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

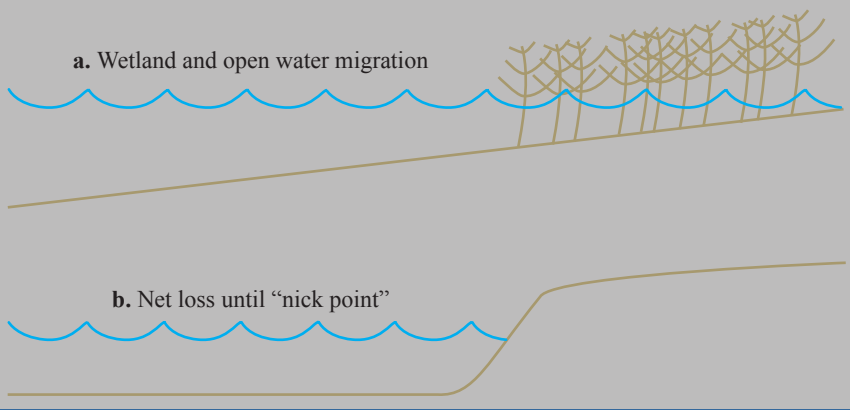
INFORMATION AND DATA REQUIREMENTS

- 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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http://www.ramsar.org/

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.

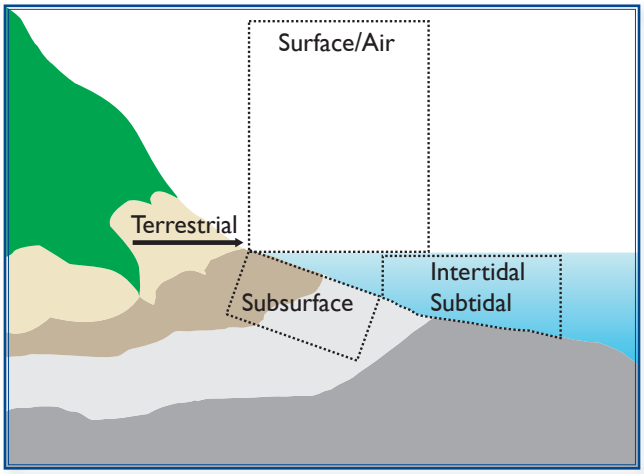
Typically, MCAs are consummated through legally binding documents/mechanisms signed by two or more parties. Common examples of formal MCA mechanisms include leases, licenses, easements, management agreements, purchase and sale agreements, concessions, and contracts. These formal mechanisms are often 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.

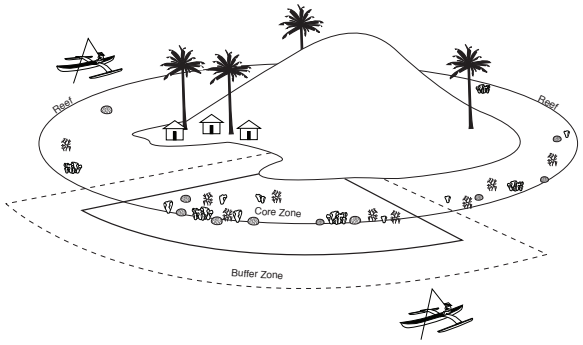
INFORMATION AND DATA REQUIREMENTS FOR ESTABLISHING A MARINE PROTECTED AREA

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.

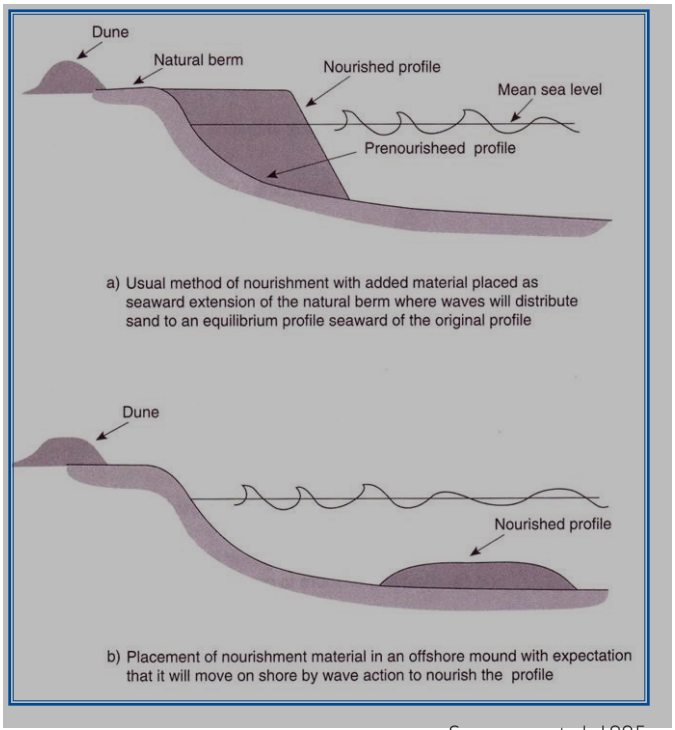
Nourishment has been used worldwide at various scales to enhance tourism beaches, protect landward development, create new land for development, and restore habitat. It has been used as a strategy for maintaining popular mass tourism destinations (Cancun, Bali, Durban, and Miami).

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.

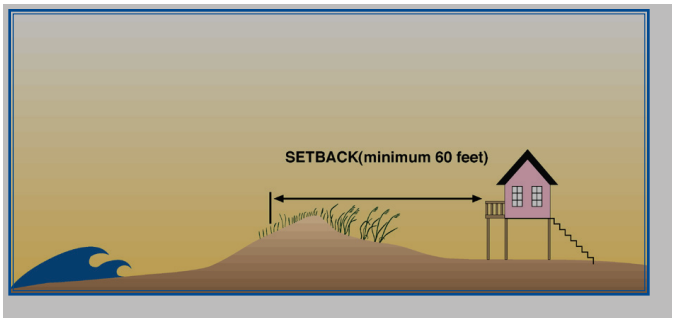
PURPOSE AND APPLICATION

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

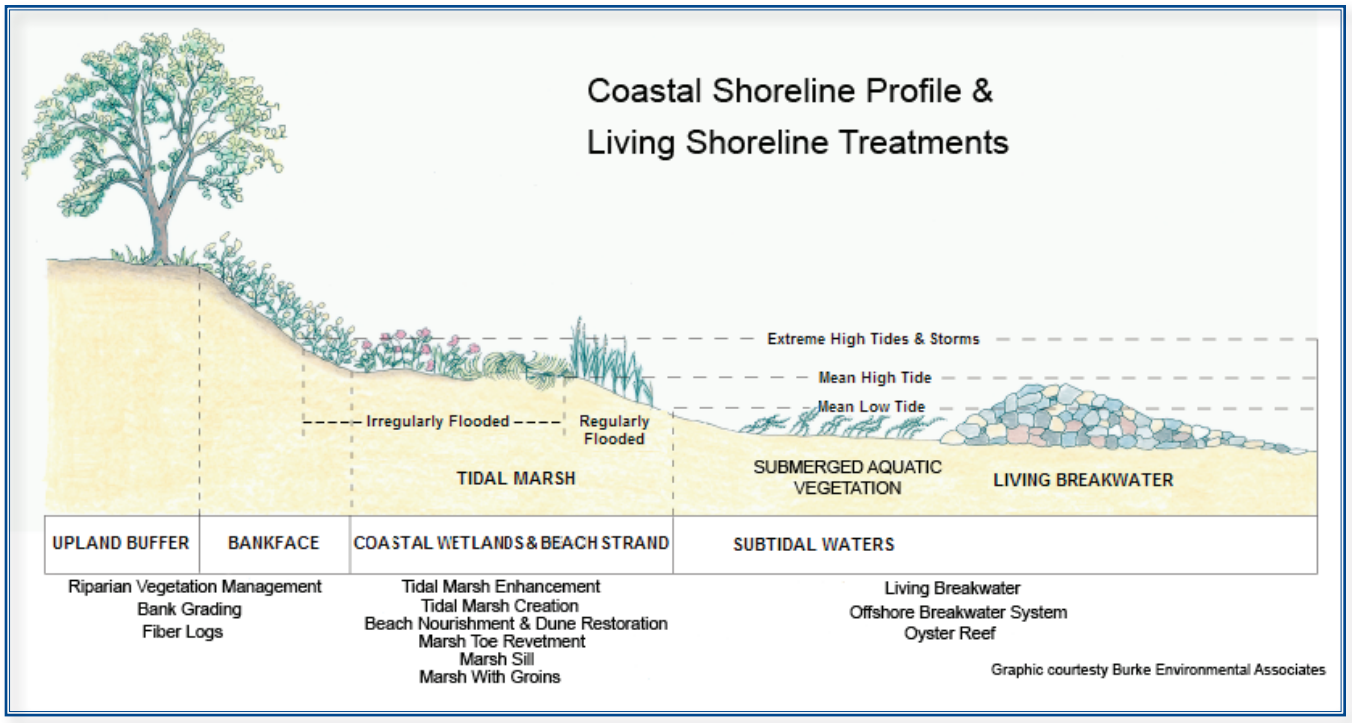
The primary benefit of a living shoreline strategy is erosion control in sheltered coastal environments. In turn, improved natural habitats provide benefits by providing ecosystem services. This includes, for example, nurseries for fish spawning and feeding areas for migratory bird. Plants from these 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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Red Cross/Red Crescent Climate Centre. http://www.climatecentre.org/

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.

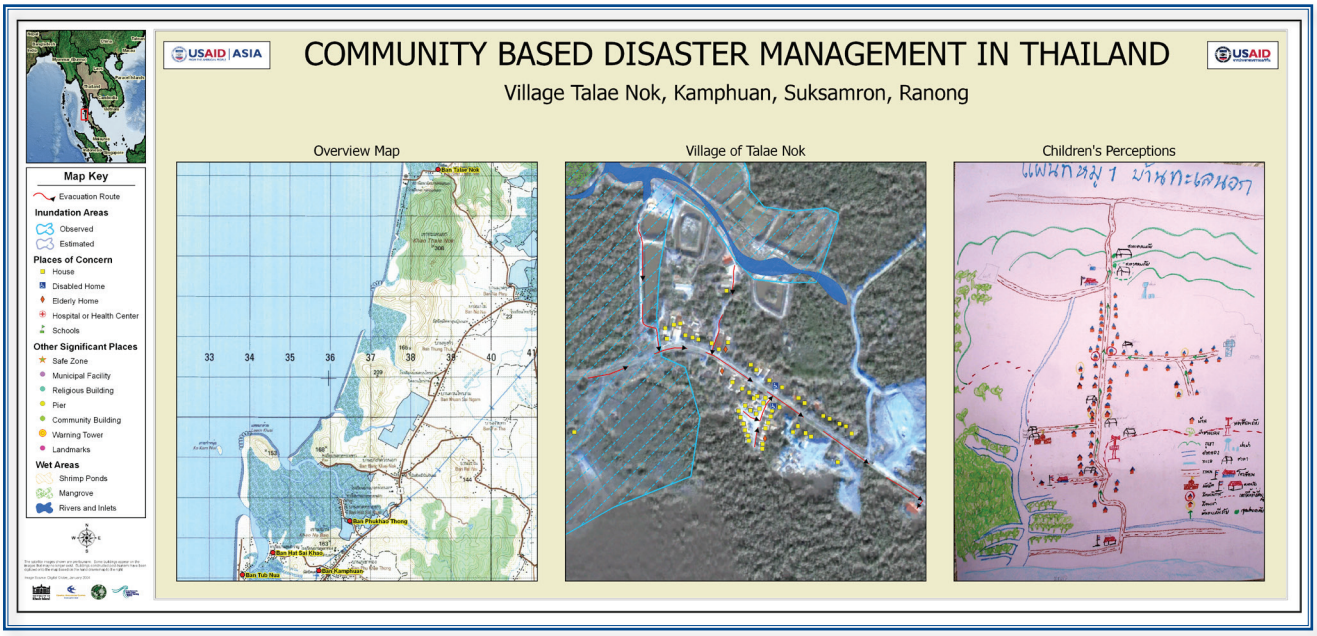
IMPROVING THE LIKELIHOOD OF SUCCESS IN APPLYING THIS MEASURE AS A CLIMATE CHANGE ADAPTATION

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.

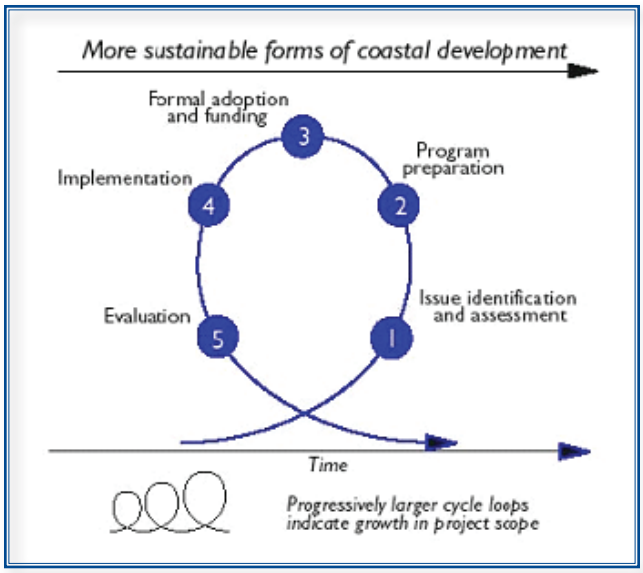
Step 5: Compare the results of the process against the desired outcome(s) and make necessary adjustments on a periodic basis.

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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