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Balancing Development and Coastal Conservation: Mangroves in Mozambique

Romy Chevallier

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All photographs: Romy Chevallier

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ABBREVIATIONS AND ACRONYMS

AFC	African Fishing Company
ANAC	Administração Nacional das Áreas de Conservação (National Agency of Conservation Areas)
BANP	Bazaruto Archipelago National Park
CBD	Convention on Biological Diversity
CCPs	Conselhos Comunitários de Pesca (Community Fisheries Councils)
CDM	Clean Development Mechanism
CI	Conservation International
CITES	Convention on International Trade in Endangered Species
CONDES	Conselho Nacional de Desenvolvimento Sustentável (National Council for Sustainable Development)
COP	Conference of the Parties
CSO	Civil society organisation
EIA	Environmental Impact Assessment
EWT	Endangered Wildlife Trust
FAO	Food and Agriculture Organization of the United Nations
FSC	Forest Stewardship Council
GHG	greenhouse gas
ICRAF	World Agroforestry Centre
IDPPE	Institute for Development of Small-scale Fisheries
IIP	National Fisheries Research Institute
INAQUA	National Institute for Aquaculture Development
INGC	Instituto Nacional de Gestão das Calamidades (National Institute for Disaster Management)
IOC-UNESCO	Intergovernmental Oceanographic Commission of UNESCO
IPCC	Intergovernmental Panel on Climate Change
ISME	International Society for Mangrove Ecosystems
ITTO	International Tropical Timber Organisation
IUCN	International Union for Conservation of Nature
LULUCF	Land use, land use change and forestry
MA	Millennium Ecosystem Assessment
MAB	Man and Biosphere Programme
MICOA	Ministério para Coordenação de Acção Ambiental (Ministry for the Coordination of Environmental Affairs)
MITUR	Ministry of Tourism
MPA	Marine Protected Area
NAMA	Nationally Appropriate Mitigation Action
NGO	non-governmental organisation
PARPA	Plano de Acção para Redução da Pobreza Absoluta (Action Plan for the Reduction of Absolute Poverty – Poverty Reduction Strategy)
PES	Payments for Ecosystem Services
RAMSAR	Ramsar Convention on Wetlands

REDD	Reducing Emissions from Deforestation and Forest Degradation
SEA	Strategic Environmental Assessment
STRP	Ramsar Scientific & Technical Review Panel
TEEB	The Economics of Ecosystems and Biodiversity
Tg	Teragram
TNC	The Nature Conservancy
TRCRA	Lubombo Ponta do Ouro-Kosi Bay Marine and Coastal Transfrontier Conservation and Resource Area
UNEP	UN Environment Programme
UNEP-WCMC	UN Environment Programme – World Conservation Monitoring Centre
UNESCO-WHC	UN Educational, Scientific and Cultural Organisation – World Heritage Convention
UNFCCC	UN Framework Convention on Climate Change
WI	Wetlands International
WWF	World Wildlife Fund

EXECUTIVE SUMMARY AND RECOMMENDATIONS

Despite their well-researched and widely recognised socioeconomic and ecological value, mangroves are among the world's most threatened vegetation types. More than a fifth of the world's mangroves have been lost over the past 30 years alone, and many of the remaining forests are degraded. The depletion of mangroves in many developing countries in particular is a cause for serious environmental and economic concern. This stems from the fact that mangroves play a vital role in moderating monsoonal tidal floods as well as other forms of coastal protection. Mangroves support numerous forms of fauna and flora, as well as estuarine and near-shore fisheries. They also sequester large amounts of carbon dioxide, which helps to mitigate climate change. Consequently, the continuing degradation and depletion of this vital resource will reduce not only terrestrial and aquatic production and wildlife habitats, but also the stability of coastal forests, thus threatening the livelihoods of people who depend on their ecosystem services and functions.[1]

The value of nature's 'services' and its non-market benefits need to be better understood, and incorporated into countries' development choices. The total economic value associated with the more sustainable management of ecosystems is often higher than the value associated with its conversion into farming, mining, logging, or other intensive and unsustainable practices. This quantification is important for establishing the 'true' value of a mangrove forest, and therefore for enticing investment back into conservation. These decisions are particularly pertinent to Africa, where numerous countries are poised to acquire significant new wealth from oil, coal and gas deposits, with potentially devastating consequences for the physical environment. In Nigeria, Guinea Bissau and Mozambique, mangrove forests coincide with fossil fuel deposits and related infrastructure developments. In the wake of this extractive boom, African countries need to fully understand the consequences of natural resource exploitation for their fragile ecosystems, in order to minimise the negative impacts and avoid unnecessary and unwise trade-offs. Commercial economic activities must be planned in ways that avoid potential conflicts with other coastal habitat users, and take biodiversity into account.

It is therefore particularly important for resource-rich African countries to start utilising the ecosystem services approach to their natural resources, thus providing them with an instrument for balancing economic growth, social development needs and environmental protection. They need to examine the intersection of these sectors and take account of exacerbating factors such as climate change, population growth, and a subsequent increase in resource needs. The ecosystem services approach provides policy-makers and planners with a framework for the integrated and sustainable management of land, water and living resources.

Mangrove ecosystem services, for example, need to be integrated into mainstream economic planning and development policy at all levels. At the national level, ecosystem services need to be incorporated into existing regulatory mechanisms, complementing existing approaches but not necessarily replacing them. Also, existing conflicts of interest in coastal zones need to be immediately addressed and resolved, thus aligning economic development with the maintenance of vulnerable coastal ecosystems. Policy-makers must be made aware of the combined and cumulative impacts of their decisions on all sectors,

thus enabling them to combine their decisions to pursue mega-projects with effective measures to mitigate negative environmental impacts. Governance tools and management planning, such as thorough Environment Impact Assessments (EIAs) and the use of Strategic Environment Assessments (SEAs), can help to achieve this goal.

Mangrove losses in various countries differ considerably, often due to national differences in policies, legislation and management. Reversing the trend of mangrove loss and the growing vulnerability of coastal communities will require a real commitment by governments to develop and implement robust high-level policies and good management practices, and establish clear frameworks for owning, using and managing mangroves. Mangroves are being restored in many countries, thus reversing the patterns of loss while bringing considerable socio-economic benefits to coastal areas. Also, restoration and protection is achievable and more likely to occur if strong economic arguments and incentive structures are used to emphasise the value of natural capital in support of sustainable development goals. In this regard, there is an urgent need for better ecosystem accounting as well as new ways of financing environmental schemes, such as Blue Carbon financing under climate change mitigation frameworks.

POLICY RECOMMENDATIONS TO SPECIFIC STAKEHOLDERS

To the government of Mozambique

1 Increase the use of ecosystem valuations and ecological accounting to help justify conservation priorities and an increase in protected areas.
2 Integrate mangrove conservation strategies and actions with broader development planning frameworks, such as national development and poverty reduction strategies and fisheries and forestry action plans, as well as pre-emptive policies, such as natural disaster risk management plans and climate change adaption strategies.
3 Urgently reconcile Mozambique's rapid economic growth with the maintenance of ecological processes and coastal biodiversity by using adequate spatial development planning and management tools to convert potential conflicts into synergies.
4 Map the current and expected human and industrial footprints in the coastal zone of Mozambique in order to develop a better understanding of the needs of coastal communities as well as their current economic activities. This will inform planning, and help policy-makers and planners to protect sensitive areas. The recommendations made in the 2013 draft report for the coastal Strategic Environmental Assessment (SEA) in Mozambique need to be implemented.
5 Integrate land use planning and coastal planning in order to maintain the ecological linkages between terrestrial and marine ecosystems.
6 Pursue an integrated, ecosystem-based management regime for all coastal ecosystems and users of coastal resources, including mining, infrastructure development, ports, tourism, fisheries and conservation.
7 Make use of centralised interdisciplinary forums, such as the National Council for Sustainable Development (Conselho Nacional de Desenvolvimento Sustentável, or CONDES), to identify and examine areas of overlap between economic development

and biodiversity priorities. This process should be inclusive, adaptive and integrative, and represent all stakeholder groups

8 Use geographic surveys to map and assess coastal ecosystems, particularly mangroves, thus providing policy-makers and planners with accurate and up-to-date data.

9 Gather the data needed to determine conservation priorities and formulate policies for regulating coastal resource extraction, coastal trade and coastal development. This must be done before concessions are granted, and before environmental impact assessments (EIAs) are conducted.

10 Conduct a comprehensive review of all legislation and regulations relevant to mangrove conservation and use, thus allowing all policies to be harmonised and environmental sustainability to be mainstreamed in all relevant policies, at all levels of government.

11 Broaden the role of the Ministry for the Co-ordination of Environmental Affairs (MICOA) to that of 'the Ministry for Co-ordinating Environmental Action', which would not only co-ordinate the state's environmental functions, but also actively manage the coastal zone. MICOA officials in other relevant ministries need to be provided with additional support. This will enhance the status of environmental issues and strengthen the capacity of all ministries and departments to make informed decisions.

12 Further develop and strengthen legislation and regulations for managing the environmental impact of land use and land use change, particularly in the coastal zone.

13 Strength the country's ability and capacity to implement EIAs and conduct objective feasibility studies of proposed developments. This is particularly urgent in the mining and other extractive sectors, the petroleum sector, and for proposed aquaculture and infrastructure development projects.

14 Incorporate the value of mangrove ecosystem services in all EIAs as well as mitigation/compensation plans and calculations.

15 Develop national climate change response plans that incorporate coastal vegetation or hybrid engineering solutions. Physical infrastructure must be complemented by investments in natural barrier restoration.

16 Widen and expand national and trans-frontier protected areas in order to conserve biodiversity and maintain ecosystem services. Strengthen the specific regulations for each conservation zone.

17 Dedicate sufficient resources to implementing these expanded conservation network plans. This can be done through innovative financing schemes such as payments for ecosystem services (PES) or other forms of compensation.

18 Educate all relevant coastal resource users and suppliers, from the commercial sector to local communities. This is particularly urgent given the growing pressures on fisheries and the importance of mangroves as barriers to rises in sea levels and storm surges.

19 Promote corporate environmental and social responsibility, ensuring that the private sector internalises environmental costs and that the principle of compensation for biodiversity loss is acknowledged.

20 Utilise co-management institutions such as the Community Fisheries Councils (Conselhos Comunitários de Pesca, or CCPs) established in the vicinity of important

mangrove habitats. CCPs manage and protect mangroves at the local level, disseminate key lessons to coastal communities, and can be the recipients of job opportunities related to mangrove restoration and reforestation.

To the users, stakeholders and authorities responsible for the management of the Bazaruto Archipelago National Park

1 Marine Protected Areas (MPAs) and special protection coastal zones should feature more prominently in Mozambique's strategy for the conservation and management of mangroves. MPAs should be extended to incorporate more marine and coastal areas, and all vulnerable or highly threatened ecosystems identified by means of scientific analysis.
2 Urgently complete the SEA for the BANP. It should address the intersection of the tourism sector, conservation, the hydrocarbon industry and fishing communities in order to resolve existing conflicts surrounding the park.
3 Include recommendations in the BANP's new management strategy (2014-2018) for reducing conflicts of interest, and minimising environmental degradation.
4 Build the capacity of communities and civil society organisations (CSOs) to engage with environmental decision-making.
5 BANP officials must engage with CCPs on the mainland to assist with education and outreach activities aimed at demonstrating the benefits of protected areas and clarifying park boundaries and fishing regulations.
6 Explore Blue Carbon options and demonstration projects in the BANP, and develop alternative livelihood opportunities to destructive practices in the Park.

To Blue Carbon-rich African countries

1 African countries with long coastlines and ample coastal vegetation should lobby for global agreements which include the carbon in coastal ecosystems in calculations of the value of ecosystem services.
2 Blue Carbon should be more fully integrated with international policy discussions of climate change mitigation in the UN Framework Convention on Climate Change (UNFCCC), well as regional and national policy discussions of marine and coastal management frameworks.
3 Mangroves, sea grasses and tidal marshes should be incorporated in national emission reduction strategies as well as Greenhouse Gas (GHG) inventory submissions at the international level.
4 The findings in the 2013 review supplement of Intergovernmental Panel on Climate Change (IPCC) on wetlands and coastal ecosystems stress their importance for climate change mitigation. This science needs to be fully considered in country mitigation plans, as well as in REDD+ strategies.
5 African policy-makers should be more vocal in calling for the integration of Blue Carbon with the financing processes of the UNFCCC.
6 A Blue Carbon policy framework for Africa should be formulated, and an African Union (AU) or NEPAD committee should be established for this purpose.

CHAPTER 1

INTRODUCTION

DEFINITIONS OF MANGROVES

The Food and Agriculture Organisation of the United Nations (FAO) defines mangroves as assemblages of salt-tolerant trees and shrubs that grow in the intertidal regions of tropical and subtropical coastlines.[2] They grow in places where fresh water mixes with sea water, creating cumulative deposits of mud. There are numerous mangrove species: the white mangrove, *Avicennia marina*, is one of the most common species along Indian Ocean coastlines, while the black mangrove, *Avicennia germinans*, only occurs in West Africa.

Mangrove forests occupy about 15 million hectares of tropical and subtropical coastline worldwide. One fifth of this area occurs in sub-Saharan Africa.[3] Although they account for only 1% of the total area of tropical forests, mangroves are highly productive ecosystems that contribute to local and global livelihoods by providing forest resources such as timber, firewood and thatching material, as well as non-timber products and services.

Mangrove forests are being destroyed at an alarming rate. This report emphasises the importance of mangrove conservation, describing the extent and status of global mangroves and the drivers of deforestation. It also examines international practice in coastal ecosystems management in terms of activities that promote the sustainable use of mangroves, and the use of legislative and regulatory tools to protect vulnerable species and limit their degradation. Lastly, it considers management tools such as afforestation and restoration in other African countries, as well as the use of international environmental protocols for protecting mangroves.

Mozambique has the third most mangrove forests in Africa (after Nigeria and Guinea Bissau), and the most in East Africa. These forests play a key role in maintaining its fisheries stocks, protecting its long and exposed coastline against natural disasters, and

Left: Red mangroves on Java Island, Indonesia. Right: Black mangroves on the banks of the Mtakatye River in South Africa's Eastern Cape Province.

storing and sequestering carbon dioxide. However, experiences in Mozambique highlight some of the management challenges around protecting ecosystems in the light of other increasingly important economic considerations, particularly when ecosystems and new developments overlap in physical terms, and one advances to the detriment of the other. Mangroves in the coastal zone and in formally protected areas are protected by legislation. However, enforcement and surveillance is a key challenge, even in well-financed and demarcated protected areas. Some 50% of mangrove forests fall outside protected zones, and therefore enjoy no legal protection.

There is also an obvious lack of understanding of the importance of mangroves. Evidence illustrating the climate change mitigation potential of mangroves, for example, has only recently begun to fuel international debates on mangrove conservation. The final chapter of this report explores the viability of mangroves, carbon markets and conservation finance in Africa, using Mozambique as a case study. It considers options for the sustainable management of coastal ecosystems in the light of new economic incentive schemes such as Blue Carbon. It also examines aspects requiring further research, particularly carbon accounting systems.

LITERATURE REVIEW

The literature on mangroves is extensive. The first global attempt to document the status and extent of mangroves was the *World Mangrove Atlas*, published in 1997 by the International Society for Mangrove Ecosystems (ISME), and financed by the International Tropical Timber Organisation (ITTO) in partnership with the UNEP World Conservation Monitoring Centre (UNEP-WCMC).[4] Updated in 2010, this study provides a wealth of information on the ecology, biodiversity, distribution, economic value, and management status of mangroves around the world.[5] Another important study, *World's Mangroves 1980–2005*, published in 2007 by the FAO,[6] presented similar evidence of the extent and loss of coastal ecosystems. In a study published in 2011,[7] Giri *et al*. updated the global data on mangrove forests, using better mapping techniques and high-resolution satellite data. According to these authors, mangrove forests are 12.3% smaller than the earlier FAO predictions.

In 2003, the UNEP-WCMC updated its mapping of mangrove quantities in Africa in a publication entitled *Mangroves of East Africa*.[8] This was supplemented by a UNEP publication in 2007 that analysed the extent of mangroves in the West and Central African eco-regions.[9] Another important report, written by Rocliffe and published by the University of York, examines marine conservation agreements in the West Indian Ocean.[10]

However, despite the availability of more advanced technology – including remote sensing – to map mangroves, there is still an apparent lack of data on coastal ecosystems, especially in Africa. Much of the data on countries such as Mozambique is outdated, and figures vary widely. The last national mangrove census in Mozambique was conducted in 2007. Private companies and international donors have also conducted studies, but the results vary considerably and are not necessarily aligned with Mozambique's Annual State of the Environment report published by MICOA. This raises concerns about the accuracy of the data about the current state of natural resources which is used for environmental policy-making and planning. Scholars at Eduardo Mondlane University in Maputo – notably

Bandeira, Cuambe and Barbosa – have worked extensively on mangrove forests in Maputo Bay and Beira Bay.[11]

Recent work on mangroves highlights the ecosystem benefits and ecological functions of coastal vegetation systems, including the carbon sequestration services provided by mangroves, sea grasses and tidal marshes. Since 2009, experts working for the International Union for the Conservation of Nature (IUCN), the UN Environmental Programme (UNEP), the Intergovernmental Oceanographic Commission of the UN Education, Scientific and Cultural Organisation (IOC-UNESCO), and Conservation International (CI) have been working on the notion of Blue Carbon and the importance of coastal ecosystems for mitigating climate change. This has culminated in a series of publications by mangrove specialists that will be dealt with in greater detail in the final chapter.

This report contributes to the existing literature by placing the challenges surrounding mangrove conservation in the context of new economic opportunities in Africa, and specifically in Mozambique. These include new opportunities in the extractive sector, such as mining for coal, oil, gas, limestone and sand, but also other commercial activities that have been and will be detrimental to coastal ecosystem conservation, such as new aquaculture development, some agricultural projects, port development, and coastal infrastructure projects.

This report aims to strengthen arguments that coastal ecosystems should be prioritised, restored, managed more effectively, and protected. To this end it advocates stricter EIAs, the expansion of marine protected areas, rehabilitation projects, and integrated coastal planning. In this regard, the recommendations in Mozambique's draft Coastal SEA[12] are particularly relevant. Published in September 2012, the report advises the government on how to minimise potential conflicts in the coastal zone, and ensure that all activities are conducted in an environmentally sustainable way. It argues that scientific coastal zoning and planning, based on improved ecological information, is needed to steer gas and oil, tourism, and other coastal infrastructure development away from sensitive habitats. The report adopts a balanced sustainable development approach, recommending that economic growth, social needs and the environment all need to be taken into account in planning processes, and that conflicts of interest in coastal areas should be thoroughly examined.

The impending development of coastal and offshore gas, oil, heavy sands, and ports has lent new urgency to make coastal zone planning. The national SEA should provide civil society and other role players with the means to call companies to account in respect of development in the coastal zones. More specific SEAs are needed to inform activities in sensitive zones such as the Bazaruto Archipelago (this is currently being conducted), the coast south of Maputo (the site of the proposed Techobanine Port), and the northern coast near Pemba (where offshore gas deposits have been discovered).

Large tracts of mangrove forests, especially in the Zambezi Delta, are relatively untouched. It is therefore an opportune time for the central government to take a strategic decision to protect these assets, or at least to manage them sustainably.

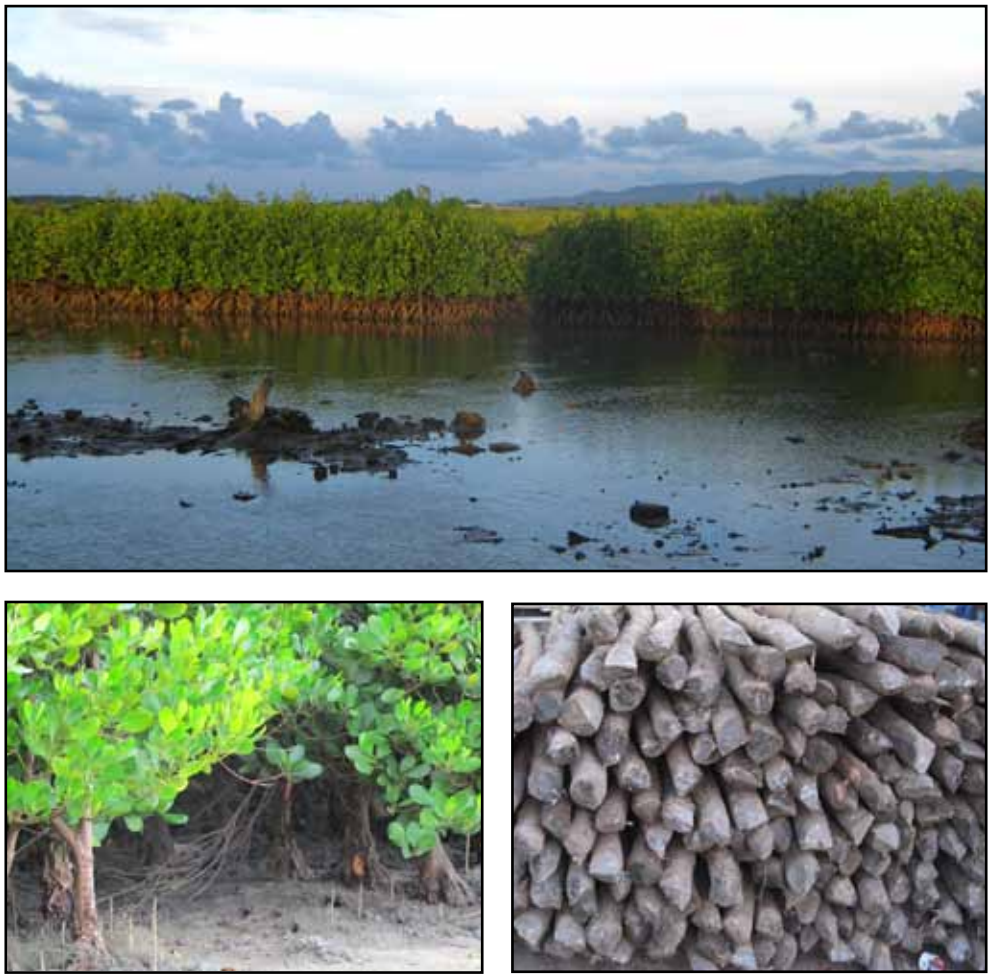
The desktop research conducted for this report was supplemented by interviews conducted during a scoping trip to Maputo in June 2012, and primary fieldwork in Beira and the Bazaruto Archipelago in July 2012. The report also draws on presentations and interviews during the Conference of Parties (COP 18) meeting in Doha in December 2012.

CHAPTER 2

MANGROVES: A GLOBAL OVERVIEW

THE STATUS AND DISTRIBUTION OF MANGROVES

According to the 2010 *World Atlas of Mangroves*, mangroves cover some 152 000 square kilometres (about a quarter of the size of Madagascar), and are found in tropical and subtropical regions in 123 countries.[13] Mangroves are largely restricted to the tropics and a few temperate regions, reaching their greatest abundance along wetter coastlines and in deltaic and estuarine areas. Mangrove habitats represent only 1% of forested areas globally and are being lost more rapidly than tropical rainforests, making it a rare forest type.



Top: Mangrove forests in Aceh, Indonesia. Bottom left: Mangrove forests near Beira. Bottom right: Mangrove wood for sale in the Beira market.

According to the *World Mangrove Atlas* (2010), countries with the largest mangrove areas are Indonesia (21% of the global total), Brazil (9%), Australia (7%), Mexico (5%) and Nigeria (5%). Most mangroves (42%) are found in Asia, followed by Africa (20%), North and Central America (15%), Oceania (12%) and South America (15%).[14] About 75% of all mangrove forests are found in just 15 countries, of which only 7% are protected via inclusion in conservation areas.[15]

In their 2011 study, Giri *et al.*[16] estimate that mangrove forests are about 12% smaller than the estimates in the 2010 *World Atlas of Mangroves*. However, they agree that Asia supports the world's largest mangrove areas, representing 34%–42% of the world's total (see Table 1). South East Asian mangroves are the best developed and probably the most species-diverse in the world.[17]

Table 1: Top 15 mangrove-rich countries and their cumulative percentages, 2000

Country	Area (hectares)	% of global total	Region
Indonesia	3 112 989	22.6	Asia
Australia	977 975	7.1	Oceania
Brazil	962 683	7.0	South America
Mexico	741 917	5.4	North and Central America
Nigeria	653 669	4.7	Africa
Malaysia	505 386	3.7	Asia
Myanmar (Burma)	494 584	3.6	Asia
Papua New Guinea	480 121	3.5	Oceania
Bangladesh	436 570	3.2	Asia
Cuba	421 538	3.1	North and Central America
India	368 276	2.7	Asia
Guinea Bissau	338 652	2.5	Africa
Mozambique	318 851	2.3	Africa
Madagascar	278 078	2.0	Africa
Philippines	263 137	1.9	Asia

Source: Giri C *et al.*, 'Status and distribution of mangrove forests of the world using earth observation satellite data', *Global Ecology and Biogeography*, Research Paper, 20. Blackwell Publishing, 2011, p. 157.

Giri *et al.* state that Africa is home to 3.5 million hectares of mangroves – 20% of the world's total.[18] All of these occur in the western Atlantic Ocean (about half of the total), central Atlantic Ocean and eastern Indian Ocean coastal zones. According to their figures, reflected in Table 1, four African countries – Nigeria (home to Africa's largest mangrove forests), Guinea Bissau, Mozambique and Madagascar – harbour 11.5% of the global total.

However, according to the *World Atlas of Mangroves* (2010), West and Central Africa harbour 13.2% of the global total, and East Africa 5.2%. It also estimates the rate of loss between 1980 and 2005 at 16% in West and Central Africa, and 7.9% in East Africa.

THREATENED MANGROVES AND CAUSES OF DEGRADATION

FAO studies claim that, despite a growing awareness of their importance, mangrove losses have been considerable and are continuing unabated. Although estimates vary widely, the 2007 FAO report states that 20% (3.6 million hectares) of total coverage has been lost since 1980,[19] and that remaining mangroves in many areas are severely degraded. Rates of loss range from 1% a year to as much as 8% a year. Moreover, 11 of 70 mangrove species (or 16%) are classified as threatened on the IUCN Red List.[20] Of special concern are two species listed as critically endangered, which may disappear within the next decade if protective measures are not enforced. The IUCN also identifies particular areas of concern, including the Atlantic and Pacific coasts of Central America, where as many as 40% of mangroves species are threatened with extinction. Across the globe, mangrove species found primarily in the high intertidal and upstream estuarine zones, which often have specific fresh water requirements and patchy distributions, are the most threatened because they are often the first cleared for the development of aquaculture and agriculture.

The ecological integrity of an estuary with mangrove forests is compromised when the mangrove cover is degraded or lost, resulting in a loss of habitat and changes in estuarine functioning. Mangroves are in constant flux due to both natural and anthropogenic forces. In the past three decades, forest loss as a result of human intervention has increased significantly. With about 44% of the world's population living within 150 kilometres of a coastline,[21] heavily populated coastal zones have spurred the clearing of mangroves for coastal development, agriculture, aquaculture or resource use. Where mangroves remain, they have often been degraded through over-harvesting.[22] It is estimated that 26% of mangrove forests worldwide are degraded due to overexploitation for fuel wood and timber production. Similarly, the clearing of mangroves for shrimp aquaculture has contributed to 38% of global mangrove loss, with other forms of aquaculture accounting for a further 14%.[23] More than 40% of mangroves on the west Indian coast have been converted into agriculture and urban development, and remaining forests are under immense pressure from clear-cutting, land use change, hydrological alterations, chemical spills, and climate change. Recent scientific research has also highlighted the potential threat of sea-level rise, exacerbated by climate change.[24] Crooks *et al.* predict future wetland loss through rises in sea levels to reach 5%–20% by 2080.[25]

MANGROVE ECOSYSTEMS AND SERVICES

Mangroves, and other coastal ecosystems such as seaweed, kelp, sea grasses and tidal marshes, perform a variety of functions – or, in terminology popularised by the Millennium Ecosystem Assessment (MA), deliver a range of ecosystem services – that help to support other natural habitats and ecosystems. Invariably, ecosystems deliver multiple

co-benefits with significant social and economic values, and can help to achieve multiple environmental, economic and social objectives.

The Millennium Ecosystem Assessment synthesis report (2006)[26] classified environmental services into four categories, namely:

- **regulating services** (natural processes such as shoreline protection, atmospheric and climate regulation, human disease control, water processing, flood control and erosion control);
- **provisioning services** (goods and products that include wood and timber for cooking fuel, fish processing, salt production, charcoal, construction, and thatching);
- **cultural services** (non-material benefits such as aesthetic value, recreation/tourism, sacred areas, ointments and traditional medicines); and
- **supporting services** (natural processes that maintain other ecosystem services such as nutrient cycling, the provision of fish nursery habitats, sediment trapping, the filtering of water, and the treatment of waste).

Mangroves perform almost all these functions.

Daily catch of fish and prawns, Njalane fishing village, Beira.

Carbon sequestration[27] and climate change mitigation

Mangroves are the coastal equivalent of rainforests in that they store organic carbon in the soil. The total above-ground biomass of the world's mangrove forests may amount to more than 3 700 Tg C,[28] and carbon sequestration in mangrove sediments to 14–17 Tg C a year.[29] Mangroves sequester up to 25.5 million tonnes of carbon a year, and provide 10% of essential organic carbon to the oceans.[30] Like rainforests, they store carbon within their 'biomass', which is released when their habitat is destroyed. Given that they capture about five times more carbon than tropical rainforests, they have attracted the interest of carbon-focused conservation strategists.

Biological importance

Mangroves are among the most important intertidal habitats for marine and coastal fisheries. This biome feeds and protects juvenile fish and prawns. It also provides a habitat for endangered, threatened and vulnerable species, such as the dugong, which we will explore later in the case of Mozambique. Some researchers estimate that 80% of global fish catches depend directly or indirectly on mangroves.[31] Mangrove-related species support 30% of fish catches and almost 100% of shrimp catches in South East Asia, while mangroves and associated habitats in Queensland in Australia support 75% of commercial fish species. According to UNEP, more than 60 per cent of fish caught between the Gulf of Guinea and Angola breed in the mangrove belt of the Niger Delta.[32]

Ecological importance

Mangroves are important sources of fertilisation and filtration, and prevent soil erosion. They also feed other in-shore marine habitats, including sea grass beds and coral reefs.

Coastal protection

Mangroves protect coastal areas against natural disasters such as tsunamis, cyclones and erosion resulting from rises in sea levels, especially on small islands. There is evidence that mangroves reduced the impact of the 2004 Indian Ocean tsunami at a number of locations.[33] Given the expected increase in weather-related events due to climate change, this is particularly important from a disaster risk management perspective.

Economic importance

Mangroves provide forest resources such as high-grade timber and non-timber products that support rural economies as well as ecotourism. Mangroves also have important aesthetic values, and provide cultural/ heritage benefits.

Given all this, it is fair to conclude that mangroves support social and economic development in many direct and indirect ways. These valuable services need to be prioritised and protected. An account of the vital role played by mangroves in the economy of Beira in central Mozambique appears below (see Box 1).

The Beira landing site, with the industrial port of Beira in the background.

Box 1: The role of mangroves in Beira

The port city of Beira is the second largest city in Mozambique and the capital of Sofala Province, housing almost a third of its population (more than half a million people). Due to its port and rail linkages, it is also the second largest industrial centre in the country, and supports the Beira Corridor. It provides Zimbabwe with access to the sea, and exports the massive coal deposits in the Mozambican interior that are currently being opened up by transnational mining companies. The city is characterised by intense commercial activity, both formal and informal, as Beira Port is the second largest in the country after Maputo in terms of handled shipping loads.

Beira lies in the central region of the country, where the Pungue River reaches the Indian Ocean. The mangrove forests in the delta support unique and varied flora and fauna, including sharks, a humpback whale nursery, porpoises, and a variety of migratory wetland birds. Sofala Bank is also one of the most important shrimp/prawn fishing grounds off Mozambique. Shrimps are generally abundant in the shallow water along the coast associated with mangroves, but also occur in deep water as well as surface water. In 2009, Sofala Bank yielded penaeid shrimps for export valued at $80 million a year, amounting to 3% of GDP. However, according to representatives of industrial and semi-industrial trawler companies interviewed in Beira, in recent years shrimp stocks have dwindled to the point where shrimp has become an uneconomical catch,[34] with the trawler fuel outstripping returns. They believe this decline is due to the destruction of coastal ecosystems.

Alongside the commercial port of Beira is Praia Nova, Beira's largest landing site for artisanal and semi-artisanal fishing vessels. It is a hive of activity, with about 7 000 registered vessels heading out to fish or returning with the day's catch (2007 figures). There is a bustling market nearby, with a sheltered space for the sale of fish and other produce. The Praia Nova CCP is the largest in Sofala District, and is housed in a building on the outskirts of the city of Beira behind the market. It is one of a number of co-management committees established along the Mozambican coast in order to involve local resource users in management and decision-making related to fisheries.

According to interviews conducted with local government representatives, there are more than 150 CCPs in Mozambique, representing almost all fishing communities.[35] They are represented at the national level on the Fisheries Advisory Committee. They issue fishing licences, determine quotas, monitor catches, and police illegal activities. They also collect revenues and pass them on to the Fisheries Administration at the local government level. CCPs form an extensive network, and meet regularly to share information and discuss common issues. There are 17 CCPs in Sofala Province alone.

According to Manuel Antonio Mashaba, a member of the Praia Nova CCP, fishermen in his district are only now beginning to understand the link between declining fish stocks, the use of illegal fishing equipment (mainly chicocotas),[36] fishing in prohibited areas such as estuaries, and the destruction of mangroves.[37] The CCP is working actively with local government to monitor and police illegal activities, including the commercial harvesting of mangroves. It also educates fishing communities, continually emphasising the vital link between fish habitats and coastal vegetation. Some CCPs also organise the restoration and planting of mangroves by unskilled coastal communities. These activities are vital to Praia Nova as it lost virtually all its mangroves during the civil war, when they were cut down by the military to deprive guerrillas of shelter. Charcoal burning is also rapidly depleting remaining mangrove forests on the city's outskirts. Despite the fact that the sale of mangrove wood is prohibited, mangrove poles and fuel wood are openly sold in the Praia Nova market. Urban growth is placing additional pressure on mangrove areas in the form of growing demand for wood and non-timber products.

Besides benefiting fisheries, mangroves also act as natural flood barriers, a vital function in Mozambique. According to the Africa Climate Change Resilience Alliance, Mozambique is the third most exposed country in the world to the cumulative effects of natural disasters and climate change.[38] Given its location, it is exposed to tropical cyclones. Moreover, some 60% of its population (20.5 million people) live in coastal areas,[39] many of them on floodplains. Over the past decade floods have become bigger and more frequent, and these trends are predicted to increase.

Between 1956 and 2008, Mozambique experienced 20 floods and 13 tropical cyclones which claimed the lives of 2 618 people, and affected some 12 000 others.[40] In 2009, the National Institute of Disaster Management (INGC) – the key implementing agency for practical mitigation and adaptation interventions – published a synthesis report which confirmed that natural disasters in Mozambique had increased over the previous three decades, and that climate change was likely to further increase its exposure. The central provinces are most prone to floods, cyclones and epidemics, with people living on the floodplains of the Zambezi River the most vulnerable.

The report identified Beira as one of the Mozambican cities most threatened by sea level rise and the increasing frequency and intensity of cyclones. Its half a million inhabitants live just a few feet above the Indian Ocean, and are only protected by decaying sea defences, eroding dunes, and a rapidly disappearing belt of mangroves. It has a sea wall

Top left: Mangrove fuel wood for sale at the Beira market; Top right: A fisherman displays his catch at the landing site in Beira; Bottom left: Shrimp trawling nets at Beira port; Bottom right: Prawns caught on the sandy banks in Sofala.

about 3,4 metres high, but there are gaps in the wall, and water flows through and over the wall every year. According to the report, if the wall is not raised, the 'coastal defence will be breached at decreasing intervals, overwhelming the population and threatening infrastructure'.[41]

Mangroves provide a natural defence against coastal flooding. Given this, it is vital for the Mozambican government to incorporate these climate change risks into its planning and investment decisions, and to formulate a national response plan to climate change that incorporates coastal vegetation. Mangroves must form an integral part of Mozambique's climate change adaptation and disaster risk reduction response. The INGC has drawn up a master plan for 2006–16, and a post-flood resettlement plan for 2007/8. The master plan includes investments in physical infrastructure, complemented by the restoration of natural barriers. The government has recognised the need for traditional engineering interventions to be accompanied by restoring mangroves, and planting trees on dunes.

This 'hybrid engineering' model enables engineers to work alongside natural processes, allowing the protective services provided by mangroves to be optimised and to complement those provided by hard infrastructure.[42] According to Wetlands International (WI), this

is a more sustainable approach, and often more cost-effective than conventional hard infrastructure approaches. Hybrid engineering approaches are also highly adaptable and flexible, and therefore relevant in times when climate change makes it difficult to predict the occurrence and intensity of coastal hazards. Mangroves and other coastal vegetation are able to capture sediment and store organic matter in the soil. As a result, they can, to some extent, 'grow' with the sea, thus keeping pace with rising sea levels.

According to Chambote and Shankland, NGOs and community groups in Beira have developed innovative strategies for protecting and restoring the mangrove forests in surrounding areas.[43] The city should draw on these experiences. About 40 kilometres from Praia Nova is a small fishing community called Njalane. It is one of few communities actively planting new mangroves, undertaken by 10 volunteers working with the local environmental authorities. However, according to Njalane's environmental officer,[44] the community faces significant challenges because its efforts are voluntary and it receives little or no financial assistance from the central government. By contrast, mangrove replanting in Beira needs to form an integral part of the city's disaster risk management plans as well as its job creation strategy.[45] The central government should provide local communities and NGOs with the financial and other resources they need to create natural storm barriers along the seafront.

CHAPTER 3

MANAGEMENT TOOLS FOR PROTECTING AND RESTORING MANGROVE FORESTS

Given the importance of mangroves, they should be restored, improved and maintained in ways that maximise their ecological benefits. Numerous instruments are available for doing so, including econometric models which can be used to calculate their economic value; examples of policies and laws which protect mangroves at a local, national, regional, and international level; various management tools for conserving biodiversity and promoting sustainable resource use; and proven methods for rehabilitating and restoring damaged ecosystems.

THE ECONOMIC VALUATION OF MANGROVE ECOSYSTEM SERVICES

The value of mangroves is often ignored when the economic values of proposed coastal developments, such as the use of land for mining, agriculture, aquaculture, energy or housing, are calculated. Given that their products and services are usually externalised, they are not adequately recognised, and other coastal developments are therefore deemed to be more profitable. If mangroves are to become a viable investment option, all their benefits need to be recognised and quantified.

Both the first and second edition of the *World Mangrove Atlas* provide powerful economic arguments for restoring, maintaining and protecting mangroves.[46] The 2010 edition estimates that mangroves generate between $2,000 and $9,000 per hectare per year, which could be more than those same areas would yield under aquaculture, agriculture, insensitive tourism, and even some forms of urban development. It estimates the global value of ecosystem services provided by mangroves at some $1.6 billion a year.

A 2011 report by The Economics of Ecosystems and Biodiversity (TEEB) initiative has found that abandoned mangrove ecosystems can be rehabilitated at a cost of $8,240 per hectare in the first year, followed by annual costs of $118 per hectare for maintenance and the protection of seedlings. The benefits of restoration include an estimated net income from collected forest products of $101 per hectare per year, habitat–fishery linkages worth $171 per hectare per year, and storm protection worth $1,879 per hectare per year.[47] The report draws together expertise from multiple sectors (including science, economics and policy formation) to highlight the costs of biodiversity loss and ecosystem degradation. It calls on policy-makers to undertake cost–benefit analyses, and – where appropriate – to accelerate, scale up and embed investments in the management and restoration of mangrove ecosystems.

The Millennium Ecosystem Assessment synthesis report (2005) states that changes in or depletions of ecosystem service abundance (observed through constant monitoring)

should be reflected in the accounts of natural wealth of a country or region. With this in mind, policy-makers can design adequate intervention strategies that can reduce and reverse the decline of ecosystem services. Conventional macroeconomic performance indicators do not effectively capture the dynamic nature of ecosystem services, and therefore do not provide adequate information about a country's natural wealth and the health of its environment. Given that ecosystems and their services are an integral component of national wealth, macroeconomic indicators should incorporate and track their status, and reflect upon their values. Sustainability should be a key consideration.

The use of markets, market-based mechanisms and economic instruments to conserve and pay for ecosystem services is a growing global trend that is gaining a solid foothold not just in carbon markets but also in biodiversity and water markets. Payment for Ecosystem Services (PES) schemes have been based on the premise that natural ecosystems provide valuable services, and that, if marketed correctly, they would allow watershed and biodiversity conservation to pay for itself and generate some income for those willing to participate. The idea is that these measures would encourage behavioural change via economic incentives, offering, where possible, additional employment benefits and supplementary income in exchange for the sustainable use of natural resources or conservation. Market mechanisms and PES schemes can offer financial incentives to protect non-market ecosystem benefits. Through a process of economic evaluation, these mechanisms help decision-makers to visualise the true impacts of their potential decisions and identify trade-offs and compatibilities between environmental, economic and social benefits. PES schemes also encourage policy-makers to recognise that ecosystem services contribute to the well-being of their constituents as well as their envisaged economic development.

THE PROMOTION OF SUSTAINABLE LAND USE CHANGE PRACTICES

It is important for countries to address the causes of mangrove deforestation, and develop sustainable practices for conserving mangroves. Where the loss of biodiversity cannot be avoided, governments and developers need to find ways to limit its impact. In Guinea Conakry, Guinea Bissau and Sierra Leone, for example, more sustainable ways of smoking fish and producing salt have been introduced to reduce the demand for firewood from mangrove sources. Improved fish smoking ovens use six times less firewood, and solar salt production plants need no firewood at all and produce more, purer salt. In Indonesia and Vietnam, sustainable shrimp farming is being promoted via the silvofishery concept, which involves replanting mangroves near and inside shrimp and fish ponds. According to WI, these approaches not only reduce the vulnerability of coastal areas to strong winds, tidal floods, abrasion and salt water intrusion, but also enhance their biodiversity.[48]

ENABLING POLICY FRAMEWORKS AND LEGISLATION

Clear and effective frameworks for owning, using and managing mangroves need to be developed. New policies and projects have led to the widespread protection of mangroves,

as well as a recognition that they need to be restored. State and non-sate actors have spearheaded various initiatives in this regard. Legislation governing land use and the management of mangroves varies drastically across countries and regions. Some countries, such as Malaysia and Tanzania, have placed all mangroves in protected forest reserves, under state ownership. Other countries have adopted blanket regulations for protecting mangroves, while yet others allow licensed exploitation. In Australia and the United States, policies of 'no net loss' have placed restrictions on future mangrove clearance, and developers are required to 'replace' areas proposed for conversion by investing in afforestation or restoration projects elsewhere. Laws have also been implemented in different countries that address aquaculture standards, pond location and the rehabilitation of abandoned ponds, or water quality pollution. Many of these laws have greatly altered the shape of new aquaculture developments. For example, in the 1950s the Philippines encouraged aquaculture development by means of state loans. This resulted in the failure of the state to regulate the shrimp industry and to enforce any mangrove protection. Mangrove forests were removed and replaced with fishponds, leading to the widespread loss of mangroves in the Philippines. Today, mangroves are being widely replanted in shrimp ponds in an effort to restore the absorption potential of the degraded land. Mexico, Belize, Tanzania and Mozambique have also passed laws aimed at protecting mangroves, which seek to control destructive activities through strict licensing systems as well as EIAs.

There have also been instances where mangroves have been successfully preserved. In the late 1990s, an Irish fishing company, the African Fishing Company (AFC), proposed building the world's largest shrimp aquaculture facility in the Rufiji Delta in Tanzania. The project would have involved cutting down 1 200 hectares of mangroves, and building shrimp ponds instead.[49] The delta harbours one of the largest estuarine mangrove forests in East Africa and is of considerable economic and conservation importance. The proposed project comprised a 10 000-hectare shrimp farm, a feed plant, a hatchery, and processing plant taking up 19 000 hectares in total in the largest continuous block of mangrove in East Africa (53 000 hectares). In 1998, the Tanzanian government accepted the EIA, and endorsed the project. However, local communities, environmental organisations and academics strongly opposed the project. Following legal action by villagers, supported by the Lawyers Environmental Action Team, the EIA was found to contain substantial errors, omissions and misrepresentations, including suppressed risks. For example, the EIA claimed that the area was virtually uninhabited. However, some 33 000 people lived in the proposed area in 19 registered villages and scattered sub-villages. The assessment was eventually reconsidered and rejected.

These protests held up implementation until, in August 2001, the decision was made to liquidate AFC and sell off its vessels in order to offset the debts that had accumulated due to the delay. This ended the project, and preserved the delta's mangrove forests.[50] In 2001 a moratorium was declared on all commercial aquaculture in Tanzania until the government had established proper guidelines for shrimp aquaculture. It also declared that aquaculture would not be permitted in ecologically sensitive areas such as mangroves. This is an important case study which demonstrates the potential benefits of decentralising the management of natural resources to local communities.

ECOSYSTEM RESTORATION AND AFFORESTATION

As more far-sighted countries acknowledge the link between coastal forests and economically important services, mangroves are being planted and replanted worldwide. Restoration efforts now cover some 400 000 hectares. Many countries are restoring wetlands, forests, grasslands, estuaries, coral reefs and mangroves. These activities are becoming increasingly important as the degradation of ecosystems continue on the one hand, while demands for their services continue to grow on the other. Restoring ecosystems is generally far more expensive than protecting them in the first place, and it is often not possible to recover them fully. Restoration or rehabilitation is used in areas where mangroves existed previously, or are degraded. Afforestation is used in areas where mangroves did not exist previously. In India, Indonesia and Senegal, non-governmental organisations (NGOs) are actively planting mangrove trees, working in collaboration with the private sector to offset carbon (see Box 2).

Box 2: Mangrove restoration in Senegal

A large-scale mangrove restoration project is under way in Senegal, led by the Senegalese NGO Océanium, and spearheaded by the IUCN, the Ramsar Convention on Wetlands and the Danone Fund for Nature. Danone, a French company, wants to use the project to offset some of its GHG emissions from its Evian mineral water operations and to test the option of using carbon finance to fund mangrove restoration.[51] The mangrove carbon project has been approved by the UNFCCC, the international authority responsible for validating and registering projects eligible for carbon credits. This is the first Clean Development Mechanism (CDM) project involving a large mangrove plantation registered by the UNFCCC. It is hoped that the mangrove plantings of 2008 and 2009 will be verified in 2013 or 2014, and result in a first delivery of carbon credits.

The initial aim of the project was to enlist 80 000 residents of 350 villages in the Sine Saloum and Casamance deltas to plant 36 million mangrove trees. The pilot phase focused on planting, while a subsequent phase has examined the broader hydrological stresses of mangrove systems in Senegal. In 2009 and 2010, 10 000 people from 428 villages planted about 100 million mangrove trees on 7 300 hectares of land.[52] Since then, another 4 000 hectares have been planted, making this the largest restoration of mangroves in the world. These mangrove forests contribute towards food security and income growth across the region, and will store nearly 800 000 Tg of carbon dioxide over 20 years.

This is an example of the activities of the Livelihoods Fund[53] – an innovative new fund which uses corporate investments to deliver carbon credits while restoring mangroves and supporting local economies. By early 2012, corporate investors had invested more than €26 million[54] in the fund, and planted 14 000 hectares of mangroves in four countries (including Senegal). These projects are very labour-intensive, and therefore create significant numbers of jobs for poor communities.


A mangrove seedling and a mangrove bush in Aceh, Indonesia.

THE EFFECTIVE MANAGEMENT OF PROTECTED AREAS

According to Braulio Ferreira de Souza Dias, executive secretary of the UN Convention on Biological Diversity (CBD), 'Protected areas are a vital policy mechanism and management tool to protect and preserve the world's natural, cultural, social and economic assets. The flows of economically valuable goods and services that are derived from protected areas enhance human health and well-being.'[55]

Well-managed protected areas are a proven method for safeguarding both habitats and populations of species, and for delivering important ecosystem services. Conservation areas vary largely in size, have varying levels of protection, and can be managed by the state, private entities or communities (or a combination of these). Effective management allows for the total protection or the sustainable use of natural resources, provided this is consistent with the protection of species, habitats and ecosystem processes. Other effective area-based conservation measures may also include restrictions on all activities that impact on biodiversity, which would allow for the safeguarding of sites in areas beyond national jurisdiction.[56] This should depend entirely on species information specific to each individual area. Data is needed to refine conservation priorities and inform policies that regulate resource extraction, trade, or coastal development. Information needs to include the presence of threatened species and the designation of critical habitats, no-take zones or marine protected areas. Various tools have been developed to help achieve this. The IUCN's Red List is regularly updated, depending on the availability of better or new data, and changes in category can be an important indicator of the success or failure of conservation initiatives. Other tools include CI's Biodiversity Hotspots, and the WWF's Global 200 Ecoregions. Vulnerable or endangered ecosystems that appear on these lists need to be dealt with in ways consistent with scientific requirements.

The IUCN defines MPAs as 'clearly defined geographical space[s], recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values'.[57]

These reserves are valuable management tools for restoring and maintaining marine and coastal ecosystems. According to the World Database on Protected Areas (2011), 12.7% of the world's terrestrial surface and 7.2% of its coastal waters (0–12 nautical miles) are protected. However, given the limit of the Exclusive Economic Zone,[58] marine protection amounts to only 4% of this area.[59] About 6.9% of the total global mangrove area is protected under the existing protected areas network (IUCN protected areas categories I–VI).[60] This percentage is slightly lower than the total forest area currently being protected (7.7%), and still less than the 10% target envisaged under the CBD Strategic Plan for Biodiversity 2011–2020.[61]

It is well known that attempts to protect sensitive areas face multiple threats and challenges. An analysis of the uses of and threats to Ramsar sites[62] in West and East Africa highlights various management challenges surrounding the protection of mangroves in particular.[63] These include financial and administrative constraints (protecting areas is expensive and requires additional financial, human and technical resources); and the fact that local managers find it difficult to engage with increasingly complex management mandates while negotiating with major stakeholders over delivering sufficient socio-economic benefits to local communities. Other factors identified as growing concerns include high levels of poverty in and around protected areas. Also, Provincial conservation authorities are often severely underfunded because they have to compete for allocations with other vital social functions such as health, education, and social welfare. Protected areas are often at risk of being reallocated to alternative, 'more economically and politically attractive' land use types.

INTERNATIONAL INITIATIVES

Protocols relevant to mangrove conservation can also provide opportunities for strengthening the management of mangrove areas. They provide national governments with a platform for showcasing their concerns about the environment, and allow a degree of international scrutiny. There are 11 international treaties that afford some protection to mangroves, namely the Ramsar Convention on Wetlands of International Importance, the CBD,[64] the Convention on the Prevention of Marine Pollution,[65] the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES),[66] the International Tropical Timber Agreement,[67] the Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the East African region,[68] the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region,[69] the UNESCO Man and Biosphere Programme (MAB),[70] and the UNESCO World Heritage Convention (WHC).[71] However, these instruments do not automatically provide mangrove ecosystems with legal protection, and none addresses the conservation, preservation, of management of particular mangrove species.[72] Penalties for non-compliance are inadequate, and are only effective if they are implemented by national parties.

Following escalating concerns about the effects of mineral developments on wetlands, the Ramsar Scientific & Technical Review Panel (STRP) set up a task team to review current methods for assessing, avoiding, minimising and mitigating the direct and indirect impacts of extractive industries on wetlands, and to provide recommendations where

possible. Resolution 26 on wetlands and extractive industries, adopted at COP 10 in 2008,[73] urges all parties to observe a range of precautionary good practices. The STRP is reviewing technological, economic and political drivers of wetland degradation, and investigating methods for overlaying geological resource maps with wetland vulnerability assessments at different scales as an aid to the prioritisation of national efforts.

Counties can use other certification schemes and governance measures to verify their forestry practices. These include the Forest Stewardship Council (FSC) – a voluntary certification system that provides internationally recognised standard-setting, trademark assurance and accreditation services for forestry activities. Although not foolproof, the FSC certification, and others, provide a credible link between responsible production and consumption of forest products, assuring consumers that their products come from well-managed forests. Mangrove wood is considered to be 'high risk' under the FSC scheme, and legal trade is therefore restricted to scientifically determined sustainable quotas. However, schemes such as the FSC are only useful when either the commercialising entity or the final consumer is concerned about sustainability, and demands FSC certified products. It does not help when local communities use mangrove wood for firewood and building, or when mangroves are destroyed by companies for whom mangrove removal is a means to a non-timber end (e.g. aquaculture).

MANAGEMENT APPROACHES AND PRINCIPLES

As noted earlier, there are numerous management tools that can be utilised to improve the status of degraded mangroves or to encourage sustainable land-use change. All these interventions should include a set of principles aimed at achieving long-term sustainability. Key aspects include the following:

- Management should be multidisciplinary and should include a range of stakeholders, from central to local government. Mangrove action plans can be developed at the national level to help ministries and departments co-ordinate formal strategies and plans. However, all approaches should ultimately be implemented and enforced at the local level. Local authorities should play a key role.
- All approaches must involve adjacent coastal communities. As the key beneficiaries of mangrove goods and services, their buy-in and involvement will probably determine the success or failure of a given conservation project. Local communities living in coastal zones can manage and protect ecosystems, and can also play central roles in restoration activities. These can offer viable job opportunities for unskilled people.
- Mangrove management should be integrated with a broader spatial framework for managing coastal zones.[74] This holistic, integrated approach, often referred to as ecosystem-based management, recognises the importance of and interplay among terrestrial, marine and coastal systems. This approach is very useful when balancing multiple and sometimes conflicting objectives related to different benefits and ecosystem services. This approach integrates all sectors that affect, or are affected by, land use change in the coastal zone.
- National and sectoral legislation should be used to support and streamline environmental decision-making and biodiversity planning. Useful instruments have

been developed for accelerating environmental authorisations without undermining sound environmental impact management principles. These are country-specific but may include, among others, SEAs, Environmental Management Frameworks, and EIAs.

- Developing an ecosystem services perspective is important for planners and managers when establishing priorities for management. Priorities can be determined by focusing on the areas and habitats that deliver the most, or host valuable, ecosystem services. Priorities can be based on the most serious threats to ecosystem services, or the most vulnerable or threatened areas.
- Long-term perspectives should be adopted, rising above short-term political considerations.
- Management must be supported with finance. New financing options are available which lessen the burden of traditional management entities, and allow more direct engagement with local communities, user groups, industries, and other stakeholders. They should maintain habitats and biodiversity, thus keeping ecosystem services flowing, make good business sense, and demonstrate the value of co-benefits such as ecosystem-based job creation. The use of incentives, compensation mechanisms and similar economic instruments is gaining ground in carbon, biodiversity and water markets.
- Good management requires good data and the improved synthesis of existing information which can be utilised to bridge the science-policy gap. The quantification of ecosystem services must be improved. This information will help to make a compelling case for conservation and restoration, and enable the inclusion of mangroves in economic frameworks for planning and coastal management.

Current human pressures and economic activities are compromising the resilience of global ecosystems and eroding their natural capacity to deliver vital services. Ecosystems services provided by mangroves are often not taken into account when assessing the true economic, ecological and social value of coastal ecosystems. According to the Millennium Ecosystem Assessment, decisions about the use of ecosystems and their services should acknowledge the multiplicity of their values and be consistent with their conservation.[75]

The improved management of ecosystems, through conservation, restoration, afforestation and sustainable use, aids natural carbon management. Countries should work towards developing effective ecosystem management tools and conservation incentives to secure their mangroves. These tools should be based on the principles identified in the previous chapter. These include multistakeholder, multisectoral approaches that include long-term and integrated coastal management practices. Effective management tools include the maintenance and expansion of Marine Protected Areas, regulated coastal development, and ecosystem rehabilitation. Sound scientific data and finance is also vital for ensuring the success and longevity of these projects. The decline of mangroves is continuing despite the existence of laws and treaties, protected zones, and management criteria. With some exceptions, mangrove areas and species of concern are not adequately represented within protected areas. Given their importance, more mangroves should be explicitly incorporated into protected areas. Besides protective legislation, governments, NGOs, and private individuals should take steps to acquire and protect coastal land, especially land with viable populations of threatened mangrove species. National

legislation and management plans are in place in some countries, but enforcement and further planning are required to protect individual species, mangrove areas, and important ecosystem functions.

CHAPTER 4

AFRICAN MANGROVES AND THE CASE OF MOZAMBIQUE

THE GEOGRAPHIC DISTRIBUTION OF MANGROVES IN AFRICA

Mangroves cover about 3.5 million hectares on the African coastline, comprising 21% of the world's total. According to the 2007 FAO study,[76] mangrove forests occur in 33 African countries,[77] but only 14% fall within nationally and internationally designated protected areas. Mangroves outside protected areas are being depleted at an alarming rate, and there is widespread concern about the efficacy of some of these protected areas, largely due to financial and administrative constraints.[78]

Table 2: Status and trends of mangrove areas in Africa

Country/area	Area, hectares	Reference year
Angola	33 600	2000
Benin	1 700	1989
Cameroon	251 545	2000
Comoros	117	2002
Congo	8 000	2003
Côte d'Ivoire	9 940	2000
Democratic Republic of Congo	19 600	2000
Djibouti	1 000	1985
Egypt	512	2002
Equatorial Guinea	25 700	1995
Eritrea	6 400	1997
Gabon	152 940	2000
Gambia	58 100	2000
Ghana	13 729	2000
Guinea	276 342	1997
Guinea-Bissau	248 400	1990
Kenya	52 980	1982
Liberia	9 244	2000
Madagascar	303 814	2004

Country/area	Area, hectares	Reference year
Mauritania	104	1993
Mauritius	120	2004
Mayotte	668	1989
Mozambique	392 749	1997
Nigeria	997 700	1995
São Tomé and Príncipe	n.a.	n.a.
Senegal	127 702	2000
Seychelles	2 900	1960
Sierra Leone	105 300	2000
Somalia	10 000	1975
South Africa	3 054	1999
Sudan	500	1995
Togo	1 094	2000
Tanzania	127 200	2000
Total for Africa	**3 242 754**	**1997**

Source: FAO, *The World's Mangroves 1980–2005*, FAO Forestry Paper 153, Rome, 2007.

The West and Central Africa eco-region

West Africa has fewer true mangrove species than East Africa, but has more mangrove coverage due to the extensive riverine systems not present in the east.[79] The types of mangrove vary considerably, from the lagoon systems in the west to systems modified by complex patterns of sediment deposition at river mouths in the centre and south.

Some 70% of mangroves in Africa occur in 19 countries in West Africa, from Mauritania to Angola. According to Spalding *et al.*, they cover about 17 000 square kilometres, with more than two thirds found in Nigeria. Satellite images suggest that coverage may be even greater, but accurate estimates are difficult because the mangroves are interspersed with swamp forests. The mangrove forests in Nigeria are the largest in Africa and the fifth largest in the world after Indonesia, Australia, Brazil and Mexico.[80] Nigeria's mangroves make up nearly 35% of total cover for the region.[81]

About 18% of the mangroves in West and Central Africa are protected. However, according to the 2007 UNEP report on the mangroves of West and Central Africa,[82] the Atlantic coast has some of the highest population densities on the continent, and most of the industry in West Africa is located in the coastal zone. These factors, combined with rapid population growth, extreme poverty, low levels of development, poor governance of rural regions and open access to coastal resources, have resulted in the decline of mangrove forests in the region. Many have been disturbed by economic activities. This is the case in Nigeria, Africa's primary oil producer. The Niger Delta is among the 10 most important wetland and marine ecosystems in the world. However, according to recent

research, about 1.5 million tons of oil has been spilled into the Niger Delta ecosystem over the past 50 years,[83] rendering it one of the five most severely petroleum-damaged ecosystems in the world.

New discoveries of fossil fuels are also likely to disturb mangrove forests in other countries in West and Central Africa. Oil production and exploration in Cameroon, Ghana, Sierra Leone, Liberia and Guinea Bissau will probably also have a negative impact on mangrove forests. Other threats include the practice of gas flaring, the use of poison and dynamite for fishing, canalisation, the discharge of sewage and other pollutants, siltation, sand mining, erosion, and the construction of embankments.

The East Africa eco-region

This area encompasses mangroves found along the Western Indian Ocean coastline in Mozambique, Tanzania, Madagascar, Seychelles, Kenya, Somalia and South Africa.[84] Although these mangroves are less extensive, they are more diverse than in West Africa. Estimates of coverage range from 2 555 square kilometres to 7 211 square kilometres.[85] The mangroves of East Africa are biogeographically related to those along the west coast of Madagascar and South Africa.

The most extensive mangroves are found in the Rufiji River Delta in Tanzania and the Zambezi River Delta in Mozambique. Protected areas harbouring mangroves include Mafia Island Marine Park, Jozani National Park and Sadaani Game Reserve in Tanzania; Watamu Marine National Park, Ras Tenewi Marine National Park and Tana River Delta in Kenya;[86] the iSimangaliso Wetland Park in South Africa; and the Bazaruto Archipelago National Park, Marromeu Game Reserve, Pomene Game Reserve, Ponta do Ouro-Kosi Bay Marine Transfrontier Conservation Area[87], Quirimbas National Park and the newly declared Primeiras and Segundas Marine Reserve in Mozambique.

There is a long history of mangrove exploitation in East Africa. According to the WWF, this dates back at least to the nineteenth century when the coastal areas of east Africa were controlled by Arab sultans, and mangrove wood was a prized resource used for building on Zanzibar and exported to the Middle East.[88] Mangrove forests in the region are also being lost due to their conversion into rice paddies, salt pans and aquaculture projects; fuel and timber needs; and urbanisation. Mangroves are also affected by untreated wastes discharged into rivers, oil and industrial pollution, silt from erosion, and pesticides contained in runoffs from agricultural areas.

AN OVERVIEW OF MOZAMBICAN MANGROVES

Mozambique is home to an estimated 390 000 hectares of mangroves, extending along its 2 770-kilometre coastline.[89] According to the 2007 FAO study, these are the second largest mangrove forests in Africa, and the largest in East Africa. However, according to a more recent study conducted by Giri *et al.*, Mozambican mangroves are the third largest in Africa, After Nigeria and Guinea Bissau. Mozambique's last national mangrove census was conducted in 2007 and is reflected in its National Forest Inventory. However, mangrove data varies significantly. According to FAO, Mozambique has lost 60 451 hectares of mangroves over from 1997–2005.[90] In 2008 Fatoyinbo *et al*. estimated total coverage at

2 909 square kilometres, some 27% less than previously estimated.[91] In a more recent study, the same authors have increased their estimate to about 3 054 square kilometres.[92] Despite the varied data, there is an overarching consensus that the destruction of mangroves is continuing and that they are highly vulnerable and valuable ecosystems.

Mozambique has a unique and varied coastline that can be divided into various ecological systems, with a variety of differentiated resources and multiple users. The unique physical and ecological attributes of each region affects the economic developments and activities in each region. The northern coast is coralline and rocky, occasionally disrupted by sandy intertidal flats and small but deep bays, estuaries and sandy beaches, favouring finfish, seaweeds and bivalves. The narrow shelf of the northern coast lends itself to the construction of deep water ports, and is also often marked by the conflicting occurrence of hydrocarbons, coral reefs and small islands. By contrast, the central zone largely comprises coastal swamps and tidal areas consisting of alluvium soils, muddy flats, and extensive mangroves. The continental shelf is extended, lending itself to fisheries and shrimp habitats and catchment areas. Given its extensive continental shelf and large rivers and estuaries, the central region is particularly vulnerable to flooding. The southern region is characterised by high dunes covered with dense and unique forest, and with the occasional occurrence of small islands and coral reefs. This geographical make up lends itself to hydrocarbons.

Mangroves occur in pockets along the entire Mozambican coastline, but are mainly found in the northern and central regions. In the southern provinces, south of the Save River, mangroves occur in the Morrumbene estuary, Inhambane Bay, the Bay of Maputo, and on Inhaca Island. The largest mangrove forests occur in central Mozambique where large volumes of fresh water is discharged into the ocean, including the Zambezi, Púngue, Save and Búzi river deltas. The mangroves of the Zambezi Delta extend for 180 kilometres along the coast and for 50 kilometres inland, and reach canopy heights of up to 30 metres. This area contains 50% of Mozambique's mangroves and is one of the most extensive mangrove habitats in Africa. In northern Mozambique, mangroves are found from the Rovuma River to Angoche, but are particularly well-developed around Lumbo, Ibo-Quissanga and Pemba Bay.[93]

The distribution of Mozambique's population also poses challenges to the coastal zone. The entire coastline harbours large numbers of people who depend on the oceans for their subsistence and daily income. According to the INGC,[94] more than 60% of Mozambique's total population (about 2.5 million people) live in coastal areas. Moreover, several large cities – including Maputo, Beira, Quelimane and Pemba – are located in the coastal zone. This coincides with the high rate of mangrove destruction and degradation in Mozambique in and around urban centres, where mangrove wood products such as charcoal, firewood and timber are in high demand. These ecosystems are also cleared for agricultural purposes and salt extraction, and will probably be affected by the mining of hydrocarbons and heavy mineral sands. Mangroves are also diminishing as a result of upper stream dam construction. For example, the Cahora-Bassa Dam has significantly reduced the flow of water in the Zambezi River, altering water conditions and shrinking its mangroves.[95] Also, high volumes of crude oil have been shipped through the Mozambique Channel, resulting in oil spills which have affected mangroves along the coastline. The Maputo Bay area is also affected by the shipping traffic and resultant pollution.[96]

Overlaps and conflicting interests

There are a large number of current and proposed development activities in Mozambique's coastal zone, many of which are putting pressure on the natural capital in the area, and compromising its ecological integrity. Mozambique's draft Coastal SEA[97] provides a thorough overview of the current situation in the coastal zone, and contains important recommendations for harmonising development and economic progress with the maintenance of natural coastal systems. It recommends that the Mozambican government should urgently identify and address current operations, conflicts and synergies in the country's coastal zones. The report briefly considers the divergent economic activities in the coastal zone, including oil and gas exploration, mining and infrastructure development, fisheries and aquaculture development, tourism, biodiversity, and community livelihoods.

Hydrocarbons, mining and port development

According to the Africa Economic Outlook report for 2012, '... 2011 was a turning point in Mozambique's economy, with the first overseas export of coal marking the birth of Mozambique as a world exporter of minerals, and paving the way for the country to secure its future fiscal sustainability through yields from natural resources'.[98] Other economic developments in Mozambique included the discovery of extensive offshore natural gas reserves in the Rovuma Basin next to Quirimbas National Marine Park, and further offshore gas exploration, extraction and pipeline construction in Inhambane province in the vicinity of the Bazaruto Archipelago.[99] Oil and gas prospecting and exploration took place in the Marromeu Complex, one of Mozambique's Ramsar sites.[100] There is a natural conflict between conservation activities, prospecting for hydrocarbons and mining. Although the Environmental Regulations of Oil Operations (Decree 56/2010) requires EIAs to be completed for all activities in conservation areas, exploration can be invasive and damage sensitive ecosystems and species. Oil spills are common and can contaminate pristine conservation and tourism areas. Mining, particularly mining for heavy mineral sands, which requires mining layers of sand over large areas which are often ecologically sensitive – can also have devastating impacts on the environment.

There are obvious instances of hydrocarbon extraction and mining overlapping with mangroves and other sensitive ecosystems. For example, prospecting in the Marromeu Complex in the Zambezi Delta in central Mozambique triggered a Ramsar Advisory Mission that recommended compensation in the event of future oil and gas exploration or exploitation.[101] Marromeu is an extremely important area for watersheds, wetlands, wildlife and biodiversity. The Mission's Advisory Report expressed concerns over drilling activities, including forest clearance for the construction of drill sites, as well as adjacent camps and roads. In this regard, the SEA has recommended that the area should be declared a 'priority zone' and that a management plan be formulated to address these conflicting interests.[102]

Other instances include Sasol's offshore gas exploration in the Bazaruto Archipelago, and conflicts between gas exploration, tourism and artisanal fisheries at Mocimboa Palama Beach. In the case of Bazaruto, the Southern African Institute for Environmental Assessment (SAIEA) conducted an EIA that highlighted the potential impacts of gas exploration on the vulnerable dugong population in the archipelago, as well as conflicts with artisanal fishing communities and tourism. The EIA suggested that all exploration

activities in shallow water be postponed until the government had concluded a SEA to assess the costs and benefits of tourism as well as oil and gas development in the area.[103]

Although there are no major coal deposits close to extensive mangrove forests, coal extraction will impact on the coastal areas where minerals are exported. Chapter 1 of Mozambique's SEA identifies several new harbour developments under consideration, as well as a number of other ports earmarked for expansion or rehabilitation.[104] Interestingly, the Mozambique government recently turned down Rio Tinto's plan to transport coal by barge down the Zambezi River from Tete Province in Mozambique's hinterland. According to officials, this decision was informed by various environmental considerations, including probable water pollution. However, another controversial case is pending in southern Mozambique, namely the proposed deep water port of Techobanine and associated infrastructural development. The proposed site is in the Maputo Special Reserve and Ponta do Ouro Partial Marine Reserve. The area has a rich and diverse marine life and is home to the leatherback and loggerhead turtle. (Leatherbacks are the largest sea turtles and classified as critically endangered by the IUCN, while loggerhead sea turtles have been classified as endangered.) The area is also visited frequently by tourists who bring in large amounts of foreign exchange.

The recognition that the fast-growing mining industry may cause environmental degradation if environmental issues are not adequately addressed has resulted in the development of specific environmental legislation, including Petroleum Law No. 3 (2001), Mining Law No. 14 (2002), Regulation of the Mining Law (Decree No. 28 (2003)), Environmental Regulation for Mining Activities (Decree No. 26 (2004)), Regulation for Petroleum Operations (Decree No. 24 (2004)), and the Basic Rules for Environmental Management of Mining Activities (Ministerial Diploma No. 189 (2006)).

Aquaculture and fisheries

As noted earlier, aquaculture is the largest contributor to global mangrove loss, especially in Asia and Latin America. Relatively little shrimp farming took place in Africa until the early 1990s, but the continent, rich in natural resources, cheap labour and low land prices, is increasingly viewed as a potential frontier for new industry. The large river deltas, including the Niger, Tana and Rufiji, are being targeted by shrimp farm developers.[105] Countries currently involved in the global shrimp trade (often referred to as prawns) include Nigeria, Madagascar, Morocco and Mozambique. African black tiger shrimps, produced in these countries, are in high demand internationally due to their good quality and large size compared to their Asian equivalents.

In Mozambique, large-scale aquaculture development is still relatively new and mostly occurs in former salt extraction areas.[106] However, many future operations are being planned. In 2009 aquaculture represented just 0.3% of total production. The main commercial shrimp farms are situated at Beira (a 132-hectare farm), Quelimane (300 and 150-hectare farms) and Pemba (a 250-hectare farm which has been completed and abandoned). However, many of these operations are currently on hold due to the widespread infection of shrimp with White Spot Syndrome Virus.[107] Diseases virtually wiped out marine shrimp farming production in Mozambique in 2011.

In 2008 the Ministry of Fisheries established the National Institute for Aquaculture Development (INAQUA) to lead the promotion, extension and management of

aquaculture. INAQUA defined aquaculture as one of Mozambique's top economic priorities and prepared a ten-year Aquaculture Development Strategy for 2008–2017 aimed at increasing the annual production of marine prawns and other species intended for export.[108] There is a general aquaculture regulation that defines the rights and obligations of all stakeholders in Mozambique (Decree 35/2001). The legislation defines specific norms and requirements for aquaculture farms, and establishes procedures for licensing as well as parameters for each farming system. Article 26 of the general regulations on aquaculture prohibits the transformation of mangrove areas into aquaculture activities. However, little has been done to enforce these measures. Future aquaculture planning, development and operational practices need to ensure that associated environmental integrity issues are effectively and adequately addressed. It is the responsibility of the Ministry of Environment, under the Environmental Act (No. 20/1997), to accept or reject proposals based on evidence gathered during EIAs. Projects that are poorly planned or demonstrate bad site selection, inappropriate management procedures or a lack of attention to environment protection are to be rejected. Project developers, for example, must compensate for the environmental and other damage caused during project implementation. Where loss has occurred, developers are responsible for restoring coastal habitats.

Eco-tourism

National parks and other protected areas are seen as one of the main tourist attractions in the country. Most tourists visiting southern Mozambique, for example, are from South Africa, and seek nature-based attractions such as diving and deep-sea and shore-based recreational fishing. While general statistics on the number of tourists visiting the country are vague, the industry is regarded as an important economic driver, at least at the local level. Bjerner and Johansson[109] estimated a consumer surplus of between $2.6 million and $4.9 million from diving-based tourism at Ponta do Ouro, but concluded that most of the profits were leaking to South Africa, and that the environment was being degraded due to poor management.

Left: Aerial view of a small portion of Bazaruto Archipelago. Right: The entry permit required to enter the Bazaruto Archipelago National Park.

THE GOVERNANCE OF MOZAMBIQUE'S MANGROVES

National legislation

Mozambique's Environmental Law (No. 20/1997) is the key law governing the use and management of the environment and its components. It prohibits environmental degradation (as defined in Environmental Quality Standards), and protects biodiversity. It also provides for the establishment of protected areas. It prohibits the deployment of infrastructure that may have a significant environmental impact, particularly in the coastal zone and in sensitive areas such as wetland areas. It also establishes instruments for environmental licensing, EIAs and environmental audits. In this regard, mangroves within the coastal protection zone[110] are subject to partial protection.[111] Decree No. 45/2004 for the regulation of Environment Impact Assessments (EIAs) states that all activities which are potentially detrimental to ecosystems recognised by 'special statute' under both national and international legislation are subject to EIAs.[112] Under this definition, mangroves may only be harvested for subsistence purposes. Commercial exploration is not allowed until an EIA has been conducted and an environmental license issued by MICOA.[113] MICOA co-ordinates the permit process and has the authority to reject project applications that do not comply with Mozambique's environmental standards. This is an attempt to ensure ecological integrity, but also to guarantee that the natural character and economic, social and aesthetic values of the coast remain intact. Under the same Decree No. 45/2004 for EIAs, activities also subject to EIAs include the clearing, fragmentation and exploitation of native vegetation in areas exceeding 100 hectares; the deforestation of areas exceeding 50 hectares; the afforestation and reforestation of areas exceeding 250 hectares; and the commercial exploitation of natural fauna and flora.

Mangroves are also protected by the Forestry and Wildlife Act (No 10/1999), which includes forests and wildlife in protected areas. However, these laws only partially protect mangroves. Mangroves outside protected areas or demarcated coastal zones are not legally protected and are therefore more exposed to threats of deforestation and degradation. Among other regulations, mangroves are further protected the Regulation of Prevention of Pollution and Protection of the Marine and Coastal Environment (Decree no 45/2006), and by the Regulation on Standards for Environmental Quality and Effluent Discharges (Decree no. 18/ 2004).

Although the institutional and political importance of EIAs has been increasingly recognised both within and beyond MICOA, their actual enforcement is still weak due to financial and technical constraints. The large size of the country, its extensive coastline and its many shared resources with neighbouring countries also makes it difficult to monitor the use and management of natural resources. Although the legal framework for environmental management has been greatly improved, the Ministry needs to be strengthened and restructured. To address these problems, development partners have provided technical assistance and other mechanisms for strengthening the institutional capacity of MICOA. They have also helped the Mozambican government to address the inadequate human and material resources in the relevant ministries and the lack of institutional capacity to conduct and review EIAs – a common challenge in many government institutions and among EIA contractors.

Also, it is imperative for EIAs to incorporate comprehensive stakeholder consultation and, where possible, community participation (public participation is formally incorporated in Decree 45/2004 on EIAs). There are obvious difficulties in implementing this and guaranteeing that all stakeholders are not only consulted but actually listened to, but the legal obligation does exist.

In interviews conducted with various stakeholders in Maputo, it was apparent that some CSOs still question the independence and transparency of decision-making around EIAs. They spoke of large economic and commercial projects where recommendations made in EIAs were overridden. In these cases, and especially with the new discoveries of oil and gas, the trade-offs between conservation and development need to be acknowledged, and decision-makers must explicitly consider the consequences of all options, determining the levels of acceptable biodiversity loss and ecological disturbance. In this calculation, ecosystem services need to be fully accounted for in order to determine the true economic, social, and environmental cost of the proposed activities. In controversial or conflicting cases, when EIAs contain restraints or other important considerations, the government should undertake centralised SEAs in order to examine the environmental impacts of land use change and coastal zone planning, and ensure that various scenarios are thoroughly evaluated. SEAs seek to 'balance' sectoral considerations towards more sustainable outcomes, and should involve all relevant ministries and stakeholders.[114] The government requested a SEA in the case of Sasol's offshore gas exploration in the Bazaruto Archipelago. While the importance of oil and gas is obvious, the assessment also recognised that tourism is well established in the area, and generates substantial local economic benefits. Also, as noted earlier, the area is an important habitat for various fish species, which supports thousands of artisanal fishermen.

The draft report of the coastal SEA (2012), commissioned by the Mozambican government and conducted by IMPACTO consultants, identifies a number of concerns that urgently need to be addressed in order to improve Mozambique's legislative framework for governing biodiversity in coastal areas.[115] SEAs are not provided for in existing legislation, particularly legislation governing land policy. This means they have no legal authority. Also, sectoral legislation regulating extractive industries in the coastal zone needs to be developed and enhanced.

Mozambique's Environmental Law (Law no. 20/1997) promotes the participation of local communities in decisions about the management of natural resources, including conservation areas. It also promotes the fair and equitable sharing of the financial benefits of natural resources. According to the Forest and Wildlife Act (No. 10/1999) and Ministerial Order No. 93/2005,[116] a total of 20% of revenue from certain activities must be devolved back to communities for social development. However, in many instances, this is relatively insignificant and there is a general lack of awareness of and information about these opportunities. Also, according to an interview conducted with an IUCN representative, such revenue is seldom fed back to help finance participatory conservation management activities or the protection of natural resources.[117]

Strengthening institutions and implementation

As noted earlier, there is an apparent lack of clarity about the roles and responsibilities of different environmental institutions in Mozambique, resulting in a lack of interministerial

co-ordination on environmental issues. In an interview, Professor Salomao Bandeira, Head of Department of Biological Sciences and associate professor of Eduardo Mondlane University in Maputo, reiterated that the roles of various state institutions in mangrove management remained unclear, with no clear focal point or co-ordinator.[118] In the current institutional set-up, the Ministry of Agriculture is ultimately responsible for the conservation and management of mangroves. This falls under the general legislation for terrestrial forests, controlled by the National Directorate of Land and Forestry. However, the government institution responsible for directing, co-ordinating and monitoring the implementation of environmental policy is MICOA. Although MICOA performs a co-ordinating role, and is responsible for many aspects of coastal zone management and wetland protection,[119] barriers remain to the devolution of responsibilities to local authorities, especially with regard to coastal zone management and law enforcement.

The Ministry of Tourism (MITUR) directs and implements policies in respect of tourism, including MPAs. Within this ministry, the directorate currently responsible for achieving Mozambique's conservation objectives is the National Directorate for Conservation Areas (Direcção Nacional de Áreas de Conservação). But this is changing. The management of protected areas is being taken over by a new parastatal, the National Administration for Conservation Areas (Adminstracao Nacional das Áreas de Conservação, or ANAC), which has been legally constituted but has not begun to operate. Its formation has been based on the idea that a parastatal agency would have administrative and financial autonomy, and would therefore be more creative and flexible in managing protected areas than a public agency. This, in turn, would improve the financial sustainability of conservation. ANAC is in the process of being formed. Legislation on conservation areas was drafted in 2011–2012, but is still being revised prior to being submitted to the Council of Ministers.[120]

The Ministry of Fisheries is responsible for managing Mozambique's fisheries and aquaculture. Within this ministry, the Institute for Development of Small-scale Fisheries (IDPPE) and the National Fisheries Research Institute (IIP) handle fisheries issues relating to MPAs. However, the ministry has no mandate to enforce or implement mangrove protection, and no patrols are undertaken in collaboration with other ministries. Fisheries law protects marine and aquatic living resources only, and does not cover coastal ecosystems or habitats related to fisheries life cycles.[121] According to an official in the Ministry of Fisheries, Mozambique's integrated ecosystem approach incorporates mangroves, prawns and line fish into Mozambique's fisheries planning. However, he added that this was a major challenge in practice, as communication among the different ministries was ad hoc. He noted that the division of responsibility among various ministries with regard to law enforcement was vague, for two reasons. The first was that coastal ecosystems sat awkwardly between land and sea and therefore did not naturally fall under a particular department. The second was that the Ministry of Fisheries did not have a mandate to enforce laws in respect of mangroves. This was very challenging in practice, because resources for surveillance were limited and fisheries patrols did not patrol the entire coastline but focus on distant fishing grounds. Coastal fisheries interventions were typically only made at landing sites. However, when the opportunity arose in a coastal area such as Beira, fisheries patrols could support the patrols for the illegal harvesting of mangrove timber.

This analysis shows that there are a multitude of laws and institutions governing Mozambique's coastal zone, many of which have overlapping mandates. A lead public agency should be appointed, and tasked with co-ordinating all coastal zone management and protection. This is particularly important in cases where conflicting sectors overlap. Without this it would be difficult to ensure integrated, harmonious and effective action in the coastal zone. In this regard, the recent SEA study recommended that MICOA should be given the powers and capacity to manage the coastal zone.

National policies, strategies, laws and regulations need to be developed, and the capacity of departments to enforce the law should be improved. Interdepartmental co-operation is needed, especially in areas where financial resources are lacking. Ultimately, all ministries should have same objective, namely to protect and preserve Mozambique's natural resources for the benefit of its people. However, their activities are poorly co-ordinated. For example, despite the direct link between fisheries habitats and mangroves, the Fisheries Master Plan does not include the protection of mangroves. Fisheries Law protects marine living resources and aquatic living resources, but does not include coastal ecosystems.

In response to these difficulties in communication and co-ordination, Mozambique has established a National Council for Sustainable Development (CONDES) with a mandate to promote and co-ordinate the sustainable use of natural resources. It is chaired by the prime minister, and its members include representatives of all ministries involved in environmental affairs, notably the ministries of the Environment, Fisheries, Agriculture, Tourism, Energy, and Mineral Resources. CONDES heads the hierarchy of environmental co-ordination and mainstreaming institutions, and is meant to support MICOA politically. It has a technical council, chaired by MICOA and with representatives of different ministries as members, which advises CONDES. CONDES has no offices at the provincial and district levels, which weakens political support for MICOA's provincial directorates. CONDES has also established environmental units and focal points for the environment in the ministries of Agriculture, Energy, Mineral Resources, Public Works and Health. In an attempt to improve research, policy development, project implementation and technical assistance at the provincial and district level, it has also set up Centres for Sustainable Development in the Coastal Zones in Xai-Xai (coastal zone-related issues), Manica (the conservation and management of natural resources), Nampula (the urban environment) and Pemba (marine and coastal research).

CONSERVATION IN THE COASTAL AND MARINE ZONES

Mangroves in coastal areas and conservation areas are protected by national environmental legislation. Therefore, the management and enforcement of existing laws in protected areas are vital. Although mangroves are not necessarily the specific focus of these protected areas, they play a key role in the integrated ecosystem approach to these zones. As noted earlier, the mandate for protected areas falls under the Ministry of Tourism and the management functions are being taken over by ANAC.

According to the State of the Environment report for 2011, Mozambique has six national parks, eight national reserves (total protection zones), 13 forest reserves and 10 *coutadas*, or hunting areas.[122] They include the Bazaruto National Park (1 430 square

kilometres) and the Quirimbas National Park (marine portion: 1 522 square kilometres). In 2000, Mozambique and South Africa concluded a protocol to establish the Lubombo Ponta do Ouro-Kosi Bay Marine and Coastal Transfrontier Conservation and Resource Area. This is one of the five components of the Lubombo Transfrontier Conservation Area, established by the governments of South Africa, Swaziland and Mozambique. It combines Mozambique's Ponta do Ouro Partial Marine Reserve (established in 2009 and covering an area of 678 square kilometres), including Inhaca and Portuguese islands and the (terrestrial) Maputo Special Reserve, with South Africa's iSimangaliso Wetland Park.[123] In November 2012, the Council of Ministers also approved the Ilhas Premeiras e Segundas as a national marine reserve. It is one of the largest marine reserves in Africa, covering 10 400 square kilometres.[124] There are several privately managed conservation areas, including the Vilanculos Coastal Wildlife Sanctuary (80 square kilometres) and Northern Quirimbas (230 square kilometres). There are other public conservation areas as well, called *coutadas*, or hunting areas (several of which fall in the Ramsar site in the Zambezi Delta). Because mangroves are fringe ecosystems that straddle the sea and land, and are also found in river estuaries, they also occur in the protected areas of Marromeu, Pomene and Maputo Game Reserves.[125]

According to a recent USAID report on the state of the environment in Mozambique, it has reached its national targets by increasing the extent of its protected areas from 11% of total area in 1995 to 16% in 2008, and about 25% in 2012.[126] However, given the biological importance of its land and sea, these are relatively modest targets. According to the draft SEA report, only 15.2% of protected land is coastal or marine-related, and other vital areas displaying high levels of marine and coastal biodiversity should also receive special attention. Most of the coastline is unprotected, and a few MPAs cover a tiny percentage of Mozambique's territorial waters.[127] For example, less than half of Mozambique's mangroves are situated within protected areas, and the remaining percentage is situated outside MPAs (mainly in the Zambezi Delta).[128] MPAs should therefore form a larger part of Mozambique's strategy for protecting and managing marine and coastal resources. However, merely declaring MPAs will not sufficiently protect the areas in question. Without effective management planning, monitoring, and financing for law enforcement and security, managing these areas will remain a challenge. This 'conservation vision' must be clearly understood by all stakeholders in a given area, and adjacent fishing communities and coastal resource users must buy into it as well. Without a common vision, stakeholders will continue to act in their own interests only, pursuing divergent goals and undermining the aim of conservation zones. For this to be recognised, incentives need to be put in place and feasible alternative livelihood options need to be considered. The case of the Bazaruto Archipelago illustrates these difficulties (see Box 3). In fact, Mozambique's SEA report specifically highlights this area as a priority zone for the urgent management of conflicting interests.

The two case studies in this report, of the port town of Beira and the protected archipelago of Bazaruto, illustrate the difficult context in which mangrove conservation is taking place. In both cases there are real developmental reasons for mangrove conservation, and in both cases conflicting interests are hampering progress. For example, given Mozambique's physical geography, coastal vegetation is an important coastal buffer, and also contributes to its biodiversity and the provision of goods and services. The clearing of natural vegetation for urban developments, mining projects, aquaculture and

agriculture is a growing cause for concern, especially for local fishermen and the prawn industry.

Urgent steps must be taken to reconcile Mozambique's rapid economic growth with the maintenance of ecological processes, the biological valuation of coastal biodiversity, and the well-being of communities living in the coastal zone. The challenge is to use adequate planning to convert potential conflicts into synergies. The two case studies show clearly that, when interests seem to collide, the relevant institutions should adopt a multifaceted, ecosystem approach which takes the interests of all important sectors and stakeholders into account. Centralised interdisciplinary forums, such as CONDES, can be used to interrogate strategic national decisions in cases of a direct trade-off between economic development and biodiversity. Affected communities should be represented on those bodies. Also integral to these decisions are objective EIAs acknowledging the true level of biodiversity loss and its subsequent developmental impacts on natural resource users. In cases where economic development priorities are favoured, consideration should be given to the most effective way to implement a project in which all negative impacts – social, economic and environmental – are minimised. Institutions and regulatory frameworks must be well-managed and effective, and roles and responsibilities for fringe ecosystems must be clearly allocated. Legislation that specifically protects mangroves and is well-enforced is an essential feature of a governance system that ensures the integrity of natural ecosystems. This is particularly relevant given the extractives boom and the state of play in many of Mozambique's vulnerable coastal areas.

Box 3: Balancing stakeholder interests in the Bazaruto Archipelago National Park

The Bazaruto Archipelago National Park (BANP) is one of Mozambique's largest protected areas. Situated in the district of Inhambane in central Mozambique, it comprises five islands and the surrounding waters of the archipelago, totalling 1 430 square kilometres. The BANP was founded in 1970 to preserve the area's coastal and marine biodiversity. It contains mangroves as well as coral reefs, sea grass beds, rocky intertidal areas and dune forests.[129] These coastal ecosystems and other habitats support highly valuable biodiversity. Given this, BANP is a popular tourist destination, and the five exclusive hotels in the Park (and associated visitors' fees) are an important source of income for the national government, the BANP authorities, and local communities.

The BANP is home to a large number of threatened and endangered species, including turtles and dugongs.[130] According to Karen Allen of the Endangered Wildlife Trust (EWT), there are only about 200 dugongs left in the park.[131] This population is geographically isolated, and remains under threat from entanglement in gill nets and the destruction of sea grass, its primary food source. Despite the shortage of conservation funding, various initiatives for preserving this last viable population of dugongs in East Africa are under way. As a result, all gill nets are prohibited within the Park and strict penalties are imposed for endangering these species. Some hotels in the BANP have co-operated with NGOs and Park authorities to help support these activities. An example of this is the secondment of Karen Allen, an EWT representative, to Marlin Lodge.

Marlin Lodge hosts Allen and provides her with a vessel and fuel so she can conduct regular patrols with the BANP authorities in order to check permits, fishing gear, and fishing sites. She also conducts training and educational awareness programmes on the islands with local fishermen. Given these and other interventions, the islands are more regularly patrolled, and fines are issued for illegal activities. However, although these conservation efforts advance the interests of the hotel and tourist operators, they are breeding resentment among local people living on the mainland, whose gear is confiscated for fishing in the prohibited locations. According to Benkenstein, much of this conflict arises from divergent perceptions of the 'appropriateness' of fishing for certain species.[132]

There are 3 500 people in the BANP, living in seven communities. Small-scale fishing is the main income for more than 70% of these households. Only people living on the five islands in the archipelago are allowed to fish in the BANP. This has created significant employment opportunities for the islanders in the tourism industry and hotels. Fishermen from the mainland may not fish in the park, and gill nets are illegal.

There are various management zones in the BANP: some no-take zones, where no fishing is permitted (for example on Magaruque Island), and some areas where fishing is allowed but restricted to islanders. The exclusion of coastal fishermen from protected areas is politically contentious. Many people living in the town of Vilanculos on the mainland rely solely on subsistence fishing and do not have other livelihood options or income-generating opportunities. This is particularly difficult in times when fisheries activities have increased and fishing stocks have substantially decreased.

It is difficult to justify these conservation activities when local people are not compensated for co-operating with conservation initiatives. In order for local people to understand and respect the rules, marine conservation needs to benefit their lives directly. Otherwise, policing such a large area will be impossible. This can be done through the engagement of local government and NGOs with the community. For example, many experts believe that when no-take zones are properly managed, for example in the Quirimbas, they increase the quantity and quality of fish caught. When designed and monitored in co-operation with local communities, this is an effective way to improve their livelihoods.

The Quirimbas National Park in northern Mozambique offers interesting lessons for other conservation areas in this regard, particularly given the large population of 125 000 people living in the broader park area. Like the BANP, Quirimbas is divided into three management zones: totally protected zones or sanctuaries, where fishing is prohibited but tourism and scientific research is allowed; zones demarcated for recreational fishing, community use and development (where people live and are allowed to fish), and activities such as mining (subject to restrictions), and buffer zones around the park.

However, in the BANP, local people still resent the restrictions and the confiscation of illegal fishing gear. There is also growing conflict between government bodies, the park authorities, tourism and hotel operators, and the local fishing community. According to the Tourism

Manager of the BANP, fees paid by tourism operators, hotel operators and other users are sent to the Ministry of Tourism in Maputo.[133] Eighty per cent of this revenue is meant to be returned to the BANP to support its conservation activities, pay the salaries of rangers, and buy fuel for patrol vessels. A percentage of the revenue is meant to be shared with local communities, thus supporting a shared vision of co-operative management which respects the sustainable use of natural resources and contributes to the conservation objectives of the BANP. However, according to rangers and officials, it takes a long time before revenue reverts to the park. Rangers are often not paid in time, and do not have enough fuel to conduct patrols. Also, because of inefficiencies at the central government level and poor management practices at the local level, many hotel and tour operators are reluctant to pay park fees, or delay paying them, on the grounds that they receive no benefits.

The channels of communication between the tourism sector, fisheries officials and fishing communities must improve. Park officials have undertaken limited engagements with CCPs on the mainland. This is essential to help BANP authorities raise awareness of the benefits of marine conservation, and clarify uncertain park boundaries and fishing regulations. At the central government level, co-ordination among key ministries must be improved. The Ministry of Tourism, Conservation, Maritime Authority and Fisheries needs to work more closely with the archipelago authorities. Their current efforts do not support one another. For example, the Maritime Authority, which has access to the patrol vessels, does not help the Fisheries Authority to monitor the use of illegal fishing gear or trading in red-listed species. The Ministry of Fisheries is not mandated to patrol protected areas, or monitor the activities of artisanal fishers. They do not have adequate staff or facilities to control capture quantities or to provide extension support at the landing sites. Yet according to the BANP, gill nets used by fishermen from the mainland constitute the biggest threat to the Park.

As noted earlier, the situation is further complicated by the discovery of natural gas reserves at Pande and Temane, which overlap with the BANP boundaries. Plans for exploiting the gas reserves are on hold pending the outcomes of an SEA for the area. Unless managed effectively drilling, exploration and gas production could have disastrous effects on artisanal fisheries, the dugongs and tourism.

Many protected areas in Mozambique, including the BANP, lack sustainable funding for management and law enforcement. BANP's four-year management strategy is currently being revised, and efforts are being made to enhance its conservation. The new management strategy (2014–18) should find ways of resolving current conflicts, and mitigate the negative environmental impacts of new developments. It should also explore opportunities for compensating users of the Park's resources. Market mechanisms and PES schemes such as blue carbon projects for mangroves and sea grasses could offer financial incentives for protecting the non-market ecosystem benefits of protected areas.[134] These mechanisms could enable investors to promote a multitude of complementary objectives such as mangrove and sea grass conservation and restoration, carbon emissions reduction, and sustainable development through the provision of funding to local communities. However, according to experts on development in Mozambique (such as representatives

of the WWF), blue carbon for mangroves is unlikely in the BANP, as the total area is very small. Little is known about blue carbon calculations in respect of sea grasses, and much effort and expense would be needed to establish whether this was viable. Given its limited human and financial resources, the BANP would struggle to undertake this soon.

Alternative livelihood options for local people should also be explored. This could include oyster harvesting, sea cucumber harvesting, trade in non-timber-based products and eco-tourism services and activities such as agro-forestry and the conservation of mangroves. Providing fishermen with other sources of income would allow fish stocks to revive. The conservation and restoration of mangroves and sea grasses would also support sustainable fisheries management as well as the replenishment of fish stocks. Enhanced educational programmes and training aimed at linking the benefits of ecosystem conservation and fisheries is essential.

CHAPTER 5

BLUE CARBON INCENTIVES FOR THE CONSERVATION OF ECOSYSTEMS

Given the ability of terrestrial forests to act as carbon sinks, restoring and conserving them has become an important part of international efforts to mitigate climate change. Several countries have developed policies and programmes for reducing their carbon footprints through various international vehicles such as the UN Framework Convention on Climate Change (UNFCCC). Mechanisms developed by the UNFCCC include Reducing Emissions from Deforestation and Forest Degradation (REDD+),[135] Nationally Appropriate Mitigation Actions (NAMAs),[136] and the Clean Development Mechanism (CDM).[137] These systems provide incentives and financial support for national-level accounting and project-level activities including the conservation, restoration and sustainable use of natural systems such as forests and peatlands.[138]

However, other ecosystems that are comparably rich carbon reservoirs and offer potential mitigation benefits, particularly coastal ecosystems such as mangroves, have largely been excluded from the global climate discussions.[139] Tidal marshes, mangroves and sea grasses capture and store large quantities of blue carbon, in plants as well as the sediment below them, trapping emissions that would otherwise contribute to harmful anthropogenic climate change. If destroyed, degraded or lost, these coastal ecosystems become significant sources of carbon dioxide.[140, 141]

The GHG emissions released into the atmosphere as a result of the poor management of coastal ecosystems and the destruction of marine habitats are not accounted for in international climate change frameworks or in National GHG Inventory Submissions. This means that countries are underestimating their contributions to anthropogenic emissions, and that the carbon savings from measures to protect and restore coastal and marine habitats will not count towards meeting international and national climate change targets.

In the terrestrial sector, the ability of tropical forests to sequester carbon from the atmosphere has led to its economic quantification, purchase and trade via carbon 'credits'. This has occurred under international and national REDD+ programmes in terms of which developing countries are compensated for maintaining the carbon sequestration functions of their forests. This has spurred forest-related carbon offset projects to protect existing forests, regenerate lost or degraded forests by planting trees, or both. The growth in the carbon offset markets has created an opportunity for small conservation projects in developing countries. The recent recognition that mangroves, sea grasses and tidal marshes also sequester and store comparable (and often larger) amounts of carbon[142] has provoked interest in the quantification of these coastal ecosystems and the further exploration of options for trading carbon offset credits.

Blue Carbon can be traded and handled in a similar way to Green Carbon, and entered into climate mitigation protocols along with other carbon-binding ecosystems. Although they are not a conservation solution, carbon markets may offer African countries

additional economic incentives to prioritise, protect, sustainably manage and restore their coastal ecosystems. However, the global carbon markets are in crisis, which affects efforts to generate finance conservation. There are also difficulties in organising, mounting and managing payments for environment services (PES) that must be considered before starting these sorts of projects.

LINKING BLUE CARBON TO CLIMATE CHANGE MECHANISMS

Because of its proven mitigation potential, many opportunities exist to promote Blue Carbon as a legitimate climate change activity.[143] However, promoting it as a new and separate agenda item under the UNFCCC is unlikely to succeed. The current climate change negotiations are already heavily overloaded, and adding another agenda item may be counterproductive, especially before the IPCC[144] reporting guidelines have been updated to include wetlands and mangroves. The IPCC is working on the IPCC guidelines to incorporate other types of coastal vegetation. Blue Carbon activities can also be included in existing NAMA and REDD+ agendas.

Several countries already refer to mangroves in their national REDD+ strategies and readiness plans, although these are mostly limited in extent and detail. Costa Rica, Tanzania, Indonesia and Ecuador, for example, refer to mangroves in their national submissions to REDD+ and to the Forest Carbon Partnership Facility (FCPF).[145] At present, REDD+ is also limited to forestry land use change,[146] and does not encompass non-forest land use such as salt marshes and sea grass-related activities. For many countries, this is a sizeable opportunity missed.

There are also prospects within the broader scope and definition of activities qualifying for NAMAs which countries are able to tailor to their specific needs and mitigation potential. The methodologies for carbon measurement within NAMAs are currently being developed and improved. This opens up space for countries, such as small-island African states, which are not typical REDD+ countries, to use NAMAs to access finance for coastal management as well as capacity-building and awareness programmes around ecosystem services and carbon sequestration. Several countries, including Sierra Leone, Eritrea and Ghana, have submitted coastal wetland-related NAMAs. Mangroves are not covered in Mozambique's national emission reduction strategies or reported on in its GHG inventory submissions at the international level.

It is therefore necessary to integrate Blue Carbon more strategically with existing international, regional and national climate change initiatives, and broaden existing definitions and terminology to better reflect conditions in African countries. It is also vital to improve access to untapped avenues of carbon financing, via the UNFCCC or through voluntary carbon markets, as primary vehicles for supporting national and project-level Blue Carbon activities. Due to the ability of mangroves to protect vulnerable coastal communities against storm surges and rises in sea levels, countries with ample coastal vegetation can also seek financing from the UNFCCC's Adaptation Fund. Moreover, other complementary funding avenues are available outside the UNFCCC, including biodiversity offsetting, conservation funding from ecotourism, private sector finance to meet corporate social and environmental responsibility targets, or funding from bilateral and multinational agencies (such as the Global Environment Facility of

the World Bank). A number of carbon market facilities and sources of funding have also been established outside the UNFCCC. The Verified Carbon Standard,[147] for example, is recognised as the most advanced standard for developing coastal carbon systems. Other standards-generating CO2 (atmospheric carbon dioxide) Certificates include the Climate, Community and Biodiversity Standard, the CarbonFix Standard, and the Plan Vivo Systems and Standard.

RECOGNISING MANGROVES IN INTERNATIONAL CLIMATE CHANGE DEBATES

Although scientific evidence supports the carbon sequestration benefits of coastal ecosystems, there is no international regulatory framework or convention for protecting the role of coastal and marine ecosystems in sequestrating carbon and mitigating climate change. Unlike terrestrial forests, the substance and certainty surrounding Blue Carbon benefits have not been communicated effectively to the broader climate change policy community. As a result, these ecosystems have not been integrated fully with policy discussions or financial mechanisms for climate mitigation. There is still a lack of confidence in the quantification of Blue Carbon. This requires scientific research to improve the quantification of emissions captured by Blue Carbon sinks, and to assess where carbon loss is occurring most rapidly, in order to prioritise those areas. Demonstration projects could also be good avenues for the development of practical, science-based methodologies and tools for the UNFCCC and other frameworks in support of carbon accounting for mangrove projects.

At present, these challenges represent barriers to finance and incentive mechanisms, including carbon markets. There is little knowledge and awareness of the financial rewards of coastal ecosystems. Trading and registry procedures for the nascent voluntary offset markets are not yet well established.

MOZAMBIQUE AND CARBON MARKETS

According to Moye and Nazerali, Mozambique's experience of carbon markets is limited, and there is an urgent need to build capacity in this realm within government ministries and the private sector. MICOA is Mozambique's Designated National Authority (DNA) for the CDM. So far only one project, the Matola Gas Fuel Switching project, has been submitted to the CDM Validation Board of the UNFCCC. Mozambique's participation has been hampered by a lack of awareness of CDM opportunities generally; a lack of up-front financing for pre-investment studies, and the lack of an appropriate national definition for 'forests' under CDM.[148] Also, little has been done to assess whether carbon projects in conservation areas are technically feasible and financially viable. Technical assistance will be needed to develop and implement these sorts of projects, and to bring carbon credits to market.[149]

Demonstration mangrove carbon projects are also new in Mozambique. However, in 2012 the WWF, USAID, the US Forest Service, and Eduardo Mondlane University, in collaboration with the government of Mozambique, initiated a pilot project in the

Zambezi Delta to provide baseline information needed for the development of REDD+ and associated climate mitigation projects.[150] Still in its infancy, the project is aimed at measuring the carbon in the vegetation and soil of mangrove forests at various locations in the delta. More specifically, the project is aimed at producing a Project Design Document[151] for the mangrove area in the Marromeu Reserve, and will therefore examine deforestation rates and degraded areas as well. This demonstration project is aimed at developing Mozambique's REDD+ programme by providing policy-relevant information needed to establish a baseline for REDD+ and other climate change mitigation activities for mangrove forests. It also seeks to build capacity for climate change mitigation and adaptation programmes, specifically by developing methodologies for compiling carbon inventories and creating associated data management systems. A pilot project such as this that catalyses the development of mangrove forest carbon in a conservation area pioneers a new approach to GHG mitigation. Other projects must be developed in line with Mozambique's National REDD+ Strategy in which mangroves are included in Mozambique's definition of forests.

In sum, climate change mitigation mechanisms offer many African countries – home to some of the largest global coastal resources – new forms of finance for maximising the ability of coastal ecosystems to reduce carbon emissions. In this regard, international schemes and carbon accounting tools can help to persuade policy-makers to project the potential impacts of their decisions, and identify trade-offs and compatibilities among environmental, economic, and social benefits.

Blue Carbon is emerging as a new option on the palette of existing global mitigation opportunities – one that also has positive spin-offs for conservation and biodiversity. This complements the conservation work already undertaken by various international forums, such as the UN Convention on Biological Diversity and the Ramsar Convention on Wetlands.

Africa needs to be at the forefront of decision-making in this regard, and African policy-makers should play a leading role in making policies specifically suited to their countries' needs. However, there are still major uncertainties about the quantification of carbon sinks that the scientific community should urgently address.

CHAPTER 6

CONCLUSION

It is widely acknowledged that well-functioning ecosystems, including mangroves, provide reliable and clean flows of fresh water and air, productive soils, healthy and balanced biota, and many other services that contribute to the well-being of humans. This report illustrates that human pressures and economic activities are compromising the resilience of these ecosystems, and eroding their capacity to deliver vital regulating, provisioning, supporting and cultural services. When the economic losses associated with natural resource depletion are factored into measurements of a nation's 'true' wealth, this significantly changes the balance sheets of countries whose economies depend significantly on natural resources. Nature's non-market benefits must be incorporated into development choices, and their economic quantification improved, so as to entice investment back into conservation and restoration. These economic development decisions are particularly pertinent to African countries which are poised for new wealth from the exploration of oil, coal and gas deposits. As noted earlier, significant fossil fuel deposits have been discovered in Mozambique, Ghana, Uganda, Sierra Leone, Liberia, Guinea Bissau, Kenya, Tanzania and Namibia. The expansion of these sectors is likely to lead to increasing interactions and conflicts between stakeholders with fossil fuel interests and those concerned about the environment. Many African states are hoping to gain major revenue flows from the sale and use of these new energy sources. However, there are disadvantages that need to be taken into account and balanced with ecosystem service considerations (for example, oil is a finite resource, and its price is extremely volatile. It also generates considerable governance challenges.) Once all the economic facts have been gathered, the trade-offs between economic possibilities and differing choices can be properly assessed.

This is particularly true of the generally poor state of mangrove conservation and management in Africa. Given impending and overlapping economic development and challenges surrounding surviving mangrove forests, more needs to be done to highlight their important and invaluable ecosystem services and functions. These choices are integral to all countries' poverty reduction strategies and development plans. The increased recognition of the value and importance of mangroves must be coupled with and supported by a better understanding of their ecology as well as their environmental and cross-sectoral linkages. Mangroves cannot be dealt with in isolation. Their health affects many different sectors, including the fisheries sector and therefore food security, climate change mitigation and adaptation, disaster risk reduction, and biodiversity management and conservation.

Developing an ecosystem services perspective is important for policy-makers and planners when establishing managerial priorities. These can be determined by focusing on the areas and habitats that deliver the most, or the most valuable, ecosystem services. Alternatively, they can be based on the most serious threats to ecosystem services, or the most vulnerable/threatened areas. Successful management will require better data, and a better synthesis of existing information that bridges the science–policy gap. Moreover,

the quantification of ecosystem services must be improved. This information will help to make a more compelling case for conservation and restoration, and enable the inclusion of mangroves in economic frameworks for planning and coastal management.

Mangrove management should be integrated with broader coastal management.[152] This holistic, integrated approach, often referred to as ecosystem-based management, recognises the importance and interplay of terrestrial, marine and coastal systems. It is very useful for balancing multiple and sometimes conflicting objectives related to different benefits and ecosystem services. It integrates all sectors that affect, or are affected by, land use change in coastal zones. Although mangrove action plans in Mozambique will be developed at the national level, they will ultimately be implemented and enforced at the local level. Local authorities will therefore play a vital role. Adjacent coastal communities – the key beneficiaries of mangrove goods and services – must be involved in their protection and enforcing their sustainable use. Local communities living in coastal belt zones are able to manage and protect ecosystems, and could play a key role in restoration. This would provide unskilled people with viable job opportunities.

Clearer and more specific policies must be developed for the management and protection of mangroves and other vital coastal ecosystems. Mangroves that are managed under more general legislation relating to the environment, fisheries, coasts or wetlands are often neglected, and their legal status is not properly acknowledged or enforced. Mozambique and other countries must use national and sectoral legislation to support and streamline environmental decision-making and biodiversity planning, and strengthen these functions where necessary. Useful instruments have been developed to accelerate environmental authorisations without undermining sound impact management principles. These are country-specific but could include, among others, SEAs, spatial planning, Environmental Management Frameworks and EIAs.

Management must be adequately financed. New financing options are available that would lessen the management burden on traditional entities, and allow more direct engagement with local communities, user groups, industries, and other stakeholders. New forms of financing should maintain habitats and biodiversity, keep ecosystem services flowing, make good business sense, and demonstrate the value of co-benefits such as ecosystem-based job creation. The use of incentives, compensation mechanisms, and other, similar instruments is gaining ground not only in carbon markets but in biodiversity and water markets as well. Carbon markets provide developing countries such as Mozambique with new opportunities for protecting and restoring their mangroves. At present, mangroves, sea grasses and tidal marshes – all of which have a large carbon sequestration potential – are not incorporated into the national climate change emission reduction strategies of most African countries, or reported on in their international GHG inventory submissions. Now that the methods for carbon market projects involving mangroves and salt marshes have either been approved or are being developed, projects to manage and restore these ecosystems for carbon credits are beginning to emerge. However, these are still new, and there are few examples of best practice for project developers to follow. Therefore, there is an obvious need to guide coastal Blue Carbon demonstration projects.

Until now, African countries and regional organisations have not taken advantage of the opportunities offered by these ecosystem markets. There are numerous reasons for this, including a lack of adequate awareness and technical knowledge, a lack of

appropriate market mechanisms, and governance failures. Regional organisations should be in the forefront of these debates, and encourage member states to take advantage of these opportunities. African countries and other stakeholders need to take stock of ecosystems markets and payment schemes, and develop equitable sharing models that would benefit vulnerable communities dependent on natural resources and ecosystems.

This report has sought to add to the current debate, raise awareness of mangroves and their services, and translate its findings into concrete recommendations. This will require longer-term strategies by governments, and the development of new tools and approaches applicable to Africa and easily understood by policy-makers. They should include new and innovative approaches based on economic incentives, such as Blue Carbon, to promote the conservation of ecosystems and their services.

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diversity is about more than plants, animals and micro organisms and their ecosystems – it is about people and our need for food security, medicines, fresh air and water, shelter, and a clean and healthy environment in which to live.

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135 REDD+ supports reductions in emissions caused by deforestation and forest degradation. It aims to strengthen and expand the role of forests as carbon pools by supporting the conservation and sustainable management of forests and forest carbon stocks.

136 Voluntary mitigation actions undertaken by a developing country to seek financing, capacity building and/or technology transfer support under UNFCCC agreements.

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145 The FCPF, financed by the World Bank, helps developing countries to prepare readiness plans for implementing the REDD+ process.

146 A GHG inventory for this sector covers emissions and the removals of GHG resulting from direct human-induced land use, land-use change and forestry activities.

147 A GHG accounting system used by carbon mitigation projects globally to verify and issue carbon credits for the international voluntary offset market.

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