



Mangroves for the Future
INVESTING IN COASTAL ECOSYSTEMS

Climate Proof

A Reference Tool to Coastal Climate Change in the
Context of Mangroves for the Future



Climate Proof - A Reference Tool to Coastal Climate Change in the Context of Mangroves for the Future (MFF)
A pre-publication version approved by the MFF Secretariat, October 2010.

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Acronyms

AGO	Australian Greenhouse Office
ALM	Adaptation Learning Mechanism
APF	Adaptation Policy Framework
AR4	Fourth Assessment Report
DRR	Disaster Risk Reduction
ENSO	El Niño-Southern Oscillation
GCM	Global Climate Model
GEF	Global Environment Fund
ICM	Integrated Coastal Management
IOTWS	Indian Ocean Tsunami Warning System
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for the Conservation of Nature
LAC	Limits of Acceptable Change
LFA	Logical Framework Analysis
MFF	Mangroves for the Future
NAPA	National Adaptation Programme of Action
NCB	National Coordinating Body
NGO	Non Government Organization
NS	National Strategy
PoW	Programme of Work
REDD	Reducing emissions from Deforestation and forest Degradation
SEI	Stockholm Environment Institute
SENSA	Swedish Environment Secretariat for Asia
TAR	Third Assessment Report
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations International Strategy for Disaster Reduction
USAID	US Agency for International Development
V&A	Vulnerability and Adaptation

Introduction

This document has been produced as a reference tool for MFF project partners. The tool is one component in a series of activities undertaken to mainstream climate change into the MFF programme. The work led by UNEP, in collaboration with UNDP, MFF and IUCN, aims to ensure that climate change adaptation considerations are included in all phases of the MFF initiative and projects.

The aim of this reference tool is to support the integration of climate change within the MFF initiative. The tool has not been designed to be read from cover to cover; each section can be read independently, allowing users to identify and use the sections which are most relevant to their needs.

The reference tool is outlined as follows:

Section 1: MFF's Programmes of Work and climate change considerations

This chapter outlines the alignment between MFF's Programmes of Work (PoWs) and climate change. MFF recognises climate change as a cross-cutting issue through all 15 PoWs and as a result the climate change considerations for each PoW are presented in this chapter. This information can be applied as a reference tool for MFF's National Coordinating Bodies (NCBs) and project proponents to collect information on ways climate change may be considered and incorporated into each of the 15 PoWs. The information contained within this chapter is also of particular value to MFF large project proponents who are involved in addressing climate change within their projects.

The section is structured as follows:

- Each PoW is presented individually;
- The climate change considerations for the PoW are outlined; and
- The actions/outputs (as proposed in the MFF plan for action) are listed for each PoW, and climate change considerations per action/output are presented.

Section 2: A review of tools and methods that support climate change adaptation

Tools to support climate change integration and adaptation are reviewed as a value-adding component in the mainstreaming process. The review is intended to support the assessment of climate related impacts and the formation of strategies to address the identified impacts. Consequently, this chapter is a valuable support tool for project proponents completing MFF large project proposals, as well as a reference tool for all MFF partners.

The review is not exhaustive, but focuses on tools and methods that may be applicable in answering the primary questions that may arise from MFF project proponents.

Section 3: Integrating climate change into the project cycle

This chapter outlines the overall approach to mainstream climate change into the MFF initiative. It explores best practice in the integration of climate change into the project cycle. The chapter also applies this information as a basis to outline the approach to mainstream climate change into the MFF programme.

The work presented in this chapter was led by UNEP, in collaboration with UNDP, to ensure that climate change adaptation considerations were included in all phases of the MFF initiative and projects.

The content of this chapter provides useful contextual information for all MFF partners, and highlights the MFF approach to mainstream climate change into projects.

Section 4: Coastal climate change: Impacts and adaptation measures

This chapter provides an introduction to climate change and climate change adaptation. It provides information on the potential impacts of climate change in the coastal zone and adaptation options to address these impacts.

This chapter provides important contextual information for MFF partners to collect information on the potential impacts of climate change and the methods to address these impacts within coastal zones.

Appendix 1: Key references and other sources

An annotated reference list that provides guidance on key resources regarding climate change impacts and adaptation approaches in coastal zones.

Appendix 2: Glossary of terms

Definitions for the terms used throughout the reference tool.

Section 1: MFF PoWs and climate change considerations

PoW 1: Improving the knowledge base for coastal planning, policy and management

Effective coastal management requires a detailed understanding of the current and projected coastal climate and how climate influences the socio-economic and ecological elements of the coastal zone on which coastal livelihoods depend. To determine the potential impacts of climate change in the coastal zone it is important to understand the current climate regime and socio-economic context in order to provide a baseline for the impacts of climate change.

A climatic baseline can be established by a review of meteorological and climate records that are long enough to encompass a range of climatic variations. A socio-economic baseline can be established through census surveys and community consultation. The information which will be collected is vital for monitoring both the impacts of climate change and the effectiveness of adaptation over time.

Vulnerability and/or risk assessments are the primary tools for understanding how climate variability and changes in climate may impact a coastal area. They also provide a means of developing strategies to address the projected impacts. Therefore, under PoW 1, it is crucial to include data coming from vulnerability and adaptation assessments and the hazard and risk assessment processes, among the information to be collected.

Actions/outputs as proposed in the MFF plan for action	Climate change considerations per action/ output as relevant
1.1 Gap analysis of existing knowledge resources and data sources, comparing the information needs of coastal managers.	1.1 The gap analysis should consider what information is needed to conduct a climate change risk assessment and adaptation planning. The information required for a risk assessment is dependent upon the degree of certainty required. For example, an assessment of the impacts of sea-level rise may be inferred from historic records or it may be established by developing of a geomorphic model, which provides more detailed information on the extent of erosion.
1.2 National and site-level baseline assessments of coastal biodiversity, ecosystems and livelihoods in order to contribute to a regional inventory, including an assessment of risk and vulnerability.	1.2 Baseline assessments that provide information on current biodiversity, ecosystem and livelihood status are an integral component to climate change risk assessments and adaptation planning. Therefore, completion of this action/output will enhance the ability to undertake climate change risk assessments and adaptation planning.
1.3 Appropriate regional and national-level information networks, resource centres, databases and/or meta-databases.	1.3. Establishing regional and national-level information networks will enhance information availability for inclusion in risk assessments and adaptation planning activities.
1.4 Support to existing national data and GIS centres in accessing and sharing relevant data regarding coastal zone ecosystems.	1.4 As above

Actions/outputs as proposed in the MFF plan for action	Climate change considerations per action/ output as relevant
1.5 Targeted research to fill key data gaps and information needs.	1.5 In many cases, information to support more detailed climate change risk assessments is unavailable. Consequently, targeted research is required to fill such gaps. For example, to obtain a more conclusive analysis of the impacts of sea-level rise on the coastal zone, geomorphic models that represent coastal responses to changes in the mean sea level are vital. Geomorphic models can be developed through targeted research programmes.

PoW 2: Designing ecologically and socio-economically sound coastal rehabilitation

Climate change is likely to modify process-response relationships within the coastal zone. For example, increased mean sea level could shift the active beach zone and increase erosion. In addition, species life cycles are aligned with climatic regimes; a shift in the climate regime may modify life cycle processes; threatening a particular species, community or ecosystem. Therefore, any coastal management activities, such as restoration and rehabilitation, must incorporate an understanding of projected climate changes and the associated ecological and socio-economical impacts to ensure the sustainability of the work conducted.

Therefore, under PoW 2, the assessment of areas suitable for rehabilitation should consider projected climate changes and how these changes may influence the area under assessment.

Further, capacity-building programmes should incorporate information on climate change, and the connections between climate change and ecosystem rehabilitation.

Risk Assessment Tools (see Section 2 of this document) can be applied to collect baseline information that will support effective coastal ecosystem rehabilitation planning.

Actions/outputs as proposed in the MFF plan for action	Climate change considerations per action/ output as relevant
2.1 Review of restoration work already underway (both before and during the post-tsunami reconstruction process); identification of national, regional and global expertise, and dissemination of best practices and lessons learned (with the possible establishment of a global database on rehabilitation projects).	2.1 The identification of global expertise, dissemination of best practices and lessons learned should include information on the impact of climate change on rehabilitation activities and methods to understand and incorporate climate change into rehabilitation processes. In addition, identification of expertise at the regional and national level, this information could be captured from other ongoing initiatives (e.g. UNFCCC regional level information, Regional Climate Change Adaptation Knowledge Platform for Asia (AIT/UNEP RRC.AP, SEI, SENSEA, UNEP)).
2.2 Within each country - identification of areas that require and are suitable for rehabilitation and those that are suitable for natural regeneration.	2.2 Review of areas that require and are suitable for rehabilitation should consider the potential climate change variability and impacts on the coastal zone (as both could potentially undermine the results of the planned intervention), and also to identify vulnerable areas where projects can be implemented.
2.3 Capacity building for rehabilitation through the development and/or dissemination of best practice guidelines and training courses in local languages.	2.3 Best practice guidelines and training courses should incorporate concepts and consideration of climate changes and how climate change can impact management and restoration activities. For example, certain locations may be more susceptible to extreme events, or saltwater intrusion, and thus require alternate and/or more proactive management approaches than would be applicable in the absence of climate change.

Actions/outputs as proposed in the MFF plan for action	Climate change considerations per action/ output as relevant
2.4 Monitoring to assess the impacts of restoration, using indicators to measure the impacts and performance at the species and ecosystem levels, as well as on the socio-economic status of surrounding human populations.	2.4 See the climate change considerations in the introductory text for PoW 5.
2.5 Application of management and eradication measures for invasive species in coastal ecosystems, and measures to halt their use for shoreline protection.	2.5 Changes in climatic conditions may result in more favourable environments for invasive species. It is important to understand how climate changes influence invasive species translocation, so that the management and eradication measures can be tailored appropriately. Effective management of invasive species may positively contribute to ensuring food security and enhancing livelihoods, and should also be considered.

PoW 3: Providing decision support for 'reef-to-ridge' approaches to land and resource management

Understanding climate change and its impact on socio-economic and ecological elements in the coastal zone is integral to effective coastal management. Similarly, the 'reef-to-ridge' approach ensures a holistic approach to coastal management is achieved. Therefore, the actions/outputs in PoW 3 should be broadened to include the concept of climate change, for example, enhancing awareness of the potential impacts of climate change as it relates to the 'reef-to-ridge' approach to coastal management.

See detailed tools and approaches to climate change integration in reef-to-ridge management approaches per actions/outputs.

Actions/outputs as proposed in the MFF plan for action	Climate change considerations per action/ output as relevant
3.1 Enhance awareness of the need for 'reef to ridge' approaches among land and resource managers of inland areas, river-basin planners and policy-makers.	3.1 Climate change will impact the coastal zone in a number of ways and will vary on a case-by-case basis; from rising sea levels resulting in erosion and inundation, to the decline in rainfall resulting in a reduction of available drinking water. The impacts of climate change in the coastal zone must be clearly understood, as these impacts have a direct interconnection on the ability to effectively manage the reef-to-ridge zone. Risk assessment tools (see Section 2 of this document) can be applied to identify these impacts.
3.2 Analysis of existing land-based activities which impact on coastal ecosystems and livelihoods, in order to identify appropriate plans for reversal and mitigation.	3.2 Climate change will also have a strong impact on ecosystems and inland activities. The impact of existing land-based activities and livelihoods on coastal ecosystems will be modified (often worsened) as a result of a changing climate. It is therefore important to understand the connection between climate drivers, inland and coastal ecosystems, and livelihoods to ensure that projected impacts can be clearly understood, and mitigated through adaptation actions.
3.3 Promote inclusion of coastal stakeholders in existing and planned integrated land and water resource management strategies and mechanisms for dialogue.	3.3. Climate changes will result in alteration to land and water resources. Potential impacts may include changes in available water resources, and loss of agricultural land through salinisation (due to sea level rise). It is important to understand the connection between projected climate change and ecosystem change (land and water resources), to ensure that livelihoods can be maintained and enhanced.
3.4 Design and distribute a decision support tool that incorporates 'reef to ridge' considerations.	3.4 The reef-to-ridge decision support tools should integrate concepts and criteria of climate variability and the impacts of climate change.

PoW 4: Integrating coastal ecosystem economic values into development planning and appraisal

Ecosystem valuation is an important contribution to vulnerability and risk assessments. Often the benefits that natural ecosystems deliver to humans are only recognised once they are lost. Ecosystem valuation ensures the value of systems is recognised and used to prioritise planning and management activities. Therefore, ecosystem valuation outputs are a primary information source in contributing to effective coastal planning.

The outputs of ecosystem valuation activities can be incorporated within a vulnerability and risk assessment approach to coastal management that considers the potential impacts of climate change. Thus it is critical that coastal ecosystem valuation should also include benefits gained from climate change mitigation and adaptation initiatives i.e. carbon sequestration, protection from extreme weather events.

At the same time, the potential impacts of the changing climate on the ecosystem should be taken into account, since this may modify the services that the ecosystem provides. Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food, water, timber, and fiber; regulating services that affect climate, floods, disease, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation, photosynthesis, and nutrient cycling (Walter et. al., 2005).

Actions/outputs as proposed in the MFF plan for action	Climate change considerations per action/ output as relevant
4.1 Development of simple, easy-to-apply ecosystem valuation tools and methods that can be used for planning and appraising coastal conservation and development activities.	4.1 The valuation tools should include considerations of climate change. At the same time, a number of ecosystem valuation tools ¹ , can be incorporated into the vulnerability and adaptation assessments as well as risk assessment processes.
4.2 Generation of information on coastal ecosystem values in response to specific development and conservation challenges and issues, and for particular high-value or threatened ecosystems and locations.	4.2 Climate change is a significant development and conservation challenge. Ecosystem services are commonly aligned to specific climatic regimes, where a change in conditions can result in loss of ecosystem services. To manage ecosystem values in a changing climate, 'limits of acceptable change' ² are used to define thresholds for ecosystem change, and consequently set management approaches to manage such change.
4.3 Training and awareness building among both development and conservation planners on the economic value of coastal ecosystems and the use of economic tools.	4.3 As stated in 4.2, climate change will impact ecosystem services and there are a number of tools that can be applied to understand both the impacts, and the economic value of projected impacts. These tools should be incorporated in training and awareness programmes.

¹ Benefit-cost analysis is the most widely used economic analysis tool because of its flexibility and broad applicability, it compares the present value of all social benefits with the present value of opportunity costs in using resources (Field 1994). For more information on Benefit-cost analysis see: Lipton et al. 1995

² LAC was developed by US Forest Services researchers to manage increasing levels of recreational use in wilderness areas and associated environmental consequences. There are nine interrelated steps in the LAC process, leading to a set of standards and associated actions to achieve them. The process is flexible and allows users to adapt and modify the application. The process seeks to define the minimally acceptable conditions or limits for social and physical resources in an area through a consensus approach. Once a baseline of information has been gathered, monitoring and management techniques are suggested to maintain the area within the acceptable limits. The steps are as follows: 1. Identify area issues and concerns; 2. Define and describe recreational opportunity spectrum classes; 3. Select indicators of resource and social conditions; 4. Make an inventory of existing resource and social conditions; 5. Specify desired standards for resource and social conditions; 6. Identify alternative opportunity class allocations; 7. Identify management actions for each alternative; 8. Evaluate and select preferred alternative; 9. Implement actions and monitor conditions.

Actions/outputs as proposed in the MFF plan for action	Climate change considerations per action/ output as relevant
4.4 Development of decision-support tools, including databases and GIS maps, which integrate data on economic values with information on biophysical and socio-economic characteristics, trends and vulnerabilities in coastal areas.	4.4. Decision support tools should incorporate climate change projections in the coastal zone, hazard map for example, to enable the alignment between climate change and impacts on biophysical and socio-economic characteristics, and, trends and vulnerabilities in coastal areas

PoW 5: Applying a Monitoring, Learning and Evaluation (MLE) approach to accelerate knowledge dissemination

The evaluation of environmental management programmes is an important tool to understand the effectiveness of different management approaches; these are applicable to all management measures undertaken to respond to environmental challenges.

When conducting an evaluation, it is important to consider the impacts of climate variability during the period of coastal management activities. This ensures that the effectiveness of any initiative is considered in relation to the system variability, i.e. true appreciation of the ability of a management response to meet targets within the context of a changing climate. When implementing specific climate change adaptation measures, the impacts of the projects must be assessed against changing hazard profiles, meaning that it is not sufficient to simply compare losses or damages before and after adaptation interventions. Where trends in climate hazards occur over periods during which assessment of project impacts are taking place, indicators of loss or damage should be 'normalised' to account for changing hazards (Frankel-Reid and Brooks 2008). The time scale for an appropriate assessment should also be considered, as the results of a climate change adaptation project may take place over a very long time frame, and can often exceed a decade from the date of initial implementation. This assessment will need to take into account the uncertainty of the scenarios and projections on which the project was based.

Actions/outputs as proposed in the MFF plan for action	Climate change considerations per action/ output as relevant
5.1 Region-wide evaluation of the environmental impacts of the post-tsunami reconstruction process, efforts at ecosystem restoration, and review of funding to environmental activities.	See 'climate change considerations' for this PoW as outlined in the introductory text above.
5.2 Development of consolidated methods and networks for environmental/ecosystem monitoring and evaluation and their application to ongoing programmes of coastal reconstruction, development and ecosystem conservation, including their application to all activities carried out under MFF.	
5.3 Dissemination and ongoing sharing of practical and policy-relevant findings and recommendations of environmental evaluations post-tsunami, including lessons learned and identified priorities for future action.	
5.4 Targeted review of the impacts of the tsunami on women's use and management of the environment for livelihoods.	

PoW 6: Promoting civil society awareness and participation in coastal decision making

The impacts of climate change will be far reaching, ranging from impacts on infrastructure in the coastal zone to impacts on agricultural production. The impacts of climate change will vary throughout the coastal zone, dependent upon exposure to the driving climatic processes and capacity of populations to adapt to the changes in climatic conditions.

Awareness raising is a key tool in increasing community capacity to adapt to the potential impacts of climate change. Consequently, targeted awareness programmes should include information on the potential impacts of climate change in the coastal zone, and the link between climate change, livelihoods and disaster risk reduction.

Actions/outputs as proposed in the MFF plan for action	Climate change considerations per action/ output as relevant
6.1 Targeted awareness programmes on the role and importance of coastal ecosystems for development and livelihoods, and for stakeholders such as women; school children; resource users; protected area buffer communities; urban dwellers; local government administration, and national development decision-makers.	6.1. Incorporate information on the potential impacts of climate change in awareness raising programmes.
6.2 Translation of key documents and information materials into the local language, and adaptation to local conditions and circumstances. 6.3 Development of primary and secondary school curricula on coastal ecosystem topics. 6.4 Support to multi-stakeholder forums for coastal zone management, at the local level and within the context of national Integrated Coastal Management (ICM) programmes. 6.5 Work with the mass media to build the capacity of journalists to report on ecosystem concerns in radio, TV, online and print, with a special focus on local language reporting. 6.6 Support for establishing a forum for women to discuss and elaborate ideas and tools for the restoration work.	See 'climate change considerations' for this PoW, as outlined in the introductory text above.

PoW 7: Building the capacity of professional coastal managers for integrated coastal management

There are a range of tools and resources available to support Integrated Coastal Management (ICM). These tools and resources assist in facilitating the completion of climate change risk/vulnerability assessments. These assessments are an integral part of ICM as they provide an assessment of the potential impacts of climate change in the coastal zone, and methods to assess management options to deal with the identified risks. Consequently, it is crucial to integrate risk and vulnerability assessments, as well as conceptual adaptation measures (e.g. disaster risk reduction) in capacity building programmes for coastal managers.

Actions/outputs as proposed in the MFF plan for action	Climate change considerations per action/ output as relevant
7.1 National capacity and training needs assessments for different stakeholder groups in order to identify gaps, needs, strengths and opportunities for building capacity in ICM.	7.1 Capacity and training needs assessments should consider the capacity of different stakeholder groups in undertaking climate change risk and vulnerability assessments. A number of approaches to climate change risk assessment and planning are outlined in Section 2 of this document.
7.2 Support to existing regional and national centres of training, research and excellence in ICM. 7.3 Support to tertiary education and research in ICM through grants, partnership and leadership development programmes.	7.2/7.3 Support to regional and national centres and tertiary education and research in ICM, should be provided to develop and refine training and leadership programmes for ICM that incorporate climate change assessment, impacts and adaptation measures.
7.4 Development of targeted training modules for continuing education of coastal practitioners and managers.	7.4 Training modules developed for continuing education of coastal practitioners and managers should incorporate concepts of climate change assessment, impacts and adaptation measures.

PoW 8: Supporting environmentally sustainable livelihoods among coastal communities

Climate change has a variety of impacts, not only on natural ecosystems but also on livelihoods. There are a number of tools and approaches available for assessing the impacts of climate change on local livelihoods (see Section 2 of this document). Understanding the potential impacts of climate change on livelihoods will provide crucial information to support and plan for environmentally sustainable livelihoods.

Actions/outputs as proposed in the MFF plan for action	Climate change considerations per action/ output as relevant
8.1 Development of models to guide livelihood restoration in post-disaster situations, and methods to promote an action-learning approach to ensure that livelihood restoration activities are adapted to specific local needs and ecosystem conditions.	8.1 Restoration activities should be completed based on an understanding of future conditions in the coastal zone, both climatic and socio-economic. This will ensure the sustainability of restoration efforts. Therefore, models developed to guide livelihood restoration should incorporate an assessment of future conditions in the coastal zone. Approaches designed to assess future conditions in the coastal zone are outlined in Section 2 of this document.
8.2 Development and replication of small community-led ecotourism activities related to mangroves and other coastal ecosystems, and improve access to markets.	8.2 As stated in 8.1, the impacts of climate change will include altering the physical coastal system through rising sea levels and changes in the frequency of extreme events. The development of coastal ecotourism activities should consider how projected climate changes might impact on coastal ecosystems, and subsequently impact ecotourism activities. In addition, ecotourism activities may be used as a tool to educate visitors about climate change and the role ecosystem services, such as mangroves, play in increasing resilience to the impacts of climate change.
8.3 Support the restoration of fisheries and aquaculture in tsunami-affected areas, and ensure that these efforts are environmentally sustainable.	8.3 The changing climate will influence oceanographic conditions and sea surface temperatures as a result of altered wind regimes and changes in the frequency and intensity of extreme events. This may have an impact on fisheries and aquaculture activities. Assessment of the potential impacts of climate change on the restoration of fisheries and aquaculture should be undertaken to ensure sustainability of restoration efforts.
8.4 Development of efforts to add value to local-use and marketing of non-fish mangrove products, linked to community-based management and conservation approaches.	8.4 The impacts of climate change on mangrove systems will vary dependent upon exposure to climatic drivers and available land for propagation. Activities to add value to local-use and marketing of non-fish mangrove products should consider the potential impacts of climate change on the site, to ensure sustainability of the activities.
8.5 Identification and information sharing on alternative livelihoods that can address the key threats to coastal ecosystems, which arise from unsustainable exploitation, or damaging harvesting methods, while also meeting the long-term needs and changing socio-economic aspirations of coastal communities.	8.5 Evaluate the potential impacts of climate change on alternate livelihoods, to ensure their sustainability.

PoW 9: Improving community resilience to natural disasters and climate change

Improving the resilience of communities to natural disasters is primarily shaped by access to information and resources on vulnerabilities and adaptive capacity, hazard risks, area planning and capacity building.

Climate change will alter the natural, socio-economic and environmental characteristics of the coastal zone, as well as modify the frequency and nature of coastal hazards. The changes will vary by location, and thus vulnerability assessments are required to provide details on the projected impacts of climate change at each location. Tools to facilitate this are outlined in Section 2 of this document.

Actions/outputs as proposed in the MFF plan for action	Climate change considerations per action/ output as relevant
9.1 Further application of vulnerability assessment and mapping in coastal areas, including integrating livelihood and ecosystem information into exiting databases and associated disaster preparedness and response strategies.	9.1 Climate change projections in key climate variables (including sea level, temperature, rainfall, and wind regimes) and projected scenarios should be included in vulnerability assessments and mapping in coastal areas.
9.2 Continuation and incorporation of additional countries into the coastal community resilience component of the USAID IOTWS. This includes replicating activities in other villages and extending methodologies for assessing community vulnerability, with particular attention to the most vulnerable groups including women and children.	9.2 Tsunamis are not climate related disasters and therefore climate change consideration might be minor in this context. However the projected impacts of climate change in the project sites would be an integral component of community vulnerability assessment (multi-hazards early warning systems). Also information on future climate conditions will be relevant in order to plan 'climate proof' IOTWS related infrastructure.
9.3 Support for activities to strengthen coastal shelter belts and green belts where they are clearly needed and where they have been proven to make a demonstrable contribution to the protection of coastal communities and settlements, using environmentally-sound techniques.	9.3 Climate change considerations form the basis of this activity. When selecting a project site, 'current needs' should be taken into account, but also future needs to address natural hazards. Determining the location of coastal shelter belts and green belts should incorporate a consideration of the potential climate changes that may be experienced within the study site, and how these may impact the coastal zone. For example, sea level rise may result in significant levels of inundation or erosion. This information will support the selection of coastal shelter and greenbelt locations. From a climate change perspective, establishment of green belts will also provide services for climate change mitigation ('carbon sinks'), which can lead to a source of income under the Reducing Emissions from Deforestation and Forest Degradation (REDD) programme.

PoW 10: Identifying sustainable financing mechanisms for coastal ecosystem conservation

Identifying sustainable financing mechanisms for coastal ecosystem conservation will support the ability to undertake coastal climate change vulnerability and risk assessments. Vulnerability and risk assessments are a fundamental component to all aspects of Integrated Coastal Management (ICM). In addition, protection and sustainable management of coastal forests and other coastal ecosystem services are important measures for climate change adaptation. These considerations might allow you to tap into several different climate change and disaster risk reduction funding mechanisms. To identify sustainable financing mechanisms:

- Seek out international organisations that offer national level assistance; and
- Engage with international non-governmental organisations, many of whom are incorporating climate change adaptation into their local aid programmes.

When identifying sustainable financing mechanisms for coastal ecosystem conservation, the impacts of future climate variability on the ecosystem conservation should also be taken into account. It should be considered that the economic value, or potential value of mangroves and other coastal ecosystems, could change as a result of future climate variability.

Actions/outputs as proposed in the MFF plan for action	Climate change considerations per action/ output as relevant
10.1 Review of innovative and sustainable funding mechanisms which are applicable to coastal areas and coastal management actions.	10.1. For example, if mangrove resources are identified to support income generation, there should be a specific focus on species resilient to climate change (i.e. with high adaptive capacity).
10.2 Development of materials which address the economic returns from investing in coastal ecosystems, and an associated awareness campaign for decision-makers who determine government budget allocations and overseas development assistance.	10.2. Coastal ecosystems represent crucial natural barriers to mitigate the impact of natural hazards on coastal areas and therefore play a vital role in climate change adaptation.
10.3 Piloting of payment for ecosystem services schemes for selected coastal ecosystems and management programmes, based on private-public-community partnerships.	10.3 Payment for ecosystem services could be easily coupled with REDD and with protective services against natural hazards.
10.4 Review of the needs and opportunities for a regional trust fund for coastal ecosystem management, leading to recommendations for development if appropriate. 10.5 Development and implementation of long-term sustainable financing strategies for key MFF actions, paying particular attention to actions aimed at protected area management, coastal ecosystem rehabilitation, and community sustainable livelihood activities.	10.4/10.5. Refer to climate considerations in PoW 5, as outlined in the introductory.

PoW 11: Supporting national integrated coastal management programmes

Understanding climate change in the coastal zone is a fundamental component to Integrated Coastal Management (ICM). Climate change will alter the physical, socio-economic and environmental characteristics of the coastal zone. However, the impacts will vary based on physical exposure and capacity of the local population.

There are a number of tools, frameworks and programmes that can be applied to facilitate the mainstreaming of climate change adaptation within coastal management programmes (see Section 2 of this document). These tools and frameworks will support national integrated coastal management programmes.

Actions/outputs as proposed in the MFF plan for action	Climate change considerations per action/ output as relevant
11.1 Assessment of national institutional mechanisms and programmes for ICM in order to identify and set up appropriate, inclusive and sustainable governance mechanisms for MFF.	Not applicable – refer to climate change considerations for PoW 5 as outlined in the introductory text.
11.2 In India, support to the operations of state-level coastal zone management authorities.	
11.3 In Indonesia, offer complete support for ICM legislation and plans for its implementation; capacity building to enable the development of Provincial and District level ICM arrangements, and support for the implementation of the National Mangrove Ecosystem Management Strategy, with particular emphasis on Aceh Province.	
11.4 In the Maldives, support to the development of measures and mechanisms for inter-sectoral coordination in integrated coastal management.	
11.5 In the Seychelles, support the revision of policy and legislation on coastal development to reflect ecosystem concerns.	
11.6 In Sri Lanka, support inter-sectoral mechanisms for integrated coastal zone management through the Coast Conservation Department.	
11.7 In Thailand, offer continued support to the development and implementation of Promotion of Marine and Coastal Resources Management Act and National Coastal and Marine Policy.	

PoW 12: Strengthening the integration and enforcement of environmental and social safeguards in coastal land use planning

Legal and regulatory measures governing coastal zone land use and development are a fundamental tool to facilitate sustainable ICM. They are integral to ensuring compliance with the management controls that support sustainable use of coastal zones. Consequently, the projected impacts of climate change should be reviewed and incorporated within planning and regulatory frameworks, to ensure that land use and development is sustainable in the future.

Actions/outputs as proposed in the MFF plan for action	Climate change considerations per action/ output as relevant
12.1 Review of legal and regulatory measures governing coastal zone land use and development, and associated information sharing among coastal planners and developers.	12.1 Coastal zone land use planning should incorporate information on project climate changes, and how these may impact land uses. For example, development setbacks should be based on a consideration of potential sea level rise and how this may impact proposed land use. Such assessments may be conducted as part of Environment Impact Assessments, completed as an integral component in the planning and review process.
12.2 Support the development of spatial plans for coastal zones at national and local levels, including the assessment of critical and vulnerable ecosystems and the needs for ecosystem protection within land- use zoning.	12.2 Spatial plans should incorporate information on climate change projections, and the impacts of projected climate changes on the natural and socio-economic systems in the coastal zone. This information will inform the identification of critical and vulnerable ecosystems and the needs for ecosystem protection within land use zoning.
12.3 Support the formation of resolution mechanisms to deal with land-use conflicts around critical ecosystems, particularly protected areas.	12.3 The impacts of climate change in coastal areas could place an additional burden on the already over-used natural resources. This could potentially create additional causes of conflicts. When addressing land-use conflicts this concept should be taken into consideration

PoW 13: Building national systems of marine and coastal protected areas that contribute to a regional network

Marine and coastal ecosystems will change under the projected impacts of climate change. The processes that govern their structure and form; temperature, rainfall, and wind regimes, will alter under climate change projections resulting in potential changes to ecosystems.

Consequently, reviews of protected areas undertaken to inform management perspectives should consider how climate change might impact on coastal protected areas. This will help to ensure that management practices are developed to manage potential impacts and take advantage of any opportunities. This may involve the development of new marine and coastal protected areas as a result of vulnerability and risk assessment results.

Actions/outputs as proposed in the MFF plan for action	Climate change considerations per action/ output as relevant
13.1 Gap analysis to review existing protected area coverage, identify regionally or nationally underrepresented ecosystems, and recommend areas in need of additional protection.	13.1 When completing the gap analysis, it is important to consider how projected climate changes may impact the existing protected areas, as well as other underrepresented ecosystems, in order to identify areas in need of additional protection. Results of vulnerability and risk assessments would assist to identify key areas of interest.
13.2 Assessment of management effectiveness of existing protected areas which lead to the development of strategies for management improvements.	13.2 Management improvements should be based on a consideration of the potential impacts of climate change on protected areas, to ensure that the management recommendations are continuing to preserve and enhance the protected area under altered climate conditions.
13.3 Provide support to the development of new, or strengthening of existing, protected areas in critical or under-represented coastal ecosystems.	13.3 The potential impact of climate change on coastal ecosystems should be reviewed to support the identification of critical coastal ecosystems that require development or the strengthening of protected areas. This would be assisted with results from vulnerability and risk assessments.
13.4 Supporting a regional forum and learning network to share knowledge and approaches on protected area management.	13.4 Forums and learning networks may consider how climate change assessment can support protected area management.
13.5 Development of codes of conduct for the use of protected areas in the tourism sector.	13.5. As per 13.2, any management controls including codes of conduct, should be based on a consideration of the potential impacts of climate change on protected areas, to ensure that the management recommendations are acting to continue to preserve and enhance the protected area under altered climate conditions.

PoW 14: Promoting adaptive coastal management programmes that include ongoing ecological and socio-economic assessment and monitoring

Adaptive coastal management programmes must consider the potential impacts of climate change and how these may be addressed to ensure system sustainability.

Monitoring plays a vital role in the collection of information to be integrated within climate change vulnerability and risks assessments. Therefore, the activities under PoW 14 are similar to PoW 1, where the primary output is the collection of information. However, training in monitoring and review processes is an additional output for PoW 14.

Actions/outputs as proposed in the MFF plan for action	Climate change considerations per action/ output as relevant
14.1 Needs assessment to identify existing socio-economic and ecological baselines, and gap-filling of deficiencies in key data and indicators.	<p>14.1. Socio-economic and ecological baselines are a key component in any assessment of climate change impacts in the coastal zone.</p> <p>In addition, risk assessment and adaptation-planning needs should be considered when identifying gaps in data and indicators for ecosystem and socio-economic change.</p>
14.2 Support regional and national systems for the spatial assessment of ecosystems using satellite imagery, and for mechanisms which develop the communication and information sharing necessary to combine data at a regional level.	14.2 Information derived through spatial assessment of ecosystems is a primary input into risk assessment, and subsequently adaptation planning for climate change. Therefore, this action supports the climate change risk assessment and adaptation planning.
14.3 Development and associated training in the use of common protocols for community-based and scientific monitoring of coastal ecosystem health and socio-economic indicators.	14.3 The monitoring of ecosystem health and socio-economic indicators should include training on the identification and review of indicators for the impacts of climate change on these systems.
14.4 Application of ecological and socio-economic assessment and monitoring mechanisms for key MFF actions, paying particular attention to actions aimed at protected area management, coastal ecosystem rehabilitation, and community sustainable livelihood activities.	14.4 The ecological and socio-economic assessment and monitoring systems applied in protective area management, coastal ecosystem rehabilitation and community sustainable livelihood activities should incorporate climate change considerations. Climate change will alter all coastal ecosystems, whether negatively or positively, and therefore it is important to ensure that an understanding of projected future conditions is incorporated in any coastal management activities. Tools outlined in Section 2 of this document can support information gathering to increase awareness of the potential impacts of climate change in the coastal zone.

PoW 15: Encouraging environmentally sustainable business practices in coastal areas

Sustainability and climate change are integrated elements that cannot be considered in isolation from one another. Consequently, any activities undertaken to encourage environmental sustainable business practices in coastal areas should consider how climate changes might impact businesses and the environment to inform the development of business practices that will be sustainable into the future.

Actions/outputs as proposed in the MFF plan for action	Climate change considerations per action/ output as relevant
15.1 Development and dissemination of sector-specific guidelines on environmental risks, threats and opportunities, and existing regulatory mechanisms involving both the adaptation of existing materials (including those produced after the tsunami) as well as production of new resources.	15.1 Development and dissemination of sector-specific guidelines on environmental risks, threats and opportunities – should include risks and opportunities derived through projected climate changes. The Australian Greenhouse Office (AGO) (2007) Risk Framework ³ outlines an approach to incorporate climate change planning into businesses.
15.2 Raising awareness amongst chambers of commerce and other business/commercial associations on green business opportunities and benefits.	15.2 Awareness raising programmes should incorporate information on the projected impacts of climate change to business and commercial organisations, and the ways in which they can manage those impacts. The AGO Risk Framework may be presented as a means of planning for climate change.
15.3 Targeted support to specific partnerships between government, non-government organisations and local communities, and the private sector in developing joint mechanisms and collaborative arrangements for identifying opportunities for green enterprise development and support to coastal conservation.	15.3 Provision of support should be based on an understanding that the potential impacts of climate change will be considered in enterprise development and coastal conservation activities. Thus ensuring sustainability of investments.
15.4 Development of codes of conduct, leading to possible certification schemes where appropriate, for key industries and business sectors such as tourism, housing and fisheries.	15.4 As per 13.2, any management controls including codes of conduct, should be based on a consideration of the potential impacts of climate change on industry and business sectors to ensure that the management recommendations promote climate change mitigation and adaptation.

³ Australian Greenhouse Office (AGO) (2007) *Climate Change Impacts & Risk Management: A Guide for Business and Government*. Australian Greenhouse Office, in the Department of the Environment and Heritage, 73pp.

Section 2: Review of selected climate change tools and methods

Introduction

As a value-adding component to the mainstreaming process, tools to support climate change integration and adaptation have been reviewed and outlined below (Tables 1-3). This review is intended to support the assessment of climate related impacts and the development of strategies to address the identified impacts. It is not an exhaustive review of all of the available tools and methods to support climate change adaptation. Rather, the review focuses on tools and methods that may be applicable to answering the primary questions that may arise for MFF project proponents. Consequently, the assessment commences with an alignment of tools to 'questions being asked' (Table 2). The aim is to provide users with a clear understanding of the types of information that can be derived through the application of different tools. MFF partners should consider their primary information needs, and then use Table 2 to determine which tools are able to meet those information needs.

A brief description of each tool is provided below in the section 'Tools and Methods'.

In many cases there is more than one tool aligned to each of the key questions to be answered. The significance and applicability of different tools within the overall appraisal varies widely according to Benson & Twigg (2007). They include:

- The nature and scale of the project being undertaken;
- The resources of the agency involved, which may limit the range of issues that can be taken into account and how thoroughly they can be assessed; and
- The type of project (for example, large-scale infrastructure development usually requires extensive environmental and social impact analysis, whereas social development projects may focus on community participation in the project design).

Consequently, each tool was screened based on the following criteria:

- Focus;
- Scope;
- Resources required including time, information needs and training; and
- MFF applicability.

Table 1: Screening criteria for adaptation tools and methods

Criteria	Description	Categories
Focus	Specifies the focus of the tool, whether it is information collection or assessment.	<u>Information</u> : the tool focuses on providing information on climate change, and/or current climatic and socio-economic conditions. The primary aim is to provide information that can be input into risk assessments or vulnerability assessments. <u>Assessment</u> : the tool outlines an approach to an assessment. This may be an approach to a vulnerability and/or risk assessment, or an approach to climate change mainstreaming. Further information on the focus of the assessment can be gathered from the 'scope' column.
Scope	Outlines the thematic focus of the tool and the type of project	Risk Assessment

Criteria	Description	Categories
	to which it will apply.	<p>Vulnerability Assessment</p> <p>Mainstreaming</p> <p>Awareness raising</p> <p>Ecosystems</p> <p>Livelihoods</p>
Scale	The scale at which the tool are applicable.	<p><u>National</u>: Provides information and approaches to assessment at the national scale.</p> <p><u>Regional</u>: Provides information and approaches to assessment at the regional scale.</p> <p><u>Local</u>: Provides information and approaches to assessment at the local scale.</p> <p><u>All</u>: Is applicable across all the three scales.</p>
Time	Specifies how much time is required to implement the selected tool.	<p><u>< 2 weeks</u>: Less than two weeks</p> <p><u>< 1 month</u>: Less than one month</p> <p><u>2-6 months</u>: Between 2 and 6 months</p> <p><u>> 6 months</u>: More than six months</p> <p><u>Variable</u>: the implementation time will depend on the level of detail to be gathered through application of the tool, and is not consistent across all applications.</p>
Information Needs (input and output)	Defines the type of information required to be input into the tool to produce an output, and the type of information produced through application of the tool.	<p><u>Quantitative</u>: Analysis applies numbers, measurements and statistics – hard data. In general terms, quantitative information is more difficult to obtain and more resource intensive (there may be a cost associated with obtaining quantitative information).</p> <p><u>Qualitative</u>: Analysis is concerned with meaning rather than numbers. Emphasis is on subjective understanding, communication, and empathy rather than on prediction and control. Qualitative methods vary and are generally based on empirical research. Qualitative information can be obtained through semi-structured interviews.</p>
Training	Specifies if training is required to be able to implement the tool effectively, as a simple 'Yes' or 'No' response. The level of training required would depend on the skills and experience of the trainee, and therefore is not specified in this review. However, a quick review of the tool itself would provide project proponents with an appreciation of the level of training they, or their staff, may require to be able to effectively implement the tool.	
MFF applicable	In some cases, the tools may be currently limited to a specific regional or national location, for example, Mesoamerica. Consequently, these tools would not be applicable to MFF target countries in their current form. However, they are included within the review to provide information on the scope of tools available. Furthermore, these tools may be updated to cover a broader regional scale, and therefore may be a valuable tool for MFF target countries in the future. Specified as a simple 'Yes' or 'No' response.	

Table 2: Tools aligned to primary vulnerability and assessment questions

Tool Category	Primary Questions Answered	Tool Name
Climate Change Impact Assessment	What are the predicted changes in climate?	<ul style="list-style-type: none"> PRECIS SDSM: Statistical Downscaling Model SERVIR Climate Change Mapping Tool (currently only available from Americas and Africa – keep watch for additional localities)
	How will the projected changes in climate impact: <ul style="list-style-type: none"> (i) ecosystems (ii) livelihoods 	<ul style="list-style-type: none"> IPCC Special Report Community-based Risk Screening Tool- Adaptation & Livelihoods (CRiSTAL) Identifying climate variability and exposure IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptation UNEP handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies Adaptation Policy Framework: Technical Paper
Climate Change Risk Assessment	What are the predicted climate changes?	<ul style="list-style-type: none"> PRECIS, SDSM: Statistical Downscaling Model SERVIR Climate Change Mapping Tool (currently only available from Americas and Africa –additional localities may be included in the future) IPCC Special Report
	How will the changes in climate impact the objectives of my organisation/project?	<ul style="list-style-type: none"> ADAPT – World Bank UKCIP: Risk, Uncertainty and Decision Making IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptation UNEP handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies
	What risks will arise from the impacts of climate change on my objectives?	<ul style="list-style-type: none"> UKCIP: Risk, Uncertainty and Decision Making IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptation UNEP handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies Adaptation Policy Framework: Technical Paper 4: Assessing Current Climate Risks Adaptation Policy Framework: Technical Paper 5: Assessing Future Climate Risks
	How can I reduce the risks and take advantage of opportunities – what climate change adaptation actions should I take?	<ul style="list-style-type: none"> Adaptation Wizard UKCIP: Risk, Uncertainty and Decision Making IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptation UNEP handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies
Climate Change Vulnerability and Adaptation Assessment	How vulnerable are my natural and human systems to climate changes?	<ul style="list-style-type: none"> Climate Analysis Indicators Tool Identifying climate variability and exposure – SEI, ACCCA Country Database IPCC Special Report Community-based Risk Screening Tool- Adaptation and Livelihoods (CRiSTAL) Participatory Capacities and Vulnerabilities Assessment (PCVA) A guide for field staff on participatory vulnerability assessment Methods for assessing human health vulnerability and public health adaptation to climate change Adaptation Policy Framework: Technical Paper 3: Assessing Vulnerability for Climate Adaptation

	How can I reduce the vulnerability of these systems – what climate change adaptation actions should I take?	<ul style="list-style-type: none"> ▪ IPCC Special Report ▪ Community-based Risk Screening Tool- Adaptation & Livelihoods (CRiSTAL) ▪ Adaptation Wizard ▪ Participatory Capacities and Vulnerabilities Assessment (PCVA) ▪ A guide for field staff on participatory vulnerability assessment ▪ Methods for assessing human health vulnerability and public health adaptation to climate change ▪ Adaptation Policy Framework: Technical Paper 7: Assessing and Enhancing Adaptive Capacity ▪ Adaptation Policy Framework: Technical Paper 8: Formulating an Adaptation Strategy
Climate change mainstreaming	How can I integrate climate change at national, sectoral and local scales?	<ul style="list-style-type: none"> ▪ Adapting to Climate Variability and Change: A guidance manual for development planning ▪ Guidance notes on tools for mainstreaming disaster risk reduction: ProVention ▪ Adaptation Policy Framework: Technical Paper 9: Continuing the Adaptation Process

Tools and methods

This chapter provides a short description of each of the tools outlined in Table 2. In addition, it provides links to further resources, such as information databases and platforms which contain further information on climate change adaptation.

The tools are structured into three groups, based on their primary roles:

- *Information generation, databases and platforms:* Tools that support information collation, whether that is information to support an assessment or additional tools and resources describing climate change adaptation.
- *Computer based decision tools:* Intended to assist users to identify climate related risks and adaptation options based on project/programme inputs.
- *Adaptation planning and risk management processes:* Guidelines and frameworks for adaptation and risk assessment.
- *Adaptation planning and risk assessment support tools:* Tools used to support the implementation of a selected adaptation and risk management process.

The information contained herein is derived from UNEP (2008); and the NAPA Platform (www.adaptationlearning.net/guidance-and-tools/napa-platform).

Information generation, databases and platforms

PRECIS - Providing Regional Climates for Impacts Studies - UK Met Office Hadley Centre

This tool provides climate impact assessments in a developing country context that is available to numerous users (only in conjunction with participation in a PRECIS workshop). The tool uses Global Climate Models (GCM) to provide grid-scale averages of spatio-temporal hydro-climatic state variables as well as soil hydrology and thermodynamics, and some vegetation dynamic variables. The tool is applicable to multiple scales, sectors and levels of screening but is limited to fine/point scale information (<http://precis.metoffice.com/>). Due to the potential constraints on accessing funding to participate in a PRECIS workshop, it is recommended that interested parties contact: precis@metoffice.gov.uk, and request information on institutions that have been involved in PRECIS. An institution in your area may have already made use of PRECIS and would be willing to share the output data from their PRECIS runs with you. In this way you can obtain the data you need to carry out an impacts study without being subject to any charge. The handbook for PRECIS can be downloaded from http://precis.metoffice.com/docs/PRECIS_Handbook.pdf

SERVIR Climate Change Mapping Tool - USAID, NASA, CATHALAC, IAGT

This web-based tool is intended to assist users of the USAID Climate Adaptation Guidance Manual to instantly access climate information needed for adaptation projects. The tool is an open platform which is applicable to multiple sectors and is available to various users. The current version focuses on Mesoamerica and Africa and is used by Central American disaster planners, TV weather reporters, cruise ship operators, resource managers, and many others (www.servir.net). This information source is currently limited to Mesoamerican and African regions, and is therefore not applicable to MFF target countries in its current format.

Statistical Downscaling Model (SDSM) – Environment Agency, UK

This computer-based information tool is open-source and is aimed at donors, governments and impact assessors. The tool provides daily, transient, climate risk information for impact assessments over the 1961-2100 time period. After calibration of data, the tool provides rapid assessments to assist impact and adaptation analysis.

- SDSM (Statistical Down Scaling Model) is a decision support tool for assessing local climate change impacts using a robust statistical downscaling technique.
- SDSM facilitates the rapid development of multiple, low-cost, single-site scenarios of daily surface weather variables under current and future regional climate forcing.

Additionally, the software performs ancillary tasks of predictor variable pre-screening, model calibration, basic diagnostic testing, statistical analyses and graphing of climate data.

Project proponents may require training in the use of the tool. (Further information can be gathered from: www.sdsm.org.uk)

Climate Analysis Indicators Tool – WRI

An information and analysis tool on global climate change developed by the World Resources Institute that provides a comparable database of greenhouse gas emissions data (including all major sources and sinks) and other climate-relevant indicators. The vulnerability and impacts component of CAIT includes information on historical impacts, particularly from disaster events, as well as a range of human development indices (<http://cait.wri.org/>). The information can be included within vulnerability and adaptation assessments and includes broad scale information on items such as the percentage of the population living close to the coast and land area lying below five metres above sea level.

Adaptation Learning Mechanism

The Adaptation Learning Mechanism (ALM) draws from experiences on the ground, featuring tools and practical guidance to meet the needs of developing countries. It seeks to provide stakeholders with a common platform for sharing and learning on climate change adaptation issues. The site contains links to a number of adaptation tools and resources; one being a Country Database (www.adaptationlearning.net/)

Country Database – UNDP-GEF

The country database was originally established to help UNDP offices to develop adaptation proposals and improve staff awareness on climate risks for other project design. It compiles a common set of information for each UNDP partner country, drawn from National Communications, NAPAs and other scientific studies, together with UNDP country programme information, on an easy to operate webpage format. The Country database can now be accessed through the Adaptation Learning Mechanism, and the information contained within the database may support the screening assessment to be conducted as part of MFF large project guidelines.

NAPA Platform

The National Adaptation Programme of Action (NAPA) platform is aimed at providing informational support to NAPA country teams, implementing agencies (UNDP, UNEP and World Bank), vulnerability and adaptation experts, and other partners providing NAPA technical assistance. It aims to facilitate the delivery of technical assistance, particularly with regards to the synthesis of existing vulnerability and adaptation information, and the formulation of relevant adaptation projects profiles. It provides multi-sectoral information aimed at the programme and project level for Least Developed Countries within the NAPA process. A resource on the NAPA Platform is the NAPA library. The library can be searched to find information and resources to support climate change adaptation, by sector.

Other information generation/database tools

Historical data and statistics on natural disaster occurrence and their impact since 1905 are available from the OFDA/CRED International Disasters Database (EM-DAT), maintained by the Centre for Research on the Epidemiology of Disasters (CRED) (www.emdat.be/). Data can be downloaded by country of interest. A wide range of historic climate data and near-term forecasting data are available through meteorological offices and through the WMO (www.wmo.int/).

IPCC Special Report - The Regional Impacts of Climate Change: An Assessment of Vulnerability

The 2007 Working Group II report "Impacts, Adaptation and Vulnerability" provides more updated information on a regional basis on vulnerability to potential changes in climate; ecological systems; socioeconomic sectors (which includes agriculture, fisheries, water resources and human settlements), and human health. The report reviews the sensitivity of these systems as well as options for adaptation. (<http://195.70.10.65/ipccreports/ar4-wg2.htm>)

Computer based decision tools

CRISTAL (Community-based Risk Screening Tool- Adaptation & Livelihoods) – IISD, IUCN, SEI, Intercooperation

A decision-support tool, which enables project planners and managers to: (a) understand the links between local livelihoods and climate; (b) assess a project's impact on livelihood resources important for climate adaptation; and (c) devise adjustments to improve a project's impact on these key livelihood resources. (www.iisd.org/security/es/resilience/climate_phase2.asp). A very useful tool but requires a significant time investment. There is also a need to participate in a training programme if current knowledge of climate change and vulnerability is low.

ADAPT - World Bank

This computer-based tool is multi-sectoral and currently being tested in South Asia and is soon expanding to a focus on Sub-Saharan Africa. The tool undertakes a sensitivity analysis for specific projects and flags activities that are sensitive to climate change and gives advice on adaptation activities. The tool utilizes project location and activity information, which are screened through a project activity sensitivity matrix based on GCM data. The tool does not utilize specific vulnerability data or adaptation at the sectoral levels. Rather, relies on a climate database to assign a 'risk' rating to the project, and set potential actions to address the identified risks. (www.worldbank.org/climatechange). Such a tool would be very useful for project proponents at the project preparation phase. The outputs of this tool could be used to complete the 'climate change considerations form' in the MFF large project guidelines.

Adaptation Wizard – UK Climate Impacts Programme (UKCIP)

The Adaptation Wizard is a web-based tool that is designed to help users gain a basic understanding of climate change as well as integrate climate risks into their decision-making. It is a high-level, generic tool that is valuable to newcomers to the climate change issue, as well as those who are preparing to adapt. The tool is specifically aimed at the UK context. It is more a decision-support than decision-making tool and plays a valuable awareness-raising and educational role. The tool walks users through an economic analysis of adaptation options and scenarios.

www.ukcip.org.uk/index.php?option=com_content&task=view&id=147&Itemid=297.

Overall, the tool guides decision making rather than providing definitive adaptation options to address specific risks. This is a good approach to generating an understanding of adaptation to climate change, but not necessarily the best tool to guide risk identification and analysis.

Adaptation planning and risk management processes

Adapting to Climate Variability and Change: A Guidance Manual for Development Planning - USAID

The Guidance Manual is aimed at USAID country missions to assist in the mainstreaming of climate change adaptation in all projects. The manual leads project designers through a series of steps to help them understand whether their project may be vulnerable to climate variability or change. The manual encourages stakeholder engagement and provides guidance on where to find more information and assistance in gathering data. (www.usaid.gov/our_work/environment/climate/policies_prog/vulnerability.html)

The report was a good approach to mainstreaming climate change and was the basis for the approach adapted in current MFF programme. This report may be seen as a resource for those that want to go a 'step further' in integrating climate change into their project proposals. It is a more detailed and resource intensive approach than that currently outlined in the MFF programme documentation. It would be a useful tool for application during project implementation.

Guidance notes on tools for mainstreaming disaster risk reduction - ProVention Consortium

The ProVention Consortium has recently published a comprehensive compendium of short briefing papers on tools and methods for mainstreaming disaster risk reduction. These approaches have much in common with climate change adaptation, particularly in their approach to tackling current variability, risk frameworks, and approaches to overcoming barriers to cross-sectoral work.

(www.proventionconsortium.org/?pageid=32&projectid=1).

This report provides a good approach to mainstreaming into the project cycle and was the basis for the approach adapted in the current MFF programme. This report may be seen as a resource for those that want to go a 'step further' in integrating climate change into their project proposals. It is a more detailed and resource intensive approach than that currently outlined in the MFF programme documentation. It may be seen as a useful tool for application during project implementation.

Adaptation Policy Framework (APF) – UNDP

The APF provides guidance on designing and implementing projects that reduce vulnerability to climate change, by both reducing potential negative impacts and enhancing any beneficial consequences of a changing climate. It seeks to integrate national policymaking efforts with a "bottom-up" movement, focusing on the involvement of stakeholders at all stages. The approach has five steps that can be used in different combinations according to the amount of available information and the point of entry to the project. The framework is particularly applicable where the integration of adaptation measures into broader sector specific policies, economic development, poverty reduction objectives, or other policy domains is desirable, (www.undp.org/climatechange/adapt/apf.html) a few technical papers are included in the resource section). While the framework itself is targeted for use at scales larger than the project level, it provides useful information on approaches to mainstreaming climate change into programmes and interventions.

The technical papers supporting the framework are particularly useful, as they outline approaches to: scoping and designing an adaptation project; assessing vulnerability; assessing current and future climate risks; engaging stakeholders; assessing socio-economic conditions and formulating and mainstreaming the adaptation strategy. The APF will be more applicable to project proponents wishing to undertake a detailed climate change adaptation project.

Identifying Climate Variability Exposure - SEI, ACCCA

This guidance sheet provides an approach to identify the key climatic hazards for a specific region and livelihood or economic activity. The outcomes of the process will allow the analyst to: identify measurable climate variables that can be obtained from climate information systems for the present and archives of global climate change models for relevant time periods in the future; identify climate variables and thresholds of concern that would be required in planning adaptation strategies and measures; identify gaps in knowledge where additional sectoral and livelihood studies are required or may be available but not brought into the team's expertise, at the local to national and even regional level.

(http://wikiadapt.org/index.php?title=Advancing_Capacity_for_Climate_Change_Adaptation_%28ACCCA%29)

Step 1 in this framework applies to the focus of the proposed intervention, for example, the target region, activity and/or vulnerable group would be based on the focus on the proposed intervention. A livelihood sensitivity matrix provides a starting point for determining which livelihoods are most vulnerable to different types of climatic hazards and the degree to which different livelihood activities are impacted by different climate hazards

UKCIP: Climate Adaptation: Risk, Uncertainty and Decision Making

The guidance provides a step-by-step decision-making framework to help judge the significance of climate change risk compared to the other risks faced, to determine what adaptation measures are most appropriate. It is recommended that the framework be applied when you have some knowledge of your climate risks but want to fully understand these and get a good understanding of your adaptation options. Alternatively, the UKCIP Adaptation Wizard (see 'Computer based decision tools') is recommended for those new to climate change who may not have a good understanding of climate risks.

IPCC Technical Guidelines for Assessment Climate Change Impacts and Adaptation

This paper outlines a set of technical guidelines that does not single out one preferred method but rather a range of methods, some of which may be more suitable than others to particular tasks, but which yield comparable results across regions and sectors. The guidelines aid users in assessing the impacts of potential climate change and in evaluating appropriate adaptations. The Guidelines outline a seven step process: (1) definition of the problem, (2) selection of the methods, (3) testing of the methods, (4) selection of the scenarios, (5) assessment of biophysical and socio-economic impacts, (6) assessment of autonomous adjustments, and (7) evaluation of adaptation strategies. A range of methods is identified at each step. This is a resource intensive approach to assessment, but provides valuable outputs. It may be seen as an option at the imple-

mentation phase of an intervention, however, would require significant human and financial resource allocations.

UNEP Handbook on Methods for Climate change Impact Assessment and Adaptation Strategies

The UNEP methodology establishes a generic framework for thinking about and responding to the problems of sea level rise and climate change. The user goes through the following seven guiding steps: (1) define the problem; (2) select the method; (3) test the method; (4) select scenarios; (5) assess the bio-geophysical and socio-economic impacts; (6) assess the autonomous adjustments; (7) evaluate adaptation strategies. The last step is itself split into seven sub-steps. At each step, methods are suggested but the choice is left up to the user.

Adaptation planning and risk assessment support tools

Methods of assessing human health vulnerability and public health adaptation to climate change – WHO

This publication is designed to provide practical information to governments, health agencies and environmental and meteorological institutions in both industrialized and developing countries on quantitative and qualitative methods of assessing human health vulnerability and public health adaptation to climate change. Part I describes the objectives and the steps for assessing vulnerability and adaptation and Part II discusses the following issues for a range of health outcomes: the evidence that climate change could affect mortality and morbidity; methods of projecting future effects; and identifying adaptation strategies, policies and measures to reduce current and future negative effects.

(http://www.euro.who.int/__data/assets/pdf_file/0009/91098/E81923.pdf)

Participatory Capacities and Vulnerabilities Assessment (PCVA)

This OXFAM handbook stems from a participatory livelihood vulnerability assessment after a disaster in the Philippines. This way, the document reflects the perspectives and experiences of the survivors themselves, as well as that of the various stakeholders' in managing and responding to disasters in the region. The result is a guide offering: a PCVA framework with participatory rural appraisal; a method to organize a PCVA; a method to conduct a PCVA in a process of learning and action; and how to improve the PCVAs. (http://www.proventionconsortium.org/themes/default/pdfs/CRA/PCVA_2002_meth.pdf)

Gender and Disaster Sourcebook- UNISDR

The Gender and Disaster Sourcebook is an electronic guide to help respond to questions about the link between gender equality and disaster risk and to understand what lessons have been learned in the field and through scientific study. The Sourcebook includes links to tools like the UNCHA - Gender Equality Tool Kit, a comprehensive stand-alone document on gender mainstreaming and a practical tool for gendering disaster risk management. While not climate specific, this tool has much in common with climate risk tools and could be complementary to better integrate climate, gender, and disaster risk management. (www.gdnonline.org/sourcebook). This is a useful resource for those that want to gather a greater understanding of links between gender and climate, but is not a tool or method in itself. Rather, it is a resource guide that provides links to further information. Therefore, it has not been included in the tool review table.

Guide for Field Staff on Participatory Vulnerability Assessment

Action Aid International developed this step-by-step guide. Part one focuses on understanding vulnerability and part two focuses on how to conduct a participatory vulnerability assessment in three steps: preparation (stakeholder mapping, data analysis etc.), analytical framework (vulnerability, causes, community capacity, action to undertake) and a multi-level analysis (<http://www.actionaid.org/assets/pdf/PVA%20final.pdf>). It provides a well-defined approach to conducting participatory V&A assessments.

Table 3: Screening assessment of tools for climate change adaptation

Tool	Focus	Scope	Scale	Time	Training	Info Input	Info Out-put	MFF Appli-cable	Comments
Information generation, databases and platforms									
PRECIS	Information	RA & VA	Multi	Variable	Y	QN	QN	Y	Would require extensive training prior to application. Data input requirements may be high.
SERVIR	Information	RA & VA	Local & Regional	<1 month	N	?	QN	N	Useful tool, but currently only available for Me-soamerica and Africa. Review this tool to check for updates that expand coverage to MFF target countries.
SDSM	Information	RA & VA	Multi	< 1 month	Y	QN	QN	Y	Provides daily, transient, climate risk information for impact assessment over the 1961-2100 time horizon Input requirements may be high. Training required.
Climate Analysis Indicators Tool	Information	RA & VA	National	< 1 month	N	none	QN	Y	Includes broad scale information on items such as per cent of population living close to the coast, and land area lying below 5 metres above sea level. Provides national level information only – more site specific information not available from this resource.
Adaptation Learning Mechanism	Information	All	All	Variable	N	none	-	Y	Provides links to information and resources to support climate change adaptation. Is an information sharing platform. The site contains links to a number of adaptation tools and resources
Country Database	Information	RA, VA, Awareness Raising	National	< 2 weeks	N	none	-	Y	Contains a common set of information for each UNDP partner country drawn from National Communications, NAPAs and other scientific studies together with UNDP country programme information, on an easy to operate webpage format. Information contained within the database may support the screening assessment, to be conducted as part of MFF large project guidelines.

Tool	Focus	Scope	Scale	Time	Training	Info Input	Info Out-put	MFF Appli-cable	Comments
NAPA Platform	Information	RA, VA, Awareness Raising	All	Variable	N	none	-	Y	A support tool for NAPA preparation, but also provides information to support climate change adaptation. A resource on the NAPA Platform is the NAPA library. The library can be searched to find information and resources to support climate change adaptation, by sector.
IPCC Special Report - The Regional Impacts of Climate Change: An Assessment of Vulnerability	Information	RA, VA, Awareness Raising	National	< 1 week	N	none	-	Y	Provides information, on a regional basis, on vulnerability to potential changes in climate, of ecological systems, socio-economic sectors and reviews options for adaptation. Information contained in the reports can be used to support the completion of the 'situation analysis'.
Decision support tools									
Community-based Risk Screening Tool- Adaptation & Livelihoods (CRIS-TAL)	Assessment	VA	Local	< 1 month	Y	QL	QL	Y	Very useful tool but requires significant investment in terms of time. Also need to participate in a training programme if current knowledge of climate change and vulnerability is low.
ADAPT – World Bank	Assessment	Main-streaming	Local, Regional	< 2 wks	N	QL	QL	?	This tool would be very useful for project proponents at the project preparation phase – and the outputs of this tool could be used to complete the 'climate change considerations form' in the MFF large project guidelines. However, problems occurred when downloading the tool (the download was not successful), and it is unclear if the climate database covers all MFF target countries.
Adaptation Wizard	Assessment	RA	All	< 1 month	N	QL	QL	Y	Overall, the tool guides decision-making, rather than providing definitive adaptation options to address specific risks. Good approach to generating an understanding of adaptation to climate change, but not neces-

Tool	Focus	Scope	Scale	Time	Training	Info Input	Info Out-put	MFF Applicable	Comments	
									sarily the best tool to guide risk identification and analysis. Can be seen as a first stage approach to adaptation, which can be followed by implementation of the UKCIP: Risk, Uncertainty and Decision Making Framework.	
Adaptation planning and risk management processes										
Adapting to Climate Variability and Change: A Guidance Manual for Development Planning – USAID	Assessment	Main-streaming	Local & Regional	2- months	6	N	QL & QN	QL	Y	Provides good approach – was the basis for the approach adapted in current MFF programme. Could be seen as a resource for those that want to go a ‘step further’ in integrating climate change into their project proposals. A more detailed and resource intensive approach than that currently outlined in the MFF programme documentation. A useful tool for application during project implementation.
Guidance notes on tools for main-streaming disaster risk reduction - ProVention Consortium	Assessment	Main-streaming	Local & Regional	2- months	6	N	QL	QL	Y	Provides good approach – was the basis for the approach adapted in current MFF programme. Could be seen as a resource for those that want to go a ‘step further’ in integrating climate change into their project proposals. A more detailed and resource intensive approach than that currently outlined in the MFF programme documentation. A useful tool for application during project implementation.
Adaptation Policy Framework - UNDP	Assessment	VA and Main-streaming	All	> months	6	N	QL & QN	QL	Y	The technical papers supporting the framework are particularly useful, as they outline approaches adaptation assessment, stakeholder engagement and assessing socio-economic conditions. The APF will be most applicable to project proponents wishing to undertake a detailed climate change adaptation project.

Tool	Focus	Scope	Scale	Time	Training	Info Input	Info Out-put	MFF Appli-cable	Comments
UKCIP: Risk, Uncertainty and Decision Making	Assessment	RA	All	Variable	N	QN or QL	QN or QL	Y	Provides a staged approach to risk assessment and adaptation planning. Can be quite complex, however data input requirements are dependent on the aims of the assessment, and can range from qualitative to quantitative assessment approaches. Potentially an option at implementation phase of an intervention.
IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptation	Assessment	RA & VA	All	Variable	Y	QN or QL	QN or QL	Y	The guidelines aid users in assessing the impacts of potential climate change and in evaluating appropriate adaptations. A range of methods is identified at each step. Can be a resource intensive approach to assessment, but provides valuable outputs. Potentially an option at implementation phase of an intervention, however, may require significant human and financial resource allocations.
UNEP Handbook on Methods for Climate change Impact Assessment and Adaptation Strategies	Assessment	RA & VA	National and Sub-national	> 6 months	N	QN or QL	QN or QL	N ⁴	Establishes a generic framework for thinking about and responding to the problems of sea level rise and climate change. A staged approach to developing adaptation strategies to address the impacts of climate change.
Tools to support adaptation planning and risk management									
Participatory Capacities and Vulnerabilities Assessment (PCVA)	Assessment	VA	Local to National	> 1 month	N	QL	QL	Y	Good outline of approach and tools that can be used. Not sure if training would be required prior to conducting?
Guide for Field Staff on Participatory Vulnerability Assessment	Assessment	VA	Local to National	2-6 months	N	QL	QL	Y	Provides a well-defined approach to conducting participatory V&A assessments.

⁴ Applicable at national scales, and not applicable at project scale.

Tool	Focus	Scope	Scale	Time	Training	Info Input	Info Out-put	MFF Appli-cable	Comments
Methods of assessing human health vulnerability and public health adaptation to climate change – WHO	Assessment	VA	Local, Regional and National	< 1 month	N	QL	QL	Y	Good outline of approach and tools that can be used. Not certain if training would be required prior to conducting.
Identifying Climate Variability and Exposure	Assessment	VA	Local	< 1 month	N	QN and QL	QL	Y	Provides a standard step-wise approach to climate variability assessment. States that climate information from climate scientists is required – but it may not specify exactly what this covers. Not entirely clear and can be difficult to follow.

Section 3: Integrating climate change into the project cycle

A key principle of MFF, along with all development initiatives, is that of sustainability. Any project or programme that fails to take account of future climate conditions and the vulnerabilities that such conditions create will not be sustainable. Consequently, mainstreaming climate change into MFF development initiatives is a vital step in ensuring project and programme sustainability.

The development of an approach which attempts to mainstream climate change adaptation into the project cycle for MFF programmes was established through a review of existing literature and best practice methodologies. The review focused on two primary areas:

- Mainstreaming climate change adaptation; and
- Mainstreaming disaster risk reduction

Disaster risk reduction (DRR) literature was included within the assessment due to the intertwined nature of disaster risk reduction and climate change. Climate change is expected to increase the severity of many climate-related hazards and to increase vulnerability to climate-related disasters through impacts on ecosystems, livelihoods and health. In fact, climate change will increase vulnerability to most forms of climate-related disasters (UNFCCC, 2008). Consequently, DRR is recognised as an important component to adaptation.

As stated, approaches to DRR address vulnerability to natural hazards and climate variability, and therefore have explicit alignment to the objectives of climate change adaptation. Conversely, there are identified disparities between DRR and climate change adaptation, for example: the melting of glaciers, sea level rise, changes in ecosystems and the salinisation of groundwater are examples of climate related risks that do not manifest themselves in the form of rapid disasters; and the sectors, livelihoods, stakeholders and decision-makers involved in adaptation are not necessarily the same as those involved in DRR (UNFCCC, 2008). Additionally, climate change adaptation does not address non-climate related events, such as earthquakes, tsunamis, and/or landslides. Despite this, it is recognised that implementing DRR policies and practices will facilitate climate change adaptation (UNFCCC, 2008).

Therefore, in suggesting tools for use to support integration of climate change adaptation into MFF programmes and projects, tools applied in the DRR arena and the climate change adaptation arena are presented. The aim is to ensure that adaptation addresses both current climate variability, as well as long-term climate changes, which threaten ecosystem sustainability.

The outcomes of the review are presented below (within 'Approaches to mainstreaming climate change in the project cycle'), while the adopted approach to climate proofing MFF programmes is presented in 'Mainstreaming climate change into the MFF project cycle'.

Approaches to mainstreaming climate change into the project cycle

This chapter summarizes existing literature on mainstreaming climate change into project cycles. The review sets the basis for the development of a climate proofing method specific to MFF, as outlined in the following section, 'Mainstreaming climate change into the MFF project cycle'.

There are a number of recognised entry points for mainstreaming climate change into the project cycle, including:

- Programming;
- Project identification;
- Appraisal;
- Approval/financing;
- Implementation; and
- Evaluation

The alignment between each stage of the project cycle and recommended climate change considerations, are shown in Table 4. The initial planning stages of the cycle (programming, identification, appraisal) are recognised as the key entry points at which climate change issues can be factored into projects (Benson & Twigg, 2007). However, climate change risk should not be overlooked during the other stages of financing, implementation and evaluation, and the various activities that take place within them.

At each stage of the project cycle there are a number of elements (policies, strategies, checklists) employed to support the various activities that take place within them. For example, at the project programming stage, strategy documents are a reference guide to sectoral and thematic focus of the programme and may provide broad ideas for projects and programmes. At the project appraisal stage, guidelines and templates are the common elements used to support proposal preparation.

In developing an approach to mainstreaming climate change into the project cycle, organisations can choose to adapt their existing methods and planning tools (i.e. the elements that support each phase of the project cycle), or adopt new purpose-designed tools. However, the chosen method must be capable of fitting within the organization's project cycle management systems and be integrated within the overall project management process (Benson & Twigg, 2007).

Vulnerability and adaptation (V&A) assessment is a fundamental tool in incorporating climate change considerations into the project cycle (Benson & Twigg 2007; USAID *et al.*, 2008). It provides the basis for a plan of action, including the selection of specific adaptation issues, management goals and objectives. The appraisal process (or project design) relies on the outputs of a V&A assessment to identify the potential climate change risks and develop adaptation strategies to address these risks. The adaptation strategies are subsequently incorporated into project design to ensure that the project is 'climate proofed'.

Data is an integral component to any assessment process and the quality of an assessment directly relates to the quality of data input. In broad scale terms, to undertake a coastal V&A assessment, data is required for the following areas: climatic influencing factors (temperature, rain, wind); non-climatic influences (population, prices, pests, policies); internal functions of the system and their climatic and other sensitivities, and the interactions (physical, biological and social) with other systems and resultant integrated behaviours (Basher, 1999). Data requirements will vary by degree of complexity and scale dependent upon the particular topic.

It is recognised that completing a V&A assessment as part of the project cycle is an additional requirement for project proponents that may be daunting for those that do not have experience in climate change assessment and adaptation. In recognition of this issue, Benson & Twigg (2007) outlined a number of points to consider when integrating climate change into the project cycle, including research requirements, provision of training and internal advocacy for climate change mainstreaming. Furthermore, Benson & Twigg (2007) suggest a two-phased approach to V&A assessment, in which a preliminary assessment of the climate changes and related vulnerability is conducted in the first stage. This would include an estimation of the frequency or probability of climate related hazard events (i.e. sea level rise, storm events) and the related severity of impacts on project components. Subsequently, on review of the outcomes of the preliminary assessment, a decision is made on level of further vulnerability and adaptation assessment that is required. This approach reduces the immediate resource requirements on project proponents, where the initial assessment is based on readily available information and expertise, prior to the commitment to a full vulnerability and adaptation assessment, which may in turn be a requirement of the project upon implementation.

Summary

Integrating climate change into the project cycle is increasingly advocated as a means to ensure that development initiatives are sustainable. Recently, a number of organizations have produced guidance manuals for integrating climate change into the project cycle (see for example USAID 2007; UNEP 2008; USAID *et al.*, 2008; and Benson & Twigg 2007). The manuals outline the primary points within the project cycle for integration, while also identifying V&A assessment as the fundamental tool for the project appraisal (preparation) phase, to ensure the potential impacts of climate change have been considered in programme design.

This information set the basis for development of an approach to mainstreaming climate change into the MFF project cycle. The adopted approach is outlined below.

Table 4: Climate change considerations at each stage of the project cycle (adapted from Benson & Twigg 2007; USAID et al., 2008; USAID 2007)

Stage of the Project Cycle	Climate Change Considerations	Associated Stages of the MFF Project Cycle
Programming	The establishment of general guidelines and principles for cooperation, agreement of sectoral and thematic focus and outlining of broad ideas for projects and programmes. Vulnerability assessment and adaptation can be incorporated when countries communicate priorities, policies, and issues – reflected in country strategy documents.	Conceptualisation
Project Identification	Within the programme framework, problems, needs and interests of possible stakeholders are analysed; ideas for projects and other actions are identified and screened. The outcome is a decision on whether or not the options developed should be studied in more detail.	Definition, planning
Appraisal	All significant aspects of the idea are studied, taking into account stakeholders' views, relevance to problems, feasibility and other issues. In some organisations' project cycles, this phase is described as 'preparation' or 'formulation'. Almost every development project design can include a description of the impact of climate change and vulnerability on the project and a proposed plan to minimize or mitigate impact. This process can be separated into two stages: (i) screening assessment to identify the potential impact of climate change on the intervention; (ii) identify and evaluate options to address the identified impacts. This information informs project design.	Formal Approval
Approval/ financing	A decision is taken by the relevant parties about whether or not to fund the project based on the appraisal. The financing institute can include appraisal criteria to assess climate-sensitivity and proposed adaptation strategy.	
Implementation	The agreed resources are used to carry out the planned activities and achieve objectives.	Execution, implementation, monitoring
Monitoring and Evaluation	Progress is assessed through monitoring to enable adjustment to changing circumstances. At the end of implementation, a decision should be made about whether to close or extend the project. The final evaluation is an assessment of the project's achievements and impact, and examines the relevance and fulfilment of objectives, efficiency, effectiveness, impact, and sustainability. It leads to a decision to continue, change or stop a project, and its conclusions are taken into account when planning and implementing similar projects. During impact evaluation, evaluators can ask whether the project anticipated and appropriately addressed climate change and vulnerability concerns.	

Mainstreaming climate change into the MFF project cycle

There are a number of elements (items/forms/guidelines) that are applied in the MFF project cycle to support project proponents in developing an intervention that coincides with the primary objectives of the MFF programme – to ‘strengthen the environmental sustainability of coastal development through the promotion of increased investment and efforts in coastal ecosystem management’. These elements provide guidance on intervention selection; proposal preparation; appraisal; approval; monitoring, and evaluation.

This chapter explores these elements and presents the approach adopted to mainstream climate change. We commence by aligning the MFF elements to each stage of the project cycle (Table 6 and Figure 1). The stages of the projected cycle are presented in two forms; the stages of the project cycle as reported in existing literature (and outlined in the chapter above), and the stages of the project cycle as advocated by MFF.

The MFF elements represent entry points to mainstream climate change into the programme. Therefore, the integration of climate change into each of these elements is vital in achieving a mainstreamed approach to climate change.

Table 5: Climate proofing entry points aligned to elements within the MFF initiative

Project Cycle Entry Point	MFF Project Cycle Entry Point	Cycle Stage ID	MFF Elements
Project programming stage	Conceptualisation	1	MFF Strategy
Project identification			MFF National Strategies and PoWs
Preparation, appraisal and approval	Definition, planning Formal Approval	2 3	MFF Project Guidelines MFF Project Template MFF Quality Assurance Checklist
Monitoring and evaluation	Execution, implementation, monitoring	4	MFF Monitoring and Evaluation Framework/ Results Frameworks
	Completion, hand-over, evaluation	5	

Important Note

In order to undertake an intervention, it is vital that the invention itself is clearly understood. Consequently, to mainstream climate change into the MFF project cycle, it is vital that there is a clear understanding of how climate change may impact proposed interventions. Vulnerability and adaptation (V&A) assessments are the primary tools to generate an understanding of risks associated with climate variability and change, and to develop adaptation strategies to address the identified risks.

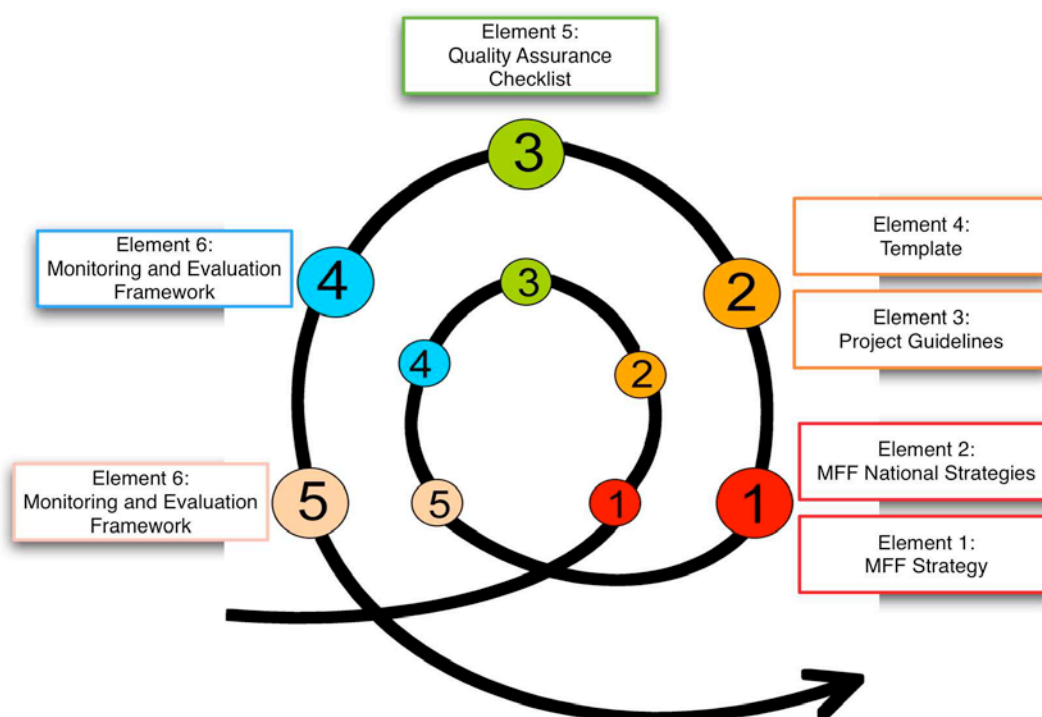


Figure 1: Elements matched to stages of the project cycle

The approach taken to integrate climate change into each of the elements supporting the MFF project cycle is explored below.

Element 1: MFF Strategy

The MFF Strategy outlines the framework for implementation of the MFF programme. To achieve its goal and objectives, MFF undertakes actions that address four key areas of influence; regional cooperation, national government support, private sector engagement, and community action. Specific actions are identified under the 15 PoWs. These are grouped under three objectives: Improve, share and apply knowledge; Strengthen ICM Institutions and empower civil society; Enhance coastal governance at all levels. The 15 PoW are designed to contribute to the goal of the MFF programme; *Conservation, restoration and sustainable management of coastal ecosystems as key natural infrastructure which supports human well-being and security*.

The Strategy identifies climate change as a cross-cutting issue through all of the 15 PoWs and thus climate change is recognised as an integral component in the project programming stage.

The alignment between the PoWs and climate change considerations is reported in Section 1 of this guide.

Element 2: MFF National Strategies

At the national level, the mandate for directing, regulating, and coordinating development and project activities is steered through National Coordinating Bodies (NCBs) in coordination with existing mechanisms for coastal management. The NCB in each country selects and recommends appropriate projects and programmes eligible for grants. At the time the NCBs were structured, countries were requested to include at least one climate change expert (possibly linked to the national climate change committee, where existing) in each NCB.

The National Strategy (NS), developed by each NCB, provides guidance on the priority areas for action (priority PoW). The PoW are analysed and the priority PoW for implementation in each target country are set within the respective National Strategies. Consequently, each target country's National Strategy informs project identification by prioritizing areas for project implementation.

In the development of the NS, NCBs were recommended to consider the results of available Vulnerability and Adaptation Assessments and NAPAs to help in the identification of relevant sites of importance in the country. It is important that climate change is considered in each NS to ensure that the potential impacts of climate change will not adversely affect the projects being implemented. Consequently, it will be important for NCBs to utilise information that demonstrates the links between climate change and the PoW (as presented in Section 1 of this guide) to support project proponents in integrating climate change into the Project Cycle.

Element 3: MFF Project Guidelines

Guidelines for the preparation of both small grants and large projects have been prepared by the MFF Secretariat with the support of IUCN, UNDP and UNEP and define the general criteria for endorsement of the projects. Consideration of the potential impacts of climate in the project sites is one of these criteria. In order to ensure that climate change considerations were appropriately addressed in each MFF intervention, climate change has been mainstreamed into the guidelines.

Element 4: MFF Climate Proof: A four step guide for coastal projects

The *Climate Proof: four step guide for coastal projects* outlines an approach to integrate climate change considerations into the project design process. The outputs of the four step process are to be recorded in the Climate Change Considerations form (example found in Appendix 1 of the *Climate Proof: A four step guide for coastal projects* and a blank copy can be downloaded at www.mangrovesforthefuture.org).

The contents of the Climate Change Considerations form can be used to demonstrate that climate change has been adequately considered as part of the project preparation process.

The completed Climate Change Considerations form should be included as an Annex to the MFF Project Proposal.

By using the four step guide, project proponents will be guided in implementing appropriate climate change adaptation responses and tools based on the identified impacts. It also ensures that human and financial resources to implement the selected adaptation tools/options as identified in the Climate Change Considerations form are included as part of the overall project resource requirements. This element establishes the groundwork for integrating climate change adaptation implementation during project scoping and design.

Element 5: Quality Assurance Checklist

In order to confirm that the climate-proofing process has been effectively undertaken, a check-list has been provided to the MFF Secretariat and NCBs. The checklist enables quick and easy confirmation that climate proofing has been undertaken.

Element 6: Monitoring and Evaluation Framework

All MFF interventions are monitored and evaluated through a Logical Framework Analysis (LFA) Matrix. The LFA matrix outlines project objectives, verifiable indicators, means of verification, and risks. Through completion of the four step approach to climate proofing an MFF intervention (see Element 3), the project objectives will be set and the climate change impacts identified. This information can be collated into the Logical Framework Analysis (LFA) matrix to ensure the actions to address the identified impacts can be evaluated during project implementation.

Table 6: Sections to integrate climate change considerations within the MFF Large Project Template

Template Section	Climate Change Considerations
Section 1: Introduction	
1.2 Project Context	To incorporate climate change considerations into a programme or project, information on the process-response relationships in the coastal zone is paramount. Without a clear understanding of how the coastal system responds to climate drivers, it is impossible to infer how the system will behave in future climates. Consequently, an important first step is to outline the climate context; describe current climate variability and the main climate drivers causing physical change in the coastal zone, i.e. storm events, tides. This information can be drawn from the completed Climate Change Considerations form, Step 1.
Section 2: Project Description	
2.5 Identification of Cross Cutting Issues	Identify climate change issues that may impact on the project objectives. The outputs of the completed Climate Change Considerations form will help complete this section. Review the outputs from Step 2 of the Climate Change Considerations form (identify the impacts). This identifies the potential impacts of climate change on project objectives, and thus the climate change issues that must be addressed.
2.6 Strategies to Address Cross Cutting Issues,	Explain how the climate change issues will be addressed. The outputs of the completed Climate Change Considerations form will help complete this section. Review the outputs from Step 3 of the Climate Change Considerations form (identification of adaptation options to manage the identified impacts), which indicates the response to inform adaptation. The response to inform adaptation is the strategy to address one of the cross cutting issues (climate change).
2.7 Inputs Required	Outline the resources required to facilitate implementation of the selected climate change tools (as specified in Step 4 of the Climate Change Considerations form). This will demonstrate a clear awareness of the actions that will be required during project implementation to ensure that the proposed project has addressed the criteria to climate proof a project.

Section 4: Coastal climate change: Impacts and adaptation measures

Introduction

The Fourth Assessment Report (AR4) of 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 (IPCC, 2007a). While temperature change is the major mechanism of this change, the effects of climate change are predicted to be far reaching; affecting global circulation, synoptic weather systems, rainfall, sea level and wave climate. Likely impacts will include a rise in mean sea level with a possible increase in the frequency and magnitude of extreme events and associated elevated storm surges and wave heights. The 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 effect that climate change will have on the coastal zone will vary dependent upon geographic location. Furthermore, projections for change in climatic parameters vary globally, based upon global circulation and synoptic systems. The Fourth Assessment Report of the IPCC (2007a) produced a range of climate change projections under a series of scenarios and timeframes. The projections are useful in generating an understanding of how the climate may change over time, and the potential effects of these climate changes in the coastal zone. However, as stated, these changes are not expected to be uniform across the globe (Figure 2). Consequently, when assessing the potential impacts of climate change, climatic changes must be considered on a regional to local scale.

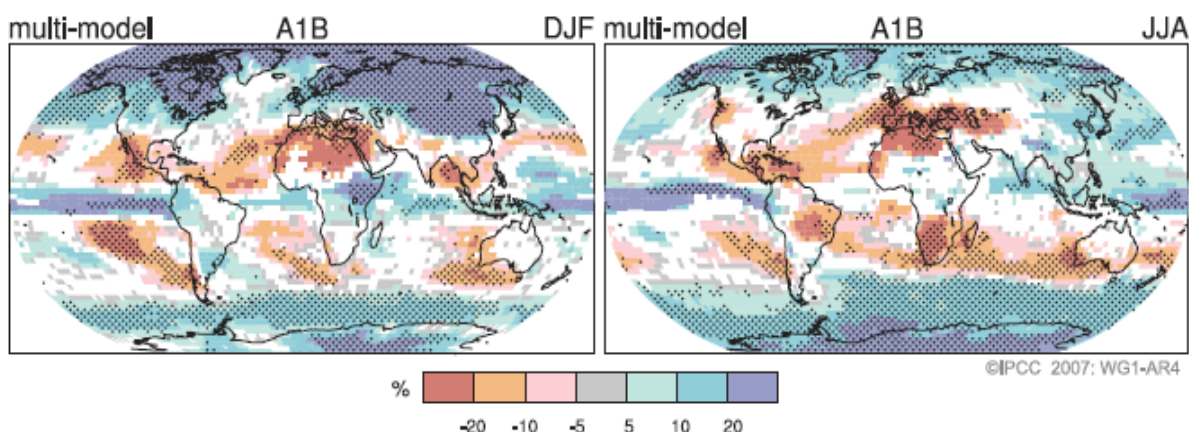


Figure 2: Relative changes in precipitation (in percent) for the period 2090–2099, relative to 1980–1999 (IPCC, 2007a)

An overview of the projected climate changes within Asia⁵ is presented in Cruz et al. (2007). These can be summarised as follows:

'Extreme weather events in Asia were reported to provide evidence of increases in the intensity or frequency on regional scales throughout the 20th century. The Third Assessment Report (TAR) predicted that the area-averaged annual mean warming would be about 3°C in the decade of the 2050s and about 5°C in the decade of the 2080s over the land regions of Asia as a result of future increases in atmospheric concentration of greenhouse gases. The rise in surface air temperature was projected to be most pronounced over boreal Asia in all seasons'.

⁵ The IPCC (2007) separates the world into a number of regions for the basis of reviewing projected climate changes and potential impacts. The regions include: Africa, Asia, Australia and New Zealand, Europe, Latin America, North America, Polar Regions, and Small Island States. MFF Focal and Outreach Countries lie within the Asian region; therefore, this is the focus of the current report.

An overview of biophysical and socio-economic impacts associated with climate changes in the coastal zone is summarized in Table 7, with a more detailed description of potential impacts, by coastal ecosystem type, outlined in Table 9. In general, these effects will vary through space and time, with some locations and communities more susceptible than others. This susceptibility (or vulnerability) may be considered as the exposure of a system to climatic changes, in the context of the capacity of the natural and human systems to respond to these changes. Having gained an understanding of this vulnerability and adaptive capacity, the projected changes in climate parameters can be reviewed to ascertain projected impacts or climate risks.

The impacts presented in Table 7 and Table 9 provides a useful broad overview of the potential effects of climate change in the coastal zone. This information may subsequently be considered in conjunction with the natural sensitivity of the system, to infer potential impacts specific to a particular region.

An understanding of natural system sensitivity can be gathered through a review of observed climate trends. Observed climate trends provide a baseline for determining system vulnerability in regards to the projected impacts of climate change. For example, the impacts of past extreme weather events, such as storms or extended periods of drought, provide insight into the potential impacts of similar projected changes in climate. A summary of observed past and present climate trends and variability in select countries within South Asia and South-east Asia is provided in Cruz et al. (2007) and summarized in Table 8⁶.

⁶ The Asian region is separated into a number of sub-regions for the purpose of describing observed climate trends in Cruz et al. (2007). MFF Focal and Outreach Countries lie within the sub-regions of South Asia and South-east Asia. The past climate changes and climate variability information is presented for select countries within these two sub-regions in Cruz et al. (2007). Climate change and variability information is not provided for MFF Focal and Outreach Counties that are not addressed in Cruz et al., (2007).

Table 7: Impacts of Climate Change in the Coastal Zone (adapted from Abuodha and Woodroffe, 2006)

Projected Climate Change Impacts	Possible Effects on the Coastal Environment
<ul style="list-style-type: none"> Higher sea levels Higher sea temperatures Changes in precipitation patterns and coastal runoff Changed oceanic conditions Changes in storm tracks, frequencies and intensities 	<p>Bio-geophysical effects:</p> <ul style="list-style-type: none"> Displacement of coastal lowlands and wetlands Increased coastal erosion Increased flooding Salinisation of surface and groundwaters <p>Socio-economic impacts associated with climate change include:</p> <ul style="list-style-type: none"> Loss of property and land Increased flood risk/loss of life Damage to coastal protection works and other infrastructure Loss of renewable and subsistence resources Loss of tourism, recreation, and coastal habitats Impacts on agriculture and aquaculture through decline in soil and water quality <p>Secondary impacts of accelerated sea level rise:</p> <ul style="list-style-type: none"> Impact on livelihoods and human health Decline in health/living standards as a result of decline in drinking water quality Threat to housing quality <p>Impacts on infrastructure and economic activity:</p> <ul style="list-style-type: none"> Diversion of resources to adaptation responses to address impacts of sea level rise Increasing protection costs Increasing insurance premiums Political and institutional instability, and social unrest Threats to particular cultures and ways of life

Table 8: Climate change and variability in select countries within the Asian region (Cruz et al., 2007)

Country	Change in Temperature	Change in Precipitation	References
India	0.68°C increase per century; increasing trends in annual mean temperature; warming more pronounced during post monsoon and winter	Increase in extreme rains in north-west during summer monsoon in recent decades; lower number of rainy days along east coast	Kripalani et al., 1996; Lal et al., 1996; Lal et al., 2001b; Singh and Son-takke, 2002; Lal, 2003
Sri Lanka	0.016°C increase per year between 1961 to 1990 over entire country; 2°C increase per year in central highlands	Increase trend in February and decrease trend in June	Chandrapala and Fernando, 1995; Chandrapala, 1996
Indonesia	Homogeneous temperature data were not available	Decline in rainfall in southern and increase in northern region	Manton et al., 2001; Boer and Faqih, 2004
Philippines	Increase in mean annual, maximum and minimum temperatures by 0.14°C between 1971 to 2000	Increase in annual mean rainfall since 1980s and in number of rainy days since 1990s; increase in inter-annual variability of onset of rainfall	PAGASA, 2001; Cruz et al., 2006
Southeast Asia (General)	0.1 to 0.3°C increase per decade reported between 1951 to 2000	Decreasing trend between 1961 and 1998. Number of rainy days have declined throughout Southeast Asia	Manton et al., 2001

Table 9: Impacts of climate change in the coastal zone, by coastal type

Coastal Type	Climate Change Impacts
Beaches and rocky shore-lines	<ul style="list-style-type: none"> Acceleration in sea-level rise will exacerbate beach erosion; however 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 hence potentially 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. Several recent studies indicate that 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 have a relatively high resistance to erosion, while cliffs formed in softer rock layers are likely to retreat more rapidly in the future due to increased erosion resulting from sea-level rise. Cliff failure and retreat may be amplified in many areas by increased precipitation and higher groundwater levels. Four physical features of climate change; temperature, precipitation, sea level, and wave climate, can affect the stability of soft rock cliffs. Soft rock cliff retreat is usually episodic with many metres of cliff top retreat occurring locally in a single event, followed by relative quiescence for significant periods.
Deltas	<ul style="list-style-type: none"> Human development patterns influence the differential vulnerability of deltas to the effects of climate change. Sediment starvation due to dams, alterations in tidal flow patterns, navigation and flood control works are common consequences of human activity. Changes in surface water runoff and sediment loads can greatly affect the ability of a delta to cope with the physical impacts of climatic change. Deltas have long been recognised as highly sensitive to sea-level rise. Rates of relative sea-level rise can greatly exceed the global average in many heavily populated deltaic areas due to subsidence, including the Chao Phraya delta, because of human activities. Natural subsidence due to auto-compaction of sediment under its own weight is enhanced by sub-surface fluid withdrawals and drainage. This increases the potential for inundation, especially for the most populated cities on these deltaic plains (i.e., Bangkok). Most of the land area of Bangladesh consists of the deltaic plains of the Ganges, Brahmaputra and Meghna rivers. Accelerated global sea-level rise and higher extreme water levels may have acute effects on human populations of Bangladesh (and parts of West Bengal, India) because of the complex relationships between observed trends in surface sea temperature over the Bay of Bengal and monsoon rains, subsidence and human activity that has converted natural coastal defences (mangroves) to aquaculture.

Coastal Type	Climate Change Impacts
Estuaries and lagoons	<ul style="list-style-type: none"> Global mean sea-level rise will generally lead to higher relative coastal water levels and increasing salinity in estuarine systems, thereby tending to 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.
Mangroves and sea grasses	<ul style="list-style-type: none"> Coastal vegetated wetlands are sensitive to climate change and long-term sea-level change as their location is intimately linked to sea level. Modelling suggests 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 CO₂ 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. 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 CO₂, storm activity and ultraviolet irradiance alter sea grass distribution, productivity and community composition. Increases in the amount of dissolved CO₂ and, for some species, HCO₃ present in aquatic environments, will lead to higher rates of photosynthesis in submerged aquatic vegetation, similar to the effects of CO₂ 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.
Coral reefs	<ul style="list-style-type: none"> Reefs have deteriorated as a result of a combination of anthropogenic impacts such as overfishing and pollution from adjacent landmasses, together with an increased frequency and severity of bleaching associated with climate change. The relative significance of these stresses varies from site to site. Mass coral bleaching events are clearly correlated with rises of surface sea temperature of short duration above summer maxima. Particularly extensive bleaching was recorded across the Indian Ocean region associated with extreme El Niño conditions in 1998.

Coastal Type	Climate Change Impacts
	<ul style="list-style-type: none"> 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. Increased concentrations of CO₂ 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. However, relative sea-level rise appears unlikely to threaten reefs in the next few decades; coral reefs have been shown to keep pace with rapid postglacial sea-level rise when not subjected to environmental or anthropogenic stresses. 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.
Human systems	<ul style="list-style-type: none"> Socio-economic impacts are also influenced by the magnitude and frequency of existing processes and extreme events, e.g., the densely populated coasts of East, South and Southeast Asia are already exposed to frequent cyclones, and this will compound the impacts of other climate changes. Significant regional differences in climate change and local variability of the coast, including human development patterns, result in variable impacts and adjustments along the coast, with implications for adaptation responses. Human vulnerability to sea-level rise and climate change is strongly influenced by the characteristics of socio-economic development. Vulnerability to the impacts of climate change, including the higher socio-economic burden imposed by present climate-related hazards and disasters, is very likely to be greater on coastal communities of developing countries than in developed countries due to inequalities in adaptive capacity. Low-lying densely populated areas in India, China and Bangladesh and other deltaic areas are highly exposed, as are the economies of small islands. The direct influences of sea-level rise on freshwater resources come principally from seawater intrusion into surface waters and coastal aquifers, further encroachment of saltwater into estuaries and coastal river systems, more extensive coastal inundation and higher levels of sea flooding, increases in the landward reach of sea waves and storm surges, and new or accelerated coastal erosion. Although the coast contains a substantial proportion of the world's population, it has a much smaller proportion of the global renewable water supply, and the coastal population is growing faster than elsewhere, exacerbating this imbalance. Many coastal aquifers, especially shallow ones, experience saltwater intrusion caused by natural and human-induced factors, and this is exacerbated by sea-level rise. Globally, freshwater supply problems due to climate change are most likely in developing countries with a high proportion of coastal lowland, arid and semi-arid coasts, coastal megacities particularly in the Asia-Pacific region, and small island states, reflecting both natural and socio-economic factors that enhance the levels of risks. Climate change is expected to have impacts on agriculture, although non-climatic factors, such as technological development and management practices can be more significant. Climate change and variability also impacts fisheries in coastal and estuarine waters, although non-climatic factors such as overfishing and habitat loss and degradation are already responsible for reducing fish stocks. Globally an increased agricultural production potential due to climate change and CO₂ fertilisation should in principle add to food security, but the impacts on the coastal areas may differ regionally and locally.

Coastal Type	Climate Change Impacts
Human systems (continued)	<ul style="list-style-type: none"> ▪ Temperature increases can shorten growth cycles, but more frequent extreme climate events during specific crop development stages, together with higher rainfall intensity and longer dry spells, may impact negatively on crop yields. Cyclones also cause floods and destruction with negative impacts on coastal areas. Rising sea level has negative impacts on coastal agriculture. ▪ In terms of fishery resources, future climate change impacts will be greater on coastal than on pelagic species. The biotic communities and productivity of coastal lagoons may experience a variety of changes, depending on the changes in wetland area, freshwater flows and salt intrusion which affect the species. Intensification of ENSO events and increases in Sea Surface Temperature (SST), wind stress, hypoxia (shortage of oxygen) and the deepening of the thermocline have the potential to reduce spawning areas. ▪ Climate change and sea-level rise affect coastal settlements and infrastructure in several ways. Sea-level rise raises extreme water levels with possible increases in storm intensity predicting additional climate impacts on many coastal areas, while salt-water intrusion may threaten water supplies. The degradation of natural coastal systems due to climate change, such as wetlands, beaches and barrier islands, removes the natural defences of coastal communities against extreme water levels during storms. Rapid population growth, urban sprawl, and coastal resort development have additional deleterious effects on protective coastal ecosystems. ▪ The population exposed to flooding by storm surges will increase over the 21st century. Asia dominates the global exposure; with its large coastal populations in Bangladesh, China, Japan, Vietnam and Thailand, facing serious coastal flooding problems.

Source: Adapted from the IPCC (2007b)

Climate change adaptation

Climate change is a reality today, not solely a future event (IPCC, 2007c; Stern, 2007). There is already evidence of increases in extreme conditions for some weather elements in some regions (UNFCCC, 2008)⁷. In the coastal belt, climate change-induced adverse impacts such as sea level rise and increase in frequency and intensity of tropical cyclones and storm surges (Bindoff et al., 2007) pose a major challenge for countries in developing and implementing appropriate, affordable, and cost-effective adaptation measures.

Climate-related hazards (i.e. droughts, floods, and storms) in vulnerable environments have repeatedly set back development gains, especially in developing countries (UN/ISDR, 2008). Climate change has the potential to intensify the impacts of climate-related hazards on development and livelihood security in two ways:

1. The occurrence of weather-related and climate hazards are likely to increase.
2. The impacts will be more significant due to increases in the vulnerability of communities to natural hazards, as a result of ecosystem degradation, reduction in water and food availability, and changes to livelihoods brought about by climate change (UN/ISDR, 2008).

Consequently, climate change will increase vulnerability to climate and non-climate hazards.

The IPCC defines vulnerability to climate change as being the degree to which individuals and systems are susceptible to or unable to cope with the adverse effects of climate change, including climate variability and extremes. This is a function of:

- *Sensitivity*: the extent to which natural or social systems are sensitive to changes in weather and climate (the exposure-response relationship) and the characteristics of the population, such as the level of development and its demographic structure;
- *Exposure* to the weather or climate-related hazard, including the character, magnitude, and rate of climate variation and long term change; and
- *Adaptation* measures in place to reduce the burden of a specific adverse outcome (the adaptation baseline), the effectiveness of which determines in part the exposure – response relationship.

Reducing vulnerability to the likely impacts of climate change thus involves modification to one or more of these components of vulnerability. Exposure to climate-related hazards can be modified through measures such as re-location of communities. However, such measures are considered extreme due to the potential impact on livelihoods. Sensitivity can be modified through adaptation. Adaptation measures in part determine the exposure-response relationship. Consequently, adaptation measures can be implemented to reduce sensitivity (or increase resilience) to climate change.

In the face of projected climate change it has become apparent that societies will need to adapt to sustain the social and ecological systems on which they rely. Adaptations are adjustments in practices, processes or structures to take account of changing climatic conditions. They may be autonomous or policy driven (McCarthy et al. 2001). The tools and techniques for adapting to climate change vary dramatically and their success will relate to the level in which they address the adaptive capacity of the community.

Climate change is only one of many interacting stresses in the coastal zone. Thus, when considering adaptation strategies and planning for increased coastal resilience; other impacts must also be considered. The ability to deal with multiple stressors is a function of socio-economic and environmental condition and existing management arrangements.

Adaptation measures commonly fall within three categories:

- **Protect**: hard structures (dykes, sea-walls, tidal barriers, detached breakwaters); soft structures (dune or wetland restoration or creation, beach nourishment); indigenous options of walls of wood, stone or coconut leaf, or afforestation;

⁷ See the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC 2007c) for details on observed change in weather extremes.

- Retreat: establishing set-back zones; relocating threatened buildings; phasing out development in exposed areas; creating upland buffer; rolling easements; and
- Accommodate: Early warning and evacuation systems; hazard insurance; new agricultural practices, such as using salt-resistant crops; new building regulations; improved drainage; desalination systems.

The type of measure appropriate to reduce sensitivity (and increase resilience) is dependent upon the natural and socio-economic system in which it will be placed. USAID (2009) identified a number of adaptation measures to mitigate the potential impacts of climate change in the coastal zone. The measures were aligned to 'anticipated outcomes' to demonstrate the potential effects of implementing the adaptation option (Table 10).

The adaptation measures include strategies and actions familiar to coastal countries not only as part of responding to episodes of natural hazards and shocks, but as part of management efforts to implement sustainable development, planned development, efficient resource use and poverty reduction (USAID, 2009). The measures therefore contribute to sustainable development objectives, whilst also ensuring increased resilience to the potential impacts of climate change. These are commonly referred to as 'no-regrets' adaptation measures, where the adaptation action is beneficial even in the absence of climate change.

In selecting an adaptation response to manage the potential impacts of climate change, the objectives of the coastal management should be considered. For example, if the management goal is to maintain and restore coastal wetlands, adaptation measures may include: coastal development setbacks; coastal zoning; protected area management; integrated coastal management, and actions to protect living shorelines (USAID, 2009). Importantly, the best response is often a combination of adaptation measures, rather than a single adaptation response.

In addition to on-ground adaptation measures to address the anticipated impacts of climate change, climate change mainstreaming is increasingly advocated as a tool to ensuring sustainable development in the face of climate change.

In contrast to on-ground management actions, climate change mainstreaming is used to describe the integration of policies and measures to address climate change into ongoing and new development policies and plans (ADB, 2005). The aim of mainstreaming is to increase the effectiveness, efficiency and longevity of initiatives directed at reducing climate-related risks, while also contributing to sustainable development and improved quality of life (ADB, 2005). In short, mainstreaming gives adaptation the funding and authority to take place (USAID, 2009).

Table 10: Adaptation measures aligned to anticipated outcomes, **X** Primary outcome, **o** Secondary outcome (USAID, 2008)

Adaptation Measure	Functioning and healthy coastal ecosystems	Reduced exposure and vulnerability of the built environment	Strengthened governance, policy and planning	Diversified livelihood support	Enhanced human health and safety
Beach/dune nourishment		X		o	
Building Standards		X	o	o	X
Coastal development setbacks	o	X			X
Coastal tourism best practices	o	X		X	X
Conservation agreements (marine)	X	X			
Coastal watershed planning*	o	X	X	o	X
Community-based disaster risk reduction*	o	X	o	o	X
Fisheries, livelihood and food security	X		o	o	X
Flood hazard mapping		X			X
Integrated coastal management*	o	X	X	o	X
Land use planning and zoning	o	X	X		X
Living shorelines	X	X			X
Mariculture best practices	o	X		X	X
Marine protected areas	X		o	o	
Payments for environmental services	X	X		o	X
Shorefront stabilisation	o	X		o	X
Special area management planning*	o	X	X	o	X
Wetland protection and restoration	X	X		o	X

* An overarching management approach or strategy that can be used to bundle a series of measures

Climate change can be incorporated (mainstreamed) within existing policies and measures at several different scales:

- National or regional level public policy;
- Sectoral investments and projects; and
- Sub-national, place-based initiatives.

Effective mainstreaming requires integration across all three scales and government and non-government partners play a vital role in fostering connections across scales. It is important to note that mainstreaming climate change has been seen as an elusive goal, with a gap between theory and practice (UNDP 2004). In many cases, adaptations that climate change might require have been proposed (but not successfully implemented) in sectoral plans. The real challenge to mainstreaming adaptation is not planning but implementation.

Climate proofing has recently come to the fore as a measure to facilitate implementation of climate change mainstreaming. Climate proofing is a tool for mainstreaming at the individual project or investment scale.

Climate proofing entails identifying risks to a project/intervention as a consequence of both current and future climate variability and extremes. It involves ensuring that those risks are reduced to acceptable levels through 'long-lasting and environmentally sound, economically viable, and socially acceptable changes implemented at one or more of the following stages in the project cycle: planning, design, construction, operation, and decommissioning' (UNEP 2008).

The outcomes of successful climate proofing are twofold:

- Projects are modified to ensure that they are no longer at risk from climate change or no longer contribute to the vulnerability of its recipients; and
- Mainstreaming ensures that future projects and strategies are consciously aimed at reducing vulnerability (increasing resilience) by including priorities that are critical to successful adaptation (UNEP 2008).

Overall, climate proofing increases the adaptive capacity of communities or other social groupings to deal with the impacts of climate change. Increased adaptive capacity implies both increased resilience (reduced sensitivity) and an ability to implement socially and economically appropriate adaptation measures.

Summary

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. Further, climate proofing provides a method to facilitate implementation of climate change mainstreaming actions at the project/ intervention scale.

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.

Appendix 1: Key resources for further reading on coastal climate change and adaptation measures

Climate change adaptation is increasingly recognised as an important tool to support sustainable development in the presence of a changing climate. This chapter outlines a number of valuable resources that provide MFF partners with information on:

- Background on climate change
- Climate change adaptation
- Coastal management tools and resources

The references can increase awareness of the link between climate change and coastal management.

Background to climate change

IPCC 4AR 2007, Observations: Oceanic Climate Change and Sea Level.

The IPCC 4th Assessment Report is a synthesis of the most up-to-date, peer reviewed, climate science. The report provides details on the projected changes in climate variables, including temperature, ocean circulation, sea level and biogeochemicals. The full report is available from:

<http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter5.pdf>

The IPCC also produce a summary report that synthesizes the information contained within this report. See reference below for further details.

IPCC 2007 Summary for Policymakers, Climate Change 2007: The Physical Science Basis.

This document provides a summary of the most up-to-date climate change projections and describes the progress in understanding the human and natural drivers in climate change. It provides global statistics and projections accompanied with a strong rationale for future change. This document is seen as a summary guidebook of climate change that should be read as high priority.

The document is available from:

<http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf>

UNEP Fact Sheet on Climate Change

- *Climate Change at a Glance* - summarizes the key projections for climate change in an easy to read and understandable format.
- *The Causes of Climate Change* - summarizes the key causes of climate change.

Available from: <http://www.unep.org/pdf/brochures/ClimateChange.pdf>

Coastal climate change adaptation

USAID (2009): Adapting to Coastal Climate Change: A Guidebook for Development Planning, USAID.

This guidebook proposes an approach for assessing vulnerability to climate change and climate variability, developing and implementing adaptation options, and integrating options into programmes, development plans, and projects at the national and local levels. It is a tool in itself and also links to other resources to help climate change adaptation efforts.

The guidebook identifies a number of adaptation measures to mitigate the potential impacts of climate change in the coastal zone (Chapter 3). The measures are aligned to 'anticipated outcomes' to demonstrate the

potential effects of implementing the adaptation option. This information may be of value to MFF project proponents when completing Step 3 of the approach to climate proofing MFF interventions.

This guidebook is a companion document to the USAID V&A Manual (see USAID 2007 below) and provides the more detailed and sector-specific guidance that is needed by practitioners in order to respond to climate variability and change impacts on coastal areas, with an emphasis on developing country contexts.

Overall, the guidebook provides:

- Information to advance your understanding of:
 - Climate change impacts along coasts;
 - Vulnerability; and
 - Mainstreaming coastal adaptation measures in policies, plans, and programmes;
- Practical adaptation options suited to respond to the impacts of climate variability and change on the coast; and
- Lessons (based on experience) on how to overcome implementation barriers and utilize an adaptive management approach to coastal climate adaptation.

The report is accessible from: <http://www.crc.uri.edu/download/CoastalAdaptationGuide.pdf>

UNFCCC (2004) Vulnerability and Adaptation Training Package: Chapter 5 Coastal Resources

The chapter presents information to support vulnerability and adaptation assessment. It describes the impacts of climate change in the coastal zone, and approaches to adaptation to alleviate the impacts.

Detailed information on approaches to coastal adaptation are not presented in this chapter. Rather, the chapter focuses on providing a general overview of approaches to increase coastal resilience.

Available from: http://unfccc.int/resource/cd_roms/na1/v_and_a/index.htm

USAID (2007) Adapting to Climate Variability and Change: a Guidance Manual for Development Planning.

The manual outlines a detailed approach to ensuring that climate change is considered and incorporated within a project intervention. The six-stage approach to integrating vulnerability and adaptation elements into projects is presented, and climate impacts and development are briefly described. The approach outlined in this manual is a more detailed approach to mainstreaming than presented within this guide. This is due to the focus of mainstreaming throughout the entire project cycle, rather than focusing on project preparation. This is a useful resource to gather an appreciation of the steps to mainstream from preparation to monitoring and evaluation.

ADB (2005), 'Climate Proofing: A Risk-based Approach to Adaptation', ADB, Manila.

Based on six case studies in Pacific Island countries, information on the approach, methods, and tools used during preparation of the case studies is presented, together with methods that might be used to incorporate climate change adaptation into policy development, planning, and decision-making processes at the national level. Thus, the tools are very much targeted at national level adaptation and climate proofing. The tool, or method, applied in the case studies is described as 'climate change adaptation through integrated risk assessment' (CCAIR), and involves the following steps:

- Adaptation Rapid Assessment;
- Risk characterization and management;
- Characterizing the baseline conditions;
- Building and characterizing scenarios;

- Cost-benefit analysis for evaluating adaptation;
- The 'SlimClim' system

The report is available from: <http://www.adb.org/Documents/Reports/Climate-Proofing/default.asp>

Guidance notes on tools for mainstreaming disaster risk reduction - ProVention Consortium

The ProVention Consortium has recently published a comprehensive compendium of short briefing papers on tools and methods for mainstreaming disaster risk reduction. These approaches have much in common with climate change adaptation, particularly in their approach to tackling current variability, risk frameworks, and approaches to overcoming barriers to cross-sectoral work.

This report provides good approach to mainstreaming and was the basis for the approach adapted in current MFF programme. This may be seen as a resource for those that want to go a 'step further' in integrating climate change into their project proposals. It is a more detailed and resource intensive approach than that currently outlined in the MFF programme documentation. It would be a useful tool for application during project implementation.

The report is available from: <http://www.proventionconsortium.org/?pageid=32&projectid=1>.

UNDP Adaptation Policy Framework and Technical Papers

UNDP led in the development of a process to help countries integrate adaptation concerns into the broader goals of national development. The result is called the Adaptation Policy Framework (APF). The APF provides guidance on designing and implementing projects that reduce vulnerability to climate change, by both reducing potential negative impacts and enhancing any beneficial consequences of a changing climate. The APF is comprised of five components:

- Component 1: Scoping and designing an adaptation project
- Component 2: Assessing current vulnerability
- Component 3: Assessing future climate risks
- Component 4: Formulating an adaptation strategy
- Component 5: Continuing the adaptation process

Each component is support by a technical paper, which provides detailed information on the methods to complete the component.

The APF is available from: <http://www.undp.org/climatechange/adapt/apf.html>. Technical papers are included in the resource section.

Identifying Climate Variability Exposure - SEI, ACCCA

This guidance sheet provides an approach to identify the key climatic hazards for a specific region and livelihood or economic activity. The outcomes of the process allow the analyst: to identify measurable climate variables that can be obtained from climate information systems for the present and archives of global climate change models for relevant time periods in the future; to identify climate variables and thresholds of concern that would be required in planning adaptation strategies and measures; to identify gaps in knowledge where additional sectoral and livelihood studies are required or may be available but not brought into the team's expertise, at the local to national and even regional level.

Step 1 in this framework applies to the focus of the proposed intervention, for example, the target region, activity and/or vulnerable group would be based on the focus on the proposed intervention. A livelihood sensitivity matrix provides a starting point for determining which livelihoods are most vulnerable to different

types of climatic hazards and the degree to which different livelihood activities are impacted by different climate hazards

The guidance sheet is available from:

<http://www.napa-pana.org/private/modules/knowledgebox/io/file.php?entry=1244&field=31>

UKCIP: Climate Adaptation: Risk, Uncertainty and Decision Making

The guidance provides a step-by-step decision-making framework to help judge the significance of climate change risk compared to the other risks faced, to determine what adaptation measures are most appropriate. It is recommended that the framework be applied when you have some knowledge of your climate risks but want to fully understand these and get a good understanding of your adaptation options. Alternatively, the *UKCIP Adaptation Wizard* is recommended for those new to climate change who may not have a good understanding of climate risks. Available from:

http://www.ukcip.org.uk/index.php?option=com_content&task=view&id=62&Itemid=184

Adaptation Wizard – UK Climate Impacts Programme (UKCIP)

The Adaptation Wizard is a web-based tool that is designed to take help users gain a basic understanding of climate change as well as integrate climate risks into their decision-making. It is a high-level, generic tool that is valuable to newcomers to the climate change issue, as well as those who are preparing to adapt. The tool is specifically aimed at the UK context. It is more a decision-support than decision-making tool, and plays a valuable awareness-raising and educational role. The tool walks users through an economic analysis of adaptation options and scenarios.

Overall, the tool guides decision-making, rather than providing definitive adaptation options to address specific risks. The tool provides a good approach to generating an understanding of adaptation to climate change, but not necessarily the best tool to guide risk identification and analysis. Available from:

http://www.ukcip.org.uk/index.php?option=com_content&task=view&id=147&Itemid=297

[Coastal management to support climate change adaptation](#)

FAO (2007) Coastal protection in the aftermath of the Indian Ocean tsunami: What role for forests and trees?

This report provides information on the role of forests and trees in protecting coastal areas from the impact of Tsunamis. The information presented in the document can be utilised to demonstrate the role of forests and trees in promoting increased coastal protection, which is beneficial under projections of climate change. More specifically, the report contains:

- Thematic papers prepared by professional experts on natural hazards to provide an objective analysis of the roles coastal forests and trees play in protecting lives, resources and infrastructure from coastal erosion, cyclones, tsunamis and wind and salt spray respectively. A coastal area planning paper on incorporating forests and trees into disaster management strategies.
- Abstracts of case study presentations (referred to as 'field study presentations'), which highlight the use of forests and trees for coastal protection in various countries of Southeast Asia.
- A summary of the key points and observations emphasized in the workshop discussions relative to each hazard

The report is available online from: <http://www.fao.org/docrep/010/ag127e/ag127e00.htm>

Perez, R. et al. (1999) *Climate change impacts and responses in the Philippines coastal sector. Climate Research.*

This paper explores the potential impacts of accelerated sea level rise in the Philippines and assesses adaptation responses. The study applies the steps in the 'Common Methodology' to assess risk and formulate adaptation strategies. However, the steps are slightly modified to fit the data and information available to the study.

The paper provides a useful example of how to undertake a coastal vulnerability and adaptation assessment. However, the assessment is completed at a large scale (approx. 50km), and thus the adaptation options may not be relevant to smaller scale assessments.

The paper is available from: <http://www.int-res.com/articles/cr/12/c012p097.pdf>

OCED (2003) *Development and climate change in Bangladesh: Focus on coastal flooding and the Sundarbans.*

The paper provided guidance in the mainstreaming of responses to climate change within economic development planning and assistance policy, with natural resource management as an overarching theme, in Bangladesh. The three-step approach: identified key sectoral impacts as a result of projected climate change and ranked against a number of criteria, to later establish priority for adaptation; identified climate risks and impacts on Bangladesh's donor activities; and conducted an in-depth analysis of the coastal zone, emphasising mangroves as they were identified as being particularly vulnerable to climate change. The paper is good case study of how other countries with important mangrove communities have identified risks (e.g. inundation) and have developed adaptation options to treat these risks. It gives examples of projects that are used to integrate coastal zone management as a process to coordinate all stakeholders' activities and maximise benefits for the 'poor people'.

The paper is available from, <http://www.oecd.org/dataoecd/46/55/21055658.pdf>

Cairns, J. (2004) *Ecological Tipping Points: A Major Challenge for Experimental Sciences.* Asian J. Exp. Sci., Vol. 18, No. 1&2, 1-16

This paper explores tipping points or thresholds of the Earth and its ecology to changes in climate. It provides various case studies of such tipping points and how they have been passed resulting in environmental or socio-economic consequence. Global warming is one of many tipping points discussed in the paper. This paper assists in understanding how both global and local tipping points or thresholds work and how they are reached.

This information is valuable in providing a background to the need for mitigation and adaptation action. However, it does not provide details on methods to establish thresholds at the local level. Furthermore, the expertise and data levels required to set thresholds at the local level are high. Therefore, whilst providing general information, the paper does not provide details on methods to incorporate this information into projects relevant to MFF project partners.

This paper is available from:

<http://www.johncairns.net/Papers/Ecological%20Tipping%20Points.pdf>

This article provides background information on climate change and presents a case for responding to climate change through adaptation. It explores the importance of reducing country level vulnerability and explains that poverty is both the condition and determinant of vulnerability. Reducing poverty is indicative of understanding a community's livelihood, and by knowing the communities capabilities and resources, successful adaptation strategies can be built. It suggests that successful adaptation strategies generally come through ecosystem management and restoration activities that improve the environmental services that poor communities rely on. The article is brief but provides a good rationale for adaptation and that understanding livelihoods is essential to providing sound adaptation advice. This paper is available from:

http://www.iisd.org/pdf/2003/envsec_livelihoods_1.pdf

Appendix 2: Glossary of terms

Adaptation (IPCC 2007b): Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation:

- Anticipatory adaptation: Adaptation that takes place before impacts of climate change is observed (also referred to as proactive adaptation).
- Autonomous adaptation: Adaptation that does not constitute a conscious response to climatic stimuli, but is triggered by ecological changes in natural systems and by market or welfare changes in human systems (also referred to as spontaneous adaptation).
- Planned adaptation: Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.

Adaptive capacity (in relation to climate change impacts) (IPCC 2007b): The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Capacity (IPCC 2007c): A combination of all the strengths and resources available within a community, society or organization that can reduce the level of risk, or the effects of a disaster. Capacity may include physical, institutional, social or economic means as well as skilled personal or collective attributes such as leadership and management.

Capacity may also be described as capability.

Climate (IPCC 2007b): Climate in a narrow sense is usually defined as the 'average weather', or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. These quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system. The classical period of time is 30 years, as defined by the World Meteorological Organization (WMO).

Climate change (IPCC 2007b): Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'. The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes.

Climate Change Impacts (MFF 2008): The effects of climate change on natural and human systems. Depending on the consideration of adaptation, one can distinguish between potential impacts and residual impacts: Potential impacts: all impacts that may occur given a projected change in climate, without considering adaptation. Residual impacts: the impacts of climate change that would occur after adaptation. See also aggregate impacts, market impacts, and non-market impacts.

Climate system (IPCC 2007c): The climate system is the highly complex system consisting of five major components: the atmosphere, the hydrosphere, the cryosphere, the land surface and the biosphere, and the interactions between them. The climate system evolves in time under the influence of its own internal dynamics and because of external forcings such as volcanic eruptions, solar variations and anthropogenic forcings such as the changing composition of the atmosphere and land use change.

Climate variability (IPCC 2007b): Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability). See also Climate change.

Disaster Risk Reduction (ISDR 2004): The conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development.

Risk (ISDR 2004): The probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions.

Beyond expressing a possibility of physical harm, it is crucial to recognize that risks are inherent or can be created or exist within social systems. It is important to consider the social contexts in which risks occur and that people therefore do not necessarily share the same perceptions of risk and their underlying causes.

Risk Assessment/Analysis (ISDR 2004): A methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend.

The process of conducting a risk assessment is based on a review of both the technical features of hazards such as their location, intensity, frequency and probability; and also the analysis of the physical, social, economic and environmental dimensions of vulnerability and exposure, while taking particular account of the coping capabilities pertinent to the risk scenarios.

Sea-level rise (IPCC 2007b): An increase in the mean level of the ocean. Relative sea-level rise occurs where there is a local increase in the level of the ocean relative to the land, which might be due to ocean rise and/or land level subsidence. Eustatic sea-level rise is a change in global average sea level brought about by an increase in the volume of the world ocean. In areas subject to rapid land-level uplift, relative sea level can fall.

Sustainable Development (IPCC 2007b): Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and the future needs (Brundtland Commission, 1987).

Sustainable development is based on socio-cultural development, political stability and decorum, economic growth and ecosystem protection, which all relate to disaster risk reduction.

Vulnerability: The conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards (IPCC 2007c). Further, vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity (IPCC 2007b).

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Climate Proof

A Reference Tool to Coastal Climate Change in the Context of Mangroves for the Future

This document has been produced as a reference tool for MFF project partners. The tool is one component in a series of activities undertaken to mainstream climate change into the MFF programme. The work led by UNEP, in collaboration with UNDP, aims to ensure that climate change adaptation considerations are included in all phases of the MFF initiative and projects.

The aim of this reference tool is to support the integration of climate change within the MFF initiative. The tool has not been designed to be read from cover to cover; each section can be read independently, allowing users to identify and use the sections which are most relevant to their needs.

Get the full guidelines and reference tool at:

www.mangrovesforthefuture.org

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