	−19.66

increase over time, mainly due to population growth, and the intensification of settlement and industry in the area.

The third and final stage of the economic analysis entailed comparing the ecosystem values foregone due to the loss of mangrove habitats with the additional income and revenues earned from their conversion to other land uses. It was important to carry out this comparison, so as to consider the full opportunity costs and economic impacts of alternative land use, investment and development choices. The three land uses which together account for the vast majority of mangrove conversion since 1992 were considered – shrimp farms, coconut plantations and salterns. Per hectare budgets were developed for establishing, developing and maintaining each of these enterprises (including the restoration and rehabilitation of mangrove cover), and applied to the annual land use change figures. This showed that in total, mangrove ecosystem services worth USD 32.29 million (with a net present value (NPV) of USD 9.5 million) were lost between 1992 and 2012 (Table 2.2). This figure is around two and a half times more than the income earned from the shrimp farms, coconut plantations and salterns that were established on cleared mangrove land.

2.6 Articulating the Economic Gains from Ecosystem-Based Approaches on the Kwale Coastline, Kenya

Even though Kenya's mangroves generate a wide range of economically valuable goods and services to surrounding populations, they are being rapidly depleted, degraded and converted. Mangrove cover in 2010 was estimated at just over 45,000 ha, representing a reduction of 18 % from that recorded in 1985 (Kirui et al. 2013). The southern portion of the coastline has witnessed some of the highest rates of loss, driven largely by rapid population growth, escalating resource demands and intensifying settlements, infrastructure and industry (Rideout et al. 2013); if current trends continue, it is likely that mangroves may soon disappear altogether at many southern sites (Huxham et al. 2015).

There is presently a great deal of debate about the relative merits of different development approaches in Kenya's coastal zone. In the face of growing concerns about the vulnerability of the local population and economy to the effects of climate change, CCD has been gaining ground. Current development plans specify an ambitious (and costly) array of investments and activities aiming to protect and climate-proof coastal settlements and infrastructure, and strengthen the resilience and adaptive capacity of local livelihoods and production systems. Yet there remains very little information about the potential gains and relative cost-effectiveness of ecosystem-based approaches. As a result, green CCD options have to date been accorded only a minor role in public investment programmes. In an attempt to fill these gaps in evidence, the valuation study aimed to demonstrate the gains and value-added from investing in mangrove rehabilitation and conservation as a core component of climate-compatible development in the coastal zone. It focused on Kwale County on the southern Kenyan coast, which stretches approximately 90 km south from Mombasa to the border with Tanzania. The study area covered the four main mangrove areas of Mwache, Gazi, Funzi, and Vanga, which together contain just under 5600 ha of mangroves and around 22,000 people or 4500 households.

The study followed a process similar to that outlined above for Puttalam Lagoon. This first of all calculated the current baseline value of mangrove ecosystem services, moved on to assess the economic consequences of ecosystem change, and then articulated the value-added and costs-avoided that might be gained from integrating ecosystem-based approaches into CCD planning. Ten mangrove ecosystem services were valued: honey, fuelwood, timber, protection against shoreline erosion, defence against extreme weather events, carbon sequestration, nursery habitat for fisheries, tourism, research, and cultural practices. A variety of market and non-market valuation techniques were applied (see Huxham 2013 for further details). These included looking at mitigative and avertive expenditures on coastal defence structures (for protection against coastal erosion services), replacement costs of building and maintaining seawalls for storm and wave protection (for shelter against extreme weather services), and effects on fisheries production (for nursery habitat services).

Table 2.3 Current value of mangrove ecosystem services on the Kwale coastline (based on data presented in Emerton 2014b)

Ecosystem services		Total value (USD '000)	Unit value (USD/ha)
Provisioning	Timber, fuelwood & honey	1148.1	206
	Capture fisheries (finfish)	609.0	109
	Capture fisheries (crustaceans)	716.2	129
Regulating	Protection against coastal erosion	2196.5	395
	Protection against extreme weather events	192.5	35
	Carbon sequestration	1397.3	251
	Tourism, education & research	228.6	41
Total		5747.5–6488.1	1033–1166

Note: Individual ecosystem service values cannot simply be summed to give a total, as this would result in double-counting. As some services are partially or wholly mutually exclusive, a range of values is given

The calculations suggested that the services generated by Kwale's mangroves are currently worth between USD 5.75–6.5 million a year, or around USD 1100 per hectare (Table 2.3). It is worth pointing out that coastal protection services (including climate mitigation, erosion control and defence against extreme weather events) dominate these figures. Together they are worth more than one and a half times as much as the direct income from the provisioning services – forest and fisheries products – that economic value estimates would conventionally be confined to.

Two possible development and ecosystem futures were then modelled: business as usual (BAU) and ecosystem-based climate-compatible development (CCD). These reflected qualitative storyline scenarios developed by local stakeholders (including representatives from government, NGOs, communities and regulatory bodies), which laid out alternative visions for future land use and development along the Kwale coastline over the next 20 years (see King and Nap 2013; Huxham et al. 2015). In brief, BAU was depicted as entailing the gradual loss of mangrove cover and degradation of remaining forests, decline in fisheries resources, increasing coastal vulnerability and poverty, while CCD emphasised ecosystem conservation and sustainable management resulting in healthy mangroves supporting improved local livelihoods and enhanced resilience. Quantitative risk mapping and modelling of forest cover was also carried out (see Huxham et al. 2015), informed by the stakeholder scenarios and assuming the continuation of key risk factors and past trends in mangrove forest loss (Kirui et al. 2013; Rideout et al. 2013).

The risk mapping and land use change projections suggested that a 43 % loss of mangroves would occur over the next 20 years under BAU (with 100 % loss at the most vulnerable site, Mwache). Under the CCD scenario, forest cover was predicted to expand by 8, 7, 9 and 13 % in Funzi, Gazi, Mwache and Vanga, respectively (see Huxham et al. 2015). Because most of the area cleared of mangroves over the past 25 years has been left unused, mangrove restoration would generally not entail opportunity costs. Thus, unlike in the Puttalam study, no comparison was made between mangroves and the value of alternative land uses. However, as was the case for Puttalam, the economic model allowed for changes in the real value of ecosystem services, according to likely future trends in resource demands, user numbers and relative dependency on mangrove goods and services. Running the scenario analysis indicated a progressive decline in mangrove values over the next 20 years under BAU and a sustained increase in ecosystem benefits under CCD, yielding total values of USD 95 million and USD 156 million respectively, or NPVs of USD 43 million and USD 61 million (Fig. 2.4, Table 2.4).

Using these figures, it was then possible to portray the economic implications of the two coastal development alternatives for the Kwale coastline. Should BAU continue, the economic model indicated that ecosystem services worth more than USD 41 million will be lost over the next 20 years as compared to those that would have been available had the area and quality of mangroves remained at current levels (Table 2.5). In contrast, the CCD scenario stands to generate economic gains

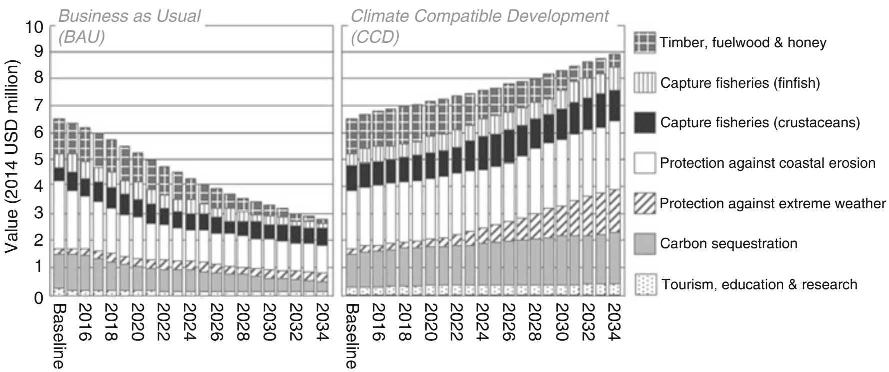

Fig. 2.4 Kwale coastline change in mangrove ecosystem service values under Business as Usual (BAU) and Climate Compatible Development (CCD) scenarios 2014–34 (Based on data presented in Emerton 2014b)

Table 2.4 Kwale coastline value of mangrove ecosystem services under BAU and CCD 2014–34 (based on data presented in Emerton 2014b)

	BAU value (US mill)		CCD value (US mill)	
	Total	NPV@10 %	Total	NPV@10 %
Timber, fuelwood & honey	16.17	8.01	19.82	9.20
Capture fisheries (finfish)	9.25	4.20	13.78	5.45
Capture fisheries (crustaceans)	12.92	5.43	19.68	7.42
Protection against coastal erosion	28.36	12.94	50.24	19.72
Protection against extreme weather	5.11	1.81	14.29	4.14
Carbon sequestration	20.10	9.02	33.55	13.04
Tourism, education & research	3.07	1.44	5.13	2.03
Total	94.98	42.85	156.48	61.01

Table 2.5 Incremental costs and benefits of BAU and CCD scenarios for the Kwale coastline 2014–34 (based on data presented in Emerton 2014b)

	Total (USD mill)	NPV@10 % (USD mill)
Costs incurred by BAU over the baseline	−41.27	−12.38
Value-added incurred by CCD over the baseline	20.23	5.77
Value-added incurred by CCD over BAU	61.50	18.16

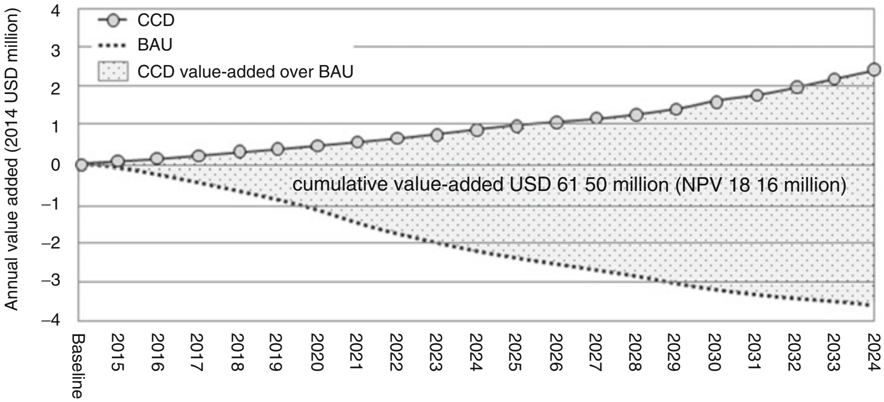

Fig. 2.5 Kwale coastline CCD value-added over BAU 2014–34 (Based on data presented in Emerton 2014b)

of more than USD 20 million as compared to the baseline. Adding these two figures together indicates the potential value-added and costs avoided of shifting from business as usual to an ecosystem-based climate-compatible development model would be in excess of USD 60 million (Fig. 2.5). This is, in effect, the return to investing in ecosystem-based CCD measures (or, conversely, the cost of policy inaction as regards mangrove conservation and rehabilitation). By the year 2034, mangrove ecosystem services will be generating values worth just under USD 10 million a year under a CCD scenario (almost 40 % more than they are worth today), as compared to under USD 3 million under BAU (less than half of today's value).

2.7 Encouraging Investments in Ecosystems as Climate-Compatible Development Infrastructure

Case studies from Sri Lanka and Kenya have been used to illustrate the ways in which economic valuation can serve to articulate both the gains from investing in ecosystems as a key component of climate-compatible development infrastructure, and the losses that can result from not doing so. On the one hand, the findings from Puttalam Lagoon demonstrate clearly the cost of omitting natural ecosystems from land use development planning. Since 1992, the conversion of mangrove habitats to seemingly more ‘productive’ or ‘profitable’ uses has cost the local economy more than USD 31 million in foregone benefits. These losses amount to a sum that is more than twice as high as the income earned by shrimp farming and the other land uses that replaced mangroves. In the Kwale case study, ecosystem-based CCD options were shown to offer the potential to secure an additional USD 20 million of adaptation, disaster risk reduction and other livelihood benefits over the next 20 years as compared to those that would have been available if the area and quality of mangroves remains at current levels. This is more than one and a half times as much as the gains that would realised under a continuation of a ‘business as usual’ model for coastal development.

These kinds of approaches thus offer a means of generating potentially powerful – and usually much-needed – evidence and data about the economic opportunities, cost savings and avoided losses associated with ecosystem-based approaches. The resulting figures make the important point that green options have value not just because they provide a cost-effective way of securing climate adaptation and disaster risk reduction gains, but also due to the considerable development co-benefits that they generate in terms of value-added and costs avoided to other economic sectors and processes. The implication is that, from an economic perspective, ecosystems should be treated, counted and invested in as an integral part of climate-compatible development infrastructure — as a stock of facilities, services and equipment which are needed for the economy to function, grow, adapt and maintain its resilience in the fact of climate change and other hazards (Emerton 2006, 2014a).

It is, nevertheless, important to underline that valuation is not an end in itself. While a lack of economic evidence may act as a major constraint to ecosystem-based approaches being fully mainstreamed into development decision-making, the story does not end with generating strikingly large figures on costs and benefits. Even if information on ecosystem values is a necessary condition for increasing the budgetary and policy priority given to green adaptation and disaster risk reduction, by itself it is rarely sufficient. In both the Sri Lanka and Kenya cases, considerable further work was required to develop and deliver a communication strategy and set of messages which would prove convincing to coastal decision-makers. Equally importantly, however much ecosystem services are demonstrated to be worth in theory, and however convinced decision-makers are that it is in the public or private interest to invest in them, this has little meaning unless it translates into real-world changes in the way in which policies are formulated and decisions are made, and is reflected in the prices and profits that people face as they choose between alternative land, resource and investment options. Ultimately, it is those who manage, use and impact on natural ecosystems on a day to day basis who must be willing – and economically able – to invest in their continued upkeep and maintenance.

Yet, for the most part, a better understanding, and more accurate quantification, of the economic benefits of ecosystem conservation (and economic costs of ecosystem degradation and loss) is still reflected weakly in the policies, markets and prices which actually drive people's economic behaviour. The Sri Lanka case, in particular, illustrates that what might be the most profitable or desirable or beneficial land, resource or investment choice from the perspective of the wider economy is not necessarily the one which has the most immediate appeal to landholders in coastal areas. Converting land to aquaculture and agriculture makes more financial sense to local landholders than sustainably using and managing mangroves. Shrimp farming, coconut farming and salt production all generate higher cash returns and more immediate sources of earnings for the landholder – even if (as is the case for shrimp farming) this income cannot be sustained over the long-term, or imposes significant negative impacts and externalities on other groups and sectors. The bottom line is that there remain few economic incentives for landholders to maintain mangroves on their land.

The key challenge then becomes one of moving beyond merely articulating the value of ecosystem services for adaptation and disaster risk reduction, to identifying where there are needs and niches to capture these values as concrete incentives and finance for ecosystem management. The application of ecosystem valuation tools and approaches does not just involve estimating and demonstrating ecosystem service values, but also seeking solutions using economically informed policy and management instruments (TEEB 2008, 2010). The aim is to help to change the economic conditions and circumstances that cause people users to convert or degrade ecosystems in the course of their economic activities, and instead set in place the economic opportunities and rewards which will encourage, enable and motivate the investments and actions that are required for continued maintenance of valuable 'natural' climate compatible development infrastructure.

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