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Report Part Author(s): Poh Poh Wong

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Adaptation Policies in the Coastal Zones of the Indian Ocean Region: Challenges, Opportunities, and Strategies

Poh Poh Wong

This study spans the countries bordering the Indian Ocean from East Africa across South Asia and includes countries in Southeast Asia and island states in the Indian Ocean. Almost all are developing countries, and some are least developed countries (LDCs) where poverty is a serious problem. The coasts and coastal resources play significant roles in the region: a large percentage of the population lives in the coastal areas, and many people are dependent on coastal and marine resources as their primary protein source and for their livelihood. In many countries, it is often the poor—largely as squatters—who live in the most exposed, low-lying coastal areas. At the same time, many coasts have been degraded by exploitive activities such as the removal of mangroves, the destruction of coral reefs by blast fishing, erosion from coastal development, industrial pollution, and poor land management. Some coastal areas are subject to cyclones and flooding, which is common, for example, in Bangladesh and the Mekong Delta.

Climate change will exacerbate environmental and social problems in the coastal areas of the Indian Ocean basin.¹ In Southeast Asia, climate change poses a grave threat to agriculture and food security, water resources, natural ecosystems, forestry, biodiversity, and human health.² For East Africa, water resources, agriculture, forestry, and coastal zones are priority sectors.³ Throughout the region, rising sea levels constitute the most serious risk for coastal nations, with Bangladesh, India, Indonesia, the Maldives, Myanmar, the Philippines, Tanzania, and Vietnam figuring among the most vulnerable. The LDCs, particularly the small island developing states (SIDS), will disproportionately bear the brunt of climate change impacts. They contribute little to world greenhouse gas emissions, yet they possess limited capacity to mitigate the impacts of global warming and face other natural hazards as well. Rising not more than 3 meters above sea level, the Maldives faces the grim prospect of being completely submerged by rapidly rising seas within the century.

Within the Indian Ocean region, the Intergovernmental Panel on Climate Change (IPCC) has identified megadeltas such as the Ganges-Brahmaputra and Mekong, low-lying coastal

cities, and small island states as climate change “hotspots”— areas particularly vulnerable to the impacts of rising sea levels.⁴ Examples of vulnerabilities in the region include the following alarming scenarios:

- A sea level rise of 0.5 meters along Tanzania’s 800-kilometer coastline would inundate 247 square kilometers of the country.
- A 1-meter sea level rise would result in the loss of 15 to 20 percent of Malaysia’s mangroves—with serious consequences for fisheries and livelihoods—and would submerge more than 80 percent of the Maldives’s land area, and displace 7.1 million people in India.⁵

In recent years, more extreme weather events and rising sea levels have increasingly affected the coastal areas of the Indian Ocean and Southeast Asia. For example, an average of 20 cyclones typically cross the Philippines each year, with 8 or 9 making landfall. In the period 1990–2003, the average annual frequency of cyclones entering the Philippines area increased by 4.2.⁶ Of 15 cyclones and tropical storms that made landfall on the coast of Mozambique between 1980 and 2007, 4 occurred in 1980–93, and 11 in 1994–2007. Two cyclones in 1980–93 were in Categories 3–5 compared to seven in 1994–2007.⁷ In recent years, Categories 4 and 5 tropical cyclones have become more intense, including in the northern Indian Ocean.⁸

While mitigation and adaptation are equally important strategies for meeting the climate change challenge, the focus of this paper is on adaptation for coastal zones. Adaptation is a complex topic, with a range of definitions and implications. This paper uses the broad definition employed by the IPCC, addressing adaptation as adjustments in natural or human systems to actual or expected climatic stimuli or their effects that moderate harm or exploit beneficial opportunities. Adaptation can be *reactive* (taking measures to respond to climate change impacts) or *anticipatory* (taking measures before impacts are observed). A related concept, *adaptive capacity*, refers to the ability to adapt to climate change and gives an indication of the differing capacities—technical, financial, institutional, etc.—of societies to respond to climate stresses.⁹ Compared to developed countries, developing countries and LDCs have a lower adaptive capacity, and so require external support. Ultimately, the aim of an adaptation policy is to reduce exposure (e.g., move settlements to higher ground) and sensitivity (e.g., design coastal infrastructures to withstand storm surges) to climate change, or to increase adaptive capacity (e.g., disaster management planning) and resilience or coping ability.

This paper provides a brief overview of adaptation and coastal zone management in the Indian Ocean and Southeast Asian region, surveying the relevant challenges and obstacles, available opportunities, and effective strategies. It concludes by providing policy recommendations.

Regional Overview of Adaptation and Coastal Zone Management

Even before the advent of climate change concerns, many countries had adopted Integrated Coastal Zone Management (ICZM) strategies to address the complex challenges of sustainable coastal development. ICZM strives to balance environmental, economic, and social objectives within the limits set by natural dynamics. It aims to draw on the participation of all stakeholders to define and achieve these objectives and to resolve potential conflicts among competing interests. Intended to coordinate the relevant policy instruments and actors at multiple scales, and to guide planning that integrates short-term demands as well as medium- and long-range needs, ICZM is considered a suitable framework for climate change adaptation in coastal areas and forms an essential part of a national climate change plan. Thus, the National Communications formulated under the United Nations Framework Convention on Climate Change (UNFCCC) by many Indian Ocean states—including Bangladesh, Indonesia, Kenya, Malaysia, Mozambique, Seychelles, and Tanzania—envisage ICZM approaches. Sri Lanka has established a fully operational national coastal zone management (CZM) plan, though it lacks a sea level rise component.¹⁰

Other models have also come into use recently in coastal zone management and adaptation to climate change, including the following:

- Adaptation can take place at many different levels—global, national, regional, and local. *Community-based adaptation* (CBA) is an innovative approach enabling communities to enhance their own adaptive capacity, empowering them to increase their resilience to climate change impacts.¹¹ CBA focuses on activities carried out by highly vulnerable and poor communities, mostly in developing countries.
- Climate change will totally transform coastal and marine ecosystems in ways that today's management systems are often unprepared to accommodate. *Ecosystem-based management* takes a broader view of management decisions in order to understand the ecosystems themselves. Ecosystem-based management looks to take account of potential future changes that may be larger than those induced by present stresses, adopting a longer perspective that includes nonclimate issues.¹²

The IPCC identifies three standard strategies of coastal adaptation to sea level rise: (1) *managed retreat* (move landward to higher ground), (2) *accommodate* (stay in the same location but make adjustments, e.g., elevate buildings on piles), and (3) *protect* (employ various hard structures such as seawalls, bulkheads, groins, and breakwaters or use soft measures such as beach nourishment, mangrove replanting, and preservation of coral reefs).¹³

From an analysis of the National Communications of Asian countries, adaptation options differ from tropical to semiarid and arid regions. Tropical coasts tend to protect wetlands

and marine resources, improve preparedness for weather extremes, and implement CZM and contingency plans for migration in response to sea level rise. For semiarid and arid coasts, the priority is on water- and soil-saving technologies, measures to improve salinized soils, providing irrigation, and protection of settlements and infrastructure from sea level rise.¹⁴ In Southeast Asia, several adaptation options and practices are now widely used, including upgrading existing coastal protection systems, conserving mangrove forests and planting new stands, relocating aquaculture farms and coastal infrastructure, improving the design of housing and infrastructure, monitoring sea level rise and mapping hazard and vulnerability risks, and providing information to stakeholders and the public.¹⁵ In the Indian Ocean islands, coral conservation is particularly important. Successful adaptation, however, is expected to go beyond these technologies.

Compared to continental land masses or terrestrial ecosystems, climate change adaptation in coastal zones poses particular difficulties for coastal managers, decision makers, and stakeholders, for a variety of reasons. These reasons include increasing population pressures in coastal zones, complex natural-human interactions in frequently limited areas, the fragility of coastal ecologies, less leeway for adaptation—especially by retreat or relocation—in relatively narrow coastal bands, and the critical thresholds present in some coastal ecosystems. For example, coral reefs exhibit critical thresholds beyond which they may not be able to adapt to changing climate conditions without radically altering their function and role in the ecosystem.

Adaptation Obstacles and Challenges

Several adaptation policy challenges confront coastal managers, decision makers and stakeholders in the Indian Ocean region. According to one assessment conducted by the UNFCCC on adaptation measures in Asia, a lack of reliable and accurate data constitutes a major impediment. Wide variation in data collection methods, processing, and reporting of data for impacts and vulnerability assessments, as well as discrepancies and discontinuities in recorded data, frequently frustrate integrated policy development. Failure of monitoring equipment is also a common concern, and time-series data are often incomplete.¹⁶ Consequently, for many coastal areas, systematic observations are lacking for a range of oceanographic and atmospheric variables needed to evaluate evolving trends and assess emerging policy needs.

A lack of funding is another major obstacle. Under the UNFCCC, international funding to support adaptation in developing countries is an obligation under the “polluter pays principle,” but funding amounts have not been decided. While several funding sources are available, including the Global Environment Facility (GEF), the Least Developed Countries Fund (LDCF), the Special Climate Change Fund (SCCF), and the Adaptation Fund, current investment is incremental and still evolving.¹⁷

The GEF, for example, provides funds for vulnerability and adaptation assessments for specific projects and programs. From 2001 to 2006, GEF funds were allocated for coastal projects in Bangladesh, the Maldives, the Philippines, Seychelles, and Tanzania.¹⁸ Funding provided by the LDCF hinges on country development of a National Adaptation Program of Action (NAPA). So far, countries in the Indian Ocean with NAPAs include Bangladesh, Cambodia, Comoros, Djibouti, Eritrea, Madagascar, the Maldives, Mozambique, Tanzania, and Yemen.¹⁹ Myanmar and Timor Leste are eligible for LDCF funding but have yet to submit their NAPAs.

The NAPA provides a means by which LDCs can identify priority activities to respond to their urgent and immediate climate adaptation needs, but the system has several flaws that limit the effectiveness of adaptation planning and implementation. First, funding was initially limited to \$200,000 per country for developing the NAPA—a sum that is a fraction of what some European cities spend on climate risk assessment. Second, adaptation costs are underestimated, because there are not enough funds in the LDCF to finance the requirements identified. Third, most NAPAs focused on small-scale projects cofinanced by donors that do not provide an adequate basis for implementing an effective adaptation strategy as they tended to focus on “climate-proofing” measures with only weak links to human development criteria and no integration into national poverty reduction strategies.²⁰

Overall, there is a significant difference between the funds pledged to and the money actually transferred by the LDCF and the SCCF. The current funding flows are largely insufficient to meet demand. The SCCF has funded one coastal CBA project for Bangladesh and coastal projects for the Maldives and Vietnam, but is now closed for new submissions until funding becomes available again.²¹ The Adaptation Fund operates under the Kyoto Protocol and is based on a 2 percent surcharge on Clean Development Mechanism project financing, but is unlikely to generate sufficient capital flows. Instead, the main contributions to the fund are likely to come from development financing and private investment.²²

According to an independent assessment, the UNFCCC has underestimated the global costs of coastal protection by a factor of 2 to 3.²³ The UNFCCC adaptation cost assessments are quite detailed and were based on extensive experience, which took into account traditional coastal engineering responses. Even so, these estimates failed to consider several key factors. For example, recent projections for future sea level rise have been substantially higher than the IPCC figures used by the UNFCCC. The UNFCCC estimates also neglected to take into account important climate changes such as extreme storms, as well as nonclimatic changes such as coastal subsidence (evident in the city of Bangkok, for example). Finally, the UNFCCC did not consider the protection of landscapes for their value as an amenity and in ecological recreation. As a result, the current level of international financial transfers to address adaptation challenges in the Indian Ocean and Southeast Asian region is far short of what is required.

Beyond the question of available funding, the complex and lengthy processes for accessing existing financial resources further complicate the implementation of adaptation measures. Moreover, the lack of coordination and cooperation among national agencies often leads to conflicting approaches and priorities. Climate change has not yet been fully appreciated as a national issue in development. The LDCs, especially those in Africa, face particular hurdles in overcoming these difficulties, since they generally possess low levels of the scientific expertise and administrative capacity needed to formulate and carry out integrated adaptation policies. For these countries, few resources are allocated at national levels to climate policy, which is seen as a lesser priority compared to other urgent needs. Indeed, international donors and other organizations sometimes contribute to the confusion of competing pressures, pushing countries to incorporate not only climate change, but also gender, HIV/AIDS, biodiversity, and other issues into their core development policies.²⁴ In Madagascar, for example, the conservation organizations prefer to address global warming within their own conservation agenda, instead of incorporating conservation programs as elements in an integrated climate adaptation strategy.

The UNFCCC synthesis of reports submitted by countries and organizations on adaptation technology revealed an important additional obstacle to adaptation in the Indian Ocean and Southeast Asian region.²⁵ Specifically, the private sector is not involved at a sufficiently early stage. Adaptation inherently suffers from several market failures, which arise because of uncertain information associated with the costs and benefits of large-scale and long-term investment such as coastal protection measures. As a result, the private sector underinvests in adaptation.²⁶

Ultimately, developing countries—including the majority of those in the Indian Ocean and Southeast Asian region—will experience climate change differently depending more on their disparate vulnerabilities and adaptive capacities than on the differing environmental impacts projected to strike their coasts.²⁷

Adaptation Opportunities

Technology transfer provides important opportunities in adaptation. It is a key component of the UNFCCC process, ensuring flows of expert know-how, practical experience, and technical equipment for climate change mitigation and adaptation among stakeholders.²⁸ Adaptation technologies for coastal zones are normally classified as “hard” or “soft,” with the former relying on permanent concrete and rock constructions, and the latter on natural elements such as sand, dunes, and vegetation. These technologies can be further classified as traditional, modern, high, and future.²⁹ *Traditional/indigenous technologies* are those that were first developed in traditional societies to respond to specific local problems. *Modern technologies* are those created since the Industrial Revolution. *High technologies* are those created from recent scientific advances, including information and communication

technologies and computer monitoring and modeling. *Future technologies* do not yet exist in a commercially viable form. Some traditional, modern, and high technologies used in the coastal zones are listed in table 1. Traditional technologies are vital for adaptation, but the transfer of modern technology is also necessary.

Technology transfer is not an easy process in the Indian Ocean region. Its success depends on several factors, including the type of technology, the availability of appropriate financial vehicles, and a policy environment that supports technology. As was noted with regard to

Table 1: Traditional, Modern, and High Adaptation Technologies in the Coastal Zones

Technology	Traditional	Modern	High
Restoration of coastal forests and coral reefs	X		
Sand dune restoration and construction	X		
Community-based conservation and aquaculture	X		
Seawalls, revetments, and headlands	X		
Beach nourishment and dune restoration	X		
Protection and reconstruction of wetlands	X		
Littoral drift replenishment	X		
Afforestation	X		
Creation of drainage areas	X		
Dikes, dams, levees, nets, and dredging	X	X	
Dikes and groins	X	X	
Saltwater intrusion barriers	X	X	
Tidal barriers	X	X	
Reef protection	X	X	
Detached breakwaters		X	
Coastal and coral erosion monitoring	X	X	X
Sea level and tide monitoring			X
Coastal zone monitoring			X
Impact assessment studies			X
Light detection and ranging			X

Source: Adapted from United Nations Framework Convention Climate Change, "Advance Report on Recommendations on Future Financing Options for Enhancing the Development, Deployment, Diffusion and Transfer of Technologies Under the Convention" (2009), p. 79, <http://unfccc.int/resource/docs/2009/sb/eng/inf02.pdf> (accessed March 4, 2010).

one adaptation program, “It is not for lack of options that adaptation lags. It is lack of determination, lack of cooperation and lack of means that impede adaptation.”³⁰

Given that several countries around the Indian Ocean face extreme weather events—and that these events are already increasing in intensity—it makes sense to link existing disaster reduction and prevention to climate change adaptation. Both approaches reduce risks.

For example, Cyclone Nargis tore into southern Myanmar in early May 2007, leaving over 130,000 people dead or missing. In comparison, 3,300 people lost their lives when Cyclone Sidr struck Bangladesh in November 2007. Cyclone Sidr was more powerful than Nargis, but the death toll was much lower in part because Bangladesh has a well-tested disaster reduction program. A primary condition for the success of this program is that the disaster reduction and climate change communities within the government, private sector, civil society, and scientific agencies must cooperate. Involving people and institutions at the local level is vital.³¹ The Mangrove for the Future initiative, established in the wake of the Indian Ocean tsunami of December 2004, was developed in part to address the challenges that climate change poses for the Indian Ocean region, offering an example of a program combining disaster reduction and adaptation. During its initial phase in 2006–11, the project is targeting the six worst-affected countries (India, Indonesia, the Maldives, Seychelles, Sri Lanka, and Thailand) as they recover from the tsunami. The project will emphasize protection of natural barriers to extreme weather events and the rehabilitation of degraded coastal areas.³²

In addition to funding and technology transfer, insurance-related actions have been identified as another important component of climate change adaptation. Insurance provides a vehicle to spread and transfer risk and to engage the private sector. It can be a useful instrument for developing countries, particularly coastal communities exposed to climate hazards, and for the tourism industry, which is dependent on the continuing viability of the coasts.³³ For poor communities, microfinance can also be used in climate change adaptation.³⁴ The idea of an international insurance scheme is not new, as proposals have been made in the past. In recent years, political support has risen for assembling suitable insurance schemes to serve the poorer countries in particular. While insurance alone will not address all of the risks or adaptation challenges of climate change, it can be a strong component of a broad-based adaptation framework.³⁵

The multilateral development banks are taking a more comprehensive approach to support strengthening adaptation and resilience. The World Bank has partnered with the United Nations International Strategy for Disaster Reduction to reduce vulnerability to natural hazards and extreme events (e.g., supporting Yemen’s ICZM). It has also initiated sector-specific and regional studies, examining Asian coastal cities and floods in India, among

other topics.³⁶ The Asian Development Bank also funds several initiatives. These include increasing the climate resilience of vulnerable sectors, such as coasts in India and Ho Chi Minh City in Vietnam, and supporting the development of private sector-based instruments such as climate-oriented insurance products.³⁷

The provision of technical and institutional capacity building through international cooperation plays an important role in overcoming some of the problems in adaptation, as seen in two examples, one completed and one now in its second phase. The first example is the Assessment of Impacts and Adaptations to Climate Change (AIACC), a global initiative developed in collaboration with the IPCC and funded by the GEF to advance scientific understanding of climate change vulnerabilities and adaptation options in developing countries. Technical and institutional capacity building were provided through three general workshops (on projects, scenarios, and vulnerability and adaptation) and a series of regional workshops. Of 24 regional assessments implemented in 2001–07 under the AIACC, two projects involved several countries in the Indian Ocean and were related to coastal areas.³⁸ In Project AS07 (Vulnerability to Climate Change–Related Water Resource Changes and Extreme Hydrological Events in Southeast Asia), the research helped enhance the capacity of Southeast Asian countries, particularly Laos and Thailand, in the study and assessment of climate impacts and vulnerability and adaptation to climate change. Project activities helped develop the research capacity of personnel as well as build networks among institutions in Laos, Thailand, and Vietnam. Project SIS90 (Impact of Climate Change on Tourism in Seychelles and Comoros) explored the problems of coastal erosion and risks to tourism in Seychelles. To build local capacity, the project supported advanced degree research that linked adaptation to climate change, training in geographic information systems, and monitoring of beaches and coral reefs.

The second example involves the Nairobi Work Program, carried out by the UNFCCC from 2005 to 2010 in two phases, with the first phase completed in June 2008.³⁹ The program assists all parties to the UNFCCC—particularly developing countries, including LDCs and SIDS—improve their abilities to assess impacts, vulnerability, and adaptation to climate change. It serves as a platform for dissemination of scientific information and to support implementation of adaptation. The program focuses on two main areas (impacts and vulnerability; and adaptation planning, measures, and actions) and carries out various activities in nine subareas (methods and tools; data and observations; climate modeling, scenarios, and downscaling; climate-related risks and extreme events; socioeconomic observation; adaptation planning and practices; research; technologies for adaptation; and economic diversification) to improve capacity at various levels and sectors. This work is being further developed in the second phase for implementation by countries, intergovernmental and nongovernmental organizations, the private sector, communities, and other stakeholders, especially for developing countries.

Effective Adaptation Strategies and Policy Recommendations

Several lessons can be drawn from an assessment of the AIACC regional projects that can be helpful to the countries of the Indian Ocean and Southeast Asian region in formulating their adaptation strategies:⁴⁰

- Follow a policy of “adapt now and don’t delay,” as adaptation will cost more in the future.
- Create conditions or policies to enable adaptation by individuals, communities, and the nation as a whole.
- Integrate adaptation with development planning to advance both adaptation and development goals.
- Increase awareness of and knowledge on adaptation, as insufficient information is often a constraint to taking action.
- Strengthen the roles of local and national institutions with regard to adaptation issues.
- Rehabilitate and protect natural resources from damage from climate change.
- Provide financial assistance for adaptation.
- Involve at-risk stakeholders in adaptation planning and implementation.
- Use location-specific strategies that are appropriate to the individual contexts of particular areas.

Underlying these lessons are certain basic truths about adaptation:

- There is no silver bullet. Adaptation must be location-specific, and institutional capacities are important for community-based adaptation.⁴¹
- Local acceptance and cooperation is vital at all stages. For successful adaptation, it is crucial to involve all stakeholders; AIACC projects have tried to involve as many as possible.
- Policy recommendations for the future should address the question of political will. Although adaptation is usually in the hands of the public sector, the private sector, NGOs, and international organizations play important roles.

A close relationship between climate change and development means that adaptation is best mainstreamed into development practice and not developed as a stand-alone activity. “Mainstreaming” refers to the integration of climate change vulnerabilities or adaptation into a related government policy, such as disaster preparedness.⁴² Although mainstreaming is an emerging process, it is now primarily donor-driven and does not necessarily consider climate change an important concern. For example, the first-generation poverty reduction strategy papers produced by the United Nations Environment Programme (UNEP)

made little reference to climate change.⁴³ Countries in the Indian Ocean and Southeast Asia regions must understand the need to incorporate adaptation into the planning process for sustainable development. Risk management and reduction can also be incorporated into adaptation planning at all levels. The UNFCCC has prepared a technical paper that explores this approach.⁴⁴ Mainstreaming tools for the coasts are also available, such as the US Agency for International Development's adaptation guidebook tailored for coastal areas.⁴⁵

Although many Indian Ocean and Southeast Asian countries face common and interrelated challenges, they lack a regional policy framework for climate adaptation. Cyclones and storm surges, coral bleaching, fisheries, and even tsunamis (although these last are not related to climate change, they also affect the resilience of coastal communities) are all transboundary issues. Reducing such environmental and climate change risks requires information and early-warning systems from a regional or international network. Regional capacity building in data collection, monitoring, and evaluation are required for countries to understand the shared problems facing the region and to work toward framing policy strategies for cooperative solutions. For example, many of the region's coastal ecosystems cross national borders, making regional cooperation an effective means to deal with cross-boundary issues such as fisheries and marine protected areas.⁴⁶

The need for a regional adaptation framework has been addressed in several forums. For example, the Medium-Term Strategy (2010–13) of the UNEP Regional Seas Programme incorporates an ecosystem management component. One element of this strategy aims to assess and address the effect of climate change on the marine and coastal environment and to promote cooperation for formulating regional adaptation strategies.⁴⁷ Such efforts are under way within the Regional Seas Programme for the Pacific and Mediterranean but not yet for the Indian Ocean or Southeast Asia. Similarly, strong regional entities are dealing with climate change in the Caribbean and South Pacific. The Caribbean Community Climate Change Centre, for example, acts as a key node for information and regional responses to managing and adapting to climate change.⁴⁸ The South Pacific Regional Environment Programme operates a climate change program intended in part to develop adaptation response measures.⁴⁹ Potential opportunities exist for a large-scale regional initiative, either by using the existing policy structures or going beyond the UNFCCC framework. Two possible implementation models could be used—a regional center or a regional project. The International Ocean Commission, or a similar regional organization with international support, could take the lead in implementing an action-oriented regional project in the Indian Ocean. The project could be part of scaling-up integrated climate change adaptation and disaster reduction policies using the existing United Nations International Strategy for Disaster Reduction Hyogo Framework for Action.⁵⁰

Current UNFCCC provisions do not mainstream climate-friendly technology into the innovation and investment frameworks of developing countries. A regional center for the Indian Ocean might therefore also help facilitate technology transfer and knowledge sharing. It could take the form of a regional center of excellence and learning to assist vulnerable communities in adaptation mechanisms, exchanging best practices, capacity building, and fostering public-private partnerships. Disseminating best practices to a wider audience is especially important for low-cost adaptation actions and measures to achieve the links among policymakers, researchers, and users. Note, however, that regional structures do not negate the necessity for place-specific strategies adapted to local contexts.

A large-scale regional initiative could also help tackle the priority problem of the small island states and low-lying deltas of the Indian Ocean and Southeast Asia. Rising sea levels and stronger storm surges pose serious risks of flooding to the densely populated Asian megadeltas, while potential inundation not only threatens small island states with the loss of their Exclusive Economic Zones but raises the specter of mass population displacements from submerged atolls. Indeed, in November 2008, the Maldivian president-elect suggested buying a new homeland abroad if sea level rise continues—an adaptation strategy with obvious international ramifications.⁵¹

Given these risks, the SIDS and low-lying deltas may need to consider some bold adaptation measures for the future. For example, the success of artificial island reclamation in shallow waters off the coast of Dubai could be applied to the reclamation of SIDS threatened by rising sea levels and possible extinction. Perhaps wealthy countries that have gained this expertise might help finance island reclamation for SIDS. In this way, instead of abandoning its atolls within the next century, the Maldives could adopt a strategy of saving some islands by using them as “fill” for other islands now.⁵² Similarly, in deltas with sediment-rich rivers, these sediments could be channeled into low areas to create land above sea level. Bangladesh has experimented with such sedimentation engineering. At Beel Bhaina, on the banks of one of the tributaries of the Ganges, silt brought by rivers across the low-lying delta has been channeled into low-lying, flood-prone depressions.⁵³ Over time, pieces of high ground are created and used for agriculture. Although this is not a technique designed to counter sea level rise, it should be evaluated for such use, as success in climate adaptation often stems from the resourcefulness of local people applying local methods.

Large-scale modular mangrove planting should be considered as another measure for protecting the coast against gradual sea level rise.⁵⁴ Mangroves grow on tidal mudflats but can also survive on various substrates and in nontidal areas. The coastal strip over which mangroves grow can be raised with the addition of a wide variety of sediments to serve as a protective barrier. Thus, replanting of mangroves and coastal forest belts can be readily

adapted to different shorelines depending on the level of exposure to erosion. Replanting typically costs less than hard protection measures, and has been carried out on a small scale by local coastal communities with varying levels of success. The Asian Development Bank's policy recommendation for Southeast Asia on adaptation for coastal sectors is to implement CZM plans, including mangrove conservation and planting.⁵⁵

Finally, some bold adaptation measures may require conceptual innovations. ICZM remains the best framework for climate adaptation for coastal regions but must be modified to meet future needs. One promising area for improvement involves integrating climate change and tsunami adaptation measures. Although tsunamis are not the result of climate change, adaptation strategies should consider both threats. Measures taken to expand and strengthen livelihoods against an extreme event such as a tsunami can also serve to increase resilience against storm surges and sea level rise.⁵⁶ At the same time, policymakers should learn to consider rising sea level as not necessarily totally negative, but as offering opportunities as well. According to the ancient Chinese treatise, *The Art of War* by Sun Tzu, one fights water with water.⁵⁷ Thus, as sea levels rise, prepared communities may be able to exploit the situation for economic gain, turning submerged land into floating gardens for food or pools for fish farming.

Conclusion

Successful adaptation will require that developing countries receive sufficient assistance both with “hardware” (appropriate technologies) and “software” (finance, institutions, and the policy environment). More importantly, such measures should show demonstrable practical solutions, especially for SIDS.

Strong national or regional policy is also necessary for adaptation. Within each country, political will is paramount. For strong regional cooperation or development of a regional framework, an impetus from outside the region or international support is sometimes necessary. Both national and regional policy must drive adaptation strategies to meet future climate change issues and challenges, which will be increasingly of a transboundary nature.

Notes

1. For overall coverage of the region's vulnerabilities, see chapters 9 (“Africa”), 10 (“Asia”), and 16 (“Small Islands”) in M. L. Parry et al., eds., *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge: Cambridge University Press, 2007).

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4. Intergovernmental Panel on Climate Change, “Summary for Policymakers,” in Parry et al., op. cit., p. 12.
5. Details on the vulnerabilities of individual countries are available in each state’s Initial National Communication submitted to the United Nations Framework Convention Climate Change (UNFCCC), listed under National Communications (Non-Annex I), at www.unfccc.int/national_reports/items/1408.php (accessed March 3, 2010).
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