



## Climate Change and Coastal Areas

Climate change effects such as sea temperatures and sea level rise, increased frequency and magnitude of tropical storms and other extreme events will have negative impacts on both ecosystems (coral bleaching, saltwater intrusion, flooding, erosion) and human well-being (loss and/or reduced productivity in goods and services provided by ecosystems).

### Corals

*Increased concentrations of CO<sub>2</sub> in seawater will lead to ocean acidification reducing calcification rates of calcifying organisms such as corals. Disintegration of degraded reefs following bleaching or reduced calcification may result in increased wave energy across reef flats with potential for shoreline erosion. There is limited ecological and genetic evidence for adaptation of corals to warmer conditions. It is very likely that projected future increases in sea surface temperature will result in more frequent bleaching events and widespread mortality, if there is not thermal adaptation or acclimatisation by corals and their symbionts. The ability of coral reef ecosystems to withstand the impacts of climate change will depend on the extent of degradation from other anthropogenic pressures and the frequency of future bleaching events. Many reefs are affected by tropical cyclones; impacts range from minor breakage of fragile corals to destruction of the majority of corals on a reef and deposition of debris as coarse storm ridges. Such storms represent major perturbations, affecting species composition and abundance, from which reef ecosystems require time to recover. An intensification of tropical storms could have devastating consequences on the reefs themselves, as well as for the inhabitants of many low-lying islands.*

Reduced protective and regulatory services of coastal ecosystems will leave coastal communities more vulnerable to climate-related disasters. Degradation or disappearance of productive coastal ecosystems will further jeopardize food security and livelihoods in marginalized coastal communities with little adaptive capacity. Low-lying coastal areas have already suffered from the negative impacts of more frequent flooding events.

Coastal ecosystems, especially mangrove forests and coral reefs, act as buffers against extreme weather conditions and natural disasters, thereby reducing the vulnerability of coastal communities and their investments (Macintosh and Epps, 2009). Sea grasses, which provide indispensable nursery grounds for many fish species, and feeding habitat for turtles and dugongs, have also declined at an alarming rate and even disappeared in some parts of the Indian Ocean. Thousands of hectares of mangrove forests have been cleared for shrimp farming and other forms of coastal development. In several Asian countries mangrove loss has exceeded 60 percent, on average, in recent decades (Macintosh and Ashton, 2002), while the total area has decreased to less than 15 million hectares worldwide from an estimated 32 million hectares originally. Rising sea temperature is considered to be the largest threat to coral reefs today. According to the CORDIO 2008 Status Report released by the Global Coral Reef Monitoring Network, 19 percent of the world's coral reefs have already been lost and the remaining may disappear within 20-40 years if current trends in carbon dioxide emissions continue (Obura *et al.*, 2008). Coastal ecosystems would, however, have a better chance of survival if other stress factors related to human activity were minimised.

### Seagrasses

*Sea grasses appear to be declining around many coasts due to human impacts, and this is expected to accelerate if climate change alters environmental conditions in coastal waters. Changes in salinity and temperature and increased sea level, atmospheric CO<sub>2</sub>, storm activity and ultraviolet irradiance alter sea grass distribution, productivity and community composition. Increases in the amount of dissolved CO<sub>2</sub> and, for some species, HCO<sub>3</sub> present in aquatic environments, will lead to higher rates of photosynthesis in submerged aquatic vegetation, similar to the effects of CO<sub>2</sub> enrichment on most terrestrial plants, if nutrient availability or other limiting factors do not offset the potential for enhanced productivity. An increase in epiphytic or suspended algae would decrease light available to submerged aquatic vegetation in estuarine and lagoonal systems.*

## Climate Change in the Coastal Zone

The effect that climate change will have on the coastal zone will vary dependent upon geographic location. The Intergovernmental Panel on Climate Change (IPCC) has confirmed that sea level rise and its associated impacts are expected through the 21st century and beyond due to human emissions of greenhouse gases. Likely impacts physical changes resulting from the effects of climate change, i.e. sea level rise leading to coastal erosion and inundation will be superimposed on an evolving coastal system, primarily shaped by human development. The potential impacts of climate change, climatic changes must be considered on a regional to local scale.

### What is MFF?

The Mangroves for the Future (MFF) initiative is based on a vision of *healthier, more prosperous and secure future for all sections of coastal populations in Indian Ocean countries*. It is an IUCN and UNDP-led partnership-based initiative which includes the countries worst-affected by the tsunami; India, Indonesia, Maldives, Seychelles, Sri Lanka, and Thailand, as well as dialogue countries in the region that face similar issues. MFF uses mangroves as a flagship ecosystem but is inclusive of all coastal ecosystems. The MFF initiative's objective is to strengthening the environmental sustainability of coastal development and promoting sound investment in coastal ecosystem management, as a means of enhancing resilience and supporting local livelihoods. In the present context of global environmental change, sustainability must incorporate measures to address the likely impacts of short-term climate variability and long-term climate change. Individual interventions supported through the MFF, and the programme as a whole, ensures that the investments in coastal ecosystem management addresses the issue of increasing adaptive capacity (capacity of society to cope with the expected or actual climate changes) to deal with the likely impacts of climate change. Furthermore, increasing adaptive capacity is an integral part of each MFF intervention.

### MFF and Climate Change Considerations

Considering the large number of people in coastal areas that could be displaced by climate change, MFF seeks to conduct activities that: mobilizes local communities and governments to undertake joint actions for sustainable

### Estuaries and Lagoons

*Global mean sea-level rise will displace existing coastal plant and animal communities inland. Estuarine plant and animal communities may persist as sea level rises if migration is not restricted and if the rate of change does not exceed the capacity of natural communities to adapt or migrate. Some of the greatest potential impacts of climate change on estuaries may result from changes in physical mixing characteristics caused by changes in freshwater runoff. A globally intensified hydrologic cycle and regional changes in runoff all portend changes in coastal water quality. Freshwater inflows into estuaries influence water residence time, nutrient delivery, vertical stratification, salinity and control of phytoplankton growth rates. Increased freshwater inflows decrease water residence time and increase vertical stratification, and vice versa. The effects of altered residence times can have significant effects on phytoplankton populations, which have the potential to increase fourfold per day. Consequently, in estuaries with very short water residence times, phytoplankton are generally flushed from the system as fast as they can grow, reducing the estuary's susceptibility to eutrophication and algal blooms. Changes in the timing of freshwater delivery to estuaries could lead to a decoupling of the juvenile phases of many estuarine and marine fishery species from the available nursery habitat. A projected increase in the intensity of tropical cyclones and other coastal storms could alter bottom sediment dynamics, organic matter inputs, phytoplankton and fisheries populations, salinity and oxygen levels, and biogeochemical processes in estuaries.*

coastal management; ensure food security through sound ecosystem management; build knowledge to better understand the links between livelihoods and climate system; and increase adaptive capacity to meet the long-term development needs of coastal communities, while securing their livelihoods against climate change impacts and helping them prepare for potential climate-related disasters.

The MFF also adopts a new approach by moving from a reactive response to progressive activities that address long-term sustainable management needs and develop community resilience, including building awareness and capacity for improved food and livelihood security, disaster preparedness, and climate change adaptation. MFF undertakes collective actions to build knowledge, strengthen empowerment, and enhance governance with climate change as a cross-cutting theme, to address the current and future threats, and to conserve and restore coastal ecosystems. MFF works in four key areas of influence: regional cooperation, national programme support, private sector engagement and community action. The programmes of work are implemented through a series of on-the-ground projects, through small and large grant modalities.

## Climate Proofing

Climate proofing provides a method to facilitate implementation of climate change mainstreaming actions at the project/ intervention scale. Methods for integrating climate change considerations into all MFF activities have been developed based on existing climate proofing tools. Most governments and institutions are aware of the need to address the impacts of climate change, but it is likely that few will know how to go about the process. Consequently their focus will be primarily on the proposed investments and efforts themselves, rather than on ensuring sustainability through “climate-proofing”. MFF’s climate-proofing method is based on two principles:

- Making a set of “tools” available to assist partners in understanding the need for, and the approach to “climate-proofing” partners proposed interventions; and
- Ensuring that the process of “climate-proofing” is integrated into the project design and implementation, rather than being an additional component in the project cycle.

### **Sandy beaches & Rocky shores**

*Acceleration in sea-level rise will exacerbate beach erosion. The local response will depend on the total sediment budget. An indirect influence of sea-level rise on the beach sediment budget is due to the infilling of coastal embayments. As sea-level rises, estuaries and lagoons attempt to maintain equilibrium by raising their bed elevation in tandem, and act as a major sink of sand which is often derived from the open coast, implying the potential for major coastal instability due to sea-level rise in the vicinity of tidal inlets. Beach protection strategies and changes in the behaviour or frequency of storms can be more important than the projected acceleration of sea-level rise in determining future beach erosion rates. The combined effects of beach erosion and storms can lead to the erosion or inundation of other coastal systems. Hard rock cliffs formed in softer lithologies are likely to retreat more rapidly. Cliff failure and retreat may be amplified by increased precipitation and higher groundwater levels.*

## Capacity Building

MFF conducts regional training courses on the use of practical climate proofing tools and methods applicable to the field/project level. Incorporating climate change adaptation considerations and enhancing adaptive capacity of coastal communities is crucial to ensure long-term sustainability of projects. The aim is to follow up with National training courses to build in-country capacities in the region to incorporate climate change considerations into project design using the *MFF Climate Change Adaptation Guidelines*. MFF aims to add value by linking up with training institutions and universities to help gather coastal and marine conservation policy-makers who are trying to decide how to proceed in addressing adaptation

challenges without creating new laws or programmes, and planners and/or project managers who want some practical approaches to act immediately, as well as communications and outreach professional seeking to make the connection between information, needs, and action. MFF also supports secondments and organizes study tours to promote cross-country exchanges of lessons learned in climate change adaptation strategies in the region.

## Integrating Disaster Risk Reduction into Coastal Zone Management

Coastal ecosystems and associated watersheds provide a wide range of services to coastal communities, which are fundamental to building community resilience to coastal hazards; yet these services are under threat from a variety of sources and global climate change is expected to increase the frequency and intensity of climate related hazards. Approaches to Disaster Risk Reduction (DRR) address vulnerability to natural hazards and climate variability, and therefore have explicit alignment to the objectives of climate change adaptation. The aim is to ensure that adaptation addresses both current climate variability, as well as long-term climate changes, which threaten ecosystem sustainability.

Integrating DRR into coastal zone management helps build disaster resilient communities. Raising awareness of the importance of DRR should be an integral component of sustainable coastal development. While there are many coastal zone managers in Indian Ocean countries, there is still a limited understanding of the principles of reducing underlying risk factors and limited engagement with national disaster reduction mechanisms and resources. MFF takes a partnerships approach to DRR, seeking to involve individuals, communities and institutions such as UN ISDR, which is the focal point in the UN System to promote links and synergies between, and the coordination of, disaster reduction activities in the socio-economic, humanitarian and development fields, as well as to support policy integration.

## Mangroves

Modelling data suggests that global losses of coastal wetlands from 2000 to 2080 of 33% and 44% given a 36 cm and 72 cm rise in sea level, respectively. Mangrove communities are likely to show a blend of positive responses to climate change, such as enhanced growth resulting from higher levels of CO<sub>2</sub> and temperature, as well as negative impacts, such as increased saline intrusion and erosion, largely depending on site-specific factors. The sedimentary response of the shoreline is a function of both the availability of sediment and the ability of the organic production by mangroves themselves to fill accommodation space provided by sea-level rise.

Groundwater levels play an important role in the elevation of mangrove soils by processes affecting soil shrink and swell. Hence, the influence of hydrology should be considered when evaluating the effect of disturbances, sea-level rise and water management decisions on mangrove systems. Vertical accretion of mangroves is variable but commonly approaches 5 mm/yr. However, many mangrove shorelines are subsiding and thus experiencing a more rapid relative sea-level rise.

## Climate Change Adaptation

Climate change is only one of the many interacting stressors in the coastal zone. Consequently, it is important that climate change adaptation is considered in conjunction with the multiple management objectives for integrated coastal management (ICM). Climate change mainstreaming is a tool to facilitate the incorporation of climate change adaptation within existing policies and practises that inform ICM.

There are a number of different adaptation measures that support climate change adaptation, which can be broken into three primary options; Protect; Retreat; and Accommodate. Successful adaptation requires a combination of adaptation measures that each contribute to the coastal management goals and objectives. The selection and success of an adaptation measure will relate to the level in which the measure addresses the adaptive capacity of the community in which it is applied.

## Climate Change Mitigation

MFF partners are seeking opportunities to develop specific activities related to REDD under the MFF initiative by means of; supporting local livelihoods and enhancing coastal ecosystem and community resilience by promoting investment in conservation of coastal ecosystems while also providing adaptation benefits and improving local livelihoods. MFF and its partners are developing and testing tools at project sites in the region. It will further aim to identify mechanisms for REDD based on an ecosystem approach that enhances natural sequestration and storage of carbon in existing mangrove forests and restore degraded mangroves areas. The effectiveness of REDD activities will ultimately depend on the success of its contribution to the development needs of communities that rely on mangrove products.

The MFF climate change considerations work programme will focus on climate change mitigation and climate change adaptation, with a greater emphasis to the latter, to assist MFF countries in the Indian Ocean to build capacity and help develop national strategies.

### *The value of mangroves in reducing CO<sub>2</sub> emissions*

MFF supports and endorses the concept of REDD (Reducing Emissions from Deforestation and Ecosystem Degradation) as a climate change mitigation option. If well designed, REDD can result in substantial CO<sub>2</sub> emissions reductions and could also be a potential sustainable source of income for marginalized coastal communities in the Indian Ocean. Mangrove forests, our first line of natural defense against climate-related disasters are disappearing at a rapid rate due to land-use change and deforestation, leading to lower capacity of carbon sequestration and increasing global green house gases (GHG) emissions. It is time to realize the value of mangroves and their efficient carbon sequestration capabilities. Without mangroves in the solution, it will be impossible to maximize carbon sequestration. But it is not only about trees, it is about people. Although, natural mangrove forests restoration will help to maintain adaptive capacity, there are other benefits of REDD far beyond carbon sequestration such as ecosystem services which include local climate regulation (cooling through transpiration, shade and wind protection), local erosion control (slope stabilization) and coastal protection. Commitments by governments, donors, NGOs and local communities to reduce emissions from deforestation and degradation offers an opportunity to help resolve the pressing issues that are leading to massive deforestation, increased vulnerability of coastal communities, biodiversity loss, and change in climate.

MFF seeks more effective and inclusive institutions, policies and mechanisms for cooperation at national and regional levels by prioritising coastal climate change considerations across national development agendas, policies and budgets.

For more information, please visit: [www.mangrovesforthefuture.org](http://www.mangrovesforthefuture.org) or email: [secretariat@mangrovesforthefuture.org](mailto:secretariat@mangrovesforthefuture.org)

