USAID
FROM THE AMERICAN PEOPLE

ADAPTING TO COASTAL CLIMATE CHANGE

A GUIDEBOOK FOR DEVELOPMENT PLANNERS

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Coastal Resources Center
University of Rhode Island

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acronyms

BMP	Best Management Practice
CRC	Coastal Resources Center
ICM	Integrated Coastal Management
IPCC	Intergovernmental Panel on Climate Change
IRG	International Resources Group
LDC	Less Developed Countries
NAPA	National Adaptation Programme of Action
PES	Payments for Environmental Services
SCCRF	Special Climate Change Fund
SIDS	Small Island Developing States
UNFCCC	United Nations Framework Convention on Climate Change
URI	University of Rhode Island
USAID	United States Agency for International Development
V&A	Vulnerability and Adaptation

acknowledgements

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preface

The challenges we all must face in adapting to climate variability and change present themselves with increasing urgency. Nowhere will these challenges be greater than in the developing world where often weak institutions and governance systems struggle to deal with mounting pressures from population growth, inadequate infrastructure, and diminishing or already depleted natural resources.

In this context, the unique ecosystem processes and extraordinary development pressures within the coastal zone require that development planners – and the donors who assist with development – give special urgency to the task of helping to build resiliency against the impacts of climate change. The changes are many and already underway. They include rising sea level, increasingly intense cyclones, altered precipitation and runoff, elevated sea surface temperature, and ocean acidification.

The decades ahead will witness increased numbers of people, infrastructure, and ecosystems at risk in the coastal zone. National and local leaders across all sectors must begin now to engage stakeholders in assessing vulnerability and designing adaptation strategies that are technically, financially, and politically achievable. Meanwhile, donors too must work to protect their investments by incorporating analyses of climate variability and change into the design and implementation of virtually every kind of development assistance program to be implemented within the coastal zone.

This Guidebook is both a tool in itself and a link to other resources to help with those efforts. The processes, tools, and resources that it contains are based on the inputs of numerous coastal planners, climate change experts, and other development professionals. It was prepared under the guidance of the Water Team and Global Climate Change Team of the U.S. Agency for International Development.

The effective application of these tools, development of new techniques and sharing of lessons will be critical to meet all of the myriad challenges of a fast evolving landscape/seascape of coastal climate change adaptation around the world. We consider this a first edition and welcome and encourage your comments, suggestions, and inputs for inclusion in subsequent editions.

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summary for policymakers

Adapting to Coastal Climate Change: A Guidebook for Development Planners (the Guidebook) provides a detailed treatment of climate concerns in coastal areas. The Guidebook proposes an approach for assessing vulnerability to climate change and climate variability, developing and implementing adaptation options, and integrating options into programs, development plans, and projects at the national and local levels. This is known as a vulnerability and adaptation or V&A approach. The summary presented here is designed for policymakers and others who are interested in the Guidebook's key messages and may review the full version later or use the Guidebook as a reference document. The summary is organized by the steps in the V&A approach that is recommended in this Guidebook. References for the information provided in this summary are included in the main body of the Guidebook.

There is an unequivocal scientific consensus that the changes brought by climate change are already occurring and will intensify in the future, likely resulting in significant alteration of coastal ecosystems, coastal hazards, and lifestyle changes for fishers, coastal resource users, waterfront property owners and coastal communities. These have far-reaching impacts on a range of challenges for coastal resource managers. Dramatically stepped up efforts are needed to guide proactive adaptation actions that benefit human and natural ecosystems for present and future generations.

STEP 1. ASSESS VULNERABILITY

The assessment of vulnerability focuses on gaining an understanding of how climate variability and change will impact coastal communities, the goods and services provided by natural resources, and human-built infrastructure.

Vulnerability assessment for climate change in specific coastal regions considers three factors: 1) the nature and magnitude of climate variability and change; 2) the human, capital, and natural assets that will be exposed to and impacted by climate change; and 3) the current capacity of coastal communities and ecosystems to adapt to and cope with climate impacts.

Climate is changing in response to increased greenhouse gas emissions, and projections for the coming decades paint a somber picture.

There is scientific consensus that increases in greenhouse gases in the atmosphere drive warming temperatures of air and sea, and that the world's oceans acidify as they absorb the carbon dioxide. Warming of air and sea causes shifts in precipitation patterns and hydrological cycles, sea level rise, and more frequent and severe extreme weather events (e.g., storms and storm surge). These effects are already being witnessed in the world's coastal regions and are projected to intensify in years to come.

Climate change will impact the health, function and productivity of coastal ecosystems, thus impacting the health and welfare of coastal communities and the billions of people that depend on these natural resources.

Climate changes will have significant and immediate consequences for the world's coasts, the goods and services provided by coastal ecosystems, and coastal inhabitants. This includes accelerated coastal erosion and loss of land and property, flooding, saltwater intrusion, shifts in the distribution and abundance of valuable marine habitats, species and biodiversity, and the accelerated spread of exotic and invasive species.

It may mean more frequent coral bleaching and increased mortality, loss of coastal wetland ecosystems and fishing grounds, and growth in the spread of marine dead zones.

The ocean is also becoming more acidic (decreased seawater pH) as it absorbs atmospheric carbon dioxide (CO_2). Ocean acidification has potential widespread effects on marine ecosystems. It may inhibit calcification, which will threaten the survival of coral-reef ecosystems. It will inhibit the growth of calcareous algae at the base of the food web and of shell-forming marine organisms (such as scallops), and it will stunt the growth of calcified skeletons in many other marine organisms, including commercial fish species. These species changes then affect local fisheries livelihoods and food supplies for coastal communities.

The ability of ecosystems and habitats to adapt to climate impacts can be increased by reducing other stressors such as overfishing and land-based pollution. Reducing these current stresses will increase the resilience or ability of the environment to adapt to future impacts, thus reducing threats to human welfare.

Coastal areas most vulnerable to climate change are low-lying islands, coastal areas and deltas; countries subjected to hurricanes and typhoons; and less developed countries

Relative to other coastal areas, low-lying islands, including many Small Island Developing States (SIDS), are more vulnerable to the impacts of climate change because they have relatively scarce natural resources (e.g., water resources, construction materials and physical space) and they have limited and high cost transportation options. Low-lying SIDS have little scope for adaptation and are particularly vulnerable to sea level rise and storm surge.

Less developed countries are vulnerable to climate change because of rapid population growth, much of it concentrated in coastal areas; high dependency on climate-sensitive industries such as fisheries, coastal agriculture and tourism; a degraded natural resource base; weak administration and governance systems; and poor transportation and communication infrastructure.

Low lying coastal areas and deltas are highly vulnerable to sea level rise, extreme weather events and storm surge. Globally, at least 150 million people live within 1 meter of high tide level, and 250 million live within 5 meters of high tide. At greatest risk are the densely populated Asian mega-deltas of rivers including the Yangtze (China), Ganges-Brahmaputra (Bangladesh), Mekong (Cambodia), and Irrawaddy (Myanmar). Other major mega-deltas at risk are the Nile (Egypt), Niger (Africa), and Mississippi (USA).

Climate change combines with and amplifies non-climate stressors on coastal ecosystems.

Coastal ecosystems are already seriously stressed in many areas of the world. Reasons include intense coastal development and overpopulation, poverty, internal conflict, fragmentation and loss of habitat, over-fishing, pollution, and spread of invasive species. These non-climate stressors will impair the resilience of ecosystems, i.e., the ability of the ecosystem to maintain its integrity and to continue to provide critical goods and services to coastal communities.

Uncontrolled development along the coast results in conflicts over access, increased demands on infrastructure, degraded water quality and increased risks to natural hazards. Sinaloa, Mexico

Mangroves, coral reefs, estuaries, seagrass beds, dune communities and other systems on or near shorelines serve critical ecological functions that are important to human society. Such functions include fisheries, storm protection, flood mitigation, erosion control, water storage, groundwater recharge, pollution abatement, and retention and cycling of nutrients and sediments. Healthy habitats function as self-

repairing "natural infrastructure," in contrast to human-built infrastructure, thus minimizing maintenance costs. When these critical resources are compromised, coastal ecosystems are weakened—and weakened, unhealthy coastal ecosystems are less resilient to climate change and variability.

Adaptive capacity refers to the ability of society to plan for and respond to change in a way that makes it better equipped to manage its exposure and sensitivity to climate change.

Adaptive capacity depends on economic well-being, ecological well-being, the extent of dependency on natural resources, infrastructure (human-built or natural), effectiveness of institutions and governance systems, insurance, secure land tenure and mediation measures, and information and communication systems. A community with the capacity to adapt is likely to be more resistant to impacts or able to recover from stressful events and conditions.

STEP 2: SELECT COURSE OF ACTION

Planned adaptation is strategic and aims to address the full range of coastal climate change hazards in ways that meet social objectives.

In general, there are two types of adaptation—'reactive' and 'planned'. Reactive adaptations are the changes in policy and behavior that people and organizations adopt after they have observed changes in climate and coastal risks. This Guidebook focuses on planned adaptation—that which is strategic, intentional, proactive, and occurs at the societal level.

The selection of a course of action to address climate vulnerability involves the identification of adaptation goals, and assessment of individual adaptation measures or measures bundled into a strategy.

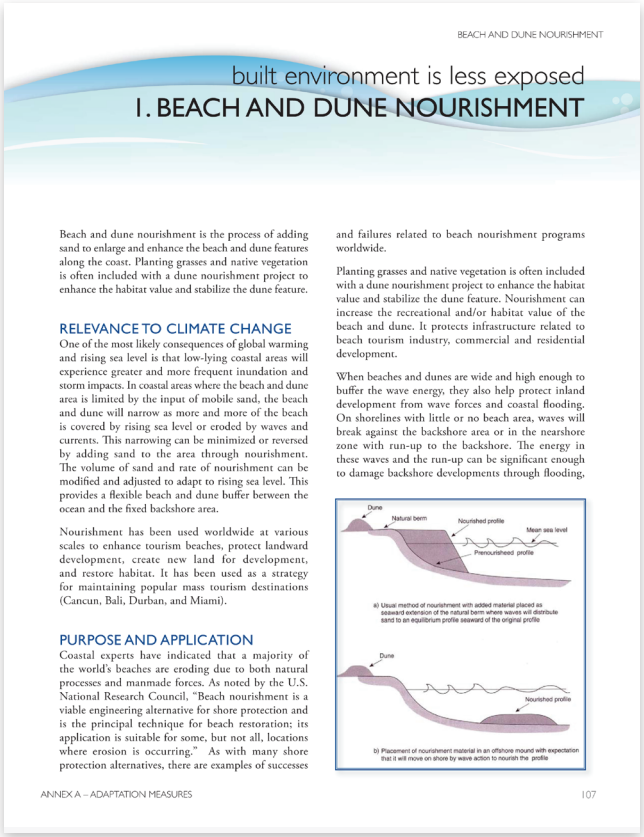
Coastal areas may be subject to a variety of climate impacts. Therefore, it is useful to prioritize your climate vulnerabilities. This will help in selecting your adaptation options and course of action. It is important to coordinate this with the decision-making procedures that govern the program, plan, or project for which climate is a concern. We urge policymakers to engage major stakeholders in setting adaptation goals, selecting criteria for and assessing adaptation options, and providing input into the final selection process. Major categories of management goals common to adaptation programs in coastal areas include:

1) Maintain functioning and healthy coastal ecosystems
2) Reduce exposure and vulnerability of the built environment
3) Strengthen governance frameworks for coastal adaptation
4) Maintain livelihood opportunities and diversify options
5) Reduce risks to human health and safety

A gallery of coastal adaptation measures has been developed for the Guidebook. Many of these will be familiar to coastal management professionals—the climate lens is new, but in most cases the tools are not.

The Guidebook includes practitioner briefs on 17 coastal adaptation measures and strategies. Each brief describes the measure's relevance, purpose and application to climate change, information and data requirements, design considerations, suggestions for improving likelihood of success, and list of resources. The 17 briefs were chosen by coastal practitioners from an initial list of 50 adaptation measures.

Traditionally, practitioners would view many of these adaptation measures in terms of their potential benefits in promoting coastal management goals. Applying a climate lens means that adaptation measures are viewed in terms of how they reduce impacts and/or improve the resilience of communities and ecosystems in the face of climate change and variability while promoting coastal management goals. In other words, it means planning with a longer time scale and a wider range of possible variability in mind.



BEACH AND DUNE NOURISHMENT

built environment is less exposed

1. BEACH AND DUNE NOURISHMENT

Beach and dune nourishment is the process of adding sand to enlarge and enhance the beach and dune features along the coast. Planting grasses and native vegetation is often included with a dune nourishment project to enhance the habitat value and stabilize the dune feature.

RELEVANCE TO CLIMATE CHANGE

One of the most likely consequences of global warming and rising sea level is that low-lying coastal areas will experience greater and more frequent inundation and storm impacts. In coastal areas where the beach and dune area is limited by the input of mobile sand, the beach and dune will narrow as more and more of the beach is covered by rising sea level or eroded by waves and currents. This narrowing can be minimized or reversed by adding sand to the area through nourishment. The volume of sand and rate of nourishment can be modified and adjusted to adapt to rising sea level. This provides a flexible beach and dune buffer between the ocean and the fixed backshore area.

Nourishment has been used worldwide at various scales to enhance tourism beaches, protect landward development, create new land for development, and restore habitat. It has been used as a strategy for maintaining popular mass tourism destinations (Cancun, Bali, Durban, and Miami).

PURPOSE AND APPLICATION

Coastal experts have indicated that a majority of the world's beaches are eroding due to both natural processes and manmade forces. As noted by the U.S. National Research Council, "Beach nourishment is a viable engineering alternative for shore protection and is the principal technique for beach restoration; its application is suitable for some, but not all, locations where erosion is occurring." As with many shore protection alternatives, there are examples of successes and failures related to beach nourishment programs worldwide.

Planting grasses and native vegetation is often included with a dune nourishment project to enhance the habitat value and stabilize the dune feature. Nourishment can increase the recreational and/or habitat value of the beach and dune. It protects infrastructure related to beach tourism industry, commercial and residential development.

When beaches and dunes are wide and high enough to buffer the wave energy, they also help protect inland development from wave forces and coastal flooding. On shorelines with little or no beach area, waves will break against the backshore area or in the nearshore zone with run-up to the backshore. The energy in these waves and the run-up can be significant enough to damage backshore developments through flooding,

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Adaptation measures are summarized as practitioner briefs in Annex A.

Criteria for evaluating adaptation measures consider technical effectiveness, costs, expected benefits, and implementation characteristics.

Countries or coastal areas may share the same climate change issues. Yet, each has different circumstances (climate, natural resources, infrastructure, technological state, economy, governance, etc.) so the responses to those climate change issues may vary. Coastal adaptations must be "tailored" to the local context through an inclusive process that matches development goals with the climate change issues and the technical capabilities and the capacity of the institutions and community stakeholders of the place. Following are key criteria for deciding the best adaptation option given the local context:

- ***Technical effectiveness:*** will the adaptation option be effective in solving problems arising from climate change while also meeting current development or management goals?
- ***Costs:*** what is the cost to implement the adaptation measure?
- ***Benefits:*** what types (and magnitudes) of benefits will be generated by the adaptation measure and who will benefit?
- ***Implementation considerations:*** how easy is it to design and implement the option in terms of the level of skill required, information needed, and scale of implementation?

It is useful to distinguish between climate benefits and non-climate benefits. Climate benefits include such things as avoiding damages and their associated costs and reducing greenhouse gas emissions. Non-climate benefits are those that result under current climate conditions. An example is enforcing prohibitions on mining coral reefs, an activity that exacerbates coastal erosion and reduces coastal protection. Adaptations that yield non-climate benefits greater than the costs of implementation are referred to as "no regrets"

options. This term implies society will have no regrets in implementing these measures—even if climate change is less significant than projected.

In general, except in intensely developed areas, adaptation options that favor ecosystem and living shoreline approaches are recommended over hard structures to stabilize the shoreline.

Living shoreline approaches address erosion and flooding by providing for long-term protection, restoration or enhancement of vegetated shoreline habitats. Such "no regrets" approaches—i.e., approaches that are beneficial even in the absence of climate change—should be a priority. The use of natural living infrastructure provides multiple benefits while minimizing repair costs. Functional coastal ecosystems are more resilient to climate change and variability. They also provide goods and services that are important to human society in the face of climate change (fisheries, livelihoods, food security, storm protection, flood mitigation, shoreline natural defenses, erosion control, water storage, groundwater recharge, retention of nutrients and sediments, and filtering of pollutants). Maintaining ecosystem biodiversity is critical to ensuring healthy ecosystems and thus natural-resource dependent livelihoods, such as wild fisheries.

Adaptation responses will often include "bundles" of adaptation measures and require additional considerations in evaluating multiple measures.

In evaluating and selecting the best combination of adaptation measures, policymakers and practitioners might consider the following:

- ***Complements vs. substitutes:*** Ideally, bundles should include adaptation measures that are complementary to each other. This capitalizes on synergies and ensures that each measure adds benefits. If measures are substitutes for each other, select and include in the bundle the measure that is least costly and/or provides the greatest net benefits.
- ***Budget constraints:*** Often, there are limited financial resources available to cover the costs of implementation. In these situations, no-cost and low-cost measures may be more attractive than expensive measures such as human-built infrastructure. Adaptation is a continuous process, so we recommend a phased approach when priority measures are not affordable.

STEP 3: MAINSTREAM COASTAL ADAPTATION

Climate change adaptation on the coast must be understood as a fundamental challenge for managing coastal resource uses and must be 'mainstreamed' into coastal policy at all levels.

Mainstreaming means that climate concerns and adaptation responses are integrated into relevant development policies, plans, programs, and projects at the national, sub-national, and local scales. National climate change adaptation strategies are more effective when guidance on adaptation is mainstreamed into development and sectoral plans and strategies and is "owned" by those authorities responsible for preparing and implementing them.

There are many entry points for mainstreaming coastal adaptation. This Guidebook highlights three of these: 1) national or regional level public policy, 2) sectoral investments and projects, and 3) sub-national, place-based initiatives. Each entry point offers challenges, creates new roles for citizens, the private sector

and government, and can create new opportunities. Government must play a pivotal role in creating enabling policy, financial and legal frameworks, capturing and sharing experience, and raising public awareness.

Engaging a broad group of stakeholdersthroughout the process is key to successful adaptation.

Guidelines and policies for mainstreaming climate concerns and adaptation responses into capital investment plans and project cycles are recommended in the face of climate change.

Development banks, such as the African Development Bank and the World Bank, are increasingly concerned that a substantial share of investments are at risk from direct impacts from climate change, thereby increasing vulnerabilities or reducing the intended development benefits. Estimates of Development Banks' portfolio at risk range from 25-40%. For example, infrastructure that cannot be adapted to withstand the impacts of climate change may expose more people and assets to risk. Mainstreaming climate concerns into capital investment plans and project cycle management entails integrating climate issues and adaptation priorities into country strategies. Greater consideration must also be given to vulnerability and adaptation in project designs, screening, selection and evaluation.

A two-track approach combining local level, community-based adaptation with national level enabling policy, finance and legal frameworks is an effective approach to adaptation implementation.

Successful mainstreaming requires reinforcing linkages between local and national level adaptation entry points. Government, together with non-government partners, must play a pivotal role in fostering the connections across national, sectoral, and place entry points.

There may be resistance to mainstreaming climate adaptation. Coastal managers can draw upon their repertoire of experience to formulate strategies to overcome such barriers.

There is often inherent resistance to the introduction of any new policy idea. Because climate change impacts are cumulative and occur over the long-term, there may be little sense of urgency to act. Individuals and organizations may resist because of the uncertainties that surround climate change and because they have different tolerance levels for the risks associated with taking action under such uncertainties. The Guidebook lists good practices for successful and sustained coastal adaptation that have proven effective in coastal management worldwide and that can help in overcoming resistance to mainstreaming coastal adaptation.

STEP 4: IMPLEMENT ADAPTATION

Implementation of adaptation measures brings new challenges and potential conflicts. Practitioners and coastal professionals need to be aware of these and address them proactively.

Implementation challenges include: inadequate administrative, institutional, and staff capabilities; lack of sustainable financing or cost recovery; weak legal frameworks and enforcement; information gaps on the costs of acting vs. not acting (doing nothing); maintaining scientific data and monitoring to sustain the measures; unengaged political leadership and stakeholders; and poor technical effectiveness of the measures. The Guidebook identifies specific responses to each implementation challenge. Many of these challenges can be anticipated and addressed prior to implementation—i.e., during the assessment, design, and mainstreaming steps of coastal adaptation.

Coastal practitioners and professionals must be alert to implementation challenges and address them proactively as they become evident. Recommended actions include periodic program reviews at the national or local levels to ensure agencies and communities are aware of successes and failures. Another action is to educate and encourage the public and property owners to be active in the stakeholder process. Also, take action to keep coastal adaptation on the public agenda, and conduct monitoring and scientific studies to reduce uncertainty about the effectiveness of the measures being implemented.

STEP 5: EVALUATE FOR ADAPTIVE MANAGEMENT

Coastal adaptation is an on-going and iterative process that will benefit from periodic evaluation of performance coupled with an adaptive management process to fine-tune implementation.

Once coastal adaptation measures are implemented, there will likely be considerable interest in how they perform. Policymakers will be keen to demonstrate that the measures are beneficial to the citizenry. They will also want to assuage stakeholders who have borne some of the costs of the measures. Evaluation is the process of reviewing and analyzing all relevant data and information required to determine if the set of adaptation options are meeting expectations. If measures do not perform according to expectations, they must be adjusted. The process of reflecting on and adjusting the course of action based on evaluation results, new information, and changing conditions is referred to as adaptive management.

chapter 1

INTRODUCTION

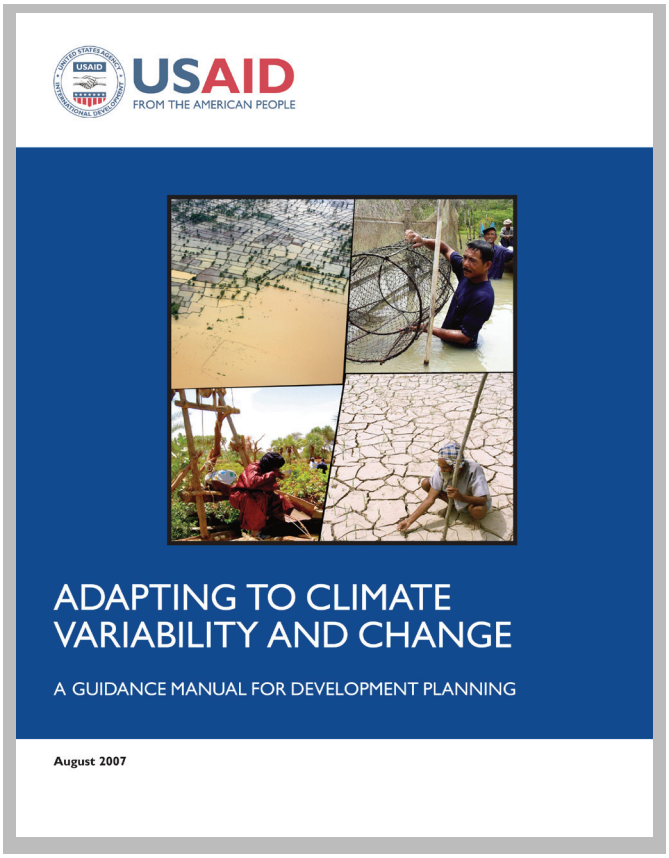
1.1 BACKGROUND

Coasts and the world's oceans are crucial to life on Earth, they support livelihoods, and are vital to the global economy in many ways. Coastal ecosystems exist at the interface between terrestrial and marine environments. They include some of the most diverse and dynamic environments on earth. This narrow band of the earth's surface attracts human populations because it is a focal point for economic growth—accounting for a majority share of humanity's infrastructure, transportation and trade, energy processing, tourism, and recreation. Coastal ecosystems provide a myriad of ecological goods and services. They provide habitat and nurseries for the majority of commercially important marine fish and shellfish species, and provide food security and livelihoods for over 1 billion people. They offer storm surge protection, erosion control, and flood mitigation. They also help retain nutrients and sediments and filter pollutants. Thus, the socioeconomic and ecological importance of the coastal zone is virtually unparalleled.

> Considering that the majority of humans reside along coasts, coastal regions have become uniquely important to the well-being of society and the need for proactive action to adapt to climate changes is ever more pressing.

Global climate change already impacts and will continue to impact coastal communities, ecosystems, and many facets of people's lives in the coastal zone where approximately 2.7 billion people—over 40% of the world's population—live. Even without climate change, coastal areas face a litany of problems associated with population growth, habitat change, resource over-exploitation and degradation, water pollution, and changes in freshwater flows. Climate change is expected to amplify many of these and other stresses on coastal areas. This in turn increases the need and urgency to include coastal adaptation as part of effective coastal management. As a consequence of these realities, climate change is considered by many to be one of the most important challenges of the 21st century and a priority for immediate action for coastal areas.

In 2007, the Global Climate Change Team in the United States Agency for International Development (USAID) Bureau for Economic Growth, Agriculture



and Trade developed guidance to help USAID Missions and partners account for and address vulnerabilities to climate variability and change in their projects and programs. The document, *Adapting to Climate Variability and Change – A Guidance Manual for Development Planning* (USAID, 2008), is structured around a six-step vulnerability and adaptation (V&A) process[1]. This process helps planners and stakeholders to assess vulnerability to climate variability and change, and to identify, assess, select, implement, and evaluate adaptation options that reduce climate impacts.

The V&A Manual was intended as general guidance on the full range of climate concerns and impacted sectors. It provides links to important sources of information and tools and offers a broad overview of methods and best practices for conducting vulnerability assessments and evaluating adaptation measures. The V&A Manual includes case studies illustrating some of these best practices.

This coastal adaptation Guidebook is a companion document to the V&A Manual and provides the practitioner with more detailed and sector-specific

1 The six steps are: 1) Screen for vulnerability; 2) Identify adaptations; 3) Conduct analysis; 4) Select course of action; 5)Implement adaptations; and 6) Evaluate adaptations

guidance for responding to climate variability and change impacts on coastal areas. The emphasis is on developing country contexts.

The Guidebook's primary goals are to:

- Advance understanding of climate change impacts along coasts, vulnerability, and approaches for mainstreaming coastal adaptation measures into development policies, plans, and programs
- Provide practical adaptation options for responding to the impacts of climate variability and change on the coast
- Draw lessons from experience on how to overcome implementation barriers and utilize an adaptive management approach to coastal climate adaptation

1.2 ROADMAP TO THE GUIDEBOOK

The Guidebook follows a common approach, or cycle, to program development as shown in Figure 1.1. The approach is similar to the Integrated Coastal Management (ICM) policy cycle often used by coastal practitioners and includes the following steps: vulnerability assessment (Step 1), planning and selection of a course of action (Step 2), formal adoption or mainstreaming of adaptation actions (Step 3), implementation (Step 4), and evaluation (Step 5). This highlights a central message of the Guidebook: the process of coastal planning and action is not radically changed by applying a climate lens. While the process and good practices of planning and program management apply equally to climate change as they do to other coastal issues, the Guidebook will show that some of the strategies of coastal management are influenced by climate change considerations. For example, there will be greater emphasis on nature-based adaptations and a longer planning horizon must be taken into account.

Each chapter of the Guidebook refers to one of the five steps of the program cycle. Chapter 2 focuses on diagnosis of coastal climate change impacts, trends, and vulnerability. Chapter 2 also summarizes current stresses and threats to coastal areas from development pressures and weaknesses in management.

Coastal communities are likely to face a number of climate-impacted issues and challenges—some in the near term and others within the next several years or decades. Chapter 3 provides guidance on setting priorities and formulating adaptation goals. It also provides a list of 17 adaptation measures and summarizes the criteria for evaluating and selecting adaptations.

TERMINOLOGY

Adaptation: Adjustment in natural or human systems in response to actual or expected climatic changes or their impacts, so as to reduce harm or exploit beneficial opportunities.

Climate change: Any change in weather averaged over time due to natural variability or because of human activity.

Climate variability: Variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events. Examples of climate variability include extended droughts, floods, and conditions that result from periodic El Niño and La Niña events.

Hazard Mitigation: Sustained action taken to reduce or eliminate long-term risk to life and property from a hazard event. Considered as one of four phases of emergency management, together with preparedness, response, and recovery.

Mitigation: Within a climate change context, mitigation is a human intervention to actively reduce the production of greenhouse gas emissions (reducing energy consumption in transport, construction, at home, at work etc.), or to remove the gases from the atmosphere (sequestration)

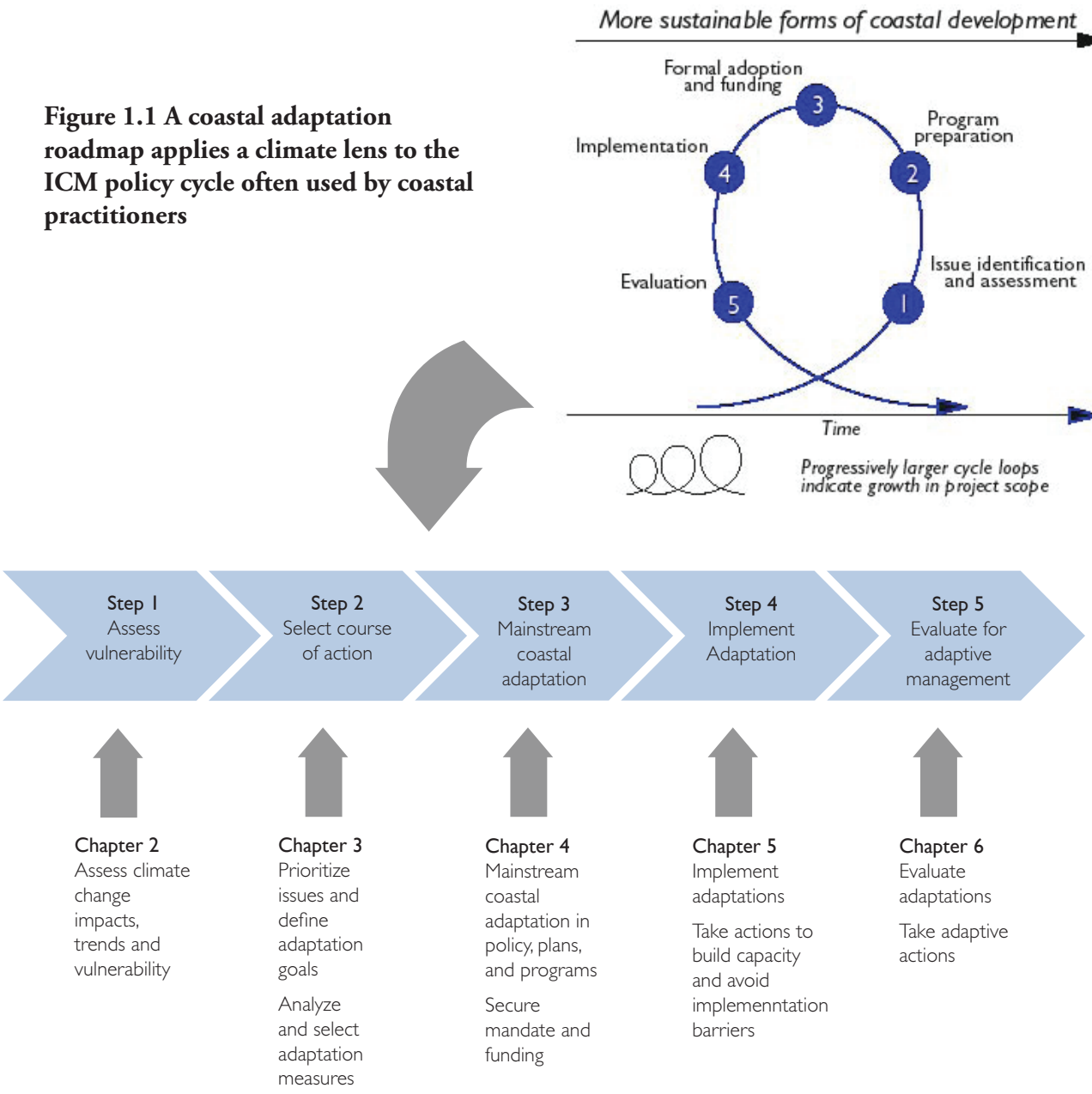
Vulnerability: The degree to which a human or natural system is susceptible to, or unable to cope with, adverse effects of climate change. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

Coastal adaptation requires a mandate and funding. Chapter 4 describes how coastal V&A can be mainstreamed into public planning and budgeting processes and policies at national, sub-national, and local scales. ICM experience has taught us that the list of potential obstacles to successful mainstreaming is long. This chapter presents lessons learned on overcoming these obstacles and offers strategies and preconditions for sustained mainstreaming of coastal adaptation.

After the adaptation options have been evaluated and selected and once there is a formal mandate and funding to proceed, you are ready to take action. Chapter 5 focuses on making adaptation plans operational and overcoming typical obstacles to successful implementation.

Coastal adaptation is not a one-time event. It is an adaptive and iterative process. Chapter 6 focuses on evaluating the progress of the actions that are undertaken and adapting to changing conditions based on valid reasons and circumstances.

Figure 1.1 A coastal adaptation roadmap applies a climate lens to the ICM policy cycle often used by coastal practitioners



Each chapter of the Guidebook refers to one of the five steps of the program cycle. ***Chapter 2*** focuses on diagnosis of coastal climate change impacts, trends, and vulnerability. Chapter 2 also summarizes current stresses and threats to coastal areas from development pressures and weaknesses in management.

Coastal communities are likely to face a number of climate-impacted issues and challenges—some in the near term and others within the next several years or decades. ***Chapter 3*** provides guidance on setting priorities and formulating adaptation goals. It also provides a list of 17 adaptation measures and summarizes the criteria for evaluating and selecting adaptations.

Coastal adaptation requires a mandate and funding. ***Chapter 4*** describes how coastal V&A can be mainstreamed into public planning and budgeting processes and policies at national, sub-national, and local scales. ICM experience has taught us that the list of potential obstacles to successful mainstreaming is long. This chapter presents lessons learned on overcoming these obstacles and offers strategies and preconditions for sustained mainstreaming of coastal adaptation.

After the adaptation options have been evaluated and selected and once there is a formal mandate and funding to proceed, you are ready to take action. ***Chapter 5*** focuses on making adaptation plans operational and overcoming typical obstacles to successful implementation.

Coastal adaptation is not a one-time event. It is an adaptive and iterative process. ***Chapter 6*** focuses on evaluating the progress of the actions that are undertaken and adapting to changing conditions based on valid reasons and circumstances.

chapter 2

ASSESS VULNERABILITY

This chapter first provides an overview of climate change observations and trends in the coastal zone, their impacts on coastal sectors, and the panoply of existing threats to human and natural ecosystems in the coastal zone. Climate change only amplifies these threats and further increases the challenges of strategically managing the coasts and seas and their extraordinary but shrinking resources. The chapter then explores four critical factors: climate change projections, exposure to climate change, sensitivity to climate change, and the capacity of society to cope with actual or expected climate changes (adaptive capacity and resiliency of coastal ecosystems). Coastal vulnerability hot-spots are also highlighted.

2.1 GLOBAL CLIMATE CHANGE AND THREATS TO THE WORLD'S COASTS

There is scientific consensus that increases in greenhouse gases in the atmosphere drive the warming of air and sea temperatures and cause the world's oceans to acidify from the carbon dioxide they absorb. Even if greenhouse gases were capped today, air and sea temperatures will continue to rise as a result of past emissions—as greenhouse gases in the atmosphere have a lifetime of between 10 and several thousand years. Warming of air and sea induces precipitation change, sea level rise, and more extreme weather events (e.g., storms and sea surge). The most significant and immediate consequences of these climate changes for the world's coasts include coastal erosion, flooding, drought, saltwater intrusion, and ecosystem change. There are also other health, economic and social impacts.

These climate changes and impacts are already affecting coastal areas and ecosystems and projections for the coming decades paint a somber picture. Table 2.1 summarizes observations and trends of the effects of increased greenhouse gases on coastal and ocean systems.

Rising sea-level poses a severe threat to countries where their coastal regions have heavy concentrations of population and economic activity. Through the 20th century, global rise of sea level contributed to increased coastal inundation, erosion and ecosystem loss (IPCC, 2007a). Until recently, studies of sea level rise typically predicted a 0-1 meter rise during the 21st century. For example, the Intergovernmental Panel on Climate Change (IPCC) anticipates that sea level will rise by 0.6 m or more by 2100 (IPCC, 2007c). Ocean thermal expansion was expected to be the dominating factor behind this rise. However, new data on rates of deglaciation (the uncovering of land previously covered by a glacier) in Greenland and Antarctica suggest that glacial melt may play a significant role in creating an even greater rise in sea level—i.e., 1-3 meters in this century (Dasgupta et al., 2007). A rise of this amount would displace hundreds of millions of people in the developing world.

> "A 0.5 °C increase in sea surface temperature is associated with a 40 percent increase in hurricane frequency and activity." Saunders and Lea, Nature, January 29, 2008

VULNERABILITY ASSESSMENT

- ☑ Assess climate change projections
- ☑ Assess exposure to climate change
- ☑ Assess sensitivity to climate change
- ☑ Assess health of coastal habitats and ecosystems
- ☑ Assess adaptive capacity

Sea level rise and other changes brought on by climate change can affect land-based activities (see Figure 2.1) and coastal ecosystems, especially wetlands and coral reefs, and have serious implications for the well-being of societies dependent on coastal ecosystems for goods and services. Rises in marine/coastal water surface temperatures lead to the bleaching and widespread mortality of coral reefs. Further, saltwater will displace or at least intrude coastal aquifers; and estuarine systems will likely become more brackish. Alterations to estuarine and marine ecosystems will have potentially severe impacts on fisheries and the goods and services provided by marine and coastal biodiversity.

As more carbon dioxide (CO_2) dissolves in the oceans, they become more acidic (decreased seawater pH). This creates the potential for widespread effects on marine ecosystems. It may inhibit calcification, which will threaten the survival of coral-reef ecosystems. It will inhibit the growth of calcareous algae at the base of the food web and of shell-forming marine organisms (such

Table 2.1 A Summary of climate change observations and trends in the coastal zone

Coastal Impact	Observations	Projected Trends
Sea Level Rise	• For the 20th century, sea levels rose at a rate of 1.7 to 1.8 mm/yr • In the last decade, the worldwide average rate was measured to be 3.0 mm/yr • Coastal erosion is increasingly observed around the world; it can be related to either sea level rise or subsidence, or both	• Sea levels are expected to rise by at least 0.6 meters by the century's end; glacial melt is expected to increase this rise • Coastal flooding could grow tenfold or more by the 2080s, affecting more than 100 million people per year due to sea-level rise, especially in Southeast Asia • It is projected that seawater intrusion due to sea-level rise could severely affect aquaculture in heavily-populated mega-deltas, such as in Southeast Asia • A one-meter rise in sea level could inundate 17% of Bangladesh and completely flood the Republic of Maldives, reduce Bangladesh's rice farming land by half and affect millions of livelihoods • A 2°C increase in temperature could result in the loss of a number of island states
Sea Surface Temperature Change	• Between 1970 and 2004, sea surface temperatures around the planet rose between 0.2-1.0°C, with a mean increase of 0.6°C • The Caribbean Sea has warmed by 1.5°C in the last 100 years • Observations since 1961 show that the ocean has been absorbing more than 80% of the heat added to the climate system • Changes in water temperature caused wide scale coral bleaching in the Asia region, damaging as much as 75-100% of coral in the Philippines in 1998	• By 2100, temperatures are projected to rise in the tropical Atlantic (2-4°C), Pacific (1.5-3.5°C) and Indian (3°C) Oceans • Increases in sea surface temperature of about 1-3°C are projected to result in more frequent coral bleaching events and widespread mortality • Studies project that with a 1°C increase in sea surface temperatures, all coral reefs in the Great Barrier Reef, Southeast Asia and the Caribbean could be bleached
Increased Frequency of Extreme Weather Events	• Increases in category 4 and 5 tropical cyclones, hurricanes and typhoons during the 20th century have been reported • Tropical cyclone activity has increased since 1970, with a trend towards longer lived storms and storms of greater intensity • Mass mortality of mangrove species in the Caribbean has been attributed to the increased frequencies of hurricanes in the region • El Niño events have become more frequent, persistent and intense during the last 20 years compared to the previous 100	• Models project a likely increase of peak wind intensities and increased mean and peak near-storm precipitation in future tropical cyclones • The population exposed to flooding by storm surges will increase over the 21st century, especially in South, Southeast and East Asia
Precipitation Change	• Precipitation has increased by up to 10% in the Northern Hemisphere and decreased in other regions (e.g., North and West Africa, parts of the Mediterranean and the Caribbean) • The frequency and severity of drought has increased in some regions, such as parts of Asia and Africa • Very dry areas have more than doubled since the 1970s • Australia incurred over US$13 billion in drought damage between 1982-2003	• Projections for Latin America show a general year round drop in seasonal precipitation of up to 60% with the greatest effects felt in Mexico and Central America • Precipitation change is very likely to increase the frequency of flash floods and large-area floods in many regions • In Tarawa, Kiribati, it is projected that drought damages could to reach 18% of the gross domestic product by 2050
Ocean Acidification	• Since 1750, an average decrease in pH of 0.1 units has been observed	• It is projected that the pH of the world's oceans could fall by up to a further 0.3 – 0.4 units by 2100, resulting in the lowest ocean pH levels in 20 million years

Sources: IPCC, 2007a, b; IUCN, 2007.

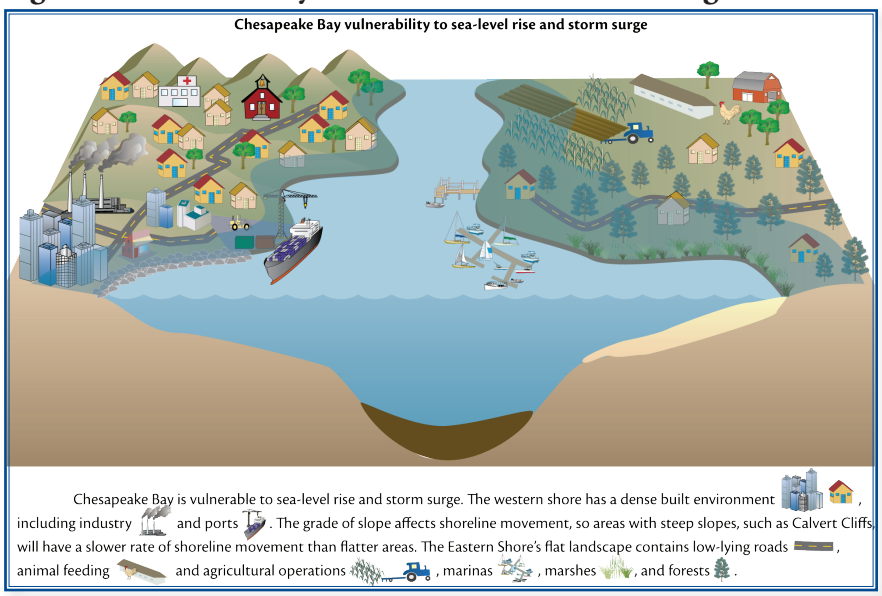
as scallops), and it will stunt the growth of calcified skeletons in many other marine organisms, including commercial fish species.

Rising sea-level coupled with increased sea surface temperatures is expected to contribute to more frequent and severe extreme weather events, such as coastal storms. These, in turn, will generate larger waves, storm surges, and increased coastal erosion. Annually, about 120 million people are exposed to tropical cyclone hazards alone; storms killed 250,000 people between 1980 and 2000 (IPCC, 2007a).

The recent human tragedies of the December 2004 Indian Ocean tsunami, Hurricane Katrina (United States, August 2005), Cyclone Sidr (Bangladesh, November 2007) and the Cyclone Nargis (Myanmar, May 2008) prove that coastal calamities can overwhelm resources and disaster responses of developed and less developed nations alike. Each coastal disaster provides tangible examples of the potential impacts that may unfold during the next century as a result of global warming and associated sea-level rise. As real disasters unfold around us, the need for global action today becomes ever more obvious and pressing.

Rainfall patterns are also changing and the effects of El Niño and La Niña episodes have worsened. This has resulted in increased cyclones, flooding and drought cycles. Runoff from more intense precipitation and changes in seasonal freshwater flows in many coastal environments can result in broad ecosystem changes. This includes changes in coastal erosion and sedimentation to which mangroves, estuaries, and coral reefs are particularly vulnerable. Meanwhile, nutrient-rich runoff under conditions of higher sea surface temperature will likely promote coastal hypoxia or seasonal hypoxic events. Changing weather patterns affect the distribution and range of species and disrupt the natural balance of many ecosystems and this has potential impacts on fisheries. When bacteria, viruses, mosquitoes or other disease vectors change their geographical range as a result of global warming, diseases also spread.

Figure 2.1 Vulnerability to sea level rise and storm surge



Source: Maryland Commission on Climate Change, Adaptation & Response Working Group. 2008

CORAL REEFS AND SEA SURFACE TEMPERATURE RISE

Scientists estimate the world has already lost 30% of its coral reefs, mostly from the effects of overfishing, nutrient pollution, and habitat conversion, but coral bleaching and increasingly acidic seas—both associated with climate change—are exacerbating these effects and pushing many coral reefs over the edge. With climate change, more than 80% of the world's coral reefs may die within decades.

Sources: Hoegh-Guldberg et al., 2007 and Nelleman, et al., 2008

Erosion impacts both public and private investments which are often built too close to the shore or do not consider appropriate building techniques for dynamic shorelines.

In short, climate change is increasing the frequency of natural disasters with overarching impacts on the health and resilience of coastal ecosystems and the global economy. Sea level rise; more frequent and severe extreme weather events; increased flooding; and the degradation of freshwater, fisheries and other coastal resources could impact hundreds of millions of people. The socioeconomic costs on coasts will escalate (IPCC, 2007a). This occurs at a time when there is an ever increasing human dependence on coastal resources and growing populations in the coastal zone. In some regions already stressed with overpopulation, poverty, internal conflict, resource overuse and the spread of disease, these impacts from climate change can be devastating.

Table 2.2 lists the many impacts of climate change on coastal sectors and concerns. It highlights that the world's coastal regions are already under assault as a result of coastal development patterns and habitat loss, over-fishing, pollution, and other environmentally-damaging activities. Climatic changes combine with and amplify existing non-climate stressors to make such coastal communities even more vulnerable.

Mangroves, coral reefs, estuaries, seagrass beds, dune communities—and the rich biodiversity provided by these and other systems on or near shorelines— serve critical ecological functions that are important to human society in the face of climate change. For example, they serve as vital nurseries and habitat for fisheries, and provide food security and livelihoods for over one billion people; provide protection from storms and wave surges; reduce impacts from flooding; provide shoreline natural defenses; control erosion; provide water storage and groundwater recharge; retain nutrients and sediments; and filter pollutants. When these critical resources are compromised, coastal ecosystems become weakened and unhealthy and are less resilient to the effects of climate change and variability. Hence, an important element of any adaptation strategy is to identify and reduce those human-based stresses on coastal ecosystems that can be controlled. By doing this, we can work with nature to increase ecosystem resilience and thereby increase the ability of coasts to cope with climate change.

Table 2.2 Threats to the coastal environment

Sector	Climate Change Threats	Other Human Threats
Coral Reefs, Coastal Wetlands and Ecosystems	• Loss of coral reefs from **coral bleaching** and **ocean acidification** • **Loss or migration of coastal wetland ecosystems,** including salt marshes and mangroves • Runoff from more intense **precipitation** causing coastal erosion, and sedimentation adversely affecting estuaries and coral reefs • Nutrient rich runoff under conditions of higher **sea surface temperature** promoting coastal hypoxia and marine **dead zones** • Change in the distribution and **abundance** of commercially valuable marine species • Increased spread of **exotic** and **invasive species**	• 30 percent of the world's **coral reefs** have been lost as a consequence of overfishing, pollution, and habitat destruction • Intense coastal development and **habitat loss** • Pollution and marine **dead zones** • **Conversion of mangroves** and wetlands for mariculture • Disruption of the quantity, quality, and timing of **freshwater inflows** to estuaries • Damage to **seagrass beds** from sedimentation, recreational boating, fishing and tourism • **Coral mining** for construction and lime making • **Oil spills** from shipping • Spread of **invasive species** • Coastal reinforcement disrupts natural **shoreline processes** • Sand and gravel **mining** of riverbeds and beaches
Capture Fisheries	• Overall decline in ocean productivity • **Eutrophication** and coral mortality leading to reduced fish catch • **Loss or shifts in critical fish habitat** • **Temperature shifts** causing migration of fishes • Extreme events, temperature increases and oxygen depletion reducing spawning areas in some regions • **Temperature changes** affecting the abundance and distribution of marine pathogens • **Ocean acidification** and increases in temperature damaging coral reefs	• **Over-harvesting** • **Destructive fishing** practices (e.g., bottom trawling, dynamite fishing, beach seining) • Land-based sources of **pollution** (sewage, industrial waste, nutrient runoff, etc.) • **Sedimentation** of coastal systems from land-based sources

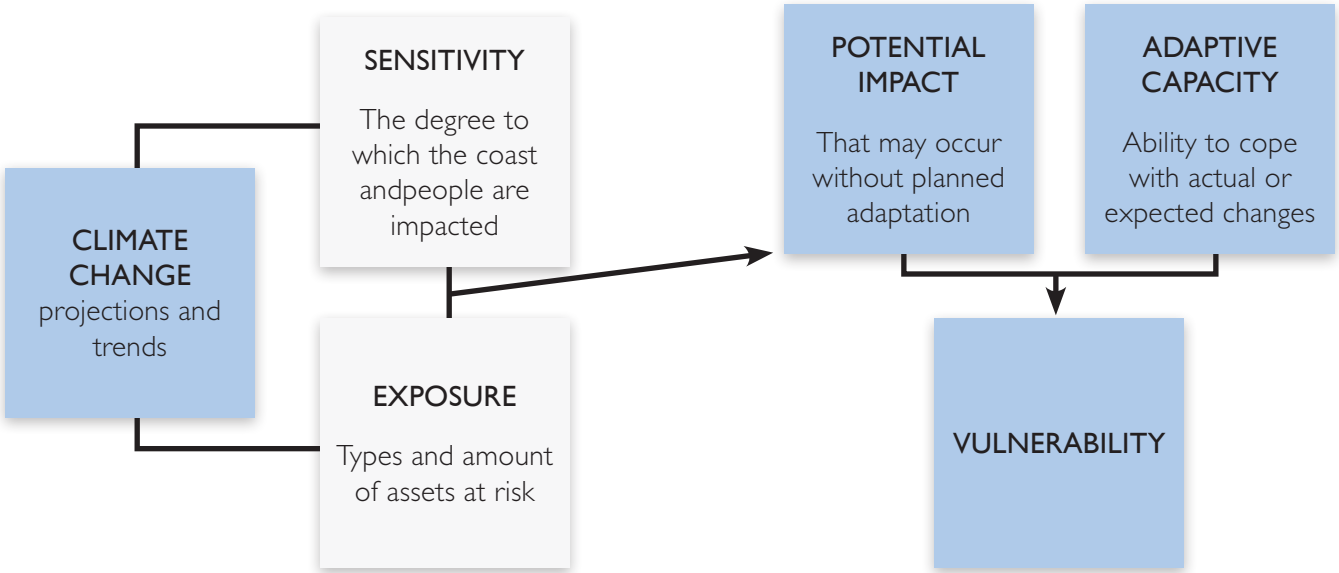
Sector	Climate Change Threats	Other Human Threats
Mariculture	• Increases in water temperature could result in **unpredictable changes** in culture productivity • Environmental changes could increase stress and vulnerability to **pathogens** and parasites in cultured organisms • Overall decline in **ocean productivity** reduces supplies of wild fish used for fish meal for mariculture sector • Changes in weather patterns and extreme weather events reduce **productivity** and damage operations (loss of infrastructure and stock)	• **Overexploitation** of juveniles and larvae seed stock for fish farms • Release of chemicals, nutrients and sediment in pond effluents • **Spreading of pathogens** and disease to local ecosystems and neighboring culture operations • **Loss of protective habitats** from improper siting of mariculture facilities
Recreation and Tourism	• **Storms, erosion, and precipitation** damaging infrastructure and causing losses to beaches • Compromised **water quality** and increasing beach closures • Increases in tourism **insurance costs** on high-risk coasts	• **Improper siting** of tourist facilities • **Alteration** of the shoreline, coastal processes and habitat • Strain on **freshwater resources** for tourist facilities • **Marine pollution** and habitat disruption from recreational boating
Freshwater Resources	• **Saltwater intrusion** of freshwater sources • Encroachment of saltwater into estuaries and coastal rivers • Waves and **storm surges** reaching further inland, increasing coastal inundation and **flooding** • **Decreased precipitation,** enhancing saltwater intrusion, and exacerbating water supply problems	• Discharge of untreated sewage and chemical **contamination** of coastal waters • Unregulated **freshwater extraction** and withdrawal of groundwater • Upstream **dams** • Enlargement and **dredging** of waterways
Human Settlements	• Coastal **inundation** causing relocation inland • Building and infrastructure damage from increasing coastal **storm intensity** and flood exposure • **Sea level rise** raising water levels during storm surge • Reduced clearance under bridges • Overtopping of coastal defense structures • **Sea level rise,** erosion, and extreme weather events leading to degradation of natural coastal defense structures	• Rapid increase in **coastal development** projected to impact 91% of all inhabited coasts by 2050 • Inappropriate **siting** of infrastructure • Shoreline **armoring** • **Habitat conversion and biodiversity loss**
Human Health	• **Heat stress** from extremely hot periods • Injuries, illness, and loss of lives due to **extreme weather events** • **Malnutrition** and food shortages during extreme events • Increased spread of vector-borne **disease** (dengue fever and malaria), waterborne diseases (diarrhea) and toxic algae (ciguatera)	• **Pollution** and water contamination
Conflict	• **Coastal land loss** leading to coastal land and resource scarcity or loss, and human migration • **Water use** conflicts due to scarcity • Population **migration** to urban areas as ocean productivity and food availability declines and fishers are displaced	• **Displacement** and loss of shore access resulting from tourism and coastal development

Sources: IPCC, 2007a, b; IUCN, 2007

2.2 VULNERABILITY ASSESSMENT

Assessing a coastal area's vulnerability to the impacts of climate change involves understanding: 1) the climate projections for a given region or locale, 2) what is at risk (climate change exposure and sensitivity), and 3) the capacity of society to cope with the expected or actual climate changes (adaptive capacity). Combined, these three factors define the vulnerability of people in a place to climate change. Figure 2.1 illustrates this relationship, which is described in the subsequent four sub-sections.

Figure 2.2 Vulnerability framework



Source: Adapted from Allison, 2007.

2.2.1 ASSESSING CLIMATE PROJECTIONS FOR A COASTAL AREA

Tailoring adaptation measures to climate change requires information on climate processes and impacts for specific coastal areas over a timeframe much longer than the typical 5-10 years used for planning and policy. When assessing vulnerability and what to do about it, it is reasonable to use a 100 year timeframe—since we know climate change impacts will grow stronger with time.

Successful adaptation requires setting clear geographic boundaries within which to focus the assessment and actions. This is especially difficult in coastal areas, but it is important. Here, the interconnectedness of issues is amplified by the flows of water from rivers and ocean currents. A tendency is to incorporate too many adaptation elements. Good practices in coastal climate change adaptation include:

- Match boundaries to issues of concern
- If issues are rooted in the larger watershed, the analysis and possibly the implementation must be broader, but avoid overextending the scope of the effort
- Differentiate between boundaries for analysis and those for policymaking and action (the latter must remain focused and is narrower) and work across political boundaries when necessary
- Understand inshore ocean currents so that, for example, an analysis of biological vulnerability includes consideration of the dispersal patterns of important larvae in the assessment areas and actions
- Recognize the temporal and spatial scope of populations—e.g., coastal populations frequently engage in seasonal employment as fishers, farmers, crew on ships; and the number of people in seaside resorts changes dramatically between high and low seasons
- Recognize the inherent dynamics of the natural environment, such as seasonal and inter-annual variations in beach sand movement, and fish stock abundance and structure

Larger scale climate change models and projections, such as those of the IPCC, as well as on-line regional mapping tools and downscaling models (e.g., the SERVIR Climate Mapper http://www.iagt.org/downloads.aspx#sv or http://www.servir.net/ and the PRECIS Regional Climate Modeling System http://precis.metoffice.com/) provide a starting point to understand an overall context, but lack the resolution and specificity needed to assess the vulnerability of specific coastal areas.

They can, however, provide a starting point from which to overlay local knowledge on past and current climate trends for the specific place. For example, local knowledge can help answer the basic question: "Has

USE BEST AVAILABLE INFORMATION AND TRADITIONAL KNOWLEDGE

By integrating the best available knowledge and involving local communities, it is possible to take responsible action in situations where there are uncertainties and imperfect information. Following the *precautionary approach*, actions should not be impeded by an absence of full scientific certainty. A skillful adaptation approach is to look at the trends suggested by existing models along with the trends that are beginning to show themselves in the region in question and to plan accordingly. Trends will continue to change and emerge for generations to come—even should mitigation efforts greatly reduce global greenhouse gas emissions.

the frequency, magnitude, or timing of precipitation, extreme weather events and other climate impacts changed in the last several decades?" A review of historic records for climate variability and hazard events in a specific area can also help validate the projections. Spatial data and maps to visualize biophysical impacts (e.g., shoreline, storm surge, and flooding maps) also aid in this exercise.

To develop climate change projections for a coastal area, assess available information and formulate assumptions to create scenarios that reflect a range of low to high degrees of change. Stakeholders can use these scenarios to assess vulnerabilities and identify issues and adaptation measures. Scenarios can also help move dialogue from a debate about exactly *how* the climate will change to a discussion among key stakeholders, experts and project staff on the *implications* of the different scenarios (high, medium, low change). Projections should include changes in temperature, precipitation, sea level rise and severe storm events along the coastal watershed (bays, estuaries, nearshore currents and rivers).

At the end of this assessment phase, there should be two or more projections of climate change and the potential impacts of each to the environment. There should also be a constituency of stakeholders who understand the context of the place relative to climate change.

At this point, it is useful to prepare an **issue statement** that provides a concise and factual description of the climate change challenges that affect the community. All stakeholders should contribute to the statement to ensure there is shared understanding of the problem. An example might look like:

"Greater frequency and intensity of storms on the island of Antigua puts at risk the health and safety of the population and infrastructure. It is in the long-term interest of the community to take measures to increase storm hazard preparedness and resilience."

2.2.2 ASSESSING EXPOSURE TO CLIMATE CHANGES

Exposure is defined as the types of valued assets that are at risk of being impacted by changes in the climate system as well as by ocean acidification. These assets include social assets (people, health, education), economic assets (property, infrastructure, and income), and ecological assets (natural resources and ecological services).

To select a course of action for adapting to climate change, communities need to answer several questions, such as: "What are the most important assets that are at risk?" "What is the threshold at which impacts will occur?" For example, in Tamboko, the Solomon Islands—where coastal communities are exposed to seasonal flooding—community-level assessments identified drinking water as the most valued asset (IFRC, 2005).

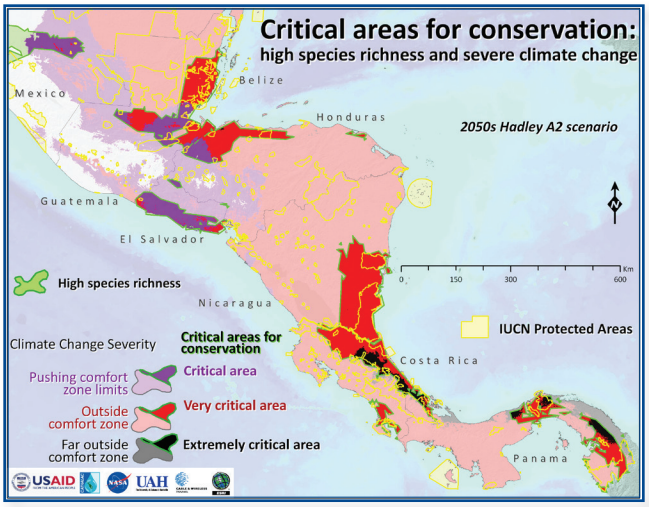
When determining the most important assets exposed to climate change risks consider:

- *Impact to critical systems:* Is a vital food (e.g., fishery), safety or economic asset at risk?

SPATIAL DATA

Maps and measurements of coastal areas are invaluable to understand how climate impacts will play out.

- Shoreline mapping—coastal elevation, sea level rise projections, erosion rates, storm surge inundation, land use and land cover
- Socioeconomic context—coastal resource uses, demographics, development density, and administrative boundaries



SERVIR can integrate and downscale global information, assess vulnerabilities from natural hazards in real time, and evaluate past and future climate trends, as seen here in this example of a CATHALAC/USAID study of regional biodiversity and climate change. For more information go to www.servir.net

- *Attitudes towards risk:* What is the community's level of risk perception and tolerance—e.g., coastal communities with tourism may perceive eroding beaches as a higher risk than those without tourism.
- *Impacts on current government/stakeholder priorities:* Does the potential impact put a major economic development priority at risk? Will there be an impact on a social problem for which significant resources have already been allocated?
- *Level of certainty about the projected consequence of climate change:* If there is high uncertainty about the likelihood of a potential risk, exposure to the risk may be considered a low priority.
- *Reversibility of changes that may occur in the absence of effective management response:* Can the asset be recovered after being impacted? If not, the issue might be a high priority. An example is a coral reef ecosystem. Once the coral animals die, the reef structure breaks down with no easy way to regain the ecological goods and services of habitat, fisheries, tourism, and storm protection.

2.2.3 ASSESSING SENSITIVITY TO CLIMATE CHANGE

The potential impact of climate change is determined by an asset's level of exposure and its sensitivity—i.e., the degree of likely damage—if exposed to climate change. For example, 100 houses along the coast may be exposed to flooding. However, the 60% that are built on raised foundations are less sensitive to damage from flood waters. Table 2.3 highlights assets and factors that can make them sensitive to the impacts of climate change.

Healthy ecosystems and social groups have significant ability to absorb impacts. An example of this is Vietnam, which experiences eight to 10 major coastal storms annually. Tidal flooding associated with these storms usually leads to the breaching of sea dykes and economic losses to the local population. To protect coastal assets and improve livelihoods, the Vietnam Red Cross has been planting and protecting thousands of hectares of mangrove forests along the northeast coast

Table 2.3 Examples of exposed coastal assets and factors of sensitivity

Groupings	Coastal Assets Exposed	Dimensions of Sensitivity
Social	People, health, education, sanitation, historic and cultural assets, social capital	Material assets and savings, secure land tenure, community cohesiveness, the state of public health, sanitation conditions in the community
Built environment	Property and coastal infrastructure, ports and shipping	Siting of buildings and coastal infrastructure and construction methods, availability of insurance systems and emergency funds
Ecological infrastructure	Natural resources, wildlife, coastal watersheds, ecological values, protected areas, unique ecosystems and landscape/seascape amenities	Existing condition and health of coastal ecosystems and natural barriers to coastal flooding, abundance and variety of natural resources and unique ecosystems, quality of coastal stewardship efforts

Source: Adapted from Kaiser, 2006

Swimming lessons for women in Zanzibar is important for their new mariculture livelihood venture. This also builds their adaptive capacity to survive if their community were to be hit by a large storm surge or tsunami.

of Vietnam since 1994. The mangroves have reduced the cost of dyke maintenance by millions of dollars annually and reduced damages from coastal storms. Similarly, after the Indian Ocean Tsunami, a regional effort was initiated to create coastal "Green Zones" and protect mangrove forests as buffers.

To assess the sensitivity of coastal assets exposed to climate change, it is useful to answer the following questions:

- How and to what degree were social, economic and ecological assets affected by past climate conditions and coastal hazard events?
- What specific characteristics make groups or systems sensitive?
- Was everyone equally impacted? If not, what were the differences between various individuals and groups?

Resilience to coastal hazards and **adaptive capacity** are linked. High levels of adaptive capacity lead to an increased likelihood of being able to absorb impacts of climate change and rebound. The Coastal Community Resilience Guidebook provides benchmarks and a methodology for conducting resilience assessments in the coastal context. (USAID, 2007)

- What is the sensitivity of "non-exposed" assets? For example, agriculture activities that take place away from the coast may rely on a highly exposed and sensitive coastal road or port for export. Losing this transportation asset could result in a loss in the value of the agricultural assets.

Answers to these types of questions help in estimating the likelihood and degree of potential impacts to systems and assets. They also help in identifying specific characteristics that make coastal assets vulnerable/sensitive and the thresholds at which impacts will likely occur. For each projection, assess what is exposed and its sensitivity to various degrees of climate change. You can then estimate the impacts by collecting data on the costs of the assets, number of people or infrastructure that will be exposed.

2.2.4 ASSESSING ADAPTIVE CAPACITY

Adaptive capacity refers to the ability of society to change in a way that makes it better equipped to manage its exposure and/or sensitivity to climatic influences. A community with the capacities to adapt is likely to be more resilient or able to recover from stressful events and conditions (see text box). Referring back to Figure 2.1, it is the first two factors, exposure and sensitivity, that dictate the gross vulnerability of a coastal community and its potential susceptibility to adverse impacts. The third factor, adaptive capacity, reflects a community's ability to manage, and thereby reduce, gross vulnerability.

When you look at a community's exposure, sensitivity, and adaptive capacity as a whole, the result is net vulnerability. Net vulnerability is the ability of a community to manage risk and thus minimize or prevent potential impacts. For example, a coastal region could have high gross vulnerability, but relatively moderate net vulnerability as a result of its high adaptive capacity. The reverse is also possible—i.e., a coastal area with low gross vulnerability may be compromised by its limited degree of adaptive capacity, thereby increasing its net vulnerability.

A broad range of factors reflect adaptive capacity:

- Political leadership and commitment
- Resource availability (e.g., human, physical, technological, and financial)

In 2004 many communities in the Indian Ocean revealed a weakness in adaptive capacity due to the strong dependence on fisheries livelihoods, which was severely impacted by the tsunami.

- Institutional and governance networks and competence
- Social capital and equity
- Information technologies and communication systems
- Health of environment

There are many studies with lists of determinants of adaptive capacity. Most indicators are focused on national scale factors such as gross domestic product, poverty indices and demographics. These indicators are helpful for comparative purposes, but not very useful for local decision-making. On a practical level, the aim of assessing adaptive capacity is to answer questions such as:

- How well do community members work together on coastal development planning and coastal management, including coastal hazards?
- What practices are currently employed to cope with natural hazards? Who is responsible for developing and implementing such measures? How effective are they?
- Are the public and decision-makers informed and engaged?
- Do most people rely on the same activity for their livelihoods? For example, does everyone rely on fishing or agriculture, such that a single event could destroy the livelihoods of many in the community or country?
- In an emergency, are there multiple means of communicating or transporting people and supplies? Or will damage to a single road, bridge, or telecommunications hub isolate a community?
- How healthy are the ecosystems and how well are natural resources managed?
- Adaptive capacity is not evenly distributed across and within societies. Also, wealthy countries have greater adaptive capacity than poorer countries (Nichols et al., 2007). This reality of adaptive capacity has been termed the "climate divide" (see text box to the left). In this sense, climate change is very much a development issue. Also within countries, it is the case that women and poor socioeconomic groups have less adaptive capacity and are the most vulnerable (see text box on next page).

Assessing the adaptive capacity of a place or sector helps in understanding why vulnerability exists in the first place. To reduce vulnerability, stakeholders must understand its root causes. These are much deeper societal issues than, for example, poorly constructed houses being located in areas of coastal erosion. Root causes might include poverty, insecure property rights, natural resource dependency, degraded resources, and weaknesses in institutions and political assets (Adger, 1999). Adaptive capacity can be strengthened through policies that enhance social and economic equity, reduce poverty, improve natural resources and coastal management, increase public participation, generate useful and actionable information, and strengthen institutions.

THE "CLIMATE DIVIDE"… WHAT IS IT?

The "climate divide" is a term used to explain the inequities and differences in responsibility for, impact from, and the capacities needed to reduce the effects of climate change. These disparities influence the strategies people use to cope with stresses and changing environments. Disproportionate impacts of climate change will be felt by less developed countries and small island developing states. Within countries, internal disparities and inequities influence how coastal climate change impacts different socioeconomic groups.

GENDER DIMENSIONS OF VULNERABILITY TO COASTAL CLIMATE CHANGE

Men and women are affected differently by the impacts of climate change and climate vulnerability. Women tend to be poorer, more marginalized and much more likely to be afflicted by natural disasters. Worldwide, women are more vulnerable because of their social roles, inequalities in the access and control of resources, lower education, poorer health, and their low participation in decision-making. Climate change magnifies existing inequities.

Women are not only the primary victims of climate change, but they can also be effective change agents, managing both mitigation and adaptation. Women have extensive knowledge and expertise that can be applied in assessing community risk, selecting adaptation measures and mobilizing communities to manage risk.

To mainstream gender into climate change adaptation, we need the following types of information:

- ☑ Women's and men's resource use patterns, access, and responsibilities (to include a discussion on how might these change with climate change, and how they would adapt)
- ☑ Women's and men's roles in decision-making
- ☑ Women's and men's vulnerability—the gender dimensions of different climate change impacts (e.g. droughts and flooding) and how they would affect women and men
- ☑ Understanding how men's and women's roles change and may complement each other when coping with climate change

Gender inequalities are deeply ingrained and difficult to change, but you can overcome obstacles by:

- ☑ Ensuring that participatory planning methods are inclusive and motivate, support, and encourage women and men to engage in the process
- ☑ Understanding practical barriers to women's participation in discussions, planning and decision-making, and in micro-enterprise
- ☑ Ensuring that issues identified and analyzed are relevant and of interest to both men and women—this will help both genders formulate ideas and engage in the adaptation process
- ☑ Learning to recognize and handle conflict—personal attitudes and feelings about equal participation and gender mainstreaming will vary and some may work against it
- ☑ Establishing gender focused and disaggregated monitoring

For more information see: Gender Equality and Adaptation, WEDO and IUCN (http://www.genderandenvironment.org/admin/admin_biblioteca/documentos/Factsheet%20Adaptation.pdf)

2.3 COASTAL VULNERABILITY HOT SPOTS

Low-lying coastal areas, deltas and countries—many of which are small island developing states—and less developed countries are especially vulnerable to climate change impacts. Each has social, economic and physical vulnerabilities that combine to increase likely impacts even further. Other vulnerability hot spots include areas with poor and insecure land tenure, and dense or urbanized populations that will have to migrate with sea level rise.

Small size and isolation mean that SIDS are more vulnerable because they have scarce natural resource supplies (e.g., water resources, construction materials and physical space) and limited and high cost transportation options. The primary climate change

Small island developing states such as the Federated States of Micronesia are especially vulnerable to climate change.

concerns for SIDS are exposure to sea level rise and more intense or frequent cyclones/hurricanes. Low-lying SIDS have even fewer options for adaptation and are particularly vulnerable. However, even in SIDS there are steps you can take to help reduce vulnerability. Examples include relocating buildings and infrastructure; using different styles of housing; and preserving coral reefs, mangroves, and wetlands that offer protection by buffering against storm surges.

SIDS and less developed countries share the same economic challenges—high dependency on climate-sensitive industries like tourism, agriculture and fisheries; a degraded natural resource base; rapid population growth; weak administration and infrastructure; and poor transportation and communication systems. These socioeconomic stressors tend to further increase the vulnerability of a place by compromising ecosystem functionality. An example of this is the case of the Cuvu and Tuva villages in Fiji where unsustainable fishing practices destroyed the coral reefs (UNFCCC, 2008).

Some of the deltas most vulnerable to climate change include the heavily populated Yangtze (China), Ganges (Bangladesh), Mekong (Cambodia), Niger (Nigeria), Irrawaddy (Myanmar), Nile (Egypt) and Mississippi (USA). Even in the absence of a changing climate, most deltas are deteriorating as a result of human activities (e.g., extraction of groundwater and construction of upriver dams, levees and channels, and destruction of coastal vegetation). These and other such activities have affected the deltas' natural flood pulses and sedimentary processes (Day et al., 1997). Climate change has the potential to amplify the further decline of deltaic systems through sea level rise, increased storm intensity, and changes in rainfall and runoff to the coast.

However, these difficulties can be overcome. In cyclone-prone Mauritius, precautionary measures have proved remarkably successful in reducing injuries and loss of life. These measure include creating a network of shelters, public education initiatives, early warning systems and the mandatory closing of schools and businesses in the case of a storm. Similarly, the result of Bangladesh's investment in warning systems, shelters, coastal housing standards and evacuation plans for its delta areas is a dramatic decline in deaths over the past 40 years—from a high of a million people in 1970 to 4,000 in 2007 (Revkin, 2008).

SOURCES FOR MORE INFORMATION

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Woman's Environment & Development Organization (WEDO) and International Union for Conservation of Nature (IUCN), 2007, *Gender Equality and Adaptation.* Fact Sheet.
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WEBSITES

Computer-based Decision Tools

Adaptation Wizard: Risk based analysis and decision-making, UK Climate Impacts Programme.
www.ukcip.org.uk

Assessment and Design for Adaptation to Climate Change (ADAPT): A Tool to Screen for Climate Risk, World Bank.
http://go.worldbank.org/AWJKT60300

Community-based Risk Screening Tool - Adaptation & Livelihoods (CRISTAL), International Institute for Sustainable Development.
www.iisd.org/security/es/resilience/climate_phase2.asp

Mapping and Modeling

Providing Regional Climates for Impact Studies (PRECIS) Regional Climate Modeling System. UK Met Office.
http://precis.metoffice.com

SERVIR Regional Modeling and Visualization System
http://www.servir.net
http://www.iagt.org/downloads.aspx#sv

Vulnerability Assessment Tutorial. U.S. National Oceanic and Atmospheric Administration
http://www.csc.noaa.gov/products/nchaz/htm/methov.htm

chapter 3

SELECT COURSE OF ACTION

Vulnerability assessment provides the basis for defining a strategic plan of action. This includes the selection of specific adaptation issues, management goals and objectives, and bundles of measures. This chapter offers guidance on these topics and Annex A provides guidance briefs for practitioners on 17 coastal adaptation measures.

3.1 IDENTIFY PRIORITIES

The vulnerability assessment identifies numerous climate change risks and potential impacts to different sectors. There will likely be more climate change risks than can be acted upon based on resource availability or institutional and technical capacity. Therefore, adaptation to climate change must be strategic. The first step is to clearly identify the priority climate change risks upon which to focus efforts and resources. These priorities then determine the choice of adaptation measures selected.

The information needed to set priorities comes from the vulnerability assessment: what assets are most *sensitive* and *exposed* to climate change, and what are the *adaptive capacities* to address climate change impacts?

Identify priorities. Given the scope and multi-faceted effects of climate change, coastal adaptation efforts need to choose an initial focus on a limited set of key climate threats and adaptation issues that capture the interest, imagination and commitment of local residents and the government departments most directly involved. A limited number of climate change issues should be selected strategically with attention to the complexity of the problems, political realities, and available resources to achieve goals.

Priorities should be selected through an *inclusive and ongoing process* that involves the major stakeholder groups and decision-makers. It is their perspectives and interests that will influence the criteria used for judging risk and prioritizing concerns. Encouraging broad collaboration and cooperation in the process ensures the salience and public and political support for coastal adaptation that are necessary for effective implementation in the short and long-term. This was the conclusion of Pacific Island countries (see text box below). While there is no formula for determining the most important climate change risks for a specific coastal area, it is possible to draw from the experience of integrated coastal management best practices.

- Identify and involve governmental agencies and other formal institutions—such as universities and user groups—that have an interest in the condition and use of the coastal ecosystems being considered
- Solicit the views of major stakeholder and other groups and, to the extent possible, the general public (e.g., through focus groups and surveys)
- Identify potential leaders and the stakeholder groups who will be involved in the implementation of the adaptation measures
- Ensure the scope and complexity of the climate change issues selected as priorities for adaptation measures are appropriate to the capacity of the institutions involved

SELECT A COURSE OF ACTION

- ☑ Identify priorities
- ☑ Define adaptation goals and objectives
- ☑ Assess adaptation measures
- ☑ Select measure or bundle of measures

LESSON FROM THE "CAPACITY BUILDING FOR THE DEVELOPMENT OF ADAPTATION MEASURES IN PACIFIC ISLAND COUNTRIES PROJECT"

"Implementation of climate change adaptation should utilize an open, transparent and highly-participatory process that engages the community in the exploration of options to reduce vulnerability and effectively balances the needs and interests of a variety of stakeholders."

Source: Taito Nakalevu, workshop presentation, 18 and 19 April 2006 in Pohnpei, FSM.

3.2 DEFINE ADAPTATION GOALS AND OBJECTIVES

The goal for addressing a climate change issue should state the desired changes in or the quality of ecological, economic and social conditions you hope to achieve. Ensure the goal reflects the principles that guide resolution of the issue. For instance, the goal to maintain a natural and functioning shoreline may be highly appropriate for a majority of coastal settings where a natural, functioning shoreline represents the most cost-effective and best option to simultaneously meet several objectives. Conversely, this goal eliminates adaptation measures that involve hard engineering practices such as seawalls and groins. Table 3.1 lists some of the major categories of management goals common to adaptation programs in coastal areas.

Goals identify the desired endpoint you want to reach. Objectives provide the specific achievements that must be met in order to reach the goals. The most successful long-term coastal management programs teach us the importance of setting objectives that are unambiguous and time-bounded for each issue the program chooses to address. Such objectives are best when they specify in *quantitative terms* what will be achieved *by a specified date*.

KEY TERMS THAT DEFINE A HIERARCHY OF OBJECTIVES

Goal: A general statement of the desired long-term outcome or impact of the coastal management project. A goal statement does not imply that the project, by itself, will be sufficient to attain this goal. Rather, coastal management may contribute to reaching goals such as sustainable forms of development, the improved adaptation capacity to climate change, or improved quality of life, in coastal communities.

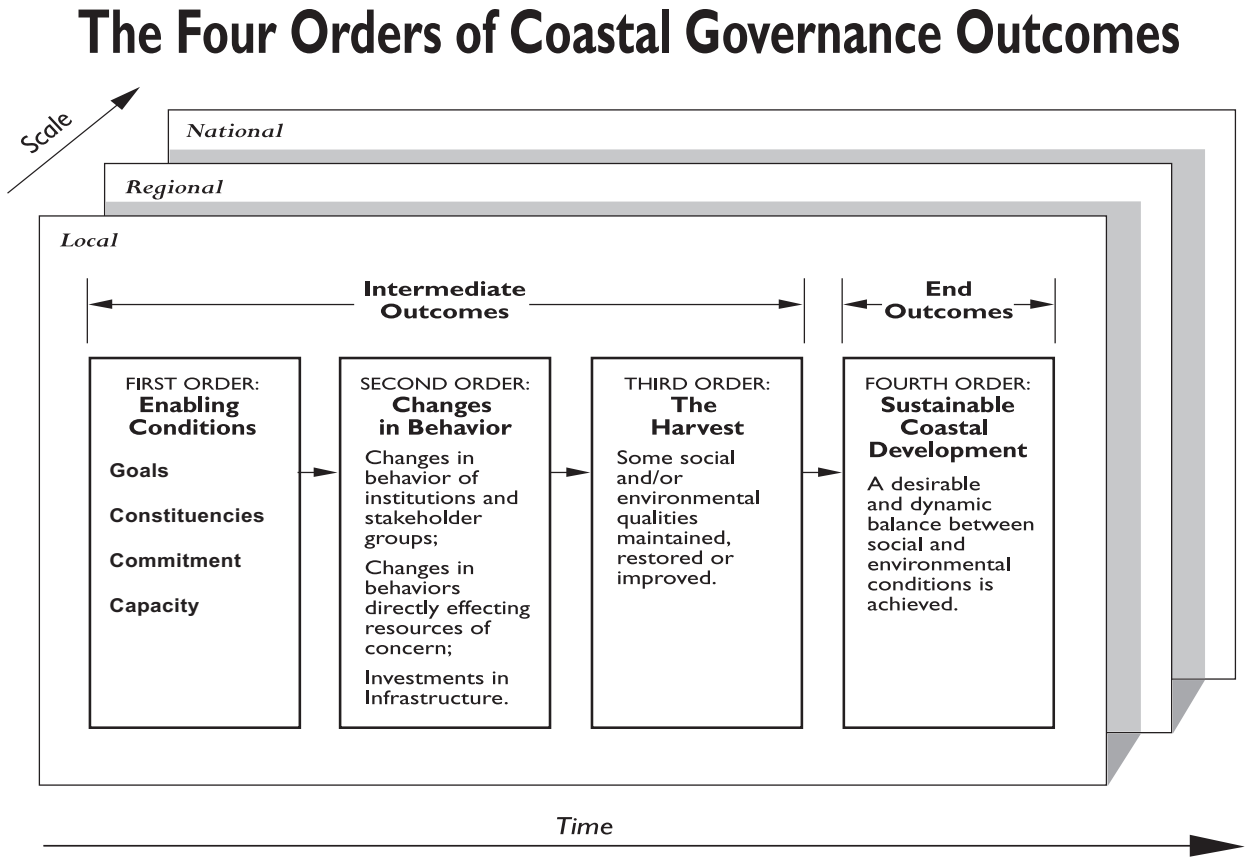
Objectives: Specific statements of the desired accomplishments or outcomes of a project. Project objectives are quantifiable and time-limited. Achievement of all project objectives should lead to the fulfillment of its stated purpose or goal.

Table 3.1 Examples of adaptation goals for coastal climate change

Illustrative Goals and Objectives for Coastal Adaptation to Climate Change

1. **Functioning and healthy coastal ecosystems**
   - **The natural shoreline is ecologically sound and functioning as a dynamic system.** Strengthened natural defenses protect people and nature from future hazards. Sand dunes, sea grass, mangroves and beaches are physical buffers.
     - ✓ Mangrove forest area is expanded by 30% within 5 years in any given coastal lagoon through community-based replanting efforts
   - **Extraction and use of natural resources do not compromise the sustainability of vital coastal ecosystems.** Reducing or eliminating non-climate stresses and unfavorable trends helps achieve functional ecosystems that are more resilient to climate change and variability. Resilient, healthy systems can better withstand all types of perturbations than can systems that are unbalanced or at the edge of their survival.
     - ✓ Illegal sand and gravel mining in coastal riverbeds and beaches is stopped in one year's time
   - **Marine fisheries are healthy and resilient to climate change. Reducing overfishing and destructive fishing** will reduce or eliminate non-climate stresses and non-climate trends helps strengthen fish populations and restore fish habitat.
     - ✓ Use of destructive small-mesh nets is eliminated in a given marine protected area within 2 years
   - **Coastal and marine ecosystems are functioning and healthy.** Functional ecosystems provide goods and services that are important to human society in the face of climate change (storm protection, flood mitigation, shoreline stabilization, erosion control, water storage, groundwater recharge, and retention of nutrients, sediments and pollutants).
     - ✓ Mangrove replanting increases mangrove habitat by 30% in a given coastal district in 2 years
   - **Key climatic refugia that will likely experience less change are reserved to "bank" ecosystem services for future climate changes.** Identifying locations that are more stable during periods of global climate change can be useful for conservation. In the marine environment, for example, these sites may have strong currents, upwelling or other oceanographic features that make them less prone to thermal fluxes.
     - ✓ Coral reef areas that are more resilient to climate changes are identified within 1 year and management plans are completed within 2 years to protect climate change resilient reef systems
   - **Freshwater supplies and access to freshwater for human uses continue to be available.** Proactive adaptation measures can reduce or avoid the undesirable impacts of climate change on access to freshwater supplies for meeting both growing human demand and environmental flow requirements.
     - ✓ Water User Associations in three Districts prepare water management plans and approve the plans within 2 years
2. **The built environment is less exposed and less vulnerable to damages from natural hazards.** Reduce human injury, loss of life, and damage and loss to public and private infrastructure with measures that protect, accommodate or avoid the impacts of climate change on the built environment.
   - ✓ A District management plan in a given District that defines coastal development setback rules is completed and formally adopted by local government in a two year timeframe
3. **Livelihood opportunities are maintained or strengthened in the face of climate change impacts.**
   - ✓ Community savings and loan mechanisms are established in three coastal districts within 15 months to increase community resilience and opportunities for fishing households to diversify their livelihoods
4. **Impacts of climate change to human health and safety are minimized.** Disaster risk management and preparedness reduce the risks to human health and safety from natural hazards.
   - ✓ Flood hazard maps for all coastal provinces are completed in 1 year and at the same time pilot disaster risk management plans completed in 5 communities
5. **Governance, policy and planning capacities for planned adaptation are strengthened.** Vigilance, planning, and continually renewed political commitment improve adaptive capacity and reduce society's vulnerability to climate change impacts.
   - ✓ National Adaptation Plan of Action prepared by national working group within 12 months and recommended implementation actions initiated within 2 years

Figure 3.1 Ordering coastal adaptation outcomes



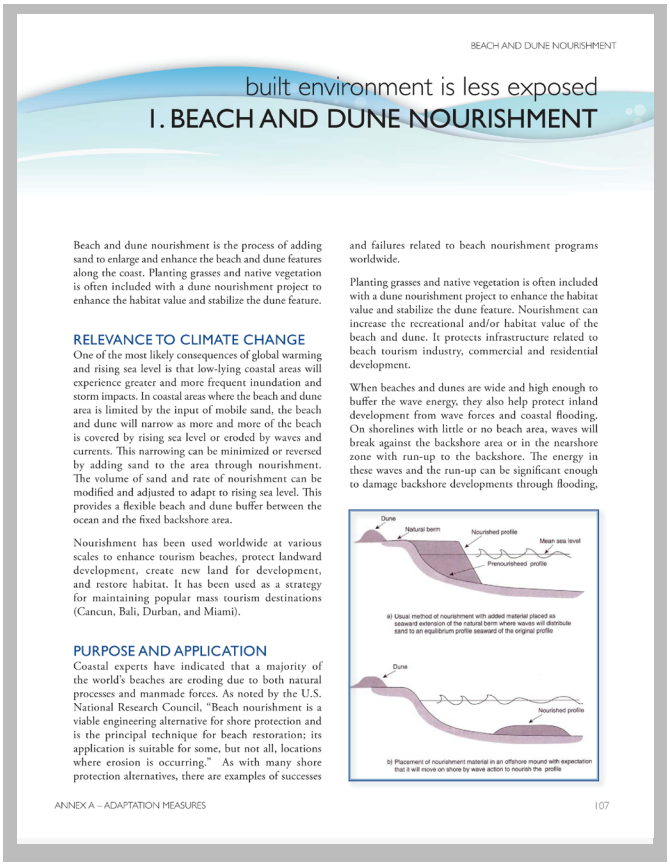
Source: Adapted from Oslen et al. 1998

Orders of Outcome framework helps to sort adaptation outcome goals and think strategically over the long term (see Figure 3.1). The **First Order** is achieved by assembling key enabling conditions for coastal adaptation including clear goals, engaged constituencies, formal commitment, and adequate institutional capacity. The third goal listed in Table 3.1 above (governance, policy, and planning capacities) is a First Order outcome. The **Second Order** marks changes in the behavior of institutions and relevant user groups. Change in coastal construction practices is a Second Order outcome. The **Third Order** marks the achievement of the specific societal and environmental quality goals such as healthy coastal ecosystems, improved human safety, sustainable fisheries, and food security. The **Fourth Order** adds the dimension of balance and asks whether the conditions achieved are sufficient to sustain a healthy, just, and equitable human society that is sustaining the qualities of the ecosystem of which it is a part.

3.3 ADAPTATION MEASURES

In general, there are two types of adaptation—"reactive" and "planned." Reactive adaptations are the changes in policy and behavior that people and organizations adopt after changes in climate and coastal risks are observed. For example, as the spatial and temporal distribution of fish stocks change with ocean warming, fishers will automatically change fishing practices. As property losses from coastal storms and sea-level rise increase, insurance companies will increase insurance rates, creating a disincentive to locate in hazard zones.

Planned Adaptation is the result of deliberate policy decisions on the part of pubic agencies vs. autonomous adaptations by private actors triggered by market or welfare changes



BEACH AND DUNE NOURISHMENT

built environment is less exposed

1. BEACH AND DUNE NOURISHMENT

Beach and dune nourishment is the process of adding sand to enlarge and enhance the beach and dune features along the coast. Planting grasses and native vegetation is often included with a dune nourishment project to enhance the habitat value and stabilize the dune feature.

RELEVANCE TO CLIMATE CHANGE

One of the most likely consequences of global warming and rising sea level is that low-lying coastal areas will experience greater and more frequent inundation and storm impacts. In coastal areas where the beach and dune area is limited by the input of mobile sand, the beach and dune will narrow as more and more of the beach is covered by rising sea level or eroded by waves and currents. This narrowing can be minimized or reversed by adding sand to the area through nourishment. The volume of sand and rate of nourishment can be modified and adjusted to adapt to rising sea level. This provides a flexible beach and dune buffer between the ocean and the fixed backshore area.

Nourishment has been used worldwide at various scales to enhance tourism beaches, protect landward development, create new land for development, and restore habitat. It has been used as a strategy for maintaining popular mass tourism destinations (Cancun, Bali, Durban, and Miami).

PURPOSE AND APPLICATION

Coastal experts have indicated that a majority of the world's beaches are eroding due to both natural processes and manmade forces. As noted by the U.S. National Research Council, "Beach nourishment is a viable engineering alternative for shore protection and is the principal technique for beach restoration; its application is suitable for some, but not all, locations where erosion is occurring." As with many shore protection alternatives, there are examples of successes and failures related to beach nourishment programs worldwide.

Planting grasses and native vegetation is often included with a dune nourishment project to enhance the habitat value and stabilize the dune feature. Nourishment can increase the recreational and/or habitat value of the beach and dune. It protects infrastructure related to beach tourism industry, commercial and residential development.

When beaches and dunes are wide and high enough to buffer the wave energy, they also help protect inland development from wave forces and coastal flooding. On shorelines with little or no beach area, waves will break against the backshore area or in the nearshore zone with run-up to the backshore. The energy in these waves and the run-up can be significant enough to damage backshore developments through flooding,

ANNEX A – ADAPTATION MEASURES 107

Adaptation measures are summarized as practitioner briefs in Annex A.

This Guidebook focuses on "planned adaptation." Planned adaptation is intentional, proactive, and occurs at the societal level. It is strategic and aims to address the full range of coastal climate change hazards in ways that meet societal objectives.

Seventeen practitioner briefs on coastal adaptation measures and strategies were developed with the assistance of coastal practitioners and are included in this Guidebook. The 17 briefs were chosen by coastal practitioners from an initial list of 50 adaptation measures. The term "measure" is used broadly and includes specific actions (e.g., a development setback) and management approaches (e.g., special area management planning) to address climate change adaptation. Table 3.2 lists these 17 measures and their relationship to the adaptation goals presented above, while Table 3.3 provides definitions. Annex A contains technical briefs on each measure, including information on:

- Relevance to climate change
- purpose/application
- Information and data requirements
- Design considerations for developing the measure
- Improving the likelihood of success in applying the measure as a climate change adaptation
- Sources for more information

Many of these adaptation measures are not "new" to those involved in managing coastal systems. They include strategies and actions familiar to coastal practitioners as part of responding to episodes of natural hazards and shocks. They are also familiar as part of everyday efforts to implement sustainable

USAID's Global Conservation Program is supporting the development and application of nature-based adaptation strategies to climate change in four large marine ecoregions—the Meso-American Reef in Central America, Wakatobi National Park and Raja Ampat in Indonesia, and Kimbe Bay in Papua New Guinea. Nature-based adaptation strategies can help people and communities deal with climate change impacts by protecting natural systems and the benefits they provide—shoreline protection, erosion control, as well as food from fisheries, jobs, and income. Solutions to address climate change impacts to the marine ecosystems rely on marine protected networks specifically designed for resilience (i.e. the ability to resist shock or recover quickly from stress) to climate change. Building resilience in coastal and marine ecosystems depends upon: (1) Spreading risk to manage for uncertainty by protecting replicates of critical habitats (i.e. mangrove forests) over a large geographic range; (2) Identifying and securing sources of "seed" or marine larvae which are critical for maintaining and restoring healthy populations; (3) Maintaining connectivity between habitats by creating refugia from other stresses, such as overfishing; and (4) Managing resources effectively by controlling other threats and pressures (i.e. sedimentation from land-based sources).

For more information: "Scientific Design of a Resilient Network of Marine Protected Areas: Kimbe Bay, West New Britain, Papua New Guinea." Source: http://conserveonline.org/workspaces/pacific.island.countries.publications

development—including sound environmental management, planned development, wise resource use, and poverty reduction. Adopting these measures with a climate lens provides an opportunity to be strategic in the face of future changes.

There are also new approaches and tools being developed, such as nature-based approaches to coastal adaptation (see text box). Nature-based approaches include new tools for managing seascapes and approaches to conserve biodiversity in the face of shifting geographies. They focus on helping people and communities deal with climate change impacts by protecting mangroves, coral reefs, estuaries, seagrass beds, dune communities, and other systems on or near shorelines and the benefits they provide. As noted earlier in section 2.1, these benefits include protection from storms; mitigating floods; controlling erosion; providing water storage and groundwater recharge; and retaining and assimilating nutrients, sediments, and pollutants. In addition to these benefits, functional ecosystems are critical to maintaining biodiversity and to fishers and other resource users whose livelihoods rely on the condition of natural systems. These approaches provide a departure for the next generation of adaptation briefs, with subsequent versions of this Guidebook and associated tools.

Using a single, stand-alone measure is usually not the best approach. To respond effectively to a wide array of climate change impacts requires combining complementary measures. In selecting the best combination, it helps to look for measures that have interdependencies, contribute to good coastal management, and bring additional benefits in terms of climate change adaptation. For example, if the management goal is to maintain and restore coastal wetlands, a variety of adaptation measures can apply: coastal development setbacks, coastal zoning, protected area management, integrated coastal management, and actions to protect living shorelines. Table 3.2 lists other measures often undertaken as part of a suite of complementary adaptation actions for a particular climate change issue or adaptation goal.

Table 3.2 Adaptation measures, goals, and climate change impacts. Annex A contains technical briefs on each Adaptation Measure listed below.

Adaptation Measures	Description	Relevance to Climate Change
FUNCTIONING AND HEALTHY COASTAL ECOSYSTEMS AS A PRIMARY GOAL		
Coastal wetland protection and restoration	Provides nursery habitats for fisheries, ecosystems services for communities and their livelihoods; serves as a natural water filter, buffer against coastal ecosystems. Climate change mitigation and adaptation measure.	Acts as buffer against extreme weather events, storm surge, erosion, and floods; limits salt water intrusion.
Marine conservation agreements	Formal or informal agreements between parties to exchange benefits, take or refrain from certain actions, transfer certain rights and responsibilities in order to restore and protect fragile coastal and marine ecosystems.	Improves the resilience of coastal ecosystems to climate change and improves the economic and social conditions of coastal communities.
Marine protected areas	Intertidal or subtidal terrain areas, their waters, flora, fauna, and cultural and historical features, of which part or all is protected. An overarching management approach or strategy that can be used to bundle a series of measures.	Maintains healthy and resilient coastal habitats and fisheries productivity; acts as "refugia" and critical sources of new larval recruits.
Payment for environmental services	Financial instruments under which beneficiaries of ecosystem services compensate the suppliers as a means to fund sustainable environmental management policies and actions. No-regrets option.	Provides incentives to protect critical habitats that defend against damages from flooding and storm surges as well as coastal erosion.
BUILT ENVIRONMENT IS LESS EXPOSED AS A PRIMARY GOAL		
Beach and dune nourishment	Process of adding sand to enlarge and enhance coastal beach and dune features as well as, in many cases, planting grasses and native vegetation. Level and rate of nourishment can be adjusted to adapt to rising sea levels.	Protects shores and restores beaches; serves as a "soft" buffer against flooding, erosion, scour and water damage.
Building standards	Delineate the minimum technical and safety requirements for the design and construction of residential and commercial structures as a means to promote occupant health, welfare and safety. Can be prescriptive or objective-oriented.	By incorporating climate considerations (e.g. effects of flooding, waves and wind) in building design, it reduces damages and human safety risks from climate change impacts, including extreme events, sea level rise, and flooding.
Coastal development setbacks	Set distance from a coastal feature within which all or specific types of development are prohibited; often includes a buffer. Useful within an overarching coastal management program.	Reduces the infrastructure losses and human safety risks of sea level rise, storm surge, and erosion.
Living shorelines	Management practice involving strategic placement of plants, stones, sand fill and other materials to achieve the dual goal of long-term protection/restoration/enhancement of shoreline habitats and the maintenance of natural processes.	Mitigates erosion and protects people and ecosystems from climate change impacts and variability in low to medium energy areas along sheltered coastlines (e.g. estuarine and lagoon ecosystems).
Structural shoreline stabilization	Shoreline hardening or armoring; ranges from technically complex structures to the placement of construction debris serving as, for instance, bulkheads, revetments and seawalls. Not a long-term strategy, but option of last response.	Temporary buffer against the impacts of erosion and flooding caused by factors such as sea level rise, storm surge, and wave attacks.
DIVERSIFIED LIVELIHOODS AS A PRIMARY GOAL		
Fisheries sector good practices	Adapting fisheries management and strengthening capacity to deal with long-term climate-related effects on relevant habitats and ecosystems. Can apply to production, infrastructure, operations and/or ecosystem protection.	Contributes to the protection of rural livelihoods, food security and marine biodiversity against the impacts of extreme climate events, precipitation change, ocean acidification, sea level rise and sea surface warming.
Mariculture best management practices	Largely self-enforced measures to better efficiency and cost in the mariculture sector in order to increase the derived benefits and promote development.	Integration of climate change considerations helps safeguard against extreme climate events, precipitation change, ocean acidification, sea level rise and sea surface warming.
Tourism best management practices	Actions that enable the tourism sector to improve services and business while minimizing the adverse effects on the environment and local communities. Can serve as climate change mitigation and adaptation measure.	Integration of climate change concerns helps promote the sector's sustainability as well as safeguard against extreme climate events, precipitation change, sea level rise and sea surface warming.
HUMAN SAFETY AND SAFETY ENHANCED AS A PRIMARY GOAL		
Community-based disaster risk reduction	An overarching management approach or strategy consisting of structural and non-structural measures that prevent, mitigate and/or help prepare for the effects of natural hazards. Can be used to bundle a series of measures.	By proactive planning and capacity building that addresses the specific needs of local communities, increases their resilience and ability to respond to the effects of extreme climate events and flooding.
Flood hazard mapping	Conducted in areas adjacent to water bodies to ensure land owners, insurers and regulators have relevant information on flooding risks.	Informs coastal planning processes and policy, reducing the impact of flooding resulting from storm events, heavy rains, storm surges, and extreme tides.
OVERARCHING PLANNING AND GOVERNANCE AS A PRIMARY GOAL		
Coastal watershed management	Integrated water resources management (IWRM) in the coastal context, which takes into consideration watershed and estuary management. An overarching approach or strategy that can be used to bundle a series of measures.	Preserves estuaries, which act as storm buffers and protect against coastal groundwater salinization.
Integrated coastal management	An overarching management approach or strategy involving planning and decision-making geared to improve economic opportunities and environmental conditions for coastal people. Can be used to bundle a series of measures.	Provides a comprehensive process that defines goals, priorities, and actions to address coastal issues, including the effects of climate change.
Special area management planning	An overarching management approach or strategy for a geographic area of critical concern, usually within the context of a coastal resources management program. Can be used to bundle a series of measures.	Improves the management of discreet geographic areas where there are complex coastal management issues and conflicts, including issues related to extreme climate events, precipitation change, ocean acidification, sea level rise and temperature change.

3.4 SELECTING MEASURES

In selecting measures, it is important to acknowledge differences among countries. What is the pre-existing degree of awareness and salience of climate change impacts? What is the locus of decision-making power? What is the capacity to address coastal issues? What is the country's "readiness" to tackle accelerated climate change? How are present and future environmental goods and services maintained?

Different country contexts drive the need to tailor adaptation measures to local conditions (see text box). Adaptation measures need to be commensurate with the realities of time, funding, personnel, and institutional capacity. Capacity to respond to climate change issues will grow with time, experience, and the positive reinforcement that comes with success. Early successes of adaptation may begin with establishing setbacks and buffer areas, for example, in undeveloped areas or areas proposed for future development that are exposed to flooding and erosion. More complex adaptation measures might include those that involve infrastructure development and maintenance.

Population density and infrastructure are other key considerations in selecting measures. For example, in developed areas facing potential increases in erosion, sea level rise, or flooding, the favored adaptation option would be structural shore protection (to stabilize the shoreline) vs. retreat. In underdeveloped areas, the opposite would be likely—i.e., a strategy of retreat would be favored. Retreat refers to a series of measures that would remove the population and development by "retreating" landward—i.e., away from the potential risk.

Coastal managers, stakeholders and decision-makers can use a range of criteria in deciding the best adaptation option within a given local context. Criteria include:

- **Technical effectiveness:** How effective will the adaptation option be in solving problems arising from climate change, (i.e. might some measures be more beneficial than others)?
- **Costs:** What is the cost to implement the adaptation option and what are the benefits? Is one approach both cheaper and more effective? Is the measure a "no-regrets" measure—i.e., would it be worthwhile regardless of climate change (e.g., protecting/restoring coastal ecosystems that are already vulnerable or of urgent concern for other reasons)?
- **Benefits:** What are the direct climate change-related benefits? Does taking action avoid damages to human health, property, or livelihoods? Or, does it reduce insurance premiums? Are there any greenhouse gas reduction advantages that could be valued according to the market price for carbon credits? Other benefits include increased ecosystem goods and services and positive contributions to economic value chains.
- **Implementation considerations:** How easy is it to design and implement the option in terms of level of skill required, information needed, scale of implementation, and other barriers?
  - Some measures require sophisticated information and specialists that are not available
  - Flexible, adaptive approaches require more knowledge and judgment than a simpler, rule-based policy
  - A standardized setback for a shoreline area is simple compared to a detailed scientific study of oceanographic, geological or other landscape-scale parameters
  - Working with a resort developer in a particular case to make adjustments may be easier than creating a broad-reaching policy that deals with all business owners in a tourism district who unwittingly made investments and physical alterations to the shore that expose them to hazards and climate change

The Climate Ready Estuaries Program of the U.S. Environmental Protection Agency has initiated a review of on-the-ground adaptation strategies available to coastal managers, with a focus on the eight management

Tailor to local conditions. Countries or coastal areas may share the same climate change issues. Yet, each has different circumstances—climate, natural resources, infrastructure, technological state, economy, governance, etc.—so the responses to those climate change issues may vary. Coastal adaptations must be "tailored" to the local context through an inclusive process that matches the climate change issues with the technical capabilities and the capacity of the institutions and community stakeholders of the place.

goals critical to the National Estuary Program. Looking at the management goals (both primary and synergistic), together with the climate stressors, benefits, and constraints helps managers identify measures and bundles of measures that may be implemented to mainstream adaptation (see Figure 3.2).

Most adaptation measures can help in achieving multiple objectives and benefits. "No regrets" measures should be the priority. For example, wetlands protection and living shoreline strategies would be beneficial even in the absence of climate change. Living shorelines protect from erosion and at the same time can enhance vegetated shoreline habitats today and in the future as wetlands migrate landward (see Figure 3.3). This, in turn, can benefit natural resources-dependent livelihoods and increase community resilience. Compare this to the option of constructing a seawall—a strategy that also could protect against erosion in a specific location, but at the same time cause problems in the future (e.g., erosion of adjacent shoreline or preventing wetland migration), and bring little benefit to the larger community and natural ecosystem. Measures that provide few benefits other than protection require a high degree of certainty about the impact from climate change at a particular site.

As a procedure, conduct basic screening of adaptation measures on an individual basis. For options that are substitutes (beach nourishment vs. shoreline stabilization), select the best option to include in the overall adaptation strategy. Consider synergistic impacts. Some measures will yield better results when combined with others (e.g., combining construction setbacks together with building codes). Take into account budget constraints and try to consider all implementation costs as part of the package. Finally, be realistic about current organizational capacity to simultaneously manage multiple adaptation options.

When selecting measures, also consider how the measure may affect greenhouse gas emissions. Many measures can be designed in a way that reduces the production of greenhouse gases or removes the gases from the atmosphere (sequestration). For example, although wetlands cover 6% of Earth's land surface, they store 10-20% of its terrestrial carbon. Preserving or restoring wetlands helps protect the shoreline and the community from climate risks and also mitigates greenhouse gas concentrations. Similarly, building standards for the coast can serve as both an adaptation measure, and be designed to reduce energy use and greenhouse gas emissions.

Local stakeholders along with the socioeconomic and institutional context of the place will determine the relative importance of various criteria in selecting the most appropriate adaptation measures. The dynamics and processes for the coastline in question will also influence these criteria. As well, it is essential to match measures to the resources, the technical capabilities, and the capacity of the institutions and community stakeholders.

Cambodia's Tonle Sap has adapted to changes in water levels, where the lake can rise up to 10 meters. This floating school moves with the community as it migrates during these seasonal changes.

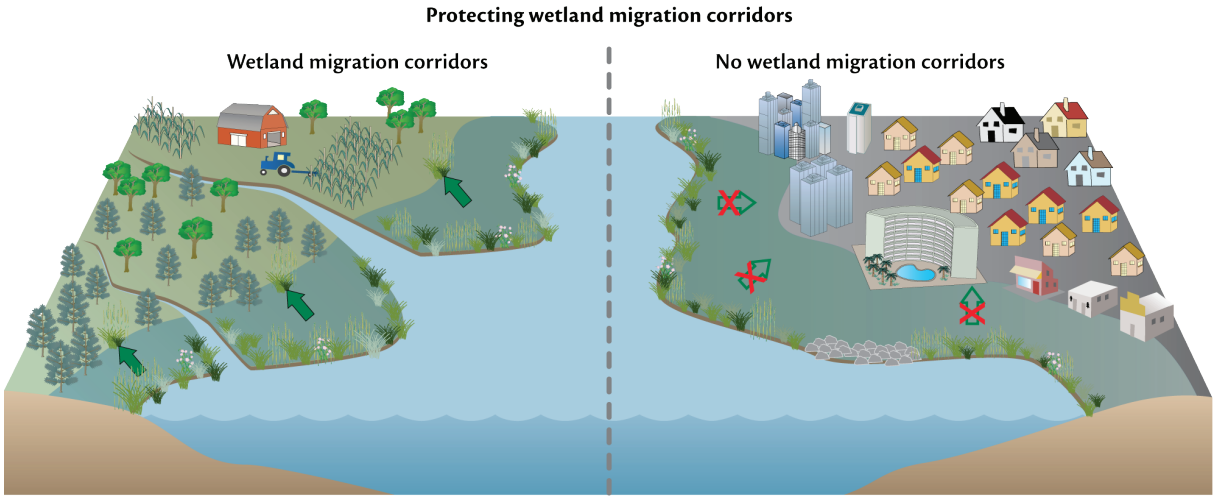
No-regrets. Many coastal adaptations yield benefits independent of climate change. These measures address current vulnerabilities and focus on increasing the ability of ecosystems and communities to cope with current environmental pressures and climate variability. They provide a benefit now, a benefit in the future, and potentially provide a benefit whether or not the projected climate changes become reality. These options are more likely to gain political support given that some climate impacts will only be felt over the medium term.

Figure 3.2 Adaptation options related to the goals of the U.S. National Estuary Program.

Adaptation Option	Climate Stressor Addressed	Additional Management Goals Addressed	Benefits	Constraints	Examples
Retreat from and abandonment of coastal barriers	Sea level rise	Maintain/restore wetlansd	May help protect estuaries, allowing them to return to their natural habitats	Not politically favored due to the high value of coastal property and infrastructure	
Purchase upland development rights or property rights	Changes in percipitation; Sea level rise	Maintain/restore wetland; Maintain water quality	Protects habitats downstream	Costly; uncertainty about sea level rise means uncertainty in the amount of property purchased	San Francisco Estuary Project (planned); Massachusetts Climate Protection Plan
Expand the planning horizons of land use planning to incorporate longer climate predictions	Changes in precipitation; Sea level rise	Preserve coastal land/development	Could inhibit risky development and provide protection for estuarine habitats	Land use plans rarely incorporate hard prohibitions against development close to sensitive habitats and have limited durability over time	San Francisco Bay Conversation and Development Commission (SFBCDC) has proposed recommendations

In evaluating each management goal within their program, managers identify an initial set of measures from which they can develop adaptation strategies to meet their management goals. Source: USEPA, 2008

Figure 3.3 Protecting wetland migration corridors will aid in sea level rise adaptation and provide mitigation to greenhouse gases.



As sea level rises, wetlands may migrate into open spaces such as forests and fields. However, wetlands cannot migrate into areas with man-made barriers such as hardened shorelines and heavy development such as urban, commercial, and residential areas.

Source: Maryland Commission on Climate Change, Adaptation & Response Working Group. 2008

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Note: Sources for more information are also listed in each of the 17 adaptation technical briefs in Annex A

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chapter 4

MAINSTREAM COASTAL ADAPTATION

Mainstreaming is what gives adaptation the funding and authority to take place. Once adaptation needs and measures are defined, a mainstreaming process is required for formal approval, funding, and implementation of the measures. In most cases, it is best if you develop the mainstreaming mechanisms in parallel with conducting your vulnerability assessment and planning. This chapter describes the meaning of mainstreaming, and highlights three mainstreaming entry points. These are: 1) national or regional level public policy, 2) sectoral investments and projects, and 3) sub-national, place-based initiatives. Good practices for overcoming mainstreaming obstacles are also listed.

MAINSTREAMING

- ☑ What is mainstreaming?
- ☑ National and regional entry points
- ☑ Sectoral investments and projects
- ☑ Coastal places
- ☑ Overcoming barriers and obstacles in mainstreaming

4.1 WHAT IS MAINSTREAMING?

It is important to recognize that climate change adaptation presents a fundamental challenge to managing the coastal resources and should be "mainstreamed" into coastal management and development at all levels. Mainstreaming means integrating climate concerns and adaptation responses into relevant policies, plans, programs, and projects at the national, sub-national, and local scales. At the national level, climate change adaptation strategies will be more effective if they are mainstreamed into development and sectoral plans and strategies, and "owned" by those authorities responsible for preparing and implementing them. The long-term goal is to have climate change adaptation integrated into public policy across many sectors, woven into organizational missions, and routinely considered in decisions about development.

> "Climate change policies cannot be the frosting on the cake of development; they must be baked into the recipe of growth and social development."
>
> Robert Zoellick, President, the World Bank Group

Mainstreaming does NOT mean allowing the climate change adaptation issue to get lost amongst many other competing priorities. Rather, it means advocating strongly for climate change adaptation and for bundles of adaptation measures to address priority issues within the scope of development goals.

Mainstreaming recognizes that adaptation measures are seldom undertaken solely in response to climate change (IPCC, 2007b). Given the scale of the problem, and the linkages between climate change and development, coastal adaptation will happen as an overlay to other ongoing initiatives and governance frameworks. Existing institutions should be in the forefront of designing and implementing adaptation measures. This could include those responsible for managing water supplies, protecting public health, responding to natural disasters, protecting coastal areas and conserving and managing marine ecosystems.

As noted earlier, coastal countries or regions use many different entry points to incorporate climate change measures appropriately. Each entry point offers challenges; creates new roles for citizens, the private sector and government; and can open up new opportunities.

Constructing water tanks for schools in Tanzania's Wawi Watershed is critical to address current climate issues and to improve for health and sanitation of the community.

Successful mainstreaming requires reinforcing linkages among the many possible adaptation entry points. Government, together with non-government partners, must play a pivotal role in fostering the connections across national, sectoral, and place entry points. Examples include:

- *Creating enabling policy, finance and legal frameworks.* This includes, for example, prioritizing adaptation in national planning and budgeting; harmonizing sectoral policies; creating national coordination committees, chaired by a ministry with power; and providing the financial and technical support necessary for adaptation measures to succeed.
- *Capturing local experience.* Coastal adaptation in a specific place or area builds practical experience and a sense of ownership for those living and working there. This experience can be shared amongst different actors at the national level to build capacity. Linkages between local communities and government strengthen community voice in planning and national policy-making for coastal adaptation to climate change.
- *Public awareness.* Awareness raising and education campaigns help convey information about the impacts of climate change and gain consensus on adaptation options. Governments need to engage more actively with the scientific community and provide easily accessible and up-to-date climate change information relevant to the needs of coastal sectors.

ENTRY POINTS

Entry Point I: National / regional settings, e.g.:

- National Adaptation Programme of Action
- National coastal management programs
- Hazard mitigation or disaster preparedness
- Poverty reduction strategies
- National budgeting processes

Entry Point II: Sectoral investments and projects, e.g.:

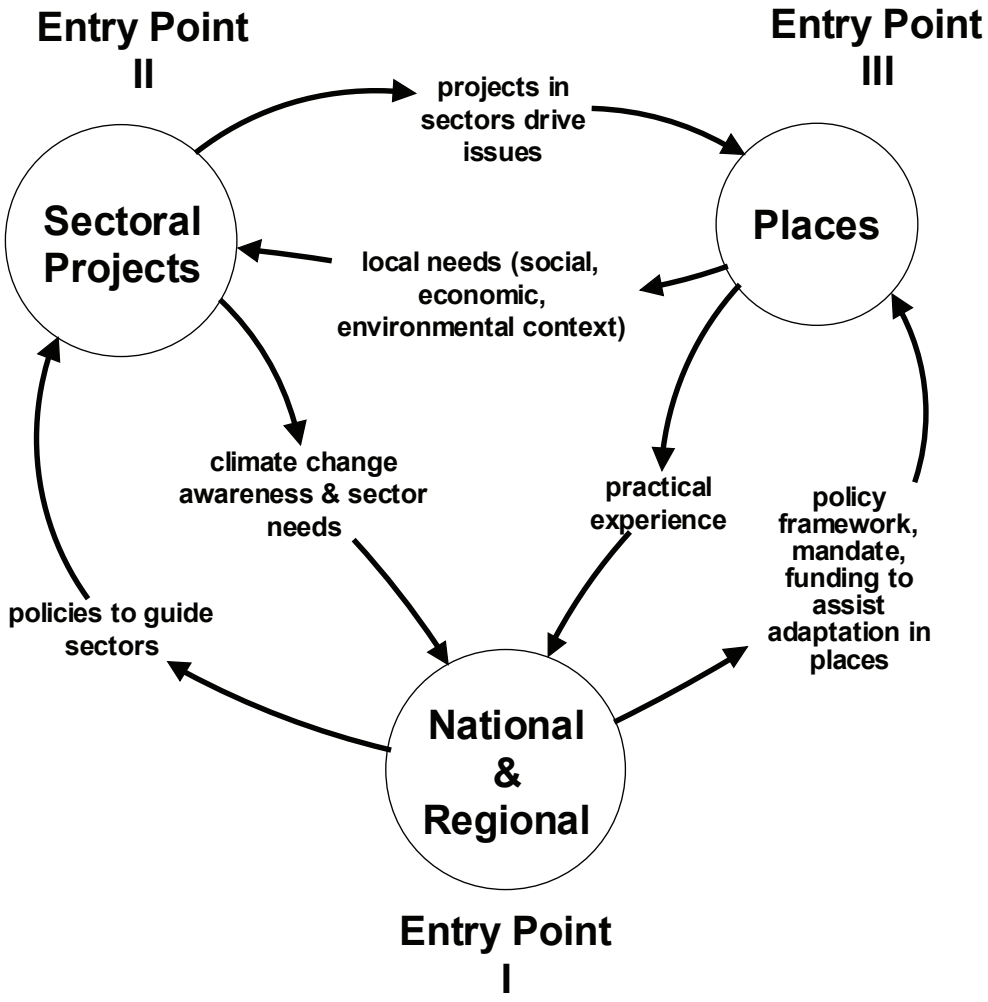
- Tourism development in specific sites
- Mariculture
- Fisheries
- Freshwater supply

Entry Point III: Coastal places, e.g.:

- Municipalities, districts, provinces
- Ecosystems (estuaries, rivers)
- Coastal watersheds
- Marine protected areas

National, sectoral, and place-based entry points share an important set of relationships as illustrated in Figure 4.1. No sectoral project can ignore the specifics—the local stakeholders, physical attributes and resources, and governance setting—of the place where it will be implemented. Likewise, a place-based approach needs to take into account the types of development trends occurring or being proposed by sectoral interests. Projects that are already or soon-to-be underway represent recognized priorities or issues for the area. They provide evidence of what is salient to leaders and citizens of the place. There are also complementary links between sectoral and place-specific entry points and the national entry point. For example, national policies, budgets and legislation provide the enabling conditions necessary for place-based and sectoral adaptation actions to occur. At the same time, it is experience in sectoral development and local adaptation initiatives that builds awareness and experience at the national level.

Figure 4.1 How entry points reinforce each other and contribute to a more integrated strategy



4.2 NATIONAL AND REGIONAL ENTRY POINTS

Until recently, national agencies and the development community seldom considered the threats posed by climate change to lives and livelihoods during development planning. That is changing slowly as climate change adaptation rapidly gains importance on national and international agendas. National climate change adaptation strategies need to be mainstreamed into other development initiatives such as poverty reduction strategies, country strategies and sector plans. The advantages of mainstreaming are two-fold. By mainstreaming climate change adaptation into development initiatives, there is ready access to the pool of resources already budgeted/identified for those initiatives. This eliminates the need to generate a separate resource pool for a stand-alone climate change adaptation effort. In parallel, by mainstreaming climate change adaptation into development investments, those investments are made more resilient. More resilient investments, in turn, serve the community more effectively, and maximize benefits and returns. It is also advantageous to integrate and mainstream adaptation to climate change into broader coastal management and disaster risk reduction programs, which often exist within the administrative framework of a country.

While there are many possible entry points at the national level, it is essential to have a strong agency with the authority and capacity as the champion of your adaptation initiative. This helps ensure effective coordination with and avoids redundancy and/or inefficiencies amongst the various agencies involved. It also helps ensure coastal climate change adaptation finds a place in the national budget. In some cases the most effective approach is to create a national coordination committee, chaired by a government department with authority, such as a country's planning or finance department.

NATIONAL MAINSTREAMING EXAMPLES

Small island developing states in the **Pacific and Caribbean** have been among the first to work on adaptation. As a regional response to the Global Conference on Small Island Developing States in 1994, the Caribbean Planning for Adaptation to Climate Change project was established in 1997. One of their five pilot projects lead to the establishment of a National Climate Change Committee in **St. Lucia** that has advanced national level awareness, provided the information and built the capacity to address climate change.

The Pacific island of **Kiribati** successfully integrated adaptation into national development strategies from within the Ministry of Finance and Economic Planning and later from the Office of the President. This shows the effectiveness of coordination on adaptation from within an important ministry.

Bangladesh has produced a National Adaptation Programme of Action and has been successful in integrating climate adaptation in a concrete way into several sectors (e.g. coastal management, freshwater resource management, and disaster preparedness).

In **Mexico,** an Inter-Sectoral Commission on Climate Change was established in 2005, with the Environment Ministry responsible for coordinating climate change policy through the Commission. Institutional fragmentation and isolation of the adaptation agenda from the development agenda are cited as barriers to effective mainstreaming under this framework. The Environment Ministry has little leverage over other government departments.

Tanzania has prepared a NAPA and other East African countries are preparing theirs (**Kenya, Uganda, Sudan**). In Tanzania, a National Climate Change Committee was formed, chaired by the Department of Environment in the Vice-President's office. There are many opportunities for mainstreaming adaptation through existing coastal management and poverty reduction programs if the political mandate and funding can be found.

The National Adaptation Programme of Action (NAPA) carried out through the United Nations Framework Convention on Climate Change (UNFCCC) has led some developing countries to examine several facets of climate change and the need for adaptation measures. The UNFCCC provides support to the 50 least developed countries (many of which are coastal) to plan, mainstream, and implement climate adaptation. An assessment of the five-year performance of the NAPA is instructive on the implementation challenges of climate change adaptation. As Table 4.1 shows, most countries are considered to have effective institutional mechanisms for developing climate adaptation policy and strategy. Seventy-five percent have started their NAPA.

However, only 10 percent have established national programs and reached an early stage of implementation. This makes the point that having a NAPA does not immediately translate to mainstreaming.

Table 4.1 An assessment of the national adaptation programme of action

2007 'REPORT CARD' OF PROGRESS WITH NATIONAL ADAPTATION PROGRAMMES OF ACTION		
CHALLENGES	**MEASURE OF SUCCESS**	**PROGRESS**
Identify urgent needs and priorities in Least Developed Countries (LDCs)	All LDCs submit high quality NAPA documents that identify agreed vulnerabilities	75%: most LDCs have started NAPAs and are able to identify urgent needs
Identify priority projects for urgent action	All LDCs that undertake a NAPA process submit high quality projects for implementation	25%: countries have developed projects from initial profiles and these are now in the pipeline of the Global Environment Facility
Learning by doing: implementing adaptation projects	All submitted projects are successfully implemented; reviews of good practice achieved	10%of LDC countries: at early stage of implementation
Mainstream adaptation planning	All countries have effective institutional mechanisms for developing climate adaptation policy and strategy and good practice in integrating climate adaptation into relevant planning processes	10%: some 30 countries worldwide (not only LDCs) have established national programs

Source: Jallow and Downing, 2007. (More information on NAPAs can be found at the UNFCCC web site: http://unfccc.intnational_reports/napa/items/2719.php)

4.3 SECTORAL INVESTMENTS AND PROJECTS

There are a growing number of calls for mainstreaming climate change in existing development frameworks and sectoral investments. Development banks, such as the African Development Bank and the World Bank, are increasingly concerned that a substantial share of investments are at risk for direct impacts from climate change and from underperformance. The estimate is that 25% of the World Bank's portfolio may be at such risk (World Bank, 2006). This may, in turn, increase vulnerabilities. For example, infrastructure that cannot be adapted to withstand the impacts of climate change may expose more people and assets to risk.

In response, organizations such as the World Bank, USAID, and other donors have developed screening tools and guidelines for integrating climate change concerns into development assistance. Some donors are requiring that plans for sectoral investments (e.g., tourism, fisheries) consider climate change issues in all components of the projects they fund, including in project identification, assessment, ranking and selection, administrative design, financing, and throughout monitoring and evaluation.

Protecting existing and future economic development is an intrinsically strong and salient motivation for mainstreaming coastal adaptation. For example, tourism development investments in specific coastal sites need to account for dynamic shoreline processes, natural hazards such as potential flooding and storm events, and the effects of climate change that can accelerate, intensify or alter the coastal conditions required for successful tourism. Similar reasoning applies to open water or pond-based mariculture. Key infrastructure such as pond walls, intake structures, and canals are

Investments in composting toilets and wetland treatment for sewage, have been critical to reducing impacts to coral reefs in Akumal, Mexico, stressed by coral bleaching, increased tourist pressures, and land-based pollution.

already vulnerable to floods and storms. Aggressive development of pond-based mariculture can destroy the buffering effect of mangrove wetlands. This puts coastal property, settlements, and the economic well-being of its residents in jeopardy. In relation to fisheries investments, this would include an enhanced focus on improved management, reducing overcapacity, and establishing networks of fisheries reserves to increase resiliency

Figure 4.2 illustrates the significance of mainstreaming coastal adaptation in tourism. The center column lists the coastal conditions needed to ensure the success of a tourism investment. On the left side are threats that degrade critical features of coastal tourism. This includes those that are generated by unsustainable tourism development itself, and those that are provoked by the impacts of climate change. On the right side are a bundle of tourism adaptation measures that reduce or avoid the effects of climate change and inappropriate tourism development.

Sectoral investments often emanate from national goals and strategies, which define specific strategies for various sectors (livelihoods, food security, water accessibility, energy, infrastructure, health, safety, biodiversity conservation). This can be an effective starting point for mainstreaming adaptation, and for securing funds for effective implementation through capital investment plans, donors or other financing organizations (see Figure 4.3).

Figure 4.2 Mainstreaming adaptation in coastal tourism

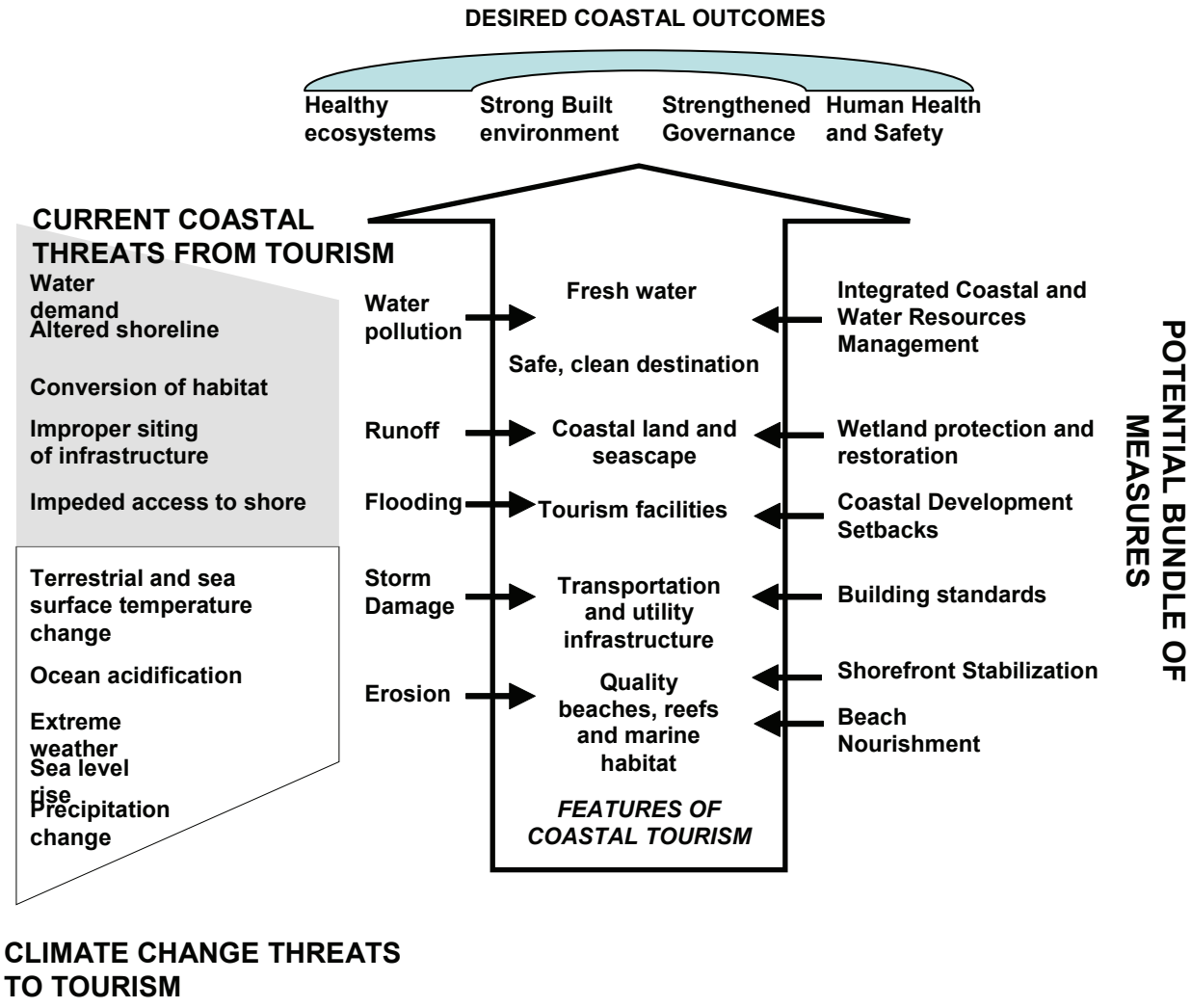
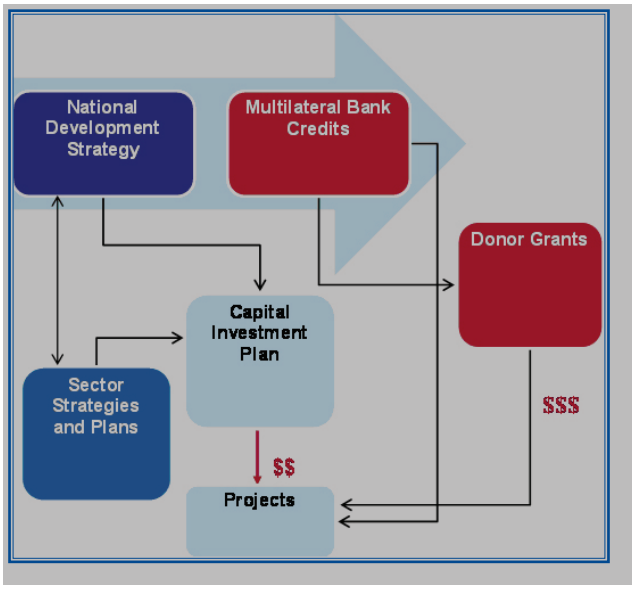


Figure 4.3 Adaptation can be mainstreamed within the national development strategy, sector strategies, or donor grants



In efforts to mainstream, it is important to think about existing processes where planning and capital investments are designed. Within a typical project cycle, there are several opportunities to mainstream climate change:

Project programming stage

- Vulnerability assessment and adaptation can be incorporated when countries communicate priorities, policies, and issues—reflected in country strategy documents.

Project identification

- Identify options and implement actions for adaptation (policy, program, or infrastructure changes).

Preparation, appraisal, approval

- Almost every development project design can include a description of the impact of climate change and vulnerability on the project and a proposed plan to minimize or mitigate impact. The agency financing the project can include criteria for assessing the project's climate-sensitivity and proposed adaptation strategy.

Monitoring and evaluation

- During impact evaluation, evaluators can ask whether the project appropriately anticipates and addresses climate change and vulnerability concerns.

4.4 COASTAL PLACES

A natural starting point for mainstreaming climate change adaptation—especially with implementing a vulnerability assessment approach as set out in Chapter 3 of this Guidebook—is with a specific coastal place. This is preferable to starting with overarching national plans and policies, or sectoral development. The reason is that municipalities, districts, provinces, and other sub-national entities already play an important role in disaster response and natural hazard planning. They often implement or co-sponsor local infrastructure, health and development projects as well. Mainstreaming cross-cutting coastal adaptation issues within overall government, and identifying citizen roles and responsibilities may appear difficult and costly. However, it is less so when stakeholders take ownership of the actions and the benefits to be gained are shared.

Place-based entry points are not restricted to existing administrative entities. Ecosystems such as coral reef systems, estuaries, coastal watersheds, and wetland habitats, are compelling focal points for adaptation planning as they also form the logical unit for scientific studies. Coastal shoreline systems, whether altered or natural, that are already subject to a mix of uses—e.g., settlements, tourism, fisheries, recreation, mariculture, and marine transportation—also need to be studied from an ecosystem perspective. Users of such areas must recognize that their continued use and benefits depend on the integrity of a functioning system.

COMMUNITY-BASED ADAPTATION PROGRAM

A new project supported by the Global Environment Facility will support 80-200 community-level climate change adaptation projects in 10 countries over the next four years, leveraging community action, while generating lessons on community-based adaptation best practices. (See www.undp-adaptation.org/project/cba/subscribe)

4.5 OVERCOMING BARRIERS AND OBSTACLES TO SUCCESSFUL MAINSTREAMING

Frequently, there is resistance to mainstreaming efforts and implementation of adaptation measures. Mainstreaming requires forging agreements with a broad array of agencies and groups, each with different

policies and constituencies. Thus, mainstreaming can be time-consuming and challenging. Some resistance is simply inherent in introducing any new policy idea. In the case of climate change adaptation, this is exacerbated by the cumulative nature and long-term timeframe of climate change impacts. It is also complicated by the fact that different individuals and organizations will have different perceptions of the uncertainties surrounding climate change and its impacts and will have different tolerance levels for risk. Other sources of resistance include:

- The scope of some adaptation measures may simply lie beyond the ability of a community to pay
- Other more immediate needs and concerns may overshadow considerations about the impacts of climate change, which are often measured in years or decades
- Investment decisions of some industries or firms may not have a long timeframe and may discount future risks
- Actors with the most to gain from adaptation measures may not be able to articulate or sufficiently influence decisions, while others have ready access to power and expertise

There is a great deal of experience in how to formulate strategies for addressing these and similar barriers to coastal adaptation. Good practices for successful implementation that have proven effective in coastal management worldwide include:

- Use pilot projects to test how a bundle of policy measures might contribute to societal benefits; then use the results of these pilots to inform the broader audience that will be essential to getting adaptation measures adopted and implemented more widely
- Move the debate from one focused on rights and narrow issues that focus on individuals being asked to modify their use of the coast, to one focused on a common search for desired societal outcomes—e.g., healthy coastal ecosystems that support livelihoods
- Build confidence by addressing a simple issue first; this sets the stage for then tackling issues that are more controversial or less clearly defined
- Conduct directed scientific research (vulnerability assessment) that adopts stakeholder concerns as real, and tests their hypotheses about the source of problems and their solutions
- Encourage a focus on interests and common threats, rather than on particular measures that might foster a hardening of positions
- Demonstrate fairness by creating broad policies that do not single out particular firms or groups, and do not deprive individuals of their constitutional rights (e.g. private property rights. See text box below)
- Encourage firms or entities to recommend and help test their own approaches and practices—possibly accompanied by a promise not to impose formal regulations on the sector as a result of the outcome of those tests
- Engage a full range of stakeholders in assessing vulnerability, selecting the course of action, and assisting in the process of mainstreaming. All important governing institutions and stakeholder groups need to be involved or informed of what is happening so that they can identify with the process and become active partners in implementation.

Community-based marine protected areas in North Sulawesi, Indonesia have increased awareness of fisheries and coral reefs, promoted local management and protection of marine resources while enhancing supplemental livelihoods. Such efforts contribute to nature-based adaptation initiatives being developed in the region.

'TAKINGS' OF PRIVATE PROPERTY AND ADAPTATION MEASURES

Potential legal constraints to certain coastal adaptation measures must be kept in mind when selecting and implementing an adaptation strategy. One potentially common legal constraint involves the takings issue.

What is a "taking"? A "taking," or "expropriation," occurs when a government takes private property for a public purpose. A taking usually has four basic elements. First, it arises by government action. Second, it affects private property, which includes land and other assets. Third, it must be taken for a valid "public purpose." The constitutions of most countries require "just" and "fair" compensation for taking of private property.

Similarly, if a regulation would significantly reduce the value of private properties, it may be held to be a taking and the constitutions of many governments would require compensation to the property owners.

How could takings affect adaptation measures? If a government enacts specific adaptation measures that deprive a private property owner of all economically beneficial uses of the property, a court could potentially find that the measures imply a "taking." This would require the government to pay just compensation to the property owner for the loss of use of his or her property. Takings could make some measures prohibitively expensive.

Making adaptation measures "takings-proof." There are ways that governments can avoid costly takings claims. In developing the adaptation measure, the rationale for the measure should have a clear mandate (for example in the preamble to a regulation or law). This is important for political, social, and legal reasons, especially where individuals are likely to bear some of the burden. The government should make the case clearly and strongly for the new restrictions or obligations. If possible, the measures should be structured to allow some uses of the property, even if some uses are prohibited or restricted. That way, the land retains some use and some economic value. The adaptation measure could also provide in-kind compensation. Finally, adaptation measures should include a mechanism for providing exceptions and relief in isolated, extreme circumstances, for example through a waiver or other means.

For more information see Environmental Law Institute www.eli.org

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chapter 5

IMPLEMENT ADAPTATION

Many initiatives fail or encounter major barriers when making the transition from assessment, planning, and preparation to implementation. This can be termed the "implementation gap." This chapter discusses the challenges of implementing coastal adaptation measures and responses to those challenges. It highlights nine areas that require attention during implementation.

5.1 ENSURE ADEQUATE ADMINISTRATIVE AND INSTITUTIONAL CAPACITY

All adaptation measures come with administrative and institutional challenges. For example, when a measure requires regulatory decisions or when it must be implemented through agencies that share jurisdictions and responsibilities, difficulties can arise. Implementation may reveal jurisdictional gaps. In such cases, it cannot be assumed that there will be effective coordination and communication between the players. When institutions are weak, management authorities may not be clear and may overlap. Considerable effort must go into ensuring the appropriateness of the design, and into coordinating the decision-making, financing and execution of adaptation measures. In addition, measures with a regulatory component and/or measures that must be carried out uniformly or area-wide—e.g., setbacks, buffers, zoning, coastal management—may struggle against an ineffective regulatory regime that has limited or no ability to carry out enforcement. If legal authority for the adaptation measure is inadequate, actions to strengthen legal and institutional frameworks are needed.

Responses to the challenge

- Closely supervise the implementation of adaptation measures to ensure they are undertaken properly. When institutions invest in the human resources to do this, they build their own institutional capacity for effective coastal adaptation. They also create gains for good governance.
- Provide support to nascent watershed organizations in building coastal adaptation into their work—alone they may lack the skills and experience to do so.
- When securing agreements and policy coordination with potentially competing line agencies that must play a role in coastal adaptation, try to locate the adaptation program in a high level position that is above line agencies. This legitimizes any agreements made and helps create a viable institutional mechanism where none exists.
- When using integrated tools such as special area management planning, tie them closely to the tools and programs of other agencies. In cases where there is no regional or national institutional support, think creatively. For example, establish a para-municipal organization or a multiple jurisdiction entity such as a council of governments.
- When dealing with measures to control development, conduct a careful review of existing policies and regulations to identify how the measures can be best incorporated.
- Use strategic planning tools, such as a modified SWOT (Strengths/ Weaknesses/ Opportunities/ Threats) analysis to formulate an implementation strategy.

IMPLEMENTATION CHALLENGES AND STRATEGIES

- ☑ Ensure adequate governance capacity
- ☑ Strengthen legal frameworks
- ☑ Strengthen personnel capabilities
- ☑ Highlight costs of "doing nothing"
- ☑ Develop sustainable funding
- ☑ Plan for externalities
- ☑ Maintain scientific basis for policy
- ☑ Maintain an inclusive and participatory process
- ☑ Select technically appropriate and effective measures

5.2 STRENGTHEN LEGAL FRAMEWORKS AND ENFORCEMENT

Legal frameworks and enforcement are common concerns to many of the measures in this Guidebook. Judicial systems may not support rigorous enforcement of some measures such as zoning and setbacks. In some countries, local government lacks jurisdiction

for enforcement over marine and coastal resources. Meanwhile, national governments that do have this control may have little interest or requirement to work with local governments, or may have no influence over local decisions in urbanized areas. When an adaptation measure does not result in the expected change in target group behavior, it is necessary to take corrective action. It may not be a faulty legal framework that is the problem. Rather, it may be that incentives for the target groups to change their behavior are lacking or ineffective. For example, developers of hotels along the coast might be induced by receiving density bonuses (allowances to have more units) in exchange for increased setbacks. You may also fail to see expected behavior change when costs to the target group for implementing the measure are too high.

Responses to the challenge

- Make modifications to the legal framework to strengthen the adaptation program
- Establish inter-agency arrangements or mechanisms to address jurisdictional conflicts
- Create economic alternatives for people adversely affected by implementation of the measure
- Encourage individual or collective self-enforcement through cooperative user groups

5.3 STRENGTHEN PERSONNEL CAPABILITIES

Many personnel in both government and private organizations are not well versed in climate change issues. Often, they also do not understand how they could contribute to climate change adaptation. A first step toward changing this is to create an understanding of the impacts of climate change, the need for adaptation, and the actions that can be taken by the individual and by others inside and outside the individual's own organization/agency.

Responses to the challenge

- Provide information on the climate change problem that can help planners and policy makers justify new or intensified use of certain adaptation measures
- Conduct training and extension on the practical aspects of implementing measures—improving chances that implementation will more closely match requirements
- Offer tailored professional guidance at the operational level—e.g., on purchasing required equipment, conducting inspections and monitoring

5.4 HIGHLIGHT COSTS OF DOING NOTHING AND COSTS OF ADAPTATION MEASURES

Often, at the point when leaders are looking for agreement to move forward with coastal adaptation measures, there has not yet been a determination of the costs of implementing those measures. Nor has there been a projection of the costs of doing nothing. This lack of cost information makes it difficult to reach agreement on moving forward.

Responses to the challenge

- Use life-cycle cost analysis in weighing benefits against costs of adaptation investments
- When possible, calculate the economic effect of expected climate change impacts on the local economy (currently most such projections are at national and global scales—when they exist at all)

Building capacity and providing opportunities for exchange among practitioners will be key to successful mainstreaming

5.5 DEVELOP SUSTAINABLE FINANCING

Even the simplest of measures requires funding and effort to first put it into action and then to maintain it. For example, if a plan stipulates that vegetated buffer zones will be in place for an area of coastline, there needs to be money and manpower to supervise

the actual implementation of those zones. They do not happen just because there is a plan.

Securing funding for a few projects or pilot efforts may be relatively easy during times when the adaptation issue is on the agenda of the government or a donor. It is more difficult to secure funding for area-wide implementation of measures, for staff to carry out regulatory measures, and for those measures that require large capital investments and follow-up monitoring and supervision.

Responses to the challenge

- Engage with international nongovernmental organizations, many of whom are incorporating climate change adaptation into their local aid programs
- Identify and tap into complementary programs such as coastal management programs, fisheries projects, and livelihood initiatives
- Mainstream climate into coastal development, thus using those funds to build resilience
- Seek out international organizations that offer national level assistance (see text box)
- Explore the use of environmental performance bonds, tourism fees, and user fees

5.6 PLAN FOR EXTERNALITIES

Many adaptation measures are "no-regrets" measures. In other words, there are net benefits, including some positive externalities. These can create new opportunities. On the other hand, adaptation measures may also generate unplanned-for negative external effects in the short term. For example, a marine protected area (a measure) might adversely affect some fishers in the short term with the intent of increasing stocks. Developing these measures should occur with the fishers so that they "own" the process and are investing in their future livelihoods. Another example is when armored structures are used as a measure to stem beach erosion and protect property. These same structures that are "protecting" one area, can also change the ecosystems and affect adjacent property owners who lack such protection.

FUNDS FOR COASTAL ADAPTATION

The United Nations Framework Convention on Climate Change has established several funds managed by the Global Environment Facility and implemented by the United Nations Development Programme, the United Nations Environment Programme, and the World Bank to assist developing countries with adapting to changing climate. Two of the funds are described below.

- **The Least Developed Country Fund.** In November 2001, Parties to the UNFCCC decided that least developed countries should be assisted in preparing National Adaptation Programmes of Action to identify urgent needs related to adaptation to the adverse effects of climate change. Countries can use LDC funds to prepare NAPAs or to implement actions identified in the NAPAs.
- **The Special Climate Change Fund (SCCF).** The SCCF under the Convention was established in 2001 to support projects and programs in development sectors most sensitive to climate change, including coastal zone management, disaster risk reduction, agriculture, and water resources management.

For more information, see: GEF/UNDP Adaptation Funds (http://www.undp.org/gef/adaptation/funds/04_1.htm) or UNFCCC Support for Adaptation (http://unfccc.int/adaptation/items/4159.php)

Responses to the challenge

- Use an area-wide approach to policy implementation—this helps account for some of the unanticipated or downstream impacts of particular measures
- Look across the full landscape of the watershed when selecting the area of concern where you will

work and, when possible, select an area where you can engage a wide range of stakeholders to address multiple issues

- Always select your place and your issues before you select your management measures
- Emphasize the precautionary approach when there may be spillover effects from measures, especially measures difficult to reverse—e.g., shoreline armoring, flood control and water management options

5.7 MAINTAIN SCIENTIFIC BASIS FOR POLICY AND MONITORING

Sustained, long-term implementation requires scientific credibility. What is needed is good, comprehensive, science-based information that includes long-term trends. For example, the general reasoning in favor of a setback needs to be substantiated by data analysis that compares past, current and projected future trends for the area of concern. Also, the measure must be monitored over time to track its effectiveness. Stakeholders need to know if the measure is doing what it was meant to do.

Responses to the challenge

- Tap into the growing wealth of scientific and technical knowledge residing in national governments, international agencies, and in professional peer networks
- Conduct periodic program reviews at the national or local levels to ensure agencies and places are aware of each others' successes and failures
- Research, evaluate, document and compare the benefits and costs of different adaptation strategies
- Conduct continuous scientific monitoring of coastal areas tapping into volunteers, students and local universities

5.8 MAINTAIN AN INCLUSIVE AND PARTICIPATORY PROCESS

Nearly all the measures in this Guidebook are best selected, developed, and implemented with active stakeholder involvement. Yet, the lead implementing agency may not have stakeholder involvement as a priority. Or, it may lack the skills needed to carry out a good inclusive process. Further, climate change adaptation is time consuming. It requires issue analysis, stakeholder dialogue and consensus building. Even simple measures need to be accepted by fishers and other marine resource users, since enforcement

Reef, habitat, and fisheries characterization and subsequent monitoring implemented by a local Mexican NGO has been essential for siting of marine protected areas. policy development, and land use decisions.

through command-and-control actions is costly and not necessarily effective. Stakeholder involvement is hard to sustain—waxing and waning based on the issues themselves and multiple other external factors. Climate change is a cross-cutting issue and requires a bundle of actions that will likely require multiple stakeholder negotiations. Yet, it can be a challenge to keep stakeholders involved and engaged over a long period of time.

Responses to the challenge

- Before designing the policy, ensure you have the support of those with the biggest stake in coastal adaptation
- Design policy to incorporate participatory management
- Increase social capital and interpersonal networks to build community resilience against natural hazards
- Promote community involvement and leadership of projects to build a sense of ownership
- Implement small, achievable actions that build support for a larger effort
- Educate the public and property owners and encourage them to be active in the stakeholder process in order to keep coastal adaptation on the public agenda

- Seek top-level government support and leadership to build trust and make participation and negotiations with stakeholders worthwhile
- For actions that need formal adoption by multiple entities (e.g., special area management plans), treat the process as a major, serious public policy formulation effort right from the start

5.9 SELECT TECHNICALLY APPROPRIATE AND EFFECTIVE MEASURES

Measures need to be appropriate for the area and its issue(s). They must also be effective—i.e., they must achieve their intended goals. There is any number of reasons, however, that can lead to the failure of even well designed and fully implemented measures. One reason is poor execution. Another is overly conservative design—i.e., one that fails to account for the accelerating rate of change expected from climate dynamics. Poor construction can also result in failure. For example, appropriately sited armored structures can be effective in addressing coastal shoreline erosion—but only if those structures are well constructed by a skilled builder.

Responses to the challenge

- Ensure that climate change adaptation measures and best practice guidelines are effective
- Engage economic actors and industry in preparing standards and formulating designs
- Take a performance-based approach to policies and actions with a focus on outcomes
- Use pilot projects and studies to test the benefits and implementation challenges of particular measures
- Conduct monitoring and scientific studies to reduce uncertainty about effectiveness
- Ensure that the preconditions necessary for a measure to succeed are in place

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http://unfccc.int/adaptation/items/4159.php

chapter 6

EVALUATE FOR ADAPTIVE MANAGEMENT

Once coastal adaptation measures are implemented, there will likely be considerable interest in how they perform. Policymakers will be keen to demonstrate that the measures are beneficial to the citizenry. They will want to assuage stakeholders who have borne some of the costs associated with the measures. The public will seek assurances that the measures afford them as much protection as possible from the impacts of climate variability. All parties will expect the measures to be adjusted if they do not perform according to expectations. *Evaluation* and *adaptive management* can help address these concerns.

6.1 EVALUATION OF ADAPTATIONS

Evaluation is the process of review and analysis of all relevant data and information required to determine if the set of adaptation options is performing to expectation. Evaluation may involve a single project review or a series of formal and informal time-dimensioned assessments. Table 6.1 summarizes the motivation for evaluation and the benefits or anticipated use of evaluation results.

All evaluations of coastal adaptation measures involve a similar methodology and steps. They may vary in their scope, types of evaluation tools employed, and the resources devoted to the evaluation. However, the basic goal of the evaluation is the same—to assess the performance of the adaptation measures in terms of their design and implementation. The steps of the evaluation include the following:

EVALUATION AND ADAPTIVE MANAGEMENT

- ☑ Specify the evaluation questions
- ☑ Establish roles and responsibilities for evaluation
- ☑ Select evaluation tools and develop timeline
- ☑ Conduct evaluation
- ☑ Communicate evaluation results
- ☑ Adapt policies, adaptation measures and strategies on the basis of evaluation results

1. ***Specify evaluation questions***—The role of evaluation is to determine if the adaptation approach is working as it should. The evaluation may need to include several questions based on the original set of criteria used to assess the proposed and selected adaptation measures. The questions should be identified early in the process. This way, evaluators can determine if the necessary baselines and data monitoring and management procedures are in place to support the evaluation.

2. ***Elaborate an evaluation plan***—The evaluation plan should clearly state the roles and responsibilities for the evaluation. Who will conduct, review, approve, and communicate the results of different evaluation results? What types

Table 6.1 What motivates evaluation and what are the benefits

Type of Activity	Motivation for Evaluation	Benefits of Evaluation
One-time Project	• Project completion • New or follow-on project	• Gauge project success • Compile lessons learned • Replicate project design
Place-based Plan or Program	• Planned/regular review • Special request from government • Unanticipated (e.g., result of natural disaster)	• Communicate performance • Adjust design of adaptation measures • Adjust implementation strategy • Identify and implement emergency measures • Compile lessons learned • Replicate plan or program
National/ Regional Policy	• Planned/regular review • Special request from government • Unanticipated (e.g., result of natural disaster)	• Communicate performance • Guide design and implementation of new policies and adaptation measures • Identify and implement emergency measures • Compile lessons learned

of evaluation methods or tools are required to answer the evaluation questions? What is the timeline for conducting the evaluation? Ideally, the evaluation plan is developed in concert with the implementation strategy. This helps ensure there is full consideration of the staff and financial resources needed to carry out the evaluation.

3. ***Conduct the evaluation***—Evaluation entails a set of individual analyses, designed to answer specific questions for specific audiences. Evaluation helps policymakers review performance, guides reforms in adaptation measures, and prompts adjustments to their implementation. For purposes of transparency and accountability, it may be advisable to use independent evaluators. This is especially important in terms of answering those questions most important to landowners, business, and the general public. These often include but are not limited to questions about the benefits and costs of the measures and their impacts on the environment.

4. ***Communicate the results***—Disseminating the evaluation results to the appropriate audiences is very important. Make sure your overall evaluation plan covers this in detail.

Climate change occurs over the long term. That means some outcomes of adaptation measures also require long periods of time before they can be properly evaluated. As well, there are certain evaluation questions—e.g., "What are the impacts of adaptation policies on biodiversity or habitat?"—that can only be answered over time.

One of the key challenges in evaluation, particularly when it is conducted over a long timeframe, is to "filter out the noise." This is necessary in order to focus only on the relevant information and analyses that answer the specific evaluation question. The following factors can contribute to both good or poor evaluation results:

- ***Attributes of the adaptation measure***—Most often, the adaptation measure will provide incentives and/or sanctions for behavior change among business and the general public. The evaluation will often try to determine how businesses and individuals react to the adaptation measure. Do they recognize its legitimacy, do they attempt to circumvent it, and if so, why?

- ***Implementation strategy***—The adaptation measure may be appropriate, but poorly implemented. There may be insufficient staff to monitor implementation. There may be too few financial resources to conduct the education and awareness activities needed to inform the public on their obligations related to a new adaptation measure.

- ***Changes in the political, economic, social, or cultural context***—A variety of factors can affect performance of the adaptation measure. These include greater or lesser political support, chronic inflation or a prolonged economic boom or recession, new policies that impact the incentives, or sanctions of the adaptation measure.

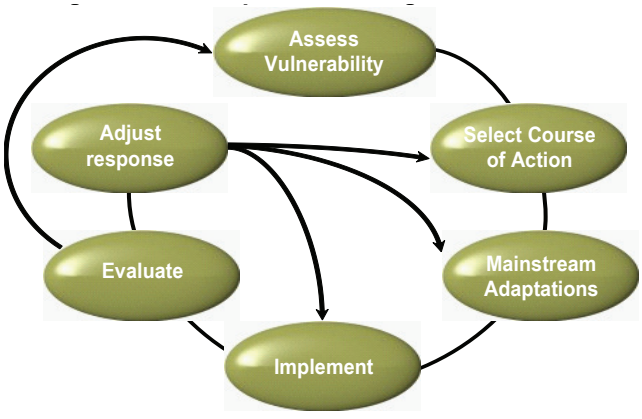
- ***Unanticipated climate variability and change***—If adaptation measures are evaluated over short time intervals, the observed climate for say a five-year period might not accord with the vulnerability assessment upon which the adaptation measure was, in part, designed. An extreme weather event—for example a 500-year flood—that occurs within the period of the evaluation may severely test the adaptation measures.

Attributing change to the relevant factors is critical in reaching the correct conclusions about performance and determining whether changes are needed in the adaptation measure or the way it is implemented.

6.2 ADAPTING EVALUATION RESULTS

The process of developing and implementing adaptation measures entails mutual learning on the part of policymakers, stakeholders, and the general public. The selection of the adaptation measure is based on the information set, analyses, and best predictions or forecasts of the future. As time passes and implementation proceeds, the database of information and analysis will change. It will expand to include information on the performance of the adaptation

Figure 6.1 Adaptive management process



measure. Also added will be information on the factors listed in the previous section. Meanwhile, time and changing contexts may also alter the stated goals, objectives, and the expected results of the adaptation measure.

Thus, as evaluation results become available, policymakers, stakeholders, or the public may be motivated to press for changes in the choice of adaptation measures, their design, or their implementation. The process of reflecting on these changes based on evaluation results is referred to as *adaptive management*[2]. In Figure 6.1, adaptive management is depicted by the oval "Adjust Response."

Adaptive management and the adjustment of responses entail a participatory/analytical approach similar to what is recommended in this Guidebook for the initial analysis, selection, and mainstreaming of adaptation measures:

1. Review the evaluation results and attribute poor performance to flaws in design and/or implementation of current measures;
2. If flaws in the design of the adaptation measure are to be addressed, determine whether current measures can be fine-tuned or if alternative or complementary measures are required;
3. If modified or new adaptation measures are promoted, revise the implementation strategy; and,
4. If flaws in implementation are to be addressed, identify, assess, and incorporate recommended changes into the implementation strategy.

Table 6.2 illustrates the types of adaptive management responses that might be considered as a result of evaluation in a hypothetical place with three types of implemented adaptation measures. In this example, the evaluation focused on management responses following a devastating hurricane with high sustained winds and seas, and flooding of a local river.

2 Adaptive management also refers to an overall management approach that embodies a "learning by doing" philosophy and is ideally suited to management of natural resources under uncertainty inherent in climate variability and change. Adaptive management approaches emphasize: 1) ongoing monitoring of performance through the tracking of key variables, complemented by research to improve the body of information and analysis; 2) periodic assessments (evaluation); and 3) modification of policies, practice, and institutional capacity as needed to improve performance.

Table 6.2 Adaptation measures and adaptive management responses

Adaptations	Evaluation Results	Adaptive Management Responses
Community-based disaster risk reduction	• Significant numbers of visitors and residents unaware of evacuation routes	• Preparation of awareness materials for residents and visitors (posted in hotels and restaurants) • Improved signage • Increased staff and volunteers to assist with evacuation
	• Scale of disaster not anticipated in disaster planning	• Revise preparedness, response, and mitigation plan to anticipate more intense and/or sustained weather events
	• Poor coordination with regional and national authorities on post-disaster support/financing	• Convene participatory discussions with regional and national authorities to coordinate roles and responsibilities • Establish emergency "bank" of supplies and equipment needed for post-disaster mitigation
Coastal development setbacks	• Severe shoreline erosion observed beyond setback distance from the shore	• Revise setback regulation to increase distance
	• Properties not subject to setback regulations suffer severe damage	• Accelerate removal or relocation of buildings within the setback distance
	• New construction observed in violation of setback regulations	• Strengthen capacity for permitting, inspection, and enforcement; increase penalties
Building codes	• Significant wind and water damage observed	• Revise building codes
	• New buildings not complying with building codes	• Strengthen capacity for permitting, inspection, and enforcement; increase penalties • Prepare awareness materials for builders, businesses, and residential buyers
	• Levies failed to contain flood waters in river	• Assess options for improved watershed management, structural options for containing flood water in main channels and overflow reservoirs
	• Significant beach erosion	• Establish natural erosion protection measures and structural shoreline stabilization options

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ANNEX A – ADAPTATION MEASURES

CONTRIBUTION TO DEVELOPMENT GOALS AND ADDRESSING CLIMATE CHANGE IMPACTS

Adaptation Measures	Relevance to Climate Change	Page
FUNCTIONING AND HEALTHY COASTAL ECOSYSTEMS AS A PRIMARY GOAL		
Coastal wetland protection and restoration	Acts as buffer against extreme weather events, storm surge, erosion, and floods; limits salt water intrusion.	89
Marine conservation agreements	Improves the resilience of coastal ecosystems to climate change and improves the economic and social conditions of coastal communities.	93
Marine protected areas	Maintains healthy and resilient coastal habitats and fisheries productivity; acts as "refugia" and critical sources of new larval recruits.	97
Payment for environmental services	Provides incentives to protect critical habitats that defend against damages from flooding and storm surges as well as coastal erosion.	101
BUILT ENVIRONMENT IS LESS EXPOSED AS A PRIMARY GOAL		
Beach and dune nourishment	Protects shores and restores beaches; serves as a "soft" buffer against flooding, erosion, scour and water damage.	105
Building standards	By incorporating climate considerations (e.g. effects of flooding, waves and wind) in building design, it reduces damages and human safety risks from climate change impacts, including extreme events, sea level rise, and flooding.	109
Coastal development setbacks	Reduces the infrastructure losses and human safety risks of sea level rise, storm surge, and erosion.	112
Living shorelines	Mitigates erosion and protects people and ecosystems from climate change impacts and variability in low to medium energy areas along sheltered coastlines (e.g. estuarine and lagoon ecosystems).	116
Structural shoreline stabilization	Temporary buffer against the impacts of erosion and flooding caused by factors such as sea level rise, storm surge, and wave attacks.	120
DIVERSIFIED LIVELIHOODS AS A PRIMARY GOAL		
Fisheries sector good practices	Contributes to the protection of rural livelihoods, food security and marine biodiversity against the impacts of extreme climate events, precipitation change, ocean acidification, sea level rise and sea surface warming.	125
Mariculture best management practices	Integration of climate change considerations helps safeguard against extreme climate events, precipitation change, ocean acidification, sea level rise and sea surface warming.	130
Tourism best management practices	Integration of climate change concerns helps promote the sector's sustainability as well as safeguard against extreme climate events, precipitation change, sea level rise and sea surface warming.	133
HUMAN SAFETY AND SAFETY ENHANCED AS A PRIMARY GOAL		
Community-based disaster risk reduction	By proactive planning and capacity building that addresses the specific needs of local communities, increases their resilience and ability to respond to the effects of extreme climate events and flooding.	139
Flood hazard mapping	Informs coastal planning processes and policy, reducing the impact of flooding resulting from storm events, heavy rains, storm surges, and extreme tides.	143
OVERARCHING PLANNING AND GOVERNANCE AS A PRIMARY GOAL		
Coastal watershed management	Preserves estuaries, which act as storm buffers and protect against coastal groundwater salinization.	149
Integrated coastal management	Provides a comprehensive process that defines goals, priorities, and actions to address coastal issues, including the effects of climate change.	154
Special area management planning	Improves the management of discreet geographic areas where there are complex coastal management issues and conflicts, including issues related to extreme climate events, precipitation change, ocean acidification, sea level rise and temperature change.	160

ANNEX A – ADAPTATION MEASURES

FUNCTIONING AND HEALTHY COASTAL ECOSYSTEMS

1. COASTAL WETLAND PROTECTION AND RESTORATION
2. MARINE CONSERVATION AGREEMENTS
3. MARINE PROTECTED AREAS
4. PAYMENT FOR ENVIRONMENTAL SERVICES

functioning and healthy coastal ecosystems

1. COASTAL WETLAND PROTECTION AND RESTORATION

Coastal wetlands protection and restoration initiatives are commonly incorporated into policy and regulatory frameworks and are implemented by government and non-government organizations as well as citizens and industry. Programs acknowledge the critical functions of wetlands in providing nursery habitats for fisheries, serving as a natural water filter for pollution, acting as a buffer against coastal ecosystems, and providing other ecosystems services for communities and their livelihoods.

RELEVANCE TO CLIMATE CHANGE

Conservation of coastal wetlands is both a climate change mitigation and climate change adaptation strategy. Wetlands mitigate greenhouse gas emissions as they store significant amounts of carbon in plants and soils.

Natural wetland habitats have proven their ability to protect and buffer communities against storm surge, erosion and floods. Because wetlands perform these and many other vital functions that reduce the impacts of climate change, conserving and restoring them is an important adaptation strategy.

That said, a lack of definitive information on sea level rise and its impacts on wetlands may constrain future efforts to protect them. There is also the challenge related to site selection for restoration—i.e., how are changing conditions expected to impact the effectiveness of restoration in a specific site/area?

Most countries have wetland protection and restoration programs of various types that contribute to their environmental management objectives. Many international conferences, declarations and agreements call for wetland protection. One of these is The Convention on Wetlands. Signed in Ramsar, Iran, in 1971, it is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. It currently has 158 Contracting Parties with 1743 wetland sites totaling 161 million hectares designated for inclusion in the Ramsar List of Wetlands of International Importance.

PURPOSE AND APPLICATION

Marine/coastal wetlands encompass mangrove swamps, seagrass beds, estuarine waters, freshwater and brackish lagoons, and intertidal mud, sand, or salt flats and marshes. Wetlands are such valuable natural areas and are so difficult to recreate, that it is critically important to conserve and restore them.

Coastal wetlands are among the world's most productive environments and perform a host of ecological and hydrological functions that benefit humankind. They provide the water and primary productivity upon which countless species of plants and animals depend for survival. They are cradles of biological diversity and home to economically important species, such as fish and crustaceans. They support a range of livelihoods and provide food security for coastal communities.

In addition to providing important livelihood resources for rural coastal communities, coastal wetland also supply other vital ecosystem services. This include providing protection against future climate change and variability. Coastal wetlands act as natural buffers against extreme weather events, storm surge and erosion and they limit salt-water intrusion. Low lying wetlands function as natural sponges by limiting the impact of floods.

MANGROVE PLANTING PROJECTS IN NORTHERN VIETNAM

Mangroves and coastal wetlands are natural assets in defending coastlines from the dangers of wind and storm surge. In northeast Vietnam, thousands of hectares of mangroves have been planted and protected since 1994 for this very purpose. Previously, coastal storms would often breach dikes, wreaking havoc in both human and economic terms. However, thanks largely to the new mangroves, in the aftermath of typhoon Wukong, which pummeled the northeast coast of Vietnam in 2000, neither dike damage nor loss of human life was reported. Since then, the mangroves have successfully reduced dike maintenance costs by millions of US dollars per year. The mangroves have also contributed to better livelihoods for inhabitants as a result of the wealth of crabs, shrimps, and mollusks provided by the mangroves.

Source: IFRC, 2002

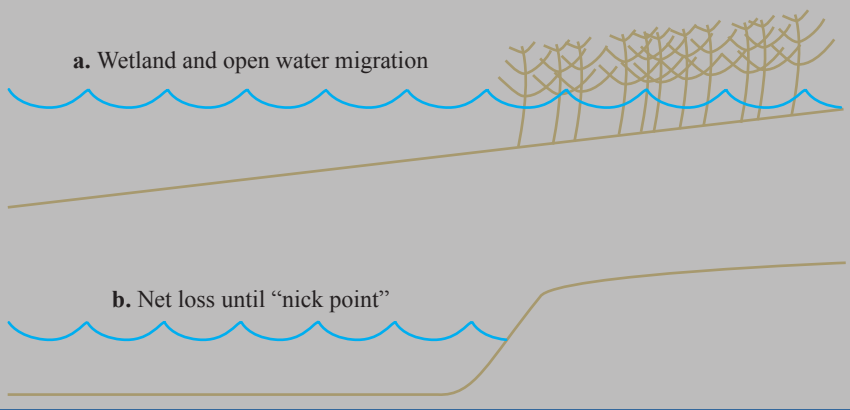
INFORMATION AND DATA REQUIREMENTS

- Map remaining intact coastal wetland systems in the region using field surveys, together with remote sensing imagery (where available) to distinguish salt-tolerant species from freshwater species.
- Analyze the vulnerability of the wetland to storms and sea-level rise to establish priorities for protection and restoration. Post-storm evaluation of wetlands and adjacent land impacts provides valuable information on the resilience of wetlands and their storm buffer capacities.
- Determine freshwater flow requirements to support the maintenance of estuarine mangroves and other brackish water wetlands. Consider potential climate change impacts on freshwater flows.
- Determine candidate sites for restoring degraded wetlands to original functions, given the long-term potential of sea level rise, salinity, and storm events

DESIGN CONSIDERATIONS FOR DEVELOPING THE MEASURE

Wetlands are extremely sensitive to sea level rise and delta submergence. The rate at which wetlands change because of sea level rise depends largely on the topography, profile, and habitats that are situated landward of existing wetlands. In a general sense, rising waters on a gently rising continuous surface should result in a band of wetlands migrating landward (Figure 1), as long as: 1) there are no barriers (i.e. development), and 2) the soil and hydrological conditions are favorable. Whether or not new wetlands will make up for the shoreward wetlands lost to rising water will depend on the details of the coastal surface—i.e., the complexity of the topography in terms of swales, depressions, and overall drainage density. It should be noted that the steeper the slope, the more narrow the migrating wetland fringe—as the appropriate water depths for wetlands growth will cover a narrower portion of the sloped profile. To a large degree, natural migration of wetlands will also depend on the nature of land use in newly inundated areas.

Coastal topography and wetland migration



a) smooth slope with migrating band of wetlands and open water surfaces.

b) steep slope may prevent landward migration of wetlands until the rising waters reach the top of the slope, and water is shallow enough for wetland creation.

Source: OECD 2007 http://www.oecd.org/dataoecd/36/22/38574805.pdf

The other common shoreline topography affecting natural migration occurs where there are discontinuities in the slope. For example, there may be abrupt rises in the slope as seen in profile b in Figure 1. Under this scenario, wetlands will be lost since the water becomes too deep to support wetland vegetation. No new wetlands can form until the water levels rise above the steep slope, at which time, the gently sloping surface will be shallow enough to support wetlands once again. How long it takes for the water to reach that point depends on the elevation of the nick point or bluff and the rate of sea level rise. Where wetlands are not able to migrate inland due to topographic and other natural constraints, one option is to create new wetlands in suitable areas to compensate for those that are lost.

There are other considerations in designing coastal wetlands conservation, migration and restoration.

- Prioritize those sites for habitat restoration that allow natural recession landward and thus provide resilience to sea level rise. Climate change scenarios should inform priorities for protection and rehabilitation.
- Select restoration sites for re-vegetation, sediment nourishment and conservation agreements that provide multiple critical functions (e.g., storm buffer for coastal communities and endangered species habitat).
- Redefine flood hazard zones to match projected expansion of flooding frequency.

In many countries, there is no one overarching policy on wetlands protection in spite of growing recognition of their importance. The institutional framework surrounding wetlands is often complex with many federal and state level agencies (with and without regulatory power over wetlands), municipal authorities, research and scientific institutions, nongovernmental organizations (NGOs), and civil society groups involved in various aspects of wetland management. Institutional and governance considerations for developing adaptation strategies for wetlands protection in the context of climate change should include the following:

- Establish or enforce land and water-based zoning requirements.
- Restrict sand mining, fishing, mangrove cutting, and other activities in protected wetland areas.
- Adopt ordinances that protect coastal wetlands from development while taking into consideration ecological and equity issues.
- Strengthen effective management and enforcement systems.
- Develop plans for removal of structures and vessels that are stranded in wetlands after a storm so the habitat is not destroyed.
- Identify special considerations for wetlands in highly urbanized areas, to determine how to protect the wetlands functions, while protecting existing development. This may require that certain wetlands are prioritized over others for future protection in the face of climate change impacts.

IMPROVING THE LIKELIHOOD OF SUCCESS IN APPLYING THIS MEASURE AS A CLIMATE CHANGE ADAPTATION

An obstacle for wetlands protection involves the preference for constructing "hard" shoreline stabilization over installing "soft" measures. Seawalls and shoreline armoring impedes adaptation of wetlands to migrate landward with sea level rise. Careful analysis of the location and designs of shoreline protection is warranted in areas with coastal wetlands. If wetlands preservation and future sea-level rise are discounted, coastal structures will contribute to the loss of wetlands or the severe transformation of their functions. There are, however, some ways to overcome these obstacles.

- When undertaking wetland conservation and restoration, use a decision-making process that is transparent and participatory and where there are opportunities for consultation and negotiation with all stakeholders within the landscape.
- Carry out wetland restoration in coastal areas with reference to existing national laws, wetlands policy and action plans.
- Develop community-led approaches for protection and restoration of wetlands, drawing on traditional knowledge and practices and with provision of incentives for sustainable livelihood development.
- Ensure that all relevant government departments are consulted and play a central role in restoration together with the local communities.

- Use an integrated, inter-sectoral and multi-scale approach.
- Adopt a landscape approach to restoration—ecosystems do not function as closed, but as open systems that are affected by ecological processes that occur in a larger scale.

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functioning and healthy coastal ecosystems

2. MARINE CONSERVATION AGREEMENTS

Marine Conservation Agreements are a technique to reach conservation goals. A formal or informal agreement is established between two or more parties who obligate themselves for an exchange of benefits, to take certain actions, to refrain from certain actions, or to transfer certain rights and responsibilities in order to achieve agreed upon ocean or coastal conservation goals.

RELEVANCE TO CLIMATE CHANGE

Marine Conservation Agreements (MCAs) are used to restore and protect fragile coastal and marine ecosystems that can attenuate the effects of sea level rise and storm surges. Examples of such ecosystems include barrier islands, shellfish reefs, coral reefs, seagrass beds, mangrove forests, and coastal forests. Restoring and protecting these natural areas can also influence local climate and play a role in carbon sequestration. When undertaken in collaboration with nature-oriented businesses, MCAs can improve social and economic conditions of coastal communities through fisheries, mariculture, and tourism activities. MCAs, commonly implemented by non-governmental or private parties, complement formal Marine Protected Areas (MPAs) by serving as catalysts for the formal establishment of MPAs. Functionally, they serve to protect areas similar to MPAs, or provide a mechanism for local stakeholder involvement in collaborative management of MPAs.

The MCA is a flexible measure that can be applied by a variety of organizations, in a range of situations and locations (Table 1). Examples of successful MCAs are found in nearly every U.S. state. They also exist at the country level, including but not limited to Chile, Costa Rica, Ecuador, Fiji, Indonesia, Mexico, Philippines, Spain, and Tanzania.

PURPOSE AND APPLICATION

The MCA is an extension of the arrangement where private, for-profit entities routinely enter into agreements and acquire rights to areas for a wide range of purposes such as marinas, utility lines, gravel mining, aquaculture, and oil extraction. In many parts of the world, marine tenure systems assign communities and fishing cooperatives with the rights to marine areas. NGOs are now using this model, in collaboration with local communities and governments, for an expanded list of purposes that include protecting the marine environment in specific areas, promoting harvesting methods, and limiting access to fragile resources.

MCAs enable communities, municipalities or NGOs to work with the owners (whether public or private) of lands and resources lying within marine areas to improve levels of protection. They are particularly effective when property rights are well-established. They can, however, also be used where communities engage in collective management. Environmentally important intertidal, subtidal, subsurface, surface/air, and adjacent terrestrial areas can be included as the focus of an MCA (see Figure 1). MCAs promote the continuation of existing or the development of future sustainable uses. Example uses are for coastal agriculture, aquaculture, seagrass beds, coral reefs, timber production, and other valuable ecosystem services (fish and wildlife habitat, clean water, clean air, or scenic open space). MCAs can prohibit certain activities, guide owners and users in conservation practices, or confer specific rights, interests, or uses to NGOs. These details are spelled out in the legal document that typically serves as the formal mechanism establishing the MCA.

INFORMATION AND DATA REQUIREMENTS

The information needed before deciding to apply this measure may be similar to that needed to assess the feasibility and desirability of choosing the following measures: marine protected areas, payments for environmental services, living shorelines and other measures related to how specific economic sectors use natural areas.

- Conservation priorities—clearly identify what is to be protected or managed.
- Threats and strategies—understand the threats (including the effects of climate change) to conservation priorities and how MCAs can help mitigate the threats.
- Ownership and current uses of the lands and resources—assess these related to the priorities and threats in order to ensure all important parties are included in the agreement.
- Applicable laws and policies—give these careful consideration as they provide the legal framework.
- Parties to the agreement and other stakeholders—identify and consult with these prior to and during the implementation of an MCA project.

DESIGN CONSIDERATIONS FOR DEVELOPING THE MEASURE

- Essential design elements for MCA projects include conservation commitments, benefits accruing to parties, compliance and enforcement mechanisms, and duration of agreement.
- While MCAs can be used to protect numerous features of the ocean and coastal environment, most typically they are applied to finfish, shellfish and their habitats.
- When possible, MCAs should involve the direct participation and agreement of local communities as well as provide opportunities for local employment.
- MCAs can be applied at different scales depending on project goals, from small scales (less than five hectares) to extremely large scales (up to 400,000 sq. kms.)
- Costs and financing—the initial and long-term costs associated with the grantor incentives and management of lands and resources should be identified and sustainable arrangements for financing should be arranged.
- Estimate the likely impacts of climate change on the area or resources targeted for protection. Ensure the terms, conditions, benefits, areas, and resources identified in the MCA account for these.
- Changes in sea level, sea temperature, and salinity, and storm events may bring about changes in areas of important biodiversity that are targeted for protection. For example, coastal ecosystems may migrate upland, if the terrain allows. Or, they may disappear if migration is not a possibility. While this constraint is not unique to MCAs, it needs to be a consideration in the planning of any MCA project.

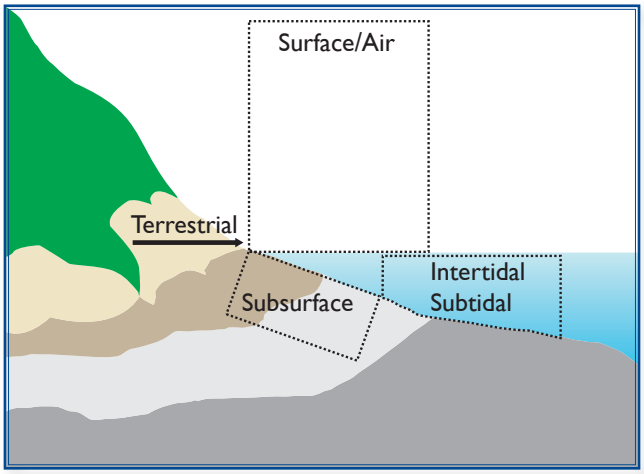
Typically, MCAs are consummated through legally binding documents/mechanisms signed by two or more parties. Common examples of formal MCA mechanisms include leases, licenses, easements, management agreements, purchase and sale agreements, concessions, and contracts. These formal mechanisms are often defensible in courts. Judicial systems in developing countries, however, can be ill-equipped for this. Hence, many MCAs rely on the benefit streams and close binding relationships between the parties to promote enforcement. In other cases, some MCAs rely on informal governance arrangements—based on good-will and verbal promises—in lieu of formal documents. In some cultures, formal documents and judicial procedures are foreign instruments, making informal arrangements the only practical option. Whether making formal or informal agreements with NGOs or communities, it is important to determine who is authorized to engage in such agreements on behalf of the community.

IMPROVING THE LIKELIHOOD OF SUCCESS IN APPLYING THIS MEASURE AS A CLIMATE CHANGE ADAPTATION

The primary reason MCAs are attractive compared to other climate change adaptation measures is that they are based on agreed upon terms and conditions that clearly define the roles and responsibilities of each party and their benefits.

MCAs provide tangible benefits to both the grantors and the grantees. The flow of benefits should be

Ocean and Coastal Areas Applicable to MCAs



monitored periodically and consistently throughout the duration of the agreement based on agreed-upon performance standards. Providing a "stream" of benefits over time helps ensure all parties will continue to abide by the terms of the agreement. Grantors (the owners and users of the land or resources) may receive incentives in the form of direct cash payments, tax deductions, community social services and infrastructure, employment opportunities, cultural preservation, and pride in local accomplishments. In return, grantees (NGOs or nature-oriented businesses) often receive a public or social benefit in the form of "protection" for lands or resources through ownership, access restrictions, harvest restrictions, or management guarantees. Continuous communication is helpful in reminding parties about the purpose of the agreement and providing evidence of its success or failure.

An implementation issue specific to MCAs related to how boundaries associated with the rights, interests, or activities identified within the MCAs change as habitats and resources change or migrate. Will the area of the MCA migrate as habitats and resources migrate? Or, will the MCA remain stationary as the original areas targeted for protection migrate? This issue can and should be identified and resolved within the language of the MCA document.

Given their innovative nature, MCA projects benefit from personal leadership and advocacy. Successful project leaders take into account the cultural, social, political, and economic characteristics and decision-making styles of the local communities. This is especially important when using informal agreements.

Elements and Variables of Marine Conservation Agreements

Mechanisms		Parties		Benefits		Examples
Formal	**Informal**	**Grantor**	**Grantee**	**Incentive**	**Protection**	
• Purchase & sale • Lease • Easement • License • Permit • Concession • Contract	• Verbal • Handshake	• Private individuals • Private companies • Communities • Local Govt. • State Govt. • Fed'l Govt.	• NGOs • Communities • Ecotourism Companies • Aquaculturists • Other for-profits	• Direct payments • Social services • Infrastructure • Jobs • Culture • Pride	• Ownership • Access • Harvest • Management	• Chile • Costa Rica • Ecuador • Mexico • Tanzania • Tropical Isl. • U.S. • U.K.
Duration defined or undefined		Lead implementer		• Behavior changes • Laws/regulations • Private MPAs • Community MPAs • State/Fed'l MPAs		

Source: http://www.leaseown.org/pdf/PMCA_Workshop/1_MCAWorkshop_FullProceedings.pdf

In 2006, the Government of Kiribati declared the Phoenix Islands archipelago and waters surrounding them as the third largest marine protected area in the world, officially named the Phoenix Islands Protected Area (PIPA). The Phoenix Islands Protected Area is a unique partnership between the Government of Kiribati that owns the Phoenix Islands, non-governmental conservation organizations (the New England Aquarium and Conservation International) and regional governments. The PIPA will be supported by a unique "reverse fishing license" financing program in which the Government of Kiribati will be reimbursed for the amount that they would have made from selling fishing licenses if PIPA were not protected. The trust will be administered by the Government of Kiribati and an advisory board, working collaboratively to ensure the long-term sustainability of this remarkable place. One of the many important natural features that PIPA will protect is coral reefs.

Coral reefs worldwide are now threatened by impacts associated with global climate change. Specifically, coral reef "bleaching" is caused by many factors that might stress the coral, such as rising water, temperatures, pollution, solar radiation, changing salinity, and bacterial infections. The death of corals and the resulting disappearance of reefs would result in the loss of an uncountable number of marine invertebrates and fishes that rely on the physical structure of the reef for survival. Coral reefs sustain large numbers of people that rely on fishing for daily food and income. They also protect coastlines by absorbing constant wave energy from the ocean, thereby protecting people living near the coast from increased storm damage, erosion and flooding. While free from the local stresses that degraded reefs might cause coral bleaching, the Phoenix Islands have not been spared the threat of global warming. In late 2002 one of the hottest ever-recorded warming events that has affected any reef around the world hit the Phoenix Islands. Because of their remote and pristine nature, high levels of damage were restricted to small areas within the Phoenix Islands, with many reef areas showing greater resistance and resilience to bleaching than have been documented elsewhere in the world. Their remoteness and the guaranteed protection by the Phoenix Islands Protected Area will help the Phoenix Islands to remain as one of the least-impacted reef systems to climate change and serve as a model target for protecting and rehabilitating other reefs heavily degraded by humans.

For more information, see:

http://phoenixislands.org/works.html

http://www.leaseown.org/DEVEL/Field_Projects/Agreement_Phoenix_Islands.html

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functioning and healthy coastal ecosystems

3. MARINE PROTECTED AREAS

Marine Protected Areas (MPAs) are defined by the World Conservation Union (IUCN) as "any area of intertidal or subtidal terrain, together with its overlaying waters, and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part, or all, of the enclosed environment."

RELEVANCE TO CLIMATE CHANGE

Healthy ecosystems that are effectively managed are likely to be more resilient to the effects of climate change by reducing other stressors. For example, coral reefs protected from overfishing and pollution have been shown to be more resistant and resilient to bleaching events. Effectively managed marine protected areas (MPAs) can be used to strategically target habitats and geographic areas that are critical to maintaining ecosystem goods (such as fisheries) and services (such as coastal protection, tourism and recreational use). In the face of climate events, MPAs can be used to:

- Maintain "coastal buffering" habitats, such as mangrove forests and coral reefs;
- Maintain fisheries productivity through healthy coral reefs, mangrove forests and seagrass meadows;
- Serve as "refugia" and critical sources of new larval recruits after a coral bleaching event or as species ranges shift with changing climes;
- Allow space for habitats to "migrate" up and along shores as sea level and temperatures rise.

Countries around the world from tropical to polar climates have established MPAs to maintain ecosystem functions, conserve biodiversity and wildlife, and protect cultural and tourism sites. The Convention on Biological Diversity strongly recommends a global effort to fully protect at least 30% of representative coastal and marine habitats by the year 2010.

PURPOSE AND APPLICATION

MPAs are useful spatial planning tools that allow for targeted management and different resource uses within a defined geographic area. MPAs can be embedded within larger management and zoning efforts - such as coastal zone management, seascapes or networks of MPAs - or used as a stand-alone measure. Ideally, MPAs should be part of a larger management effort, but the lack of resources and capacity often necessitate a more limited and targeted approach. MPAs have a range of sizes, configurations and functions. MPAs can range from small, locally managed areas that are only a few hectares in size, to vast international transboundary MPAs. Regardless of their size or configuration, most MPAs use zoning schemes to designate certain areas for particularly human uses or for ecological reserves. Such zoning serves multiple objectives including helping to reduce user conflicts while protecting highly valued habitat and resources. Most MPAs include at least one core area within which all extractive and direct impact activities such as fishing and boat anchoring are prohibited; these critical ecological reserves serve to maintain ecosystem function and integrity and can contribute to fisheries productivity.

Regulations on resource access and use can be tailored to each MPA based on that area's unique ecological and social conditions. These regulations can reduce direct impacts to valued ecosystems and support the recovery and/or replenishment of habitat and fisheries. MPAs can also attract tourism by protecting the health and beauty of the very habitat that draws visitors to the areas. Local communities and stakeholders can effectively implement and manage small scale MPAs when granted the appropriate governance or management authority. This can reduce the strain on

RESPONSE TO CORAL BLEACHING EVENT IN THE SEYCHELLES

In its response to the 1998 coral bleaching event, the Seychelles Government and partners assessed resources to determine factors leading to resilience (e.g. areas of increased currents, shading, and marginal coral reefs). Together with an extensive monitoring program, the government increased protection for key refugia areas and installed moorings for areas impacted by anchors. Areas capable of high resilience will be considered for future expansion of the MPA network.

Source: Marshall, P. and H. Schuttenburg. 2006. A Reef Manager's Guide to Coral Bleaching. Great Barrier Reef Marine Park Authority, Townsville, Australia.

national/provincial governments, which often do not have the funding needed to carry out a centralized administration of protected areas. "Ownership" by the local stakeholders of the MPA, where they understand and appreciate the benefits of the MPA, is critical to successful management.

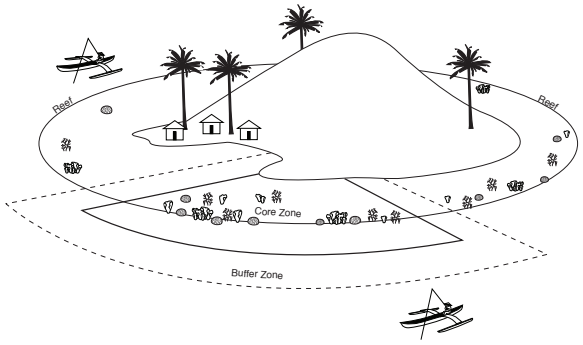
INFORMATION AND DATA REQUIREMENTS FOR ESTABLISHING A MARINE PROTECTED AREA

Establishing a MPA requires in part some unique information. There are simple techniques to help in gathering this information with the help of resource users and community members.

- Compile or develop resource maps that depict key habitat, species location, and population and migration patterns. Identify the areas that may be more resilient to sea surface temperature change, or can help mitigate against sea level rise or increased frequency of storms.
- Identify nearshore currents and source and sink areas for seeds/larvae to replenish species in the MPA. Determine if there are areas with reduced water circulation, upwelling and high sea-surface temperatures, which might be increasingly vulnerable to climate change.
- Determine the types and intensities of resource uses and identify stakeholder dependency on fishing, tourism, and mining in the area.
- Identify existing community resident perceptions of resource access and use rights.
- Identify the larger watersheds and river systems affecting the MPA, nearby human settlements and up-current sources of pollutants. This information is similar to that needed for integrated coastal and water resources management planning.
- Determine which species and habitats are most vulnerable currently and in the future. Determine representative and replicate sites as insurance against future impacts.

DESIGN CONSIDERATIONS FOR DEVELOPING THE MEASURE

- Use the MPA's goals and objectives as a guide to site selection and configuration criteria.
- Based on objectives, identify high priority areas for representativeness of habitat and refugia. Consider both current and future conditions and vulnerabilities when prioritizing. To increase resilience of MPAs to climate change include representative areas of key habitat and species and protect refugia that provide sources of seeds and larvae. If possible, locate parts of the MPA up-current from sources of pollutants—e.g., rivers, and areas that are urbanized or prone to sedimentation.
- Locate MPAs close to communities to enable shore-based surveillance, which encourages enforcement.
- Consider the habitat of and the capacity for managing the MPA, as well as all its goals, in deciding the size of the MPA and its design—e.g., it is better as one large area or several small areas. For example, in small rural coastal communities, several smaller areas may be more manageable than one large area., but may not be as resilient and may incur more impacts.
- Make the shape of the MPA simple and easily defined, using permanent markers placed into the substrate, floating buoys, or natural markers such as shore-based physical structures or coastline features.



An MPA is chosen from candidate locations. In this example the MPA is within a coral reef that surrounds a small island. Typically the MPA has a core zone where uses are highly restricted and a buffer zone where some activities may occur. In the example, fishing is permitted only outside the MPA and its buffer zone.

(M. Squillante, www.ksgraphic.com)

- Design an enforcement program including penalties for non-compliance with resource use and access rules.

Design and implement a simple community monitoring program to evaluate impacts of human behavior, climate change, and ecological changes on the MPA and its resources; and use this information to make rapid management adaptations as necessary.

IMPROVING THE LIKELIHOOD OF SUCCESS IN APPLYING THIS MEASURE AS A CLIMATE CHANGE ADAPTATION

There is limited understanding of exactly how marine ecosystems will respond to climate change at the local level. Thus, MPA managers must monitor ecological change and associated impacts to stakeholder interests. The manager then should use an adaptive management process that provides the flexibility to respond to climate change impacts on specific marine resources as and when those impacts become evident. Unfortunately, there are many existing natural and anthropogenic stresses both inside and outside the MPA boundaries. Incorporating MPAs within a larger coastal management program for the area can assist in addressing widespread impacts from beyond the boundaries of an MPA. Locally managed marine areas have been successful when stakeholders are engaged, partnerships are formed and tangible benefits are perceived.

MPA management requires sufficient budget for data collection, mapping, monitoring and enforcement. The creation of MPAs could also result in opportunity costs related to lost fishing grounds. This latter cost, however, can be reduced by offsetting this figure with the estimated potential value from increased numbers and size of species expected to migrate out of the MPA—this is referred to as the spillover effect. Other benefits could include increased revenue streams from tourism to the MPA and increased opportunity costs of preserving an area in its natural state, such as greater value from a healthy coastal buffer.

Participatory planning processes are now the standard for effectively designing and managing MPAs and help address and diffuse potential resistance to them. Stakeholders need to participate early on in the process when debating the benefits of establishing an MPA as a management tool, deciding upon the zoning scheme, and establishing rules to balance conservation goals with economic interests. Cooperative management systems are often effective in building trust and compliance with MPA rules.

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functioning and healthy coastal ecosystems

4. PAYMENT FOR ENVIRONMENTAL SERVICES

Payments for environmental services (PES) refers to various financial instruments that can be used to provide long term funding for environmental management policies and actions. These can be either voluntary or mandatory in nature. They usually involve some exchange of financial resources to compensate the parties who own, use or control an important natural resource or ecosystem for the costs of practicing good stewardship and sustainable use (or non-use) of that resource.

RELEVANCE TO CLIMATE CHANGE

Healthy ecosystems provide services that can help coastal communities minimize damages from severe storms (river and coastal flooding, storm surges), reduce coastal erosion, and help support community livelihoods, recreation and ecotourism. Most of the ecosystem services supported by PES investments can be justified on the basis of current climate conditions and represent no-regrets adaptation measures. Making projections about ecosystem response is often difficult. Future accelerated climate change and variability could impact the relative values of ecosystem services. In addition, under changed climate conditions, areas not currently highly valued for PES could be so valued in the future.

Hundreds of PES programs have been implemented in North America, Central America and the Caribbean, South America, Africa, and Asia. Most have focused on one or more ecosystem services. Most often, PES transactions focus on biodiversity protection, water supply and regulation, and carbon sequestration. Large scale PES initiatives have been implemented in Costa Rica, China, and Mexico. Several international nongovernmental organizations (NGOs) including World Wildlife Fund and The Nature Conservancy are involved in the design and management of PES programs. The Katoomba Group conducted a survey of PES programs in four African countries (Kenya, Tanzania, Uganda, and South Africa) that identified 17 carbon projects, 18 biodiversity projects and 10 water projects at various levels of development. Twenty percent of these already featured financial transactions.

PURPOSE AND APPLICATION

Payment for ecosystem services is one of several economic instruments designed to ensure that services that contribute to adaptation strategies and increase resilience to climate variability and change are provided on a sustainable basis. In PES arrangements, the suppliers of ecosystem services are compensated for engaging in sustainable best management practices by the beneficiaries of those services.

The Millennium Ecosystem Assessment classifies ecosystem services into four groups:

- Provisioning services—food, fresh water, biomass fuel, fiber, and genetic resources
- Regulating services—climate regulation, water regulation, water purification, natural hazard regulation, erosion regulation, pollination, and disease regulation
- Cultural services—recreation and ecotourism, aesthetic, spiritual and religious, and cultural heritage
- Supporting services—soil formation, nutrient cycling, water cycling, and primary production

PES works best when: 1) a consensus is reached on the importance and value of the ecosystem services, 2) beneficiaries are willing to pay for those services, and 3) suppliers (particularly private landowners) of ecosystem services can be identified and contracted to provide the services on a sustained basis. A variety of tools can help ensure the sustained provision of ecosystem services.

There are legal instruments that include regulation and restrictions. There are voluntary programs that focus on awareness and moral suasion, and there are also economic instruments such as sanctions, taxes, and fees. The benefit of PES over regulatory approaches is that it can provide landowners with compensation that allows them to finance and adopt best management practices and/or pursue other livelihood options.

PES programs have focused primarily on regulating services related to water supply, water purification, and erosion control plus carbon sequestration. PES arrangements financed by beneficiary groups such as hydropower producers and water companies, businesses and industries that require reliable supplies of fresh water have compensated owners and managers of forests and agricultural lands. In these cases, payments encourage owners to maintain land in desired uses and sustain or adopt best management practices. Today's keen interest in carbon sequestration, is directing considerable attention to the reforestation of areas previously converted to agriculture. In coastal areas, there are a number of potential PES applications related to natural hazard regulation, recreation and ecotourism, and provisioning (crops, capture fisheries, aquaculture products).

INFORMATION AND DATA REQUIREMENTS

While various reports and training materials present in different ways the steps to designing a PES program, the schematic below provides a good summary of these.

Following are listed the essential steps of the PES design process as adapted from PES Learning Tools, The Katoomba Group. The first two steps focus on information gathering. This information is in addition to the scientific and technical data that might normally be compiled to address a particular environmental management problem.

Step 1: Identify and assess ecosystem services, sellers, and buyers

- Define and measure ecosystem services, accounting for the incremental benefits of services related to mitigating climate change and variability
- Assess market value, sellers, and potential buyers

Step 2: Assess institutional and technical capacity

- Determine if laws and policies support PES
- Clarify land tenure and property rights
- Identify implementing institutions and assess/build capacity

DESIGN CONSIDERATIONS FOR DEVELOPING THE MEASURE

The third and fourth steps focus on the design of agreements and implementation approach.

Step 3: Structure PES agreements

- Design basic management and business plan
- Assess transaction costs and identify options for reducing them
- Evaluate and select payment mechanism

Step 4: Implement PES program

- Design and implement outreach/awareness program
- Implement verification and monitoring protocol
- Evaluate and report PES program progress

IMPROVING THE LIKELIHOOD OF SUCCESS IN APPLYING THIS MEASURE AS A CLIMATE CHANGE ADAPTATION

PES programs have been successfully implemented throughout the world under a range of institutional arrangements. PES represents a no-regrets option. No-regrets means that the effort put into preparing the analysis and carrying out the related instruments produces benefits regardless of whether it offers additional benefits to aid in climate change adaptation. It is desirable to implement PES in most situations on the basis of current climate and variability. There are two potential and interlinked obstacles that may face PES transactions. First is assessing the likely climate impacts on the services. Second is quantifying the incremental benefits of the ecosystem services as they relate to climate change and variability. Where consensus cannot be reached on the magnitude of the incremental value, the PES program may still be implemented, but the negotiated value of ecosystem services will depend in part on the relative negotiating positions of buyers and sellers.

In designing and implementing PES programs, a key consideration is transaction costs. This is a factor often overlooked in traditional planning and management approaches. Transaction costs include: 1) search costs—finding buyers and sellers and establishing ecosystem values; 2) negotiation costs; 3) approval costs (where governmental support is required); 4) monitoring costs; 5) enforcement costs; and 6) insurance policy costs for compensation in the event of the loss of the good (adapted from USAID PES Sourcebook, 2007). The magnitude of transaction costs will depend on the spatial scale, number of market participants, and the complexity of the market and payment mechanisms. Many of these costs must be incorporated into and financed by the PES program. Thus, minimizing transaction costs, relative to the marketable financial value of ecosystem services, is key to establishing a successful PES program.

In terms of adaptation, there may be economic costs if the incremental value of ecosystem services attributed to increasing resilience to climate change and variability are less than anticipated. In this scenario, buyers would have paid too much for environmental services. There would have been a greater investment in management than was necessary. In some cases, if the continued costs are much greater than the values received, PES contracts could be renegotiated or terminated.

PES programs also require a range of organizational skills and commitment over a long time period. Most local and national governments lack direct experience in designing PES programs. However, many international and regional NGOs do have this experience and can assist in designing and implementing PES programs. That said, governments must be prepared to adopt laws, policies, and/or administrative rules to facilitate the cost-effective and efficient operation of PES programs. Depending on the scale of the PES program, it also may be necessary to establish a permanent secretariat to manage transactions and monitor sellers' performance in implementing PES management practices.

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ANNEX A – ADAPTATION MEASURES

BUILT ENVIRONMENT IS LESS EXPOSED

1. BEACH AND DUNE NOURISHMENT
2. BUILDING STANDARDS
3. COASTAL DEVELOPMENT SETBACKS
4. LIVING SHORELINES
5. STRUCTURAL SHORELINE STABILIZATION

built environment is less exposed

1. BEACH AND DUNE NOURISHMENT

Beach and dune nourishment is the process of adding sand to enlarge and enhance the beach and dune features along the coast. Planting grasses and native vegetation is often included with a dune nourishment project to enhance the habitat value and stabilize the dune feature.

RELEVANCE TO CLIMATE CHANGE

One of the most likely consequences of global warming and rising sea level is that low-lying coastal areas will experience greater and more frequent inundation and storm impacts. In coastal areas where the beach and dune area is limited by the input of mobile sand, the beach and dune will narrow as more and more of the beach is covered by rising sea level or eroded by waves and currents. This narrowing can be minimized or reversed by adding sand to the area through nourishment. The volume of sand and rate of nourishment can be modified and adjusted to adapt to rising sea level. This provides a flexible beach and dune buffer between the ocean and the fixed backshore area.

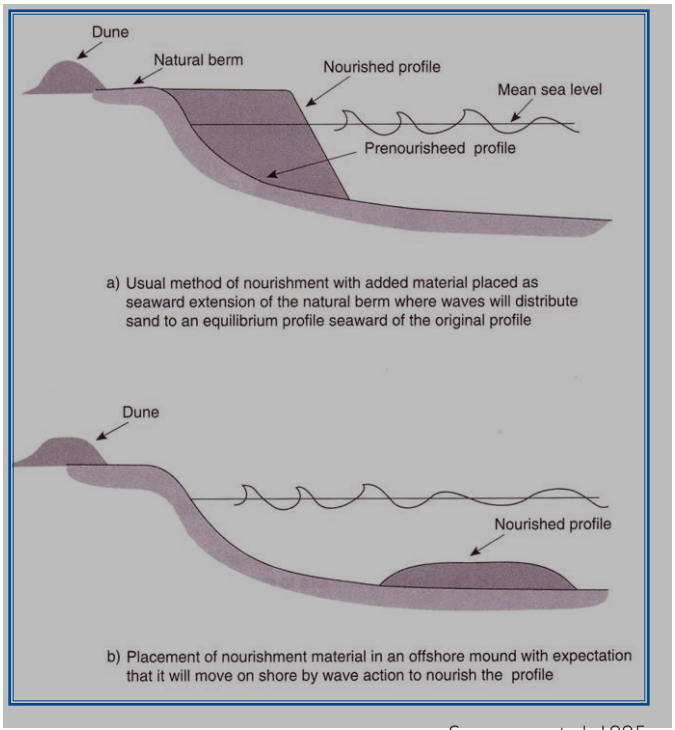
Nourishment has been used worldwide at various scales to enhance tourism beaches, protect landward development, create new land for development, and restore habitat. It has been used as a strategy for maintaining popular mass tourism destinations (Cancun, Bali, Durban, and Miami).

PURPOSE AND APPLICATION

Coastal experts have indicated that a majority of the world's beaches are eroding due to both natural processes and manmade forces. As noted by the U.S. National Research Council, "Beach nourishment is a viable engineering alternative for shore protection and is the principal technique for beach restoration; its application is suitable for some, but not all, locations where erosion is occurring." As with many shore protection alternatives, there are examples of successes and failures related to beach nourishment programs worldwide.

Planting grasses and native vegetation is often included with a dune nourishment project to enhance the habitat value and stabilize the dune feature. Nourishment can increase the recreational and/or habitat value of the beach and dune. It protects infrastructure related to beach tourism industry, commercial and residential development.

When beaches and dunes are wide and high enough to buffer the wave energy, they also help protect inland development from wave forces and coastal flooding. On shorelines with little or no beach area, waves will break against the backshore area or in the nearshore zone with run-up to the backshore. The energy in these waves and the run-up can be significant enough



Seymore, et.al, 1995.

to damage backshore developments through flooding, erosion, scour, and water damage. Often seawalls and revetments are built along the coast. These create hardened, engineered shorelines that can resist the wave forces, reduce backshore erosion and protect inland development. However, a broad sand beach or healthy beach and dune system can also direct the wave forces away from inland development. This provides a form of "soft" coastal protection. A nourished beach and dune system can further enhance this buffer and minimize or eliminate the need for hard shore protection, which often causes secondary impacts by eroding adjacent shorelines.

INFORMATION AND DATA REQUIREMENTS

To determine if beach nourishment is feasible and desirable requires information similar to what is needed when assessing "living shorelines" and structural stabilization adaptation measures.

- Historic data on changes in erosion and seasonal shorelines is essential. However, the past may not be predictive of the future. Accelerated sea level rise, changes in intensity/frequency of storm events or changes in the natural supplies of sediment to the coast may increase the rate of shoreline change.
- Estimates of sea level rise over the period of time when beach nourishment will take place.
- Information on existing patterns of wind, wave and current conditions. Consider potential changes to these parameters as a result of future climate change.
- Estimates of the sediment budget of the beach. This is defined as the amount of sand entering and leaving the beach that is being nourished. Consider the effects of potential changes to the shoreline that may alter this sediment budget—e.g., when there is increased sea wall construction on adjacent properties.
- Inventory of sediment supplies for nourishment, including land and sea deposits.
- Inventory of ecological assets that may be affected and should be evaluated in the environmental assessment. This includes coral reefs, wetlands, sea grasses and beaches that host turtle nesting, bird migration, or marine mammal haul outs.

DESIGN CONSIDERATIONS FOR DEVELOPING THE MEASURE

- Clarify the goals of the nourishment program, and its anticipated benefits and beneficiaries. Ideally these should be incorporated within an overall regional beach management plan that looks beyond the area of immediate concern.
- Identify the costs and benefits of the beach nourishment. Also identify the time period during which the program will be in place (initial nourishment and future maintenance).
- Consider the potential for changing conditions, where sea level rise and increased frequency of storms may increase the scope of future maintenance.
- During the environmental assessment, identify potential impacts (positive and negative) today and in the future. Consider how changes in sea level, erosion patterns, and habitat conditions will impact critical habitats and natural beach processes.
- Identify potential future dredging projects that might provide a source of sediment. Utilize appropriate testing protocols to ensure consistency between the source of the sediment and the nourishment site (i.e. sediment size, chemical composition).

Two main sources have and will continue to provide the sand for large beach nourishment efforts. These are sand from dredging and sand from offshore excavation. When a nearby port or harbor is dredged for safe navigation, the dredged material may be reused to nourish eroding beaches and dunes. There are two key considerations, however. The sediment type of the dredged material and that of the beach must be compatible. Also, the dredged sediments must be pollutant-free.

- When using dredged material to create/enhance dunes or intertidal/subtidal habitats, it is necessary to plant vegetation. This serves dual functions. It creates high quality habitat and stabilizes the sediment. In selecting the type of vegetation to plant, consider both existing and future conditions (i.e. salinity and temperature). Remember also that native species may be propagated from locally collected seed and plant banks.
- Estimate future beach maintenance requirements, costs and frequency—making sure to consider changes in sea level, erosion, storm frequency. Also consider the future availability of sediment sources.

- Develop a beach monitoring program and a protocol for maintenance.
- Design a sustainable funding mechanism. Nourishment is a long term program that requires ongoing maintenance to be effective.

A beach nourishment program requires public policy decisions that take an integrated approach across environmental, social and economic disciplines. These will almost always also cross government agency jurisdictions and/or scales (municipal, provincial, national). An overall beach management plan for an area of coast can be part of a longer term vision for nourishment and would have a scope that goes beyond individual shorefront lots. Nourishment programs should be managed like all other public infrastructure—i.e., ensuring there is funding and monitoring to support ongoing maintenance. When nourishment benefits only a certain economic sector (e.g., tourism) or a specific neighborhood or community, these beneficiaries should provide an appropriate level of cost-share toward the program.

IMPROVING THE LIKELIHOOD OF SUCCESS IN APPLYING THIS MEASURE AS A CLIMATE CHANGE ADAPTATION

The cost of the nourishment must account for both the initial project investment and the long-term costs of maintenance or augmentation needed to achieve the goal of the program (e.g., to ensure a popular recreational beach remains above sea level). There are multiple benefits to account for as well. This includes the protection of the back shore; of the recreational and habitat value of the beach and dune; and of the tourism value that comes with maintaining a natural, non-armored shoreline. Evidence of multiple environmental, social, and economic benefits for multiple stakeholders helps in justifying a potentially expensive nourishment program.

Education and outreach for citizens and public officials should explain that beach and dune nourishment are shore protective options that can provide valuable recreational and habitat areas. Sand is very mobile and nourishment at one location can often provide long-term enhancement not only to the beach that is nourished but also to down-drift beaches. The recreational value of beaches is well recognized worldwide. Hence, some highly valued beaches may require nourishment to maintain high investments and market share. Coastal ecologists have focused attention on the complexity of the beach ecosystem and the importance of beach structure as habitat. This includes valued nesting areas for shore birds and sea turtles, haul-out areas for marine mammals, and feeding grounds for migrating birds. Beach and dune nourishment may maintain the viability of this coastal habitat and its many related benefits, especially in a time of accelerated sea level rise and increased erosion.

To keep costs low, a new, small scale beach and dune nourishment project or maintenance effort could make use of "opportunistic" sand. Opportunistic sand sources can include excavations from foundations (buildings or underground parking), slope cuts, site grading, or sand accumulated in reservoirs. However, utilizing opportunistic sand is not always the most appropriate solution. It may require setting up a temporary stockpile storage area—where materials can be stored until there is sufficient quantity to implement the project. Another reason is that opportunistic sand comes from a variety of inland locations and its grain size may not be compatible with the sediment requirements of the beach. Finally, it may have contaminants that could create health or water quality problems. Communities undertaking nourishment should develop a program to identify potential sources of sand (land or sea) and prepare protocols for testing, transport, stockpiling, and placement.

The public needs to be educated on how beach nourishment projects are implemented. As a beach nourishment effort gets underway, there can be an array of construction-related impacts on the beach and its adjacent waters. There may be vehicles on the beach. Existing biomass may get buried. Turbidity may occur. Offshore sediment transport may affect fisheries, water quality, reefs and sea grass. While these impacts are often temporary, the public needs to be aware of and understand them. As well, the public also needs to understand that waves and currents can easily erode any beach and dune areas—whether formed by natural supplies of sand or by natural supplies augmented by nourishment.

In most locations, beach and dune nourishment must occur on a regular basis to maintain the desired buffer areas. In 1995, the National Research Council examined beach nourishment and noted that it should be considered as an on-going process and not as a single, one-time project. Unfortunately, people are often uncomfortable with this as each nourishment

event requires additional funding. Thus, it is important to make the point with stakeholders and decision makers that while a nourishment program is an ongoing effort with recurring costs, it can also generate many long term benefits that offset these costs.

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built environment is less exposed

2. BUILDING STANDARDS

Building standards identify minimum acceptable levels of safety for buildings and non-building structures. These standards promote health, safety, and welfare of the occupants.

RELEVANCE TO CLIMATE CHANGE

Issues of human health and safety are key reasons for establishing standards and formalizing them into building codes. The demand for safer building practices has only increased with the aftermath of widespread destruction from such episodic disasters as the 2004 Indian Ocean Tsunami or Hurricane Mitch in Central America in 1998.

Climate change may bring increased storm activity, flooding, or sea level rise, which in turn will increase wind and wave forces on buildings, including in those areas not currently vulnerable. Changes in temperature and precipitation patterns could also promote mold, and affect the air quality and temperature within business and residential structures.

Many developed and developing countries have incorporated building standards as mandatory procedures, although the scope and standards of application vary significantly. Model codes are available at the international level and at the regional level (e.g., the Caribbean Model Code adopted by various governments). Those developed by the International Standards Organization (ISO) offer practical solutions and incorporate a significant level of technological know-how that are being utilized or adapted in different situations. These include a growing recognition of climate change effects.

PURPOSE AND APPLICATION

Building standards outline technical requirements for design and construction of residential and commercial structures. Standards are often formalized into codes. They also provide a basis for establishing a permitting program that requires municipal or state inspection officials to ensure structural integrity and maintain quality control in building practices.

Typically, an industry standards organization defines minimum requirements. These can then be exceeded by the designer or the municipal authority adopting these standards. Standards cover many aspects of construction (i.e. structural integrity, electrical, plumbing, sanitation) and incorporate consideration of such issues as the impact of flooding, wave and wind forces on structures. Standards also exist for other infrastructure including dams, bridges, wastewater treatment facilities, wells, and on-site sewage systems.

Building codes, adopted by government officials at the local, state, province, national or international level, lay out the required standards for construction of new buildings, alterations to existing buildings, changes in the use of buildings, and demolition of buildings.

Some building codes are prescriptive, and specify the specific materials, design and construction methods designers and builders must use. Other codes are performance- or objective-oriented—e.g., they specify the desired characteristics of the structure by outlining the goals and objectives to be achieved, but allow for a variety of methods or materials to meet the standards.

INFORMATION AND DATA REQUIREMENTS

National or international codes are based on industry-wide experience, but local adaptations can be made based on technical information about the unique circumstances of a municipality or region.

- Estimate the magnitude and characteristics of current and future natural hazards of the area (e.g., wind speed, flooding, wave run-up) to determine how to design hazard-resistant buildings.
- Identify existing maps or models for wind, seismic activity, waves, and flooding so that it is clear where buildings may be subjected to extreme wind, water or wave action.
- Design criteria that incorporate projections for future changes in intensity of storms (especially wind and wave conditions), flooding elevations, and sea level rise.
- Identify pre-established or model codes that may apply to the location of concern. Adapt these model codes for the specific building styles and engineering measures that will minimize the effects from expected hazards.
- Use evaluations of the local damages from past hazard events to inform decisions on potential solutions for the future. Coastal management programs may choose to adopt stricter requirements for various types of construction in the coastal environment, which then can be incorporated into municipal or state level codes.

DESIGN CONSIDERATIONS FOR DEVELOPING THE MEASURE

- Incorporate local practices, culture, and experience and make links to issues of health and safety.
- For infrastructure that has a long design life, consider requiring the use of materials and techniques appropriate for changing climate conditions (heating, cooling, moisture considerations).
- Design and implement standards that reflect acceptable levels of risk from natural hazards. This is especially important for critical public facilities that may be a lifeline for communities in vulnerable areas or islands (e.g., shelters, hospitals, etc.) In some cases, buildings may need to be retrofitted to comply with code. Critical uses may simply need to be relocated to safer areas.
- Identify the pros and cons of implementing prescriptive or performance-based codes.
- Determine how industry best management practices and guidelines can complement the codes so that a climate of collaboration rather than conflict can be maintained.
- Establish a system of enforcement and inspection to address day-to-day activities and emergency procedures for natural hazard disaster events—ideally, have a plan in place for how local officials make decisions during disaster response and recovery that sets out which properties will be allowed to be reconstructed.
- Develop financial or other incentives to effectively implement standards, which when applied will ensure buildings are more resilient to natural hazard events.
- Provide the training necessary to raise the competency level of architects and inspectors. This includes ensuring they understand not only the current situation but predicted future conditions and how to develop climate change adaptation techniques.
- Develop guidelines that reflect the standards and serve as a teaching tool for good practices for use by builders, artisans and local officials. Guidelines can be voluntary or can complement a regulatory program.
- Incorporate "green building" standards that reduce greenhouse gas emissions, considering such factors as options for ventilation and siting, water-reuse within wastewater systems or alternative energy sources.

IMPROVING THE LIKELIHOOD OF SUCCESS IN APPLYING THIS MEASURE AS A CLIMATE CHANGE ADAPTATION

Applying building codes can be costly and face resistance from consumers, designers, builders and local authorities. There is likely to be pressure from individuals, corporations, and trade associations to reduce the costs and bureaucracy that can accompany implementation of codes and thus hamper economic development. As a result, it is not always feasible to apply a new code without a phasing-in period. Successful implementation of building standards also requires strong political will to implement stringent building standards given the challenges of applying and enforcing them.

Once established, however, building codes provide important guidance on acceptable methods for rebuilding after natural disasters in a way that reduces future losses of life and property.

ADAPTATION TO EXTREME EVENTS IN FIJI'S COASTAL TOURIST RESORTS

To prevent damage from storm surges and sea-level rise, resorts are now built at least 2.6 m above mean sea level and 30 m off the high tide mark (these standards might be reviewed in the future). The building code prescribes that structures need to withstand wind speeds of 60 km per hour. Individual businesses (at least the larger resorts) should have evacuation plans, insurance coverage and procedures before the start of the cyclone season, such as staff training, water and food storage, first aid kits, trimming of trees and a direct line to the Meteorological Service for early warnings. These efforts are being developed and implemented in coordination with government departments and tourism businesses.

Source: Simpson et.al. 2008

It is essential to consider the costs to developers (private and public) of applying the building standards and to government for overseeing and enforcing them. While adhering to building standards/code may increase initial construction costs, it can reduce longer term costs to individuals and the community when recovering from a disaster. This includes the costs of replacing buildings and other infrastructure. Reconstruction after natural disasters may provide an opportunity to upgrade or retrofit buildings. It may be appropriate, in this case, to ensure that public buildings (including shelters and hospitals) adhere to a system of building standards, inspection and enforcement that exceeds minimum code. This strategy increases resiliency and minimizes damages and loss from future natural disasters and/or climate change.

Enforcement capacity is the key to the effectiveness of building standards and codes for both the private and public sector. The system should include a mechanism for oversight of the permitting process and field operations. Inspections are a core element of the oversight process and are one way by which to determine compliance.

Ongoing training is essential to any building standards/code program. This is especially the case for local officials who are responsible for ensuring the standards are being effectively and consistently implemented. Given what are often financial and human resources limitations, it may be appropriate to design a system where national codes provide an overarching framework of standards and implementation, which is then scaled to address priorities (i.e. urban vs. rural, commercial vs. residential, public vs. private) or scaled to meet building size thresholds. Implementation can also be linked to land use plans, where specific hazard zones have different building standards. Training for designers, builders, and local officials, together with financial incentives, and the use of best management practices can help to promote a responsible industry.

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built environment is less exposed

3. COASTAL DEVELOPMENT SETBACKS

A coastal development setback may be defined as a prescribed distance to a coastal feature, such as the line of permanent vegetation, within which all or certain types of development are prohibited (Unesco, 1997).

RELEVANCE TO CLIMATE CHANGE

Setbacks create a buffer between shoreline development and the sea that provides some protection against the destructive effects of erosion or land loss resulting from accelerated sea-level rise or increased storm activity. Setbacks, which are used worldwide, are designed to minimize damage from erosion and increase public access to beaches.

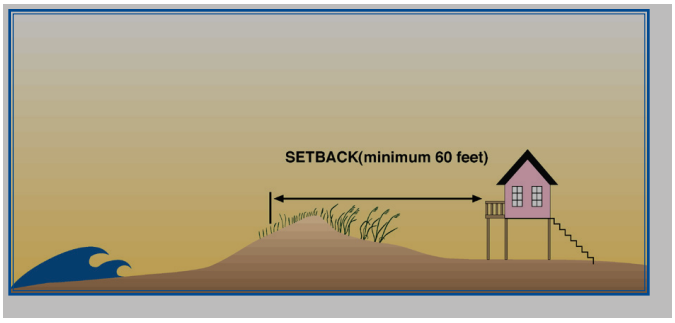
PURPOSE AND APPLICATION

Setbacks locate new development away from hazards (e.g. erosion areas or low-lying areas) or sensitive landforms (e.g., dunes). They accommodate seasonal and long term fluctuations in the shoreline profile. Setbacks are normally established from an identifiable location (i.e. a dune crest, high tide line) and measured landward. Often setbacks contain a buffer zone—a natural area that must be retained in, or restored to, a natural vegetative condition. Development seaward of the setback is often prohibited or is restricted to structures that are temporary or easily moved landward, if necessary.

Setbacks can reduce current and potential future adverse impacts to coastal development situated in erosion or flood-prone areas. At the same time, they protect sensitive areas from the impacts of development. They can help reduce the need for costly, and often damaging, structures to control shoreline erosion. They also help maintain natural shore dynamics and shorefront access—both of which are critical in changing shoreline conditions.

Provisions for water-dependent uses (such as landing areas for artisanal fisherman) are often accommodated within the setback area. Setback areas often support public access to the waterfront. Setbacks for rural and urban shorelines may vary significantly with differing policies for those areas adjacent to armored shorelines. Setbacks in urban areas are especially suitable for public shoreline walkways and landscapes that are designed to filter storm water to remove contaminants (non-point source pollution). A "no-build" development setback is most effective when implemented on a multi-lot scale, and is commonly used in low density areas without hardened shorelines.

Setbacks are implemented on and provide benefits for both public and private lands. Because setbacks may limit the buildable area available to property owners, they are sometimes controversial. Controversy can be reduced through public education, dialogue and incentives to landowners. It is important to gain consensus during a public dialogue and find a proper balance between public safety, environmental security and private property rights.



In North Carolina, USA, the setback is determined by multiplying the average erosion rate by 30. The minimum setback distance is 60 feet from the first stable line of natural vegetation. http://dcm2.ehnr.state.nc.us/Hazards/rebuild.htm

INFORMATION AND DATA REQUIREMENTS

Setbacks require information that is similar in kind to living shorelines and non-structural shoreline protection.

- Conduct an analysis of beach dynamics, shoreline ecology and historical erosion rates before establishing setbacks. Shoreline dynamics and subsequent setback distance may vary from beach-to-beach.
- Set up basic beach profile monitoring transects to determine erosion rates—long term data sets will be more accurate to characterize shoreline dynamics. Erosion rates are likely to change with accelerated sea level rise and changes in storm frequency and intensity, however predicting this change requires more detailed modeling.
- When evaluating historical rates (from maps, beach profiles, traditional knowledge), determine if the rates of erosion have changed from one decade to the next. Also determine if changing trends are the result of climate change factors (changes in storm activity or sea level elevations) or man-made causes (e.g. removal of wetlands, construction of shoreline erosion control structures or local land subsidence).
- Observe characteristics of the beach profile from seasonal changes and current climate variability (e.g. El Niño). Consider the stability of landforms (barrier beaches, dunes, bluffs) and the potential changes that may result from accelerated sea level rise, increased storm activity and subsequent erosion.

DESIGN CONSIDERATIONS FOR DEVELOPING THE MEASURE

Setback policy is typically established by a state or national authority and implemented by issuing construction permits for new, expanded, or rebuilt development. In many countries, there is a federal zone where the government has the authority to limit development in the inner-tidal area and adjacent shore. Periodic review of current setback standards may be warranted as new information on climate change becomes available and/or if development is significantly damaged by a natural event.

IMPROVING THE LIKELIHOOD OF SUCCESS IN APPLYING THIS MEASURE AS A CLIMATE CHANGE ADAPTATION

- In justifying setback policies, identify how they will contribute to reducing the impacts on shoreline development from both current and future (changing) conditions.
- Identify multiple objectives for setback areas. For example, identify how the setback may not only benefit public access, but also contribute to habitat restoration or other ecosystem services. When designing vegetated landscapes within the setback area, consider potential climate change affects on precipitation patterns and species composition.
- Determine the lifetime of the proposed shoreline development and anticipate its future conditions. Incorporate setback guidance for rebuilding the development should it be damaged or destroyed as

APPLYING COASTAL DEVELOPMENT SETBACKS IN ANGUILLA

Setbacks can be useful in coping with present and future coastal erosion. In Anguilla, the Government designed a protocol for coastal development setbacks in 1996 as a measure for adaptation to climate change and to ensure safe and sustainable coastal development. These setbacks were calculated on a site-by-site basis and were based on historic erosion rates, projected coastline retreat due to sea level rise and increased storm activity, and other local factors. For over a decade, these setbacks have been used to guide coastal development. Enforcement of these guidelines has proven difficult, however, as the setbacks guidelines are perceived as being at odds with the interests of developers. In response, the original guidelines are being amended and subsequent policy drafted to establish uniform and agreed-upon coastal setback policy. In 1998, Nevis adopted setback guidelines similar to those of Anguilla, and in 2007 began revising their guidelines to establish mandatory policy.

Tiempo Climate Newswatch, 2008

a result of future natural hazards events. Include provisions that prevent property owners from receiving public compensation for hazard impacts to their development.

- Make sure that setbacks—either defined as a rate (e.g. expected life of structure multiplied by annualized erosion rate) or a specified distance (e.g. 50 meters for all development)—consider, where feasible, projected erosion and sea level change. The width of the setback's no-build zone should be greater in areas currently undeveloped (which may be developed in the future), than in already urbanized areas.

- Conduct fair and transparent processes that promote community participation in defining the setback policy. It is critical to understand the costs and benefits of such decisions and to identify equitable options that promote safety and security for people and their traditional livelihoods that depend on shorefront access—for example, fisheries.

- Realize that setbacks are also a component of policies for public access to the shore as well as for protection of water-dependent uses.

The cost of adopting setbacks as a policy is primarily borne by the property owner. Where development pressures and property values are high, the opportunity cost is also high. With or without climate change, setbacks yield a variety of benefits. These are linked to the fact that setbacks can help reduce property damage and safeguard lives from the impacts of erosion and flooding. Setbacks also provide landscape, public access and natural ecosystem amenities. It is important to emphasize the wide range of benefits from setbacks as a counterbalance to concerns about the cost or possible financial impacts on property owners.

Good technical data is needed to establish effective setback lines. While it is known that coastal beaches, dunes and bluffs will generally respond to accelerated sea level rise through increased erosion, it may be difficult to model future rates of erosion with certainty. Setback design should consider local input (both citizens and technical experts), community goals, and political will, together with the specifics of a site analysis, historic information, and best professional judgment. Analyzing historic trends (maps, aerial photographs), or long-term beach profiling data is invaluable, and can be done by involving citizens and students so that such studies become a part of the education process.

It is wise to use setbacks as an adaptation tool within an overarching integrated coastal management program as its benefits are significant, it can meet multiple objectives, and it can be considered a precautionary measure, or a no-regrets approach to climate change. In promoting the use of setbacks, it may be useful to bring stakeholders to other areas that have the same problems and where setbacks have been used to advantage. This can help stakeholders better understand and visualize how setbacks can be used to address the same or similar shoreline problem as the one they also face today or anticipate facing in the future. It is important to note, however, that setbacks may not protect structures from damage indefinitely. When/if the shore erodes closer and closer to the development, there is a decision to be made—a decision to retreat or to stabilize the shoreline.

It is essential to educate the public on erosion rates and dynamics, as well as management options. Otherwise, owners may perceive setbacks as a burden that only reduces their options for fully developing their valuable waterfront property. It is critical to reach a public consensus on setback policies, taking into consideration the need to balance public safety with private property rights.

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4. LIVING SHORELINES

"Living shoreline" refers to a management practice that addresses erosion by providing for long-term protection, restoration or enhancement of vegetated shoreline habitats.

RELEVANCE TO CLIMATE CHANGE

Climate change impacts from increased storm frequency and intensity (including wave energy) will accelerate shoreline erosion. However, using living shorelines measures can stabilize shorelines and also help control erosion in estuaries, lagoons, and in riverine areas. The design of living shorelines may also help accommodate the landward transgression of wetlands that results from sea level rise.

Living shoreline treatments were first developed and implemented in the Mid-Atlantic Region of the United States. To be implemented in other areas of the world, their design and application must be adapted for other natural systems (e.g., tropical and subtropical areas, mangroves and coral reef habitats, etc.).

PURPOSE AND APPLICATION

Living shorelines are accomplished through the strategic placement of plants, stone, sand fill and other materials. They are designed to stabilize the shore while maintaining natural processes. This includes processes such as tidal exchange; sediment movement; groundwater flow; and plant community transitions between upland, intertidal and aquatic areas. Enhancing the natural defenses along a shoreline can protect people and their ecosystems from future hazards due to climate change and variability.

Living shorelines seek to maximize habitat and natural processes in a range of low to medium energy areas found along sheltered coastlines (estuarine and lagoon environments). They are not appropriate for high energy open ocean coasts. Typically, habitat benefits decrease and the structural components increase when projects are implemented in higher energy environments. Non-structural or "soft" approaches (e.g. marsh creation or enhancement, beach nourishment, dune restoration, riparian restoration/management, and fiber log placement) often can be designed for low energy areas. Projects implemented in medium energy areas are designed as "hybrids" (e.g., marsh toe revetment, marsh sill, living and offshore breakwaters, and reef establishment), since they combine the vegetative soft structure with the commonly used "hard" structural solutions.

It is important to note that the natural shoreline is not a fixed line in the sand. Rather, it is a continuum from the upland to sub-aquatic habitats (see cross section). The maintenance, enhancement or restoration of a vegetative buffer (green belt) should be part of implementation of any living shoreline strategy.

A hybrid solution for this medium energy environment includes a rock toe at the edge. Source: Burke Environmental Associates: http://www.burkeassociates.biz/LivingShorelinesP.php

INFORMATION AND DATA REQUIREMENTS

Much of the site-specific information needed to design living shorelines is similar to that required to establish coastal development setbacks, carry out beach nourishment and implement other shorefront stabilization measures.

- Define the problem (episodic or chronic erosion) and scale of the shoreline region of concern. Analyze historic erosion rates. Evaluate the condition of adjacent shorelines. Identify potential future problems related to sea level rise, storm frequency, and intensity.
- Determine the exposure of the shoreline from wind generated waves (referred to as fetch) as well as boat wakes, tidal ranges, and currents. This will help to verify that it is a low to medium energy environment. Identify projected changes to the shore dynamics to ensure the site will continue to be an effective candidate for this measure, in terms of wave energy.
- Consult with knowledgeable persons in fields of agronomy, and landscape architecture. Assess the correct balance of vegetation, considering current and future changing conditions related to temperature (land and water), precipitation, salinity, and tidal conditions.

DESIGN CONSIDERATIONS FOR DEVELOPING THE MEASURE

- Assess whether vegetation (upland, intertidal, subtidal) alone can address the problem, or if structural components (sand, stone) must be added in order to dampen wave energy and exposure to the shore.
- Where feasible, employ an ecosystem approach—one that links subtidal, intertidal and upland protection and restoration initiatives. Consider the potential for landward transgression of vegetation with sea level rise.
- It may take years to realize the full benefits from steps taken to prevent erosion (some erosion-controlling vegetation have very slow growth rates). It may be necessary to take interim measures that involve the use of sand and stone or organic materials.
- Involve community stakeholders from the very beginning in planning for and actions to protect and restore the natural shoreline. Educate property owners and other stakeholders on how to maintain the living shorelines. Provide incentives for property owners to participate.
- Ensure either the property owner(s) or government officials monitor its effectiveness in preventing erosion. This will help determine if the current strategy is working to control erosion or if the strategy needs to be adjusted to address changes in conditions.
- Enact ordinances or develop voluntary agreements that prohibit activities that reduce or alter beach/barrier configuration and dune height (e.g., removal of vegetation or construction of groins and jetties that prevent sediment transport).

IMPROVING THE LIKELIHOOD OF SUCCESS IN APPLYING THIS MEASURE AS A CLIMATE CHANGE ADAPTATION

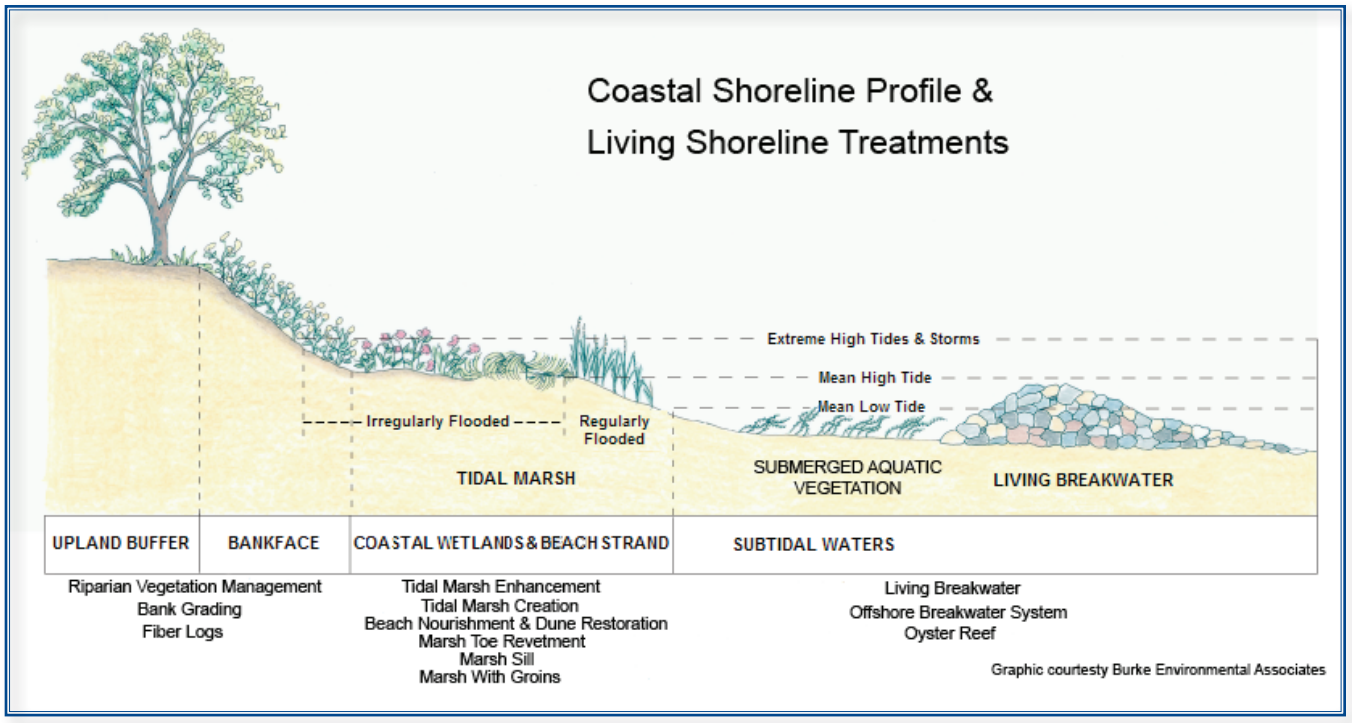
The primary benefit of a living shoreline strategy is erosion control in sheltered coastal environments. In turn, improved natural habitats provide benefits by providing ecosystem services. This includes, for example, nurseries for fish spawning and feeding areas for migratory bird. Plants from these habitats also serve as natural filters that absorb nutrients from upland sources that typically pollute water bodies with excess nitrogen and phosphorous.

In lower energy areas, people tend to "over-stabilize" their shorelines in an effort to get what they consider to be the most protection for their money. They may discount some of the softer solutions of a living shoreline approach as they are less confident in their effectiveness. Implementing demonstration (pilot) projects in areas visible to the public can help raise understanding of these approaches, and awareness that they can be as highly technical as a structural stabilization treatment or can include "softer" treatments such as vegetative planting.

The longevity and success of living shoreline treatments are limited by two factors—sea level rise and the level of maintenance required by the particular treatment. For example, extreme rises in sea level may inundate the vegetation that is planted as part of the living shoreline and cause it to die out leaving the sand fill exposed and vulnerable to erosion. If die-out occurs, the

problem must be assessed and quickly mitigated and the vegetation replanted. Climate change may also increase wave action, which could reduce the effectiveness of living shoreline treatments as a management option for higher energy areas.

Finally, it may be appropriate for the local authority to enact policy and/or ordinances that promote living shorelines as a priority measure where appropriate. They can do this by means of regulations or voluntary agreements. Either way, the authority may prohibit activities that impact natural shoreline processes and sediment flow (such as sand mining or large groins), which is critical to maintaining an equilibrium shoreline.



For a medium energy environment, a hybrid solution may be required, and would include both a vegetated shoreline, with a constructed "living breakwater", sill or toe at the edge of shoreline, created to reduce wave energy to the shore.
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built environment is less exposed

5. STRUCTURAL SHORELINE STABILIZATION

Constructing shoreline stabilization structures, often referred to as shoreline hardening or armoring, is an approach taken to "defend" the shoreline from erosion or flooding.

RELEVANCE TO CLIMATE CHANGE

Structural shoreline stabilization techniques provide property owners with the ability to minimize the destructive effects of flooding, erosion, and land loss to their property that results from sea-level rise or increased storm activity. Long term planning to relocate infrastructure or consolidate essential services in a less hazardous area could eliminate the need to stabilize the shoreline. However, island communities or dense urban areas that have no place to retreat, the only acceptable long term solution may be to stabilize and fill in order to raise the elevation of the land.

Engineered and structural responses to shoreline hazards are commonplace throughout the world. Structural stabilization runs the technical spectrum from highly engineered designs to the simple placement of construction debris to quickly abate the erosion risk. Regardless the level of sophistication, structural approaches should be viewed as an option of last response. They should be used only to buy the time needed to plan, relocate, or identify a more suitable management strategy to address current and future climate-based risks.

PURPOSE AND APPLICATION

Hardened structures are often used to protect property from further erosion—especially when infrastructure loss is imminent or where space is limited (as in urban areas). Common shoreline structures include bulkheads, revetments and seawalls. Structures to improve navigation channels include jetties, groins and breakwaters. Climate change will exacerbate shore erosion through increased coastal inundation (flooding). This can occur as result of permanent changes in condition (sea level rise) and/or through episodic events (storm surge and wave attacks associated with storm events). As climate change causes sea levels to rise, the social and political pressures to stabilize the shore and protect property tend to increase significantly.

The structures identified above are typically made of concrete or stone. Such structures are particularly effective in high energy environments. If properly designed, they can reduce landward flooding or slow erosion rates landward of the structure. Such structures are designed to either deflect the wave energy from the shore, thus reducing erosion to the land or, they reduce wave energy behind the structure (e.g., with a breakwater). Structural shoreline stabilization is expensive. While it may deflect wave energy at one site, it may lead to erosion problems on adjacent shorelines or to the sub-aqueous environment. In such cases, if the decision is still to go with a hard solution, the recommendation is to choose a sloped revetment structure versus a vertical seawall to reduce wave refraction and associated erosion.

When selecting a strategy of stabilization, consider the choices in structural design. Carefully assess the tradeoffs between environmental impacts and infrastructure performance. There are several drawbacks to a stabilization strategy. One is the exacerbation of erosion seaward or to adjacent areas. Another is the loss of beach and intertidal habitat. Others include the possibility of alterations to the shoreline and water circulation; a potential short life-span before the structure fails; and ineffective use in low energy environments. Shoreline stabilization structures must be maintained . Even then, they will eventually fail or need replacement. Uncertain marine conditions resulting from climate change will only add to these challenges.

INFORMATION AND DATA REQUIREMENTS

Some of the information needed to help design other measures/options such as living shorelines and setbacks are also useful when considering stabilization as an adaptation measure. Given the expense of constructing shoreline stabilization, and the potential for adverse environmental impacts, it is important to also gather and analyze additional data.

- Identify the historic erosion rates and records for the area to help estimate the level of design needed—the traditional knowledge of community elders may provide important information on past events or trends.
- Estimate future erosion rates and sedimentation patterns to assess potential consistency with historic trends.
- Identify studies on local coastal hydrodynamics, sediment processes, and coastal geology to understand the seasonal and inter-annual dynamics of the targeted coastline, as well as the sand budget (i.e. the volume and transport of sediment within the area) .
- Evaluate designs of shoreline structures that already exist in the region to determine the types of structures most effective in similar conditions.
- Identify a benchmark to determine the mean high water level and access the best climate projections to estimate them 50 years from now as a result of sea level rise. Where there are no definitive sea level rise projections, employ the precautionary principle in design and decision-making.

DESIGN CONSIDERATIONS FOR DEVELOPING THE MEASURE

- Identify the threat to infrastructure and property and prioritize the site based on other areas at risk to ensure capital resources are being wisely allocated.
- Determine if other adaptation strategies could be put in place of or in conjunction with the structure to further address the hazard risk.
- Determine how future climate change scenarios or projections will be incorporated into the structural design (i.e., the life-of-the-design, wave energy, rainfall, flooding inundation levels).
- Assess the site conditions and the regional coastal processes and identify the potential impacts of the structure on natural and public resources.
- Analyze the benefits and costs of structures in light of existing and future coastal conditions.
- Identify procedures for monitoring and maintenance programs. Assess the structural integrity and environmental conditions to ensure that changing factors (e.g., mean sea level, actual wave heights) do not impact the effectiveness of the structure or the adjacent shoreline.
- Ensure contingency plans to protect human lives during failure of the structure.

When addressing shore erosion, managers and decision-makers are in a continual struggle to balance the trade-offs between protection of property and potential loss of landscapes, public access, recreational opportunities, and environmental impacts. They need to consider how structures might alter the economic, recreational, and esthetic properties of the shoreline and the impact on the public use of and private business activities along that valuable shoreline. Sand mining and coral mining may provoke additional concerns if they are occurring within the same sand supply system.

In general, most regulatory/permitting systems foster a reactive response to immediate-term situations of erosion and flooding. This means, decision-making is often made parcel-by-parcel and based on relatively little environmental or climate-related information or analysis. Moving forward, agencies may need to revise the criteria by which they permit the use of stabilization structures to include consideration of the longer term

Design of shoreline structures must consider the adjacent shorelines to insure that the erosion is not exacerbated.

cumulative impacts of such structures. This would include consideration of climate variability and sea level, and impacts on the larger ecosystem.

IMPROVING THE LIKELIHOOD OF SUCCESS IN APPLYING THIS MEASURE AS A CLIMATE CHANGE ADAPTATION

Shoreline stabilization projects are costly. Thus, it is important to prioritize the areas for which specific measures will be implemented as part of an overall adaptation strategy. Coastal managers and engineers need to consider the characteristics of the broader coastal system and the potential cumulative impacts of individual site-by-site decisions.

It is difficult to predict how shorelines will respond to accelerated sea level rise and determine the extent of erosion. Although armoring a few properties along the shoreline has little impact on an ecosystem, a proliferation of structures along a shoreline can inadvertently change coastal environments and ecosystems. This can lead to a reduction in the benefits that coastal ecosystems can provide for coastal communities (including flood protection).

Determining the construction costs of a structure and the infrastructure it protects is a relatively straightforward engineering calculation. Assessing the tradeoffs and the value of lost habitat or other services, however, is harder to estimate. The cost of "other" services include those for ongoing maintenance and the potential future replacement or retrofit, should changing conditions make this necessary.

Little is known about the cumulative effects of shore stabilization. However, an understanding of them is necessary to ensure the impacts of individual projects on the environment are not underestimated. Too often, information on the causes of erosion at specific sites and the overall patterns of erosion, accretion, and inundation in the broader region are unavailable or insufficient to support the development of an integrated plan for managing shore erosion (NAS, 2006). However, creating a proactive "regional approach" to shoreline management could address some of the unintended consequences that result from a case-by-case approach and reactive decisions on permits. A regional approach also provides for a more efficient allocation of limited capital resources.

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ANNEX A – ADAPTATION MEASURES

DIVERSIFIED LIVELIHOODS

1. FISHERIES SECTOR GOOD PRACTICES
2. MARICULTURE BEST MANAGEMENT PRACTICES
3. TOURISM BEST MANAGEMENT PRACTICES

diversified livelihoods

1. FISHERIES SECTOR GOOD PRACTICES

Fisheries is an important sector that supports rural livelihoods, food security and marine bio-diversity. Good practices in fisheries management, including production, infrastructure, operations, and ecosystem protection can be used or adapted to help address the likely impacts of climate change on this vitally important sector.

RELEVANCE TO CLIMATE CHANGE

Fisheries managers have long dealt with climate variability and its impacts on the ecosystem, the industry and the communities that depend on it. For example, the El Niño Southern Oscillation (ENSO), and other phenomenon demonstrate that climate directly affects marine ecosystem structure and function. For example, changes in atmospheric temperature affect ocean temperature; changes in strength and direction of winds alter currents and mixing; and changes in precipitation affect salinity.

Historically, strategies and government support for fisheries have focused largely on short-term variability in the sector. As climate change accelerates, however, this must change. There need to be major investments in adapting fisheries management to address the predicted long-term, climate-induced shifts in fisheries-dependent habitat and ecological systems. Climate change will impact many aspects of community life and well-being—employment, food security, and nutrition. It will also directly affect infrastructure, including but not limited to port facilities.

There are regional differences in both the significance of the biophysical change that is happening and the nature of its impacts. Impacts will be both positive and negative and will be influenced by local circumstances, vulnerabilities and communities' adaptive capacity. For example, fish stocks may relocate to other areas where habitat conditions are more suitable. This creates a situation where fishers in one area may "lose" some stocks to another area, but "gain" different stocks that have moved in from outside the area and vice versa. Meanwhile, changes in water temperature and precipitation in estuaries could affect the recruitment levels, productivity, and susceptibility to disease of important economic species such as shrimp. This may in turn impact the fishery, the processing, and export of local products.

PURPOSE AND APPLICATION

Fisheries and related industries employ over 155 million people worldwide. Ninety-eight percent of these are from developing countries (FAO, 2006). Fishing is important for economic growth and exports, and is an important source of domestically produced protein.

Fisheries ecosystems—including its human dimensions—are increasingly vulnerable to the impacts of climate change. To build resilience, fisheries managers need to build their capacity to adapt to the changes underway and still to come. One way to do this is to adopt an ecosystem-based management (EBM) approach for the sector. In the face of increasing uncertainty and inability to accurately predict effects of climate change on fisheries in any given location, EBM allows for the timely adjustment that will be needed. Many of the core principles of ecosystem-based fisheries management, as listed below, will help address impacts from critical alterations of fisheries resulting from climate change and variability.

INFORMATION AND DATA REQUIREMENTS

In order for fisheries management to incorporate good practices that will address the major shifts caused by climate change, there are several types of specialized information needed. This includes information on the

Examples of Climate Impact Pathways on Fisheries			
Types of Changes	**Climate Variable**	**Impacts**	**Potential Outcomes for Fisheries**
Physical Environment	Changes in pH	• Effects on calciferous animals, e.g. mollusks, crustaceans, corals, echinoderms and some phytoplankton	Potential declines in production for calciferous marine resources
	Warming upper layers of the ocean	• Warm water species replacing cold water species	Shifts in distribution of plankton, invertebrates, fishes and birds, towards the north or south poles
		• Plankton species moving to higher latitudes	
		• Timing of phytoplankton blooms changing • Changing zooplankton composition	Potential mismatch between prey (plankton) and predator (fish populations) and declines in production
	Sea level rise	• Loss of coastal habitats e.g. mangroves, Coral bleaching reefs and breeding habitats	Reduced production of coastal and related fisheries
Fish Stocks	Highwater temperatures Changes in ocean currents	• Changes in sex ratios • Altered time of spawning • Altered time of migrations • Altered time of peak abundance	Timing and levels of productivity across marine and fresh water systems possibly affected
		• Increased invasive species, diseases and algal blooms	Reduced production of target species in marine and fresh water systems
		• Affects fish recruitment success	Abundance of juvenile fish affected and therefore production in marine and fresh water
Ecosystems	Reduced water flows & increased droughts	• Changes in lake water levels • Changes in dry water flows in rivers	Reduced lake productivity Reduced river productivity
	Increased frequency of ENSO events	• Changes in timing and latitude of upwelling	Changes in pelagic fisheries distribution
		• Coral bleaching and die off	Reduced coral-reef fisheries productivity
Coastal infrastructure and fishing operations	Sea level rise	• Coastal profile changes, loss of harbors and homes • Increased exposure of coastal areas to storm damage	Costs of adaptation make fishing less profitable, risk of storm damage increases costs of insurance and/ or rebuilding, coastal households' vulnerability increased
	Increased frequency of storms	• More days at sea lost to bad weather, risks of accidents increased	Increased risks of both fishing and coastal fish-farming, making these less viable livelihood options for the poor; reduced profitability of larger-scale enterprises, insurance premiums rise
		• Aquaculture installations (coastal ponds, sea cages) more likely to be damaged or destroyed	
Inland fishing operations and livelihoods	Changing levels of precipitation	• Where rainfall decreases, reduced opportunities for farming, fishing and aquaculture as part of rural livelihood systems	Reduced diversity of rural livelihoods; greater risks in agriculture; greater reliance on non-farm income
	More droughts or floods	• Damage to productive assets (fish ponds, weirs, rice fields etc) and homes.	Increased vulnerability of riparian and floodplain households and communities
	Less predictable rain/dry seasons	• Decreased ability to plan livelihood activities - e.g. farming and fishing seasonality	
This table is not intended to be comprehensive but to give examples of potential impact pathways that can affect the distribution and production of fish stocks, the risk and viability of fishing operations and livelihoods, and the economic contribution of fisheries to poverty reduction.			

Source: FAO, 2006 Building Adaptive Capacity to Climate Change http://www.sflp.org/briefs/eng/policybriefs.htm
Modified from Allision, E.H. et. al. (2005)

existing geographic and spatial scale of the fishery of concern. It also includes data on predictions of climate change and how that change might alter the distribution of stocks within the region and adjacent waters. If available, also collect and analyze information related to ecosystem dynamics over time—e.g., temperature structure, salinity, currents and phytoplankton.

Understanding trends is critical for managing under changing conditions, so it is important to collect baseline (and historic, if available) information on fisheries efforts, stocks and harvests to determine catch-over-time. This is the basis against which to assess the results of future monitoring of industry changes. It may also help in identifying relationships between fisheries and climate variability.

It is also essential to understand the existing capacity of the fishers and their community to adapt to climate change impacts. The more quickly they can adapt to changes in the types of species caught and their geographic locations due to biophysical changes to the fisheries ecosystem (e.g., water temperature, shifts in currents, etc), the more resilient they will be to negative impacts of these changes. This includes the need for changes in vessel design and rigging, types of gear being used, and other fishing methods. A further adaptive measure would be for fishers to diversify their livelihoods so fishing was not their sole source of income and food protein. Again, the more easily and readily fishers and their communities can adapt to these and other changing conditions, the greater their resilience and ability to minimize the negative impacts of these changes on their lives.

DESIGN CONSIDERATIONS FOR DEVELOPING GOOD PRACTICES

Fisheries management is complex and often fraught with conflict. Incorporating a climate change adaptation perspective may work best when associated with an ecosystem-based fisheries management policy that addresses key components such as management structure, livelihoods diversification and retrofitting infrastructure.

THE 10 COMMANDMENTS OF ECOSYSTEM-BASED FISHERIES MANAGEMENT

Keep a perspective that is holistic, risk-adverse, and adaptive.
Question key assumptions, no matter how basic.
Maintain old-growth age structure in fish populations.
Characterize and maintain the natural spatial structure of fish stocks.
Characterize and maintain viable fish habitats.
Characterize and maintain ecosystem resilience.
Identify and maintain critical food-web connections.
Account for ecosystem change through time.
Account for evolutionary change caused by fishing.
Implement an approach that is integrated, interdisciplinary and inclusive.

Hixon, et al. 2007

Climate Ready Management Structures

Incorporate climate change issues into fisheries planning efforts. An important starting point is to identify risks. Another is to discuss with the community different scenarios on how climate change may affect the fisheries and associated aspects of community life. Develop strategies for adapting management approaches that seek to avoid overfishing and that promote ecosystem health. This encourages a more sustainable fishery.

Emphasize management under uncertainty—i.e., where adaptive approaches and adaptive capacities are key features. Identify ways to introduce flexibility in terms of the gear that is used, the species that are fished, the fishing areas to be managed, and the allocations that are harvested.

To increase the resilience of fisheries stocks to replenish themselves, identify linkages with programs that address habitats and ecosystems. This includes coastal management programs or wetlands policies. Engage in restoration initiatives for areas of critical habitat.

Promote the use of Codes of Conducts and incorporate adaptation strategies into local fisheries practices. The FAO Code of Conduct for Responsible Fisheries provides a foundation for good management that would benefit the fisheries sector in this time of uncertainty. The Code promotes relevant approaches such as the participatory approach, capacity building, the use of traditional knowledge, and the application of the precautionary principle. The precautionary principle posits that when the information is not available or sufficient, take action that "does no harm"—as uninformed decisions can inhibit future options for adaptation..

Strengthening and Diversifying Livelihoods

Be proactive in incorporating a sustainable coastal livelihoods framework—an integrated, multi-sectoral approach—into fisheries policies and programs. Such approaches help to diversify fishers' livelihoods, making them less dependent on fisheries as the sole income source and more resilient to natural shocks and changes resulting from climate change.

Consider diversification through Integrated Aquaculture and Agriculture (IAA) strategies. This approach increases the adaptive capacity of coastal households and communities. By integrating aquaculture and agriculture, the farmer and/or fisher addresses climate variability that affects each livelihood in different ways. It may impact the farmer through drought that makes the land unsuitable for growing its traditional land crops. It could impact fishers through increased storm activity that might limit their days at sea. An example of an adaptive IAA approach for the fisher (or the farmer) to address these impacts would be the use of saline lands for aquaculture of species such as milkfish or shrimps.

As climate change alters the biophysical conditions, different species may populate the waters. Research the feasibility of marketing and selling these potential new species. Further, encourage fishers to consider expanding the market for existing and new product(s) by value-added processing. For example, salted or canned fish might generate additional profits over the sale of the raw fish alone.

Protecting Infrastructure and Operations

When designing new or renovating existing infrastructure or shore-side facilities, consider the impact of changing conditions related to sea level rise and storm intensity. Infrastructure may need to be elevated or relocated to accommodate rising seas or flooding. Fishing practices may need to adapt to changes in stocks and target species. This, in turn, may require another consideration—a change in vessels and gear design.

Identify risks to boats and coastal facilities from extreme storms, flooding events and long term sea level rise. Implement actions to reduce vulnerability and future damage (i.e. elevate and secure shore-side machinery or fuel storage tanks). Develop a preparedness plans for storms (i.e. securing or relocating boats).

To increase safety levels of people and property from the impacts of storms, fishers must access weather forecasts via radio or by short message service (SMS) and understand the local implications of different forecasts. They should also have basic training related to fishing practices during extreme weather events, including the use of survival equipment, personal flotation, and deployment of life rafts. Fishers and other community members should be taught to swim. This skill increases an individual's safety while at sea and inland during times of flooding.

IMPROVING THE LIKELIHOOD OF SUCCESS IN APPLYING THIS MEASURE AS A CLIMATE CHANGE ADAPTATION

The challenges in integrating climate change adaptation into fisheries management are largely the same as those faced by sustainable fisheries management overall. However, as climate change alters waters and the species they contain, fisheries regulation becomes more complicated. Various species are managed and/or regulated at different levels—local, regional, international. Changes in species distribution have implications for management/regulation of the species—i.e., management and regulation structures may need to change and incorporate analysis and cooperation that extend beyond traditional boundaries. Another issue to address is the element of uncertainty that accompanies climate change. This includes periodic shocks to the ecosystem and its associated human dimensions—a reality best addressed by a decentralized and co-managed fishery that can adapt quickly to the changes.

Resistance to behavior change occurs at all levels. A historical lack of trust between fishers and regulators will make it difficult to address new management issues on top of those that already exist. Fishing communities

often have few other economic opportunities, and fisheries may be the employment of last resort. As such, locals may perceive management measures that curtail fishing as a threat.

There is strong evidence, however, that local communities or groups that are given the responsibility, authority, and incentives to manage their natural resources, feel a sense of ownership and do manage them well. Incentives for long-term sustainable use of resources can include rights-based approaches. This includes territorial use rights, community quotas, or long term exclusive rights to certain fisheries. Organized cooperatives and community groups with strong leadership can be effective in planning and managing the resources, integrating across community needs, developing scenarios for the future, and engaging in risk-averse techniques that increase their adaptive capacity. In communities that are dependent on fish for their food protein and/or livelihood, this includes seeking other protein sources or engaging in other activities such as mariculture.

The above said, it is essential to ensure the community has the capacity to succeed in managing the fishing effort. In cases where that capacity is lacking or weak, it is essential to build that capacity before proceeding with a decentralization of fisheries and other natural resources management. Again, however, given the opportunity and armed with the right skills, fishers and fishing communities can serve as effective stewards and managers of the resource.

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2. MARICULTURE BEST MANAGEMENT PRACTICES

Mariculture Best Management Practices (BMP) are recommendations developed to improve production efficiency and cost for the mariculture sector, while reducing environmental impacts. BMPs related to cultured fish, shellfish or seaweed can enhance the benefits of mariculture and contribute to sustainable development objectives through acceptance and voluntary adoption from the sector, and where appropriate, incorporation into formal policy.

RELEVANCE TO CLIMATE CHANGE

Mariculture production is practiced in coastal countries worldwide, but is largely concentrated in tropical and sub-tropical areas. Temperate areas often are where high-valued species are fattened and raised. For example, the salmon culture industry—the largest component of marine fish culture—is located in temperate areas. Throughout the world, mariculture will be directly and indirectly affected by climate change impacts affecting critical variables, including water temperature, salinity, and current patterns (see text box below). Adaptation opportunities and strategies will vary by region and species.

Changes in temperature and precipitation (affecting salinity) may affect mariculture-related feed sources (e.g., fishmeal products). Sea level rise and extreme weather events can also pose a problem to facilities and infrastructure. Climate change is likely to increase these and other uncertainties inherent in cultured fish production. This is all at a time when the growing pressure on capture fisheries is driving the increasing demand for aquaculture production. This poses new challenges for the development and adoption of mariculture best practices.

PURPOSE AND APPLICATION

Mariculture is the culture of marine organisms (in saline aquatic habitat) in coastal, marine, and estuarine environments. Finfish, shellfish, and seaweed are cultured in these environments— either through direct seeding or with techniques involving cages, ponds or net-pens. Effective, comprehensive government regulation of mariculture operations is not common, however, especially in developing countries.

Meanwhile, there is growing demand for the mariculture industry to ensure: 1) its production methods protect the environment, and 2) its products are safe to eat. In response, the industry is developing standards and guidelines reflecting best practices that address environmental, operational and sanitary issues. Since there is little or no government regulation, the emphasis is on self-enforcement of best practices to ensure quality. The rationale behind this approach to behavior change is that self-enforcement is in the individual's self-interest—i.e., a higher quality, environmentally friendly product has greater sales potential.

Seaweed Farming in Tanzania

Adaptation to climate change in the mariculture sector is aimed at reducing the negative impacts in order to promote further growth in this sector which is so critical in supplying the world with food security and livelihoods.

INFORMATION AND DATA REQUIREMENTS

Mariculture operations cover a wide range of species and culture techniques. As such, it is difficult to generalize about information requirements. Some of the data requirements are similar to those for fisheries management.

- Identify appropriate species (including native species) for changed climate conditions, including water temperature, salinity, water circulation patterns.
- Generate models to determine more accurately the potential impacts on spawning migrations and changes in availability of larvae and juveniles for subsistence cage and pond farming.
- Study likely invasive species and diseases with different climate conditions.
- Evaluate potential increases in the virulence of dormant pathogens due to climate change impacts.
- Assess cage culture carrying capacity and conduct regular monitoring of biophysical parameters.
- Assess availability of food resources for mariculture, in particular finfish.

DESIGN CONSIDERATIONS FOR DEVELOPING THE MEASURE

Best practices related to climate change issues in mariculture are similar to those for good operational practices in mariculture in general. The key is to apply sound outreach and extension activities that keep mariculture facility operators engaged in the formulation, testing and adoption of new or revised practices that can enhance the industry and the environment with conditions changing.

Following are examples of current best practices to address climate change in mariculture:

- Reduce water use in pond culture.
- Identify practices that reduce pumping, aeration, transportation and other practices that require fuel, as fuel is increasingly expensive and contributes to greenhouse gases.
- Enhance feed management practices, especially as fish meal and fish oil becomes more scarce and expensive;

SUMMARY OF POTENTIAL CLIMATE CHANGE IMPACTS ON MARICULTURE

- All cultured aquatic organisms are affected by water temperature changes, with greatest impacts on temperate species.
- Increased rate of eutrophication, increased stratification and associated harmful algal blooms cause shell fish poisoning and harmful effects on the productivity of cage culture operations, especially in static waters.
- Overall decline in ocean productivity reduces supplies of traditionally underutilized species used for fish meal for mariculture sector.
- Changes in weather patterns and extreme weather events reduce productivity and damage operations (loss of infrastructure and stock).
- Decreased freshwater availability in major estuaries or river deltas where there is intense mariculture activity (e.g. deltaic areas like the Mekong and the Meghna-Brahamaputra in Bangladesh).
- Increased sea temperature results in spread of pathogens and parasites of cultured organisms to new areas.

and reduce dependence on practices that rely on low-value fish as feed.

- Alter cage culture practices to accommodate carrying capacity in waters of low circulation.
- Adjust best management practices to address an increased likelihood of the spread of disease and greater costs of water, electricity and fuel.

There is an interaction between best practices (typically implemented on a voluntary basis by the private sector) and public policy on mariculture operations. This interaction is driven by a public interest in both the economic success of the sector and concern about environmental and social problems that may be generated.

It is essential to build adaptive capacity for the governance mechanisms that address mariculture:

- Review and adjust, if necessary, existing management plans for mariculture to ensure they assess potential climate change impacts and adaptation responses.
- Encourage industry-led good practices and government incentives to promote adaptive measures.
- Identify information gaps and capacity-building requirements and address these gaps through networks of research, training and academic agencies.
- Create—and nurture— international networks that encourage regional or global exchanges of information, data and research and that link mariculture issues with those of other sectors such as water management, trade and food security.
- Identify and establish financial instruments that can promote risk reduction practices. This includes incentives such as providing monetary allowances for those who agree to relocate from areas that might be inundated by sea level rise or flooded more frequently. It also includes disincentives for those working in mariculture that impact wetlands or maintain practices that contaminate adjacent waters.
- Strengthen insurance and emergency funds to increase self protection of producers, distributors and processors.

IMPROVING THE LIKELIHOOD OF SUCCESS IN APPLYING THIS MEASURE AS A CLIMATE CHANGE ADAPTATION

Perhaps the key to the development and widespread adoption of best practices lies in appreciating why the public sector, together with the private sector, needs to act. Aquaculture (mariculture and freshwater culture) is the fastest growing primary production industry. It now contributes approximately 35% of total fish supplies and nearly 50% to global seafood consumption. This contribution continues to increase, with mariculture having the greater potential for further growth. Aquaculture is expected to play a critical role in meeting the future demand for food fish supplies (reaching 50-60%). This demand makes planned and proactive adaptation to climate change essential if mariculture is to continue to play its role in providing the world, especially the world's rural poor, with livelihoods and food protein. Research and extension programs need to include climate change related trends as part of their ongoing efforts in the larger process of promoting and managing this sector.

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3. TOURISM BEST MANAGEMENT PRACTICES

Best management practices are specific actions that businesses, tourists, and government authorities can implement to improve their operations and contribute to the sustainability of the tourism sector.

RELEVANCE TO CLIMATE CHANGE

Tourism development best management practices (BMPs) provide the tourism sector with practical tools for both adapting to climate change conditions and mitigating greenhouse emissions. Climate change will directly impact many tourism-dependent economies. It will also have more indirect environmental and social consequences—e.g., resulting from beach erosion, inundation, ecosystem degradation, and public health issues (aquifer contamination, vector borne disease). In addition, frequent severe weather presents safety issues for visitors, affects insurance premiums for businesses, and increases the cost of maintaining public and private infrastructure. The tourism industry also contributes to climate change through emissions from buildings, vehicles, planes and vessels. In 2005, these contributions amounted to an estimated 5% of global greenhouse gases for the sector as a whole (Simpson et.al, 2008).

There are, however, many BMPs for the tourism industry to use in addressing climate change concerns. The International Ecotourism Society reports there are nearly 80 environmental certification programs in the travel industry. Meanwhile, additional new programs are being developed in countries in Latin America, Asia, and to a lesser extent, Africa. Most are nationally based efforts with a major focus on accommodations. In these programs, there has been significant success in reducing demands on energy and water. As well, there has been an increase in the number of programs focused on climate change impacts on parks, beaches, guides, tour operators, transportation, and destinations, etc. Worldwide numerous guidebooks and programs exist to explain how businesses, municipalities, tourism authorities, and non-profit organizations can use BMPs—as part of a voluntary or mandatory effort to address climate change impacts.

PURPOSE AND APPLICATION

Tourism—business or leisure travel and related services—is one of the largest and most dynamically growing sectors of the world economy. It generates foreign exchange, investment and jobs for all countries in the world. It will continue to be a vital component of the global economy and an important contributor to the Millennium Development Goals. BMPs aim to improve the quality and image of the service and business while having the least possible negative impact on the environment and the local communities. BMPs are often divided into environmental, socio-cultural and economic actions.

BMPs can be used at multiple entry points (policy, projects, site-based activities), which may complement each other and enhance their effectiveness. Voluntary guidelines can be used to promote sustainable practices. There are numerous organizations that develop and implement BMPs and associated codes of conducts as a requirement for certifying sustainable tourism enterprises. Non-profits and industry often compile and use guidelines for building the professional capacity of designers and practitioners engaged in community development. Governments often utilize BMPs within their environmental assessment procedures or zoning regulations. Businesses might prefer applying voluntary, industry-vetted practices rather than a regulatory approach.

INFORMATION AND DATA REQUIREMENTS

- Identify key stakeholders and inventory current knowledge of tourism impacts related to climate

concerns (coastal hazards, safety, water, health). Consider current and future potential impacts at a national and/or destination scale. Collect information from a number of sources, including local knowledge, research findings, or industry studies.

- Determine where impacts to structures and adjacent environment (beach erosion, flooding, wind or storm damage) have occurred from improper construction or siting of tourist facilities. Identify the corrective measures that have been taken. Assess their effectiveness, individually and collectively, to reduce damages. This will help determine which adaptations may be the most effective options for this region.
- Identify existing good practices, certification programs and associated initiatives being used in the region. These may be related to tourism providers, activities (e.g., diving or marinas), natural resources (e.g., beaches or mangroves), hotels, or destinations. They also might address coastal construction techniques used by developers and policy makers. Determine if and how these good practices address climate change concerns and the extent to which they may be used to mitigate and adapt to future change.

DESIGN CONSIDERATIONS FOR DEVELOPING THE MEASURE

- Expand upon corporate social responsibility related to the triple bottom line (economic, environmental and social values) and incorporate climate as a business value and measure for organizational success. The 2007 United Nations Davos Declaration calls for "sustainable tourism that reflects a 'quadruple bottom line' of environmental, social, economic and climate responsiveness."
- Incorporate climate change adaptation awareness within coastal stewardship programs aimed at tourism developers and government policy makers. Use climate change impacts as an added incentive to enforce building setbacks, discourage filling of mangroves, or prohibit the filling of wetlands or the mining of sand.
- Promote good practices within government policies that support mitigation and adaptation—e.g., in 2007 Sri Lanka's Tourism Authority launched "Towards a Carbon Clean Sri Lanka: A Tourism Earth Lung". This initiative promotes various mitigation measures to reduce CO2 emissions.
- Determine the extent to which best management practices that reduce impacts from coastal hazards can be incorporated into development policy. For example, in Mexico's Caribbean coast, the Costa Maya tourism corridor adopted a regional ordinance that incorporates building practices that protect dunes and beaches—promoting dune growth as a natural barrier to reduce impacts to shoreline development.
- Identify how to undertake mitigation and adaptation actions at different scales—i.e., from the tourist destination resort to the state or national government scale.
- Promote incentives for "green tourism". Green tourism provides alternatives that help reduce impacts on natural resources, health and safety and that reduce greenhouse gas emissions. An example alternative is to use solar vs. traditional energy sources to heat water or generate electricity. Another is to use low flush toilets, harvesting rainwater, and recycled grey water as ways to conserve water. Sustainable building designs should incorporate local building techniques that may be suited for natural ventilation, flood prevention, or renewable materials.
- Incorporate good practices as voluntary or mandatory measures within national adaptation plans as a "no-regrets" approach. Effectively applying these, together with building codes, environmental impact assessments, sustainable building design, wetlands protection policies, tourism incentive awards, annual outreach events, and standards for tourism providers

Mexico's environmental certification program, supported by the National government, includes a voluntary clean beaches program.

will benefit the tourism product with existing climate variability concerns.

IMPROVING THE LIKELIHOOD OF SUCCESS IN APPLYING THIS MEASURE AS A CLIMATE CHANGE ADAPTATION

Within the tourism industry, there are poor to moderate levels of knowledge of the potential affects of climate change on the sector (by region). The lack of practical information at the local or destination scale is a challenge for businesses that want to do the right thing but are unsure of what really works. Non-profit organizations or universities are often a good source of information. They often welcome the opportunity to work with the private sector to research, monitor or disseminate existing information. Promoting leadership and partnerships within the tourism sector will enhance efforts to implement practices that are realistic and that benefit the industry, the environment, and the community.

It is difficult to overcome the frustrations of the climate divide—i.e., small tourism businesses in developing countries contribute little to climate emissions but are affected heavily by the impacts of climate change. At the same time, the costs to mitigate green house gas emissions and make adaptations for responding to climate change are often prohibitive for small businesses and community-based organizations. The same may be true for those with a great amount of infrastructure in place.

While these are real challenges, tourism is also a development investment and is vital to many developing countries and small island economies. The United Nations World Tourism Organization statistics show that tourism represents over 70% of Least Developed Countries (LDC) exports of services and is the main foreign exchange source of 46 of the 49 LDCs. Good tourism practices are currently used as a key tool to promote sustainable development and offer multiple benefits. These benefits range from helping to conserve biodiversity and traditional culture to helping diversify livelihoods—factors that can also help strengthen a community's overall resilience to the impacts of climate change.

In the tourism sector, it is especially relevant to note that adaptation actions could reduce the costs of climate change impacts and thus reduce the needs for mitigation both globally and at the destination site itself. Subsectors of the tourism industry have significantly different ability levels for adapting to climate change. Consistently, however, individuals, corporations, communities and government authorities all need to improve their capacities.

EXAMPLES OF BEST PRACTICES AND CERTIFICATION INITIATIVES

Blue Flag certifies beaches and marinas. With coastal stewardship at its core, the program includes monitoring water quality and beach conditions, education, and safety—all of which can support tourism industry activities.

Green Globe certifies hotels and destinations through business audit and management systems. Recommendations for retrofitting infrastructure and establishing practices to enhance environmental stewardship often result in long-term economic benefit as well.

Country-based programs, such as Costa Rica's Certificate for Sustainable Tourism (CST), certify tourist hotels and their sustainability practices. CST promotes good practices that focus on the natural, cultural, and social resources of the country.

Sustainable Tourism Certification Network of the Americas recognizes the benefits of promoting good practices through certification programs. The Network links partners throughout the region to strengthen tourism initiatives based on mutual respect and recognition, to harmonize systems, and to share information and experience. Good practices have been used to identify criteria for sustainable tourism.

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ANNEX A – ADAPTATION MEASURES

HUMAN HEALTH AND SAFETY ENHANCED

1. COMMUNITY-BASED DISASTER RISK REDUCTION
2. FLOOD HAZARD MAPPING

human health and safety enhanced

1. COMMUNITY-BASED DISASTER RISK REDUCTION

Community-based disaster risk management is an overarching strategy comprised of structural and non-structural measures to avoid (prevention) or to limit (mitigation and preparedness) adverse effects of natural hazards. Communities engage in a systematic process of administrative decisions, apply organizational and operational skills, and implement policies and strategies to enhance their coping capacities to the impacts of hazards and related disasters.

RELEVANCE TO CLIMATE CHANGE

With increased frequency of storms and climate variability due to global climate change, local level preparedness is increasingly important as a key adaptive capacity and an essential component to community resilience.

Community-based disaster risk reduction (CBDRR) is practiced and applied worldwide, especially as the number of people affected by coastal hazard events has grown in the last decade. Due to recent deadly disasters such as the 2004 Indian Ocean Tsunami and the U.S. Hurricane Katrina, there is a heightened recognition of the need to reduce vulnerability and risk before an event happens.

As global experience repeatedly shows, the net benefits of preparedness are positive and the net costs of a lack of preparedness can be devastating. The United Nations has estimated that globally on average of 100,000 lives are lost and properties worth $300 billion are damaged each year due to natural disasters. These damage estimates do not take into account the many indirect and secondary effects on economic activities.

PURPOSE AND APPLICATION

CBDRR ensures that communities vulnerable to natural hazards are ready and able to take precautionary measures in advance of an imminent threat and are prepared to respond to and cope with the effects of a disaster once it has hit. Over recent years, there has been growing realization that the top-down, specialist-driven approaches to disaster management of the past fail to address the localized needs of vulnerable communities. It is the communities themselves that are on the "disaster front". It is they who must be able to prepare and respond to events that threaten their well being.

INFORMATION AND DATA REQUIREMENTS

CBDRR requires careful attention to the process of combining local knowledge with technical studies and scientific data.

Identify national databases, university professionals, and government agencies that have information on natural hazards, climate, meteorology, and disaster management. Determine if there are trends related to specific hazards and their impacts.

Compile existing community flood inundation and hazard maps, together with maps on existing land use, natural resources, census, and infrastructure. Determine how future projections (climate-related or land-use) will further impact these hazards.

Assess the root social, economic and environmental causes of a community's vulnerability to natural hazards, such as access to education or transportation options.

Gather information and assess community capacity (past, present, future) for reducing risk. Identify vulnerable groups and determine their capacities and coping mechanisms.

Interview local elders, business leaders, fishers, and others to gather local knowledge about past hazards.

This will provide valuable information on the risks as well as the community capacity to respond and recover.

This last point is especially important as most indigenous people have detailed knowledge of local natural hazards as a result of their long and close associations with the land and its resources. This may include oral histories and traditions that record past catastrophic hazard events, place names that designate areas that are high risk, and environmental indicators that inform about the safety and viability of activities linked to changes in the environment. This environmental knowledge can provide a valuable source of information that can contribute to contemporary hazard management and mitigation. It can become a valuable resource for community education and involvement in hazard preparedness.

DESIGN CONSIDERATIONS FOR DEVELOPING THE MEASURE

Preparedness involves developing and regularly testing warning systems, evacuation plans and other measures used during a disaster alert period to minimize loss of life and property. It also involves the education and training of officials and the population at risk; the establishment of policies, standards, committees and operational plans to be applied following a natural hazard event; and the securing of resources (possibly including the stockpiling of supplies and the earmarking of funds). The strategy needs to take into full consideration the special aspects of directly working with citizens as well as a broad array of professionals.

Community drill in Thailand included first aid response by community members

Steps in CBDRR include:

- Form local coalitions of committed local stakeholders.
- Undertake community risk assessment with the direct involvement of community members and other stakeholders. Community mapping and other participatory rural appraisal techniques are effective approaches.
- Confirm local level mechanisms and procedures, including standard operating procedures (SOP) for each hazard to which the community is exposed.
- Establish a system for issuing early warning to the community about impending hazards linking to national or regional systems where available.
- Conduct periodic drills to test early warning systems, evacuation, first aid, and search and rescue mechanisms.
- Formulate a disaster risk reduction and response plan at the community level.
- Design and implement mechanisms to monitor risks and note changing hazards, vulnerabilities and capacities.

CBDRR strategies should be tailored to a specific place, the capacities of the communities, the availability of information and the technical analysis of vulnerability, This highlights the need to incorporate local knowledge to complement and validate other information sources. When engaging in this process it is also important to realize that coastal hazards have repeatedly had a disproportionate impact on women, children, and the elderly—regardless of cultural setting. CBDRR plans should provide special consideration for these groups.

Since CBDRR incorporates a bottom-up process, it requires local stakeholders to initiate and maintain pressure on their government. It cannot be expected that institutionalization will naturally evolve from the top down. That said, central government must play a key role in developing legislation, allocating resources such as technical expertise and financing, and developing uniform standards for the country. This includes explicit linkages between national efforts and the local CBDRR programs. It is also important to clearly define the responsibilities of non-governmental organizations, of government agencies from the central to the regional level, and of communities. Then each of these groups can be held accountable for their actions or inactions.

IMPROVING THE LIKELIHOOD OF SUCCESS IN APPLYING THIS MEASURE AS A CLIMATE CHANGE ADAPTATION

Too often, hazards only become tangible to coastal residents after they occur. This is particularly true of building houses in the back beach area or other potential inundation zones. Settlements of people with few resources or land of their own and who reside along rivers and beaches, are particularly vulnerable. Yet, in "pre-disaster" planning it can be difficult to obtain local community and political commitment to planning and action that will reduce the risks of hazards that could potentially occur in the future.

Since CBDRR emphasizes locally tailored activities and measures, it can be extremely difficult to determine what risks will be exacerbated by climate change at this scale. Consistent with existing community vulnerability assessment approaches, Red Cross/Red Crescent stresses that communities should start by recognizing that the past no longer explains the future. Planning for climate change does not need to be seen as something new and complicated—and, it should always remain rooted in the priorities and understanding of the community. On a positive note, it may encourage the taking of a fresh look at regional or national government plans and programs and prompt the integration of new information on climate vulnerabilities. It may also make it easier to mobilize new volunteers and establish partnerships with governments, donors and other stakeholders.

A lack of coordination and integration between levels of government often inhibits disaster risk reduction efforts. Poor coordination is often exacerbated by poor communication between governments and their local communities. It is therefore important for local leaders to build constituencies at the village and community levels, and to help ensure that there are redundant (cross-level supportive) systems in place.

When communities have taken action to reduce risk from disasters, they stand to protect human safety, reduce property losses, and protect high risk vulnerable communities and groups. They do this by clarifying for the community the steps, procedures and measures necessary to reduce damage and respond to disaster, and by putting in place the communication systems needed to provide early warning of impending disasters.

ANTIGUA AND BARBUDA VIDEO ON CLIMATE CHANGE

Recognizing that preparedness is essential to reducing impacts of disasters, the Red Cross/Red Crescent Society has engaged numerous countries in their Climate Change and Disaster Preparedness Program. Acknowledging that local understanding of risks is key to the Community Vulnerability Assessment, climate has become a part of the local dialogue. As part of their Red Cross community service project, Antigua and Barbuda completed a community disaster program with the residents of Pigotts, Bath Lodge, Yorks and Barbuda—areas prone to environmental disasters.

As part of the project, a video on climate change was produced and featured the voices of several officials who deal closely with the climate change effects—e.g., the chief environment officer, the chief fisheries officer, Barbuda residents and others. The video also features the island feeling the effects of hurricanes, droughts, and provides other snippets of daily life. Approximately four minutes long, the video was submitted to Red Cross International and chosen to be added to YouTube.com. At the time, Antigua and Barbuda was the only country this medium spotlighted on the topic of climate change.

The short video on Climate Change in Antigua and Barbuda can be viewed on YouTube at http://www.youtube.com/watch?v=f-zpbeyFRnU

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human health and safety enhanced

2. FLOOD HAZARD MAPPING

Flood hazard maps are prepared for areas adjacent to water bodies to provide land owners, insurers and regulators with information on their risks of flooding from a variety of environmental conditions.

RELEVANCE TO CLIMATE CHANGE

Understanding risks is the first step to identifying the capacities of institutions, individuals, and communities needed to address the effects of flooding due to climate change. In general, if an increase in sea level and the frequency and/or intensity of storms is expected to occur, then the vulnerability to flooding would increase. Creating a map of those areas most exposed to flood hazards as a result of these changes will also help in designing adaptation or hazard reduction techniques.

Developed and developing nations alike create flood maps. These most often are created by national or local agencies, universities and private company initiatives. However, the mapping is typically part of a larger national data and map program. As such, the maps must meet national standards— as they are used to carry out policies supported by a central government charged with disaster prevention.

A complementary information gathering technique is what is called community-based participatory mapping. It provides an opportunity to not only provide local leaders with risk information about flood hazards, but to educate these and other groups about flood and climate change issues.

PURPOSE AND APPLICATION

Maps and other information on inundation (flooding) are essential to any efforts to reduce risks from flooding and related hazards. Local communities, governments, and private companies use accurate, detailed hazard maps to:

- prevent loss of life;
- identify evacuation procedures;
- guide development to low hazard areas;
- prepare plans for a community's economic growth and infrastructure;
- maintain the natural and beneficial function of floodplains;
- protect public lands; and
- protect private and public investments.

Flood hazard maps are used to plan for and reduce impacts from the riverine and coastal flooding that would likely result from cyclones, heavy rains, storm surges, extreme tides, and tsunamis. A range of techniques are used to map the hazard risks associated with these events. These range from the use of highly complex computer models to the use of simple field-based techniques—e.g., beach profiling, marking flood heights on buildings, and identifying areas of historic flooding using community informants. Once the maps are generated, the information can be incorporated into risk reduction (including evacuation and community-based disaster risk reduction plans) procedures or adaptation measures (e.g., construction of flood control structures; establishment of warning systems; formulation of development policies and standards such as setbacks, zoning, building codes, etc.). As multi-hazard risk reduction strategies become more widely used, mapping should be expanded to include other natural risks including erosion, landslides, and fire prone areas.

INFORMATION AND DATA REQUIREMENTS

Some of the information needed for flood hazard mapping is the same as that needed for other measures and strategies described in this report (e.g., community-based disaster risk reduction, seawalls and other shoreline structures, living shorelines, and designating setbacks).

The mapping of flood hazards typically begins by taking observed data or historic information on previous events and combining it with hypothetical information about future events to predict the potential magnitude of flood waters. This can be done with the use of engineering computer models or through participatory mapping. The information is often represented by the probability or likelihood of a particular magnitude event occurring, such as a "100 year flood". The "100 year flood" describes the area of land which has a 1% chance of being submerged by flood waters every year.

Once the height of the flood waters or depth of inundation is determined, these flood elevations and depths are compared to the ground elevations to map the risk area. In the case of riverine flooding, this risk area is often called the floodplain—the area of land adjacent to a stream or river that experiences occasional or periodic flooding. In coastal areas that experience floods from storm surges, cyclones or tsunamis, the risk area is often referred to as an inundation zone. Needed information can be generated from a variety of sources.

- Historical information such as personal accounts and records on stream flows or tide can help identify the magnitude and impacts of previous events.
- Computer simulations can be used to predict the extent of different flood events using data inputs such as topography, bathymetry, slope, surface roughness, and precipitation.
- Beach profile monitoring programs can help determine erosion rates (although long term data sets will be more accurate to characterize past and present shoreline dynamics).
- Information that comes from understanding seasonal changes resulting from recent and current climate variability events (e.g., El Niño) is another useful information source.

DESIGN CONSIDERATIONS FOR DEVELOPING THE MEASURE

- When determining flood hazards, consider historic events, current conditions, and a range of future scenarios. In some places, residents will have a strong memory of the impacts of prior events. However, in places where most of the population is recently arrived, the absence of these memories itself is a danger.
- Before mapping flood hazards, determine how the information will be used by communities and governments. This will determine the technical requirements of the mapping activity and help make a match between budget and the scope of the mapping effort.
- Examine how flood hazard maps have been used in other communities and countries to determine an appropriate use.
- Use maps and the map-making activity as a community education and outreach strategy.

Flood hazard mapping is often supported through local and/or national policy. Provincial and/or national authorities may allocate resources to undertake mapping activities in support of water resource management, coastal resource management, and disaster risk reduction goals. However, the priorities of these authorities may not coincide with local needs. Further, when national or provincial government programs are not in place, local leaders are the ones who must identify and map flood prone areas in order to influence development decisions. To do this, they must draw upon any available source of technical assistance. Regardless of which level—local, provincial, or national —is responsible, it should be aware that in locations where land use or building controls are not in place or enforced, there are likely to be unregulated settlements in flood prone areas. This can exacerbate loss of life and property in floods.

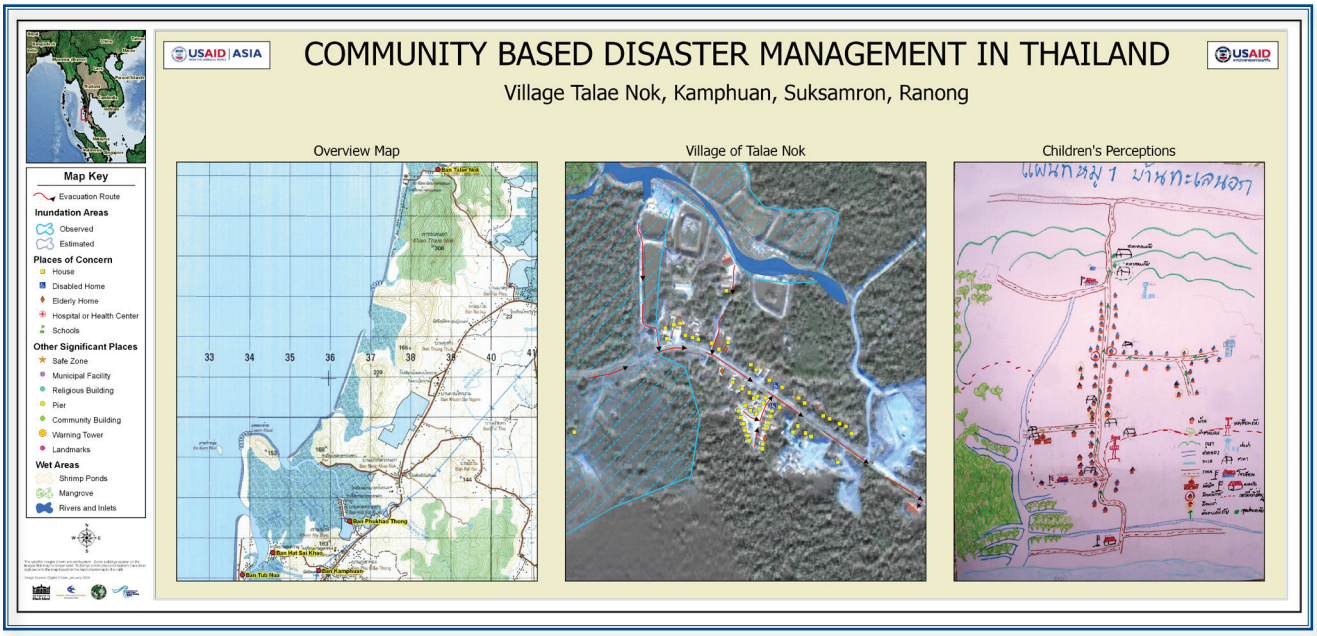
IMPROVING THE LIKELIHOOD OF SUCCESS IN APPLYING THIS MEASURE AS A CLIMATE CHANGE ADAPTATION

While existing flood hazard maps likely do not account for the accelerated risks of climate change, it is possible to create ones that do. Clarifying the climate scenarios is critical to mapping these risks. However, depending on the type of shoreline, it may be technically difficult

to model and project precisely the impacts of sea level rise or increased storm activity, as the dynamic coastal processes that determine these impacts are highly variable. Developing a partnership with university and government agencies to create new flood hazard maps can be useful for good scientific data and appropriate modeling techniques.

A persuasive argument for investing in mapping is that flood hazard maps provide critical information needed for a variety of short and long-term decision-making at the community as well as national levels. This is especially true in regard to public safety and security. Flood hazard maps are often used to identify evacuation zones, which can save lives in cases of tropical cyclones, heavy rains, and tsunamis. Flood hazard maps can also contribute to the development of policies and standards that help reduce damage due to natural resources and infrastructure.

As with all measures, there are costs to flood hazard mapping. The offsetting benefits are significant, however. Mapping identifies the must vulnerable risk areas, providing the community with the opportunity to take informed action to eliminate or minimize that risk. In so doing, it is possible to avoid huge costs related to future damage to and/or loss of lives, structures, and livelihoods that might result if no mapping were conducted or corrective action taken. The argument for mapping can be even more persuasive when it is made clear that information from the mapping is useful for decision-making on a breadth of additional issues. For example, flood hazard maps can also be used to guide development away from sensitive habitats in flood plains, maintain critical ecosystem services (such as flood storage in wetlands), and reduce impacts to development.



Risk mapping in southern Thailand combines high technology geographic information systems with satellite imagery, together with local knowledge community-mapping.

MAPPING ENGAGES COMMUNITY PARTICIPATION

Involving the local community is one of the best approaches for prevention and/or mitigation of disaster, and might even include activities such as geo-data collection, map generation, action-plan development and data maintenance. Mapping enables a community to recognize its own resources and capacities that are important in changing the "victim and survivor" mindset in relation to hazards - the idea that one must wait passively for rescuers and relief workers to bring help. In the battle against disaster the individual must be shown how the community can act to avoid it and must be persuaded to participate.

Participatory Disaster Risk Assessment aims at diagnosing the risks and how people can overcome them. It involves guided assessments of hazards, vulnerabilities and capacities. Community members characterize the hazards they face; their vulnerabilities and resources, check this exercise by field-work, and map it all. Finally, action plans are developed based on the findings and the map. In this way the community is able to perceive the risks facing it, own the data and understand what it has on the ground to combat hazard. An important caveat is that a community should not be the only stakeholder. Local government participation in, for example, training sessions, ensures that officials are aware of the process, the quality of data, and of any assessments and action plans.

As they map, community members put into their spatial context local resources such as landmarks, houses, roads, rivers, schools, and hospitals. The people who control these resources are inventoried. Potential hazards and their areal extent are mapped, marked or colored. Next, members living in vulnerable areas or having few resources are identified and their medical fitness are determined to set evacuation priorities. Everyone can provide data; for example, in flood-risk mapping, data provided by locals may include height of flood, presence of potable water, or a tall house in the neighborhood suited for a temporary evacuation centre. Casting a professional eye over community maps one sees absence of scale, projection and arrow indicating north, and the top is usually not north-oriented. Hazards, vulnerabilities and resources are often represented on the same map. Color use is determined by culture, but if people are made aware of the color-coding scheme used by a national disaster-management agency, they will use it.

Rather than just generating another GIS application, the GIS community would be better served by comparing hazard areas on a community map with their own and going into the field with locals to check and update their maps. A community is often happy to get such input. Use of telecommunication might also help. For example, an early warning system (EWS) might include a two-way link between agency and families under threat. Some communities have received additional training in reading flood markers and rain gauges and transmitting data in real time over handheld, two-way radios with a city flood-monitoring station. The CBDRM training makes clear the need for regular checking, even 24/7 when necessary. This translates into improved hydrological data quality, prediction and scenario generation.

Experience shows that community maps contain only what the community perceives as relevant to their risk. After landslides in Bangladesh in June 2007 local people were urged to redraw their maps to include the landslide hazard, testimony that risk maps are living documents. All communities have used their maps to plan evacuation routes, emergency response and small-scale disaster-mitigation projects. The GIS community should watch and learn from this.

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ANNEX A – ADAPTATION MEASURES

OVERARCHING PLANNING AND GOVERNANCE

1. COASTAL WATERSHED MANAGEMENT
2. INTEGRATED COASTAL MANAGEMENT
3. SPECIAL AREA MANAGEMENT PLAN

overarching planning and governance

1. COASTAL WATERSHED MANAGEMENT

Integrated Water Resources Management (IWRM) within a coastal region integrates river and catchment (watershed) management with estuary management, taking into account "the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems."

RELEVANCE TO CLIMATE CHANGE

Climate change impacts on water resource availability and flow will take many forms. The variability of climate is already posing profound challenges for the management of water resources in developing countries. This will be exacerbated by expected increases or decreases in rainfall in different locations and by the increased intensity or duration of flooding and droughts. Integrated water management for a river system examines variability in past and current water flows and the role that climate has and continues to play in that variability. It does this as part of a process to allocate water among economic sectors, people and the environment. Many countries that depend on glaciers or snow covered mountains for fresh water (e.g., Mt. Kilimanjaro and the Pangani River Basin in Tanzania) are increasingly concerned about the impacts of global warming. Changes in precipitation, flow, land use and conflicts over water allocation that occur upstream have direct implications for coastal areas in terms of water supply, coastal agriculture, industry, coastal ecosystem productivity, wildlife, sedimentation and fisheries.

Watershed assessments in many coastal regions have begun to "downscale" global climate scenarios for basin-specific implications—generating valuable data for coastal adaptation as well. From a coastal management perspective, the future of fresh water flows to estuaries, tidal mega-deltas and coastal waters are key issues—issues that may, in turn, be linked to salinization of groundwater and soils and changes in habitats and fisheries. It is important to recognize that coastal issues alone are not likely to be the drivers of improved watershed governance. Other resource allocation issues at stake in watershed management often take priority. This includes issues driven by the interests of agriculture, industrial production, energy generation and flood protection for riparian cities. National water law is also at the core of water allocation issues. Precisely because of the scale and scope of watershed issues, however, many watershed plans and institutions are starting to incorporate climate change adaptation considerations.

PURPOSE AND APPLICATION

Within coastal regions, the Integrated Water Resources Management approach recognizes that catchments, coastlines, estuaries and near-shore tidal waters are all elements of discrete, but closely coupled ecosystems (USAID, 2006). Estuaries provide important environmental services to people, and freshwater is an estuary's lifeblood. The high-protein output of estuary-

Agriculture is one of the key uses of water in the Usumacinta Watershed in Southern Mexico and has implications for the estuary's fisheries.

based fisheries is the product of the inflow and mixing of freshwater in a unique combination of physical, chemical and biological functions. These work in unison to make estuaries extremely productive of plant and animal life. Healthy, functioning estuaries and their associated wetlands also serve as storm buffers that absorb wave energy and rising tidal waters during storms. Intact watershed landscapes combined with limits on water allocations can help guarantee environmental flows, protect against coastal groundwater salinization, and reduce downstream erosion and sedimentation damage from flooding.

A key IWRM concept is the cross-sectoral integration of the management of different water uses. This includes water used for people, food, nature, industry, hydropower and navigation. IWRM is an expression of ecosystem-based management. It is rooted in principles such as the practice of decentralized democratic governance and the application of sound science to the planning and decision-making process.

INFORMATION AND DATA REQUIREMENTS

In coastal situations, IWRM can be triggered in a variety ways. It can start at the local level in response to the degrading qualities of an estuary. Or, it may also get started from the top—for example, when responsible government agencies note changes of concern in the watershed and catchment. As a result, new types of information are needed to fully utilize IWRM as a complementary tool for coastal communities and watersheds. This includes information on:

- The meteorological, hydrological, biophysical, and socioeconomic aspects of water, coastal aquaculture, or fisheries resources, through inventories, surveys, and other approaches;
- The local context (boundaries of geographic area of concern, identity and interests of stakeholders, and strategic opportunities for addressing climate change adaptation);
- Natural hazards, potable water and sanitation issues; the impacts of flow changes (volume, timing and flow pattern) on environment and downstream uses; risks of salinization of soils and fresh water supplies; and issues associated with different agricultural irrigation practices;
- Stakeholders' values and how these affect adaptation decisions (planned and responsive), and the consequent barriers to mainstreaming adaptation;
- Legal and institutional analysis that focus on the capacity of and the quality of procedures, administrative functions and laws that control the allocation, supply, infrastructure, maintenance and monitoring of water use;
- Perceptions among water users of their legal or traditional access and use rights;
- Vulnerability and coping strategies for addressing water quantity variability, as well as flooding, storms, erosion and changes, within watershed and coastal systems;
- Climate projections and predictions, provided in a way that can be used to assess impacts and adaptation strategies such as at the sub-basin level;
- Demographic and economic trends and forecasts of the watershed and the adjacent coastal areas;
- Economic costs, benefits and feasibility of alternative adaptation measures for water supply, wastewater treatment, water conservation, health, land use and development, wetlands and watershed protection.

DESIGN CONSIDERATIONS FOR DEVELOPING THE MEASURE

Water resource planning usually involves national level stakeholders and policy interests that might be far better organized and prepared to argue for their allocations than small holders, villages or downstream users who often have little or no contact with water management authorities. The organizational framework of regional or watershed-based policy may be weak and primarily driven by large scale economic interests. In many countries, water planning and policy-making is being decentralized, creating opportunities for a greater local voice in decisions. However, participants in water boards and water use committees may have little knowledge or interest in collaborative approaches to policy-making that take environmental and downstream user interests into account.

Countries developing National Adaptation Plans of Action are frequently proposing coastal and watershed actions for climate change adaptation. Australia, for example, is urgently concerned about likely reduced rainfall in its southern and eastern regions, salinization

of coastal ground water from sea level rise and increased flooding in lowland fresh water wetlands (Pittock, 2003). Bangladesh squarely links climate change impacts on water resources and its coastal zone: "The combined effect of higher sea water levels, land subsidence, siltation of estuary branches, higher riverbed levels and reduced sedimentation in flood-protected areas will impede drainage and gradually increase water logging problems. This effect will be particularly strong in the coastal zone." (Ministry of Environment, 2005). The larger challenges include: 1) getting the attention of a water board or authority to recognize downstream coastal issues, and 2) having the technical ability to address sophisticated environmental questions. There are other design considerations as well.

- Build IWRM around issues identified through a participatory process and make explicit the linkages between the downstream (estuary) and upstream riverine and watershed areas.
- Work at both the national and local levels with strong linkages between the levels (the "two-track" approach).
- Develop an open, participatory and democratic process, involving all stakeholders in planning and implementation. Link watershed and estuaries through issues, stakeholders and policies.
- Build constituencies and political support for resource management through public education and identify incentives for collaboration.
- Strengthen or introduce mechanisms for cross-sectoral action.

IMPROVING THE LIKELIHOOD OF SUCCESS IN APPLYING THIS MEASURE AS A CLIMATE CHANGE ADAPTATION

The adoption and implementation of IWRM measures are made difficult by two factors: 1) the upstream demand for water, and 2) the infrequent consideration of impacts on the coast. The entry point for addressing coastal climate change adaptation concerns in watershed management may be linked to downstream impacts. This includes downstream issues regarding water allocation, landscape management or water contamination. Increasingly, water managers are considering environmental flow or water-for-nature allocations. Globally, there are many pilot projects that are looking explicitly at environmental flow questions tied to climate change. This is creating opportunities for a broader understanding of coastal area concerns at regional scales and is increasing the support for implementing helpful measures throughout the watershed.

There are varied constraints to designing adaptation measures within the coastal IWRM context. Institutional and legal frameworks for water resources management sometimes may make basin-specific planning difficult or even impossible to account for environmental flows, coastal estuarine freshwater needs, or other downstream impacts of water management decisions. Planning cycles for a basin-focused approach may not coincide with the time frame for a key decision or initiative related to climate change adaptation. Institutions may lack readiness for the regional planning, technical studies, and political decisions that are needed to address water allocation and capacity development for communities. What might be warranted in these cases is a pilot project that emphasizes building capacity in basic watershed planning in addition to adaptation. Basin planning may focus on large scale structural investments in flood control, energy generation and irrigation. As such, basin planning might be an excellent target for adaptation, but may also have weak environmental reviews or may not require consideration of downstream impacts. Therefore, it is critical to engage relevant stakeholders from different parts of the watershed to help ensure that environmental flows for the watershed and estuary are incorporated into the water allocation equation.

IWRM responses to climate change, when not coordinated through an intersectoral approach, can have both positive and negative impacts. These may sometimes even counteract each other. The Pantabangan-Carranglan Watershed is "one of the most important watersheds in the Philippines." It supplies water for irrigation and power generation, with a dam constructed in 1974 that destroyed communities and displaced population. This disturbed watershed provides the background for a study of the cross-sectoral impacts of adaptation measures proposed by sectoral institutions on the environment and communities of the watershed. In examining likely impacts on flooding and landscape change, researchers have found that "adaptation strategies for forests/agriculture have mixed effect on the various institutions in the watershed. Most of the adaptation strategies recommended require additional investments." In addition, "adaptation strategies are not neutral; that is, they could affect other sectors both

positively and negatively. Thus, a cross-sectoral analysis should be done at the watershed scale to ensure that negative effects are anticipated and mitigated before the implementation of adaptation strategies." (Lasco et al., 2006)

INTEGRATED MANAGEMENT OF WATER RESOURCE AND SUSTAINABLE DEVELOPMENT OF THE SAN JUAN RIVER BASIN AND ITS COASTAL ZONE (NICARAGUA AND COSTA RICA)

An early example of basin planning that incorporates coastal zone and climate change was sponsored beginning in 1994 by the Organization of American States for the San Juan Basin. The program continued through funding from the Global Environment Facility. A bi-national conference held in 2002 led to recommendations on incorporating climate change considerations such as flooding, droughts, and hurricanes into basin planning. In 2003, the San Juan Biosphere Reserve was created. The International Union for the Conservation of Nature initiated a follow-up program in 2004, focusing on local stakeholders. In 2008, a consortium of civil society groups released the Carta del Río San Juan, which calls for supporting protected areas and strengthening government watershed conservation efforts in the bi-national area, especially in light of the expected impacts of climate change on worsening flooding and other impacts. The Meso-American Biological Corridor is an important component of the watershed. A number of institutional and policy conflicts remain over priority uses, decision making, and navigation access to the river.

For more information: http://www.oas.org/sanjuan

CLIMATE CHANGE SCIENCE FOR BASIN PLANNING

"The Murray-Darling Basin Sustainable Yields Project provides the science to underpin the sustainable planning and management of the Basin's water resources, which currently supplies at least 40 percent of Australia's agricultural production and covers a seventh of the area of the continent. The project is likely the first water resource assessment at this scale in the world that is taking into account climate change and surface and groundwater interactions. The assessment of current and future water availability takes into account future climate and development, and informs stakeholders of the overall impact on the Basin's water. The predicted water availability and water use is assessed, synthesized and accounted for under current water sharing arrangements, with regional reports being progressively released by the Australian Government over 2007 and 2008. By considering the hydrological implications of an integrated modeling system, water management agencies can assess the potential consequences of their management policies and decisions at a regional or Basin scale."

For more information: http://www.csiro.au/partnerships/MDBSY.html

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overarching planning and governance

2. INTEGRATED COASTAL MANAGEMENT

"Integrated coastal management (ICM) can be defined as a continuous and dynamic process by which decisions are taken for the sustainable use, development, and protection of coastal and marine areas and resources. ICM is multi-purpose oriented, it analyzes and addresses implications of development, conflicting uses, and interrelationships between physical processes and human activities, and it promotes linkages and harmonization among sectoral coastal and ocean activities" (Cicin-Sain and Knecht, 1998).

RELEVANCE TO CLIMATE CHANGE

Integrated coastal management (ICM) involves planning and decision-making that is specifically designed to improve economic opportunities and environmental conditions for coastal people. It typically already incorporates considerations of such issues as natural hazards and climate variability. ICM programs often address erosion, storms, and variable water levels as well as water quality, sanitation, fisheries and habitat, tourism, ports and infrastructure. They will also often seek to develop hazard resilience through the use of tools such as floodplain management, building standards, and conservation of ecosystems.

Many international conferences, declarations and agreements call for all coastal countries to have ICM programs. This has resulted in a spectrum of coastal management frameworks applied differently throughout the world. Those coastal programs that already exist are gathering new information and considering modifying their policies to galvanize attention on the need for dramatic new policies to address current and future challenges of climate change.

Until recently, many coastal programs have viewed sea level rise as an historic trend occurring at a constant rate. Today, it is increasingly recognized that this and other coastal changes are accelerating at a more rapid pace. This will require revising local and state policies and adapting new management priorities. This will require increased cooperation among the multiple agencies and stakeholders already working to formulate and implement ICM plans and policies.

PURPOSE AND APPLICATION

For decades, ICM has been recognized and practiced globally as a strategy for the conservation and sustainable development of the coastal zone. It is widely promoted as an appropriate policy framework to deal with current and long-term coastal challenges that cut across traditional departments (the sectoral approach). The distinguishing feature of ICM is multiple use management and inter-organizational activities in which success depends on coordination of effort and effective linkages among the actors involved. ICM is organized through a participatory and collaborative process that is tailored to the needs and context of individual places. A limited number of management issues are selected strategically with attention to the nature of the problem, and dimensions of capacity and complexity. ICM may be initiated at the national, provincial or local level, with the aim of harmonizing policy and implementation among different levels of government to ensure effectiveness and efficiency.

INFORMATION AND DATA REQUIREMENTS

Over time, a coastal management program can address numerous issues. However, it is not advisable to set out to collect all available and possibly relevant information about the coast when establishing a program. The compilation of past information and the commissioning of new studies needs to be purposeful and constrained to its relevance in addressing the issues that are spurring

the formulation of a coastal policy or program in the first place.

- Compile information on the environmental, social and economic context (boundaries, stakeholders, threats) focusing on key issues in the area of coast;
- Assess past events, current natural hazards, and potential future natural hazard risks;
- Analyze existing governance capacities to implement a coastal program. Include an evaluation of vulnerabilities and coping strategies to address natural hazards;
- Obtain climate projections and predictions provided in a way that can be used in impact and adaptation studies;
- Estimate costs, benefits and feasibility of alternative measures for key policy issues; and
- Conduct a range of activities to understand stakeholders' values and their effects on adaptation decisions, and the consequent barriers to adaptation.

Even in the U.S, where relevant scientific information is relatively abundant, coastal states have tended to focus on flood plain management as well as historic sea level rise. They are now struggling to obtain accurate and integrated inundation and shore change information that would allow for scientific justification of needed policy changes, as well as to understand the implications of other climate change impacts. (Coastal States Organization, 2007)

DESIGN CONSIDERATIONS FOR DEVELOPING THE MEASURE

The process of developing climate change adaptation measures within an ICM context follows the same model as the cycle for developing any public policy.

Step 1: Identify and analyze the issues relevant to specific coastal areas.

Step 2: Set objectives and prepare options for policies and actions.

Step 3: Make decisions on both policy as well as the need for new laws, decrees, projects or interagency agreements to support implementation.

Step 4: Use the mandate, policies, funds and administrative arrangements to forge an operational program that generates tangible results, such as case-by-case permit decisions on coastal development, conflict resolution, enforcement, and the building of physical infrastructure.

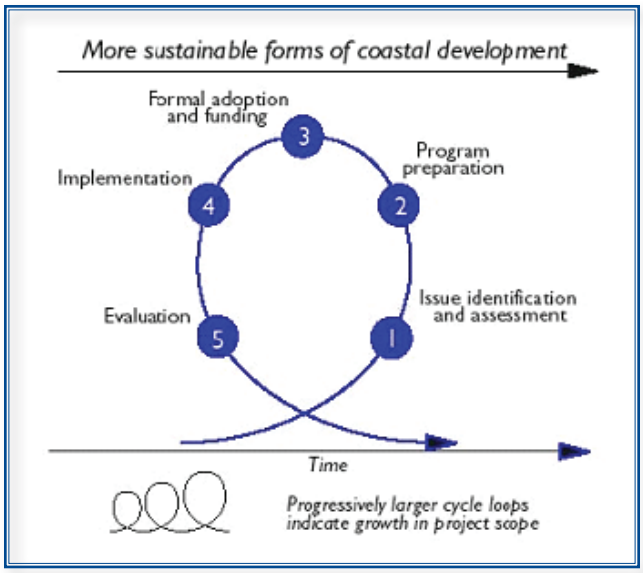
Step 5: Compare the results of the process against the desired outcome(s) and make necessary adjustments on a periodic basis.

Other ICM program design considerations include:

- Maintain an open, participatory and democratic process, involving all stakeholders in issue identification, planning and implementation;
- Build ICM around those issues highlighted in the above process;
- Work at and develop strong linkages among layers of government—national, provincial or state, and municipal;
- Build constituencies and political support for resource management through public education to avoid plans getting derailed at the implementation stage;
- Strengthen or introduce mechanisms for cross-sectoral action, especially when the legal and institutional framework keeps policy fragmented within traditional sectors.

In some cases, coastal management is concerned primarily with bringing greater order and predictability to the process of shorefront development. Such programs usually have a strong focus on environmental protection and heavy reliance on regulatory procedures to achieve management objectives. Integrated coastal management strives to go beyond the shorefront and adopt an ecosystem-based approach to planning and decision-making in more broadly defined coastal watersheds and the adjoining coastal ocean. ICM programs give attention to protection of important coastal features, while democratically defining and achieving socially and environmentally sustainable forms of development.

The legal and institutional settings for ICM vary widely. Many countries reserve decisions about marine and coastal uses to the national government since these areas are considered national patrimony. Other countries have weak or limited national policy, relying instead on a combination of sectoral policies and decision-making at the regional and local levels. Disaster preparedness and response, hazard mitigation, research and coastal



planning functions are frequently carried out by different agencies without the benefit of coordinating mechanisms or back up from the judicial system. For ICM to be successful in addressing climate change, these functions clearly need to be integrated.

IMPROVING THE LIKELIHOOD OF SUCCESS IN APPLYING THIS MEASURE AS A CLIMATE CHANGE ADAPTATION

Given the scale of the problem of climate change, and the wide range of overlapping and inter-connected coastal impacts it will have, an inter-sectoral and issue based approach to coastal adaptation is most appropriate. Responses to coastal climate change impacts need to be implemented in the broader context and the wider objectives of coastal planning and management. The window of opportunity for incorporating climate change adaptation policy into ICM is cyclical, requiring many years for technical information and policy studies to find their way through the decision-making process.

The causal relationship between the impacts of climate change and existing societal forces acting on coastal systems may not be widely appreciated by policy makers, managers and the public. The uncertainty over the nature of climate change and its implications contributes to this knowledge gap. Additionally, failure to include the true economic, social and environmental costs of present policies, may even subsidize risky coastal development. This makes it difficult to build constituencies for ICM planning and policy for coastal adaptation.

The costs and benefits of ICM strategies, policies and plans depend on the interventions undertaken. Costs are easier to quantify. Benefits are typically measured in terms of avoided climate impacts, (e.g. avoided loss of property, infrastructure and reduced exposure of population to risk) and can be difficult to quantify. ICM is an inclusive process that balances multiple objectives and priority issues of coastal planning and management—one of which is to generate equitably distributed social and environmental benefits for society.

Typical institutional obstacles to ICM include:

- The planning and management of human activities is organized and justified sector by sector and cannot respond to the complex interrelationships within coastal regions.
- Sectoral emphasis creates overlapping areas of jurisdiction in government entities and can prompt interagency conflicts.
- In other instances, particular activities/uses may not fall under the legal responsibility of any agency—such gaps and overlaps in authority and responsibility complicate management.
- Weak leadership and policy direction at many levels may delay the response to the accelerating changes in coastal conditions.
- Untrained staff lack the skills and human capacity needed to effectively manage institutions.
- Conflicts arise from the centralized decision-making process, which is slow to respond to concerns of local stakeholders that are the ones most affected by the decisions.
- There are inadequate funds and/or capabilities to implement existing procedures and regulations.
- There is a lack of public support for environmental management initiatives.
- Procedures and laws for public disclosure of governmental decisions are lacking.
- Better coordination and enforcement of existing legislation is required, but missing.

Overcoming obstacles requires addressing governance bottlenecks and constraints. Therefore, it may be necessary to create new institutional mechanisms to support increased interagency and intergovernmental coordination. Such mechanisms might include

interagency memoranda of agreement for managing specific resources or activities (e.g. aquaculture), interagency task forces or commissions, routine information sharing, joint hearings, coordination meetings, interagency plans, etc. These provide structures for developing mutually beneficial working relations and exchanging views on coastal climate change issues. Interagency coordination can also facilitate more efficient information gathering, analysis and planning, and regulatory decision-making needed in coastal adaptation.

Information limitations and capacity issues can be addressed in a number of creative ways. Develop handbooks, websites and other educational materials to clarify each agency's legal jurisdiction and authority in coastal areas—and possible jurisdictional conflicts and overlaps. Coordinated databases—on coastal resources, uses (e.g. farming, fishing, and industry), geo-spatial data, including property lines, and demographic data on coastal residents—are needed both for more effective coastal adaptation planning and can inform the improved allocation of resources in a post-hazard situation.

Building capacity of government and private sector professionals is key to incorporating climate adaptation. For instance, training for land use professionals in hazard risk assessment and the physical identification of hazard areas will help them plan and regulate development differently.

Comparison of ICM Programs in Five Tropical Countries

Attribute	Country				
	Ecuador	Tanzania	Indonesia	Sri Lanka	Philippines
Primary level of government concerned with ICM	National, local	National, local	National, provincial	National	National, local
Overall approach	Top-down, bottom-up	Top-down, bottom-up	Top-down, bottom-up	Top-down	First top-down, then bottom-up
National policy	No	National strategy	Yes	Coast Conservation Act	Yes, national policy for local governments to adopt ICM
National agency	Programa de Manejo de Recursos Costeros	Nascent body formally created in National Environment Management Council (NEMC)	Marine and Coast Directorate	Coast Conservation Division	Department of Environment and Natural Resources, Department of Interior and Local Government
Type of approach	Planning, educational, monitoring, municipal projects, sustainable development, coordinated enforcement	Regulatory, planning, consensus-building, district projects for sustainable development, enforcement	National policy and decentralized planning and management at regional and local levels	Regulatory, permit system, special area management strategy	Decentralized regulatory, area planning, participatory, sustainable development
Extent of implementation	Partial implementation	Partial implementation	Partial implementation	Full implementation	Partial implementation
Climate change or hazards management measures?	Focus on water through Ministry of Environment	National Adaptation Program of Action	National action plan	Core issues for policy, regulation and investments	Inter-agency working committee

Integrated Coastal Management is being adopted by Philippine Local Governments as a means to address their mandate to manage coastal and marine resources.

The Philippines has a long coastline bordered by 832 municipal and city government units that have full jurisdiction over the protection and management of their shoreline and marine resources to 15 kilometers off shore. This mandate vested to local governments based on laws of 1991 and 1997 has encouraged them to develop integrated management plans for their jurisdictional areas based on a nationally devised coastal resource management benchmark system that was adopted by national and local governments in 2005. The coastal resource management benchmarks (i.e indicators for advancement) provide basic guidance for each local government to develop their plans and to provide support for implementation. The broad benchmarks include: participatory plan developed and implemented, budget allocated, ICM coordination body formed and active; foreshore setbacks implemented; and a set of ICM best practices being implemented. Typical best practices include: marine protected area, fisheries management, mangrove restoration, alternative livelihood program in place and others as appropriate. This system is being adopted by increasing numbers of local governments with technical guidance provided by the national agencies and several foreign supported projects (White et al 2006).

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overarching planning and governance

3. SPECIAL AREA MANAGEMENT PLAN

The term "special area management plan" (SAMP) refers to a relatively comprehensive plan for a geographic area of critical concern, usually within the context of a national, state or municipal level coastal resources management program. This plan typically incorporates an overarching strategy that bundles together many different coastal management measures to address environmental, social and economic issues.

RELEVANCE TO CLIMATE CHANGE

Some climate change adaptation measures require coordinated action that cuts across policy sectors and government jurisdictions, which in turn requires considerable public and private sector support. The special area management plan (SAMP) process fosters an integrated perspective by addressing interrelated issues of concern for a variety of groups. Climate change could serve as a unifying theme since it impacts multiple aspects of the coastal ecosystem and its critical areas.

As of 2008, several countries are using SAMPs to address ecosystem problems that cut across jurisdictions. This includes Sri Lanka, the U.S., Mexico, Ecuador, and the Philippines. Other countries employ a related approach that is usually limited to an administrative boundary such as a district, province or municipal level. In all cases, the SAMP effort supplements national policies and programs.

PURPOSE AND APPLICATION

SAMP strategies create a comprehensive plan for a geographic area of critical concern. It usually involves addressing more than one issue. It pursues multiple objectives as a way to balance different needs within a geographic area—i.e., the need to protect natural resources with the need for growth in coastal-dependent economic activities. A stakeholder participation process is combined with technical studies to prepare a detailed analysis of environmental, social and economic conditions and a comprehensive statement of policies, standards and criteria to guide the use of public and private lands and waters in the critical area.

Timely implementation of a SAMP often requires adapting existing or creating new administrative mechanisms. For example, this might involve working with existing authorities but assigning a lead agency to provide coordination of the process. Or, it might involve testing a totally new arrangement. SAMPs are encouraged as part of the U.S. Coastal Zone Management Act and are used by several U.S. coastal states. They are also a key strategy in countries such as Sri Lanka, which uses the SAMP as a way to link sectoral government agency authorities with issues that span ecosystem boundaries. Methods for creating and implementing a SAMP share much in common with the local ecosystem-based and provincial coastal management planning used in the Philippines and Indonesia or the district action planning that is used in Tanzania. SAMPs can also be compared to larger scale ecosystem-based approaches such as regional scale lake or estuary management efforts. For example, the U.S. Chesapeake Bay Program requires consensus among five states and the U.S. Great Lakes Program also involves negotiations between two countries.

The Intergovernmental Panel on Climate Change (IPCC) notes challenges to adaptation in specific areas. "Identifying the optimal policy mix is problematic as it requires consensus on many issues." SAMPs combine participatory procedures with technical analysis to attain such a consensus.

INFORMATION AND DATA REQUIREMENTS

Special area management plans typically cover several issues and require an understanding of the dynamics

and interactions of components of the ecosystem and resource use activities. Since the SAMP strategy bundles together many different management initiatives, the information that is collected needs to address several issues. This information is gleaned from the combination of available studies plus targeted short term research that seeks the answers to key questions related to one or more of the issues.

A SAMP site might be large enough in geographic scope to allow for downscaling of regional climate scenarios. Other information that could be useful includes sector-specific information (e.g., future river flow from anticipated changes in land cover or upstream glacier melting; or basin-wide rainfall pattern shifts, which could help in understanding likely scenarios with sediment supply or estuary salinity gradients).

DESIGN CONSIDERATIONS FOR DEVELOPING THE MEASURE

There are a variety of ways to approach detailed planning for a special area. A national coastal program might survey all coastal sites and choose those at greatest economic and/or ecological risk or of high national significance. This is what Sri Lanka has done. In other cases, the SAMP starts with local leaders who care deeply about the future of the ecosystem they depend upon. These leaders work to gain the attention of stakeholders and scientists in order to prompt a response from government agencies. For a SAMP to become adopted as public policy it is necessary to:

- prepare a proposal for review by government and stakeholders that sets the geographic scope of and issues to be addressed in the SAMP;
- develop a terms of reference and funding proposal to initiate and sustain what typically is a multi-year process;
- confirm funding and a workplan for preparing the SAMP—multiple funding sources are needed to cover costs of meetings, technical studies, research and stakeholder participation;
- appoint one or more committees, boards, or commissions to oversee preparation of the plan;
- organize the project team, and incorporate scientific knowledge and technical expertise;
- create mechanisms to engage the participation of key actors and ensure a full range of opinions and concerns; and
- sustain this participation throughout all phases of the SAMP—issue identification, analysis, consideration of options, and adoption—as SAMPs need to tap into a wide policy network in order to attain consensus and carry out adopted measures.

IMPROVING THE LIKELIHOOD OF SUCCESS IN APPLYING THIS MEASURE AS A CLIMATE CHANGE ADAPTATION

The need for climate change adaptation is not sufficient reason alone to initiate a SAMP. Rather, a SAMP is part of an integrated approach that addresses multiple issues and objectives. That said, climate change will likely cut across these issues. Scenarios on how climate change might affect a special area may call into question the existing rules for controlling development in that area. Or, it may question key assumptions used by coastal investors and authorities to make decisions about coastal infrastructure. Special area planning can be time consuming. It requires high quality technical support and sustained facilitation of committees, including stakeholder groups and agency staff not always accustomed to interacting. The concerted and coordinated action of many public and private entities is necessary in order to carry out the specific, sometimes costly measures involved in implementing a SAMP. For this reason, a national or regional government may prefer to adopt simpler, more focused and uniform policies such as setbacks, designated hazard zones and construction standards.

All elements and phases of a SAMP—from its design, to its guidelines, and its adoption into regulation—must be incorporated into the policies and work agenda of multiple institutions as few legal structures (national or regional) specifically recognize this form of plan. It is also essential to establish unified leadership and advocacy for the SAMP; secure appropriations; raise additional funds; and establish permanent budgeting within agencies, advocacy groups or special government funds.

The cost of mobilizing stakeholder involvement combined with the cost of conducting scientific and technical studies for a special coastal area or ecosystem varies. In rare cases—depending on the scale of the

special area, the number and severity of issues, the extent of discord and the outcomes at stake—it can cost as much as a few million dollars. Raising a portion of such funds is generally feasible when: 1) the area faces severe threats, 2) a number of people and groups are affected, 3) there is an international dimension, and 4) potential solutions can serve as a model for other locations.

SRI LANKA RELIES ON SPECIAL AREA MANAGEMENT PLANS AS A 'SECOND GENERATION' COASTAL MANAGEMENT APPROACH.

"Special area management projects study in detail the problems relating to specific areas under severe development pressure. Management strategies must consider critical issues and impacts arising from their interactions. Climate change issues facing Sri Lanka include: (a) inundation of low-lying areas, including coastal settlements and coastal wetlands; (b) coastal erosion; (c) flooding and storm damage; (d) quality of surface and groundwater; (e) salinisation of estuaries and freshwater aquifers; (f) degradation of marine ecosystems—coral reefs; (g) changes in the hydraulic force regimes of sea-defense structures and breakwaters leading to greater vulnerability to impacts of increased erosion and extreme events. SAMs can address these issues in the context of national policies related to erosion management and disaster preparedness." (S.S.Hettiarachchi and S.P. Samarawickrama, 2005) SAMP sites are noted for the economic and livelihoods value of the resources they hold. Together the SAMP sites, Ramsar sites, and marine protected areas help protect ecosystem services for conservation and/or use, while also addressing hazards of low lying coastal areas, erosion, and other damaging affects of extreme weather events including tropical storms and tsunamis. (IUCN, Sri Lanka)

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