National Adaptation Programme of Action (NAPA)

Republic of Maldives

Prepared by

The Government of Maldives

Ministry of Environment, Energy and Water

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ISBN

Published by:
Ministry of Environment, Energy and Water, 2007
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Cartography, design and layout by: Ahmed Shaig
Photos courtesy of: Portrait Gallery
Printed by:

Foreword

By President of the Republic of Maldives

27 December 2006

Our world is today faced with many serious threats to the prospect of life and the well-being of our future generations. Poverty, terrorism and global pandemics rank among the most serious perils facing us. However, to the three hundred thousand inhabitants of the Maldives none of these threats compare, in magnitude and likelihood, to global climate change and consequent sea level rise.

Twenty years ago, the Maldives activated the alarm bells on this impending threat to the survival of our nation. Slowly but surely, we caught the attention of the international community. Two decades on, the scientific evidence of climate change is overwhelming. Climate change and sea level rise are already happening. Although some work is being done to mitigate against climate change, there is no local-level fix to this global problem.

Numerous challenges lie ahead of us in the quest to safeguard the Maldives and its people from the rising seas. We must find ways to adapt to higher sea levels, higher levels of natural stress on coral reefs, higher temperatures, higher frequency of severe storms and varying rainfall patterns. Thus, this National Adaptation Programme of Action (NAPA) will hopefully guide us in this endeavour in the years ahead. It outlines the activities that we must implement to adapt to climate change. I note with satisfaction that the NAPA was developed with wide stakeholder participation and through extensive consultations at the atoll and national levels. Thus, the views and priorities in the Programme have the endorsement of the public.

The reverberating message here is that the commitments agreed on in the Kyoto Protocol fall way short of reversing the climatic trends. It is therefore absolutely essential that those who have made those commitments at least prove their good faith.

I call upon all Government agencies, our international development partners and friends to extend their full cooperation to us to make this adaptation programme a success.

Maumoon Abdul Gayoom

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The National Adaptation Programme of Action Maldives was prepared by the Integrated Climate Change Strategy (ICCS) Projects of Ministry of Environment, Energy and Water.

The Ministry of Environment, Energy and Water wishes to acknowledge the valuable support of Global Environment Facility and its implementing agency, United Nations Development Programme. We would like to thank Ms.Hudha Ahmed, the UNDP Programme Co-ordinator for her commitment, helpful support and guidance throughout the NAPA process.

The Ministry gratefully acknowledges the support and guidance given by the Project Steering Committee and special thanks to the Project Director, Deputy Minister of Environment, Energy and Water, Mr. Abdullahi Majeed and for the undivided devotion and effort put forth by the Assistant Director General, Mr. Amjad Abdulla, as the Focal Point of the Ministry of Environment, Energy and Water.

The Ministry of Environment, Energy and Water is grateful for the work undertaken by all the National Project Managers during the period of NAPA project, and a particular appreciation to the National Project Manager, Ms. Lubna Moosa for coordinating the stakeholder consultative process and producing the draft NAPA report.

We would also like to thank the members of the Climate Change Technical Team from the following government and private agencies for their valuable time and input to the NAPA process from the following government agencies and the private sector.

- Ministry of Fisheries, Agriculture and Marine Resources
- Marine Research Centre
- Maldives Transport and Contracting Company
- Ministry of Health
- Ministry of Planning and National Development
- Ministry of Tourism and Civil Aviation
- Ministry of Housing and Urban Development
- Ministry of Construction and Public Infrastructure
- Ministry of Transport and Communication
- Ministry of Education- Educational Development Centre
- Ministry of Economic Development and Trade
- Ministry of Atolls Development
- Department of Meteorology
- Maldives Fishermen's Association
- Land and Marine Environmental Resources Group Pvt. Ltd.
- Seamarc Pvt Ltd
- Banyan Tree Maldives

Appreciation is also extended to representatives from the atolls who participated in the regional stakeholder consultations and those from the government and private agencies who participated in the national workshop. We thank the staff of the Integrated Climate Change Strategy Project, Atoll Ecosystem Conservation Project, and the Environment Section of the Ministry of Environment, Energy and Water for the support extended by them.

Acronyms

7NDP	Seventh National Development Plan
CCTT	Climate Change Technical Team
ENSO	El Niño-Southern Oscillation
FNC	First National Communication
GDP	Gross Domestic Product
GEF	Global Environment Facility
ICCS	Integrated Climate Change Strategy
IOTC	Indian Ocean Tuna Commission
IPCC	Intergovernmental Panel on Climate Change
MDGs	Millennium Development Goals
MSL	Mean Sea Level
MTL	Mean Tide Level
NAPA	National Adaptation Programme of Action
SRES	Special Reports on Emission Scenarios
SST	Sea Surface Temperature
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Chang
V&A	Vulnerability and Adaptation

Male' International Airport

Chapter I
Introduction

"...there must be a way out. Neither the Maldives nor any small island nation wants to drown. That's for sure. Neither do we want our lands eroded nor our economies destroyed Nor do we want to become environmental refugees either. We want to stand up and fight.

President Maumoon Abdul Gayyoom,
Small States Conference on Sea Level Rise, Male', 1989

The Maldives is among the most vulnerable to predicted climate change and non-action is not an option for the country. The number of scientific and technical assessments undertaken in the country since 1987 has reiterated the need for long-term adaptation to climate change. Since the commencement of sea wall construction around the capital Male' in September 1988 the government has implemented several projects aimed at adaptation to environmental threats.

The Maldives played an important role in the negotiations that led to the United Nations Framework Convention on Climate Change (UNFCCC) and was the first to sign the Kyoto Protocol to the UNFCCC. The Maldives submitted the First National Communication (FNC) to the UNFCCC in 2001 following the implementation of the Maldives GHG Inventory and Vulnerability Assessment: A Climate Change Enabling Activity. The FNC contained mitigation and adaptatic measures and the project profiles for continuing climate change adaptation and mitigation process.

This is the first National Adaptation Programme of Action (NAPA) developed to communicate the most urgent and immediate adaptation needs of the Maldives as stipulated under UNFCCC Decision 28/CP.7. NAPA was prepared with support from the Global Environment Facility (GEF) and United Nations Development Programme (UNDP). Preparation of NAPA began in October 2004 and the process was halted because of the South Asian tsunami of December 2004. NAPA work recommenced in February 2006.

NAPA process was guided by the principles of broad stakeholder engagement, partnership building among focal agencies and ownership by the people of Maldives especially the atoll population. A multidisciplinary National Climate Change Technical Team (CCTT) was established as a first step to foster stakeholder engagement. Community consultations and awareness raising activities were held for representatives from seven atolls of the Maldives and the capital Male'. Targeted awareness raising and activity-based learning was conducted for school children from five secondary schools. Existing climate data for the Maldives was analysed with international expertise culminating in the first Climate Risk Profile for the Maldives. National experts produced vulnerability and adaptation (V&A) related technical papers for priority sectors identified by the NAPA Working Group. Extensive consultations at regional and national level were undertaken based on a prior agreed methodology to identify vulnerabilities and adaptation activities and to prioritize these activities.

The NAPA is intended to be concise as well as brief and contains seven chapters. Following this introduction Chapter Two presents the NAPA goal and describes the National Adaptation Policy Framework. Chapter Three describes the country characteristics and national development goals. Chapter Four depicts the climate hazards and risks. Chapter Five analyses vulnerabilities and the biophysical impacts of climate change. Chapter Six lists the adaptation needs and priority activities. NAPA concludes with Chapter Seven that contains the project profiles for adaptation to climate change in the Maldives.

Chapter II
Adaptation Policy Framework

This chapter presents the goal of the Maldives NAPA and the overall adaptation policy framework adopted for the country.

2.1 NAPA Goal

The goal of the NAPA is to present a coherent framework to climate change adaptation that enhances the resilience of the natural, human, and social systems and ensures their sustainability in the face of predicted climate hazards.

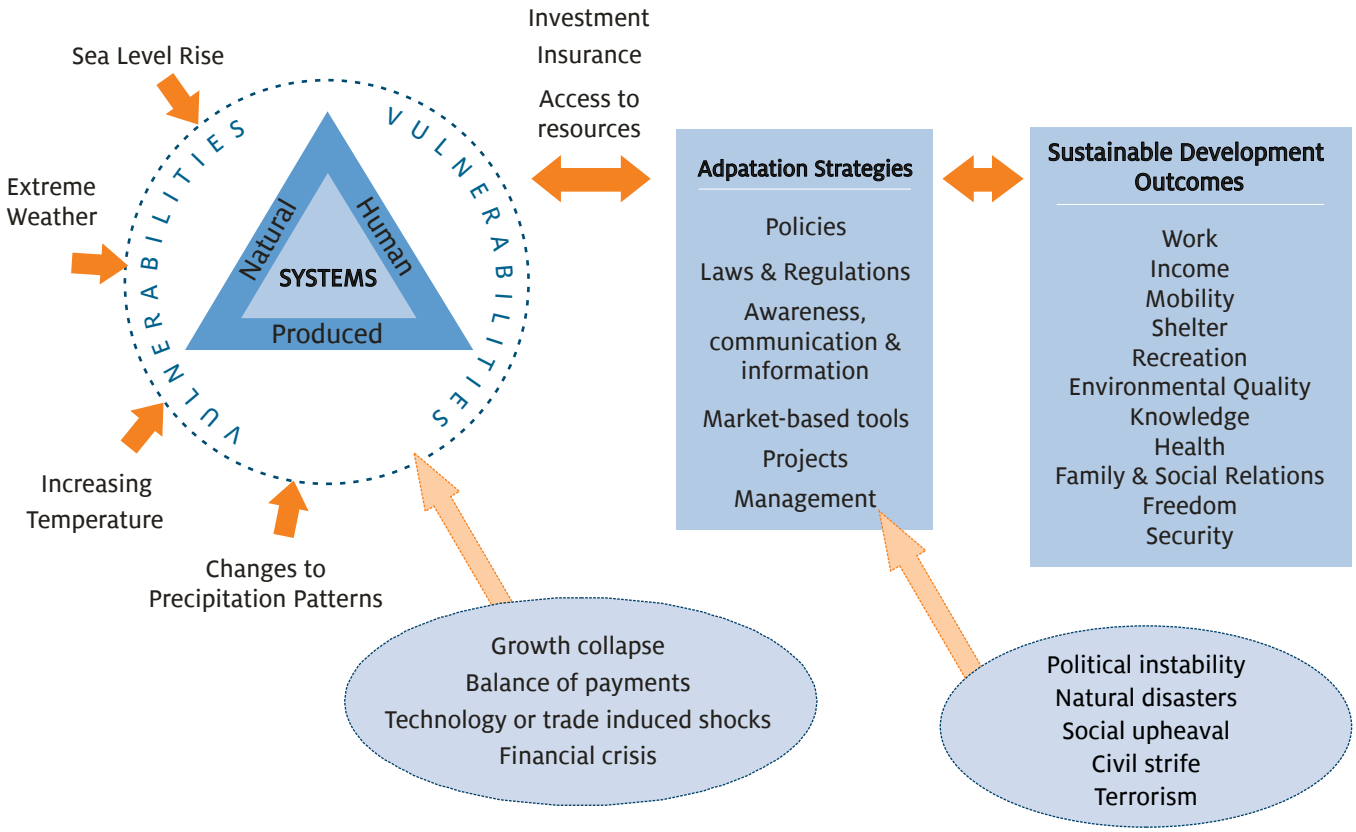
2.2 Maldives Adaptation Policy Framework

Figure 2.1 provides a simplified picture of the policy framework for adaptation to climate change in the Maldives. It presents the interactions among climate hazards and risks; exposure and vulnerability of the systems; the desired sustainable development outcomes; and adaptation strategies.

According to the Intergovernmental Panel on Climate Change (IPCC) "vulnerability is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes" (IPCC 2001:388). Adaptation refers to "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC 2001:365). For the Maldives NAPA, adaptation is a multi-dimensional goal that aims to increase resilience of the vulnerable systems against climate hazards and risks to achieve sustainable development outcomes.

It is acknowledged that a complete adaptation policy framework would be

Figure 2.1: *Conceptual framework of NAPA illustrating the complex relationship between sustainability and adaptation to climate change.*



more complex than is depicted here. Because of the limitations in human knowledge on complex systems such as society and ecosystems it is not possible to have a perfect adaptation policy framework. However, there is plurality of values in the framework presented here as it attempts to bring climate change into the national development agenda and identify key interrelationships.

Societies have always faced risks and shocks. Sustainable societies are those that have devised mechanisms to help reduce or mitigate risk and cope with the effects of shock. The focus of the adaptation framework is on climate change related hazards, risks and shocks and what the Maldives will do to cope with them. The **first** component of the framework is the climate change-related hazards for the Maldives. The hazards are assessed based on the Climate Risk Profile of the Maldives, the Disaster Risk Profile of the Maldives and the IPCC Third Assessment Report. The hazards are described in Chapter Four. Other types of risks such as growth collapse, balance of payments, financial crisis and technology or trade induced shocks are also shown in the framework which may impact the vulnerable systems concurrently and hence future adaptation outcomes.

The **second** component of the adaptation policy framework is vulnerable systems. The vulnerable systems are characterized by high vulnerability through exposure to different specific climate hazards, as well as being strategically important at national level. For the purposes of the Maldives NAPA 'system' comprises of natural, human and produced systems.

Natural systems are the natural and environmental resources broken down into; (i) renewable natural resources; (ii) non-renewable resources; (iii) the ecosystems and services which support and maintain the quality of land, air and water; (iv) the maintenance of a vast genetic library, referred to as biological diversity and (v) land, the space in which human activities take place. Human system refers to human lives, human health and knowledge, skills and competences of individuals. Produced systems are the human-made material resources that can be used to produce a flow of future income which includes the basic infrastructure (transport, buildings, water, energy and communications), and production equipment such as machinery and tools (Saeed 2005).

Children playing on the beach of an inhibited island. Improperly planned development activities can often alter conditions of the highly volatile beach systems.

The vulnerability of these systems to climate hazards is described in Chapter Five. This chapter is based on synthesis of scientific and technical vulnerability assessment studies that have been conducted in the Maldives since 1987 and the V&A assessment contained in the FNC in 2001.

The **third** component depicted on the right hand side of the adaptation framework is the sustainable development outcomes. Sustainable development is not an easily defined concept and it is almost impossible to define how much of it is adequate. The essential elements of sustainable development can only be understood relative to place, time, local context, culture and value systems. The goals of the Seventh National Development Plan (7NDP) are taken as a good basis for understanding the sustainable development outcomes for the Maldives relative to present time and local context. The country characteristics and the national development goals are described in Chapter Three.

A society's ability to achieve sustainable development outcomes depends on choices made by individuals, firms and

governments on how they use and transform the systems and how they mitigate or reduce the risk of climate change to the systems. The **fourth** component of the adaptation policy framework is the processes that interact with the systems to influence adaptation. In order to achieve the sustainable development outcomes, there has to be a process for maintenance, replacement and renewal of the systems. This process needs to be equal to or exceed the processes of depreciation, degradation and loss in the system. Replacement would not automatically take place and deliberate investment decisions are needed. On the other hand, climate change poses dangers or irreversible losses to critical systems. Hence, a policy of prudent insurance is needed as well.

In order to make wise investment and insurance decisions, signals need to be picked on the status of the systems, the hazards and risk levels to the systems, how society currently uses the systems, and how the society has coped with risks in the past. This requires the generation of information, fostering learning and knowledge. In the NAPA the decision processes are termed adaptation strategies. The signals on the adaptation needs of the society and the relative values of the adaptation strategies were obtained through carefully planned expert analysis and regional and national level stakeholder consultations. The key adaptation needs as identified and prioritised by stakeholders are listed in Chapter Six.

The **final** component of the adaptation framework is the barriers to implementation. There are several socio-political shocks and stresses such as political instability, social upheaval and terrorism that could affect speedy implementation of national adaptation activities. Such shocks have a tendency to alter and reshape national priorities over the short and medium-term. Natural shocks such as tsunamis, storms and epidemics also reshape priorities in the short-term.

Provided that national priorities do not change then the key barrier to implementation of adaptation strategies are weak institutions. Although the adaptation strategies are clear most of the organizations lack strategic direction and human, financial and technical resources to implement them. Furthermore, lack of knowledge, education and awareness among the public on the science and impacts of climate change tends to reduce the demand the public place on the government and private sector to supply adaptation and mitigation to climate change.

In the project profiles in Chapter Seven of the NAPA special attention has been given to remove barriers to long-term adaptation to climate change in the Maldives.

Chapter III
Country Characteristics and National Development

This chapter provides the background on geography, climate, society, the economy and the national development goals.

3.1 Geography and climate

Maldives is an archipelago of 25 low-lying coral atolls located in a north to south direction on the Laccadives-Chagos submarine ridge in the Indian Ocean (Figure 3.1). This chain is 860km long and the width varies between 80 to 120km. There are 1190 small tropical islands out of which 358 islands are being currently utilized mainly for human settlements, infrastructure and economic activities. The largest island is Gan in Laamu Atoll which is barely 6km^2.

Figure 3.1: *Location map of Maldives.*

Maldives has a tropical monsoon climate. The south-west monsoon is from May to November and the north-east monsoon is from January to March. Daily temperature varies between 31°C and 23°C. The mean daily maximum temperature is 30.4°C and the mean daily minimum temperature is 25.7°C. Humidity ranges from 73 to 85% (MEC, 2004; Meteorology, 2006).

The annual average rainfall for Maldives is 2,124mm. Southern atolls on average receive 2,277mm while northern atolls receive 1,786mm of rainfall annually.

Figure 3.2: *Map of Maldives showing geographic and climate features*

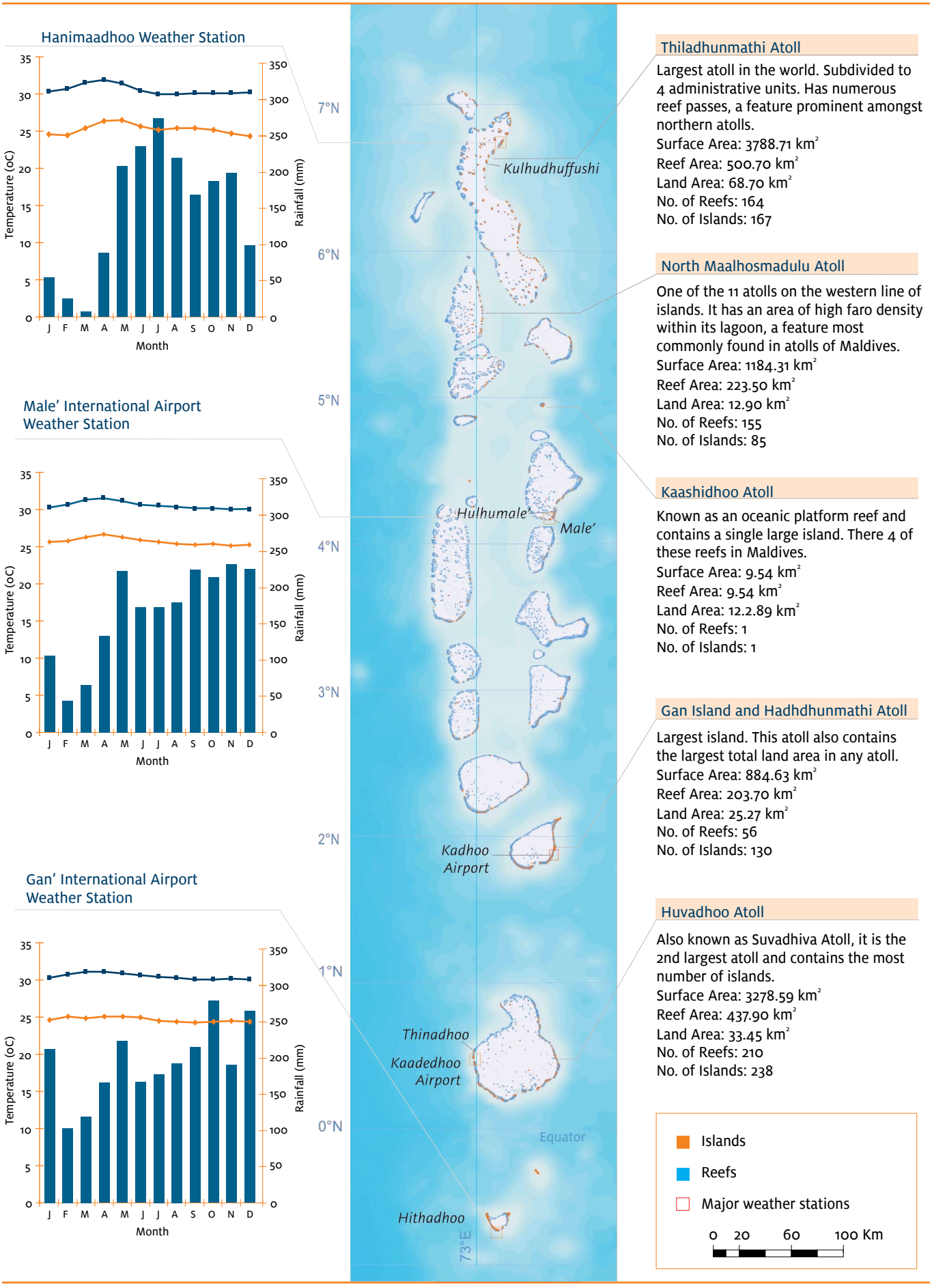
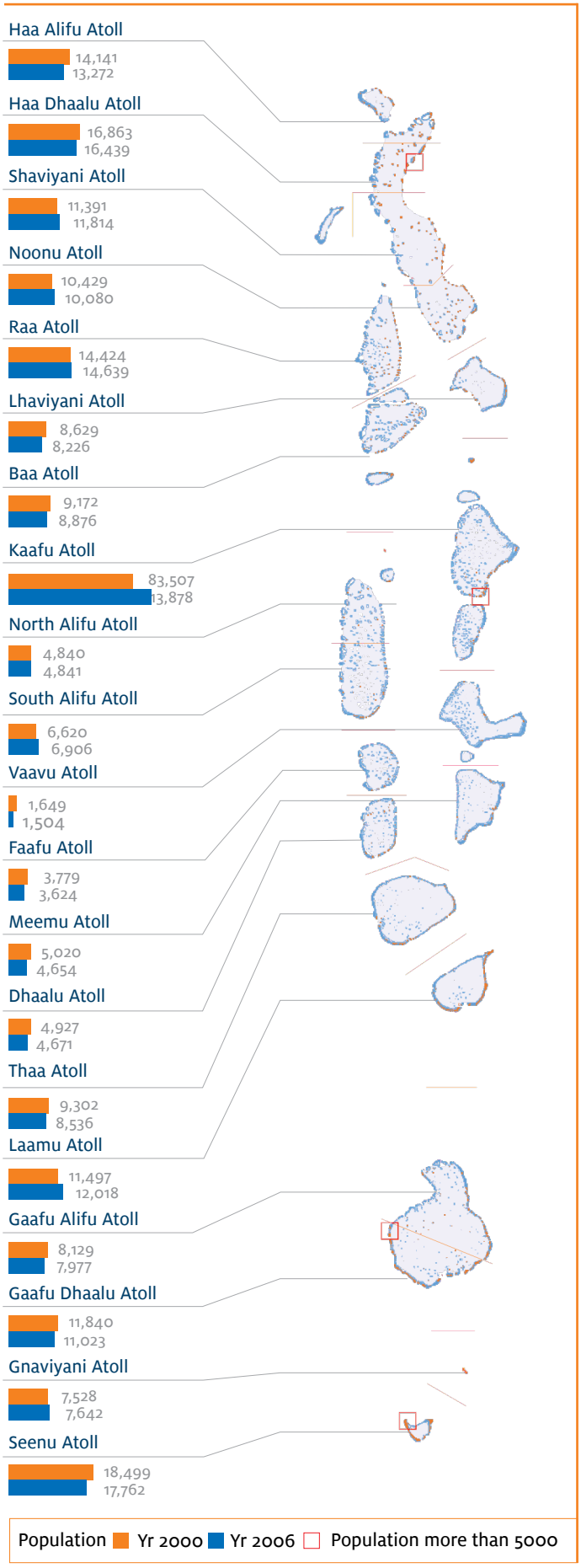


Figure 3.3: *Population distribution in year 2000 and 2006*



Lowest annual rainfall recorded in the last 30 years is 1,346mm in 2002 at Hanimaadhoo Weather Station and the highest is 3,185mm in 1978 at Gan International Airport Weather Station. The highest rainfall recorded within 24 hours to date is 220mm on 9 July 2002 at Kaadedhdhoo Weather Station (Meteorology, 2006).

3.2 Society

The Maldivian society is perhaps unique in the world as a nation since everyone speaks the same language and belongs to the same religion. Maldivians speak Dhivehi and the contemporary population is culturally homogeneous although originally from a varied ethnic mixture of Indo-Aryan, Dravidian, Sinhalese and Arabs.

Population of the Maldives passed the 300,000 mark in July 2006. The population growth rate is 1.8 per annum (MPND, 2006). In 13 out of the 20 atolls the population declined in the census period 2000-2006. Figure 3.3 shows the distribution of the population by atoll.

Population size among the atolls and the islands differs across the country. More than a third of the total population numbering 104,403 persons lives in the capital Male'. Out of the atolls Seenu Atoll has the highest population at 17,922, while Vaavu Atoll has the lowest population at 1,614 (MPND, 2006). Apart from Male', there are only three islands that have a population greater

than 5,000. They are Hithadhoo (Seenu Atoll) with 9,407, Fuvahmulah (Gnaviyani Atoll) with 7,642, and Kulhudhufushi (Haa Dhaalu Atoll) with 7,206 persons. In 2006, the number of islands that had a population between 5000 and 1000 people was 57, while 60 islands had between 1,000 and 500 people and 74 islands had a population of less than 500 people.

From 1997 to 2004, there is evidence of significant increases in income levels of the people (MPND, 2006). The headcount ratio shows that in 1997 the proportion of population having less than Rf 15 per person per day was around 45%, while by 2004 it had come down to about 20%. Even though income levels has been increasing, income inequality between Male' and the atolls has increased. There is also evidence that northern atolls are becoming poorer relative to southern atolls (MPND, 2005).

3.3 Economy

The annual gross domestic product (GDP) increased from Rf 385 million in 1978 to Rf 7,934.0 million in 2005 (MPE, 1988; MMA, 2004). The estimates of 2005 show that tertiary sector dominates the GDP with 73%, while the secondary and primary sectors contribute 17% and 10% respectively (MPND, 2004). Tourism is the main economic activity and contributes about one third to the GDP. Fisheries is the largest contributor to exports and contributes about 7% to the GDP. Agriculture plays a minor role in the economy and the sector contributed only 2.8% to GDP in 2000 (MPND, 2004).

Tourism industry is now the mainstay of Maldivian economy

3.4 NAPA and National Development

Synergy with national development goals is one of the objectives of NAPA. In the selection and prioritization of adaptation activities NAPA uses development goals in Vision 2020, Seventh National Development Plan (7NDP) and the Millennium Development Goals (MDGs).

The Vision 2020 outlined by President Maumoon Abdul Gayoom on 26th July 1999 provides the direction for sustainable development of the Maldives and is the basis for current national development policies. NAPA will contribute to the achievement of the Vision 2020, particularly through providing a planned approach to combat the climate change threat.

The 7NDP lays down the development policies and strategies of the Government for the period 2006 to 2010. The policies and strategies in the 7NDP are targeted at improving the quality of life for the people living in the Maldives, particularly the poor, the disadvantaged and the vulnerable groups. A key principle of the 7NDP is that the development policies should not compromise the ability of future generations to achieve non-declining per capita well being. The proposed way forward is optimal use of the available natural resources and the protection of critical natural capital such as water resources, coral reefs and fish breeding grounds.

The specific goals of the 7NDP are:

1 Create an environment conducive for growth and generate employment

2 Enhance trade, support businesses and build competitive industries

3 Invest in strategic and state-of-the art infrastructure to enable ease of movement, enhanced access to services, and build competitive advantage

4 Create a built environment with opportunities for equitable access to housing, sports, and recreation and preserve cultural heritage

5 Protect the natural environment and make people and property safer

6 Invest in people through providing equal opportunity for education, life long learning and training

7 Improve health and well-being

8 Promote gender equality, family values and youth development.

9 Safeguard the values, rights and freedoms necessary to allow all to live a life of dignity.

10 Promote access to justice, rule of law and maximize public safety

11 Strengthen governance and national security

At the United Nations Millennium Summit held in September 2000, Maldives along with other nations of the world committed to achieve the MDGs. The eight broad goals and the 18 specific targets to be achieved by 2015 are designed to:

1. Eradicate extreme poverty and hunger.

2. Achieve universal primary education.

3. Promote gender equality and empower women.

4. Reduce child mortality.

5. Improve maternal health.

6. Combat HIV/AIDS malaria and other diseases.

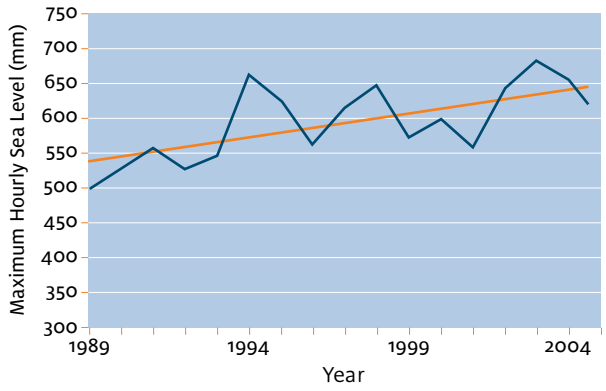
7. Ensure environmental sustainability.

8. Develop a global partnership for development.

North harbour of Capital Male'

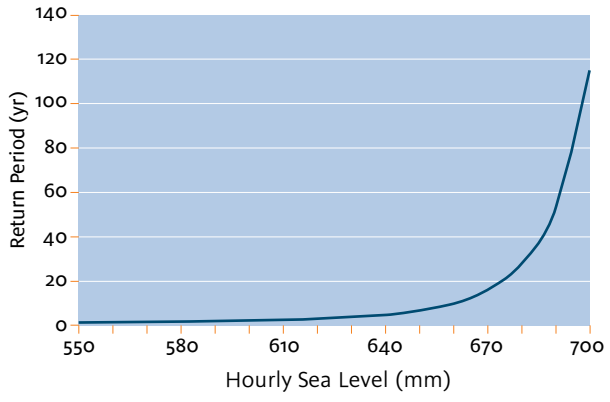
Chapter IV
Climate Change and Climate Variability

Figure 4.1: *Maximum hourly sea level, by year, and its linear trend for Hulhulé (1989 to 2005).*



Source: MEEW (2006)

Figure 4.2: *Relationship between hourly sea level and return period for Hulhulé, based on observed hourly sea level for 1989 to 2005*



Source: MEEW (2006)

The first component of the Maldives Adaptation Framework (Figure 2.1) described in Chapter Two is climate change-related hazards. This chapter summarises the global and national predictions for climate hazards. The hazards reviewed are sea level rise, precipitation, temperature and extreme events.

4.1 Sea level rise

The global mean sea level rose 10 to 20cm during the 20th century at the rate of 1to 2mm/year. Future sea level i projected to rise within the range of 9 t 88cm between 1990 and 2100. Sea level is projected to rise under all scenarios of IPCC Special Reports on Emission Scenarios (SRES). The projecte average rate of increase is 5mm/year, with a range of 2 to 9mm/year (IPCC 2001).

For Maldives, the observed long term trend in relative sea level for Hulhulé (Male' International Airport Weather Station) is 1.7mm/year. The maximum hourly sea level is increasing by approximately 7mm/year, a rate far in excess of the observed local and global trends in mean sea level (Figure 4.1).

For Hulhulé an hourly sea level of 70cm above mean sea level (MSL) is currently a 100-year event. It will likely be at least an annual event by 2050 (Figure 4.2).

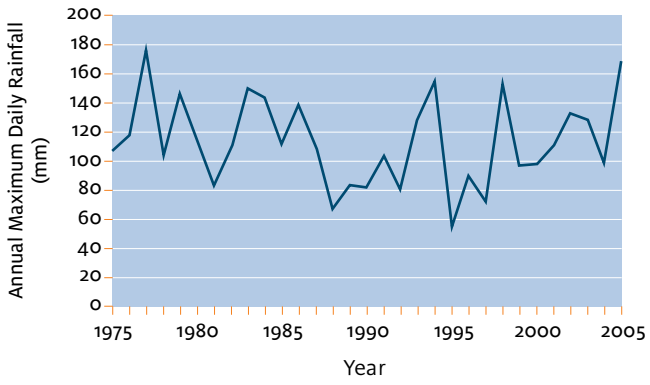
4.2 Precipitation

Global average water vapour concentration and precipitation are projected to increase during the 21st century (IPCC, 2001). A marginal decline in precipitation is projected for the Indian Ocean region (Nurse and Sem, 2001).

In the case of Maldives, no significant long term trends are evident in the observed daily, monthly, annual or maximum daily rainfall (Figure 4.3).

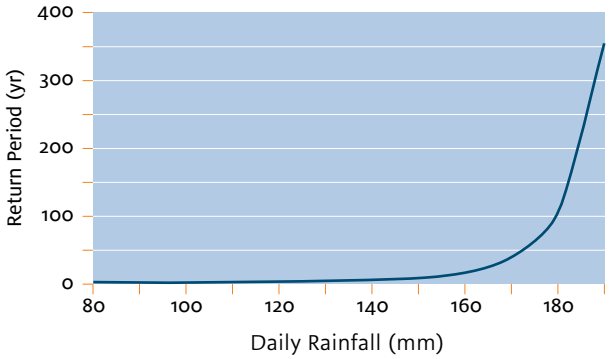
Currently a daily rainfall of at least 160mm is a relatively rare event at Hulhulé, with a return period of 17 years. An extreme daily rainfall of 180mm is currently a 100-year event. It will likely occur twice as often, on average, by 2050. An extreme three-hourly rainfall of 100mm is currently a 25-year event. It will likely become at least twice as common, on average, by around 2050 (Figure 4.4).

Figure 4.3: *Maximum daily rainfall, by year, for Hulhulé (1975 to 2005)*



Source: MEEW (2006)

Figure 4.4: *Relationship between daily rainfall and return period for Hulhulé, based on observed daily rainfall for 1975 to 2005*



Source: MEEW (2006)

4.3 Temperature

The global average surface temperature is projected to increase by 1.4 to 5.8°C over the period 1990 to 2100. The projected rate of warming is much larger than the observed changes during the 20th century (IPCC, 2001). For the Indian Ocean region, temperature is expected to increase by 2.1°C for the 2050s and 3.2°C for the 2080s (Nurse and Sem, 2001).

For Maldives, there is relatively high confidence in projections of maximum temperature. The annual maximum daily temperature is projected to increase by around 1.5°C by 2100. A maximum temperature of 33.5°C is currently a 20-year event. It will likely have a return period of three years by 2025.

The present average monthly Sea Surface Temperature (SST) in the Maldives ranges from 28°C to 29°C, rarely increasing above 30C. Mean monthly SST is lowest in December and January reaching its highest in April and May.

An increasing trend in SST has been observed in the Maldives (Singh et al. 2001; Khan et al. 2002). Large seasonal variations in the SST trends were observed at Gan (Gan International Airport) in Seenu Atoll. SST and Mean Tide Level (MTL) trends at Hulhule' (Male' International Airport Weather Station) have been steadily increasing across seasons and the rising rates are very high. The annual mean SST trends at Hulhule' and Gan are 0.2±°C and 1.1 to 1.6°C/decade respectively. The higher trends observed for Gan maybe due to Gan being located near the equator.

During May 1998 mean monthly SST was 1.1°C above the highest mean monthly SST expected in any 20 year return period (Clark et al. 2001).

4.4 Extreme events

Greater extremes of drying and heavy rainfall is projected, increasing the risk of droughts and floods especially during El Nino events (IPCC 2001). Tropical cyclones are predicted to be enhanced in intensity by 10 to 20% (Nurse and Sem 2001).

Table 4.1: Probable maximum storm tide

Return Period (Years)	Pressure drop (hPa)	Storm Surge Height (m)	Average Tide height (m)	Storm Tide (m)
100	20	0.84	0.98	1.82
500	30	1.32	0.98	2.3

Source: UNDP (2006)

Table 4.2: Probable maximum storm tide by region

Hazard Zone	Storm Surge Height (m)	Average Tide Height (m)	Storm Tide (m)
Southern Atolls	-	-	0
Central-west Islands	0.45	0.93	1.38
Central-east Islands	0.6	0.93	1.53
Northwest Islands	0.99	0.98	1.97
NorthEast Islands	1.32	0.98	2.3

Source: UNDP (2006)

Table 4.3: *Storm tide estimates for medium and high sea level rise scenarios*

Zone	Present Day			Storm Tides at Predicted SLR Scenarios 2080-2100	
	Storm Surge Height (m)	Average Tide Height (m)	Storm Tide (m)	Medium (0.48m)	High (0.88m)
Southern Atolls	-	0.93	NA	NA	NA
Central-west Islands	0.45	0.93	1.38	1.86	2.26
Central-east Islands	0.6	0.93	1.53	2.01	2.41
Northwest Islands	0.99	0.98	1.97	2.45	2.85
NorthEast Islands	1.32	0.98	2.3	2.78	3.18

Source: UNDP (2006) and Shaig (2006)

According to the Disaster Risk Profile for Maldives (UNDP, 2006), maximum storm surge height is reported to be 1.32m with a return period of 500 years. If coupled with high tide, it could generate a storm tide of 2.30m (Table 4.1).

The probable maximum storm tide by region in Table 4.2 shows that the islands in the northeast of the Maldives could face storm tides of 2.30m in height.

The study also reported the forecasted maximum storm tides for different regions of the Maldives based on medium and high sea level rise scenarios (Table 4.3).

Based on these assumptions, scenarios, and given that the average height of Maldivian islands is 1.5m above MSL, sea level rise would cause regular tidal inundations in most islands even at the medium prediction. The high prediction could cause inundations recurrently in almost all islands. Storm surges can create up to 2.78m waves under medium prediction, enough to completely inundate a medium to small sized island in the Maldives. A storm surge at high prediction could cause a 3.18m wave that could inundate even the largest of islands. These surges do not take into account regular monsoonal wind generated flooding which is considered the most common in Maldives (Shaig, 2006; UNDP, 2006).

The terrifying moment of tsunami waves overtopping breakwaters on eastern side of Male'. Flooding events are predicted to increase in Maldives.

Figure 4.5: Cyclone tracks over Maldives between 1877-2004

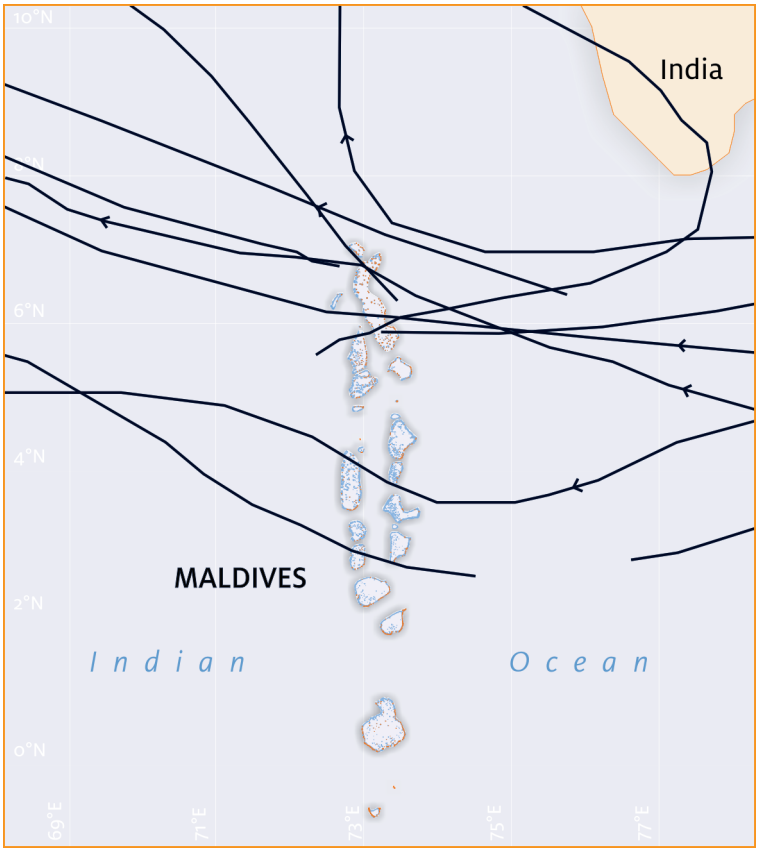


Table 4.4: Return period of wind speeds associated with cyclones in Maldives

Type	Wind Speed (knots)	Return periods (years)
Tropical Depression	28-33	10-20
Tropical Depression	34+	23
Cyclone	65+	134.6

Source: UNDP (2006)

Table 4.5: Cyclone hazard zone in Maldives and the probable maximum wind speed

Hazard Zone	Probable Maximum Wind Speed (knots)	Saffir-Simpson Scale (Hurricane Category)
Southern Maldives	0	0
South Central	55.9	0
Central	69.6	1
North Central	84.2	2
Northern Maldives	96.8	3

Source: UNDP (2006)

Maldives lies out of the tropical cyclone zone due to its proximity to equator. However, there have been incidents from the past where cyclonic storms have passed over Maldives and their still remain the probability for future such events. Figure 4.5 shows the tracks of cyclonic system over Maldives in 128 years.

There is a clear pattern of northern Maldives being exposed to more frequen freak storms than the south. Table 4.4 shows the predicted return periods for cyclonic activity based on historical records of wind data. Currently an extreme wind gust of 60 knots has a return period of 16 years. It is estimated that this will reduce to 9 years by 2025 (MEEW 2006). The cyclonic wind hazard zone mapping predicts category 3 cyclone for the northern Maldives in a 500 year return period (Table 4.5) (UNDP 2006).

Chapter V
Vulnerabilities and Impacts

The second component of the Maldives Adaptation Framework (Figure 2.1) described in Chapter Two is vulnerable systems. This chapter presents the vulnerabilities inherent in the different components of the natural, human and produced systems to the climate hazards described in Chapter Four and the predicted impacts of climate change on the Maldives.

Vulnerability assessments were undertaken for critical components of the systems and stakeholder consultations were conducted to complete hazard-vulnerabilities-impacts matrices and verify the results. The assessments and consultations showed how the vulnerabilities in the components interact with the climate hazards to impact key development sectors.

The impacts on the vulnerable systems are described in this chapter for the high risk sectors identified through the V&A assessment process. These are (i) Land, Beach and Human Settlements; (ii) Critical Infrastructure; (ii) Tourism; (iv) Fisheries; (v) Human Health; (vi) Water Resources; (vii) Agriculture and Food Security and, (viii) Coral Reef Biodiversity.

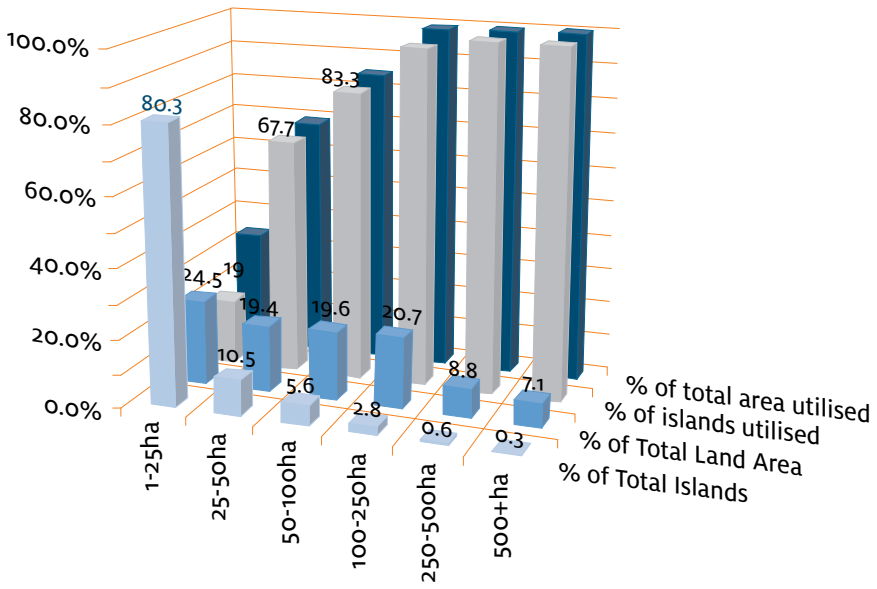
Most inhabited islands of Maldives are highly vulnerable to natural hazards

5.1 Land, Beach and Human Settlements

The small size, extremely low elevation and unconsolidated nature of the coral islands place the people and their livelihoods at very high risk from climate change, particularly sea level rise.

Maldives is the sixth smallest sovereign state in terms of land area. The total land area of the Maldives is estimated to be approximately 235km^2, based on the latest satellite and aerial imagery. This land is divided over 1192 coral islands and 96% of the islands are less than 1km^2 in area (Figure 5.1). Only 10 islands are more than 2.5km^2. The largest island Gan (Laamu Atoll), has an area of 6.1km^2 (Table 5.1). Land is highly scarce and the 358 islands that are currently in use account for 176km^2. The 834 unutilised islands make up only 59km^2.

Figure 5.1: *Island size and land utilization across Maldives*



Source: Shaig (2006)

Table 5.1: *Largest inhabited and uninhabited islands of Maldives*

	Inhabited Islands			Uninhabited Islands		
Rank	**Island**	**Atoll**	**Area (km^2)**	**Island**	**Atoll**	**Area (km^2)**
1	Gan	Laamu	6.13	Gan	Seenu	2.89
2	Hithadhoo	Seenu	5.26	Gan	Gaafu Dhaalu	2.51
3	Fuvahmulah	Gnaviyani	5.01	Kaadedhdhoo	Gaafu Dhaalu	1.87
4	Isdhoo	Laamu	3.73	Madidhoo	Shaviyani	1.07
5	Hanimaadhoo	Haa Dhaalu	3.04	Kadhdhoo	Laamu	1.03
6	Kaashidhoo	Kaafu	2.81	Kalhufahalafushi	Thaa	1.03
7	Filladhoo	Haa Alifu	2.70	Maafahi	Haa Alifu	1.02
8	Baarah	Haa Alifu	2.68	Maavaarulu	Gaafu Dhaalu	0.98
9	Kedhikolhudhoo	Noonu	2.15	Keylakunu	Haa Dhaalu	0.91
10	Nolhivaramu	Haa Dhaalu	2.10	Farukolhu	Shaviyani	0.88

Source: Shaig (2006)

Over 80% of the total land area of the Maldives is less than 1m above MSL. The highest point recorded in the country is a beach ridge at Fuvahmulah (Gnaviyani Atoll), with an elevation of 4m above MSL (MHAHE 2001). As future sea level is projected to rise within the range of 9 to 88cm between 1990 and 2100, the islands of Maldives would be submerged in the projected worst case scenario.

The coral islands that make up the Maldives are morphologically unstable and change in their size, shape, elevation and position on reef platforms over time. The beaches of these islands are particularly dynamic with substantial seasonal changes. At present, the total beach area is estimated at 13km^2 or 5% of the total land area and the coastline of the Maldives is estimated to be 2,300km long (Shaig 2006).

The small size of the islands forces people to live next to the sea. At present, 44% of the settlement footprints of all islands are within 100m of coastline. This translates to 42% of the population and 47% of all housing structures being within 100m of coastline. More than 50% of the housing structures in 121 islands are within 100m of coastline (Shaig 2006). Only Nolhivaramu (Haa Dhaalu), has all its housing structures 100m away from the coastline. Given the close proximity of the settlements to the sea and low elevation of the islands, homes of people are at severe risk of inundation with higher sea levels.

The small size of the islands and their low elevation also makes human settlements defenseless against severe weather events and storm surges. Over the last 6 years more than 90 inhabited islands have been flooded at least once and 37 islands have been flooded regularly or at least once a year (Shaig 2006). The series of swells, between 10-15 feet, which hit the Maldives on 15-17 May 2007, impacted an estimated 68 islands in 16 atolls and more than 500 housing units were damaged. An estimated population of more than 1600 people was evacuated from their homes (OCHA 2007). Since housing designs, structures and materials are not adapted to flooding, it exacerbates the vulnerability (UNEP 2005). The flooring of houses does not have adequate elevation from the ground and because of the poor construction material used for housing structures, higher frequency and increase in intensity of flooding could make these islands uninhabitable.

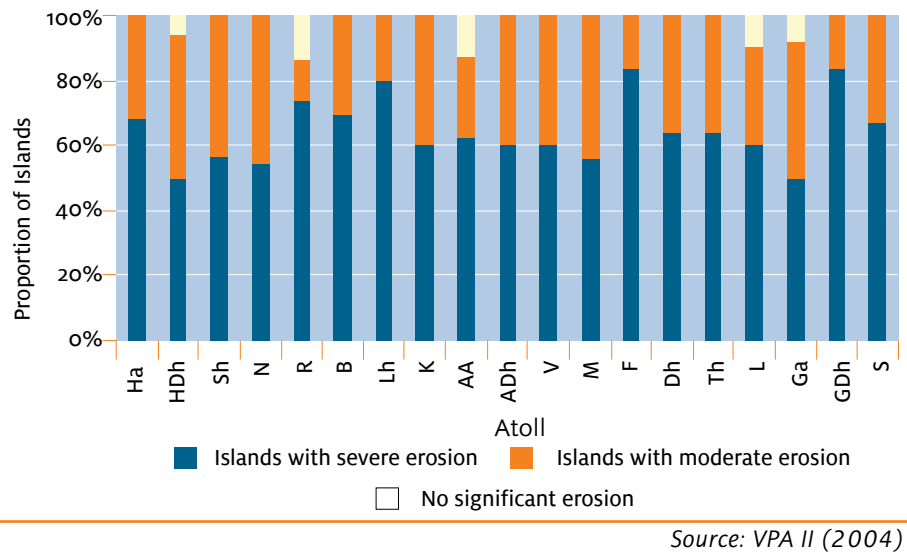
Most islands in Maldives are barely 1m above sea level. Under the predicted worst case sea level rise scenario, large areas of Maldives could be inundated.

Coastal erosion is a major environmental hazard in Maldives

The beaches that represent 5% of the total land area of the Maldives, are of unconsolidated nature and naturally dynamic and unstable. More than 97% of inhabited islands reported beach erosion in 2004, of which 64% reported severe beach erosion (Figure 5.2). Erosion patterns of inhabited islands have been further complicated due to human intervention in coastal areas. The problem of erosion is not specific to inhabited islands. More than 45% of the 87 tourist resorts have reported severe erosion (Shaig, 2006). Although beach erosion can be attributed to a number of factors, changes in climatic conditions is known to exacerbate erosion (Nurse and Sem, 2001). In the Maldives the intensity and duration of northeast and southwest monsoons affect beach erosion patterns. Further aggravation of erosion through elevated sea level and storm surges would cause significant loss and damage to people's property, tourist resorts, valuable land and critical infrastructure. About 85% of the 68 impacted islands during the series of wave surges that hit the Maldives in May 2007 reported having significant erosion of the island coastline (OCHA 2007.)

Human pressures also increase the vulnerability of the land and beaches to predicted climate change. The population of the country has increased by four-fold since 1911 and overcrowding is a significant problem. Already 34 of the inhabited islands do not have additional land for new housing and another 17

Figure 5.2: *Extent of coastal erosion in Maldives*



Source: VPA II (2004)

islands will reach their carrying capacity by 2015 (Shaig, 2006). Land reclamation work has been carried out to alleviate population pressure on land. Table 5.2 lists some of the major land reclamation projects in the last 30 years. Hulhumale' (Kaafu Atoll) is the largest land reclamation project where approximately 2km^2 was reclaimed to reduce population pressure on Male'.

Apart from land reclamation, several other human activities have increased vulnerability of land, beaches and human settlements. They include construction of poorly designed coastal infrastructure, poorly engineered coastal protection measures, removal of coastal vegetation, and sand mining. Coral reefs have a critical coastal protection function, yet there have been a number of human stresses on the reef system such as coral mining, reef entrance blasting, dredging, solid waste disposal and sewage disposal that has affected the health, integrity and productivity of reefs.

A number of human Activities have in the past contributed to increase the vulnerability of islands.

The scarcity of land in the Maldives, the smallness of the islands and extreme low elevation makes retreat inland or to higher grounds impossible. Building setback has limited utility and beach replenishment may only be a temporary remedy for beach loss. Unless expensive coastal protection measures are undertaken the human settlements face the threat of inundation.

Table 5.2: *Major land reclamation activities in Maldives*

Island	Atoll	Area Reclaimed (Km^2)[1]	% Reclaimed (Present Island)	Rationale
Hulumale'	Kaafu	1.89	100%	Population Pressure
Male'	Kaafu	0.82	41%	Population Pressure
Maamigili	Alifu Dhaalu	0.80	51%	Economic and infrastructure
Hulhule	Kaafu	0.76	58%	Infrastructure
Thinadhoo	Gaafu Dhaalu	0.66	60%	Population Pressure
Hithadhoo	Seenu	0.53	10%	Population Pressure
Thilafushi	Kaafu	0.49	100%	Infrastructure
Naifaru	Lhaviyani	0.37	68%	Population Pressure
Thulhaadhoo	Baa	0.14	66%	Population Pressure
Hinnavaru	Lhaviyani	0.12	54%	Population Pressure

Source: Shaig (2006)

5.2 Critical Infrastructure

Significant investments have been made to develop infrastructure in the country. At present there are five airports of which two are international. Three major commercial sea ports have been developed in the *Male'*, *Kulhudhuffushi (Haa Dhaalu Atoll)* and *Hithadhoo (seenu Atoll).* More than 128 island harbours have been developed by year 2006 in inhabited islands, resorts, airports and islands leased for economic and administrative purposes. There are at least 350 piers in resorts and inhabited islands. The main causeways are located in Laamu and Seenu Atoll (Shaig, 2006).

Male' International Airport: One of the most vulnerable and critical infrastructure in Maldives

Tourism infrastructure in the 87 resorts with 21,156 beds makes up the bulk of economic infrastructure both in terms of investment value and quantity. Each resort has its own power generation, water production and sewerage system. More than 1200 over-water structures have been developed as guest rooms, spas and restaurants in tourist resorts (Shaig, 2006).

Other critical infrastructure includes environmental services and utilities. There are waste management systems, sewerage systems and erosion mitigation measures such as near-shore breakwaters and groynes. Utilities infrastructure include powerhouses and desalination plants and their distribution systems (Shaig, 2006).

The location of infrastructure within close proximity to the coastline makes them highly vulnerable to sea level rise and storm conditions. The infrastructure of the two international airports is within 50m of the coastline. About 30% of the infrastructure of Male' International Airport lies within this range and additional land reclamation done on the island towards the ocean-ward side has resulted in parts of the island being within 15m of the wave break zone (Shaig, 2006).

More than 90% of all resort infrastructure and 99% of all tourist accommodation, which make up the most crucial economic product of the

country, are within 100m of coastline. The average width of a tourist resort is 190m while 63% of resort islands have a width less than 200m and 88% have less than 300m. Furthermore, 70% of all fisheries infrastructure are within 100m of coastline where proximity to beach is taken as an advantage (Shaig 2006).

The average width of inhabited islands is 566m resulting in all infrastructures built within 233m maximum from the coastline. In both inhabited islands and resorts 80% of the powerhouses are located within 100m of coastline. Also, 90% of the islands have their waste disposal sites within 100m of coastline and on the ocean-ward side of the island. More than 75% of communications infrastructures are located within 100m from the coastline. In addition, land reclamation on some islands have caused settlements and associated infrastructure to be located close to the coastline (Shaig, 2006).

All infrastructures on an island are at the low elevation of 1.5m above mean sea level (MSL). Over-water structures in resorts are built above the high tide and require high investment costs. The average height of the causeways and bridges is 1.6m above MSL. Guidelines for setting up powerhouses require the generator sets to be placed on concrete pads usually 6 to12 inches high (Shaig, 2006).

In the location, design and construction of infrastructure climate change hazards have not been taken into account. With the predicted rise in sea level and increased frequency and intensity of extreme weather, the critical infrastructure such as airports, harbours, coastal protection structures, tourist facilities, hospitals, schools and utilities are at high risk. If appropriate adaptation measures are not taken, frequent inundations could virtually obliterate the critical infrastructure damaging the

Top: Male' Port, Bottom: An island harbour. Ports and harbours are considered on the most critical infrastructures vulnerable to climate change in Maldives

economy threatening safety and security of the people. The scale and magnitude of damage that may be caused to infrastructure can be deduced from historical records.

The flooding event of 1987 caused damages worth US$4.5 million to the Male' International Airport alone (MHAHE, 2001). During tsunami waves of 2004, over-water structures in resorts were amongst the most impacted and the total damage estimated for the tourism sector was US$230 million (World Bank et al. 2005). The damage to transport and communications infrastructures were estimated to be US$20.3 million where 4,200m length of quay wall and 15,000m of harbour/sea walls and breakwaters were damaged or destroyed (World Bank et al. 2005).

An over-water bungalow in a tourist resort. Tourism infrastructures are extremely vulnerable to climate change due their close proximity to beach areas.

5.3 Tourism

Tourism with 87 resorts and 21,156 beds is the most dominant and fastest growing economic sector in the Maldives (MPND, 2004). In December 2004, tourist arrivals reached more than 600,000 within a calendar year (MoT, 2005). Tourism contributes about one third to the GDP and accounts for 17,000 direct jobs (World Bank et al. 2005). The sector also provides indirect employment and other opportunities in transport, communication, agriculture, distribution and construction as well as in the more dispersed local economies. The tourism industry, directly and indirectly accounts for a high portion of government revenues. Lease payments from hotel projects were US$48 million in 2004 with bed and departure taxes contributing US$41 million and custom duties another US$43 million (World Bank et al. 2005). The tourism sector is expected to grow significantly over the next five years with the opening of 53 new resorts with an additional 10,000 beds (MPND, 2006).

The marine biological diversity, tropical climate, small island environment and the world-class hotels are the unique marketable assets of the tourism sector. The reef ecosystems of Maldives are the seventh largest in the world and their diversity is amongst the richest in the world. The sun-sand-and-sea product is the mainstay of tourism in the Maldives and climate is a key determinant in choosing the Maldives as a destination.

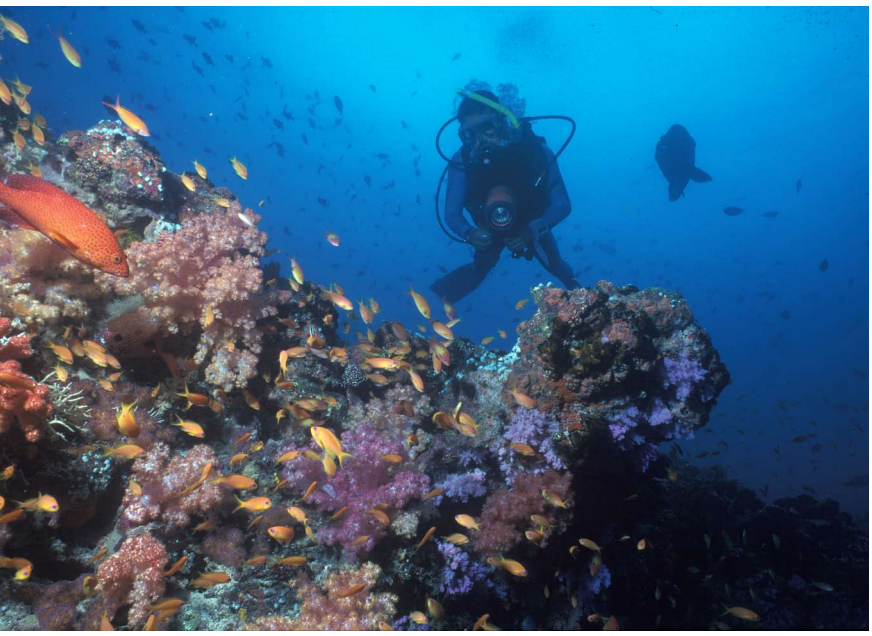
White sandy beaches, swaying coconut palms and lush tropical vegetation are essential components of the image of the Maldives tourism. Investments in a resort range from US$10 million for an average tourist resort with 200 beds to over US$ 40 million for modern high-end resort (MHAHE, 2001). According to the World Travel Awards 2006, Maldives is the World's Leading Dive Destination and Indian Ocean's Leading Destination (World Travel Awards, 2006).

Climate change influences the viability and profitability of tourism, both directly and indirectly. In the Maldives one resort is one island and these small tropical tourist resorts are among the most vulnerable and least defensible in the world. The resort islands are vulnerable due to its smallness, low elevation and geographical dispersion. The tourist resort islands are extremely small with 73 out of the 87 resorts being less than 0.1km2 while the largest tourist resort is just 0.5km2 (Shaig, 2006). The average elevation of tourist resorts is 1.5m above MSL. The tourist resorts are distributed along a length of 830km.

The tourist resorts are already experiencing damage to the environment and natural resources that are consistent with climate change. One of the most important assets of tourist resorts is beaches with 70% of tourists visiting the Maldives primarily for beach holidays. Sea level rise would disrupt tourism through loss of beaches. Already 45% of tourist resorts have reported varying degrees of beach erosion (MHAHE, 2001). Saltwater intrusion will impact the groundwater lens in resorts affecting the tropical vegetation. The present investments in tourist resort infrastructure exceed US$1 billion and loss, or even under-utilization, of such infrastructure due to climate variability and change will devastate the Maldivian economy. Vulnerability of tourism to extreme events is evident as shown by the combined cost to tourist resorts and loss of Government revenue from the tourism sector as a result of the Indian Ocean tsunami in excess of US$300 million (MPND, 2005).

All major infrastructure in resort islands are generally in close proximity to coastline due to their small size.

Snorkelling and diving are the two main tourist activities. At any resort at any given time 70to 80% of tourists are snorkellers while 25 to 35% of tourists visit the Maldives primarily for diving (Westmacott, 1996). Assuming 1.5 dives for every tourist arrival (Anderson, 1997) the total number of annual dives in 2006 is estimated at about one million.



Diving has become an integral part of the tourism product. The declining quality of reefs due to temperature changes can have significant impacts on the reef environment and the tourism industry.

The earning from a single dive ranges from US$45 to 55. Coral reefs thrive in a narrow temperature range and are highly sensitive to changes in temperature. Given the current predictions for increase in SST and the observed relatively more frequent or persistent El Nino episodes, coral bleaching is expected to rise rapidly and significantly (IPCC, 2001). Coral bleaching events occurred in the Maldives in 1977, 1983, 1987, 1991, 1995, 1997 and 1998, with the latter being the most severe. Almost all the shallow reefs in the country were impacted in 1998 and on average live coral cover before and after the bleaching was approximately 45% and 5%, respectively (MHAHE, 2001). Coral bleaching events will have significant implications for the tourism sector.

Climate change and its various impacts on marine biological diversity pose a significant risk to tourism. Damage to coral reefs of a popular shark diving spot in 1995 and 1996 reduced the number of divers resulting in a loss of revenue of US$500,000 in a single year (Anderson, 1997). Coral reefs are not only economically important to the tourism sector in terms of the aesthetic value and ecosystem services they provide, they also represent natural sea-defence acting to buffer beaches from wave action and other oceanic forces. Increased bleaching coupled with reduced calcification will affect coral growth and reef integrity and, reduce the ability of the reef to keep up with sea level rise.

The additional risks to tourism are in many cases indirect, with the initial impacts being imposed on the infrastructure, fisheries, water resources, agriculture and human health. For example, over 99% of tourists arrive to the Maldives by air and Male' International Airport is the only entry point by air. The airport sea defenses are barely adequate and any damage to the international airport by climate change and sea level rise will cause extreme loss to the tourism sector.

Climate projections for the Maldives, including those related to variability and extreme events, indicate increasing likelihood of conditions detrimental to the tourism sector. The consequences of climate change will be felt not only within the tourism sector but also by the individuals, communities, enterprises and entire sectors that are in turn dependent on tourism. At the same time adverse

climatic conditions will impact on the tourist experience and, in extreme situations, on tourists' health and safety and on the reputation of the country as a tourist destination.

5.4 Fisheries

Fisheries is a critical component of the economy. More than 20% of the population depend on fisheries as the major income earning activity. Fisheries is also the most dominant in terms of employment of the local labour force employing over 15,000 fishermen and contributes 7% to the GDP. Fish, particularly tuna, is the primary source of dietary protein for the Maldivians and tuna is served daily in every meal (Adam, 2006).

The total fish catch was 186,000 metric tons in 2005 and export revenue then stood at over US$100 million. Tuna and tuna-related species accounted for approximately 89% of the total fish catch and tuna products provided US$97 million of fish export revenue. Skipjack tuna makes up 71% of total fish catch followed by yellowfin tuna at 13%. These two fishery are significant even at the Indian Ocean wide catch levels, representing 20% and 7% respectively. In the Maldives, fish other than tuna species are classified as reef fish. In 2005, 11% of the fish catch was reef fish and contributed US$7 million to the fish export revenue (Adam, 2006; MPND, 2006).

Fishermen at work. Variations in tuna stock due to climate change have serious repercussions for the fishing industry.

Fisheries industry is highly vulnerable to climate change as tuna is highly attuned to the biophysical conditions of the pelagic environment, particularly ENSO and associated changes in SST. During the 1997/1998 El Nino the Indian Ocean purse seine fishery was shifted to the east, unlike other years owing to the elevated depth of the 20°C isotherm (Adam, 2006). In the Maldives during the El Nino years, catch rates of skipjack tuna are depressed while catches of yellowfin tuna are elevated and the effect is reversed in La Nina years (Adam and Anderson 1996; Adam and Anderson, 1996).

Tuna movement and abundance in the Indian Ocean is closely linked to the climate driven ocean productivity (Adam, 2006). The Somali Basin and the north Arabian Sea is particularly productive during the southwest monsoon. The recent trend of declining winter and

spring snow cover over Eurasia is causing a land ocean thermal gradient that is particularly favourable to stronger southwest monsoons. Such favourable conditions have caused over 300% increase in phytoplankton biomass in the area (Goes et al. 2005). These in turn could have profound implications for tuna distribution and abundance in the Indian Ocean (Adam, 2006).

As tuna fishery of Maldives is part of the wider Indian Ocean tuna fisheries, climate-induced changes and fishery overexploitation occurring elsewhere may have local repercussions (Adam, 2006). The most recent assessments of the tuna stock in Indian Ocean revealed that yellowfin tuna stock is considered to have reached maximum sustainable levels (IOTC, 2005).

The dependency of pole-and-line tuna fishery method on livebait makes the tuna fishery further vulnerable to climate change and variability. Live bait is a pre-requisite for the pole and line fishery in the Maldives. For every 7 to 10kg of tuna catch a kilogram of livebait is required which approximates to 21,000 tons of livebait each year (Adam, 2006). Without adequate and continuous supply of livebait pole-and-line fishery will not exist in the Maldives. The bait is taken from small schooling varieties associated with the coral reefs. The most popular species are silver sprats, fusiliers and cardinal fish.

The habitats for livebait are coral reef systems that are highly vulnerable to changes in SST and other climate changes. This has significant implications for the availability of livebait as shown by the 1998 coral bleaching event when abundance of long nose file fish *(Ocymonocanthus longirostris)* rapidly declined. This particular species is an obligate corralivore and the rapid demise of the live corals had an impact on their survival (Adam, 2006).

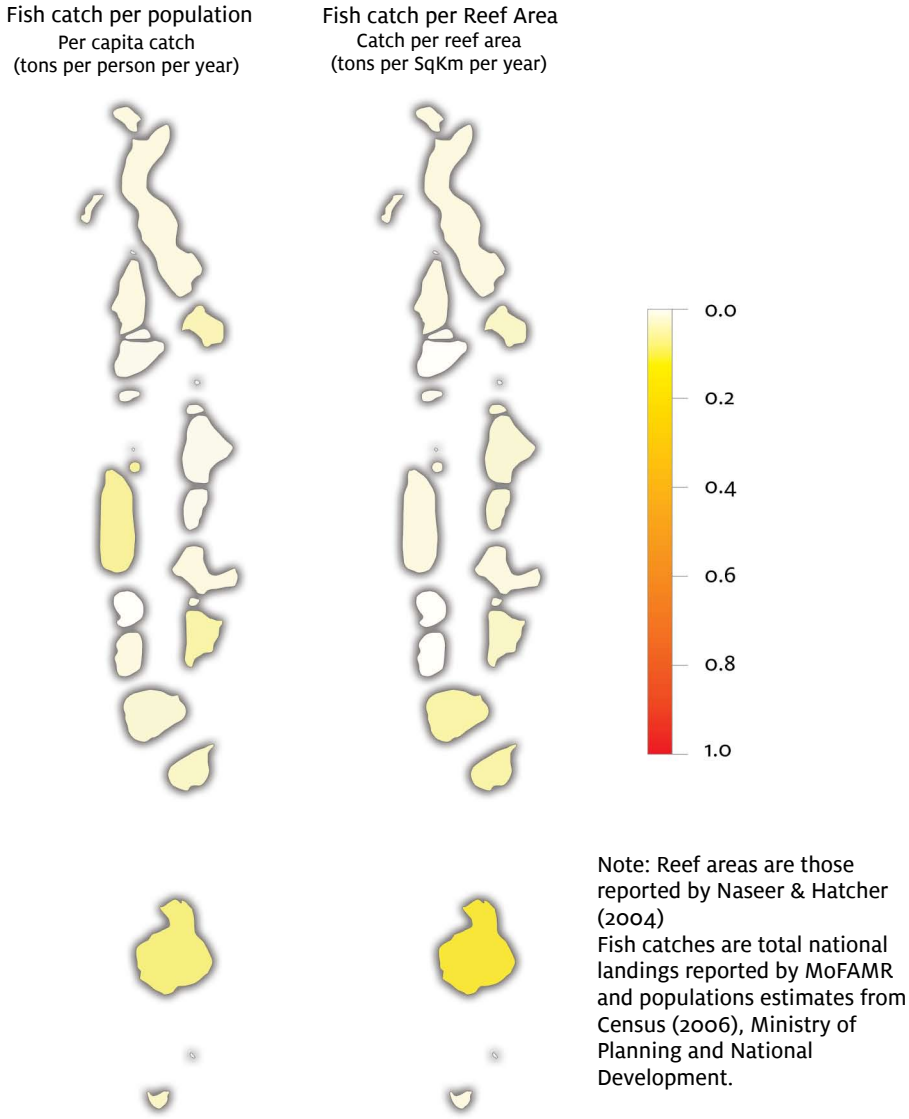
Improved access to export markets and increasing demand from tourist resorts makes reef fishery an important source of livelihood for atoll communities. Groupers, live-tropical fish and sea-cucumber are fished exclusively for export while lobsters and other reef fish are harvested to meet demands of tourism sector. Natural or anthropogenic disturbances on coral reefs are known to cause changes in community structure and species resilience which has implications to the reef fishery. For example, *Gobiodon citrinus* and *Ocymonocanthus*, two reef fish species disappeared from exports after the 1998 coral bleaching event. Both species feed predominantly on acropora polyps which were most affected during the bleaching. Human stresses such as overexploitation, catch of immature fish and fishery during spawning periods exacerbates the vulnerability of reef fishery.

The fisheries catch data shows there are geographic variations in fish catch which makes population of particular atolls more vulnerable to the impact of climate

change on fisheries than others. Highest catch per capita is seen in Gaafu Dhaalu, Meemu, Alifu and Lhaviyani atolls while fish catch per reef area is highest in Gaafu Dhaalu, Thaa and Laamu Atolls (Figure 5.3). The capital investments in fisheries are increasing rapidly with the privatization of the fisheries making the fisheries dependent island communities particularly vulnerable.

Decline in tuna fishery will have direct implications on food security in the Maldives. Fish is the main source of protein and local consumption of fish exceeds 50,000 metric tons (MPND, 2006). Reef fish is a significant item of the tourist resort cuisine and impacts on reef fishery will affect tourism and communities who depend on reef fishery as a source of income.

Figure 5.3: *Relative estimates of fish catch by atoll units in terms of population and reef area*



(Source: (Adam 2006))

5.5 Human Health

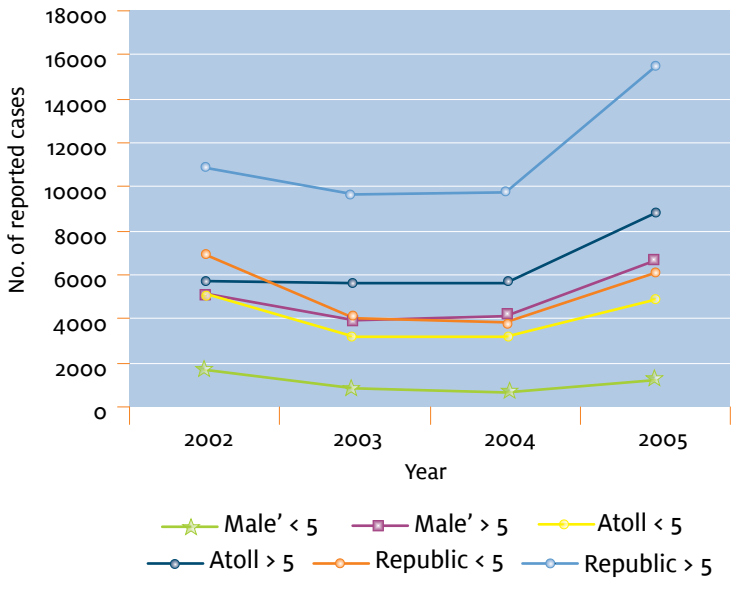
The health status of the Maldivian population has improved significantly over the last two decades. In 2005, the infant mortality rate was 12, maternal mortality was less than 1 per thousand and life expectancy was 72.2 years. The population per practising doctor was 775 in 2005 (MHAHE, 2002; MPND, 2006).

Maldives is now in a transition phase from communicable to non-communicable diseases. Communicable diseases such as malaria and vaccine preventable diseases such as polio, neonatal tetanus, whooping cough and diphtheria have been successfully eliminated while non-communicable diseases such as heart disease, diabetes, hypertension, cancer and renal diseases have emerged as major health concerns in recent years. Furthermore, the Maldives has one of the highest known incidences of Thalassaemia in the world with one out of every six Maldivians being a Thalassaemia carrier. Added to this is the growing problem of accidents and injuries leading to death and disabilities.

Despite the improvement in health status the country still experiences high incidences of water- and vector-borne diseases that are attributed to climate change. Although mortality due to diarrhoea and acute respiratory infections has been reduced to zero, they continue to cause significant morbidity to children and adults, indicating inadequate access to safe water and sanitation. The number of cases of acute gastroentritis increased by 50% from 10,000 cases in 2004 to 15,000 cases in 2005 (Figure 5.4).

Changes in temperature and rainfall regimes are causing higher incidence of vector-borne diseases. There is evidence that dengue outbreaks are becoming more frequent and it appears that there is an association with ENSO events. The first outbreak of dengue occurred in 1979, the second in 1983 and the third 1988 which was the worst with 2054 cases of dengue fever and nine deaths in children under 10 years. After that for 10 years there were no outbreaks until the next occurred in 1998 with a total of 1750 cases and no reported death. Since 1998 every year cases have been reported from Maldives and there is continued high prevalence from mid 2005 (Figure 5.5). In 2005 the case

Figure 5.4: *Incidence of acute gastroenteritis in the Maldives 2000-2005*



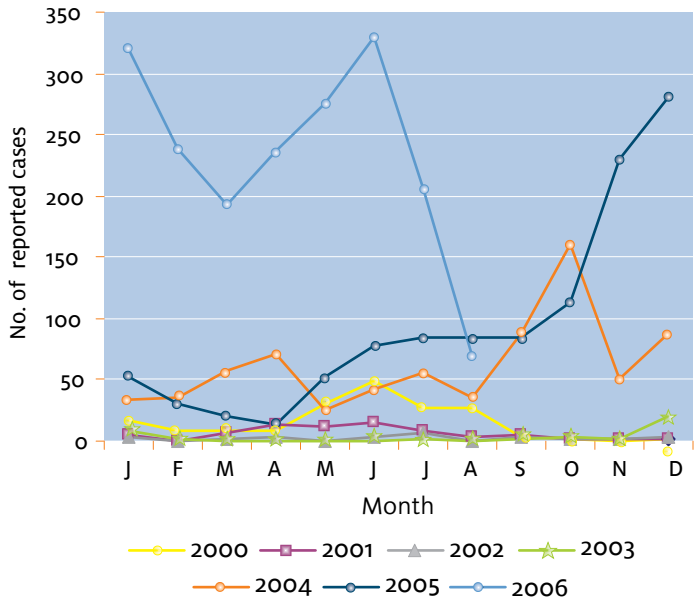
Source: Epidemiological Surveillance Records - DPH, Moosa (2006)

load increase is about 52% with as compared to 2004.

Among the other vector-borne diseases of public health concern, Scrub Typhus which was endemic 60 years ago re-emerged in 2002 (Figure 5.6) with mortality rates as high as 10% (Moosa 2006). Chikungunya was for the first time diagnosed in December 2006 and reached epidemic proportions. In addition to these climate related communicable diseases there has been an increase in the conditions of the skin, subcutaneous tissue and eye that has close linkages to climate change caused by increase exposure to UV radiation.

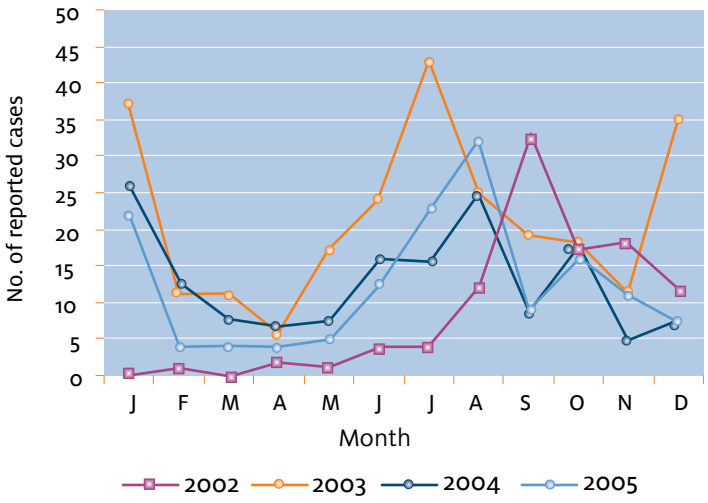
The islands of the Maldives are a mere 1.5m above MSL which makes them highly vulnerable to flooding and salinization of freshwater supplies due to rise in sea level. The islands are also vulnerable to storms and cyclones that can adversely affect water supplies. Water-borne diseases such as shigella could increase as a result of disruption of sewage and water systems due to flooding. The high level of risk to the health of the population from climate change related water-borne diseases is evident from the 50% increase in the number of flooding related gastroenteritis cases in 2005 following the tsunami. Evidence also shows that people in the atolls are more vulnerable to diarrhoeal diseases than in Male' and this disparity is more pronounced in children under five years (Moosa 2006).

Figure 5.5: *Incidence of dengue in Maldives 2000-2006*



Source: Epidemiological Surveillance Records (Dept of Public Health)

Figure 5.6: *Incidence of scrub typhus in Maldives 2000-2005*



Source: Epidemiological Surveillance Records (Dept of Public Health)

At present 18% of inhabited islands experience rainfall and/or ocean-induced flooding at least once a year (Shaig 2006). With the projected increase in sea level and higher frequency of extreme events incidents of flooding is likely to be more frequent and severe. Increased flooding coupled with

Parents and children feeling the affects of heat during a busy 'school day'. Increase in air temperature will be increasingly felt by the inhabitants due to climate change.

increased surface air temperature will cause higher incidence of vector-borne diseases in the Maldives. Already the vector-borne disease dengue has spread to the atolls at epidemic proportions. Children and the population living in remote islands where diagnostic and treatment facilities are lacking are particularly vulnerable to the climate related vector-borne diseases.

The vulnerability to climate change related health risks is further compounded by local characteristics such as the high level of malnutrition in children, accessibility and quality of healthcare, high population congestion and low income levels (Moosa 2006). The nutritional status of children varies across the atolls and in 2004 the prevalence of underweight in children under five years of age was estimated at 27%. The forecasts are that one in four children may still be underweight in Maldives in 2015. Even though there are 6 regional hospitals, 10 atoll hospitals, 65 atoll health centres and 52 health posts the population in the remote islands face difficulty in getting access to healthcare delivery system, and during bad weather medical evacuation is almost impossible. With more frequent extreme weather events, significant mortality and morbidity will be a serious challenge to the atoll population (Mohamed 2006).

Climate change related impacts on fisheries and agriculture, threaten food security in the Maldives. Such impacts will have direct effect on nutrition status of children and overall health of the population. Impacts on infrastructure and human settlement during extreme events could cause physical injury to the people.

5.6 Water Resources

Groundwater is a scarce resource because of the hydrogeology of the country. The freshwater aquifer lying beneath the islands is a shallow lens, 1 to 1.5m below the surface and no more than a few meters thick. Surface freshwater is lacking throughout the country with the exception of a few swampy areas in some islands. Traditionally people depended on shallow wells to get access to the groundwater lens for drinking water. However, 90% of the atoll households now use rainwater as the principal source of drinking water. In Male', 100% of the population has access to piped desalinated water. Following the tsunami

38 islands have been provided with desalination plants that are being operated daily or on emergency basis.

Thickness of the groundwater aquifer in the islands is determined by net rainfall recharge, size of the island and permeability of the soil column. The freshwater aquifers already stressed from over-extraction face the risk of total depletion if dry periods extend. As the islands have a precarious hydrological system, with the predicted sea level rise and during periods of wave-induced flooding, there is a very high risk of saltwater intrusion into the freshwater lens. Salinization of groundwater would affect the quality of life in the islands as people depend on groundwater for washing, bathing and other non-potable uses. Saltwater intrusion would also affect soil and vegetation causing impacts on agriculture and terrestrial ecosystems.

Rainwater is the main source of drinking water in the atolls. The annual average rainfall for Maldives is 2,124mm. Southern atolls on average receive 2,277mm of rainfall annually while northern atolls receive 1,786mm. Lowest annual rainfall recorded in the last 30 years is 1,346mm in 2002 at Hanimaadhoo Weather Station in Haa Dhaalu Atoll and the highest is 3,185mm in 1978 at Gan Weather Station in Seenu Atoll. Highest rainfall is during the months of May and October and the highest rainfall recorded within 24 hours to date is 219mm on 9 July 2002 at Kaadedhdhoo Weather Station in Gaafu Dhaalu Atoll. The lowest rainfall is during February and March (Meteorology 2006).

Although the global average precipitation is projected to increase during the 21st century, a marginal decline in precipitation is projected for the Indian Ocean region (Nurse and Sem 2001). The predicted changes in precipitation have the potential to impact on rainwater harvesting across all the atolls and in particular the northern atolls. Drinking water shortages during dry periods is a significant challenge for the atoll population even at present. Water shortages were reported by 30% of the atoll population in 2004 (MPND 2005).

The harvested rainwater is collected and stored in communal or household storage tanks. An estimated 75% of the population use water from these rainwater storage tanks (UNEP 2005). The rainwater storage facilities presently used are very vulnerable to flooding and high wave incidences. This has been demonstrated during the Indian Ocean Tsunami of December 2004. Tsunami damage assessments by the Maldies Water and Sanitation Authority revealed that a high percentage of rainwater storage tanks and/or catchment areas were damaged on the worst impacted islands.

5.7 Agriculture and Food Security

Agriculture is vital to the food security, nutritional status and livelihoods of the atoll population. Agriculture contributed 2.6% to GDP in 2005 (MPND 2006). The total cultivable land area is estimated at 27km^2, including 18km^{2}on inhabited islands and 9km^2 on uninhabited islands (MFAMR 2006). The main subsistence crops include banana, watermelon, cucumber, taro, coconut, breadfruit, mango, sweet potato, pumpkin, papaya, luffa, cabbage and brinjal.

Food security for future generations of Maldives are under threat due to climate change

Agriculture sector is constrained by the limited availability of cultivable land, poor quality of soil and the abundance of cheap imports of vegetables and fruits. The available cultivable land is 103m^2 per capita (MFAMR 2006). Soil is generally made up of medium-sized calcium carbonate sand grains. A typical soil profile is made up of a thin sandy layer at the top, a layer of organic matter 15 to 40cm deep, layer of hardpan 30 to 50cm deep before reaching unweathered bedrock. The soil is absent of silt and clay reducing the adsorption capacity only to the organic matter layer while the medium sized calcium carbonate grains result in high infiltration rates. The average pH is 8.5 due to high calcium content of the soil causing deficiencies in micro-nutrients. In addition, the soil lacks nitrogen and potassium due to excessive leaching making the fertility low (FAO 2005; MFAMR 2006).

Every year more than 17 million kilograms of rice, 17 million kilograms of flour and 10 million kilograms of sugar are imported (MCS 2006). Imports of fresh vegetables and fruits have also increased mainly due to the expanding tourism sector. In 2003, the Maldives imported US$32.4 million worth of vegetable products, US$25.9 million worth of meat and meat products, US$3 million worth of animal and vegetable fats and oils, and US$37.8 million worth of prepared foodstuffs (MFAMR 2006). Due to the high import dependency, the food security of Maldives is vulnerable to climate change related impacts on agriculture of other countries.

Climate hazards such as changes in temperature, precipitation and timing of extreme or critical threshold events will affect agriculture in the Maldives. The critical impact pathways include heat stress on plants, changes in soil moisture and temperature, loss of soil fertility through erosion of fertile top soil, less water available for crop production, changes in height of water table, salinization of freshwater aquifer and loss of land through sea level rise. The consequences of such impacts are likely to be more severe in the Maldives because agriculture is already under stress due to poor soil, limited land available for cultivation and water scarcity. The subsistence crop agriculture will also be affected by severe weather events. Over the past six years 90 islands have experienced flooding and amongst these 37 islands had flooding six times or more (Shaig 2006). The recent sea induced flooding of 68 islands, in May 2007, resulted in 33 islands being affected by salt water intrusion. This caused significant damage to crops, agriculture farms, home gardens and vegetation (OCHA 2007).

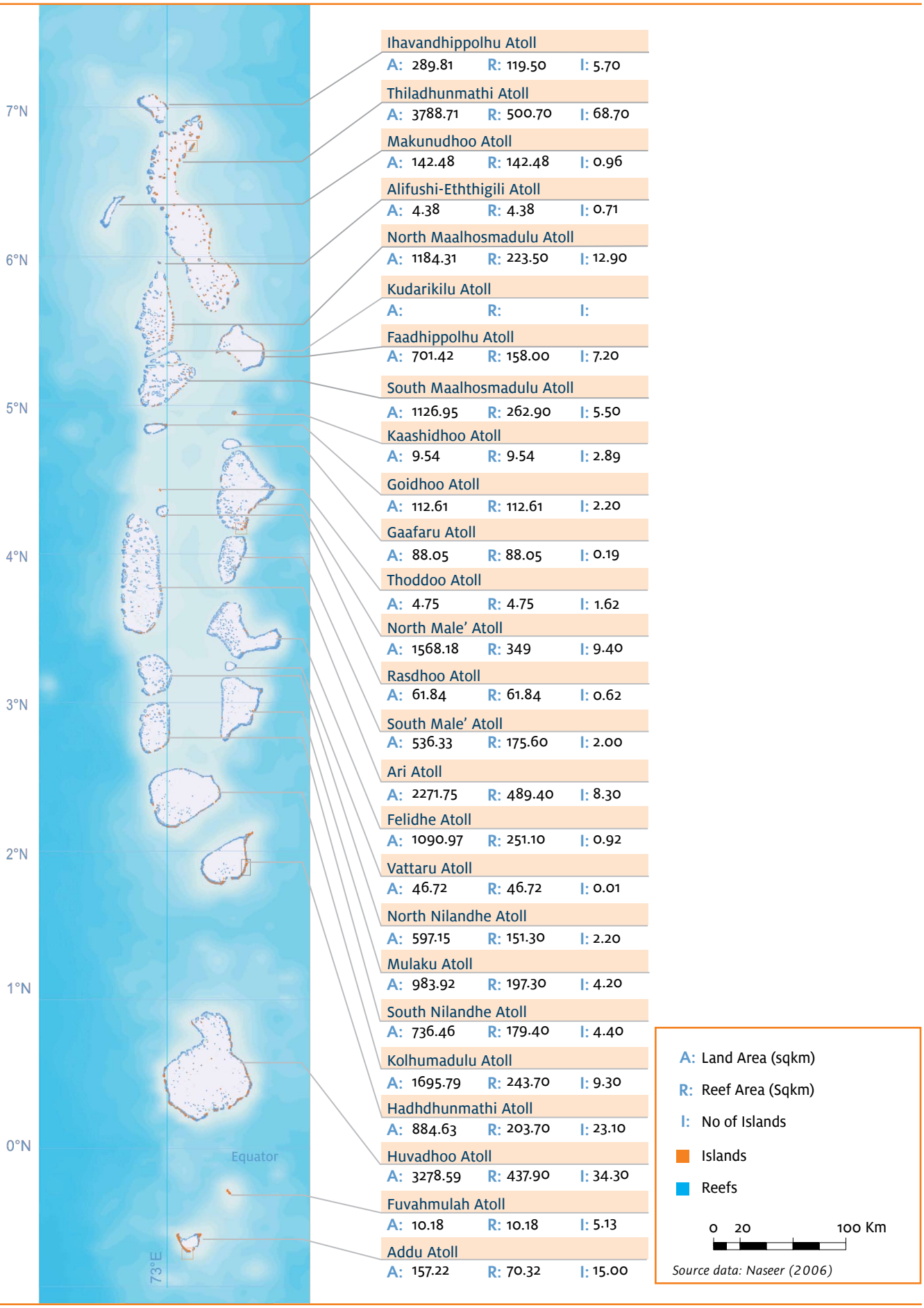
Heavy import dependency, limited food storage and ad hoc distribution also pose severe food security risk to the population. The Maldives imports almost all food items except fresh tuna and coconut. Long-term and emergency food storage is virtually absent except for warehousing in Male' and nine other islands (STO 2006). Since food distribution system is by boat from Male' to islands and the quantity that can be transported across on one trip is small (MHAHE 2001), higher frequency of extreme events associated with climate change would increase food security problems. In 2003, 7% of the population experienced food crisis and for nearly half of this population it lasted for less than 10 days (MPND 2004).

5.8 Coral Reef Biodiversity

Coral reef ecosystems of the Maldives are significant both at international and national level. They form the seventh largest reef system and are among the richest in the world in terms of species diversity. It has two of the largest natural atolls in the world, Thiladhunmathi Atoll with a total surface area of 3,788km^2 and Huvadhoo Atoll with a total surface area of 3,278km^2. At the national level, the Maldives is a nation of coral islands where the reefs function as natural sea

The seventh largest reef system in the world is under threat from increased sea surface temperatures and sea level rise.

Figure 5.7: *Map coral reef structures*



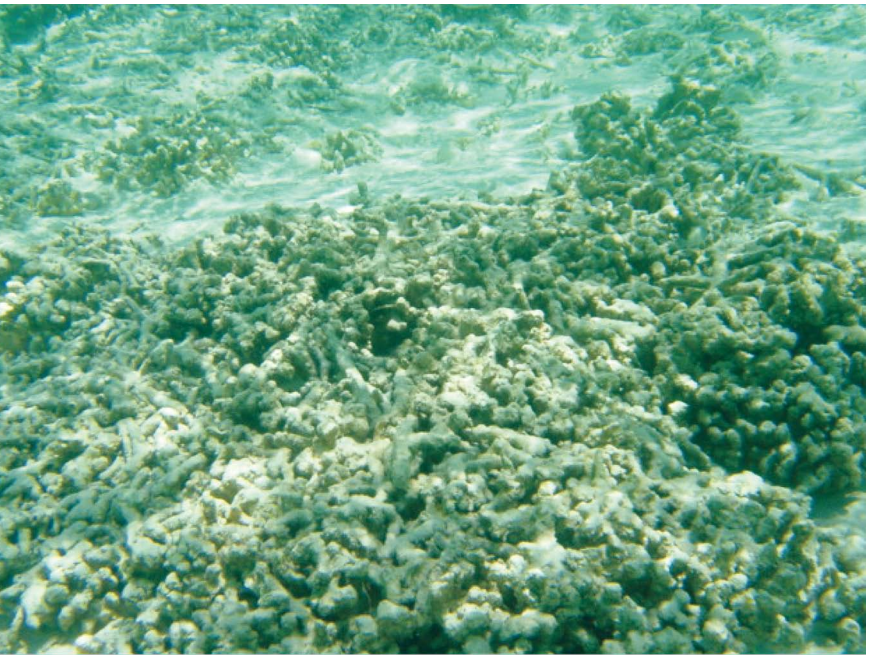
defences for the highly vulnerable islands. The two major economic activities tourism and fisheries are reef based and provide more than 80% of the total revenues to the country. The reefs also provide food and are the source of coral sand that is used as a construction material.

In the 25 natural atolls of the Maldives there are 2,041 distinct coral reefs (Naseer 2006). About 529 reefs are found on the rims of the 16 complex atolls, five make up ocean faros and four are oceanic platform reefs. The rest are found as patch reefs within the lagoons of the complex atolls. Figure 5.7 summarises information on these major coral reef structures. The total area of the atolls including the atoll lagoons is approximately 21,372km^2 and the total reef area is close to 4,500km^2 representing 20% of the total area of the atolls. Thiladhunmathi Atoll has the largest reef area with approximately 500km^2 while Ari Atoll has the second largest with 489km^2 (Figure 5.7).

The coral reef system of the Maldives supports rich marine biological diversity. Over 1090 species of fish, 36 species of sponges, 180 species of stony corals and 250 species of hermatypic corals are found. In addition, 9 species of whales, 15 to 20 species of sharks and seven species of dolphins and five species of turtles have also been observed. Altogether 285 species of algae, five species of seagrass, 400 species of molluscs, 350 species of crustaceans and 80 species of echinoderms have been documented (MHAHE, 2002; MEC, 2004).

Corals are highly sensitive to changes in temperature and some species of corals live at or near their thermal limits (Goreau, 1992). As a result the incidence of bleaching will increase in frequency and intensity with the projected rise in SST. The evidence from the reefs of the Maldives supports that warming of the ocean surface leads to significant coral bleaching. During the 1998 El Nino event monthly mean SST was 1.2±4 S.D. above the 1950 to 1999 average, with the greatest anomaly in May of +2.1 C (Edwards et al., 2001). During that event coral bleaching was first reported in mid-April. Bleaching was reported to be severe from late April to mid-May with some recovery evident by late-May.

The reefs in the central and northern region were more affected than the other regions (Zahir, 1999). Significant reductions in live coral cover were seen at reefs in the central atolls, with average live coral cover decreasing from about 42% to 2%, a 20-fold reduction from pre-bleaching levels. Almost 98% of branching corals died whereas the majority of massive corals survived the bleaching (Edwards et al., 2001). Monitoring programs have shown that recovery of both coral cover and species diversity is underway with dominance of recruitment by branching corals (Edwards et al., 2001). On 23 March 2003, several species of branching corals from the genus Acropora released thousands



A pile of dead coral: In the 1998 El-Nino event, almost 98% of the branching coral died. There are numerous implication for the coral reef survival due predicted increase in Sea Surface Temperatures.

of bright red eggs and sperm bundles into the Indian Ocean. This indicates that the corals have reached maturity and as the new generation of coral colonies continues to grow, increased spawning is expected in the coming years and there is hope that the Maldivian reefs will fully recover.

On the other hand, estimates of April mean monthly SST suggests a rise of 0.16°C per decade. If this trend continues, by 2030 mean April SST in the central atolls will normally exceed the anomaly level at which corals appear susceptible to mass bleaching (Edwards et al., 2001).

As mass spawning and recruitment in the reef ecosystems is cued to environmental conditions coral reef biodiversity is particularly vulnerable to climate change. After spawning, coral larvae usually drift with the currents for at least four days before settling on nearby reefs. Many reef fish are also known to have seasonal spawning cycles which may be disrupted by changes in environmental conditions resulting in recruitment failure. In addition, reef fishes have a pelagic larval phase ranging from days to few weeks. Survival of larvae depends on favourable conditions of the pelagic environment as well (Adam 2006).

Coral reefs in the Maldives are also vulnerable to the projected rise in sea level. Most reefs of the Maldives appear to be at the point where they are sea level limited and with no potential for upward growth. Reefs appear to be now growing outwards laterally and filling up inside (Naseer 2006). It is predicted that sea level rise would induce reefs to grow vertically upwards. However, increased SST and oceanic CO_2 concentrations may alter the calcification potential of coral reefs resulting in slow growth. The calcification rate of corals is expected to decline by 14 to 30% by 2050 (IPCC 2001). Reef health is also being severely affected by human activities. Hence reefs may not be able to keep pace with the predicted rise in sea level. This also reduces the chances of the islands of Maldives to naturally adapt to the predicted rise in sea level.

The impacts on the reefs would affect tourism, fisheries, food security and human settlements. These impacts are considered in details in the respective sections of this chapter.

Chapter VI
Adaptation Needs and Priority Adaptation Strategies

The fourth component of the Adaptation Framework is the adaptation strategies (Figure 2.1 Chapter Two). This chapter first lists the adaptation needs and then the priority adaptation strategies.

6.1 Adaptation Needs

The adaptation needs were identified through wide stakeholder consultations. The adaptation needs are classified here under the priority sectors presented in Chapter Five. These sectors are similar to those given in the FNC (2001).

6.1.1 Land, Beach and Human Settlements

1. Consolidate population and development.
2. Acquire support for the speedy and efficient implementation of Safer Island Strategy.
3. Strengthen land-use planning as a tool for protection of human settlements.
4. Build capacity for coastal protection, coastal zone management and flood control.
5. Protect beaches through soft and hard-engineering solutions.
6. Protect house reef to maintain natural defense of islands.
7. Improve building designs and regulations to increase resilience.
8. Integrate climate change adaptation into national disaster management framework.

6.1.2 Critical Infrastructure

1. Develop coastal protection for airports and development focus islands.
2. Strengthen capacity for planning and design of infrastructure to ensure development of resilient infrastructure.
3. Protect powerhouses and utilities.
4. Protect telecommunication infrastructure.

6.1.3 Tourism

1. Protect beaches and tourist infrastructure.
2. Develop climate change adaptation policy and strategy for tourism.
3. Diversify the tourism product to reduce over-dependency on marine environment.
4. Strengthen tourism institutions to coordinate climate response in the tourism sector.
5. Incorporate climate change adaptation measures to upcoming resorts.

6.1.4 Fisheries

1. Improve fish finding and fish harvesting.
2. Establish aquaculture/mariculture as an alternative to natural breeding to reduce the economic and social impacts of changing tuna abundance.
3. Undertake research and disseminate information on fisheries and climate change.
4. Experiment new and alternative species and breeding methods for livebait.
5. Integrated reef fishery management.
6. Exploit new species and promote poultry farming as alternative sources of protein to reduce over-dependency on tuna for protein.

6.1.5 Human Health

1. Strengthen regulatory and institutional capacity for vector control.
2. Streamline the planning of healthcare services and strengthen medical emergency response.
3. Promote healthy lifestyles, healthy islands and healthy buildings.
4. Strengthen the capacity for healthcare delivery.
5. Undertake research and disseminate information on climate change related diseases.
6. Increase nutrition promotion campaigns.

6.1.6 Water Resources

1. Acquire appropriate sewage treatment and disposal technologies to protect water resources.
2. Increase safe rainwater harvesting.
3. Acquire desalination technologies appropriate for small islands.
4. Undertake recharging of aquifers to reduce salinisation from saltwater intrusion and storm surge flooding.
5. Protect and preserve natural water catchment areas.

6.1.7 Agriculture and Food Security

1. Develop a national food security strategy.
2. Secure trade agreements with foreign trade partners to ensure food security.
3. Establish capacity for emergency food storage in development focus islands at regional level.
4. Introduce new technologies to increase local food production.
5. Strengthen marketing and sale of local food items.
6. Improve allocation of land for agriculture.
7. Promote traditional food preservation and storage practices for local food.
8. Enforce and strengthen quarantine and integrated pest control to prevent pests and diseases.
9. Introduce new irrigation technologies.

6.1.8 Coral Reef Biodiversity

1. Provide alternatives to coral and sand as construction materials and enforce the ban on coral mining.
2. Enhance the capacity for waste management to prevent pollution of marine environment.
3. Formulate and implement an oil pollution contingency plan.
4. Acquire appropriate sewage treatment technologies.
5. Establish marine protected areas.
6. Establish an information base on coral reefs and climate change.
7. Undertake monitoring and research to prevent coral diseases and rehabilitate coral reefs.
8. Develop measures to protect coral reefs from development activities.

6.2 Priority Adaptation Strategies

The adaptation needs were prioritised by community, government and private sector stakeholders using analytical hierarchy process. Details of the prioritisation method are given in Annex I. The top ranking priority adaptation strategies are listed in Table 6.1. The priority project profiles developed to implement these strategies are given in Chapter Seven.

Table 6.1: List of priority adaptation strategies

Adaptation Measures	Score	Rank
Build capacity for coastal protection, coastal zone management and flood control.	76.14	1
Consolidate population and development.	44.47	2
Introduce new technologies to increase local food production	35.62	3
Acquire support for the speedy and efficient implementation of Safer Island Strategy.	32.94	4
Develop coastal protection for airports and development focus islands.	32.94	5
Integrat e climate change adaptation into national disaster management framework.	32.03	6
Strengthen tourism institutions to coordinate climate response in the tourism sector.	29.78	7
Improve building designs to increase resilience and strengthen enforcement of building code.	29.09	8
Acquire appropriate sewage treatment and disposal technologies to protect water resources.	28.32	9
Incorporate climate change adaptation measures to upcoming resorts	27.83	10
Promote healthy lifestyles, healthy islands and healthy buildings.	27.45	11
Enhance the capacity for waste management to prevent pollution of marine environment.	27.03	12
Provide alternatives to coral and sand as construction materials and enforce the ban on coral mining.	26.54	13
Integrated reef fishery management.	24.42	14
Streamline the planning of healthcare services and strengthen medical emergency response.	23.72	15

Table 6.1 (Continued): *List of priority adaptation strategies*

Adaptation Measures	Score	Rank
Increase safe rainwater harvesting.	23.66	16
Develop measures to protect coral reefs from development activities	22.83	17
Undertake recharging of aquifers and other measures to reduce salinisation from saltwater intrusion and storm surge flooding.	19.37	18
Undertake research and disseminate information on climate change related diseases.	19.26	19
Strengthen the capacity for healthcare delivery.	19.02	20
Strengthen capacity for planning and design of ports, harbours and jetties.	17.40	21
Develop climate change adaptation policy and strategy for tourism.	16.84	22
Protect house reef to maintain natural defense of islands.	16.27	23
Protect and preserve natural water catchment areas.	15.15	24
Experiment new and alternative species and breeding methods for livebait.	14.54	25
Enforce and strengthen quarantine and integrated pest control to prevent pests and diseases.	13.89	26
Strengthen regulatory and institutional capacity for vector control.	13.74	27
Protect beaches and tourist infrastructure.	13.02	28
Review the marketing strategy of tourism to diversify the tourism product and reduce over-dependency on coral.	12.89	29
Acquire desalination technologies appropriate for small islands.	11.93	30

Chapter VII
Adaptation Projects

7.1 Adaptation Projects

This chapter presents the projects that are necessary for long-term adaptation of Maldives to the adverse effects of climate change. The project profiles in Table 7.1 are based on the priority adaptation strategies in Section 6.2.

Table 7.1: *List of project profiles*

Project Number	Project Title
1	Integration of Future Climate Change Scenarios in the Safer Island Strategy to Adapt Sea Level Rise and Extreme Weather Risks Associated with Climate Change
2	Coastal Protection of Safer Islands to Reduce the Risk from Sea Induced Flooding and Predicted Sea Level Rise
3	Coastal Protection of Male' International Airport to Reduce the Risk from Sea Induced Flooding and Predicted Sea Level Rise
4	Enhance adaptive capacity to manage climate change related risks to fresh water availability by appropriate technologies and improved storage facilities
5	Enhance adaptive capacity to manage climate change related risks to fresh water availability by appropriate wastewater treatment technologies

Table 7.1 (Continued): *Project profiles*

6	Increase the resilience of local food production through enhancing the capacity of farmers, local communities to address food security issues caused by climate change and climate variability
7	Improve the health status of the population by the prevention and management of vector-borne diseases caused by changes in temperature and flooding due to extreme rainfall.
8	Improve resilience of Island communities to climate change and variability through sustainable building designs
9	Investigating alternative live bait management, catch, culture and holding techniques in the Maldives to reduce vulnerability of the tuna fishery sector to the predicted climate change and variability.
10	Improve the design and construction of access infrastructure in Maldives to increase the resilience of access infrastructure and island beaches to climate change.
11	Increase resilience of coral reefs to reduce the vulnerability of islands, communities and reef dependant economic activities to predicted climate change.

7.2. Implementation Strategy of NAPA Adaptation Projects

The NAPA process should also ensure successful implementation of NAPA, and hence, an implementation strategy has been developed in consultation with the CCTT. While the overall implementation of the NAPA will be overseen by the National Commission for Protection of the Environment (NCPE), a special interagency task force would ensure the respective agencies of the government mobilise international financial assistance and allocate public financing to the priority project profiles in the NAPA. The implementation task force would also be responsible for ensuring that the proposed projects are implemented in a consolidated approach and in-line with national development objectives.

Due to the integrated nature of the proposed projects and the need for close collaboration between the implementing agencies, the implementation strategy was designed to make use of existing mechanisms, and hence, avoid duplication of similar efforts. The present NAPA Steering Committee with the technical support from the CCTT would continue the role of the implementation task force.

Project 1

Integration of Future Climate Change Scenarios in the Safer Island Strategy to Adapt Sea Level Rise and Extreme Weather Risks Associated with Climate Change

Rationale

All the islands of the Maldives are among the most vulnerable to the rise in sea level associated with climate change. Recent incidences of swells and storms have impacted more than half the populated islands resulting in flooding, loss of property, impacts on water resources and agriculture. The primary aim of this project is to enhance people's safety from climate change impacts and natural disasters, and the path selected is to improve and strengthen the Safer Island Strategy developed by the government to resettle communities from the smaller, more vulnerable islands onto larger, better protected ones. Several components of the Safer Island Strategy may in fact contribute to making islands more vulnerable to climate change impacts and natural disasters, if the climate change scenarios are not adequately considered in the land-use planning and development of safer islands.

At present, the Government of Maldives has planned to undertake a Detailed Risk Analysis of the proposed safer islands. Funding has already been secured to undertake the Disaster Risk Assessments for 9 of the proposed 14 safer islands. The initial risk assessment have highlighted the need to do more detailed analysis on aspects of coastal engineering and adaptation measures on all the islands. The aim of the proposed NAPA project is to ensure that climate change related hazards and vulnerability assessments are adequately covered in the Disaster Risk Assessments and also secure funding to conduct such an analysis for the remaining 5 proposed safer islands. This project would contribute to the resilience of the Maldives in the face of climate change and its capacity to respond effectively to increasing threats posed by climate change and natural disasters.

Description

Goal

Ensure climate change concerns are addressed in the Maldives Safer Island Strategy

Objectives

1. Undertake detailed hazard and vulnerability assessment for 5 of the proposed safer islands.

2. Develop a hazard mitigation and vulnerability reduction action plan

Activities

1. Undertake a hazard and vulnerability assessment which includes risks from climate change
2. Undertake a composite risk assessment and action plan for hazard mitigation and vulnerability reduction

Short term outputs

- Hazard assessment of identified safer islands
- Assessment of vulnerability to natural hazards, economic, social and infrastructure and building vulnerability and a coastal risk assessment
- Climate change sensitive criteria for safer islands identified
- Action plan developed

Potential long-term outcomes

Adaptation to future climate change scenarios integrated into the Safer Island Strategy of the Maldives

Implementation

Institutional arrangement

Lead agency:

Ministry of Planning and National development.

Partner agencies:

National Disaster Management Centre; Ministry of Atolls Development; Ministry of Environment, Energy and Water; Ministry of Housing and Urban Development; Ministry of Construction and Public Infrastructure.

Risks and barriers

- Limited Data on hazards
- Climate hazard at the specific island level difficult to predict
- In some aspects there are no immediate solutions available

Evaluation and monitoring

The project will be monitored according to the national M&E standards set by President's Office and MPND. Quarterly progress reports, expenditure reports, annual monitoring reports will be submitted to MPND. In addition, any donor finance agency requirements on M&E will be fulfilled.

Financial resources

Total project cost: US$ 248,820.

Activity		Cost (US$)
1.	Undertake a hazard and vulnerability assessment which includes risks from climate change	135,200
2.	Undertake a composite risk assessment and action plan for hazard mitigation and vulnerability reduction	113,620
	TOTAL	248, 820

Project 2

Coastal Protection of Safer Islands to Reduce the Risk from Sea Induced Flooding and Predicted Sea Level Rise

Rationale

The small size of the islands and their low elevation makes the Maldives one of the most vulnerable countries to the predicted climate change and impacts such as sea level rise, extreme weather events and storm surges. The Maldives NAPA process has identified strengthening coastal zone management and improving coastal protection of islands as urgent and immediate adaptation measures. This project is aimed to develop and implement demonstration coastal protection measures suitable for small islands, ensuring that risks from climate change impacts are addressed in the design of the coastal protection. The location for implementing this project is to be selected from the islands identified to be developed as a safer island under the Safer Island Strategy (SIS) developed by the Government of the Maldives. The SIS was developed following the Indian Ocean Tsunami of 2004, to resettle communities from the smaller, more vulnerable islands onto larger, better protected ones. The concept of the ìsafer islandî is to extend the population consolidation strategy to incorporate the aspect of extreme vulnerability and develop measures to mitigate ecological disasters and enable the communities to sustain social and economic development in times of emergencies and disasters.

Initial risk assessment of 9 of the selected safer islands have highlighted the need to do more detailed analysis on aspects of coastal engineering and adaptation measures on all the selected islands. This project seeks funding to conduct such a detailed analysis on 5 of the safer islands where initial risk assessments have been undertaken.

Description

Goal

Reduce vulnerability of the developed safer islands to current climate risks and future climate change risks.

Objective

Demonstrate innovative coastal protection measures suitable for small islands

Activities

1. Undertake detailed technical and engineering studies for coastal protection options and adaptation measures for 5 safer islands
2. Implement demonstration coastal protection measure for 1 selected safer island

Short-term Outputs

- Climate change concerns addressed in the design and engineering for coastal protection of safer islands
- Appropriate coastal protection for demonstrated safer island

Potential long-term outcome

Increased resilience of safer islands and the consolidated population to current climate risks and risks from predicted climate change

Implementation

Institutional Arrangement

Lead Agency

Ministry of Construction and Public Infrastructure

Project Partners

National Disaster Management Centre; Ministry of Planning and National Development; Ministry of Housing and Urban Development; Ministry of Environment, Energy and Water

Risks and barriers

High capital investment cost

Evaluation and monitoring

The project will be monitored according to the national M&E standards set by President's Office and MPND. Quarterly progress reports, expenditure reports, annual monitoring reports will be submitted to MPND. In addition, any donor finance agency requirements on M&E will be fulfilled.

Financial resources

The total project cost is US$ 3,055,000

An activities based budget for the project is given below.

Activity	Cost (US$)
1. Undertake detailed technical and engineering studies for coastal protection options and adaptation measures for 5 safer islands	344,000
2. Implement coastal protection measure at selected safer island	2,711,000
TOTAL	3,055,000

Project 3

Coastal Protection of Male' International Airport to Reduce the Risk from Sea Induced Flooding and Predicted Sea Level Rise

Rationale

Airports, especially the two international airports are amongst the most critical economic infrastructures of Maldives due their importance in the limited transportation network. The tourism industry is almost entirely dependent on the proper functioning of the international airports. Due to the major import dependency of food, the functioning of the airports is also extremely important for the food security of the country. At times of disasters it is also the main entry point for international aid, the main distribution points of emergency aid and perhaps the main evacuation point at times of a major disaster. Unfortunately, due their low elevation and proximity to coastline, the infrastructure of the five main airports are highly vulnerable to damage from severe weather related flooding and future climatic change. In the past, during natural disasters and severe weather events, airport operations have been interrupted due to extensive flooding of main infrastructures.

This project focuses on the protection of the Male' International Airport (MIA). The Maldives Airports Company (MAC) also identifies this as a priority but the lack of financial resources to undertake such a large scale protection of the infrastructure has been a barrier against implementation of the required coastal protection. The proposed project for the NAPA aims to facilitate the construction of appropriate coastal protection for the MIA and ensure that risks from climate change impacts are adequately addressed in the design of the coastal protection measures.

Description

Goal

Reduce vulnerability of the Male' International Airport (MIA) to current climate risks and future climate change risks.

Objective

Protect MIA from sea induced hazards and predicted climate change impacts

Activities

1. Undertake detailed technical and engineering studies for the coastal protection of MIA, including cost-effectiveness of the proposed solutions

2. Develop detailed engineering and design of coastal protection measures for MIA
3. Construction of demonstration coastal protection measures on part of the coastline of MIA

Short-term Outputs

- Technical and feasibility studies developed for the coastal protection of MIA
- Appropriate coastal protection measures identified for MIA
- Detailed design developed for coastal protection of MIA
- Climate change concerns addressed in the design and engineering for MIA coastal protection
- Appropriate coastal protection demonstrated

Potential long-term outcomes

- Increased resilience of the main economic sectors, tourism and fisheries, to predicted climate change impacts
- Increased resilience to food security and local food distribution
- Increased capacity to adapt to disasters and predicted climate change impacts

Implementation

Institutional Arrangement

Lead Agency

Maldives Airports Company

Project Partners

Ministry of Transport and Communication; Ministry of Construction and Public Infrastructure; Ministry of Environment, Energy and Water

Risks and barriers

High capital investment cost

Evaluation and monitoring

The project will be monitored according to the national M&E standards set by President's Office and MPND. Quarterly progress reports, expenditure reports, annual monitoring reports will be submitted to MPND. In addition, any donor finance agency requirements on M&E will be fulfilled.

Financial resources

The total project cost is US$ 9,300,000

An activities based budget for the project is given below.

Activity	Cost (US$)
1. Undertake detailed technical and engineering studies for the coastal protection of MIA, including cost-effectiveness of the proposed solutions	220,000
2. Develop detailed engineering and design of coastal protection measures for MIA	
3. Construction of demonstration coastal protection measures on part of the coastline of MIA	9,080,000
TOTAL	9,300,000

Project 4

Enhance adaptive capacity to manage climate change related risks to fresh water availability by appropriate technologies and improved storage facilities

Rationale

Fresh water is one of most scarce resources in the Maldives. To the Maldivian community, the effect of climate change on water resources would mean changes to freshwater availability. The December 2004 tsunami had aggravated the limited freshwater availability of the islands. In addition to flooding causing salinization of the groundwater, a high percentage of rainwater storage tanks and/or catchment areas were damaged on the tsunami impacted islands. This event itself demonstrates the vulnerability of the water resources of Maldives to future impacts of climate change.

Increasing the capacity for rainwater harvesting and storage in the island communities has been identified as an important adaptation options by the NAPA process. This project is also intended to ensure that rainwater storage facilities are designed to be protected from impacts of flooding and high wave incidents. As seawater is an abundant resource in the Maldives, the use of desalination technologies to provide emergency freshwater has also been recognized as a needed adaptation measure. This project contains two components which looks into the above mentioned adaptation options. The location of the project will be an island selected for development as a Safer Island under the national development planning.

Description

Goal

To increase adaptive capacity to manage climate change related risks to fresh water availability

Objectives

1. Increase rainwater harvesting capacity and storage
2. Acquire technology for emergency freshwater provision

Activities

1. Establish rainwater harvesting and storage facilities on all public buildings
2. Develop community awareness on safe rainwater harvesting and storage practices
3. Establish emergency backup desalination system

Short-term Outputs

- Community rainwater collection and storage established
- Information on safe rainwater collecting and storage practices developed and disseminated to community
- Emergency water secured

Potential long-term outcomes

- Increased security of fresh water availability
- Improved health and well-being of community due to access to safer drinking water
- Increased resilience to water shortages in case of disaster, emergency and predicted impacts of climate change

Implementation

Institutional Arrangement

Lead Agency

Ministry of Environment, Energy and Water

Project Partners

Ministry of Atolls Development; Ministry of Planning and National Development; Ministry of Construction and Public Infrastructure; Ministry of Housing and Urban Development; Atoll Offices; Island Offices; NGOs and community level organisations

Risks and barriers

Lack of human and financial resources

Evaluation and monitoring

The project will be monitored according to the national M&E standards set by President's Office and MPND. Quarterly progress reports, expenditure reports, annual monitoring reports will be submitted to MPND. In addition, any donor finance agency requirements on M&E will be fulfilled.

Financial resources

The total project cost is US$ 900,000

An activities based budget for the project is given below.

Activity	Cost (US$)
1. Establish rainwater harvesting and storage facilities on public buildings	430,000
2. Develop community awareness on safe rainwater harvesting and storage practices	30,000
3. Establish emergency backup desalination system	440,000
TOTAL	900,000

Project 5

Enhance adaptive capacity to manage climate change related risks to fresh water availability by appropriate wastewater treatment technologies

Rationale

The NAPA process has identified that the inappropriate treatment and disposal of wastewater in the Maldive islands is an important area that has to be addressed in terms of adaptation to climate change. This would address the identified adaptation strategies for water resource protection, promoting healthy lifestyles and islands and protection of the coral reef biodiversity in the Maldives. The Indian Ocean Tsunami of 2006 caused the destruction of the poorly constructed sewerage systems in the impacted islands of Maldives. This lead to contamination of the freshwater resources and caused subsequent health problems. This event demonstrates what similar impacts from climate change would cause. The access to safe drinking water, the provision of sanitation and the promotion of hygiene are the foundations of human dignity, public health and economic and social development and are among the priorities for Maldives outlined in the 7NDP.

The prevailing systems of sanitation in most of the islands depends onsite disposal systems using septic tanks and soak-pits. The government has started a programme to improve the sanitation situation of the islands. This project will look into demonstrating appropriate wastewater treatment technology and improving the design of existing systems and thereby complement the existing government programme by incorporating climate change related issues. This project will also help the Maldives achieve MDG targets to halve by 2015 the number of people without access to basic sanitation, and to halve by 2015 the proportion of people without sustainable access to safe drinking water. Although the project is targeted to reduce vulnerability to climate change and particularly extreme events, the project will lead to many cross-cutting benefits such as protection of water supplies, address land and marine-based sources of pollution, related downstream coastal area management, protection of coral reef biodiversity, sustainable management of fisheries, and tourism development. The project will be implemented in an island selected for development as a Safer Island under the national development planning.

Description

Goal

To increase resilience of water resources, human health and coral reef biodiversity to climate change related hazards by improving present wastewater treatment and disposal capacity.

Objectives

1. Identify and demonstrate innovative, appropriate and cost-effective wastewater treatment and disposal systems.
2. Educate the community on appropriate wastewater treatment.

Activities

1. Design and construct appropriate wastewater treatment and disposal system
2. Develop information material for public on best practices on wastewater treatment

Short-term Outputs

- Demonstration of appropriate wastewater treatment and disposal
- Community educated on best practices for wastewater treatment

Potential long-term outcomes

- Improved health and well-being of community
- Protection of ground water aquifer from contamination
- Assist in achieving national targets on access to safe sanitation

Implementation

Institutional Arrangement

Lead Agency

Ministry of Environment, Energy and Water

Project Partners

Ministry of Atolls Development; Ministry of Planning and National Development; Ministry of Construction and Public Infrastructure; Ministry of Housing and Urban Development; Atoll Offices; Island Offices; NGOs and community level organisations

Risks and barriers

- High initial capital investment.
- Lack of access to models and demonstrations of sewage and wastewater management technologies.
- Lack of appropriate policy, legislation, planning and administration.

Evaluation and monitoring

The project will be monitored according to the national M&E standards set by President's Office and MPND. Quarterly progress reports, expenditure reports, annual monitoring reports will be submitted to MPND. In addition, any donor finance agency requirements on M&E will be fulfilled.

Financial resources

The total project cost is US$ 1,500,000

An activities based budget for the project is given below.

Activity	Cost (US$)
1. Design and construct appropriate wastewater treatment and disposal system	1,300,000
2. Develop information material for public on best practices on wastewater treatment	20,000
TOTAL	1,500,000

Project 6

Increase the resilience of local food production through enhancing the capacity of local farmers and communities to address food security issues caused by climate change and climate variability

Rationale

Climate change will impact agriculture and food production in the Maldives through sea level rise, salt intrusion into the ground water aquifer, salinization of soil and flooding caused by increased rainfall. In addition, the heavy import dependency of the Maldives for almost all of the food requirements makes the Maldives vulnerable to climate change impacts on the agriculture sector of other countries. The NAPA process has identified increased local food production as a key adaptation measure to tackle such food security issues posed by climate change.

Presently, in the Maldives, farming is done on subsistence to small and medium scale commercial level. Increasing local food production would require improving the sustainability and productivity of existing farming schemes through increased knowledge of innovative farming techniques, marketing approaches and particularly, strengthening of the links to consumer markets. This project is designed to increase the capacity of farmers and communities by enhancing knowledge, access to technologies and best practices.

The most lucrative market for local farmers is the tourism industry and hence, this project focuses on analyzing the tourism market for local agriculture produce and trial commercial scale production based on the tourism market.

Description

Goal

To improve local food production for food security by introduction of sustainable commercial scale food production

Objectives

1. Strengthen the links between farmers and consumer markets to ensure sustainable local food production
2. Improve local food production and at the same time reduce dependency on food import

Activities

1. Agriculture market analysis

   Undertake an analysis of the tourism market for major agricultural consumer preferences, including identification of options for development of local production

Identify future expansion options of local produce

2. Based on the tourism market analysis, trial an identified food produce(s) for commercial scale production
3. Educate farmers on commercial farming practices and on maintaining quality standards required for the tourism market.
4. Explore options for value-adding through further processing and branding of local produce
5. Develop information kits on commercial farming and value-adding practices for local farmers

Short-term Outputs

- Agriculture market analysis report developed
- Commercial scale farming introduced and trialled

  Value-added to local produce
- Community education materials developed and disseminated

Potential long-term outcomes

- Improved sustainability and productivity of existing farming schemes
- Increased local adaptive capacity to tackle food security issues

Implementation

Institutional Arrangement

Lead Agency

Ministry of Fisheries, Agriculture and Marine Resources

Project Partners

Ministry of Atolls Development; Ministry of Tourism and Civil Aviation; Atoll Offices; Island Offices; NGOs and community level organisations

Risks and barriers

Lack of human resources, technical expertise and financial resources.

Evaluation and monitoring

The project will be monitored according to the national M&E standards set by President's Office and MPND. Quarterly progress reports, expenditure reports, annual monitoring reports will be submitted to MPND. In addition, any donor finance agency requirements on M&E will be fulfilled.

Financial resources

The total project cost is US$ 825,000

An activities based budget for the project is given below.

Activities	Cost (US$)
1. Agriculture market analysis	10,000
2. Establishment of commercial scale farming	615,000
3. Educate farmers on commercial farming practices and on maintaining quality standards required for the tourism market.	50,000
4. Explore options for value-adding through further processing and branding of local produce	100,000
5. Develop information kits on commercial farming and value-adding practices for local farmers	50,000
TOTAL	825,000

Project 7

Improve the health status of the population by the prevention and management of vector-borne diseases caused by changes in temperature and flooding due to extreme rainfall

Rationale

Both the Maldives' First National Communication to the UNFCCC and the NAPA process in the Maldives has identified outbreaks of vector-borne diseases as a major impact of climate change and climate variability. Climate related diseases such as dengue and scrub typhus are major communicable diseases of public health concern in the Maldives. In December 2006 the country had its first outbreak of Chikungunya, another climate related vector-borne disease. The Maldives NAPA projects that the incidence of these vector-borne diseases in the Maldives will increase with the predicted climate change, particularly changes in temperature and rainfall regimes.

The control of vector-borne diseases is a priority of the government as outlined in the 7NDP. Vector control activities in the Maldives are currently confined to the health sector and mainly the non-systematic use of chemical interventions as the main form of vector control. As human stresses on the environment, such as poor solid waste disposal, poor sewage and wastewater disposal, increases vector breeding sites and hence, contribute to increasing the spread of vector-borne diseases, it would be more effective to use an integrated vector management (IVM) approach to control outbreaks of vector borne diseases. IVM is environmentally sound, intersectoral, selective, targeted, cost-effective and sustainable. IVM creates the opportunity to create synergies between various vector-borne disease control programs.

Presently, the Maldives lacks the technical guidance and expertise for planning and implementation of IVM. This project will help establishment a foundation for IVM in the Maldives and thus help to reduce the risks of vector-borne diseases in the country.

Description

Goal

To protect community health through improved management and surveillance of vector borne/climate sensitive diseases

Objectives

1. Undertake Integrated Vector Management (IVM) to control climate change related vector-borne diseases in target atolls

2. Develop national capacity for IVM and disease surveillance
3. Undertake community based behavior change programmes in target atolls to enable adaptation and reducing vector-borne disease impact of climate change

Activities

1. Development of IVM plan

   Undertake a Vector Control Needs Assessment

   - Undertake epidemiological, entomological and ecological assessments

   Identify IVM objectives and targets

   - Design interventions including selection of options, cost-effectiveness analysis and combination of methods.
2. Conduct training on IVM principles to health care personnel
   - Organise national workshop for health and agricultures to learn from IPM and Agricultural practices
3. Develop the capacity for early diagnosis and establish effective disease and vector surveillance system for planning and response
4. Educate community on elimination of vector breeding grounds and other vector control measures

Short-term Outputs

- A national Vector Control Needs Assessment developed
- A national IVM plan developed
- Mechanism developed for reporting and standard operating procedures on vector-bone diseases
- Healthcare, agriculture and environment personnel trained in IVM
- National capacity developed for implementation of IVM
- Training materials developed on IVM principles
- National capacity developed for implementation of IVM
- Community awareness materials developed

Potential long-term outcomes

- Technical capacity developed within Ministry of Health to implement IVM
- Community empowered to undertake adaptation/protective measures to reduce health impact
- Improved community health

Implementation

Institutional Arrangement

Lead Agency

Department of Public Health/Ministry of Health

Project Partners

Ministry of Environment, Energy and Water; Ministry of Atolls Development; Male' Municipality; Atoll Offices; Island Offices; NGOs and community level organisations

Risks and barriers

- Lack of human resources, technical expertise and limited financial resources.
- Limited staff time of various stakeholders will be a challenge unless there is strong ownership by public health, environment and agriculture sectors as well as the community.
- Possible pandemic influenza or natural emergencies are looming risks..

Evaluation and monitoring

The project will be monitored according to the national M&E standards set by President's Office and MPND. Quarterly progress reports, expenditure reports, annual monitoring reports will be submitted to MPND. In addition, any donor finance agency requirements on M&E will be fulfilled.

Financial resources

The total project cost is US$ 350,000

An activities based budget for the project is given below.

Activities	Cost (US$)
1. Development of IVM plan	85,000
2. Conduct training on IVM principles to health care personnel.	75,000
3. Develop the capacity for early diagnosis and establish effective disease and vector surveillance system for planning and response	100,000
4. Educate community on elimination of vector breeding grounds and other vector control measures	90,000
Total	350,000

Project 8

Improve resilience of island communities to climate change and variability through sustainable building designs

Rationale

The low elevation and small size of Islands of the Maldives, makes the population highly vulnerable to the predicted rise in sea level and frequent and more intense extreme weather events. Over the last 6 years more than 90 inhabited islands have been flooded at least once and 37 islands have been flooded regularly or at least once a year. The average width of inhabited islands is 566m resulting in most settlements to be within close proximity from the coastline. There is little opportunity for communities to retreat inland. It has been found that 44% of the settlement footprints of all islands are within 100m of coastline which translates to 47% of all housing structures and 42% of the population being within 100m of coastline. Majority of the islands, have more than 50% of their housing structures within 100m of coastline.

There is currently low adaptive capacity due to insufficient knowledge, limited human resources in institutions and poor regulatory framework. The current building code does not take climate change associated impacts into account and the linkage is poorly understood due to inadequate information dissemination. This project proposes to review and improve existing building designs and methods to enable resilience to climate change impacts. This project would create an enabling environment for replication of similar projects. This project would also complement the tsunami reconstruction efforts of the Housing and Infrastructure Reconstruction Unit (HIRU) of the Ministry of Planning and National Development.

Description

Goal

Develop better and stronger buildings to increase resilience of island communities to climate change and variability

Objectives

1. Develop and demonstrate climate change resilient building structures.
2. Develop building methodology to enable replication of more resilient building design.

Activities

1. Review existing designs and methods used for building design and compile methodology and guidelines for constructing more resilient buildings
2. Construct demonstration structures on location identified by HIRU
3. Based on experience of the demonstration project, translate and publish in local language and metric conversions, the building methodology and guidelines for replication purposes
4. Develop and disseminate public awareness materials on development of more resilient building structures

Short-term Outputs

- Climate change concerns addressed in the design of building structures
- Methodology for construction of climate change resilient buildings developed
- Climate change resilient building structures implemented
- Materials developed for replication of similar projects
- Community awareness materials developed

Potential long-term outcomes

- Increased resilience of buildings to predicted rise in sea level and frequent and more intense extreme weather events.
- Improved protection of island communities

Implementation

Institutional Arrangement

The project will be implemented by the identified lead agency. The implementation of all the proposed NAPA projects will be overseen by the NAPA Steering Committee.

Lead Agency

Ministry of Construction and Public Infrastructure

Project Partners

Ministry of Planning and National Development; Ministry of Housing and Urban Development; Ministry of Atolls Development; Ministry of Environment, Energy and Water; National Disaster Management Centre;

Risks and barriers

Potential high costs of developing climate change resilient structures.

Evaluation and monitoring

The project will be monitored according to the national M&E standards set by President's Office and MPND. Quarterly progress reports, expenditure reports, annual monitoring reports will be submitted to MPND. In addition, any donor finance agency requirements on M&E will be fulfilled.

Financial resources

The total project cost is US$ 1,970,000

An activities based budget for the project is given below.

Activity	Cost (US$)
1. Review existing designs and methods used for building design and compile methodology and guidelines for constructing more resilient buildings	50,000
2. Construct demonstration structures	1,865,000
3. Translate and publish the building methodology and guidelines for replication purposes	25,000
4. Develop and disseminate public awareness materials on development of more resilient building structures	30,000
TOTAL	1,970,000

Project 9

Investigating alternative live bait management, catch, culture and holding techniques in the Maldives to reduce vulnerability of the tuna fishery sector to the predicted climate change and variability.

Rationale

The ability of Maldives to manage its fisheries is crucial to sustain livelihoods and social and economic well being. The fishery catches almost 150,000t of tuna every year with fish exports valued at US$88 million. The fishing activity itself provides direct employment for about 16,000 people and thousands more in post-harvest activities. The fisheries contribution to annual GDP is more than 7 percent.

Live bait is a pre-requisite for the pole and line fishery in the Maldives. Without adequate and continuous supply of live bait pole-and-line fishery will not exist. Coral reefs are the habitats for live bait and they are highly vulnerable to changes in SST and other climate changes. This has significant implications for the availability of bait as shown by the 1998 coral bleaching event when abundance of long nose file fish (Oxymonocanthus longirostris) rapidly declined. With such direct vulnerability of live bait availability to changes in coral reef ecosystem evident, it is imperative that alternative ways and means of live bait is sought to adapt to climate change. One obvious means is mariculture.

Captive culturing of live bait species is new and needs to be investigated in the Maldives. The possibility of catching live bait in the open outer atoll water will be another useful adaptation option. It will have the additional benefit of relieving exploitation pressure on coral reef for live bait. This will contribute to richer biological diversity and sustainable ecotourism development.

If successful, the activities proposed in this project have potential to limit or cease the bait fishing activities on the reef thereby promoting sustainable use of the coral reefs and making them more resilient to natural disturbances caused by climate change. The expected benefits in the immediate term would be better know how, and demonstration of alternative bait fishing methods and bait fish breeding options. Fishery research and development is a key priority policy in the seventh National Development Plan (NDP) and research on bait fish is a priority strategy of the seventh NDP. In addition to the national benefits, the proposed project would generate several global benefits and help fulfill important obligations of the Maldives under international conventions and agreements relating to sustainable use of

living marine resources, and maintaining biodiversity.

Description

Goal

Better bait fishery management and exploration of alternative techniques of live bait catching, culture and storage to reduce the vulnerability of bait fish to predicted sea surface temperature changes and consequent habitat changes.

Objective

Enhance the knowledge on bait use and utilization, alternative live bait, catching methods and improved holding techniques.

Activities

1. Undertake a comprehensive analysis of bait fishing in the Maldives
   - Review of bait biology, bait use and utilization
   - Catalogue and map popular bait fishing grounds in each atoll
2. Develop and implement a pilot on mariculture of alternative bait species
3. Conduct bait fishing trails in various regions of the Maldives in different periods to investigate efficacy of attracting live bait using different methods
4. Evaluate the cost effectiveness of alternative methods of bait catching
5. Develop and disseminate information of findings to fishing communities

Short-term Outputs

- Targeted research study reports on bait biology, use and utilization
- Bait resource use maps for each atoll
- Practicality and applicability of mariculture for bait trialled.
- Information made available on different methods of attracting live bait
- Economic and financial feasibility of alternatives to bait and different methods of bait catching established
- Information material developed and disseminated

Potential long-term outcomes

Well informed decision making for sustainable development & management of bait fishery based on up-to-date scientific knowledge

Implementation

Institutional Arrangement

Lead Agency

Marine Research Centre/ Ministry of Fisheries, Agriculture and Marine Resources

Project Partners

Ministry of Environment, Energy and Water; Ministry of Economic Development and Trade; Fishing communities

Risks and barriers

- Research and development investments are low in the Maldives.
- Few qualified scientists.

Evaluation and monitoring

The project will be monitored according to the national M&E standards set by President's Office and MPND. Quarterly progress reports, expenditure reports, annual monitoring reports will be submitted to MPND. In addition, any donor finance agency requirements on M&E will be fulfilled.

Financial resources

The total project cost is US$ 1,027,000

An activities based budget for the project is given below.

Activity	Cost (US$)
1. Undertake a comprehensive analysis of bait fishing in the Maldives	10,000
2. Develop and implement a pilot on mariculture of alternative bait species	450,000
3. Conduct bait fishing trails in various regions of the Maldives in different periods to investigate efficacy of attracting live bait using different methods	487,000
4. Evaluate the cost effectiveness of alternative methods of bait catching	
5. Develop and disseminate information of findings to fishing communities	80,000
TOTAL	1,027,000

Project 10

Improve resilience of island communities to climate change and variability through sustainable building designs

Rationale

The importance of sea transport in the socio-economic development of Maldives has meant that appropriate and functioning access infrastructure is a basic necessity in all inhabited islands. Unfortunately, such infrastructure is also highly vulnerable to severe weather events and predicted climate change risks. The unconsolidated nature of coral islands and low elevation means than the predicted sea level rise and increase in intensity and frequency of storm activity in the Indian Ocean could potentially expose access infrastructure to considerable risks. These climatic root causes and their potential magnitude of damage are exacerbated due to improper design and construction. High demand for access infrastructure combined with massive capital costs associated with construction, has inadvertently led the Government to adopt short-term solutions by constructing low cost harbours. Maldives being one of the least developed countries could not in the past afford the high costs of climate resilient structures. As a result, majority of the access infrastructure were poorly designed and constructed, and are not expected to withstand future climate change, let alone present severe climatic events. During the tsunami of 2004, 68% of all existing harbours were damaged, some beyond use. This project proposes to review existing studies and designs of access infrastructure and design infrastructure that is more resilient to climate change impacts.

Description

Goal

Improve the resilience of access infrastructure and island beaches to severe weather events and predicted climate change

Objective

Develop and demonstrate climate change resilient, environment friendly and cost-effective engineering solutions for access infrastructure

Activities

1. Review existing studies and designs of access infrastructure engineering, taking into consideration the current climate change scenarios.
2. Develop designs more resilient to climate change impacts and

undertake a cost-effectiveness analysis of suitable designs.

3. Demonstrate and test the effectiveness of improved design by constructing a model harbour in a selected Safer Island.

Short-term Outputs

- Climate change impacts incorporated in design of access infrastructure.
- More resilient and cost-effective access infrastructure designed.
- Climate change resilient access infrastructure implemented.

Potential long-term outcomes

Cost effective climate change resilient and environment friendly access infrastructure designs developed and mechanisms to replicate new designs nationwide established.

Activity	Cost (US$)
1. Review existing studies and designs of access infrastructure engineering, taking into consideration the current climate change scenarios.	100,000
2. Develop designs more resilient to climate change impacts and undertake a cost-effectiveness analysis of suitable designs.	100,000
3. Demonstrate and test the effectiveness of improved design by constructing a model harbour in a selected Safer Island.	3,600,000
TOTAL	3,800,000

Implementation

Institutional Arrangement

Lead Agency

Ministry of Construction and Public Infrastructure

Project Partners

Ministry of Planning and National Development; Ministry of Housing and Urban Development; Ministry of Atolls Development; Ministry of Environment, Energy and Water; National Disaster Management Centre;

Risks and barriers

Potential high costs of developing climate change resilient structures today.

Long-term studies required to assess potential effective designs may be beyond the project timeframe.

Evaluation and monitoring

The project will be monitored according to the national M&E standards set by President's Office and MPND. Quarterly progress reports, expenditure reports, annual monitoring reports will be submitted to MPND. In addition, any donor finance agency requirements on M&E will be fulfilled.

Financial resources

The total project cost is US$ 3,800,000

Activities based budget is shown on left.

Project 11

Increase resilience of coral reefs to reduce the vulnerability of islands, communities and reef dependant economic activities to predicted climate change

Rationale

Maldives is a nation with coral reefs as its geologic setting. The low elevation, small size and unconsolidated nature of coral islands makes the islands highly reliant on the biological and geomorphologic functioning of the reef environment for their stability. Much of the economic base such as tourism and fisheries, and livelihood of most Maldivians are directly linked to the coral reefs. The stability and survival of coral reefs has been questioned with the predicted climate change, particularly the risks associated with the Sea Surface Temperature (SST) rise and Sea level rise (SLR). Not only does the SST and SLR threaten physical survival of islands, but also could lead to the loss of major industries such as tourism and fisheries industry. The risks linked to climate change are further exacerbated due to non-climate related human activities such as sand and coral mining, snorkeller damage, anchor damage, inappropriate designs and methods used in coastal modifications, improper sewage disposal and over-exploitation of reef fish.

There are a currently a number of hindrances to protect the reef from what now appears to be an obvious onset of climate change. The coral reef and coral island environment of Maldives is poorly understood and there are considerable gaps in scientific research. Research is required on coral reefs, coral islands and how they naturally adapt to climate change so that appropriate adaptation measure could be devised. The regulatory framework and management of human induced stress on coral reefs and islands are weak. Capacity to undertake coral reef protection and minimise human induce stress is limited. Finally there is an apparent lack of awareness amongst the public, community groups and even decision makers.

This project aims to overcome some of the gaps in scientific research, to pave way for climate risk adaptation programme for coral reefs. It is intended that the project will develop needed research capacity in coral reef management for the Maldives.

Description

Goal

Minimize human stress on coral reefs of Maldives to facilitate natural adaptation of reefs and islands in the face of predicted climate change.

Objective

Increase the knowledge base and understanding of the natural adaptation process in coral reefs.

Activities

1. Conduct research to understand how coral reefs and islands adapt to climate change and identify ways and measures required to enhance the natural adaptation process.
2. Conduct research on how human induced stresses such as reef fishery, tourism, land reclamation and other developmental activities affect growth and functioning of coral reefs to facilitate informed decision-making on coral reef management.

Short-term Outputs

- Research report on how coral reefs and islands adapt to climate change and recommendations on measures to enhance the natural adaptation process.
- Research report on influence of human induced stresses on coral reef and recommendations on mitigating such stresses.

Potential long-term outcomes

- Knowledge gap on coral reefs and coral island adaptation to climate change reduced.
- Increased national capacity for coral reef research and management.

Implementation

Institutional Arrangement

Lead Agency

Marine Research Centre/ Ministry of Fisheries Agriculture and Marine Resources

Project Partners

Ministry of Environment, Energy and Water; Ministry of Tourism and Civil Aviation; Ministry of Atolls Development; Ministry of Planning and National Development; Ministry of Construction and Public Infrastructure

Risks and barriers

Lack of capacity in coral reef research and management

Evaluation and monitoring

The project will be monitored according to the national M&E standards set by President's Office and MPND. Quarterly progress reports, expenditure reports, annual monitoring reports will be submitted to MPND. In addition, any donor finance agency requirements on M&E will be fulfilled.

Financial resources

The total project cost is US$ 1,062,000

An activities based budget for the project is given below.

Activity	Cost (US$)
1. Conduct research to understand how coral reefs and islands adapt to climate change	354,000
2. Conduct research on how human induced stresses affect growth and functioning of coral reefs.	708,000
TOTAL	1,062,000

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Annex

Annex 1
Maldives NAPA Process and Key Steps

NAPA process was guided by the principles of transparency, broad stakeholder engagement, partnership building among focal agencies, community participation and ownership by the people of Maldives especially the atoll population, multi-disciplinary analysis and synergy with national development policies.

The procedures in the UNFCCC Annotated Guidelines for the Preparation of National Adaptation Programmes of Action was adapted and streamlined to suit the Maldives. The Maldives has already undertaken several studies on the vulnerability of the nation and the special adaptation needs of the country. The Maldives submitted its FNC in 2001 that included National GHG Inventory, Mitigation Plan for GHG Emissions, Vulnerability to Climate Change, Adaptation to Climate Change, Policies and Measures, and Project Proposals. The country-driven NAPA of 2006 is the successive climate change adaptation strategy that precedes the Second National Communication. Hence the NAPA goes beyond the policies and measures in the FNC and the project profiles included needs speedy implementation.

The NAPA project in the Maldives was implemented as part of the Integrated Climate Change Strategy (ICCS) that included the Technology Needs Assessment for mitigation and adaptation and, the National Capacity Self-Assessment.

The ICCS is also consistent with the policy directive in the Sixth National Development Plan to pursue a programmatic as opposed to project-based approach when implementing the Government's policies and to create

meaningful and sustainable partnerships between the public and private sectors and civil society, in order to achieve the goals of national development.

Participatory process

Stakeholder engagement

A multi-disciplinary team was established to formulate the NAPA. The CCTT was responsible for formulating the NAPA and, in the future, will be responsible for coordinating the implementation of activities under the NAPA framework. The CCTT was appointed through an open and flexible process that was inclusive and transparent. At the inception meeting of the project key stakeholders had the opportunity to review membership of the CCTT and propose additional members.

The CCTT comprises of representatives of Ministry of Environment, Energy and Water the lead agency, and other key players including stakeholders such as members of relevant government ministries and private sector. The stakeholders represented in the CCTT are:

- Ministry of Tourism and Civil Aviation
- Ministry of Fisheries, Agriculture and Marine Resources
- Marine Research Centre
- Ministry of Construction and Public Infrastructure
- Maldives Transport and Contracting Company
- Ministry of Transport and Communication
- Ministry of Economic
- Development and Trade
- Ministry of Housing and Urban Development
- Ministry of Atolls Development
- Ministry of Planning and National Development
- Energy Section - Ministry of Environment, Energy and Water
- Water Section - Ministry of Environment, Energy and Water
- Department of Meteorology
- Environment Research Centre
- Educational Development Centre
- Ministry of Health
- Maldives Fishermen's Association
- Land and Marine Environmental Resources Group Pvt. Ltd.
- Seamarc
- Banyan Tree Resort Maldives

Partnership building

Experience has shown that it takes considerable time to enhance national and local capacity to implement adaptation measures. As such capacity enhancement activities were undertaken as part of the NAPA formulation process. The aim of capacity enhancement was to ensure that key partners play an appropriate, meaningful and productive role in the development and ultimate implementation of the NAPA. In capacity building the focus was on addressing the

urgent need for (i) personnel who have the technical understanding of vulnerability to climate change and of possible adaptive responses, who are competent in applying methodologies for vulnerability and adaptation (V&A) assessments, who can translate their technical knowledge and skills into recommendations for policy and decision-makers and who can assist in providing longterm and continuous assistance towards implementing project level adaptation activities; (ii) enhanced awareness for both political and community levels in relation to the current vulnerability of the Maldives to climate and sea level variability, to the potential increase in climate hazards and associated risks as a result of climate change, and to the opportunities to reduce the vulnerabilities and risks through adaptation.

The following ministries and agencies benefitted from the partnership building activities.

- Ministry of Fisheries, Agriculture and Marine Resources
- Ministry of Planning and National Development
- Marine Research Centre
- Department of Public Health
- Ministry of Transport and Communications
- Maldives Water and Sanitation Authority
- State Electric Company
- Maldives Transport and Contracting Company
- Male' Municipality
- Ministry of Environment, Energy and Water
- Maldives College of Higher Education
- Commerce, Development and Environment Pvt Ltd
- Haa Dhaalu Atoll Office
- Gaafu Alifu Atoll Office
- Gaafu Dhaalu Atoll Office
- Seenu Atoll Office

Awareness raising

In addition to the training activities undertaken to build technical knowledge and skills of relevant individuals in the government and private sector climate change targeted public awareness raising was also undertaken. Awareness raising materials were prepared in both Dhivehi and English language taking into account the capacities, needs and concerns of the stakeholders. Dedicated radio and TV programmes were funded by the NAPA project.

Awareness raising sessions were held for the students of Muhibbuddin School - Hithadhoo (Seenu Atoll), Seenu Atholhu Madharusa -Hulhumeedhoo (Seenu Atoll), Gnaviyani Atoll Education Centre - Fuammulah, Majeediya School - Male', English Preparatory and Secondary School - Male' and Ghiyasuddeen School - Male'.

A special public lecture was organised with national NGO, Volunteers for Environment, Social Harmony and

Improvement (VESHI) to provide information on the latest science of climate change. The internationally recognized scientist Prof. John Hay provided the public lecture.

Community awareness raising sessions were held for multi-sector representatives from Haa Alifu, Haa Dhaalu, Shaviyani, Gaafu Alifu, Gaafu Dhaalu, Gnaviyani and Seenu Atoll. Awareness raising sessions were held in Kulhudhuffushi (Haa Dhaalu Atoll), Hithadhoo (Seenu Atoll) and Fuammulah (Gnaviyani Atoll).

Stakeholder consultations

Three stakeholder consultations were organised one at national level and two at regional level. The consultations were organised to seek the views of key opinion leaders and representatives from key sectors on critical vulnerabilities to climate change and priority adaptation measures. The first regional consultation was held in the North region at Kulhudhuffushi (Haa Dhaalu Atoll) from 11th to 12th September 2006. Altogether 28 participants from Haa Alif, Haa Dhaal and Shaviyani Atoll attended the consultation. The second regional consultation was held in South region at Hithadhoo (Seenu Atoll) from 16th to 17th September 2006. Altogether 37 participants from Gaafu Alifu, Gaafu Dhaalu, Gnaviyani and Seenu atoll attended. The national consultation was held in Male' (Bandos Island Resort) from 13th to 14th September 2006. A total of 30 participants from 20 agencies including the private sector participated in the consultation. A follow-up consultation session was held on 01st October 2006.

Multi-disciplinary approach

In formulating the NAPA a multi-disciplinary approach was adopted. The NAPA framework was built upon key theories of sustainability, risks, capital deepening and institutions from ecology, sociology, economics and political science literature.

Given the multi-disciplinary approach adopted for NAPA it was necessary to bring expertise from a variety of sectors, civil society and government. A working group was established to ensure that the NAPA was comprehensive and covers the social, economic and environmental aspects of sustainable development. The NAPA Working Group also facilitated high standard for the project profiles and allowed CCTT to work closely with policy-makers in relevant sectors and with officials from the Ministry of Planning and National Development and Ministry of Finance and Treasury. The NAPA Working Group consultative process helped increase the knowledge base of the CCTT and assisted them to carry out NAPA formulation. The NAPA Working Group consisted of senior executives from key partner agencies and private sector. The following are the members of the NAPA Working Group:

- Dr. Mohamed Shiham Adam Executive Director, Marine Research Centre
- Dr. Abdulla Naseer - Executive Director, Ministry of Fisheries, Agriculture and Marine Resources
- Dr. Sheena Moosa Director, Health Science, Ministry of Health
- Dr. Simad Saeed - Project Manager, Atoll Ecosystem-based Conservation project, Baa Atoll
- Mr. Amjad Abdhulla Director, Ministry of Environment, Energy and Water
- Mr. Ahmed Jameel Director, Ministry of Environment, Energy and Water
- Ms. Mariyam Saleem - Senior Research Officer, Marine Research Centre
- Mr. Ibrahim Shaheen Director, Maldives Transport and Contracting Company
- Ms. Fathmath Shafeega - Assistant Director, Ministry of Planning and National Development
- Dr. Ahmed Jamsheed Mohamed - Senior Medical Officer, Department of Public Health
- Mr. Ahmed Shaig PhD Candidate, James Cook University, Australia
- Mohamed Aslam - Director, Surveying, Land and Marine Environmental Resources Group Pvt. Ltd
- Mr. Hussain Naeem Senior Environment Analyst, Ministry of Environment, Energy and Water
- Ms. Lubna Moosa - National Project Manager, Integrated Climate Change Strategy Projects, Ministry of Environment, Energy and Water
- Ms. Hafeeza Abdulla - NAPA National Consultant

A hazard-vulnerability-impact matrix was developed from a multi-disciplinary perspective to gauge the critical vulnerabilities and impacts on the Maldives. Based on the results of the interactive cause and effect matrix detailed V&A assessments were conducted for fisheries, coral reef biodiversity, human health, land, beach and human settlements, and critical infrastructure.

A series of climate policy research papers were prepared for discussion and advocacy. These papers were disseminated widely for feedback, presented at a national consultation and made available for public review on the website of the Ministry of Environment, Energy and Water. These papers will be published in the future as official policy research reports.

Method

In the NAPA six steps were followed in sequence each feeding its output as input to the next step.

1. Development of criteria for prioritization

2. Identification of priority vulnerable sectors
3. Detailed V&A for priority sectors
4. Identification of adaptation activities
5. Prioritization of adaptation activities
6. Development of project proposals

1. Development of criteria for prioritization

The criteria for prioritization were developed by the NAPA Working Group. The criteria and the process for prioritization were pilot-tested in Gn.Fuammulah in June 2006. Based on the pilot-testing the method was refined and improved.

Two broad objectives were used to prioritize the development sectors that are vulnerable to climate change. These objectives are:

1. Relevance to national development
2. Degree of climate impact

Four broad objectives were selected as the basis for prioritization of adaptation activities and criteria were developed to assess adaptation activities against each objective. The objectives and the respective criteria are:

Objective 1: Reduce the degree of adverse effects of climate change.

1. Degree to which adverse effects of climate change to natural capital (beach, vegetation, water, coral reefs and related ecosystems) is reduced.
2. Degree to which adverse effects of climate change to produced capital (public infrastructure, utilities such as power, water supply and telecommunications) is reduced.
3. Degree to which adverse effects of climate change to human capital (loss of life, human health) is reduced.

Objective 2: Reduce poverty and promote equality to enhance adaptive capacity.

4. Degree to which disparity between Male' and the atolls is reduced.
5. Degree to which empowerment of women is achieved.
6. Degree to which food security is increased.

Objective 3: Achieve synergy with national development goals and MEAs.

7. Degree to which the economy can be strengthened and diversified.
8. Degree to which employment opportunities can be increased particularly for youth and women.
9. Degree to which the natural environment will be protected.
10. Degree to which people and property can be made safer from damage caused by natural disasters.

Objective 4: Cost-effectiveness.

11. Degree to which adaptation measure is socially accepted.
12. Degree to which the adaptation measure is financial feasible.
13. Degree to which the measure is technically feasible.

2. Identification of priority vulnerable sectors

In order to list the sectors that are vulnerable to predicted climate change a review of (1) the latest global climate scenarios predicted by the IPCC, (2) local climate trends estimated in the Climate Risk Profile for the Maldives, (3) FNC, (4) IPCC Third Assessment Report; and (5) other relevant international studies on the impact of climate change on small island states was undertaken.

Based on the literature review a summary matrix of the global and local trends in climate change, key vulnerabilities of the Maldives to the predicted climate change hazards and the impacts on the different development sectors was drawn up. The matrix was used as a guide to produce the list of vulnerable sectors that needed further assessment.

A national workshop was held to prioritise sectors.

3. Detailed V&A assessment for priority sectors

The priority sectors based on the objectives and the hazard-vulnerability-impact matrix are:

1. Land, beach and human settlement
2. Critical infrastructure;
3. Tourism;
4. Fisheries;
5. Human health;
6. Water resources;
7. Agriculture and food security and,
8. Coral reef biodiversity.

Detailed V&A assessments were carried out by national consultants for coral reef biodiversity, fisheries, human health, land, beach and human settlement and critical infrastructure. It was not possible to undertake detailed V&A assessments for tourism, water resources and, agriculture and food security due to lack of local capacity and time constraints.

4. Identification of adaptation activities

In order to identify adaptation activities three stakeholder consultations were held. The stakeholders were informed about climate hazards, specific vulnerabilities of the islands' ecosystem, economy and people to the identified hazards and about the impacts of climate change. These stakeholders were also informed about the adaptation measures recommended in the V&A assessments. Following the provision of background information the stakeholders were asked to identify

- what are the key
- vulnerabilities/impacts to climate change?

- what are the existing measures that reduce the vulnerability of systems and groups to climate change?
- what are the existing development policies and measures that increase the vulnerability of systems and groups to climate change?
- what are the new adaptation policies and measures required to address critical vulnerabilities and impacts?

The answers to these questions were used to identify adaptation activities. Group discussions were held to agree on the key adaptation activities.

5. Prioritization of adaptation activities

Once the adaptation activities were identified by the regional and national level consultative process, analytical hierarchy process was used to prioritize adaptation activities. The multi-criteria decision tool pair-wise ranking was used by the stakeholders to first give weights to the criteria for prioritization. Next the stakeholders were asked to provide a score from 0-10 for each activity against each criterion. The scores were then summed based on the weight for the criteria.

6. Development of project proposals

The project profiles for priority adaptation activities were initially developed by the members of the NAPA Working Group. The profiles were circulated for feedback and input from respective government agencies who will have primary responsibility for their implementation. The profiles were also circulated widely for comments and presented to the CCTT and a national workshop for endorsement.

Country-drivenness

The NAPA of the Maldives was developed through a country-driven process. As an important element of the NAPA the Maldives Adaptation Policy Framework was developed. This Framework captures from a national perspective the important interactions that would lead to adaptation to climate change in the Maldives.

The key sectors assessed in the NAPA reflect specific geographic and economic characteristics of the country. Maldives is a coral reef based small island developing state made up of 1190 small tropical islands. As such fisheries, tourism, coral reef and beaches play a critical role in the economic agenda of the country.

The Maldives is divided into 20 administrative regions called atolls. Since there are no significant variations in environmental features across the atolls the impact of climate change on all the atolls is likely to be similar. Specific islands may be more vulnerable to different hazards than others but a regional analysis was not warranted.

the public consultations held a very high level of enthusiasm was shown by community leaders which augers well for the implementation of the NAPA. In the aftermath of the tsunami there is a very high level of realisation of the vulnerability of the country and the need for risk reduction.

The criteria for prioritization of adaptation activities were determined based on national development priorities. A tailor-made analytical framework based on how the adaptation measures affect the level and quality of capital assets natural, human and produced capital was used to evaluate adaptation activities.

Contribution to overall sustainable development goals

The Maldives NAPA will contribute to national sustainable development goals. The national Vision 2020 envisions that protective measures will be taken to combat global environmental threats and environment friendly lifestyles will be adopted in the Maldives. NAPA is dedicated to adapt to the threats posed by global climate change.

The seventh millennium development goal is to ensure environmental sustainability. Target nine of MDGs is to integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources. NAPA identifies policies and measures required to adapt to global climate change and these policies and measures are integrated into the 7NDP. Most of the NAPA policies and measures are cross-cutting in nature and contribute to several important development sectors. The NAPA policies also contribute to the protection of important environmental resources such as water, soils, land and biological diversity.

The adaptation measures in the NAPA are directly relevant to the guiding principles, goals and strategies of the 7NDP. The 7NDP identifies the vulnerable low lying islands and fragile reef environment as a key challenge to sustainable development in the Maldives and endorses the NAPA as a means to address the challenge posed by global warming and sea level rise. The policies and measures in the NAPA are integrated into the national development policies on macroeconomic and financial management, tourism, fisheries, agriculture, construction, transport, land development, environmental management, natural disaster preparedness and mitigation, water resources management, healthcare and housing. In order to integrate the policies into the 7NDP the NAPA Team worked closely with the officials of Ministry of Planning and National Development, Ministry of Finance and Treasury, Ministry of Health, Ministry of FIsheries , Agriculture and Marine Resources and Ministry of Environment, Energy and Water.

Government endorsement and commitment

NAPA is endorsed at the highest level of government and in his foreword to the NAPA the President called for all government agencies to extend their full cooperation to implement the NAPA.

In addition to the inclusion of NAPA in the 7NDP the Third National Environment Action Plan contains a dedicated chapter for addressing global climate change based on recommendations of the NAPA. The Ministry of Environment, Energy and Water has developed an implementation strategy to ensure the successful implementation of NAPA. The National Commission for the Protection of Environment (NCPE) will oversee the implementation of NAPA and a special interagency task force is envisaged to ensure the respective agencies of the government mobilise international financial assistance and allocate public financing to the priority project profiles in the NAPA.

Transparency

The NAPA was formulated through a transparent and open process. New ideas and differing opinions were encouraged from the beginning and consultative process was adhered to. The CCTT were informed about all the decisions taken and methods adopted. National and regional level consultations were held to seek the views of community and key sector representatives on the priority vulnerabilities and adaptation measures. The NAPA Working Group contributed to the operational management of the NAPA process and provided continuing feedback to improve the NAPA.

The draft methods, reports and working papers were circulated for comments and feedback. The draft text of the NAPA was distributed to all the members of the CCTT and key agencies of the government for comments and feedback. The NAPA was endorsed by the government at a national workshop held on [date].

Annex 2
List of participants in the national and regional workshops

NAPA Nation Workshop on Identifying and Prioritisation of Adaptation Measures

1	Hawwa Nizma	(Department of Public Health)
2	Dr.Sheena Moosa	(Ministry of Health)
3	Shazly Shafeeq	(Ministry of Economic Development & Trade)
4	Thomas le Berre	(Seamarc Pvt.Ltd)
5	Marie Saleem	(Marine Research Centre)
6	Ahmed Adham	(Ministry of Transport & Communication)
7	Man B. Thapa	(UNDP)
8	Gulfishan Safeeq	(Education Development Centre)
9	Aishath Niyaz	(Water Solutions Pvt. Ltd)
10	Mohamed Ali Janah	(Maldives Association for Construction Industry)
11	Mohamed Latheef	(Ministry of Transport & Communication)
12	Mohamed Azim	(Ministry of Housing & Urban Development)
13	Azim Musthag	(Maldivers Diving Center)
14	Aminath Haifa Naeem	(Ministry of Planning and National Development)
15	Abdul Azeez Abdul Hakeem	(Banyan Tree Maldives)

16	Ahmed Zuhoor Mohamed Hussein	(State Trading Organization)
17	Zahid	(Department of Meteorology)
18	Aishath Shahida	(Maldives Food and drug Authority)
19	Dr. Ahmed Jamsheed Mohamed	(Department of Public Health)
20	Mohamed Fayaz	(Ministry of Construction and Public Infrastructure)
21	Ismail Raheed	(Ministry of Construction and Public Infrastructure)
22	Ahmed Musid	(Waste Management Section)
23	Azzam Ibrahim	(State Electric Company)
24	Mohamed Fizan Ahmed	(Waste Management Section)
25	Dr. Mohamed Shareef	(Ministry of Planning and National Development)
27	Abdul Azeez Jamal Aboobakuru	(Ministry of atolls Development)
26	Aiminath Haifa	(Ministry of Environment, Energy and Water)
28	Ahmed Jameel	(Ministry of Environment, Energy and Water)
29	Aishath Aileen Niyaz	(Ministry of Environment, Energy and Water)
30	Dr.Simad Saeed	(Ministry of Environment, Energy and Water)

NAPA North Regional Workshop on Identifying and Prioritisation of Adaptation Measures

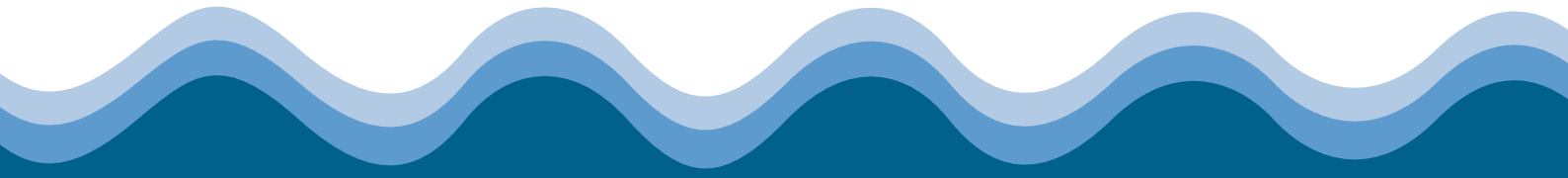
1	Ahmed Naseem	Kelaa-Haa Alifu
2	Najma Najeeb	Kelaa-Haa Alifu
3	Mohamed Hassan	Maarandhoo-Haa Alifu
4	Adam Naseer	Dhidhdhoo-Haa Alifu
5	Ibrahim Khaleel	Ihavandhoo-Haa Alifu
6	Abdulla Saeed	Hoarafushi-Haa Alifu
7	Fathimath Zahira	Hoarafushi-Haa Alifu
8	Mohamed Zahir	Baarah-Haa Alifu
9	Sifla Shakir	Utheemu-Haa Alifu
10	Afra Ibrahim	Muraidhoo-Haa Alifu
11	Mohamed Zahir	Baarah-Haa Alifu
12	Abdul Razzaq	Hanimaadhoo-Haa Dhaalu
13	Idhrees Abdulla	Hanimaadhoo-Haa Dhaalu
14	Abdul Rahman Ismail	Kulhudhuffushi-Haa Dhaalu
15	Khadeeja Ali	Kulhudhuffushi-Haa Dhaalu
16	Ibrahim Hassan	Kulhudhuffushi-Haa Dhaalu
17	Musthafa Hussein	Nolhivaran-Haa Dhaalu
18	Ali Mahir	Nolhivaran-Haa Dhaalu

19	Shareefa Ahmed	Kulhudhuffushi-Haa Dhaalu
20	Mohamed Zahir	Vaikaradhioo-Haa Dhaalu
21	Adam Mohamed	Vaikaradhioo-Haa Dhaalu
22	Hassan Shiham	Neykurendhoo-Haa Dhaalu
23	Mohamed Arif	Kanditheemu-Shaviyani
24	Ahmed Shareef	Goidhoo-Shaviyani
25	Hathim Moosa	Feydhoo-Shaviyani
26	Mohamed Abdul Rahman	Maroshi-Shaviyani
27	Ismail Ibrahim	Komandoo-Shaviyani

NAPA South Regional Workshop on Identifying and Prioritisation of Adaptation Measures

1	Mohamed Zaeem	Villingili-Gaafu Alifu
2	Musthafa Mohamed	Villingili-Gaafu Alifu
3	Ali Zubeir	Villingili-Gaafu Alifu
4	Masood Ahmed	Villingili-Gaafu Alifu
5	Ahmed Zareer	Gemanafushi-Gaafu Alifu
6	Nasrulla	Gemanafushi-Gaafu Alifu
7	Mohamed Didi	Kandu Hulhudhoo-Gaafu Alifu
9	Thagiyyu Ibrahim	Kolamaafushi-Gaafu Alifu
10	Amjad Musthafa	Maamendhoo-Gaafu Alifu
11	Athir Ibrahim	Thinadhoo-Gaafu Dhaalu
13	Mohamed Nasih Rasheed	Thinadhoo-Gaafu Dhaalu
15	Mohamed Manik	Hoadedhdhoo-Gaafu Dhaalu
16	Layagath Ali	Fares-Gaafu Dhaalu
17	Ibrahim Riyaz	Gadhdhoo-Gaafu Dhaalu
18	Mohamed Shaheedh	Gadhdhoo-Gaafu Dhaalu
19	Mohamed Igbal	Fiyoree-Gaafu Dhaalu
20	Ashraf Rasheed	Maathodaa-Gaafu Dhaalu
21	Ahmed Waheed Mohamed	Fuvahmulah-Gnaviyani
23	Ali Nafiz	Fuvahmulah-Gnaviyani
25	Ibrahim Abdulla	Fuvahmulah-Gnaviyani
26	Thoriq Ahmed	Fuvahmulah-Gnaviyani
27	Mohamed Ahmed Didi	Fuvahmulah-Gnaviyani
28	Mohamed Musthafa Ahmed	Fuvahmulah-Gnaviyani
29	Eenaas Ali	Fuvahmulah-Gnaviyani
30	Khadeeja Ahmed	Fuvahmulah-Gnaviyani
31	Shabana Waheed	
32	Ibrahim Shiyam	

33	Ahmed Haneef	
34	Mohamed Zahid	
35	Ibrahim Rasheed	Hithadhoo-Seenu
36	Mohamed Rasheed Moosa	
37	Aishath Zuhaira	Hithadhoo-Seenu
38	Fathmath Shifaza	Hulhudhoo-Seenu
39	Mohamed Shimaz	
40	Saudulla Hameed	Hithadhoo-Seenu
41	Aminath Mohamed	Hithadhoo-Seenu



Ministry of Environment, Energy and Water