

Environment

MATTERS AT THE WORLD BANK



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toward sustainable development • 2008 Annual Review



Valuing Coastal and Marine Ecosystem Services

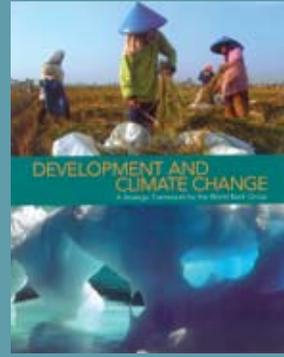
CLIMATE INVESTMENT FUNDS

Recognizing that global deliberations on a future funding strategy for climate change mitigation are under way, the World Bank Group and other multilateral development banks (African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, and Inter-American Development Bank)—together with a number of countries—

New Funding Source for Climate Change Mitigation

have developed the Clean Investment Funds (CIF) as an interim measure to scale up assistance to developing countries. The CIF includes a Clean Technology Fund for scaling up investments in low-carbon technologies, and a Strategic Climate Fund for supporting various programs to test innovative approaches to climate action. The CIF was approved by the World Bank's Board of Executive Directors on July 1, 2008, and received pledges totaling over \$6 billion on September 26, 2008. For more information, see www.worldbank.org/cif.

together with a number of countries—



Global Climate Change — The Bank's Strategic Framework

A new report by the World Bank concludes that global efforts to overcome poverty and advance development can no longer ignore an urgent need to address global climate change.

The report—*Development and Climate Change: A Strategic Framework for the World Bank Group*—notes that climate change “has the potential to reverse the hard-earned development gains of the past decades and the progress toward achieving the Millennium Development Goals. It can cause mass migration and contribute to conflict. An effective response to climate change must combine mitigation of global GHG emissions—to avoid the unmanageable—and adaptation at regional, national, and local levels—to manage the unavoidable.”

The report sets out a comprehensive strategic framework for WBG actions in this area, articulating objectives, guiding principles, areas of focus, and major initiatives to guide the operational response for the next three years. It identifies six action areas for the World Bank Group's engagement on climate change: (1) supporting climate actions in country-led development processes; (2) mobilizing additional concessional and innovative financing; (3) facilitating the development of market-based financing mechanisms; (4) leveraging private sector resources; (5) supporting the accelerated development and deployment of new technologies; and (6) stepping up policy research, knowledge, and capacity building.

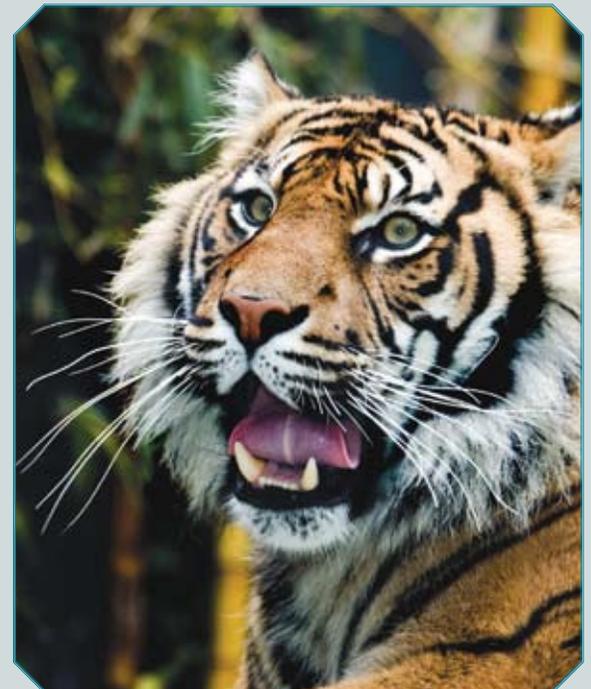
Bank Sponsors New Program to Protect Threatened Species

The World Bank, Global Environment Facility (GEF), and the International Union for Conservation of Nature (IUCN) are launching a new effort to encourage corporate support for the protection of threatened and endangered species. The new partnership also includes the government of France and the Noé Institute, a Belgian NGO.

The core of the new initiative is that many corporations have built their brand using images of threatened and endangered species and that it is now time for those enterprises to invest in saving these creatures before they disappear.

The *Save Your Logo* campaign seeks to leverage private sector and multistakeholder engagement for dramatically expanded funding for threatened species. While focusing on particularly threatened species, this initiative will also target those animals used for branding and in logos of global corporations. The fund will be invested in the long-term sustainability of their natural habitats.

“These efforts will complement and expand current Bank commitments to biodiversity conservation, including the Global Tiger Initiative, which President Zoellick launched in June 2008 in partnership with the GEF and national and international NGOs,” said Warren Evans, director of the Bank's Environment Department.



LETTER FROM KATHERINE SIERRA

VICE PRESIDENT
SUSTAINABLE DEVELOPMENT

The focus of this year's *Environment Matters* is long overdue. Although we are creatures of the land, 50 percent of humanity is distributed along the narrow margins of the world's ocean within 100 kilometers of a coast. Since ancient times major civilizations have settled along the shores of continents and islands, their economies linked to the sea through fishing, connected to each other by maritime trade and exchanges of culture and people. With the growth of urban centers, leisure time, and disposable income, coastal tourism has flourished into one of the fastest growing industries in the world.



Although the numbers are hard to quantify, as this issue of *Environment Matters* points out, estimates of the annual contribution of coastal and marine ecosystem goods and services to the global economy have exceeded \$20 trillion, over a third of the gross world product. Nonmarket values such as biodiversity and climate regulation are incalculable, and the spiritual worth of an intact seascape and the wonder of a coral reef are impossible to quantify. Yet for all the benefits they provide to humankind and the planet, marine ecosystems are grossly undervalued in our calculus of development trade-offs and the investments we are willing to make to preserve precious natural capital.

Our inability to adequately capture and account for these values, nurtured by our land-centric bias, has greatly jeopardized the health of marine ecosystems and their ability to continue to provide essential services in fisheries productivity, tourism amenities, coastal protection, and CO₂ uptake.

The last two decades have seen a rapid loss of critical wetlands and coral reefs. The UN Food and Agriculture Organization reports that 20 percent of the world's mangroves were lost between 1980 and 2005. Some 16 percent of the world's coral reefs died in the wake of widespread coral bleaching tied to the El Niño events of 1997. While some reefs have recovered, others are succumbing rapidly to a combination of human and climate-change-related impacts. Under a business-as-usual scenario, scientists warn that we may witness the disappearance of coral reefs in our lifetime.

The loss of these vital ecosystems and their services cannot be measured only in economic terms. Provisioning and regulating services from these systems are the lifeblood of coastal populations around the world, but especially the small-island developing states, whose people are almost completely dependent on healthy marine systems for food, livelihoods, and coastal protection.

Vulnerability will only increase with climate change. Sea level rise, increased storm activity, a warming and acidifying ocean, and a greater incidence of disease are all predictable effects of climate change. Countering these effects will require far greater investments—of both political and financial capital—in coastal zone management, control of land-based pollution, and stewardship of fish stocks. Maintaining robust and resilient ecosystems in the face of climate change is one of the best defenses we can mount. Science tells us this, countries are demanding this, and we must gear up to respond.

While this edition of *Environment Matters* is alarming in some aspects, I hope you find it instructive in describing the challenges we face and some of the solutions before us.

A handwritten signature in white ink that reads "Katherine Sierra". The signature is fluid and cursive, written over a background of light blue wavy lines.



Sustainable Development Network

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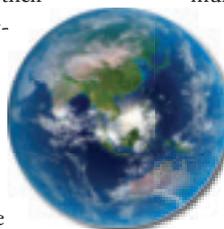
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Welcome to *Environment* matters...

Our blue planet is 70 percent ocean—one interconnected body of water that wraps around the globe. The ocean is the origin of life on Earth and its greatest source of biodiversity. It provides vast quantities of food and stores carbon, a critical service in an era of climate change. Yet these vital ocean services have been treated as free goods, and the marine and coastal ecosystems that provide them have consequently declined through overuse, pollution, and physical destruction. Climate change now threatens to push many of these systems over the edge, with severe consequences for society, but especially the world's poor.

The theme of this issue of *Environment Matters* is valuing coastal and marine ecosystem services and their contributions to sustainable development. Anada Tiéga, secretary general of the Ramsar Secretariat, recounts the myriad services provided by wetlands and their multiple benefits to communities. Professor M.S. Swaminathan, founder and chair- man of the MS Swaminathan Research Foundation and world-famous agricultural scientist, emphasizes the disproportion- the rural poor and their dependence hood, nutrition, and social resilience. ate importance of these natural assets to at Columbia University and Narriman at Columbia University and Narriman Jiddawi of the Institute of Marine Sciences applied to assess the value of coral reefs describe how economic valuation can be and mangroves to the economy of Zanzibar. The Bank's Stefano Pagiola describes the challenges of adapting a system of payments for environmental services (PES) to coastal ecosystems, while Walter Vergara and his team warn of the consequences of losing coral reefs in the Caribbean to climate change.



Regional reviews offer a brief inventory of the range of coastal and marine ecosystems that characterize each region, their status, and the value of goods and services they provide to coastal economies and to community livelihoods. The heightened exposure of coastal populations, and particularly small-island developing states, to sea level rise, increased storm surge, and flooding and saltwater intrusion carries far greater risk as coral reefs succumb to bleaching and acidification and as mangroves and coastal forests are reclaimed for coastal development.

How is the World Bank Group responding to these challenges? It is ramping up investments in sustainable fisheries through good governance and legal and policy reforms, supporting marine biodiversity conservation through the establishment and comanagement of marine protected areas, and introducing alternative livelihoods to relieve pressure on natural resources. It is also promoting integrated coastal zone management through institutional strengthening and more robust regulatory frameworks. Finally, by demonstrating the links between sustainable coastal resources management and social and ecological resilience to climate change, the Bank is helping build the political will required for countries to invest in protecting their natural capital now as part of a no-regrets policy for the future.



COVER IMAGE

Boy swimming over reef, Solomon Islands:
© Stephen Frink/CORBIS

Marea E. Hatzioiols
Senior Environmental Specialist
Environment Department

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Though challenging, it may be possible in some cases to use the payments for environmental services (PES) approach to help safeguard coastal and marine areas, writes Stefano Pagiola.

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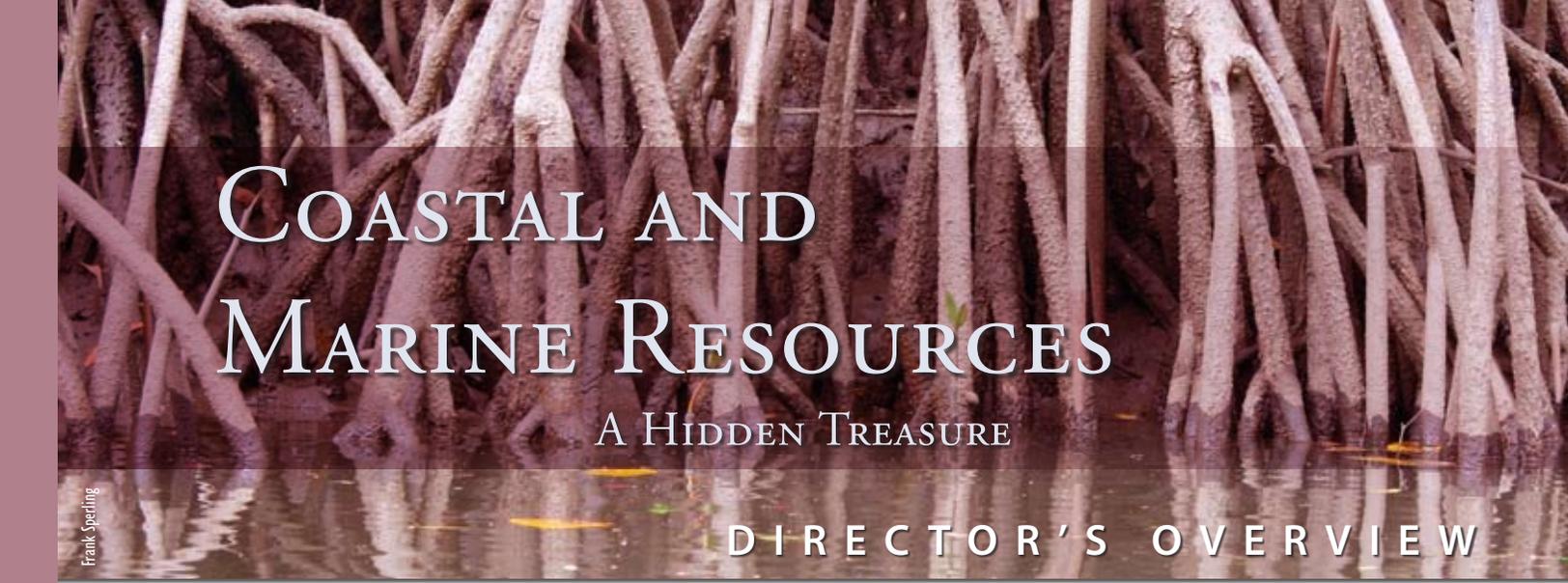
Institutional

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The International Finance Corporation's current investment portfolio supports different approaches through which the private sector can contribute to and create incentives for the sustainable management of coastal and marine ecosystems and their services, writes Robert Gerrits.

A Policy and Legal Framework Supporting Payments for Ecosystem Services 51

To ensure sustainable PES schemes, countries need supporting legal and institutional frameworks, write Patrice Talla Takoukam and Sachiko Morita.



COASTAL AND MARINE RESOURCES

A HIDDEN TREASURE

DIRECTOR'S OVERVIEW

Frank Sperling

— JAMES WARREN EVANS
ENVIRONMENT DEPARTMENT

Coastal and marine ecosystems play a complex and vital role in supporting economic prosperity and social welfare in developing countries. They sustain the livelihoods of millions of poor households, provide multiple ecosystem services that are essential for life, yield vast amounts of food, and play a critical role in driving weather and climate.

As we progress further into the 21st century, the importance of these coastal and marine resources is certain to increase. Both in absolute terms and as a proportion of the whole, more of the world's population will live along or near coastal areas. If we are to make further inroads in reducing poverty around the world, it will be vitally important to manage coastal and marine resources more sustainably.

In many of the articles presented here, a recurring theme is that coastal and marine ecosystem services are undervalued. In the case of coastal wetlands, Tiéga notes that we have not yet fully recognized the major role different coastal and inland wetlands play in the global carbon cycle—for example, the role of intertidal marshes or forested coastal systems such as mangroves in carbon sequestration and storage (see page 6). As the predicted impacts of climate

change materialize, the value of carbon storage is certain to increase. Furthermore, that value will increasingly be recognized by governmental entities.

Climate change is also expected to be accompanied by an increase in the intensity of coastal storms. Coastal ecosystems can play a valuable role in absorbing the impacts of these storms, so we can reasonably anticipate that the value of these coastal systems as buffers will increase in the coming decades.

Valuation of indirect ecosystem services, such as the regulating role of coastal and marine resources in providing habitat for fish, as a receptor for wastewater, or to control beach erosion, is weak. As Lange and Jiddawi point out (see page 10), these nonmarket services are an important input in provisioning services with direct economic value, such as fisheries or the viewing of coral reefs by tourists.

Better Valuation: Priceless

It is clear that some supporting services are immensely valuable yet are not amenable to economic valuation. The loss of corals can have measurable economic costs, but

we do not yet fully understand the relationship of such highly diverse ecosystems to offshore ocean environments. As Vergara and others point out (see page 20), we must now contemplate the complete loss of coral ecosystems, and the impact of that loss cannot possibly be measured only in economic terms.

Why does valuation matter? Certainly, it matters in the political context. In the day-to-day work of decision makers, putting even rough valuation numbers on these services can help make the case that governments, private enterprise, and international institutions must make investments in the sustainable management, protection, and restoration of such services.

In Zanzibar, for example, the fact that marine ecosystem services support nearly one-third of that nation's GDP certainly should alert decision makers to the stakes that are at risk. It also should engage the attention of decision makers that 75 percent of global fish stocks are fully exploited or depleted and that there is gross overcapacity in global fishing fleets—reducing the annual economic benefits from global marine fisheries by about \$50 billion a year, according to a new World Bank/FAO report, *The Sunken Billions* (see page 18).



Getting the Policies and Institutions Right

Valuation is one part of the challenge, but there are many other factors at play. As with so many environmental issues, many authors point to the fragmentation of government responsibilities and the cross-sectoral nature of these issues as a key challenge going forward. As Swaminathan, Damodaran, and Vel note (see page 8), overlapping jurisdictions and mandates have tended to fragment governmental interventions in coastal areas and overlook the role of shore communities and local stakeholders. Greater reliance on stakeholder consultation and conflict resolution can help overcome these problems.

Greater appreciation of coastal resources also can result in positive changes in governmental regulations. In India, for example, new coastal zone regulations have created conditions for the consolidation and strengthening of management of critical mangrove and coral reef estuaries for conservation. The idea behind all these measures, Swaminathan notes, has been “to optimize the ability of coastal zones to provide ecosystem services for local communities, resulting in improved livelihoods as well as incentives for better environmental stewardship.” To ensure long-term success, it is vital to provide stakeholders and local coastal communities

with an assured stake in the benefits that coastal and marine resources can provide. As the case of Zanzibar makes clear, local communities often receive only a fraction of the benefits produced by coastal and marine ecosystems.

At the global level, we face significantly different challenges. How, for example, can we reduce global fishing effort and rebuild global fish stocks? As Kelleher suggests (see page 18), fisheries reform “requires broad-based political will founded on a social consensus. Social safety nets and the creation of alternative livelihoods can be an important element of reform. These reforms can be integrated with poverty reduction programs and other instruments of economic and social development.” Sustainable fisheries, he adds, “require political will to replace incentives for overfishing with incentives for responsible stewardship.”

The Bank’s Response

The World Bank’s engagement in these issues is growing. We are increasingly prepared to invest in strengthening governance and policy regimes to better manage marine fisheries at levels that are both more environmentally sustainable and more profitable, as well as to reduce illegal fishing and to encourage private investment in local sustainable fish production. For example, the West Africa Regional Fisheries Project (\$90 million GEF/IDA) will help countries sustainably generate more local wealth from fish resources. In Asia, the Bank is investing in alternative income generation options. Seaweed farming, an alternative livelihood, is an example of a small-scale solution to overfishing; the Bank supports such programs in Indonesia and the Philippines. The Bank is also supporting community-based coastal fisheries resources management.

As illustrated by the Strategic Partnership for Nutrient Reduction in the Danube/

Black Sea Basin and other programs in the Mediterranean Sea, the Bank is increasingly cognizant of the importance of reducing pollution from land-based sources into large water bodies and coastal zones, including discharges of untreated urban wastewater and agricultural runoff.

Given the fact that some impacts of global climate change, particularly sea level rise and storm surge, now seem inevitable, the Bank also is investing in prudent initiatives to adapt to these impacts. In the Bay of Bengal, where coastal communities are particularly vulnerable to sea level rise, the Bank—through the Global Environment Facility and in partnership with the Food and Agriculture Organization of the United Nations—is supporting a transboundary diagnostic analysis of the priority environmental issues that will need to be addressed in a strategic action plan for the Bay of Bengal.

More broadly, the Bank is making real progress in mainstreaming climate vulnerability and risk management into country dialogue and into working with client countries. We have improved our understanding of country-specific adaptation challenges, achieved greater inclusion of adaptation in Country Assistance Strategies, launched a “screening tool” to help identify climate risks, and worked with the Global Facility for Disaster Risk Reduction and Recovery to integrate climate change. In IDA projects, support for comprehensive climate risk management will likely be the largest source of funding for adaptation in the least developed countries in the immediate future.

Our future management of the world’s coastal and marine ecosystems will play an absolutely critical role in deciding the fate of the global environment, not to mention the future prospects for hundreds of millions of poor people living in coastal areas who rely on the benefits of coastal and marine ecosystems for their basic needs.

WE MUST VALUE AND CONSERVE OUR COASTAL WETLANDS



Anada Tiéga
Secretary General
The Convention on Wetlands
Ramsar Secretariat



The services provided by wetland ecosystems are immense, arguably at least \$14 trillion per year, according to the 2005 Millennium Ecosystem Assessment. Yet the value of these services still remains widely unappreciated, as we are continuing to destroy both coastal and inland wetlands faster than any other ecosystem. We need to radically shift our thinking and decision making to recognize coastal wetlands as key tools for our future livelihoods.

Under the Ramsar Convention on Wetlands, wetlands include all coastal and nearshore marine systems to a permanent inundation depth of six meters. Such systems include marine subtidal aquatic beds; coral reefs; rocky marine shores; sand, shingle, or pebble shores; estuarine waters; intertidal mud, sand, or salt flats; intertidal marshes; intertidal forested wetlands such as mangroves; coastal brackish/saline lagoons; coastal freshwater lagoons; and karst and cave systems. Coastal wetlands also are integral parts of large marine ecosystems—the regions of ocean and coastal space that encompass river basins and estuaries and extend out to the seaward boundary of continental shelves and the seaward margins of coastal current systems.

Many studies highlight the vital role of coastal zone management. For instance, coastal habitats provide over 80 percent of the marine fish that humans consume. Coastal

wetlands also play an important role in many other areas that affect human livelihoods, including food security and health care, flood control, shoreline stabilization and storm protection, water purification, sediment and nutrient retention, climate change mitigation and adaptation, recreation and tourism, and enrichment of cultural values. For example, recent studies have calculated that for the coastal areas of the United States, coastal wetlands provide \$23 billion each year in storm protection services.

The multiple roles of wetland ecosystems and their value to humanity are increasingly understood and documented. This has led to massive expenditures to restore lost or degraded hydrological and biological functions of wetlands. However, there is also ample evidence that it is much more cost-effective to maintain our coastal wetlands than to restore systems that have been degraded or destroyed. Restoration alone is not enough; we have to improve sustainable management practices on a significant global scale, particularly as the world's leaders try to cope with the accelerating water crisis and the effects of climate change.

Although we know an increasing amount about the values of different wetlands, including coastal systems, the science of ecosystem valuation is still developing and evolving, and much more needs to be done to understand the

full value of such systems. For example, we have not yet fully recognized the major role different coastal and inland wetlands play in the global carbon cycle. We can anticipate that forested coastal systems such as mangroves are playing a role in carbon sequestration and storage. A recent assessment by the Ramsar STRP also indicates that wetlands—particularly intertidal marshes such as salt marshes—play a major role in carbon storage that may be an order of magnitude greater than for many inland peatlands. While there is still uncertainty over the precise figures, it is becoming clear that we need to pay much more attention to maintaining the ecological character of such coastal wetlands not only for their services such as food and coastal protection, but also in our climate mitigation and adaptation strategies.

Integrated coastal management is an important organizing principle that can have positive results on many



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wetland values, including biodiversity, fisheries, and the management of marine protected areas. Both the World Bank's work and the experience of the Ramsar Convention emphasize that the conservation and wise use of coastal wetlands are potentially affected when development occurs along the coasts or when resources are extracted or altered. It is also encouraging to recognize that many countries are taking major steps to conserve, restore, and enhance the wise use of the multiple values of wetlands. For example, Coastal America's Corporate Wetland Restoration Partnership—with more than 400 corporations and NGOs working together to provide matching funds and in-kind services—has made significant contributions to wetland restoration and protection.

Many coastal wetlands have major aesthetic and recreational value. In Asia and Pacific developing countries, as well as in Africa's small-island countries such as Mauritius and the Seychelles, tropical coastal tourism is a major industry, contributing significantly to economic growth and local employment. However, we have to recognize that coastal tourism is dependent on the natural environment. In this regard, the trends are not always good; in some cases, biodiversity hotspots are increasingly being turned into tourism hotspots. It is important to recognize that the coastal ecosystem of small islands is particularly vulnerable to ecological damage caused by excessive numbers of tourists. Inadequate tourism planning can lead to unsustainable coastal tourism, with significant direct and indirect impacts on biodiversity conservation.

The Contracting Parties to the Ramsar Convention met for their 10th Conference (COP10) in late October 2008. The meeting was hosted by the Republic of Korea. Participating governments paid particular attention to the closely interrelated issues of water, human health, climate change, food security, poverty reduction, and human well-being in relation to the key role of wetlands. COP10 provided an opportunity for all governments, and not just those parts of governments directly responsible for wetlands, to stress that the success of all development sectors depends on maintaining wetlands and their services, as much as wetlands themselves depend on decisions made in other sectors. Working more closely together for a sustainable wetland future will be critical.

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VALUING ECOSYSTEM SERVICES OF COASTAL ZONES



Professor M. S. Swaminathan
Member of Parliament (Rajya Sabha), India

Challenges for India

India's vast area of coastline and estuaries—an estimated 8,000-kilometer coastal belt and estuaries comprising about 2.7×10^4 square kilometers—are a vital part of its national wealth. Comprised of wetlands, lagoons, mangroves, and seagrass beds, India's estuaries, linked to the country's vast network of rivers, are sources of nutrients and are rich in biodiversity. They also support rich brackish and marine fish stocks. Estuaries provide a variety of economic and ecosystem functions, including supporting aquaculture activities, facilitating navigation, providing fresh water, and recycling nutrients. Estuaries and their greenbelts also make an immense contribution to ecosystem resilience and protection from natural disasters, a benefit that has been unappreciated until recently.

Yet as rich and diverse as these ecosystems are, they are under considerable stress. Demographic pressures—more than 300 million people live in India's coastal areas—have had significant impacts, including the extension of settlements and industrial activities. Pollution is another significant issue. In spite of programmatic interventions on the part of the central and state governments to control point source pollution in coastal areas, the incidence of land-based pollution is very high in India's coastal areas.

Natural disasters have also played an important role in the dynamics of India's coastal zone. Following the December 2004 tsunami in the southern Indian Ocean, millions of people—mainly in small coastal communities—lost their livelihoods. However, in pockets where estuary management was sustainable, mangroves and reefs absorbed the onslaught of the tsunami. For instance, the mangroves in

the Pitchavaram and Muthupet regions of Tamil Nadu acted like a shield and bore the brunt of the tsunami. The impact was mitigated and lives and property of the communities in the region were saved.

Rehabilitation measures undertaken in the post-tsunami period in India included restoration of dwellings and capital assets of coastal communities, such as fishing boats and nets. However, in order to achieve their intended objective of enduring asset reconstruction, these measures need to be complemented by significant steps to restore the ecological capital of the affected areas—including mangroves and other wetlands.

Over the years, the gradual decline of community property resources denied coastal communities their traditional rights to shoreland resources such as small timber and husks (Damodaran 2005). This, in turn, reduced income diversification options for these communities. Until the 1980s, investment in coastal management in India was designed to secure higher efficiency in fishing operations. This changed in the early 1980s, when new coastal zone management guidelines took effect, putting brakes on development projects—such as energy-intensive fisheries and the construction of tourism amenities with unsustainable features. In addition, these coastal zone regulations placed restrictions on the use of shorelands for recreation purposes in the sensitive (and regulated) coastal zone closest to the high-tide line. A consequence of India's coastal zone regulations has been the favorable condition created for the takeover of critical mangrove and coral reef estuaries for conservation. Similarly, degraded shorelands have been restored through afforestation.

tion and conservation activities. The idea behind all these measures has been to optimize the ability of coastal zones to provide ecosystem services for local communities, resulting in improved livelihoods as well as incentives for better environmental stewardship.

Due to overlapping jurisdictions and mandates, public interventions in shore areas in the past have resulted in fragmented governance patterns that have denied shore communities the opportunity to optimize their livelihood options. Integrated coastal zone management principles, which include stakeholder consultation and conflict resolution, can help overcome fragmented governance and non-community-based systems of shoreland management, thus strengthening community empowerment. The ideal of sustainable livelihoods for coastal communities will bear fruit only under such circumstances.

In 2005, a high-level government committee chaired by the author comprehensively reviewed shore-zone regulations and suggested measures to reconcile the goals of development with that of conservation. The committee recommended integrated approaches to solving the problems of shore-zone ecosystems. The elements of integrated shore management included “area planning,” which is based on intergenerational equity, promotion of economic development, stewardship of resources for conserving biodiversity, conflict resolution, protection of public safety to meet natural hazards, and proprietorship of public submerged lands and waters in a manner that ensures economic returns to the public from government-held shore areas (Swaminathan and others 2004).

While the principles of integrated coastal zone management are sound, more needs to be done at the policy level to make it sustainable. There is a need for integrated environmental policies that capture environmental externalities and internalize them into development decision-making. Currently in India, for example, market-based instruments such as water fees are levied on industries to reduce unsustainable water consumption by industries. But these fees do not take into account wastewater generation and contamination of waterways. Coastal industries that discharge wastewater directly into nearby estuaries need to be assessed differently for their wastewater. Incentives for such industries—such as rebates for cleaner production processes—could be effective.

Valuing coastal resources and the ecosystem services they provide appropriately is essential to accurately calculating tradeoffs in investment decisions in the coastal zone. If coastal areas are protected based on their biodiversity and natural capital wealth and discount rates are set appropriately, cost-benefit analysis will be able to yield the right results for conservation causes. Such a system could also contribute to the emergence of a scheme of payments for ecosystem services rendered by estuaries. Still better would be a system of coastal resource valuation that captures option values that run the risk of not getting realized due to irreversible land use and habitat change in coastal areas due to development projects.

To sum up, the challenge before policy makers in India is enormous when it comes to capturing and valuing the ecosystem services provided by India’s coastal areas and estuaries. Integrated coastal zone management calls for a slew of measures involving resource valuation and guided investments, which need to be backed by economic instruments that are employed in creative ways. It is obvious that the biodiversity and livelihood significance of India’s coastal areas and estuaries is too important for these key habitats to be valued only for their real estate and recreational values.

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Marine Conservation

How Economic Valuation of Ecosystem Services Can Help

Marine ecosystem services are seriously undervalued, resulting in underinvestment in conservation and lost opportunities for economic growth and poverty reduction. Economic valuation provides stakeholders with a powerful tool for decision making by showing how dependent the economy is on an ecosystem and what would be lost if the ecosystem is not protected. When integrated with the national income accounts, economic valuation can help two distinct but equally important groups: (1) line ministries, the private sector, and civil society organizations directly involved in the use and management of the marine ecosystem and (2) agencies with responsibility at the macroeconomic level—like the Ministry of Finance—that control the national budget and make policies that indirectly affect the marine ecosystem. The former are often quite receptive to valuation studies, which can clearly help them with management. The latter have no direct responsibility for the marine ecosystem and must be convinced that they, too, have a stake in sustainable ecosystem management.

To engage decision makers at the macroeconomic level, we must demonstrate what their stake is. We do this by integrating ecosystem values with national income accounts to show the ecosystem's influence on the major indicators of macroeconomic performance, such as the contribution to GDP, employment, and the balance of payments. But it is not sufficient just to estimate values; the distribution of benefits is crucial both for sector-level managers and macroeconomists.

At the sectoral level, information about the distribution of benefits contributes to improved management. Countless studies have shown that incentives for sustainable management are strongest when benefits accrue to those who steward natural resources. At the macroeconomic level, policy makers in many countries have adopted development plans in which poverty reduction has joined the traditional macroeconomic goals of economic growth and stability. Valuation that shows the distribution of incomes from marine ecosystem services, especially the share accruing to poor communities, can

demonstrate to macroeconomists the role of sustainable marine ecosystem management in achieving poverty reduction goals.

The Earth Institute at Columbia University and the Institute of Marine Sciences, University of Dar Es Salaam, collaborated to apply this “environmental accounting” approach to the economic valuation of marine ecosystems in Zanzibar.

Economic Growth and Threats to the Marine Ecosystem

Zanzibar is a small, densely populated island archipelago off the coast of Tanzania with many endangered and rare species of corals, fish, seagrass, mangroves, and other flora and fauna. Its population of 1.1 million is highly dependent on the marine ecosystem, which accounts for 30 percent of GDP. But despite its clear economic importance, the marine ecosystem is seriously degraded due



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to both human and natural causes, including uncontrolled tourism development, rapid population growth, overfishing and destructive fishing practices, overharvesting of mangroves, dumping of untreated wastewater from urban areas, and periodic coral bleaching. Why has this happened?

Twenty-five years ago, local communities in Zanzibar were responsible for managing the marine ecosystem and received all the benefits. Harvesting of fish and other marine products was the only major marine activity. Since then, tourism has grown rapidly, largely to take advantage of the island's spectacular beaches and coral reefs and its rich cultural heritage, which merited designation as a World Heritage Site. From 1985 to 2007, Zanzibar's tourism-based economy experienced rapid growth—annual tourist arrivals increased from about 19,000 to 220,000. However, the impact of this growth on the marine environment was largely overlooked. Furthermore, local communities had little stake in the new economy.

We wanted to understand why degradation of the ecosystem occurred in Zanzibar and identify opportunities to promote marine conservation and sustainable development in the future. To do so, we explored the value of marine ecosystem services in the macroeconomy, how economic benefits are distributed among different stakeholders, and the incentives or disincentives this creates for marine conservation.

Marine Ecosystem Services and the Macroeconomy

Poverty is extensive in Zanzibar; roughly 50 percent of the population falls below the poverty line, and average per capita GDP was only \$415 in 2007. The major marine-based economic activities include tourism, fishing, seaweed farming, and mangrove harvesting. They account for 30 percent of GDP, 77 percent of investment, a large share of formal sector employment, and most of the nation's foreign exchange earn-

ings (see *Table*, below). Tourism is by far the most economically important marine ecosystem service, accounting for most of the income, foreign exchange, and investment. However, it does not generate very much employment—and many of those employed are non-Zanzibaris or Zanzibaris from outside the local communities where tourism activities are based.

There are several additional, but unpriced, marine ecosystem services. Education and research services are provided through several institutions of local, regional, and international significance. Critical regulating services include habitat for fisheries, wastewater assimilation, and control of beach erosion by seagrass beds and coral reefs. These nonmarket services are what economists call “indirect” ecosystem services because their economic value derives from their use as an input to something else that has direct economic value, such as fisheries or the viewing of coral reefs by tourists. The ecological information necessary for economic valuation is not currently available, but evidence from around the world indicates that these services have a high value.

TABLE Contribution of marine ecosystem services to the macroeconomy in Zanzibar, 2007

	GDP (income generated, thousand \$)	Share of GDP (%)	Foreign exchange earnings (thousand \$)	Employment	Share of investment, 2003–2007* (%)
Provisioning services					
Seaweed farming	1,663	0.4	2,397	16,422	
Fishing**	29,179	6.2		37,203	1
Mangrove harvesting	28			unknown	
Recreation and tourism services					
Total value	150,506	30.2	187,326	62,976 +	77
Other ecosystem services, nonmarket					
Education and Research			Value unknown, but likely to be significant		
Regulating services: Fisheries habitat, wastewater assimilation, shore protection			Value unknown but likely to be significant		

Notes: Blank indicates negligible or zero value.

*Cumulative value of investment projects approved by the Zanzibar Investment Promotion Authority.

**Only artisanal fishing is included here, not deep-sea fishing, which is licensed to foreign operators.

Source: Adapted from Lange and Jiddawi (forthcoming).

Who Benefits from Marine Ecosystem Services in Zanzibar?

Of the major economic activities based on the marine ecosystem, all but tourism deliver most of their benefits to local communities (see *Table*, below). Local communities receive only 20 percent of income from tourism, while 80 percent of income goes to stakeholders outside local communities: other Zanzibaris (13 percent), government (15 percent), and non-Zanzibaris (52 percent).

Commercial Seaweed Farming. Commercial seaweed farming was introduced in the late 1980s and now involves more than 16,000 farmers, mainly women. Seaweed provides carrageenan, a thickening and gelling agent used mainly in processed foods, dairy products, and other products such as toothpaste. The raw material is sold to a few companies for export—too little is grown

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to support local processing. Most farmers earn very little due to a combination of low global prices for seaweed and low farm productivity; even the exporters currently earn very little under current market conditions. The role of seaweed farming in economic development is controversial, but for many rural women it is still the only source of cash income.

Fishing. Fishing is mainly an inshore, artisanal operation involving about 34,000 fishers and another 3,000 people in the transport and marketing sectors. (Foreigners are licensed to fish offshore within the 200-mile EEZ.) Nearly half the vessels are dugout canoes; only 11 percent of boats are motorized. In 2007, the catch was nearly 26,000 tons, most sold without further processing in local markets. Overfishing and destructive fishing practices have contributed to the decline of Zanzibar's marine ecosystem. But in an environment of low incomes and rapid population growth in largely unregulated, open-access fisheries, there is insufficient incentive to change. Changing this behavior would require much greater involvement with—and income from—activities that depend on healthy coral reefs and fisheries.

Mangrove Harvesting. Mangrove harvesting is presently a minor activity because of the massive loss of mangrove forests, particularly on the main island of Unguja. Only an estimated 20,000 hectares of mangroves remain, mostly on Pemba.

Tourism. Tourism is by far the most important ecosystem service in terms of macroeconomic indicators. But the benefits of tourism mostly go to non-Zanzibaris rather than local communities. Furthermore, within the dominant segments of the tour-

TABLE Distribution of income from marine ecosystem services in Zanzibar, 2007 (thousand \$)

	Zanzibari beneficiaries			Non-Zanzibari beneficiaries	Total
	Local communities	Zanzibaris outside local communities	Government		
Provisioning services					
Seaweed farming	1,616		46		1,662
Fishing*	29,179				29,179
Mangrove harvesting	28				28
Recreation & Tourism services					
Total value	54,726	15,211	17,541	63,028	150,506
Other ecosystem services, nonmarket					
Education & research	X	XX	XX	XX	NA
Regulating services					
Fisheries habitat	XX	X	X	X	NA
Wastewater assimilation	XX	X	X	XX	NA
Shore protection	XX	X	X	XX	NA

Notes: Blank indicates zero or negligible value.

NA: not available

*Only artisanal fishing is included here, not deep-sea fishing, which is licensed to foreign operators.

"X" indicates the relative importance of service to the stakeholder group for services that cannot be precisely valued. "XX" is greater than "X."

Source: Adapted from Lange and Jiddawi (forthcoming).

ism industry—all-inclusive, “club” tourism, and large, up-market tourism—economic incentives for marine conservation are not strong. Many of these tourists go for boat rides or spice-farm tours, or simply enjoy the beach, but do not participate as much as other tourists in activities like snorkeling or diving, where the health of coral reefs and fisheries is essential. The government obtains much of its revenue from these segments of the tourism industry, so it also has less incentive to make marine conservation a priority. By contrast, tourists in the small, up-market segment participate the most in diving and snorkeling and have the highest average daily spending, but constitute the smallest segment of the tourist market.

Nonmarket Ecosystem Services. Nonmarket ecosystem services have not been valued, but it is possible to rank the benefits received by different stakeholders. All stakeholders benefit, but local communities—whose livelihoods from fishing, seaweed farming, and tourism depend most heavily on these services—benefit the most.

Conclusions and Recommendations

Unless there are shared incentives for sustainable management, the future of Zanzibar’s marine ecosystem is not promising. Greater local participation in the tourism economy will help, but only if tourism policy favors ecotourism, which has the greatest

stake in marine conservation. Increased productivity in seaweed farming and reduced losses from fishing can help increase local incomes, but large increases in income will only come from tourism. Initiatives to increase the provision of local goods to hotels and restaurants will help. Greater participation in tourism will require improvements in education. The development of high-end tourism will require substantial improvements in infrastructure.

Zanzibar, like many countries, has set a goal for tourism development in terms of a target number of annual visitors. A better approach would be to set a target revenue stream and promote the kind of tourism that meets that target with the least impact on the environment and most benefit for society. On Unguja, Zanzibar’s main island, it may be too late because of the large number of big hotels already built. But it is possible to reconsider policy for Pemba, a relatively pristine island with great ecotourism potential.

The institutional challenge, common to most countries, is the fragmentation of decision making and management; no single agency has responsibility for all activities affecting the marine ecosystem. Comprehensive economic valuation can help overcome fragmentation and build a broad, cross-sectoral alliance of stakeholders by quantifying the common interests and mutual dependence of different stakeholders, and providing a scientific basis for assessing trade-offs among options for development.

Policy makers worldwide increasingly recognize the importance of economic valuation, but several aspects critical for policy have often been neglected, such as (a) bringing natural capital into the national income accounts in order to involve stakeholders both at the sectoral and macroeconomic levels; (b) analyzing the distribution of economic benefits to understand the incentives and disincentives for sustainable management; and (c) accurately valuing the nonmarket, regulating ecosystem services that underpin the marine economy. To promote marine conservation, we need (a) a global database of economic valuation studies of marine ecosystems that can be used by governments, communities, the private sector, and other stakeholders in development planning; (b) more training of local environmental economists to carry out economic valuation studies; (c) increased dialogue among stakeholders (scientists, local users and managers of ecosystems, governments, private sector, NGOs) to understand how to interpret and best use valuation studies; and (d) increased collaboration between economists and natural scientists to provide accurate, policy-relevant valuation of indirect ecosystem services like habitat provision and storm protection.

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Can Payments for Environmental Services Help Protect Coastal and Marine Areas?

In recent years, considerable efforts have been devoted in many countries to developing systems of payments for environmental services (PES). The PES approach has been developed to address the classic problem of environmental externalities; that is, many of the benefits that an ecosystem provides, and the costs resulting from the loss of those ecosystem services, do not affect those who make decisions about how that ecosystem should be managed. As a result, they have little or no incentive to take these offsite benefits into account when they make their management decisions, and thus these benefits are often degraded or lost. For example, farmers stand to receive the benefits of the crops they can cultivate if they clear forest for cultivation but do not suffer from the ensuing increased erosion. Downstream water users suffer from the impact of erosion but have no say in how the upstream ecosystems are managed. Under the PES approach, those who benefit from a particular ecosystem service compensate those who manage the ecosystem in such a way that it provides the desired service.

PES is a market-based approach to conservation financing based on the twin principles

that those who benefit from environmental services (such as users of clean water) should pay for them, and that those who contribute to generating these services (such as upstream land users) should be compensated for providing them. The approach thus seeks to create mechanisms to arrange for transactions between service users and service providers that are in both parties' interests, internalizing what would otherwise be an externality. The PES approach is attractive in that it (a) generates new financing, which would not otherwise be available for conservation; (b) is likely to be sustainable, as it depends on the mutual self-interest of service users and providers and not on the whims of government or donor financing; and (c) is likely to be efficient, in that it conserves services whose benefits exceed the cost of providing them and does not conserve services when the opposite is true.

Experience with PES

There has been considerable interest in the use of PES throughout the world. Interest has been especially high in Central and

South America, where the effects of Hurricane Mitch in 1998 underscored the dependence of the population, especially poor people, on environmental services and the protection provided by natural ecosystems.

A few developing countries have established nationwide PES programs. Costa Rica's PES program, operated by the National Fund for Forest Financing (FONAFIFO), is the oldest. Under the 1997 Forestry Law, land users can receive payments for specified land uses, including new plantations, sustainable logging, and conservation of natural forests. Costa Rica's PES program currently protects about 250,000 hectares of forest. Mexico created a similar program in 2003, administered by the National Forest Commission (CONAFOR), which currently protects about 2 million hectares of forest. Ecuador recently announced a plan to establish a similar payment program, Socio Bosque. In China, the Sloping Lands Conversion Program (also known as "grain for green") pays farmers to reforest erosion-prone lands, with a goal of protecting over 14 million hectares by 2010.

The vast majority of PES initiatives, however, have been for smaller-scale initiatives



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at the scale of individual watersheds. Service users paying for watershed conservation include many municipal water supply systems (ranging in size from that serving Quito, the capital of Ecuador, to those serving small rural townships), hydroelectric power producers, irrigated agriculture, and industrial users. Although these initiatives cover much smaller areas, they tend to be much more efficient than the larger, government-financed programs.

There has also been considerable use of the PES approach to sequester carbon, with buyers seeking emissions reduction credits—necessary to satisfy obligations under national laws or the Kyoto Protocol—by paying for reforestation or afforestation activities in developing countries. There is also an active voluntary (“retail”) market for sale of carbon emission reductions to individuals or firms wishing to reduce their carbon footprint. Negotiations are under way to expand eligible activities under the Reduced Emissions from Deforestation and forest Degradation (REDD) approach.

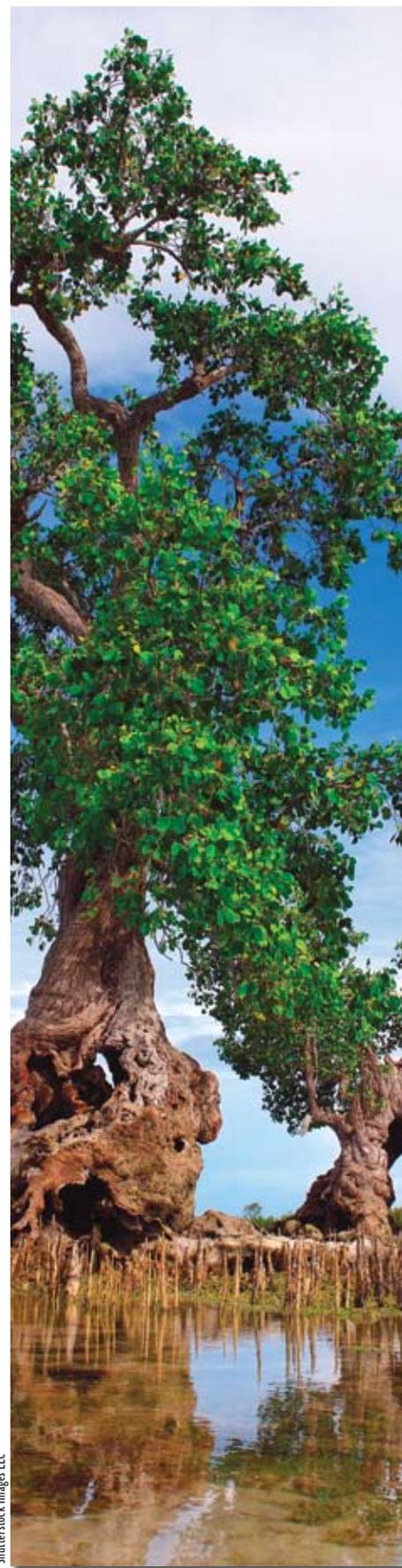
The World Bank has been active in supporting its client countries in implementing

PES programs. Several projects supporting both national and watershed-scale PES programs are under implementation, and others are under preparation. The World Bank has also played a pioneering role in helping develop carbon markets for ecosystems, initially through its BioCarbon Fund. The Forest Carbon Partnership Facility, launched in late 2007, will play a similar role for REDD markets.

PES in Coastal and Marine Ecosystems

Throughout the world, coastal and marine ecosystems and the valuable environmental services they provide are under severe threat. The causes of this degradation are often very similar to those facing terrestrial ecosystems: many of the benefits of coastal and marine ecosystems are not received by those who manage them, but by others. Both mangroves and coral reefs, for example, play very important roles in the lifecycles of many commercially important fish. These fish, however, are often caught at some distance from the mangroves and reefs. Thus the benefits of these ecosystems are enjoyed by faraway fishers, not by those who directly manage them. The latter thus have limited incentives to protect these ecosystems. In principle, it therefore seems that PES could help protect these ecosystems. To date, however, no PES programs have been implemented for coastal and marine ecosystems.

Before examining the challenges to implementing a PES approach for coastal and marine ecosystems, it is important to bear in mind that not all problems are amenable to PES as a solution. When coral reefs are degraded by cyanide or dynamite fishing, for example, the problem is not primarily one of externalities but of open access—the “tragedy of the commons.” Fishers use these



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techniques to capture, easily and cheaply, some of the direct benefits of reefs. They may be well aware that their efforts are damaging the reef but have no incentive to modify their behavior because others might step in their place. A PES approach would not be applicable to these cases, as there would be no limit to the number of potential claimants. A minimal level of tenure security is necessary before PES can be used. Likewise, the threat to reefs caused by rising temperatures resulting from global climate change cannot be addressed with PES. Only mitigating global climate change will help.

In many cases, coastal and marine ecosystems provide valuable on-site benefits in addition to whatever off-site benefits they might gen-

erate. In such cases, the most practical solution is to seek to generate revenues from those on-site benefits through direct user fees rather than through PES. On-site benefits are generally much easier to charge for, because direct access to the site is necessary to enjoy on-site benefits. This makes entry fees for marine protected areas, for example, a viable financing mechanism whenever access can be controlled. Even voluntary entry fees have sometimes proved successful. The revenue generated by a voluntary fee program instituted by the Cancun Marine Park, for example, was enough to double its operating budget. This approach has already been applied successfully in many reef areas. It obviously has its limits, however, as not all reefs can attract a sufficient number of

tourists. Moreover, such direct uses must be carefully managed to avoid damaging the very asset they depend on.

Emerging lessons from the application of PES in watersheds and for carbon sequestration suggest the steps that would be needed to implement PES programs in coastal and marine areas. The first step is to clearly identify the services that the ecosystem is providing and the users of those services. To the extent possible, it is useful to quantify the service levels that users receive, and how they would change if the ecosystem were degraded. The second step is to develop ways to charge service users. Ideally, service users would be charged directly, but in some cases this is impossible or impractical. In these



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cases, it then becomes necessary for the government or another third party to step in. This should generally be a last resort, however, as many of the advantages of PES may be lost. The third step is to develop payment systems that reach ecosystem managers and induce them to change their behavior in the desired way. Finally, institutions must be established to implement the mechanism. Of these steps, the first and second usually prove to be the biggest hurdles; this is likely to be true for coastal and marine ecosystems as well.

Identifying and quantifying the specific services that ecosystems provide, and how they would be affected by ecosystem degradation, is a critical first step. It is difficult to induce people to pay for a service if that service and the benefits it brings them are not clearly defined. In a watershed context, experience shows that it is better to begin with a problem affecting specific service users (such as dirty water) and then trace it back to its source (degradation in a watershed). But what works in the unidirectional world of waterflows may not be as effective in the context of coastal and marine ecosystems. There may thus be little alternative to inventorying the services that a particular coastal or marine ecosystem provides, and then trying to determine whether its degradation would affect a specific group of users. Both qualitatively and, especially, quantitatively, we are likely to find that we know much less about the environmental services generated by different kinds of land uses than we often think we do. That mangroves contribute to fisheries, for example, has long been known, but there has been limited documentation of the magnitude of this link. Some efforts have been made in this direction, however. For example, recent work has demonstrated that mangroves are responsible for about one-third of landings (by volume) by small-scale fisheries in the Gulf of California. More such work is needed to clearly identify how coastal and marine ecosystems contribute to specific economic activities. This work can

be based on either a close understanding of the ecology of the ecosystems concerned or through statistical analysis, as in the case of the Gulf of California research.

Documenting the link between ecosystems and their users is only the first step, however. Turning this link into a flow of payments is the second major hurdle. The situation in the Gulf of California illustrates this challenge. The fisheries involved are mainly small-scale, artisanal fisheries. The main problem in getting them to pay for the services they receive from mangroves is not, as is commonly supposed, that these fishers have relatively low income levels. If the mangroves collapsed, their income levels would be even lower. They would be better off with the mangroves, even if they had to pay for their conservation, than they would be without the mangroves and without the cost of conservation. There are many examples throughout the world of even poor communities paying for conservation through PES because the alternative would be even worse. Rather, the main obstacle to the fishers paying for mangrove conservation is that the fisheries industry is too fragmented, with a large number of individual fishers. This creates a collective action problem, in which even though fishers as a group have a strong incentive to pay for conservation, every individual fisher has the incentive to try to avoid paying, as they would then get the benefit of that conservation without bearing any of the costs. In such cases, intervention by some governing body might be required to overcome the collective action problem. This could take the form of a fee imposed on the relevant users (on the fishers, in this case) by the government, with the revenue being used for conservation. While this would be better than nothing, it would lack the efficiency advantages of voluntary payments by users. Both the amounts and the use of these payments would be determined by political processes rather than by the users acting in their own self-interest. Many countries, for example, assess water fees to

fund watershed conservation, yet irrigation is almost universally exempted from paying these fees despite being the largest single water user.

There are thus considerable challenges to the use of PES to safeguard coastal and marine ecosystems—particularly for user-financed PES programs. These are likely to be greater than for many other ecosystems, because the very nature of coastal and marine ecosystems makes cause-and-effect relationships between ecosystem condition and the services provided harder to establish and because the actors involved are more often numerous and dispersed, leading to significant collective action problems. Harder does not mean impossible, however. The low-hanging fruit are likely to be cases in which the benefits provided are relatively short-range, such as coastal protection, so that cause-and-effect relationships are relatively easy to assess and the number of actors involved is limited. Outside such cases, the use of PES may be limited to government-financed programs. There is a strong rationale for the use of public funding (whether from the general budget or from earmarked fees) to protect valuable ecosystems, but such efforts are dependent on the existence of sufficient political will. Moreover, in such cases the efficiency and sustainability benefits of PES will be harder to reach.

For Further Reading

See the special issue of *Ecological Economics* on Payments for Environmental Services (Vol. 65, No. 4, May 2008).

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Improved Governance of Marine Fisheries Can Recover up to \$50 Billion Annually

Poor fisheries management—including overfishing and oversized fleets—means that the annual economic benefits from global marine fisheries are \$50 billion less than they could be. Over the last three decades, the cumulative loss totals over \$2.2 trillion.

The Sunken Billions: The Economic Justification for Fisheries Reform, a report produced by the World Bank and the Food and Agriculture Organization of the United Nations (FAO), argues that well-managed marine fisheries could turn most of these losses into sustainable economic benefits for millions of fishers and coastal communities.

Marine fishing operations are only part of the \$400 billion global seafood industry, but economically healthy catch operations underpin the sustainability of supply and profitability of onshore activities, which are a major source of employment in developing countries. For each person working at sea, it is estimated that another three are employed in processing, distribution, and other onshore activities. All told, such activities provide livelihoods for over 200 million people; 90 percent of these people are

in developing countries and over half are women.

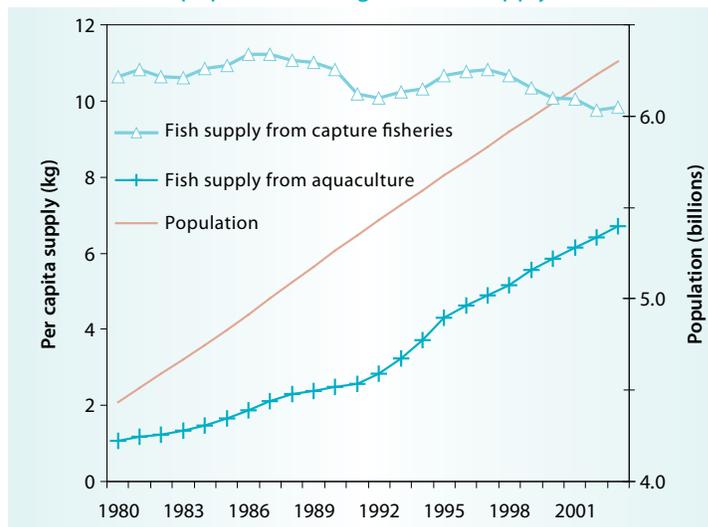
The Economic Losses

Increasingly over the last several decades, catching operations—the foundation of the industry—have become less economically efficient. The bulk of economic losses occur in two main ways. First, depleted fish stocks—more than 75 percent of the world’s fish stocks are “underperforming assets,” according to FAO—mean that there are fewer fish to catch, and therefore the cost of finding and catching them is greater than it might be (see *Figure*, at right). Second, fleet overcapacity means that the economic benefits of fishing are

dissipated due to redundant investment and operating costs.

Other factors also play a role. For example, the loss of fishery habitat, pollution, rising sea temperatures, and the increasing acidity of the oceans are placing additional stress on already stressed ecosystems. Illegal fishing and unreported catches undermine fishery science, while subsidies continue to support unsustainable fishing practices.

FIGURE World population and global fish supply, 1970–2003



Source: FAO FishStat Plus; World Bank 2006.



P. Jørgensen/World Bank Photo Library

fish resources result in stagnant productivity and economic inefficiency (see *Figure*, below). In response to the decline in physical productivity, the global fleet has attempted to maintain profitability by reducing labor costs, lobbying for subsidies, and through increased investment in technology.

Right now, no one is winning. The real income levels of fishers are depressed, much of the industry is unprofitable, fish stocks are depleted, and other sectors of the economy foot the bill for an ailing fishing industry.

Recovering the Sunken Billions

Growing pressures from climate change further reinforce the arguments for concerted national and international actions to rebuild fish wealth, while the heavy carbon footprint of some fisheries adds to the justification for fisheries reform.

This and previous studies highlight the massive overcapacity in the global fishing fleet: the current catch could be achieved with roughly half the current global fishing effort. These excess fleets competing for limited

The recovery of the “sunken billions” can take place through two main approaches. First, a reduction in fishing effort would increase productivity, profitability, and net economic benefits. Second, rebuilding fish stocks would lead to increased sustainable yields and lower fishing costs.

At the same time, strengthened fishing rights can provide fishers and fishing communities with incentives to harvest responsibly and efficiently. Phasing out subsidies will

improve efficiency. Greater transparency in the allocation of fish resources and greater public accountability for the health of fish stocks will help private initiatives to certify sustainable fisheries.

Reforms also will require investments in good governance, including measures to reduce illegal fishing and subsidies. In particular, subsidies for fuel and for investment in fishing vessels and fishing gear have contributed to the decline in catch-per-fisher and catch-per-vessel. Over \$10 billion in subsidies that directly impact fishing capacity and foster overfishing were provided in 2000. Close to 80 percent of the total global subsidy is provided by developed countries. Regular public reporting on the state of national fish stocks and their contribution to national wealth would also promote accountability and good governance.

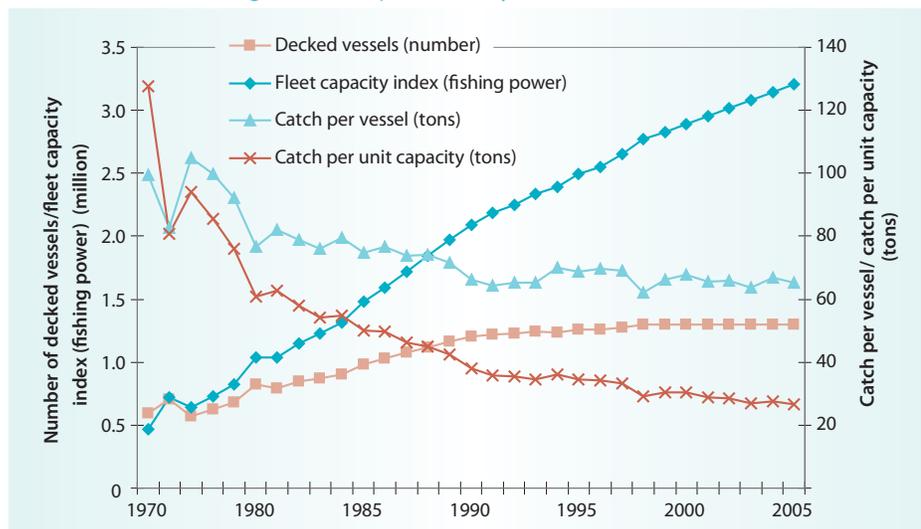
Fisheries reform requires broad-based political will founded on a social consensus. Social safety nets and the creation of alternative livelihoods can be an important element of reform. These reforms can be integrated with poverty reduction programs and other instruments of economic and social development.

The alternative to reform—business as usual—is a continued decline in global fish wealth, increasingly inefficient harvest operations, growing poverty in fishery-dependent communities, increased risks of fishery stock collapses, and increasingly compromised marine ecosystems. In short, sustainable fisheries require political will to replace incentives for overfishing with incentives for responsible stewardship. It is not just about boats and fish.

The Sunken Billions was supported by PROFISH, a World Bank partnership focused on policy initiatives for sustainable fisheries. www.worldbank.org/sunkenbillions

This article was prepared by Kieran Kelleher (kkelleher@worldbank.org) of the Agriculture and Rural Development Department. AGR website: www.worldbank.org/fish.

FIGURE Evolution of global fleet productivity (decked vessels)



Source: Authors' calculations; Garcia and Newton 1997; FAO FishStat Plus; FAO FIEP.



The Consequences of Climate-Induced Coral Loss in the Caribbean by 2050–80

Coral reefs support more than 25 percent of all marine species, making them the most biologically diverse of marine ecosystems and an equivalent, in terms of biomass productivity, to rain forests on land ecosystems. Corals have been around for hundreds of million years and have evolved over time to adjust to relatively stable environmental conditions in tropical seas, defined through a narrow range of temperatures, salinity, and pH. Because of their stable environment, most corals are also very sensitive to changes in environmental parameters. When stressed by rising temperatures, corals can lose their symbiotic arrangements to conduct photosynthesis, leading to their bleaching and eventual death. Increased carbon dioxide concentrations in the atmosphere also lead to more acidic seas, which impairs the ability of corals to assimilate carbonates and calcify. Corals also play very important roles for other species by providing the habitat for spawning of many life forms and protection and mechanical support for other plants and animals.

Gradual and consistent increases in sea surface temperatures have yielded increasingly

frequent bleaching events (1993, 1998, 2005), the latest of which caused wide bleaching throughout the Caribbean region. The extended coral mortality caused during such events may be only partially recovered over time, provided that no subsequent bleaching takes place. More than one bleaching event over a short time frame can be devastating. Under conditions anticipated by the IPCC, during the current century temperatures in the Caribbean may reach threshold values that would lead to a collapse of the coral biome.

A coral collapse is anticipated to have major impacts on fisheries, tourism, coastal protection, and ecosystem integrity. It will cause severe losses in biodiversity and species. Appropriate monetization of these impacts is not easy. Among these impacts, the loss of species and ecosystem integrity are the most difficult to evaluate, yet they may represent the most important of the consequences. Of the more than 700 species of reef-building corals worldwide, one-third are already threatened with extinction. In the Caribbean, it is estimated that 60 to 70 endemic species of corals are in danger. Extinction risks are increasing due to more

frequent bleaching events experienced in recent years and expected in the future due to climate change. The cost of reducing the vulnerability of corals to bleaching and accelerating the recovery of affected populations through artificial means is likely to be very large, yet it remains unassessed.

Modeling Climate-Induced Coral Bleaching in the Caribbean

While a lot has been learned from recent bleaching events in the Caribbean, there is still a great deal of uncertainty as to the specific responses, at a specific coral-reef level, to a warmer future. For conservation and preservation planning, it is particularly important to appraise the timing and intensity of coral mortality under currently projected scenarios of climate change in the Caribbean. The Coral Mortality and Bleaching Output (COMBO) model can be used to assess the prospects of coral bleaching and



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mortality in the region. COMBO models the response of coral growth to changes in sea surface temperature, atmospheric CO₂ concentrations, and high-temperature-related bleaching events. The model has been described in detail elsewhere (Buddemeier and others 2008).

The A1B (IPCC) scenario—which considered a temperature increase of +2°C as a response to a doubling of CO₂ concentration over pre-industrial levels—suggests that the effects of both warm seas and severe high-temperature episodes could likely lead to the mortality of all corals in the area between 2060 and 2070.

Estimation of the Damage of Coral Loss

What are the consequences of the collapse of the coral reef biome in the Caribbean? Traditional economic theory considers that all benefits provided by any species are received by human beings. However, this does not consider benefits accrued by other

species. In this analysis, we estimate (a) the direct economic losses associated with coral degradation reflected in lost economic returns (such as fisheries, tourism activity, coastal protection); (b) the indirect economic losses, which would only indirectly result in losses to humans (loss of ecosystem integrity caused by coral collapse); (c) the losses of non-use value; and (d) the loss of intrinsic value. This component does not follow traditional economic theory, but we have made an effort to document it with examples. The four terms are reflected in the following expression:

$$L \text{ (value of corals lost)} = L_{\text{direct}} + L_{\text{indirect}} + L_{\text{non-use}} + L_{\text{intrinsic}}$$

(a) *L_{direct}* (direct use losses). In order to have a rough estimate of the direct value of lost economic services, we estimated annual losses of economic services for coastal protection, tourism, fisheries, and pharmaceutical uses in a setting of 50 percent and 90 percent coral reef mortality (see *Table*, below). Simulations done suggest that 50 percent coral reef mortality could be expected as soon as by 2040, and 90 percent mortality by 2060, under the A1B climate change scenario.

These estimates are very sensitive to the data and assumptions, because valuation is affected by many variables in specific circumstances and uncertainties.

(b) *L_{indirect}* (indirect use value). This is the value of the lost services that are of no

direct use to the human species. This value results in goods and services that are not tradable in markets and are unpriced. Given the importance of assessing the relative economic worth of these goods or services using nonmarket valuation techniques, economics has developed a range of valuation techniques for assessing the economic value of biodiversity and ecosystems.

Some economists have alluded to the concept that the web of life provides an overall integrity to the global biosphere on which all species depend. They consider that the services directly and indirectly provided by natural ecosystems are essential to maintain human activity and the integrity of Earth and thus should be credited accordingly.

Alternatively, one can credit all of the services provided by other species that depend on or benefit from corals that, in the end, are of direct economic value to us. For example, one would account for the income generated by the tourism industry at turtle nesting sites for species that forage in coral reefs, and the increase in productivity of habitats adjacent to coral reefs as a result of this connectivity, which ultimately results in the sustenance of species that may be of human use. The list may be endless, limited only by lack of information on the linkages between ecosystems.

(c) *L_{non-use}* (option and non-use value). This reflects the economic cost of species loss. This could also be assessed through the proxy of the willingness to pay to main-

TABLE Annual losses of economic services of Caribbean coral reefs (*L_{direct}*) in 2040 and 2060 (2008 \$ million)

	50% of corals in Caribbean lost by 2040		90% of corals in Caribbean lost by 2060	
	Low estimates	High estimates	Low estimates	High estimates
Coastal protection	438	1,376	788	2,476
Tourism	541	1,313	973	2,363
Fisheries	195	319	351	574
Pharmaceutical uses	3,651	3,651	6,571	6,571
Total	4,825	6,659	8,683	11,984

Source: Authors' data.



tain the species for reasons that exclude its direct or indirect economic value (such as fishery income, tourism income). However, these estimates also have limitations in capturing the true value of coral biodiversity, just like other valuation approaches. Other economic agents willing to contribute to biodiversity conservation (governments, donors, philanthropic foundations, environmental NGOs, general public) were not consulted, making this willingness to pay exercise a lower bound estimate.

(d) *Lintrinsic (intrinsic value of lost coral)*. This value relates to the issue of the intrinsic value of corals as repositories of unique genetic information. Again, there is no consensus on how best to assess their value from an economic perspective.

Our review of the consequences of coral loss in the Caribbean highlights the lack of economic tools for appraisal and the existence of only partial assessments of the value of corals. There is a need for improvement of scientific knowledge about complicated direct and indirect linkages of coral reefs with other species, the integrity of ecosystems,

and the economic evaluation of coral reefs. In particular, valuations of indirect and non-use values are currently beyond the scope of adequate quantification by traditional economic tools, but they remain significant. This is partly due to current limited scientific knowledge in this regard to support such valuations.

Direct coral loss, as shown above, can have significant economic impacts. However, it is an estimate limited to direct services provided by corals. There are many other valuable functions of coral reefs, including some we do not yet fully understand, such as their relationship to offshore ocean environments, which are not amenable to economic valuation. The extinction of an entire ecosystem as biologically diverse and productive as coral reefs is difficult to contemplate—yet this is what is predicted, not just in the Caribbean but on a global scale, if CO₂ concentrations are allowed to exceed 450 ppm. Calculating this loss to society and the planet in purely economic terms greatly underestimates its impact and undermines the urgent case for reducing GHG emissions and conserving coral reefs throughout their distribution.

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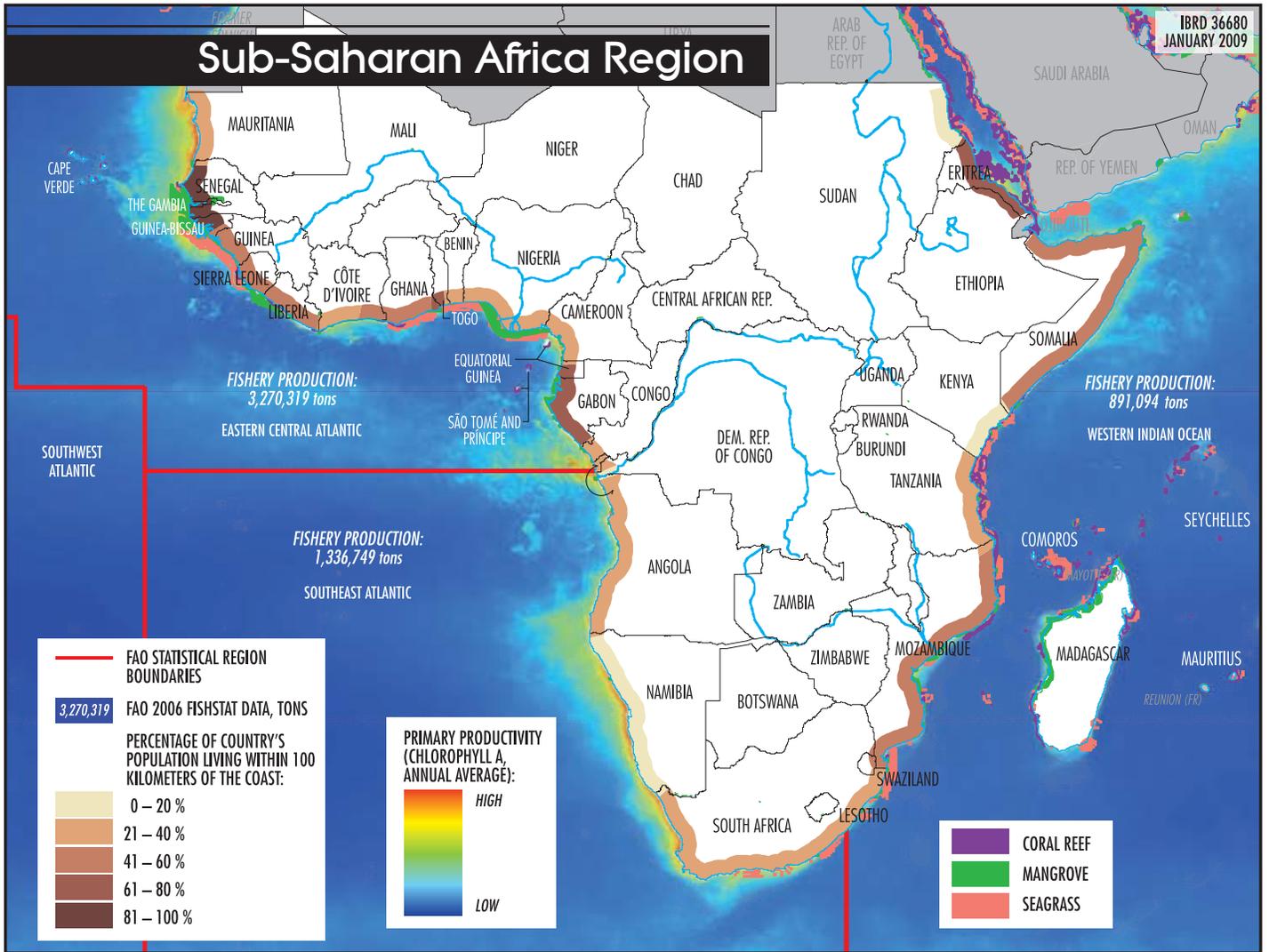
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The Importance of Africa's Coastal and Marine Ecosystems

Sub-Saharan Africa is endowed with a variety of coastal ecosystems—such as estuaries, coral reefs, mangrove forests, wetlands, and dunes—that provide critical services to numerous coastal communities and to national economies. Those benefits include coastal stabilization from severe weather and sea level rise, regulation of water quality and quantity, biodiversity, and spawning habitat for many aquatic species.

More specifically, a wide continental shelf that benefits from a strong upwelling current along the northwest coast of Africa (Mauritania and Senegal) supports some of the richest fishing grounds in the world. Further south, the West and Central African coasts are naturally forested by mangrove species, with coastal waters that are very rich in demersal and pelagic fish populations. The southern and eastern coasts of the continent, including Madagascar and the archipelagos of Comoros, are characterized by a wide distribution

of coral reefs and mangrove forests. Lastly, the northeastern coast along the Red Sea is characterized by coral reefs and high biodiversity, which also support rich fisheries. These coastal ecosystems, when maintained, host high levels of biodiversity and provide habitat for the reproduction of a wide range of fish and invertebrate species that coastal communities harvest for their livelihoods.

Throughout Africa, rural coastal fishing communities—which are directly dependent on the services provided by these coastal and marine ecosystems—are often poor, vulnerable, and likely to suffer most from environmental change. As there are often few livelihood alternatives in such communities, more sustainably managed marine resources can be a significant factor in poverty reduction and shared growth. More specifically, fish resources provide livelihoods and contribute to food security. Fisheries provide employment for up to 10 million people in Africa, often in labor-intensive, small-scale fisheries that include both subsistence and commercial activities for people involved in harvesting, selling, and processing of fish products. In Senegal, for example, the sector provides employment

for some 17 percent of the active workforce. In terms of food security, fish provide up to 70 percent of the daily animal protein intake in some coastal countries in Africa. In addition, the fisheries sector generates foreign exchange and public revenues for countries. The value of net exports of fish products for the continent reached the equivalent of \$2.4 billion in 2005, exceeding the net foreign exchange income reported for any other agricultural commodity. Furthermore, in Mauritania or Guinea-Bissau, the marine fisheries sector contributes 25 to 30 percent of government budgetary receipts.

Coastal and Marine Ecosystems and Resources at Risk

Following a common pattern around the world, Africa's growing population in coastal areas and global demand for fish, along with increased availability of fishing technology in an environment of open or poorly regulated access to the resources, have driven widespread overfishing and degradation of supporting ecosystems. The result has been a loss for the coastal and marine environment, for local livelihoods, and for African economies. Capture from marine fisheries in the continent seems to have reached a plateau in

the early 1990s and declined in some areas since then. This, combined with an increase in global demand for fish products, has made fish less affordable for poorer people. Over the past 20 years, per capita fish consumption in Sub-Saharan Africa has declined. For instance, Senegalese fishers increasingly work off Guinea-Bissau and Mauritania as a result of the depletion of demersal fish stocks, and 40 percent of Senegal's fish exports actually come from foreign waters.

The overwhelming cause of overfishing in African waters is the lack of appropriate governance and management frameworks to control the use of fish resources and restrict access to this public good. Access to these resources is often open to all, leading to increasing overcapitalization and excessive fishing pressure, given the strong price signals from the global marketplace for food fish. Many countries in the region have not been able to build the capacity necessary to sustainably manage the resource base of the fisheries or to prevent illegal fishers from taking the resources.

In addition to overfishing, risks to coastal habitats and marine resources from climate change are increasing and significant. These risks include modifications to surface water temperatures, rising sea level, and changes in

precipitation and water availability. These potential environmental changes will have an impact on natural systems, such as altering the health of coral reef and mangrove forests, and thus fish productivity around them. Direct resource users may find it more difficult to catch the fish resources they traditionally harvest and may have to find ways to adapt to maintain their livelihoods. To date, efforts to conserve the health of marine and coastal ecosystems as a buffer against such climatic changes have been shown to be the most effective adaptation strategy for communities.

Valuing Africa's Coastal and Marine Ecosystems

Despite the importance of these ecosystems and resources to livelihoods and economic growth in most coastal countries in Africa, World Bank investments in this area are still relatively small, and often dependent on Global Environment Facility (GEF) cofinancing. The World Bank is currently supporting operations in Senegal, Tanzania, and Guinea-Bissau aimed at protecting coastal and marine ecosystems and fish resources. Senegal is implementing the Integrated Coastal and Marine Resources Management Proj-





R. Nardello

ect (GIRMaC), totaling \$15 million in IDA and GEF funds to support the protection of coastal ecosystems and the introduction of comanagement of coastal fisheries in the central region (see *Box*, below). Tanzania is implementing a Marine and Coastal Environment Management Project (MACEMP) totaling \$60 million (IDA/GEF, primarily IDA); it involves management of industrial as well as small-scale fisheries through an integrated coastal management framework. Guinea-Bissau is implementing the Coastal and Biodiversity Management Project (CBMP) totaling \$8 million in IDA and GEF funds, which includes support for marine, coastal, and terrestrial protected areas. The Bank also is executing GEF grants to support their management in Namibia and regionally in the Southwest Indian Ocean. It

is implementing the South-Western Indian Ocean Fisheries Project (\$15 million), a regional program aimed at improving information available to regional fisheries organizations through stock assessment and other vital oceanographic information.

The benefits and services these ecosystems and resources provide to coastal countries, and their potential to make a much greater contribution to shared economic growth if more sustainably managed, have not often been appreciated. For example, recent estimates show that West African countries may lose the equivalent of roughly \$400 million per year just to illegal fishing without including the further potential losses resulting from poor management and overexploitation of the fisheries.

Potential Economic Benefits of Marine Resources

The case for ramping up investments is becoming stronger as a better understanding of costs and benefits emerges. For example, economists calculate the most profitable levels of fishing—and those that generate the greatest wealth for a country—are actually at levels of capture and fishing effort below the maximum harvest levels that are biologically sustainable. A win-win situation for economic and environmental sustainability can be created by promoting fishing effort at levels below the biologically maximum sustainable yield and by regulating access to

Comanagement — Empowering Users to Better Manage Coastal and Marine Ecosystems and Resources

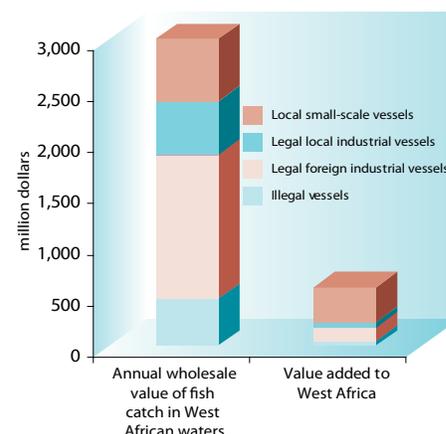
The comanagement of fisheries is an approach that decentralizes natural resource management responsibility to direct users. It is a management instrument that engages and empowers local resource users in partnership with government to manage marine resources in a way that generates sustainable returns. The approach encourages local fishing communities to reduce their fishing effort by adopting better fishing practices such as nets with bigger mesh size, adopting biological rest by temporarily restricting fishing access to certain areas, or abandoning predatory fishing practices such as dynamite fishing, which allows some fish catch but essentially destroys unwanted species and habitats. Reduction of pressure from local users can be achieved with appropriate incentives and regulations, along with acceptable livelihood diversification compensation and opportunities, including microfinance and training available for communities to engage in value-added processing, better access to markets, sustainable aquaculture, or small- and medium-size enterprises outside the sector. These methods can increase local revenues by allowing local fishers to fish less and produce and market their products better, while at the same time permitting renewal of stocks with less fishing pressure and improved habitat protection.

The West Africa Regional Fisheries Project

An estimated \$3 billion worth of fish is captured from the marine waters of West Africa every year, but most of that value is taken by foreign nations and illegal fishing vessels, while the fish stocks are becoming more and more depleted due to overexploitation and poor governance. The estimated annual wholesale value of what is caught in West African waters vs. the actual value these fish products add to the region's economy shows a striking difference (see histogram). Essentially, of the estimated total capture in West African waters, an estimated 15 percent is stolen by illegal or pirate vessels and almost another 50 percent is taken by legal foreign vessels, both of which provide less than \$200 million in local value-added to the region. In total, this \$3 billion only provides some \$571 million in local value-added to the region, almost all of which comes from local small-scale fisheries.

Many countries are also losing a large portion of the fish in their waters because large numbers of foreign vessels "mine" fishery resources and move on, without obtaining legal permits to gain access to the fisheries or ever landing their catch in the region, providing little value to the countries. For example, a study carried out in 2006 showed that of 92 trawlers spotted off the coast of Guinea, 1 in 10 had neither a flag nor a name, almost a third had no license, and close to half were fishing illegally at some time. With significant sector reforms, investments in local infrastructure, and more private sector investments, the offshore economy can slowly start to come onshore, increasing the value that the resources bring to the countries.

The aim of the West Africa Regional Fisheries Project (\$90 million IDA/GEF), which is currently under preparation, is to help the countries to sustainably generate more wealth from these fish resources and to capture a greater portion of that wealth by reducing illegal fishing, strengthening the governance and management of the sector, and supporting reforms and increased investment in local value-added.



fish stocks through the creation and allocation of fishing rights within a limit of total allowable catch to communities and users. This could be done through a transparent and equitable process that eliminates excess capacity and improves benefit sharing, in addition to efforts to protect critical habitats that affect fisheries' productivity. The problem is that many fisheries have already far exceeded these levels, so that often drastic reductions in fishing effort and capacity are required, along with strengthening governance to prevent illegal and unsustainable fishing. But the benefits can provide fishers with needed incentives for sustainable and equitable management of resources. This is a long process of reform that can take many years, significant investments in both strengthened governance and fishing effort reduction, and, most important, incremental steps. The scope of the investments needed to start the transition to such reforms and the potential economic benefits of healthier fisheries and coastal and marine ecosystems

provide a strong rationale for greater World Bank investment in these areas in Africa.

The Horizon for World Bank Investments

Governments of Africa are starting to understand that their fisheries and supporting ecosystems are key to maintaining many livelihoods and that they need to invest in improving the governance of the sector and management of the resources. The World Bank will increasingly help countries to invest in strengthening governance and policy regimes to manage the use of their marine fish resources at levels that are both more environmentally sustainable and more profitable, as well as to reduce illegal fishing and to encourage private investments in local sustainable fish value chains. There are currently several World Bank-financed projects under preparation to help countries protect

their marine ecosystems and ensure increased capture of benefits for the country and local communities. For example, Senegal is preparing a Sustainable Management of Fish Resources Project for \$10 million (GEF/IDA), together with an additional \$15 million in parallel financing from the government and other donors. Similarly, Kenya is preparing a Coastal Management Project for roughly \$35 million in IDA and GEF funds that would help sustainably manage the coastal ecosystems and resources. Last, the World Bank is currently preparing the West Africa Regional Fisheries Program—including nine eligible countries from Mauritania to Ghana—with the aim of sustainably increasing the contribution that marine fisheries can make to economic growth in these countries (see *Box*, above).

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East Asia and Pacific Region



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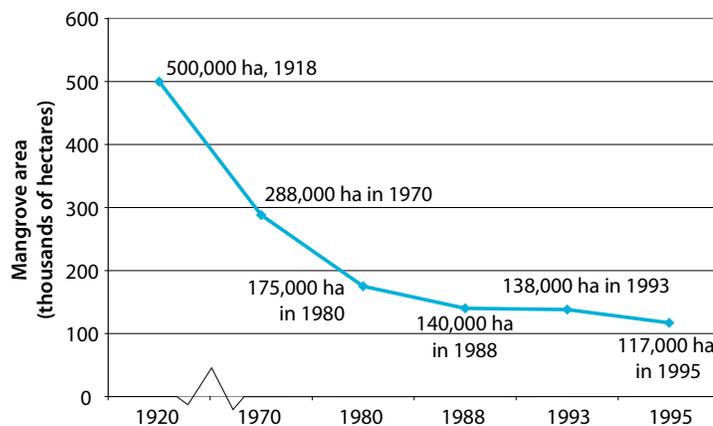
INDONESIA

The East Asia and Pacific region (EPA) is home to about 2 billion people, many of whom are economically and nutritionally dependent on natural resources. Over half of the region's population resides in coastal locations and in low-lying islands; these populations depend heavily on agriculture and marine resources. The region has thousands of islands and is home to some of the world's most important marine resources, including coral reefs, a wide range of fish species, and other biodiversity. A notable example is the "Coral Triangle," a 6-million-square-kilometer triangle in the Indo-Pacific Sea that contains about 75 percent of all known coral species, over half the world's coral reefs, over 3,000 fish species, and the greatest extent of mangrove forests of any region. It is also the spawning ground for the largest tuna fishery in the world. For its biodiversity importance, it has been dubbed the "Amazon of the Seas." It extends from eastern Southeast Asia across the central western Pacific Ocean and includes the Great Barrier Reef in Australia.

Marine resources of the region suffer, however, from overfishing and depletion, largely as a result of increased fishing capacity, destructive fishing practices, and loss of critical habitat. For example, from 1980 to 2005, the region's mangrove cover—which plays an important role in spawning and the growth of juvenile fish—declined by about 22 percent, from 8.6 million to 6.7 million hectares, according to FAO (for example, see *Figure*, top of next page). Coral reefs, which provide critical spawning and nursing habitats for many marine fishes of economic importance, are also under severe stress.

These trends have contributed to a decline in catch per unit effort in many areas, but also a decline in the value of what is caught, since often the more valuable species are the first to be caught and overfished. Lower benefits from fishing are also attributed to a lack of postharvest facilities, such as a lack of ice production, processing, and marketing centers. In addition, in most countries in the region, governance is weak, with open access or inadequate fishing regulations. In countries where regulations on catch limits and gear

FIGURE Mangrove resource decline in the Philippines



Source: D.M. Melana and others, "Mangrove Management and Development in the Philippines," paper presentation, Mangrove and Aquaculture Management, Kasetsart University, Bangkok, Thailand, Feb. 2000.

restrictions do exist, there is often a lack of enforcement capacity for local as well as foreign fishers.

Impacts of Depletion on Local Livelihoods

In Xiangshan County, a major fishing area of the East China Sea, fishers have witnessed a sharp decline in yields and are considering a government proposal to establish a marine protected area that would allow stocks to replenish themselves. In southwestern Mindanao in the Philippines, Bongo Island fishers who depend on catches around nearby coral reefs have become severely impoverished as a result of destructive fishing, particularly through the use of explosives, poisons, and nets with small mesh. In Ha Tinh Province in central Vietnam, a coastal fisher believes that the best option for his family is to educate his children for alternative employment elsewhere. These are but a few examples of the numerous stories commonly told within communities of smallholder fishers and marine resource managers over the past two decades throughout the region.

Despite these pressures, smallholder fishing still plays an important economic role in the region. The region's gross catch of fish has stabilized at about 24 million tons annually (worth roughly \$20 billion). Of the 4 million fishing vessels used in the region in 2004, about 2.7 million were small boats,

of which about 1.9 million (nearly 50 percent) were without motors and used by coastal fishers. In terms of livelihoods, approximately 36 million people are involved in fisheries in Asia, of which about one-third are involved in aquaculture. Although this is a relatively small percentage of the region's total population—about 1 percent—their livelihoods are highly dependent upon sustainable management of the resource, which includes key coastal habitats.

Fisheries, aquaculture, and marine transportation industries make a significant contribution to the regional economy. In Indonesia, the fisheries sector amounted to 3.1 percent of the country's GDP in 2003. East Asia provides about one-fourth of the world's supply of tuna—a total landed value of around \$2 billion a year. Almost half of this catch comes from the waters of Pacific island countries, with a landed value of \$800 million to \$900 million. Catches in 2006, estimated at over 2.3 million tons, were the highest recorded; but two of the most valuable species, yellow fin and big-eye tuna, are at serious risk of being overfished. Illegal, unreported, and unregulated fishing in Indonesian waters costs the state around \$2 billion annually in lost revenues.

Coral reefs sustain livelihoods in roughly 10,000 coastal villages across the country. Potential sustainable economic benefits from coral reefs in Indonesia—from fisheries, shoreline protection, tourism, and aesthetic value—have been estimated at \$1.6 billion

per year. The demand for live seafood in Asia has spawned a lucrative trade in live coral reef fish, which in 1995 had an estimated global annual retail value of over \$1 billion. But the live reef fish food trade poses serious ecological problems stemming from over-exploitation of target species and cyanide fishing, which poisons reefs. More than 80 percent of Southeast Asia's reefs are now at medium to high risk of destruction, in large part from the consequences of the live reef fish trade.

The deterioration of coastal and marine ecosystems also threatens regional tourism, a significant source of income in the region. In the Hon Mun Marine Protected Area (MPA) in Vietnam, for example, total recreational benefits from the reef-related recreation industry are estimated to be around \$4.2 million.

Climate Change Posing Additional Challenges to Coastal and Marine Ecosystems in EAP

The East Asia and Pacific region is particularly vulnerable to climate change due to its geography and settlement patterns. Many of its islands are only a few feet above sea level, and several countries—such as Indonesia, the Philippines, and Kiribati—are archipelagic. Extreme climatic events have already



S. Shen



R. Zweig

caused coastal flooding, and wetlands in the major river deltas of Southeast Asia have been substantially affected by land degradation and saltwater intrusion from increased storm surge.

The Intergovernmental Panel on Climate Change (IPCC) predicts that by the end of the century temperature will increase in East Asia above the global average (about 1.5°C before 2040). In conservative IPCC projections, sea level might rise by 18 to 59 cm. This will likely increase precipitation patterns and heat waves, as well as the intensity of extreme weather events. Delta and estuarine ecosystems, some of which contain unique plants and animals, are very sensitive to sea level rise and might become more prone to flooding and saltwater intrusion as a result. Some low-lying atolls are expected to disappear completely. For example, Kiribati could experience inundation of up to 80 percent in parts of some islands. Rising seas not only inundate wetlands and low-lying islands, but also erode beaches, intensify flooding, and increase the salinity of groundwater. In many Pacific islands and in China, where

population settlements are concentrated in a narrow coastal band, saltwater intrusion is already threatening the security of drinking water supplies.

Continued warming and ocean acidification threaten to undermine coral reefs, thereby

reducing their ecosystem services, which translate to major food security and income issues from lost fisheries and tourism. On the smallest islands, shoreline retreat as a result of sea level rise and the higher frequency of extreme weather events poses a threat not only to human populations but to coastal infrastructure and natural amenities, including beaches, thus negatively affecting tourism and fisheries-related livelihoods. The cumulative threats to coastal areas from local stressors and associated climate change are all the more urgent in the East Asia and Pacific Region, given that over 30 megacities (with populations of more than 5 million) are located on the coast and hence are highly vulnerable to natural hazards such as cyclones and storm surge, in addition to flooding from sea level rise.

Response to Conserving Coastal and Marine Resources

Local and national governments, bilateral and multilateral agencies, and nongovernmental organizations have taken various

Community-Based Management in Vietnam—Hon Mun Marine Protected Area and Wetlands Restoration

The Hon Mun Marine Protected Area, established through a World Bank/Danida project (2001–05), is often cited for its diverse coral species community. It is home to about 175 species and other vertebrate, invertebrate, and algal marine species. The project focused on conserving significant and threatened marine biodiversity, while at the same time improving livelihoods of local island communities. In addition to a major educational, training, and public awareness program, the project successfully introduced an alternative livelihood program and created a self-financing system that assured the sustained management and protection of the MPA.

The Coastal Wetlands Protection and Development Program (1999–2007) focused on the re-establishment of coastal mangrove wetland ecosystems and the sustainable management and protection of the coastal ecosystems of four provinces in the southern Mekong Delta. In addition to helping restore biodiversity, poverty rates in vulnerable communes decreased by 38 percent and average annual incomes increased by 55 percent.

actions to support the conservation and sustainability of coastal and marine resources in the region. Those activities include improved coastal zone planning, coastal and marine ecosystem conservation, improved fisheries management, reduced overcapacity, and investment in alternative income generation options. Seaweed farming, an alternative livelihood, is an example of a small-scale solution to overfishing; the Bank supports programs in Indonesia and the Philippines. The Bank is also supporting community-based coastal, marine, and fisheries management (see *Box* on previous page and *Box* at right).

The Way Forward

The World Bank plans to continue investments in improving management, protection, and sustainability of coastal and marine ecosystems, most likely in conjunction with support for adaptation to climate change. While World Bank assistance toward improved and comprehensive coastal planning, monitoring, management, and development combined with other related interventions can be pivotal in helping to reverse the deg-

radation of coastal and marine ecosystems and the vulnerability of tens of thousands of coastal communities, it is clear that such as-

Indonesia Coral Reef Rehabilitation and Management Program

For 10 years, the World Bank—with the Global Environment Facility, Asian Development Bank, and several environmental NGOs—has been cofinancing a multi-phased coral reef rehabilitation and management program (COREMAP). The program supports community-driven collaborative management or comanagement in over 500 coastal villages across 12 Indonesian provinces. COREMAP Phase II is focused on supporting coastal communities in establishing reef management systems and associated ecosystem resources. The innovation of COREMAP II is to support the transformation of women's economic and social status by improving women's capacity to engage in coral reef management and community development.

sistance will need to be scaled up significantly to have any real impact. This will require leveraging new resources and partnerships among governments, international organizations, and, most important, local communities. In this context, the Coral Triangle Initiative (CTI) provides a platform to galvanize political commitment and resources to safeguard the outstanding coastal and marine resources of the region for current and future generations (see *Box*, below).

The Coral Triangle and Pacific Islands Initiative

To protect the Coral Triangle from overexploitation and destructive fishing practices, the Coral Triangle Initiative seeks to improve the governance of the region's rich marine resources, with a focus at the village level. This approach has proved to be successful in Indonesia, the Philippines, and elsewhere across the Asia-Pacific Region. "If we want to protect coral reefs and rehabilitate fisheries, it is not by planting new corals; it is by educating people and changing their mindsets," says Eko Rudianto, CTI's coordinator. The CTI was launched by Indonesian President Susilo Bambang Yudhoyono in 2008, designated as the International Year of the Reef. The plan of action is expected to be adopted in May 2009 at the World Ocean Conference in Manado, Indonesia. The project is supported by 10 participating governments, GEF, international organizations (ADB, UNDP, FAO, and the WB), bilateral development assistance agencies, and NGOs.



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Europe and Central Asia Region



M. Hatzigeorgidis

In the Black and Mediterranean Seas, excessive nutrient discharges from agriculture and other point sources of pollution have created unsustainable conditions, causing periodic algal blooms, or “red tides,” which kill fish and irritate bathers, and “dead zones,” large submerged areas with too little oxygen to sustain marine life in the coastal waters of these semi-enclosed and hence highly vulnerable marine systems.

These conditions endanger the economy and livelihoods of many coastal communities. For example, the drastic decline in Black Sea fish stocks in the 1970s—a result of overfishing, water quality degradation, and alien species invasion—led to a collapse of the fishing industry and resulted in more than \$2 billion in losses over the 1970–90 period. The nutrient-fed algal blooms in the Adriatic Sea in the 1980s caused several million dollars in losses in the Italian tourism industry.

The decline in fish stocks also eliminated the prey of an invasive and highly predatory comb jelly, thus controlling further outbreaks

of this invasive species and allowing the population of plankton-eating fish and foodwebs to recover, bringing back some balance to the ecosystem. In many cases, however, curbing fishing pressure is not sufficient to return the ecosystem to its former state; controlling nitrogen and phosphorus pollution and protecting critical habitats and species biodiversity also are essential, as is careful management of the river basins that drain to the sea.

The Black Sea — A Dramatic Recovery

The Black Sea coastline has endured serious anthropogenic pressures. Untreated wastewater and agricultural runoff remain major sources of pollution. Nitrogen and phosphorus runoff from agricultural, municipal, and industrial sources has seriously degraded the ecosystem, disrupted fisheries, reduced biodiversity, posed health threats to humans, and resulted in billions of dollars of economic losses.

All this contributed to the collapse of the Black Sea ecosystem in the 1970s and 1980s, when vast amounts of dead plants and animals covered the beaches of Romania and western Ukraine. Between the 1980s and today, Romania and Bulgaria experienced a tenfold drop in the Black Sea fishery catch. From 1973 to 1990, an estimated 60 million tons of bottom animals were lost, including 5 million tons of fish.

Losses in fish catch alone might have been worth \$2 billion. In addition, the annual loss in tourism revenue from poor bathing water quality was estimated at over \$500 million. Health impacts associated with environmental degradation and inadequate infrastructure were also significant across the region, with more than 21,000 cases of serious waterborne infections a year in littoral states.

The economic collapse in Central and Eastern Europe that followed the breakup of the Soviet Union in the early 1990s brought about the closure of numerous livestock facilities, a dramatic reduction in the use of fertilizers, and less pressure on fishing. By 2007, the “dead zone” in the western Black Sea had been virtually eliminated and the invasive alien comb jelly (*Mnemiopsis*) was significantly curtailed. The concerted actions taken by the Black Sea littoral states (Roma-

nia, Bulgaria, Turkey, Georgia, Russia, and the Ukraine) also contributed to the recovery. As a result of these efforts, including key investments supported by the World Bank under the GEF Strategic Partnership for the Danube/Black Sea Basin, nitrogen emissions have decreased about 20 percent and phosphorus almost 50 percent in the Danube/Black Sea basin in the last 15 years.

The Mediterranean Sea — Under Threat from the Land

The Mediterranean Sea is under increasing threat of degradation, and some of its more enclosed parts, like the Adriatic Sea, already show some of the signs that preceded the Black Sea ecosystem collapse. Nevertheless, the Mediterranean coastline is an area of valuable biodiversity. It harbors 10 percent of the world’s higher plant species, half of them endemic to this region, as well as 6 percent of known marine species, one-third of which are endemic.

The population of the Mediterranean’s coastal states has doubled in the last 40 years to 450 million in 1999 and is expected to reach over 600 million in 2050. Between 1970 and 2005, international tourist arrivals quadrupled, reaching 265 million in 2005, and are expected to rise to 350 million in 2025, doubling the population along the coast during the summer. Twenty million inhabitants along the sea’s southern and eastern shores have no access to drinking water, 47 million have no access to sanitation, and 290 million could face water shortages by 2050. Climate change is likely to exacerbate some of these trends. The region has been experiencing significant effects of climate change: air temperatures in the Mediterranean basin rose 1.5–4° C in the last century (the global average increased 0.7°C), with an accompanying drop of 20 percent in precipitation in some areas.

As much as 80 percent of the sea’s pollution load originates from land sources, mainly in the form of untreated discharges of urban wastewater from coastal sources and rivers. Lack of sewage collection, treatment, and disposal infrastructure is still the greatest problem in many Mediterranean countries. Nevertheless, despite many donors’ initiatives, coordination appears to be inadequate, both in the region and within countries. Only 55 percent of coastal cities with more than 10,000 inhabitants have sewage treatment plants, resulting in a large annual discharge of more than 3 billion cubic meters of untreated sewage to the sea. Overall, 66 million m³ of untreated industrial wastewater is discharged to the Mediterranean each year. Uncontrolled coastal development, population expansion and increasing coastal tourism, unregulated and unsustainable fishing, damming, and pollution are the greatest threats to the sea’s coastal and marine ecosystems.

Partnering with the World Bank for the Recovery of the Seas

Launched by the World Bank together with UN agencies and the European Union (EU), and cofunded by GEF in 2001, the Strategic Partnership for Nutrient Reduction in the Danube/Black Sea Basin was intended to support the restoration of the Black Sea to pre-1960 environmental conditions. The initiative addresses the degradation of the ecosystem at its roots: in the large agricultural plains of Romania, along the Danube wetlands of Bulgaria and Romania, and upstream, even reaching the discharges of raw sewage in Budapest and the river basins of inland Turkey.

Through the Black Sea/Danube Basin Investment Fund for Nutrient Reduction, the World Bank provided \$65 million in GEF grants and leveraged about \$200 million in



S. Mihov

cofinancing to support investments in both the agriculture sector and municipal and industrial wastewater treatment sector, as well as for wetland restoration. Active since 2002, the fund has supported projects in Bosnia and Herzegovina, Bulgaria (see *Bulgaria Box*, below), Croatia, Moldova (see *Moldova Box*, right), Romania (see *Romania Box*, bottom right), and Serbia and Turkey. These projects promoted reforms, innovative investments, and new approaches, including low-cost wastewater treatment methods (Bosnia and Herzegovina, Moldova); wetland restoration and management (Hungary, Moldova, Bulgaria); restoration of degraded land and reduction of soil erosion (Moldova); waste segregation and water quality monitoring (Romania); and manure management facilities and support for organic farming (Turkey).

As of 2007, a number of remarkable improvements in the environmental conditions of the Black Sea were detected: the “dead zone” in the western Black Sea has been virtually eliminated (although dead zones in the deeper areas of the Black Sea persist); oxygen levels were at near-saturation in many areas;

Bulgaria Wetlands Restoration and Nutrient Reduction

Active since 2002, the project seeks to reduce transboundary nutrient loads and other pollution in the Danube River and the Black Sea. It conserves biodiversity through the restoration and management of two wetlands along the Danube. The project also supports the adoption of environmentally friendly agricultural practices. Besides providing a model for nutrient trapping that can be replicated in the region, it led to the return of several rare animal species. The restoration of the two wetlands provided a boost to fishing and additional protection against flooding.

See: www.worldbank.org/blacksea

Moldova Agricultural Pollution Control Project



B. Battaglini

The project promotes mitigation measures to reduce nutrient runoff into water bodies through manure management techniques, promotion of environmentally friendly agricultural practices, planting forest vegetation, restoration of wetlands, and monitoring water and soil quality. It also strengthens national policy and regulation capacity in the agriculture sector, raises public awareness about water pollution, and replicates results from pilot areas at the country level.

As a result of the project, 8,250 farmers in Moldova adopted at least one environmentally friendly agricultural practice on 14,028 hectares of land.

See: www.worldbank.org/blacksea

Romania Agricultural Pollution Control

The project focuses on reducing the discharge of nutrients and other agricultural pollutants into the Danube River and Black Sea through integrated land and water management and ecologically sustainable use of natural resources. Rural communities increased their ability to control expected nutrient releases by building manure storage and household bunkers and by segregating waste materials. The percentage of area under nutrient management systems rose from 1 to 34 percent. Nutrient discharge into surface and groundwater decreased about 15 percent for nitrogen and 27 percent for phosphorus in 2006. For local communities, the project provided additional income from more effective use of organic waste (manure as fertilizer), crop rotation, organic produce, and improved livestock grazing practices. It also provided improved production efficiency through better farm management.

See: www.worldbank.org/blacksea

the number of benthic species increased 1.5–2 times (since 1980); invasive alien species (*Mnemiopsis*) were significantly curtailed; and the upper reaches of the Danube Basin were no longer considered at risk.

The observed recovery is certainly linked to the dramatically reduced use of fertilizers that followed the economic collapse in central/eastern Europe in the early 1990s, but also to the significant nutrient reductions achieved through the investments and governance reforms promoted through the GEF Strategic Partnership and the EU accession processes.

In the Mediterranean, a recently formed alliance between the Mediterranean Action

Plan (the Secretariat of the Barcelona Convention for the Protection of the Mediterranean Sea) and its regional centers, GEF, UNEP, and the World Bank supported the establishment of an effective partnership among key agencies and institutions. The Strategic Partnership for the Mediterranean Sea Large Marine Ecosystem was launched in 2006 to accelerate investments and policy reforms that address the threat of dead zones in pollution hot spots and protect key natural habitats.

In September 2008, Bosnia and Herzegovina and Croatia signed an agreement with the World Bank and GEF to work together toward improving environmental quality



along their rivers and protecting coastal and marine biodiversity. The Neretva and Trebisnjica River Basin Management Project is the first to receive funding from the World Bank–GEF Investment Fund for the Mediterranean Sea, the financing mechanism for the Mediterranean Sea Partnership (see *Cro-*

atia Box, below). With an initial GEF contribution of \$25 million, an expected overall envelope of \$70 million in GEF grants, and cofinancing of more than \$200 million, the Mediterranean Sea Investment Fund supports interventions addressing land-based pollution and coastal habitat degradation.

Countries eligible for financing include Albania, Algeria, Bosnia and Herzegovina, Bulgaria, Croatia, Egypt, FYR Macedonia, Lebanon, Libya, Morocco, Montenegro, Syria, Tunisia, and Turkey, as well as West Bank and Gaza.

Croatia/ Bosnia and Herzegovina — Neretva and Trebisnjica Management Project

The project seeks to reduce pollution discharges into the eastern Adriatic Sea from the Neretva and Trebisnjica River basin through improved transboundary water resource management. The lower course of the Neretva River contains the largest and most valuable remnants of the Mediterranean wetlands in the eastern Adriatic coast and is one of the few areas of this kind remaining in Europe. The wetlands serve a number of functions important to water resource management, including water purification, nutrient reduction, sedimentation sink, flood management, and prevention of shoreline erosion. They also provide critical habitats and support the local economy. The project's expected outcomes include a reduction in nutrient and other pollution from municipal and industrial sources in selected municipalities in the basin, improved maintenance of environmental flows, and a reduction in saltwater intrusion.

See: www.worldbank.org/medfund

The Mediterranean Sea Investment Fund recently approved financing for the Croatia Coastal Cities Pollution Control Program (wastewater treatment). Projects in the pipeline include the Land and Water Optimization Project (Tunisia), the Coastal Zone Management Project in Alexandria (Egypt), and the Sustainable Tourism Development Project (Montenegro).

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Latin America and Caribbean Region



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TOBAGO

The global path of CO₂ emissions already surpasses the worst-case standard emissions scenarios of the IPCC. The current trend may result in a situation that exceeds the direst of anticipated consequences. Although there remain uncertainties, there is high confidence that impacts from climate change—even under significantly more modest emission scenarios—will affect the functioning and integrity of key ecosystems worldwide. These impacts will add to the stress already resulting from local anthropogenic effects; combined, they represent an unprecedented challenge to the global biosphere. While the impacts are being felt globally, some regions will be more acutely affected than others.

Relatively modest amounts of carbon dioxide emissions are generated in the subcontinent. Nevertheless, climate change is likely to have a substantial impact on Latin America and the Caribbean, which is characterized by a substantial—but intrinsically fragile—natural capital and a number of climate-sensitive ecoregions.

The Bank's Latin America Region has been working on the assessment and implementation of adaptation measures to address the consequences of climate impacts since 1997 and has developed a large portfolio of adaptation measures. The program on adaptation has focused on regional climate hotspots (see *Table*, at right). Coastal and marine ecosystems are a key area of concern.

Climate Change Impacts on Coastal Ecosystems

The effects of increased atmospheric CO₂ concentrations—such as changes in ocean chemistry—will adversely affect the physical and biological characteristics of coastal systems, modifying their ecosystem structure and functioning. As a result, coastal nations face losses of marine biodiversity, fisheries, and shorelines. Coral reefs, which are among the most biodiverse ecosystems on Earth, are highly sensitive to increases in sea surface temperature. A 2°C increase, associated with CO₂ concentrations of 500 ppm, threat-

ens to destroy most coral reefs. Along with increasing temperatures, more acidic conditions in the ocean associated with dissolved CO₂ from Earth's atmosphere threaten to transform living reefs into seaweed-dominated mounds of rubble.

Climate impacts will also affect wetlands, which provide many environmental services, including regulation of the hydrological regime; human settlement protection through flood control; protection of the coastal region; help in mitigating storm impacts; control of erosion; conservation and replenishing of coastal groundwater tables; reduction of pollutants; regulation and protection of water quality; retention of nutrients, sediments, and polluting agents; sustenance for many human communities settled along the coast; and habitats for waterfowl and wild life.

Coastal wetlands are already subject to land use changes, mangrove deforestation, pollu-

tion, and water diversion, which increase the ecosystem's vulnerability to expected climate change impacts and exacerbate the impacts. Land use changes increase the vulnerability of these ecosystems and are expected to worsen the climate change impacts on wetlands along the coast. Low-lying coastal areas and associated swamps could be displaced by saltwater habitats, disrupting freshwater-based ecosystems as a result of sea level rise. Such changes may also result in the loss of important brackish water habitats. Migratory and resident birds and fish may lose important staging, feeding, and breeding grounds, which are difficult to replace under competing demands for scarce land. This deterioration of wetland habitat may result in impacts on commercially important fish species, seriously affecting the sustainability of fisheries.

As part of the adaptation portfolio and in combination with the development of opportunities for carbon sinks, the Latin

America and Caribbean Region has a number of ongoing or planned activities to build resilience to future climate impacts based on protection of coastal ecosystems and their services. Some of these are presented below.

Adaptation to Climate Impacts on the Wetlands of the Gulf of Mexico

The wetlands of the Gulf of Mexico have been identified by the National Institute of Ecology / Ministry of Environment and Natural Resources of Mexico as the most critical and threatened ecosystem affected by climate change in the country. The Gulf of Mexico is characterized by a very high exposure to extreme weather events, with populations that live in high-risk areas prone to flooding and other extreme weather events, and the

TABLE Some major climate hotspots in Latin America (two correspond to coastal and marine systems)

Climate hotspot	Direct effect	Immediacy	Irreversibility	Magnitude of physical impacts	Economic consequence
Coral biome in the Caribbean	Bleaching and mass mortality of corals	Now	Once temperatures pass the threshold for thermal tolerance, corals will be gone.	Total collapse of ecosystem and wide-ranging extinction of associated species.	Impacts on fisheries, tourism, increased vulnerability of coastal areas.
Mountain ecosystems in the Andes	Warming	Now	The thermal momentum in mountain habitats will result in significant increases in temperature, leading to major unidirectional changes in mountain ecology.	Disappearance of glaciers, drying-up of mountain wetlands, extinction of cold-climate endemic species.	Impacts on water and power supply, displacement of current agriculture.
Wetlands in the Gulf of Mexico	Subsidence and salinization; increased exposure to extreme weather	This century	Irreversible sea level rises will submerge coastal wetlands, affecting their ecology.	Disappearance of coastal wetlands, displacement and extinction of local and migratory species.	Impacts on coastal infrastructure, fisheries, and agriculture.
Amazon Basin	Forest dieback	This century	If rainfall decreases in the basin, biomass densities would also decrease.	Drastic change to the ecosystem, leading to potential savannah.	Impacts on global water circulation patterns, agriculture, water and power supply on a continental scale

Source: Modified from W. Vergara, (forthcoming). "Climate Hotspots: Climate-Induced Ecosystem Damage in Latin America." In World Bank. *Assessing the Costs of Climate Destabilization in Latin America*. Washington, DC: World Bank.



J. Acosta

presence of important economic sectors such as Mexico's oil industry and tourism. Three Mexican national communications reports and other studies have documented ongoing changes in the wetlands of the Gulf of Mexico and have raised urgent concerns about their integrity. These wetlands perform very important environmental functions that are critical to economic activity over a wide area of the country.

Located in the lower reaches of the Gulf's main water tributaries, the Gulf wetlands are considered the most productive ecosystem in Mexico. Changes in the distribution and characteristics of river flows may affect the biological functioning of the wetlands, impacting the economy of coastal areas.

To address these impacts, the government of Mexico is formulating, with assistance from the World Bank, a project to reduce the vulnerability to anticipated impacts of climate change (focusing on integrity and stability) on coastal wetlands and associated inland basins of the Gulf of Mexico. The project will support pilot adaptation measures in four wetlands: (1) Río Panuco Corredor Sistema Lagunar (Tamaulipas); (2) Laguna de Alvarado (Veracruz); (3) Carmen-

Pajonal-Machona (Tabasco); and (4) Punta Allen (Quintana Roo), including the coastal coral reefs in the region. These were selected during the formulation phase of the project and respond to the magnitude of the impacts induced by climate change, the value of compromised economic and environmental services, the readiness of local institutional capacity, and the participation of the local community. In addition, the project seeks to identify national policies to address the impacts of climate change on water resources at the national level (global overlay). The total budget is estimated at \$25.5 million, with a Bank-GEF contribution of \$5 million.

Adaptation to Climate Impacts in Coastal Zones of the West Indies

Also of particular concern are the impacts on the coral biome in the Caribbean. Coral reefs support more than 25 percent of all marine species, making them the most biologically diverse of marine ecosystems and an equivalent, in terms of biomass produc-

tivity, to rainforests on land. Corals have been around for over 200 million years and have evolved over time to adjust to relatively stable environmental conditions in tropical seas, defined through a narrow range of temperatures, salinity, and pH. Because of their stable environment, most corals are also very sensitive to changes in environmental parameters. When stressed by rising temperatures, reef-building corals can lose their photosynthesizing symbionts—microscopic algae that live inside the soft coral tissue, converting the sun's energy and CO₂ into food and giving the coral its color. Loss of these photosynthetic elements leads to coral bleaching and, eventually, death from starvation and disease. Corals also play very important roles for other species, providing feeding grounds and the 3-D structure essential for fish populations and a multitude of other plant and animal species.

Gradual and consistent increases in sea surface temperatures have yielded increasingly frequent bleaching events (1993, 1998, 2005), the latest of which caused wide-scale bleaching throughout the Caribbean Region. Under conditions anticipated by the Intergovernmental Panel on Climate Change, increased temperatures in the Caribbean are likely to lead to a collapse of the coral biome during this century.

In the wake of coral collapse, major impacts on fisheries, tourism, and coastal protection are anticipated, as well as severe loss of biodiversity and species extinction and impacts on ecosystem integrity. One-third of the more than 700 species of reef-building corals worldwide are already threatened with extinction. It is estimated that between 60 and 70 endemic species of corals in the Caribbean also are in danger; extinction risks are increasing due to more frequent bleaching events experienced in recent years and expected in the future due to climate change. The cost of adapting corals to anticipated environmental conditions in the Caribbean, as well as protecting and recovering affected

populations, is unassessed but likely to be very high.

With Bank assistance, the region is implementing a project to support efforts by Dominica, Saint Lucia, and St. Vincent and the Grenadines to implement specific, pilot adaptation measures addressing the impacts of climate change on their natural resource base, focused on biodiversity and land degradation along coastal and near-coastal areas. As part of the effort, work is planned for the assessment of alternatives to conserve and adapt the coral ecosystem in the region. The project has a budget of \$5.5 million, with a Bank-GEF contribution of \$2.1 million.

Restoration of the Nariva Wetland in Trinidad and Tobago

Coastal wetlands, in particular mangroves, also provide a coastal protection function. Mangroves have a natural buffering capacity to wind and storm surges, thus providing protection against extreme weather events. Wetlands have been shown to reduce the impact and intensity of wind in inland com-

munities during hurricanes and tsunamis. The natural buffering capacity also provides a cushion against inland flooding. The protection and restoration of these coastal ecosystems can be seen as an adaptation measure to the likelihood of intensified storms in the Caribbean basin.

The Nariva RAMSAR wetland targeted by the proposed project has the most varied vegetation of all wetlands in Trinidad and Tobago, with distinct zones of swamp forest, palm swamp, herbaceous swamp, and mangrove woodlands of distinct global biodiversity value. It is especially important for large numbers of waterfowl, including migratory species, and is the major wetland in Trinidad that still sustains anacondas (*Eunectes murinus*), blue and golden macaws (*Ara ararauna*), and manatees (*Trichechus manatus*).

On the basis of these characteristics, the Trinidad and Tobago government has declared the highest level of protection available in the nation to Nariva, incorporating the wetlands in the “Nariva Environmental Sensitive Area” (Nariva ESA). This protected area covers 15,568 hectares of one of the most important natural habitats in Trinidad and Tobago. The wetlands, as a landform,

cover approximately 7,000 ha. The remainder is mostly covered by upland forest, which surrounds the wetland and could be interpreted as a buffer/protection belt to the inland areas. Nariva ESA has a very rich mosaic of vegetation communities, including tropical rain forest, palm forest, mangroves, swamp forest, and swamps.

The Bank is supporting efforts to restore and conserve the Nariva wetlands through the recognition of the services it provides as a carbon sink and a biodiverse ecosystem. This will be done through actions designed to restore and conserve about 1,160 ha of its associated forest stands. The restoration of the wetlands will result in additional environmental benefits, including reduction of GHG emissions and the conservation of endemic species in the area.

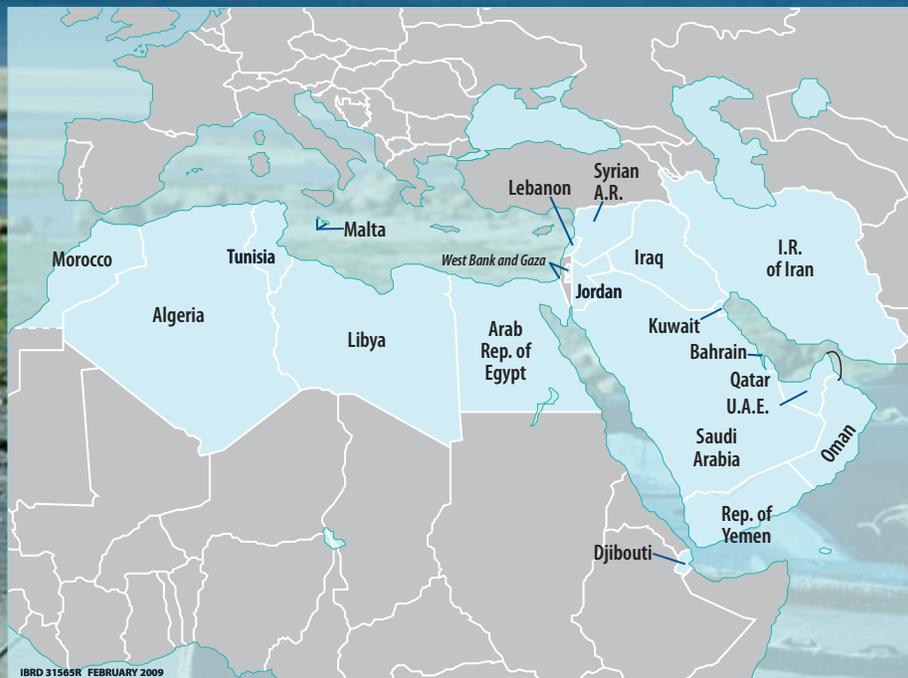
Effective restoration and protection of Nariva will also provide for recovery of the protection and storm buffering character of the wetland. The project was approved with an estimated carbon sink and GHG mitigation asset valued at \$2.1 million. Carbon finance will be used to credit the accumulated biomass resulting from the activities of the project, as well as the anticipated reduction in greenhouse gas emissions from the wetland once it restores its hydrological balance.

Looking forward, there is a need to consolidate and expand initiatives to protect these valuable coastal and marine ecosystems, particularly to combine traditional conservation efforts with adaptation to climate impact and carbon sink programs. The combination of these resources will increase the ability to respond to the immense challenges and provide a practical example of linkage between the biodiversity and climate change agendas in the region.

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Middle East and North Africa Region



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TUNISIA

The seas surrounding the Arabian Peninsula—the Red Sea, Gulf of Aden, Gulf of Oman, The Gulf, and the Arabian Sea—are an area of striking contrasts. They are bordered by some of the world’s richest and poorest countries. The region is globally renowned for its great diversity of marine and coastal environments, the number of unique species, and the importance of marine resources to the continued social and economic development of the region.

Over the past four decades, the region has also experienced rapid development in the coastal zone, which has led to the degradation of the marine and coastal environment and a loss of its potential to sustain coastal populations. Furthermore, regional wars and internal conflicts have introduced new dimensions to the region’s environmental problems and stressed both its financial and its natural resources.

Socioeconomic Value

Both fisheries and tourism provide significant economic and social value to the region.

Fisheries. Fisheries production within the region has expanded greatly over the past 30 years; by 2001, the gross value of fisheries output for all six nations of the Gulf Cooperation Council (GCC) was \$466.7 million. Fisheries are generally artisanal in nature, with the exception of some industrial trawlers operating out of Saudi



R. Baldwin

Arabia, Oman, and Kuwait. The artisanal sector represents approximately 80 percent of total fisheries output and the industry offers a significant investment opportunity for the private sector in commercial food production and export. In Kuwait, the value of the artisanal fleet is about \$51 million; in Oman, the traditional sector provides 75 to 80 percent of total fish landings, valued at \$180 million in 2004. In Yemen, the fishing sector accounts for 15 percent of GDP and is considered one of the most promising areas for commercial expansion.

Tourism and Recreation. With an attractive marine life and favorable climate, tourism is a major source of revenue for many of the countries in the Gulf and provides a strong economic alternative to the petroleum industry. The United Arab Emirates tourism sector leads the region with an estimated contribution of 22.6 percent of GDP, valued at \$49 billion in 2008. Recreational activities such as swimming, diving, and fishing are a huge draw to the region and provide ample opportunities for small business development and local employment.

Threats

Among other things, the region's coastal and marine resources are threatened by oil pollution, land-based sources of pollution, habitat degradation, overexploitation of some fishery stocks, and climate change.

Oil Pollution. The Gulf is known as one of the waterways most vulnerable to oil pollu-



A. Wilson

tion in the world. Estimated oil pollution in the Gulf is about 3 percent of the global total, or nearly 50 times the average for marine environments. In addition to spills at oil terminals, about 1.2 million barrels of oil are spilled in the region every year from the routine discharge of ballast water. Regional wars have also contributed to the degradation of coastal and marine resources. The Iran/Iraq war (1980–88) contributed 2 to 4 million barrels of spilled oil, and 6 to 8 million barrels were spilled into the Gulf and the Arabian Sea during the First Gulf War.

In the northwestern part of the Gulf, about 250 sunken and leaking ships and tankers—another legacy of regional conflicts—pose a threat not only to the marine environment, but also to maritime traffic. As an indication of the possible impact of a major oil spill, the World Bank estimated that the total cost of environmental degradation due to a recent oil spill (12,000 to 15,000 metric tons) in Lebanon (a result of the hostilities in July 2006) was about \$203 million in lost revenue from fisheries, beach pollution, damage to recreational facilities and activities, and damage to marine life. This represents about 1 percent of Lebanon's GDP.

Land-Based Sources of Pollution. Adverse ecological effects associated with sewage pollution have been observed in several areas of the Gulf. In Saudi Arabia, the discharge of raw sewage is as high as 40,000 m³/day. This poses a potential threat of eutrophication in confined areas such as bays, as well as a potential public health risk. In August and September 2001, unusually high sea surface temperatures contributed to the development of a harmful algal bloom in Kuwait Bay that killed nearly 3,000 tons of wild mullet and sea bream and resulted in great financial loss to the fishing industry.

Another major source of pollution is from desalination plants, which discharge heated, concentrated brine and associated chemicals. Power and desalination plants constitute

about 48 percent of the wastewater discharged into the Gulf.

Habitat Degradation. Most acute ecological problems have arisen from the loss and degradation of productive coastal habitats, caused by coastal landfills, dredging, and sedimentation. Reclamation has been undertaken for residential developments, ports, bridges, causeways, and tourism. The areas have included intertidal flats with mangroves, shallow bays, and other biologically productive areas, which also serve to sequester carbon. In some Gulf states, as much as 40 percent of the coastline has now been developed, eliminating critical habitat for wildlife and biodiversity.

In the northern Gulf, many important commercial fisheries are dependent on the Shatt Al-Arab waterway, where the waters of the Tigris and Euphrates Rivers join. The marsh and estuarine areas are important spawning and feeding grounds as well as providing a nursery habitat. The loss of the Iraqi marshes after the first Gulf war has caused a significant decline in coastal fisheries due to loss of spawning grounds, as well as an increase in pollution.

Exploitation of Fisheries and Other Resources. Fishery production from the Arabian region has expanded enormously in the last 30 years. Certain high-value stocks have been overexploited, however, particularly where development of the fishery has proceeded more rapidly than legislation and enforcement to control it. In most of the countries of the Gulf and the Red Sea, landings of valuable finfish species—such as grouper, kingfish, and Indian mackerel—declined by as much as 70 percent between 1989 and 2001. In Oman, for example, the kingfish fishery declined from a peak catch of 27,000 tons/year in 1988 to under 2,000 tons/year since 2002.

The Gulf of Aden rock lobster fishery has similarly declined since 1990, virtually collapsing in the late 1990s. Total fish land-



ings from the Red Sea declined by around 36 percent in Saudi Arabia over the period 1989–2001, despite a more than doubling of the artisanal and industrial fishing fleet.

In shallow waters of the Gulf, unsustainable fishing practices, such as bottom trawling, contribute to the capture and destruction of non-target species and the destruction of productive benthic habitats and associated coral reefs. In the western Gulf, the shrimp fishery by-catch ratio is as high as 74:1, causing a depletion of non-commercial fisheries that are valuable in the overall food chain.

Climate Change. The Gulf is also prone to natural disasters from flooding and sea level rise as a result of climate change. The Intergovernmental Panel on Climate Change models predict increases in both summer and winter temperatures. Some models show decreases in winter precipitation for

the northwest of the Arabian Peninsula and increases in summer precipitation over most of the Arabian Peninsula. This may lead to an increase in flash floods, which are already a problem in these regions. Many cities in the Gulf are situated in floodplains and are susceptible to torrential flooding.

Furthermore, extreme weather conditions, such as the recent cyclone that affected Oman in June 2007 (and caused \$4 billion in losses) are likely to increase, causing damage to life and property onshore, as well as to offshore oil installations and desalination plants. In addition, large areas of land could be lost at the head of the Gulf in the Tigris-Euphrates delta of southern Iraq.

Periodic sustained increases in mean sea surface temperature (SST) could result in massive bleaching and mortality for corals in the Red Sea and Gulf regions. Sub-tidal habitats

in the Gulf, including coral reefs, showed no adverse impacts from the Gulf War oil spill, but they were severely affected by elevated SSTs in three major bleaching events in 1996, 1998, and 2002, causing most in-shore and shallow-water offshore corals to die. There were hardly any signs of recovery until 2007.

Management and Conservation

Some of the main problems facing the future of the region are due to ineffective management practices. Most countries currently use a “command and control” approach through national laws and end-of-pipe regulations. Enforcement of regulations however, remains a generic problem for pollution abatement. The alternative pollution prevention

approach remains largely untried in the region.

An integrated ecosystem approach to the management of the Arabian ecosystem is essential. This would require countries to perceive the ecosystem as a regional commons and approach the management of pollution and other anthropogenic stressors from a holistic perspective, requiring collective action. The key objective of this ecosystem approach would be to foster a shared vision of the strategic importance of the region's resources as well as the principles and values relating to sustainable management among the stakeholders. The largest constraint to this approach lies in the sectorally oriented culture that prevails in the region.

Conclusion

Marine ecosystems in the region are largely outside the market and are too often ignored or undervalued. As these services become more stressed and scarce due to ongoing pressures and any future impacts from climate change, their capacity to support coastal communities will gradually diminish. Increased investment in sustainable management of marine resources is urgently required. The World Bank, through some of its planned and future activities, can play a vital role in addressing this issue.

Current World Bank activities related to the marine environment in MENA are concentrating on country-level operations in Yemen and a recently approved GEF-funded project focusing on the Red Sea and Gulf of Aden.

The Red Sea and Gulf of Aden Strategic Ecosystem Management Project (GEF, \$3 million). In partnership with PERSGA (The Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden), this project is focused on the conservation and promotion of sustainable exploitation of the marine resources of the Red Sea and Gulf of Aden to improve the

socioeconomic benefits to the people of the region. It builds on the activities of the first Red Sea project in support of the implementation of the Strategic Action Plan, particularly in the areas of fisheries governance and marine protected areas.



T. Bennett

The Yemen Fisheries Resource Management and Conservation Project (IBRD loan, \$25 million). The project will contribute to one of Yemen's key development objectives, namely achieving economic growth through the development of the fisheries sector. By strengthening planning, monitoring, and surveillance functions and controlled development of fisheries resources, the project will also help the country to implement its National Environmental Action Plan, which focuses on sustainable development of Yemen's natural resources.

While the Gulf countries are not borrowers, technical cooperation with the World Bank has been ongoing for some time. This is entirely client-driven, and yet the marine environment has not been high on the list of priorities. However, this should begin to change with the establishment of the Gulf Environment Partnership and Action Program (GEPAP), which is a new program of cooperation between the Bank and the riparian countries of the Gulf to address and effectively manage shared environmental resources. The Gulf countries have concluded that a regional approach is needed to develop a vision, a common set of principles, a framework for cooperation on a transboundary dialogue, and actions for developing support for the development and conservation of the waterway. GEPAP will achieve this objective by enhancing cooperation among governments, the private sector, and civil society in the Gulf countries, especially through knowledge sharing, collaboration, information exchange, and investment promotion for environmental issues. GEPAP will also have a strong public policy impact by helping decision makers make informed environmental policy decisions and take specific actions to effectively curb environmental degradation in the Gulf.

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South Asia Region



T. Sennett

BANGLADESH

South Asia's five coastal countries (Bangladesh, India, the Maldives, Pakistan, and Sri Lanka) account for less than 2 percent of the world's total coastline (see *Table*, below). Yet the low elevation coastal zones of these countries, with an area of about 160,000 km², contain 135 million people—22.5 percent of the global population living in such zones (see *Table*, top of next page). The coastal zones also contain about 40 percent of the economic activities in the region and most of its critical economic infrastructure.

South Asia's coastal regions are extraordinarily rich in ecological diversity (see *Table*, bottom of next page). More than 8 percent of the world's mangrove areas are in South Asia. The Sundarban delta is the world's largest continuous stretch of mangroves. These—as well

as the coral reefs of the Maldives, India, and Sri Lanka, and the dryland mangroves of Pakistan—support thousands of floral and faunal species.

This ecological richness, however, has been subjected to great pressure through overextraction of resources, enhanced pollution, and physical alterations in coastal ecosystems. Mangroves have been exploited for timber, fuelwood, and other purposes. For about 200 years, large mangrove areas have been cleared for agricultural activities and for shrimp farming, particularly in India and Pakistan (see *Table*, middle right next page). Mangroves, coastal wetlands, and

TABLE Coasts of the South Asia Region

Country	Coastal length (km)	Continental shelf (thousand km ²)	Territorial sea (thousand km ²)	Claimed Exclusive Economic Zone (thousand km ²)
Bangladesh	3,306.000	59.6	40.3	39.9
India	17,181.000	372.4	193.8	2,103.4
Pakistan	2,599.000	43.7	31.4	201.5
Sri Lanka	2.825	19.2	30.5	55.8

TABLE Population & urbanization in the low elevation coastal zones of South Asia

Country	Area of LECZ (km ²)	Population, 2001	Urban population	% urban in big cities (>5 million)
Bangladesh	54,461	65,524,048	15,428,668	33
India	81,805	63,188,208	31,515,286	58
Pakistan	22,197	4,157,045	2,227,118	92
Sri Lanka	5,536	2,231,097	961,977	-

other coastal habitats also have been severely affected by discharges of untreated industrial and domestic sewage, freshwater interceptions for irrigation, and dredging and re-suspension of contaminated silts. Oil pollution also increasingly threatens coral reefs, often located in areas where large-scale petroleum industries, tourism, and fishing industries flourish. Most of the shallow-water coral reef habitats of Sri Lanka, the Maldives, and India have been severely damaged as a result of bleaching. The northern Indian Ocean is one of the 10 hotspots of the world's threatened coral reef areas. The entire coral reef area in Bangladesh is under threat, as are most of the reefs in India (61 percent) and Sri Lanka (86 percent).

Economic Value of Coastal and Marine Ecosystem Services

In South Asia, the fisheries industry is a major driver and safety net for economic development and rural livelihoods. The Bank's

Bangladesh Country Environmental Analysis (CEA) reported that the fisheries sector contributes about \$1.5 billion (4 percent of Bangladesh's gross domestic product), and the seafood export sector is the country's second largest source of foreign exchange. Similarly, the Bank's Maldives Climate Investment Report estimated that the fisheries sector generates almost half of the Maldives' merchandise exports (\$60 million annually), which is a very significant portion of the country's foreign exchange earnings. In Sri Lanka, the fisheries sector represents approximately 2.4 percent of the GDP.

From a livelihood perspective, it is estimated that four out of five rural citizens of Bangladesh (over 85 million people) are directly or indirectly dependent on aquatic and marine resources. The fisheries sector provides direct employment to about 9 percent of the country's labor force. Over a million people fish full-time and another 11 million are part-time fishers. In India, coastal fishing employs a million people full time (including

The economic resilience of marine ecosystems in South Asia is heavily dependent on the productivity of coastal breeding grounds and habitats, mainly mangroves and coral reefs. Every hectare of the region's mangrove ecosystem is estimated to generate more than 450 kilograms of marine catch. However, mangrove vegetation, coastal breeding grounds, and habitat areas are rapidly eroding. In the Maldives, the productivity of the tuna fishery, the second largest export industry in the country, is dependent on good management, including of bait fish stocks from coral reefs, which are increasingly at risk from climate change and ocean acidification.

TABLE Mangrove areas in South Asia

Country	Area of mangrove (ha)		
	1980	1990	2000
Bangladesh	596,300	609,500	622,600
India	506,000	492,600	479,000
Pakistan	345,000	207,000	176,000
Sri Lanka	9,400	8,800	7,600

Significant tourism infrastructure also is at stake. Coastal and marine resource-based ecotourism accounts for 70 percent of the Maldives' gross domestic production.

Climate Change Risks to Coastal Communities and Infrastructure

According to the Intergovernmental Panel on Climate Change (IPCC), Asia will be one of the most severely affected regions of the world as a result of "business-as-usual" global warming. South Asia is likely to have increased exposure to extreme events, including cyclones and tropical storms, floods, and severe vector-borne diseases. Sea level rise might cause large-scale inundation along the coastline and recession of flat sandy beaches. The ecological integrity of mangroves and coral reefs would be at risk.

Studies notice a significant acceleration in sea level rise in Asia, an average rise of

TABLE Biological diversity of the coasts and seas of South Asia

Seabirds	Species	26	Shrimps	Species	94
	% of All	9		% of All	27
	Endemics	n/a		Endemics	n/a
Pinnipeds	Species	-	Lobster	Species	23
	% of All	-		% of All	15
	Endemics	n/a		Endemics	n/a
Turtles	Species	5	Sharks	Species	58
	% of All	71		% of All	17
	Endemics	n/a		Endemics	6
Seagrass	Species	9	Cetaceans	Species	28
	% of All	19		% of All	32
	Endemics	n/a		Endemics	n/a
Molluscs	Species	246			
	% of All	6			
	Endemics	n/a			

Note: n/a = data not available.

Source: UNEP.

3.1mm/year over the past decade, compared with 1.7–2.4mm/year over the 20th century. There has also been an increase in the frequency and intensity of extreme weather events. A number of studies in the region have explored linkages among the observed changes in mean climate variables, extreme weather events, and changes in biophysical and human systems.

The IPCC goes on to estimate that even under its most conservative scenario, sea levels in 2100 will be about 40 centimeters higher than today, which will cause an additional 80 million coastal residents in Asia alone to be flooded. The majority of those flooded will be in South Asia, particularly in Bangladesh and India. A 1-meter sea level rise would flood nearly 6,000 km² in India alone. By including the effect of ice-sheet dynamics, other studies suggest a 3–5m rise in sea levels by 2100. Such an increase would have a devastating impact on the region. In South Asia, large coastal cities such as Dhaka, Mumbai, and Kolkata are at average elevations of 2–10 meters above mean sea level. Overall, some 47 million people live in urban areas in low-elevation coastal zones, half of them in cities larger than 5 million in population. A 3–5 meter rise in average sea level could effectively de-urbanize the region along the coast. Whether the eventual sea level rise is as low as about 40 centimeters or as high as 3–5 meters, a large urban and rural population will be affected. Significant population movements will likely occur toward other large urban settlements in the interior of the country rather than get dispersed in the hinterland of existing coastal cities. These will put considerable stress on coastal and inland urban areas. Further, the large infrastructure investments in ports, industries, and other facilities are at greater risk due to rising sea levels.

Sea level rise will affect the coastal zone in multiple ways, including the inundation and displacement of wetlands and lowlands, coastal erosion, increased coastal storm floods, increased salinity in estuaries and

freshwater aquifers, alteration of tidal ranges, and changes in sediment and nutrient transport. Rapid urbanization—which has led to the enlargement of natural coastal inlets and dredging of waterways for navigation, port facilities, and pipelines—has exacerbated saltwater intrusion into surface and ground waters. The areas protected by mangroves, deltas, low-lying coastal plains, coral islands, sand beaches, and barrier islands are less likely to be impacted by sea level rise compared with the built-up areas. However, these areas and resources are already under stress. Most of the sandy beaches are eroding. Sand dunes are disappearing due to anthropogenic activities, such as the stoppage in the supply of fresh water and sediments in the coastal estuaries. All such degradation of coastal ecosystems will aggravate climate-change-induced sea level rise by increasing shoreline retreat or by coastal flooding.

The most vulnerable communities will include those having maximum exposure to these stresses, as well as those with the least capacity to respond and ability to recover. These physical changes will take place in abrupt, nonlinear ways as thresholds are crossed. The least resilient communities—for example, those dependent on subsistence fishing—will be the first to experience “tipping points” in their life systems; they will have little choice but to abandon their homes and search for better prospects elsewhere.

Extreme climatic and nonclimatic events have already caused coastal flooding resulting in substantial losses and fatalities (see *Box*, at right). The frequency of cyclonic events (especially during November, the month of severe cyclones) has increased by 25 percent in the Bay of Bengal and by 100 percent over the north Indian Ocean over a period of about 100 years (1877–1998). Salt water from the Bay of Bengal is reported to have penetrated 100 kilometers or more inland along tributary channels during the dry season. Climate change has the potential to exacerbate water resource stresses in most regions of South Asia, affecting agriculture

through declining production, as well as through reductions in arable land area and food supplies for fish. Climate change also poses substantial risks to human health in Asia. Within the region, empirical studies project that the largest population at risk of dengue fever will be in India.

Improved Governance of Coastal and Marine Ecosystems

In South Asia, as in many regions in the world, coastal and marine ecosystems have largely been managed in a piecemeal fashion and do not balance the protection of fragile coastal resources with rapid economic development in coastal areas. As a result, the added “piecemeal” regulation of coastal and marine ecosystems has led to unsustainable pressures on natural resource services and

Economic and Environmental Damage from Extreme Events on South Asia Coasts

The 2007 Cyclone Sidr caused 3,447 deaths and damage estimated at \$1.8 billion. The storm damaged 25 percent of the forests and the agricultural industry in the Sundarban area in Bangladesh. The 1999 cyclone in Orissa caused 9,803 deaths and economic damage estimated at \$5.1 billion. It left 1.67 million people homeless, destroyed 17,110 km² of cropland, and uprooted 90 million trees. The 2004 Indian Ocean tsunami took more than 225,000 lives in 11 countries. It damaged mangroves, coral reefs, coastal wetlands, sand dunes, rock formations, biodiversity, and groundwater.

growing conflicts among development uses. This problem is further exacerbated by the institutional regulatory framework, which spreads the management of coastal and marine resources across multiple agencies without adequate coordination, technical capacity, or enforcement. To promote the sustainability of coastal and marine ecosystems, the Bank has supported several regional initiatives for improved governance.

In India, an expert committee chaired by Professor M.S. Swaminathan reviewed the country's coastal laws and regulations (see *Viewpoint*, page 8). It found that ensuring the long-term sustainability of coastal and marine ecosystems will necessitate an integrated coastal zone management approach that simultaneously addresses resource protection, infrastructure planning, and community livelihoods. The government of India is proposing to replace the current regulatory



Sundarban Coastal & Marine Protection Initiatives

The Sundarban in the Ganges Delta in India and Bangladesh is the world's largest contiguous stretch of mangroves. These mangroves are breeding grounds for shrimp and fish, which feed higher trophic marine organisms. It is also home to the Royal Bengal tiger, the endangered Olive Ridley turtle, some of the largest estuarine crocodiles, and a variety of avifauna. The Bangladesh and Indian portions of the forest are listed separately in the UNESCO World Heritage list as the Sundarban and the Sundarban National Park, respectively. The continued existence and management of the Sundarban mangrove forest is of critical importance to the entire marine fishery in the Bay of Bengal. A management regime has been developed and adopted. The Bank will be supporting efforts to better assess and manage the marine assets in the Sundarban through several initiatives, including (a) the proposed India Integrated Coastal Zone Management Project, (b) nonlending technical assistance for preparation of a strategic action plan for the biodiversity conservation and socioeconomic development of the Sundarban area of India, and (c) through the ongoing transboundary review of priority environmental issues that need to be addressed in a strategic action plan for the Bay of Bengal.

framework with an integrated coastal zone management approach and has requested Bank support for an integrated coastal zone management project that will (a) map and delineate a hazard line and ecologically sensitive areas as a basis for preparing integrated management plans for all coastal zones in the country; (b) help build capacity in integrated coastal zone management at the state and national levels, including setting up a national coastal zone management institute; and (c) invest in promoting state-level approaches to integrated coastal zone management.

In the Maldives, marine ecotourism—the country's number one industry—is increasing population densities in some areas; at the same time, growing threats to the marine ecosystem are key impediments to sustainable development. Revenues from ecotourism support large investments in public education, health, and infrastructure. To ensure the sustainability of these investments, the Bank's Maldives Environmental Management Project will support improved governance of coastal and marine resources by (a) establishing a regional solid waste management program; (b) strengthening the regulatory and community capacity for environmental management; (c) expanding the knowledge base for monitoring critical

marine resources, such as fisheries and coral reefs; and (d) preparing a regional strategic environmental assessment.

Finally, the Bay of Bengal is one of the most important large marine ecosystems in the world, affecting approximately 400 million people in a catchment area in eight countries. The absence of a collaborative approach to transboundary challenges—for example, migratory species and coastal flooding—could lead to disastrous consequences for national economies and coastal communities in the region. The Bank—through the Global Environment Facility and in partnership with the Food and Agriculture Organization of the United Nations and other donors—is supporting a transboundary diagnostic analysis of the priority environmental issues that will need to be addressed in a strategic action plan for the Bay of Bengal. The Bank is also providing nonlending technical support to preparation of a strategic action plan for adaptation to climate change risks in the Indian part of the Sundarban ecosystem (see *Box*, above).

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Private Sector Contributions to Improved Coastal and Marine Resource Management



J. Wyjie / PNK

The International Finance Corporation's (IFC) current investment portfolio affecting coastal and marine resources comprises a small number of projects, including coastal hotels and resorts, agribusiness projects such as shrimp ponds, and offshore oil and gas. IFC also supports a range of innovative and ex-

ploratory technical advisory projects involving coastal and marine resources, including (a) the Komodo Collaborative Management Initiative (KCMCI) in Indonesia; (b) the Asian Conservation Company (ACC) in Palawan/Philippines; (c) the Maldives Resorts Coral Reef Rehabilitation Project; and (d) an IFC small-and-medium enterprise project

Komodo Collaborative Management Initiative

Pt. Putri Naga Komodo (PNK), a joint venture company, supports the Komodo National Park Authority in management of the Komodo National Park in eastern Indonesia. PNK shareholders are The Nature Conservancy (TNC) and Jaytasha Putrindo Utama. PNK, with the Komodo National Park Authority, is supported by a seven-year grant (2005–12) provided by IFC with matching funds from TNC. The Komodo Collaborative Management Initiative, which is the basis for the business model, is a groundbreaking experiment by the government of Indonesia involving the following policy elements: (a) new park management and financing models; (b) collaborative management approaches; (c) adaptive management approaches, and; (d) socioeconomic development programs.

The PNK business model relies on incremental and sustainable ecotourism revenues to sustain ongoing management and conservation. Through the provision of resources and facilities for park and tourism management and the collection of revenues from tourists, the company works with KCMCI to support (a) basic park management activities such as community outreach, communications, monitoring, surveillance, and enforcement of the park zoning system; (b) development of a comanagement structure maximizing involvement of local stakeholders; (c) sustainable community development through microfinancing and microenterprise development; and (d) destination marketing. Project outcomes include protection of the national park's resources, sustainable development of local communities living in and around the park, and a contribution to sustainable financing of park management through ecotourism development.



J. O'Hare / PNK

involved in seaweed production in eastern Indonesia. The *Boxes* on these pages describe some of these projects.

All of these projects are subject to the requirements of IFC's sustainability policy and performance standards. The policy and the standards help the private sector (and IFC) integrate social and environmental sustainability into their projects while simultaneously addressing social and environmental risk and maximizing the development opportunities of the projects. They make the consideration of ecosystem services more explicit and reinforce positive investor behavior regarding conservation of these services.

Conserving Coastal and Marine Biodiversity in Palawan, Philippines

The Asian Conservation Company Project—a partnership between a private equity investment holding company (ACC) and a local NGO (El Nido Foundation)— aims to conserve coastal and marine biodiversity in the El Nido-Taytay Managed Resource Protected Area, a 92,303-hectare terrestrial and marine park in Palawan, Philippines. The project relies on cofinancing from several stakeholders, including local government; private sector operators, including an ecotourism resort operation and a charter airline; the El Nido Foundation; and donors, including IFC. ACC component interventions include conservation partnership; conservation management; conservation enforcement; information, education, and communication; sustainable livelihoods; sustainable institutions and financing; and biodiversity research and monitoring. The project's conservation efforts have focused on a small area and have not been extended to the overall park. The sustainability of revenue streams that allow investment in conservation remains a key issue.

Maldives Resorts Coral Reef Rehabilitation Project

In 1998, the Maldives suffered extensive damage to its coral reefs resulting from increased ocean temperatures brought about by the global El Niño phenomenon. Shallow coral reefs in the central and northern atolls of the Maldives have been gradually recovering from the widespread coral bleaching but remain prone to a number of localized physical impacts from tourism activities, including reef walking, snorkeling, and diving in the vicinity of island resorts. A number of resort companies in the Maldives recognized the commercial value and environmental benefits of maintaining healthy, attractive coral and fish populations on their local reefs. These companies became interested in enhancing coral recovery rates and reducing the risk of their resorts becoming surrounded by extensive algae-covered rubble fields.



R. Hilliard

Since October 2004, in collaboration with Villa Hotels and Taj Maldives Private Limited (Taj MPL), IFC has supported a demonstration-based training and research project on the management of resort reefs. The project aimed to provide demonstration-based training and technical assistance for resort reef management and rehabilitation trials. The project focused on testing active and passive methods designed to enhance the growth and recovery of hard corals in areas frequently accessed by snorkeling and diving guests at resorts operated by Villa and Taj MPL.

Coral nurseries were established at three resorts by collecting loose and precarious coral fragments from representative colonies, attaching them to concrete plugs on 1 x 2-meter tables, and setting them on the lagoon floor in shallow water (2–5 meters deep) in sites where good tidal water and channel flow would maximize survival and growth rates. Once the nursery stock reached maturity, the concrete plugs were distributed randomly across the “house” reef.

The nursery and reef enhancement trials were monitored regularly. A national workshop held at the conclusion of the project aimed to disseminate the project results to a broad range of stakeholders and to build community awareness. Project outcomes included (a) an ongoing commitment to house reef management, (b) improved capacity of resort staff, (c) physical improvements to resort house reefs, and (d) interest from other regions, including Sri Lanka and Zanzibar/Tanzania.



R. Hilliard

Promoting Seaweed Production in Eastern Indonesia

Between 2004 and 2008, IFC focused on the promotion of small-and-medium enterprise development in Indonesia. The program addressed various sectors, including handicraft production, agribusiness, and supply chain linkages in the extractive industries.

In the agribusiness sector, IFC supported a project to improve the transparency of the seaweed marketing network and demonstrate profitable seaweed production and processing to increase the incomes of poor coastal communities. (Seaweed is a source of carrageenan, which is primarily used as a food additive.) Typically, seaweed production involves the cultivation of seaweed in bottles placed in "owned" and managed marine plots. Cultivators are responsible for the crop from seeding to harvest, a growth period of 40 to 45 days. At harvest, the farmers process and dry the seaweed before selling it to middlemen or end-users.

The project was initially tested in coastal communities in Sulawesi but was subsequently expanded to cover eastern Indonesia. It involved three distinct areas: (1) a farmer cooperation project to demonstrate best practices and improve productivity and household incomes; (2) attracting investment into establishing mini-processing facilities near growing areas to allow farmers to retain more of their value-added; and (3) a market information and crop forecasting service linking farmers and end-users. The project was successful in farmer outreach but less successful in promoting investment in processing.



Dr. I. Neish (SEAPlant Network Foundation)

The establishment of the SEAPlant Network Foundation (SPNF) (www.seaplant.net) provided the basis for improved transparency between producers and markets and ongoing outreach to producers. The managed cultivation associated with seaweed production implies a degree of protection/conservation that increasingly is attracting attention from other mariculture projects, including giant clam, abalone, and sea cucumber. Finally, the project raised awareness of the opportunities offered by seaplant cultivation and has stimulated donor interest in funding work (often with the SPNF) in Indonesia and the Philippines.

Conclusion

These projects present different approaches through which the private sector can contribute to and create incentives for the sustainable management of coastal and marine ecosystems and resources. The first approach attempts to bring together commercial and conservation interests at the ecosystem level. Unique ecosystems with high biodiversity value and significant tourism potential become the core resource for the project. The second approach (the Maldives project) involves private sector stakeholders with vested interests in marine resource conservation engaging in the management of the resource on their doorstep. The third approach relies on commodity-based interventions through the identification of existing commodities (seaweed) and/or market mechanisms (product certification) to create greater value and thereby promote improved management of the resource.

These approaches share an important attribute, namely that where individual enterprises and the sectors in which they operate are reliant upon the sustainability of ecosystem services, they are more likely to invest in conservation. In the face of coral bleaching and rising sea levels, for example, tourist resort operators in the Maldives were increas-



R. Hilliard

ingly willing to invest in the protection and restoration of coral reefs. This commitment to sustainability requires a long-term investment horizon and a sense of environmental and social corporate responsibility.

Where there are appropriate incentives, the private sector may internalize externalities and adopt sustainable management practices for ecosystem goods and services. At larger scales, where there are increasing numbers of stakeholders with competing demands, a greater private sector contribution to coastal and marine resource management would require development of local, regional, and national management frameworks that define the roles and responsibilities of all parties involved.

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legen

A Policy and Legal Framework Supporting Payments for Ecosystem Services

Payments for ecosystem services¹ (PES) are generally viewed as a voluntary arrangement between a provider of environmental services (such as sustainable land or water management) and those that benefit from such services. Under this scheme, a service provider is compensated by those who benefit; in turn, this encourages continuation or improved provision of these services beyond what would have been provided without the compensation. To date, PES has been applied largely to terrestrial/freshwater ecosystems and is in its infancy with respect to coastal and marine ecosystems.

The institutional framework for a successful PES scheme usually includes a number of national and local organizations, as well as mechanisms that support the implementation of the scheme, including (a) public institutions responsible for environmental management, (b) community-based organizations and NGOs involved in the management of natural resources, and (c) public/private financial institutions providing resources for the improvement of natural resources management. The institutional framework should be inclusive, with broad engagement of local communities in the design and implementation of the plan.

The legal framework for the implementation of a PES instrument should clarify land and resource tenure, provide specific rules and transaction mechanisms, and determine compliance and enforcement mechanisms. These requirements include (a) the rights over the resources in terms of ownership and access to the resources, (b) the payment of fees, and (c) the use and sharing of benefits among the stakeholders.

The International Context

Several multilateral environmental agreements lay out a broad framework for the protection of biodiversity that may be help-

ful for the development of a PES scheme. For example, the Convention on Biological Diversity (CBD) requires in Article 8 that each Contracting Party “establish a system of protected areas or areas where special measures need to be taken to conserve biological diversity” and “promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species.” At a meeting of the CBD in Bonn in 2008, the Parties agreed to “explore new and innovative financial mechanisms at all levels” to achieve the goals of the Convention. The decision (Decision IX/11) identified PES schemes as one such mechanism.



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The UN Convention on the Law of the Sea (UNCLOS) provides in Article 192 that “states have the obligation to protect and preserve the marine environment.” The treaty acknowledges the sovereign rights of coastal states to explore and exploit the natural resources in their exclusive economic zone, subject to the requirement of “proper conservation and management measures” so that the maintenance of the living resources is not endangered by overexploitation (Article 61). The 1995 FAO Code of Conduct contains nonmandatory principles for sustainable fishery management and provides a framework for national and international efforts to ensure sustainable exploitation of aquatic living resources. Specifically, Article 6 provides that “States and users of living aquatic resources should conserve aquatic ecosystems. The right to fish carries with it the obligation to do so in a responsible manner so as to ensure effective conservation and management of the living aquatic resources.” Article 6 also states: “All critical fisheries habitats in marine and fresh water ecosystems, such as wetlands, mangroves, reefs, lagoons, nursery and spawning areas, should be protected and rehabilitated as far as possible and where necessary.”

PES Schemes at the National Level

Several countries have developed and implemented a PES scheme at the national level, including Costa Rica, Vietnam, and China.

Costa Rica. The PES Program in Costa Rica was created in 1987, and the legal basis was provided in Forest Law 7575 adopted in 1996. This law recognizes four environmental services provided by forest ecosystems: (1) climate change mitigation; (2) watershed protection; (3) biodiversity protection; and (4) landscape beauty. Several institutions are entrusted with the management of the PES program to ensure that these services are protected, including the National System



P. Takoukam

of Protected Areas and the National Forest Financing Fund, which was established as a decentralized body of the forestry administration to handle financial issues for forests and natural resources.

The implementing regulation of the Forest Law provides that the government enter into multiyear contracts with landowners for reforestation, sustainable forest management, and forest protection. On average, landowners receive \$63/hectare/year for forest conservation, \$41/ha/yr for forest regeneration, \$816 over five years for reforestation, and \$1.3/tree for agroforestry. The bulk of funding for Costa Rica’s PES program has been derived from a fossil fuel sales tax; a newly established water fee will provide additional resources in coming years. Support has also been received from GEF and from Germany, Norway, international environmental NGOs, and several local and international companies. The contracts are renewable, and the landowners are free to renegotiate or sell their rights to other parties. As of the end of 2008, approximately 280,000 hectares—more than 10 percent of the country’s forest area—were under contract.

Vietnam. The Pilot Policy on Payment for Forest Environmental Services—Pilot Policy 380, signed on April 10, 2008—is the first of its kind in Southeast Asia. One of the new program’s pilot projects is in the Southern

Dong Nai River Basin, which was chosen for its large supply of water and heavy concentration of forested areas. This project involves collaboration among Vietnamese government bodies, industry, and local people, with support from the International Union for Conservation of Nature, Winrock International, and the U.S. Agency for International Development. Under this pilot project, hydroelectricity plants, government water companies, and ecotourism companies provide financial and other incentives to upstream communities to keep the downstream watershed clean. After the pilot phase (2008–10), this policy is expected to be applied elsewhere in the country as a financial tool for achieving the 2020 Forest Targets, which seek to increase forest cover from the 12.7 million hectares identified in 2006 to 16 million hectares by 2020. Vietnam also has a PES scheme for marine protected areas. For example, the Nha Trang Bay Marine Protected Area is supported by fees on sightseeing and a service charge for divers and snorkelers.

China. The Sloping Land Conversion Program—initiated by the Chinese central government in 1999 in response to the historic 267-day Yellow River drought in 1997 and the Yangtze River floods in 1998—is the largest land retirement program in the developing world. The primary goal of this program is to reduce water and

soil erosion by retiring steeply sloping land (greater than 25 degrees) from cropland and turning it into forests and grassland. The central government compensates farmers that participate with an annual in-kind amount of grain, a cash payment, and free seedlings. By the end of 2003, 7.2 million hectares of cropland had been enrolled in the program, which covered more than 2,000 counties in 25 provinces, mainly in western and central China, the most underdeveloped areas of China.

Recommendations

As these examples suggest, the PES concept has been established in many countries not via law but through specific programs or projects. However, to ensure sustainable PES

schemes, countries need appropriate legal and institutional frameworks.

An effective legislative framework for PES would define the institutional arrangements, responsibilities, contract requirements, and mechanisms for ensuring payments and the resolution of conflicts. The critical aspects of governance are the recognition and protection of the rights of local communities over the resources, the sharing of responsibilities between the national and local institutions through decentralization, the conditions of the public/private transactions, the financial mechanisms, and sharing of the benefits among stakeholders.

The PES schemes described here also demonstrate that the PES approach has mainly

been used for watershed protection, carbon sequestration, biodiversity benefits, and landscape conservation. It may be possible to broaden the PES scheme to services provided by coastal areas. For example, mangroves may be protected through a PES scheme that compensates those who steward them for the economic value they provide as a fish nursery or carbon sink.

While PES schemes are still relatively new, countries should exchange lessons learned. In an effort to develop appropriate institutional and legal frameworks for PES, it is equally critical to provide necessary technical and financial support, particularly to ensure the sustainability of effective PES schemes.

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Note

1. "PES" in some cases has also been used for the term "payments for environmental services." For the purposes of this article, the term "payments for ecosystem services" is used.

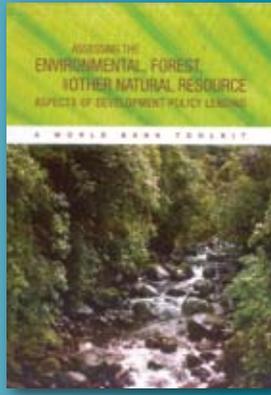
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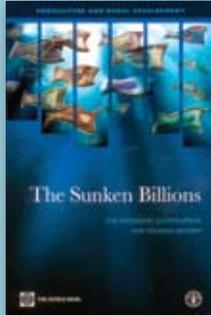
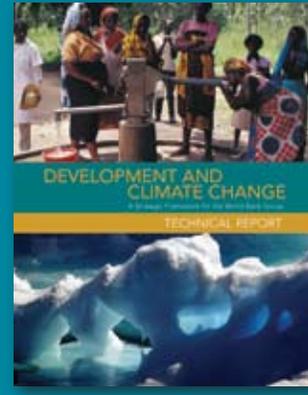
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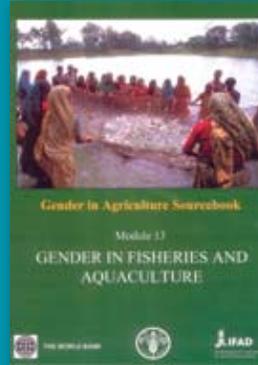
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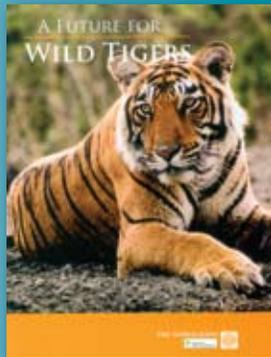


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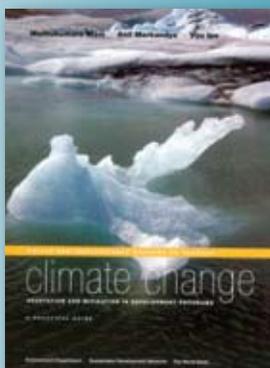
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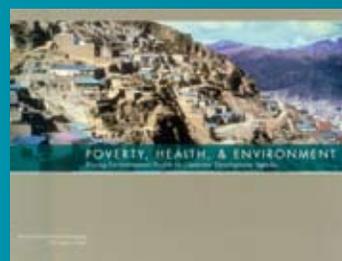
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