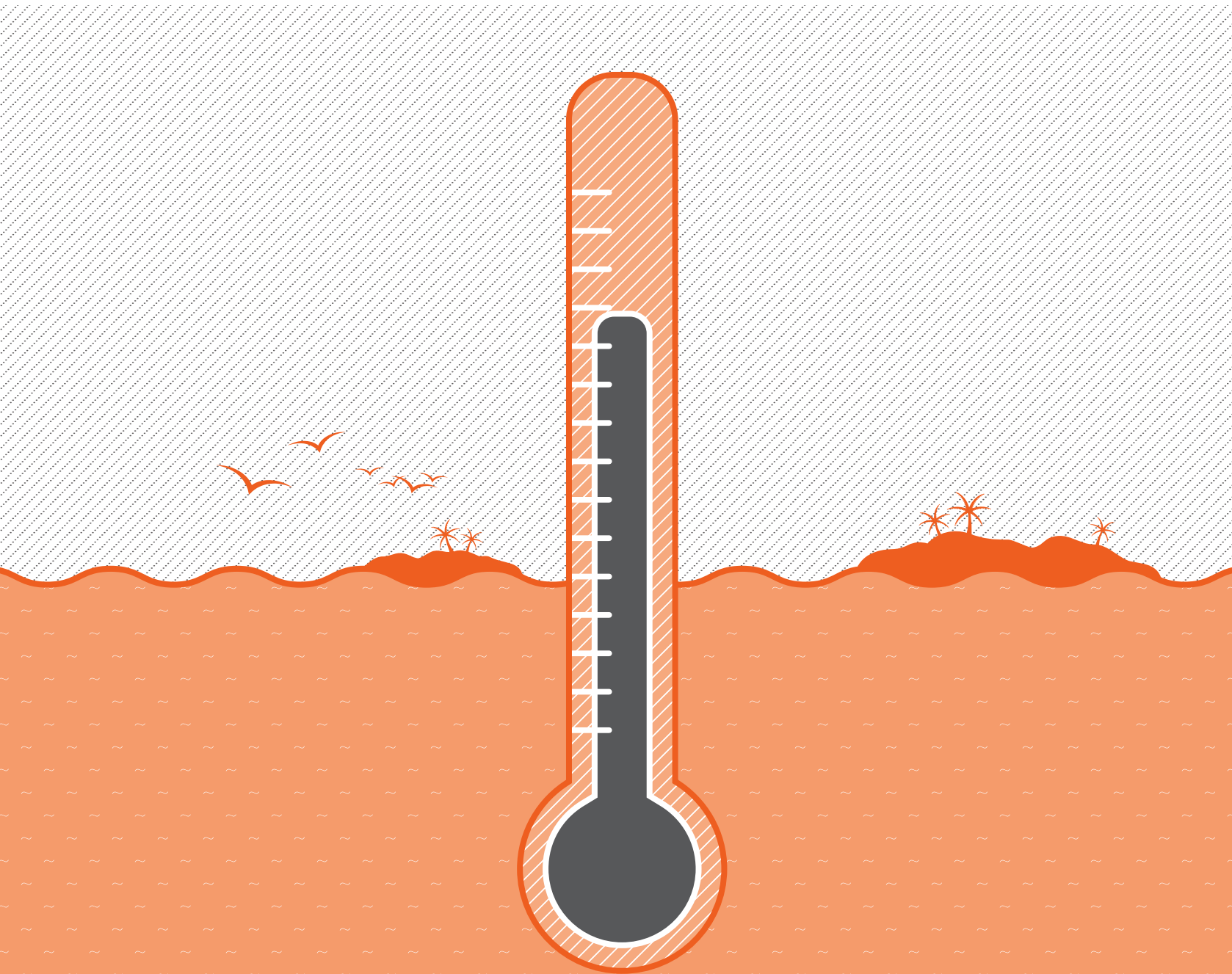
National Climate Change Research Strategy

Integrating Climate Change Risks into Resilient Island Planning in the Maldives Project



2015

Ministry of Environment & Energy

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Foreword

In the past twenty years, as a nation, we have made commendable strides towards preparing the Maldivian communities for the impacts of Climate Change. Innovative projects have been implemented and research conducted through both international and local experts. We have gained some knowledge on what could be our best options to reduce the impacts of Climate Change. However, this knowledge is currently distributed and exists in silos. We have not streamlined our efforts to demystify Climate Change in the context of the Maldives and make our knowledge base cohesive. We need to systematically focus our initiatives and coordinate the production and dissemination of knowledge on Climate Change as it pertains to our country.

Maldives has been at the forefront of voicing out the fears of countries vulnerable to Climate Change. We have played an important role in strengthening the efforts of the Small Island Developing States (SIDS) and must continue to do so. We have a significant opportunity to become a research hub and strengthen our individual and collective position based on information that is corroborated by scientific research. In this respect, having a national research strategy on climate change is a stepping stone.

This research strategy, formulated in consultation with relevant technical experts and policy makers can pave the way towards coordinated and focused research in Climate Change. And reduce the knowledge gap for technical and policy requirements specific to the Maldives. By building on our research base we can ensure that policies and regulations are developed based on scientific knowledge for a more resilient society.

I wish to acknowledge with appreciation the contributions made by the Global Environment Facility and the United Nations Development Programme.

Thoriq Ibrahim
Minister

EXECUTIVE SUMMARY

The Maldives has been identified as one the most vulnerable countries to climate change and one of the first countries to be made uninhabitable with the projected sea level rise scenarios. Its characteristics such as a small, morphologically unstable and low lying island nation, which features a living coral reef platforms, precarious groundwater systems and dispersed nature makes islands highly susceptible to even minor changes in climatic patterns. Given this climate sensitive physical environment and the relatively poor economy of Maldives, the protection of population and investments from climate change related threats, and the provision of basic public services in such a widely dispersed setting will be very expensive and often impractical.

The Maldives realizes that its inhabitants and economy are vulnerable to adverse effects of climate change so measures are underway to ensure that current development activities and policies take climate change-related risks and opportunities into account.

A major challenge in designing climate resilient pathway is the lack of scientific research that could seamlessly be incorporated into the national, regional and local decision making and planning processes. The bulk of the climate change related research activities related to Maldives have been conducted by international academic and research institutions but very few in the Maldives are aware of the results. Local research is undertaken by a small number of government funded or government institutions, often with no coordination and substantive duplication across agencies. The knowledge generated from such research frequently fails to reach decision makers and community planners. Data is collected by various government departments and private institutions but data sharing and knowledge management is disorganized. There are institutional weaknesses in facilitating research, particularly coordinating, regulating and disseminating research activities and information. There are regulatory weaknesses which prevent the country from progressing forward as a knowledge seeking society. Hence, a strategy is required to facilitate relevant and applied climate change research and promote the use of research results at all levels of policy and investment decision making.

The aim of this research strategy is to ensure that government agencies, private developers and communities in Maldives are provided with relevant and useful research results that enable them to make the best possible decisions to manage climate change-related trends, risks and effects. It also seeks to establish the Maldives as a research hub and testing ground for climate change impacts and suitable adaptation options in small island developing states (SIDS).

This strategy was prepared after broad consultations with a number of stakeholders and is envisaged for a timeframe of 10 years. It identifies three major areas which account for: current research needs on climate change and adaptation; ways to facilitate research; and ways to manage and disseminate relevant knowledge. They are summarized below.

Area 1: Building Knowledge

National Research Priorities: The stakeholders identified the following research themes:

i. Understanding climate change: *Knowing about past climate patterns, current trends and projected future changes to climate*

ii. Understanding the implications of climate change: *Accurately identifying the impacts on our physical environment, infrastructure, economy and society.*

iii. Becoming carbon neutral – managing emissions: *Knowing about practical and cost-effective solutions to make Maldives carbon neutral.*

iv. Living with climate change – towards climate resilient islands: *Understanding practical and cost effective measures to lead us to a climate resilient pathway.*

v. Understanding how we can communicate risks: *Knowing what, who, how and when to communicate climate information for towards a climate resilient pathway.*

Area 2: Enabling Research

- Funding: Ensuring sustainable flow of domestic and international funds to facilitate research in Maldives. The proposed approach is international collaborations and financial support from international aid agencies for the short-term. The approach for the long term is to establish a consolidated local fund within a research foundation for research activities.
- Institutional Arrangements: Ensuring a well organized institutional setup to manage and facilitate research, and make Maldives a premier hub for climate change related research. The proposed arrangement is to establish one lead institution among the proposed Climate Change Centre, Maldives National University, proposed National Research Foundation or Science Foundation and a proposed new joint research facility for MEE and MoFA. They will regulate, coordinate and facilitate all research activities in Maldives.
- Capacity Building: Ensuring effective and efficient functioning of research institutions in Maldives and publication of locally relevant research findings.
- Managing knowledge and accessing information: Ensuring a state-of-the-art knowledge management system which will facilitate climate change research. The proposed lead institution will manage the system through a single portal which may be connected to a series of existing data sharing initiatives and research institutions or individuals.
- Underpinning regulatory Framework: Ensuring research facilitation by providing more guarantees for data sharing, intellectual property rights, and establish standards for conducting research and collecting data

Area 3: Linking Decision Makers and Facilitating Change

- Ensuring policy decisions, community activities and private sector investment decisions are taken with the backing of scientific knowledge on climate change.
- A number of options are proposed to gradually bridge the gap between decision makers and researchers or research findings, including regular forums where relevant stakeholders such as researchers, decision makers, developers and communities could periodically meet.

This strategy is a major and critical first step to nationally coordinated climate change research, development and timely dissemination of information that will lead to a holistic approach towards sustainable development in a high climate risk nation. There is a high level of political will in the Maldives towards mainstreaming climate change into development and it is essential they continue to support strategic approaches to facilitate change.

1. NEED FOR A RESEARCH STRATEGY

1.1 Context

The Maldives has been identified among the countries most vulnerable to the predicted impacts of climate change (IPCC, 2007).

The characteristics that make Maldives highly vulnerable are numerous and inherent in archipelagic small island states. Land in the Maldives is comprised of dispersed coral islands. They are small and low lying, with barely 1.5 m above mean sea level. The islands are morphologically unstable due to its unconsolidated nature and are highly susceptible to erosion based on changing climatic variables. The archipelago is geologically setup on a sand stone coral reef platform and physical stability of the islands are dependent on the health and ability of the coral reefs to keep up with and adapt to changing climate. The hydrological systems in small islands are precarious and are dependent on a relatively stable sea level. Temporary changes in sea level during natural hazard events, as seen in the 2004 Indian Ocean Tsunami event, have caused considerable damage in the past. The protection of population and investments against climate change, and even basic public services in such a widely dispersed setting is very expensive and often impractical, especially since the Maldives is a relatively poor country.

A rising sea level is the single biggest threat to the survival of Maldives. The projected sea level rise of 0.88 m by year 2100 (IPCC, 2007) is expected to make most islands uninhabitable. The predicted changes in natural hazards, particularly abnormal wave activity are expected cause extensive damage particularly when combined with a rising sea level.

Changes in temperature, rainfall, sea surface temperature (SST), ocean currents and chemistry, winds and extreme weather conditions will affect the physical environment and socio-economic functioning of the island communities. Damage to coral reefs due to high SST and ocean acidity could damage coral reefs which in turn will severely affect the basic economic sectors of the country – fishing and tourism. Changes to ocean currents and chemistry could disrupt the distribution, growth, recruitment and productivity of fish stocks in the Indian Ocean. Increased severe weather events may reduce food security, increase health risks and cause extensive infrastructure damage.

The human factor in increasing the vulnerability of Maldives to climate is also a concern. The Maldives plays an insignificant role in carbon emissions so has limited contributions to the causes of climate change. However, the improper development activities undertaken in the fragile coral islands are contributing to exacerbate the consequences of climate change. Development activities such as coastal infrastructure, land reclamation, deforestation, sand mining and coral mining have caused irreparable damage in some areas. This has occurred both due the lack of knowledge and awareness regarding the role of natural environment against climate change impacts and weaknesses in incorporating such knowledge into development planning.

The Maldives realizes that island communities are vulnerable to adverse effects of climate change. Measures are underway to ensure that current development activities and policies

take account of the potential adverse effects against climate change. Long term measures are gradually coming to focus albeit mainly in terms of adaptation. Development planning and physical planning are considering to gradually incorporating climate change considerations. There is clear commitment by the Government of Maldives to ensure that climate changes risks are incorporated in the future development of Maldives. These include the provisions in the Strategic Action Plan of the ruling Maldives Democratic Party (MDP) Manifesto, National Adaptation Programme of Action (NAPA), First National Communication to the United Nations Framework Convention on Climate Change (UNFCCC) and National Environment Action Plan. However, in practice there still seems to be a lack of actual policy responses and good practices in incorporating climate risks with national development priorities.

One of the main challenges facing planners and decision makers in incorporating climate change risks into their activities is the lack of Maldives or small island states specific research. These range from knowledge about the physical and biological environment, and its response patterns against climate change to health risks associated with rising temperatures.

Current planning activities and policies with direct relevance to managing climate change impacts include the resilient island development policy, coastal infrastructure projects, renewable energy investments and improving the transport sector fuel efficiency, to name a few. The resilient island planning is perhaps the single most influential policy in ensuring climate change knowledge is incorporated at the island level. Most developments in islands are now geared towards this policy, which includes risk reduction measures against natural hazards and measures to build socio-economic resilience. Its concepts, however, have been hampered by lack of climate change knowledge.

Current domestic research activities are limited, fragmented and lacks a systematic approach. They have a number of limitations such as lack of staff capacity, funds and research facilities.

There are also a number of issues in properly facilitating research. Data sharing and accessibility has been identified as key weakness in promoting research. In addition, weaknesses in institutional setup, coordination, legislations, guidelines and process to facilitate research collaboration are crucial factors that need to be resolved.

There is an opportunity to systematically address the challenges in facilitating research and in incorporating research findings into policy development and planning activities. One of the first steps will be to develop a proper research strategy for climate change to address the above challenges. This will help consolidate the efforts to facilitate, gain, distribute and properly apply knowledge to build the future of Maldives.

This research strategy seeks to meet the need of policy planning and development activities, while at the same time establishing a systematic process of facilitating, collecting, managing and disseminating climate change related knowledge

1.2 Aims and objectives

The aim of this research strategy is to ensure that climate change-related research in Maldives is systematically coordinated and directed to applied questions which help Government agencies, private developers and communities in Maldives to make the best possible decisions to manage climate change-related risks and effects. It also seeks to establish the Maldives as a research hub and testing ground for climate change impacts and effective adaptation options in low lying Small Island Developing states (SIDS)

The specific objectives of the strategy are:

i. To identify national climate change research priorities.

ii. To focus international and domestic climate change research activities on areas that are relevant and needed.

iii. To identify and establishing mechanisms to remove barriers in facilitating climate change research in the Maldives.

1.3 Target audience

Target audiences of this document are:

i. International academic and research institutions (such as universities, climate change think tanks, networks and platforms)

ii. International development partners and funding agencies

iii. Domestic educational institutions and public agencies

iv. Decision/policy makers in national government entities, atoll and island councils

v. Research students

vi. Private sector investors and managements

1.4 Developing the Research Strategy

The development of this research strategy has been undertaken by CDE Consulting for Ministry of Environment and Energy. The lead consultant for the project is Dr. M. Shiham Adam. Other support team members included Dr. Ahmed Shaig, Dr. Simad Saeed and Ms. Lubna Moosa.

This activity is funded by the 'Integration of Climate Change Risks into Resilient Island Planning in the Maldives' (ICCRRIP) Project. The overall goal of the ICCRRIP project is to increase the resilience of the Maldives in the face of the climate change and improve the country's capacity to respond effectively to climate related hazards. The objective of the project is to ensure that climate change risks are integrated into resilient island planning and that national, provincial, atoll and island authorities and communities are able to prioritize and implement climate change adaptation measures. The ICCRRIP project seeks to elaborate, demonstrate and promote community based and other climate change adaptation measures used in the Maldives.

The key objective of commissioning the development of research strategy under this project is to identify specific climate information needs for planners, and decision makers, identify key technical information and research capacity gaps and options for developing this and obtain high level endorsement from the key stakeholders as a directive or as a regulation.

The strategy was formulated after stakeholder consultations (see Appendices 1 to 3). The following key contributors and stakeholders were identified and where possible one-on-one interviews were conducted.

Key Contributors

Environment Protection Agency
Marine Research Centre
The Maldives National University
Department of Meteorology
Ministry of Environment and Energy – Climate Section
Presidential Advisory Council on Climate Change

Other Stakeholders

Ministry of Fisheries and Agriculture – Fisheries Section
Ministry of Fisheries and Agriculture – Agriculture Section
Ministry of Tourism, Arts and Culture
Ministry of Health and Family
Department of Public Health
Ministry of Education - Ministry and Schools
Ministry of Economic Development
President's Office
United Nations Development Programme (UNDP) Maldives
State Electric Company (STELCO)
Resorts – Sun Island Resort, Shangri-la at Viliglli Island Resort and Sonevafushi Island Resort
Environmental Consultants
Administrative (province office)

Following the initial draft of the strategy, a national level workshop was conducted at the Ministry of Environment and Energy, where extensive and fruitful discussions were held among the stakeholders (See Appendix 2). The final draft of the report was modified according to the discussions.

A final presentation was held for policy and decision makers to get their endorsement (see Appendix 3). However, it has to be noted that some of the key high ranking policy officials, particularly from the Ministry of Environment and Energy, were unable to attend despite confirming their attendance.

The proposed timeframe for this document is medium-term (10 years). However, some research aspects may be used of the long-term (20+ years). The document intended to be reviewed at least every five years. The lead agency designated for ensuring this process is Ministry of Environment and Energy.

2. STATE OF KNOWLEDGE AND CAPACITY

2.1 State of knowledge and research gaps

The climate change studies specific to the Maldives are extremely limited. This is rather surprising given that the Maldives is amongst the first countries expected to be severely affected by the projected rise in sea level.

Much of the knowledge that exists on Maldives has been gathered by international research institutions under the leadership of expatriate academicians. This knowledge is only accessible through scientific publications, many of which are inaccessible at the local level due to prohibitive costs.

Most of the international research relevant to Maldives has focused on climate science, specifically on aspects such as sea level rise, air temperature, rainfall, sea surface temperature and wind. A small group of scientists, namely from Australia and New Zealand, have focused on the geological and geomorphological studies but there still seems to lack "critical mass" in knowledge to advance those studies further. There are limited studies on coral reef monitoring particularly those documenting recovery following natural disturbance. Studies on socio-economic impacts, adaptation and mitigation have been very limited. The following subsections describe some of the research activities on various themes.

2.1.1 Climate Science

A number of sources summarize the current status of climate change-related research in Maldives. A partial bibliographical listing of existing studies and summaries are presented in Appendix 6. Some of the key summaries could be found in the following publications.

The First National Communication of Maldives to the UNFCCC (Ministry of Home Affairs Housing and Environment, 2001);

- The Climate Risk Profile for Maldives, which was developed as input to the formulation of a National Adaptation Programme of Action (Hay, 2006);
- A number of scientific publications about regional climate projections, which have contributed to the 4th Assessment report of the IPCC (e.g. Mitchell, 2002; Christensen et.al., 2007)
- National Adaptation Programme of Action (NAPA) and five research papers developed as inputs to NAPA

The debate on climate change and its impacts is ongoing. However, the majority of scientists now believe that climate change is happening and is projected to change over the coming century, with potentially grave consequences for low-lying countries like the Maldives. During the last decade there has been considerable surge interest in using Maldives as a testing ground for potential impacts on small island states. Perhaps this interest was created by the media, which portrayed the 'catastrophic disappearance' of small island states like Maldives, Kiribati and Tuvalu (for example: Lamb, 2005, Lean, 2006). Table 3.3 summarises some of the key findings from the literature on the predictions for climate change in Maldives.

Sea level rise, one of the most critical climate change variables that will affect Maldives, has been strongly debated recently based on specific evidence from Maldives. On the one hand, in arguably the best evidence supporting sea level rise in the Maldives region, Singh et. al, (2001) reported that, over the past few years, sea level has risen approximately 5.8-8.5 mm per year, along the Maldives coast. On the other hand, Morner (Morner et al., 2004, Morner, 2004) argued that sea level has fallen in Maldives over the past millennia, and more recently during the last 30-50 years. Some leading scholars in the field of geomorphology, including Kench et. al (2005) and Woodroffe (1993), suggests that Maldives have survived a higher sea level rise in the past and may survive a future rise as well, but no concrete answers have been found yet.

Table 1 Present climate change predictions for Maldives

Factor	Projected rate of change	Projected change (overall rise)		Impacts	Source
		Best Case	Worst Case		
Sea Level Rise	3.9 - 5.0 mm / yr	Yr 2050: +0.2m Yr 2100: +0.4m	Yr 2050: +0.4m Yr 2100: +0.88m	Tidal flooding; increase in swell wave flooding; reef drowning	(IPCC, 2007, Khan et al., 2002, Singh et al., 2001)
Air Temperature	0.4 °C / decade	Yr 2050: +1.72° Yr 2100: +3.72°	NA	Increase in tropical diseases	(Singh et al., 2001, Hay, 2006)
Sea Surface Temperature	0.3 °C / decade	Yr 2050: +1.29° Yr 2100: +2.79°	NA	Increase in storm surges and swell wave flooding; coral bleaching & reduction in coral defences	(Singh et al., 2001)
Rainfall	+0.14 % / yr (or +32 mm/yr)	Yr 2050: +1384mm Yr 2100: +2993mm	NA	Could affect coral reef growth	(Giorgi and Francisco, 2000, Hay, 2006)
Wind gusts	5% and 10% / degree of warming	Yr 2050: +3.8 Knots Yr 2100: +8.3 Knots	Yr 2050: +7.7Knots Yr 2100: +16.7 Knots	Increased windstorms; increase in swell wave flooding.	(Hay, 2006)
Swell waves	Frequency expected to change. Wave height on reef expected to be higher			Increase in swell wave flooding.	(Kitoh et al., 1997)

Despite some lively debate, there remain substantial gaps in specific research on Maldives. Much of the existing knowledge is concentrated at a regional level and needs to be developed specifically at the country level, including sea level models and regional climate models. We also know very little about the historical climatic and sea level conditions in Maldives, which are essential in predicting the future changes.

2.1.2 Implications on coral islands and reefs

Worldwide, coral reefs remain the most threatened of ecosystems (UNEP-WCMC 2006; Wilkinson 2000). For a country like Maldives, where the survival is entirely dependent on the coral reef, very little site specific research has been undertaken.

Impacts of coral reefs have been sparsely studied for coral bleaching (Brown 1997, Hoegh-Guldberg 1999), increased concentration of carbon dioxide and its effect on the chemistry of calcification of corals and reef growth (Gattuso et al 1999, Buddemier et al 2004, (Hoegh-Guldberg et al., 2007)) and effects of sea level rise (Buddemier et al 2004).

In recent years, there has been an interest in understanding the geological and geomorphological response of small coral islands against climate change. For example Kench et. al., (2005) suggested that the midrange projection of 0.48 m of sea-level rise by the year 2100 (Church et al., 2001)) is unlikely to physically destabilize the reef islands of Maldives. Hence, according to Kench et. al., (2005):

'contrary to most established commentaries on the precarious nature of atoll islands Maldivian islands have existed for 5000 yr, are morphologically resilient rather than fragile systems, and are expected to persist under current scenarios of future climate change and sea-level rise' (p.148).

These findings by Kench et. al., (2005) also need to be viewed with caution, since their studies were primarily based on 'undisturbed' uninhabited islands.

Monitoring studies undertaken by the MRC has shown the recovery of reefs following natural disturbances can vary widely (Zahir et al., 2002). While some reefs have shown remarkable resilience and rapid rates of recovery other are slow to recover. Targeted research on understanding resilience of the Maldivian reefs to anthropogenic and climate stress are required to understand the implication of climate change Maldivian coral reefs.

Hence, wide gaps in research still remain as to what will actually happen to the Maldives, particularly to the building blocks (coral reefs) and fragile coral islands. This is perhaps one of the biggest questions that will need answers for policy makers.

2.1.3 Impacts on the socio-economic environments

Research on socio-economic impacts of climate change is almost non-existent. Perhaps this aspect has been foreshadowed by the interest in learning about climate science and physical impacts related to climate change.

The most substantial guide to the potential impacts at the local levels are perhaps the UNDP risk assessment reports on selected inhabited islands (UNDP, 2006, UNDP, 2009b) and feasibility studies for coastal protection measures against climate change (UNDP, 2009a). In addition, impacts on human health have been studied elsewhere and are highly relevant to the Maldives.

2.1.4 Adaptation and mitigation

Adaptation and mitigation research is well established across the globe. However, Maldives specific research is very limited. For example, research on the impact of coastal structures on future climate risks, suitability of coastal adaptation measures against climate change scenarios, land use planning requirements for the future and ground water susceptibility assessments are not available at the local level. Such information is highly relevant to the policy makers and private investors.

Mitigation research on the other hand can be duplicated across various settings. However, research such as renewable energy requires knowledge on the climatic conditions to test whether they are applicable to the Maldives. There are a number of climatic data collection initiatives ongoing for various renewable energy projects is Maldives and are funded by potential investors.

2.2 Institutional setup

The key agencies and institutions involved in climate change related research activity are the Marine Research Centre (MRC), Environment Protection Agency (EPA), Department of Meteorology (DoM), STELCO and newly established the Maldives National University. In addition a number of new institutions such as the Villa College and Madhanjeeth Institute have a number of research activities planned but has not been initiated yet. Some Government agencies such as Ministry of Environment and Energy, Ministry of Fisheries and Agriculture and Department of Public Health have projects which are involved in funding various levels research components. The Maldives National University is currently not undertaking any specific research but has plans to undertake some research under its environmental management programme initiated by Maldives Environment Management Project funded by GEF/WB.

At present there is no specific institution which coordinates or manages research activity in Maldives. As a result, there are duplicate activities and expenditure on data collection and research activities. There is no single agency mandated with approving or overseeing research activities. The Ministry of Fisheries and Agriculture approves and issue research permits for "marine research" in the Maldives targeted exclusively for foreigners. The Department of National Planning (DNP) gives clearance for socio-economic research in the Maldives.

There is no single repository of research information. Climate change related studies have been undertaken by various agencies under different foreign funded projects but the reports are locked up in the originating agency. Quite often there is no inter-agency sharing of research information or data. Some agencies are not aware of the type of activities being undertaken in other agencies, which could otherwise complement research activities. Access to research data is also difficult, particularly for research students and overseas organizations. There are a few initiatives in sharing information such as web-based distribution of agency specific information on their sites, the dissemination through "Government IT Network" and use of specialized network based computer programs such as the National Geographic Information System (NGIS). None of these are operational yet.

In summary, there is an urgent need to establish institutional arrangements which facilitate the exchange and dissemination of climate-related research across relevant governmental and non-governmental institutions; to better coordinate climate-related research activities; and to facilitate more systematic and collaborative knowledge sharing and management between the national, regional and local levels.

2.3 Institutional capacity

Research capacity is limited in most of the agencies involved in climate change research. All the agencies interviewed reported lack of qualified staff, funding and adequate facilities to conduct research. The institutions under The Maldives National University, at present, are mainly concerned about delivering undergraduate and graduate coursework courses rather than research.

It is apparent that Maldives will have to rely on collaborations with international institutions and research activities undertaken elsewhere to fill the short-term gaps in research needs. It is unlikely that research capacity can be improved locally in the short term.

2.4 Financing

There does not seem to be an organized financing mechanism for research activities in the Maldives. Local funding is mainly in the form of Government budget allocated to the agencies and educational institutions but they are rarely enough or consistent from year to year. A major source of funding for small scale research projects comes from research components embedded in major development projects funded by international donors or financing agencies.

International collaborations with educational institutions have been recently introduced as a means of funding research. However, collaborations like Milano Biccoca University outpost and Madhanjeeth Institute are yet to begin their research activities.

A clear approach and strategy to funding relevant research in urgently required.

2.5 Acquisition and use of knowledge

Policy makers and planners often do not systematically use new research to guide their decisions. New research often comes to their attention through a project based presentation or sometimes once a concept becomes largely redundant in the international arena. This can be seen by the delayed implementation of internationally popular national planning strategies like the 'Atoll Development Programme'[1] to 'Growth Centre Strategy'[2].

Much of the research has been infiltrated into planning aspects through foreign educated students who have either studied trends in the climate change field or undertaken research themselves.

Urgent attention is needed to establish a mechanism to link climate change knowledge and the decision making / planning process.

2.6 Legislative Framework

The legislative framework for regulating and coordinating research activities is weak in the Maldives. There are no specific laws designed to facilitate national level research across various fields. The only laws which explicitly facilitate and regulate research activity are the Fisheries Act 5/87 and the Maldives National University Act 3/2011. Fisheries Act is mainly concerned with regulating and coordinating marine resource related research, particularly fisheries related research. The University act mainly defines the provisions for conducting research as an academic activity within the context of university development.

There are clear regulations and procedures to undertake research activities related to marine resources and socio-economic statistical surveys. The marine research activities cover a broad range of research activities from coral reef, fish and aquaculture. The Statistical Regulation of Maldives covers a broad range of surveys and research activities but is mainly geared towards regulating socio-economic data collection, usage and publication.

A detailed review of the existing laws, regulations, guidelines, policies and activities is provided in Appendix 4.

+ Maldives as a small island state testing bed for Climate change effects and adaptation an mitigation options

3. THE STRATEGY

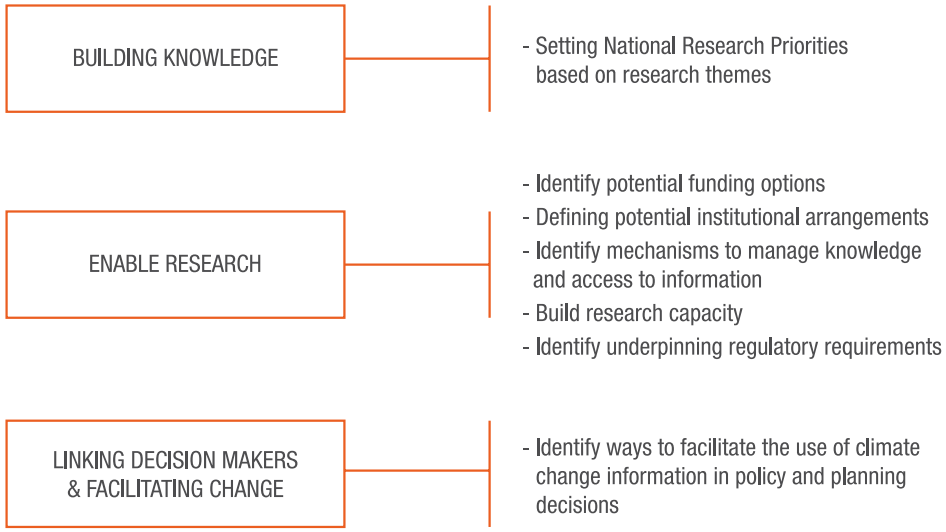
The Maldives is faced with a development predicament: how to efficiently provide socio-economic development in sparsely populated settlements, while having to cope with the natural disasters and climate change risks, especially the projected sea level rise. The questions are similar for private sector developers: how to invest in the Maldives amidst the ongoing challenges to climate change. A solution to this predicament will require judgments based on informed decisions. The desired outcome of this research strategy is that the Government agencies, industries and communities in Maldives are equipped with state-of-the-art scientific information to make the best possible decisions to manage climate change and its effects.

The approach in developing this strategy is to base it on four simple questions:

1. What information do we need?
2. How do we get the information?
3. Who is going do it?
4. How are we are going to use the information?

Based on these filter questions the following framework has been developed to guide the preparation of the strategy.

Figure 2 Figure 1: Framework for developing the strategy



The vision in relation to climate change research activities is to transform the Maldives into a premier small island state testing bed for climate change effects and, adaptation and mitigation options.

The following subsections will expand on this framework based on consultations with the relevant parties as described in the chapter.

3.1 Building Knowledge – National Research Priorities

Based on discussions with the stakeholders, the following questions were identified as the primary questions which needed to be answered to achieve the information needs for the next five to ten years.

1. What is happening to climate change?

   Policy makers, planners, developers and communities need to understand what is happening to climate change and accurately predict the future scenarios at the local level.
2. What are the implications of climate change to Maldives?

   Policy makers, planners, developers and communities need to understand what is going to happen to their physical environment, their economy and livelihood, and the functioning of their society.
3. How can we live with climate change?

   Policy makers, planners, developers and communities need to know the options to adapt to climate change, their technical effectiveness, cost effectiveness and practicality.
4. How can we reduce our contribution to climate change?

Policy makers, planners, developers and communities need to know the options for making the Maldives carbon neutral and manage their emissions.

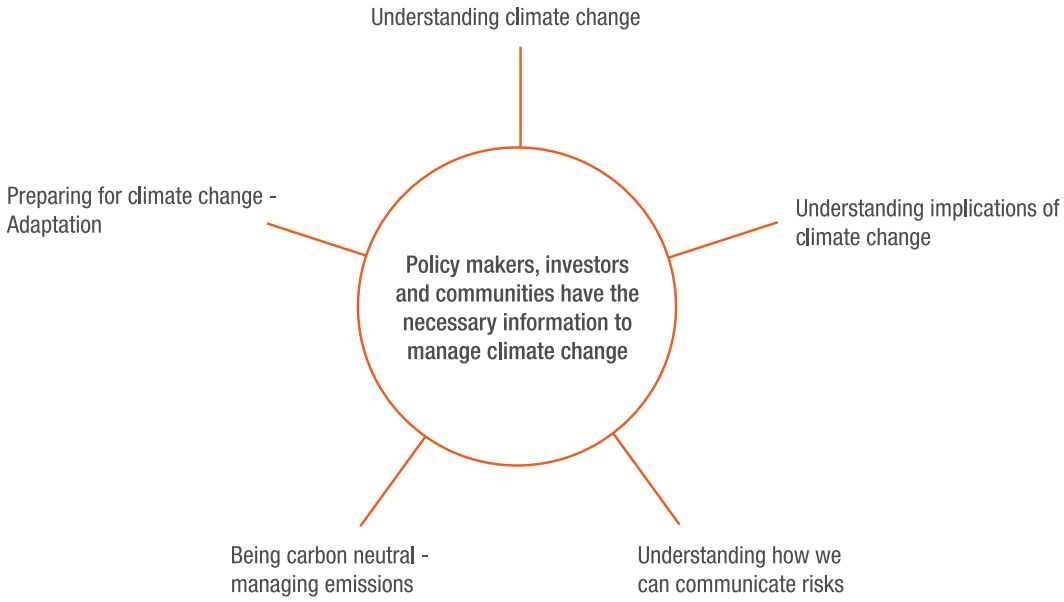
5. How can we spread the message?

Policy makers and communities need to understand what the community knows, what they need to know and how they prefer to receive their messages.

Based on these guiding principles, five areas have been identified as research priority themes to assist policy makers, planners, developers and communities make the best decisions to manage climate change in the short- to medium-term.

Figure 2 below provides a conceptual map of the key research themes. The following subsections provide the details of each theme.

Figure 3 Figure 2: Conceptual map of the priority research themes



3.1.1 Understanding climate change

Statement of need

Understanding what has happened in the past climate, current climatic trends and projected climate changes is central to determining how we can live with climate change, reduce our contribution and communicate the relevant information. At present we have very limited knowledge at local level to determine past monsoonal patterns and other climatic variables, especially during periods of past climate variability. Similarly, we do not have accurate models at the local level to predict the likely climatic variations in the future. Hence, this theme expected to provide the building blocks for the rest of the research themes.

Objectives and outcomes

The objectives of this research theme are to: understand past climatic conditions specifically around Maldives; to determine the present climatic condition; and accurately predict future climate change in Maldives.

The expected outcome is a body of research that accurately predicts climate change at a localised level.

Focus Research Sub-themes

- Evaluating past evidence on climate variability of monsoon (including timing and intensity), and of the key climate variables (e.g. temperature, wind and rainfall).

- Evaluating past evidence on sea level change
- Analyzing and monitoring trends in present sea level change across the Maldives
- Monitoring changes to oceanographic conditions (e.g.: coastal productivity / changes in the distribution patterns of productivity, waves, currents and sea surface temperature)
- Monitoring changes to ocean chemistry (e.g. salinity and acidity).
- Monitoring changes and predicting severe weather events.
- Understanding spatial variations across Maldives in natural hazard exposure.
- Downscaling climate models to local level, including sea level models.
- Baseline information to better understand climate parameters.

3.1.2 Understanding implications of climate change

Statement of need

Understanding and predicting the physical changes to landscape of Maldives, particularly in response to sea level rise, is essential understand how we can manage and live with climate change. Similarly, knowledge on the implications of global and localized climate change on the economy and society are critical in preparing a community to live with climate change. Very little is known about the physical and biological impacts from climate change in the Maldives. Yet, the physical stability of the island and growth response of coral reefs to climate change is believed to be central to understanding whether the Maldives would be able to survive the projected rise in sea level. Similarly, we are aware that most of our infrastructure and economic assets are at risk but little is known about the implications various climate change scenarios on the key industries. We also need to determine how the functioning of the society is affected, for Maldivians in the past have migrated from island to island in response to natural hazards. Such information is essential in preparing the community to live with climate change.

Understanding and predicting the natural response and physical changes to the islands and coral reefs of Maldives against sea level rise has been identified as the highest priority research area during consultations.

Objectives and outcomes

The objectives of this research theme are to: understand what is going to happen to physical environment of the Maldives; determine the economic implications of climate change; and determine the societal implications of climate change.

The expected outcome is a body of research that accurately identifies the impacts on our physical environment, economy and society.

Focus Research Sub-themes

- Determining physical vulnerability of coral islands against climate change (including but not limited to island geomorphological stability, geological setup of Maldives, groundwater system impacts, effects on wetlands, changes to vegetation and spatial variations in geophysical features across Maldives);
- Evaluating biological impacts of climate change (including but not limited to coral reef growth response, changes to reef, demersal and pelagic fish stocks – their recruitment, distribution and abundance, health risks and diseases and effects on food security);
- Monitoring current changes and collecting baseline information (including but not limited to coral reef health, beach and island morphology, vegetation and groundwater system).
- Determining economic vulnerability (determining economic sectors, critical infrastructure and functional aspects at risk, calculating costs of economic losses against severe weather events, and understanding the local island economy and their functional links at the national level).
- Determining social vulnerability (determining and mapping vulnerable populations at island level, understanding social cohesion, community social processes, community interaction mechanisms, food security, climate change awareness, urban effects, climate health risks and climate related diseases).
- Understanding practical planning solutions and testing practical solutions to level that could be reduced to an implementation level.
- Determining the implications of current development practices on projected climate change related impacts (e.g. land reclamation, coastal infrastructure development, coastal protection)

3.1.3 Becoming carbon neutral – managing emissions

Statement of need

Becoming carbon neutral is a national goal for the current administration. It's symbolic in nature but serves as a motivational action for other countries and for the locals to become climate change aware and prepare for the inevitable. The requirement for managing emissions is for research and development in low carbon or carbon free technologies to replace the existing fossil fuel depended energy production. Maldives relies heavily on fossil fuel for power generation and marine transport. Cost effective alternative technologies are needed to replace existing power sources and transport demands without affecting the economic functioning both at local and national level. Such technologies need to be imported, borrowed or adopted from new development in the international arena. At the same time, local base line information is required to match the new technology and local climatic and physical conditions.

Objectives and outcomes

The objectives of this research theme are to: understand the measures that could be taken to become carbon neutral at the island and country level; and determine the most cost-effective and best-practicable options for the Maldives;

The expected outcome is a body of research that paves the way for making Maldives carbon neutral.

Focus Research Sub-themes

- Understanding our carbon footprint
- Determining cost effective best practicable renewable energy options for the Maldives (e.g. wind, wave, solar, waste-to-energy and other new technologies)
- Determining cost effective and best practicable options for marine transport sector fuel efficiency.
- Evaluating cost effective and best practicable waste management practices suitable for the Maldives
- Determining innovative designs and best practicable options for improving energy efficiency in buildings.
- Determining the socio-economic implications of a low carbon development pathway.
- Understanding clean development mechanisms with respect to Maldives economic development policy and other small island states, and its potential for making Maldives carbon neutral.

3.1.4 Living with climate change – towards resilient islands

Statement of need

One of the most important information relevant to the policy makers, developers and communities is to understand how we can live with climate change. From their perspective, this is the priority research gap. The foremost question is: how can we protect against a rising sea level and increased ocean induced natural hazards, like flooding? The need for physical resilience as a guarantee for survival is seen as a priority research area. This is followed by the need to understand how we can alter our current high impact practices to limit our contribution to potential negative impacts of climate change and enhance the natural process that facilitate natural adaptation. There is also a need to understand how we can provide economic resilience and social resilience to individual islands and the country as a whole. In this regard, the public sector focus is very much on filling the research gaps for further developing the resilient island policy. The private sector focus is more on physical resilience and economic resilience through innovative developments that suit vulnerable small islands and financial models that work well for moderate to high risk areas.

Objectives and Outcomes

The objectives of this research theme are to: understand the measures that could be taken to make Maldives physically, environmentally, economically and socially resilient to climate change; and determine the socio-economic implications of choosing a climate resilient pathway;

The expected outcome is a body of research that paves the way for developing resilient islands against climate change.

Focus Research Sub-themes

- Understanding how to improve physical resilience of islands (e.g. best practicable coastal protection measures, sustainable water production, sustainable construction designs, land use restrictions, etc…)
- Understanding how to improve environmental resilience of islands (e.g. enhancing natural resilience measures such as coastal ridges, vegetation belts and coral reefs; determining how to change high impact development activities like reclamation and harbor development to suit natural adaptive processes, role of vegetation like mangroves and coastal vegetation, sustainable water use etc…)
- Understanding how to improve economic resilience of islands (e.g. innovative insurance and re-insurance options to manage climate risks, economic analyses to determine cost-effectiveness of adaptation options, innovative economic activities at island level to facilitate change during climate change, determining economic implications of living with climate change)
- Understanding how to improve social resilience of islands (e.g. impacts on most vulnerable populations, disaster response capacity, food security, role of gender, etc…)

- Understanding possible 'business cases' to assist private sector involvement in adapting to climate change
- Developing, evaluating and monitoring environmental policy

3.1.5 Understanding how we can communicate risks

Statement of need

Conveying the message of climate change, its impacts, mitigation measures and adaptation measures is essential for a highly vulnerable country like Maldives. Most importantly, best practices in living with climate changes needs to be disseminated effectively to ensure that there is national progress towards living with climate change. One of the main challenges facing Maldives with regard to communication is the lack of understanding of how people perceive climate change, how they receive messages, the drivers of information and opposition. Research is needed to fill these gaps.

Objectives and outcomes

The objectives of this research theme are to: understand the key stakeholders in climate change information delivery; understand awareness levels; understand behaviors and motivational barriers towards climate change; and how information can be best delivered.

The expected outcome is a body of research that assists in making the population of Maldives aware of climate change, its impacts and how to live with it.

Focus Research Sub-themes

- Understanding the stakeholders and various groups like drivers, fence-sitters, opposition and users of climate change information.
- Understanding level of awareness and knowledge on climate change among various groups
- Understanding current behaviors and practice of climate change awareness
- Understanding the motivational/barriers to hearing, believing and accepting climate change information.
- Preferred methods of receiving information.

3.2 Enabling Research

3.2.1 Funding

Approach

It is apparent that amidst the macro-economic challenges facing Maldives and funding shortages for socio-economic development, it is highly unlikely that enough public finance could be raised in the short-term for research activities. Hence, it is unlikely that the existing educational and research institutions will be able to raise sufficient funds themselves for climate change related research activities. This issue is compounded by the current budget-category model where specific agencies get a budgeted amount of money for research activities, which is usually inclusive of day-to-day administrative costs. In addition, these institutions are unlikely to be able to resolve their shortages in human resources and research facilities in the short-term.

The preferred method funding for the short-term is international collaboration with research institutions, financial support from international aid agencies, bilateral funding and involvement of private sector in research funding. The foundation model as proposed for the National Research Foundation is more desirable than the present budget-category financing model.

In the medium- to long-term the approach is to gradually build-up local capacity and funding options while being complemented by international research. The vision to become the premier testing ground for climate change related research will need to be achieved by attracting international institutions and achieving 'critical mass' in research activities.

Objectives and outcomes

The objective of the funding approach is to ensure that there is a sustainable flow of domestic and international funds to facilitate research in Maldives.

The expected outcome is enough funding and research activity to generate critical mass in research activity to make Maldives a premier hub for climate change related research.

Domestic Funding options

- Establish a foundation model to financing (as proposed for the National Research Foundation) or a mix of foundation model and budget-category model. This would involve pooling funding into a specific research fund rather than to individual departments or institutions. The disbursement of funds will be based on national research priorities and evaluated systematically to ensure delivery.
- Establish at least 0.2% of the national budget for climate change research related activities (excluding recurrent costs). This could come from within the proposed 1% of the budget as planned for the National Research Foundation.
- The private sector contributes to the fund and undertakes research activities as well.
- Use a business model as proposed for the Climate Change Research centre (see next section).

International Funding Options

- Collaborations with research institutions
- Bilateral funding and research grants
- Research components embedded in projects funded by foreign aid or loans

International Aid Coordination

- International aid coordination will be required at the Government level to manage climate related bi-lateral and multi-lateral research funding. The existing aid coordination mechanisms in the Ministry of Foreign Affairs will need to be streamlined to follow the NRS.

3.2.2 Institutional Arrangements

Approach

The achievement of the dual objectives of achieving information sufficiency for managing climate change and developing Maldives as a climate change research hub requires an institutional setup which serves both the domestic and international needs.

The approach presented here is to develop a wholly local set up which only serves local research needs and is geared towards advancing local research.

The alternative is to establish a set up where local needs are served initially and will be expanded to serve international needs in the future.

The proposed centre could either be a national level institution which serves all forms of research activity or sub-institution which works with or under a national level institution.

Objectives

The objective of the institutional arrangement approach is to ensure that research activities are coordinated and managed efficiently in the Maldives. The activities to be performed by the leading agency will be research facilitation, coordination, knowledge management, information dissemination and management of financial resources.

The expected outcome is a well organized institutional setup to manage and facilitate research, and make Maldives a premier hub for climate change related research.

Institutional options

1. A national level overall research institution: The proposed National Research Foundation or Science Foundation

There has been a proposal in the former Science and Technology Masterplan to develop a National Research Foundation (NRF). The concept has been taken onboard in the current administration's Strategic Action Plan as well, with its proposed Science Foundation (see Annex 4). The original plans for the NRF were designed to develop it as one of the leading authorities in all fields of research in Maldives. Its proposed key functions are: (i) research funding; (ii) knowledge management (computerized research archive); (iii) clearinghouse on research funding support, and; (iv) research advocacy.

The initial proposal was to house NRF under the former Ministry of Communications, Science and Technology (MCST), which is now abolished. It was to have staff resources allocated from MCST but have a management board with both Government and private sector representation. At present, there is no Government indication for a specific institutional placement of the proposed Science Foundation. Hence, the institutional placement of a future Foundation is unclear. Preferably, the Foundation could be linked to the Maldives National University.

The proposed NRF was proposed to cover all research aspects. Climate change research interests could be embedded in the overall framework as a priority research area or a climate research foundation could function separately under the institutional framework of the NRF.

The proposal for the NRF was prepared based on broad national consultations and has been prepared in detail. It may be more practical to follow the NRF plan, if a national level research institution is necessary, particularly since the present administration prescribes to a similar model.

1. A national level climate research institution: proposed Climate Change Centre for Adaptation and Low Carbon Development

The Government of Maldives in association with UNDP is discussing the option to create a climate change centre to facilitate research activities in Maldives. The vision of the Centre is to be a model centre for adaptation and mitigation development in low-lying coral reef islands and ecosystems, and facilitating key research and acting as a project implementation partner to help the Maldives and other countries to timely scale up climate resilient, low carbon sustainable development.

The objectives of the Centre are:

- Strengthen knowledge management and sharing
- Build capacity in a cost effective way, through a learning by doing approach
- Establish the Maldives as the ideal laboratory/testing ground for adaptation and management solutions for low-lying coral reef ecosystems
- Translate research into practical applications
- Coordinate mitigation and adaptation activities on the technical and financial levels
- Promote the development of low-carbon, climate resilient project ideas.

There proposed strategic lines of activity and services:

- Research facilitation
- Advisory services
- Knowledge management
- Maldives climate change coordination hub
- Sustainable business platform

This proposed centre is well placed to achieve the dual objectives specified in this strategy: acquire the local knowledge required for development and establish Maldives as hub for climate change research in small island states.

1. A separate institution within MEE and MoFA

A separate research institution similar to the above the above Climate Change Centre could be established under the custodianship of MEE and MOFA. This will be a separate institution but will provide direct services to the Government and regulate all research activities in Maldives. The advantage of such as new institution would the extended control over the research activities.

2. The Maldives National University

The newly established University is also well placed to take over the responsibility of research activities. Their existing setup could accommodate the roles of coordinating, regulating, knowledge management and dissemination services, providing advantages in improving efficiency. However, at present, they are mostly geared toward delivery of coursework rather than research activities. There may also be conflicts with regard to national research priorities and the University's research priorities since the university runs on a business model designed to achieve their goals.

3. National Research Foundation as a semi-autonomous unit within Maldives National University

The Department of Higher Education proposes to develop the National Research Foundation as a semi-autonomous and self supporting research institute within the Maldives National University. Their roles would be similar to those described above. In addition, the international research aid could be coordinated by the NRF, rather than Ministry of Foreign Affairs.

3.2.3 Managing knowledge and accessing information

Approach

One of the biggest challenges and issues in progressing research activities identified during the consultations is the lack of access to existing data and research work. There were complaints of data being held up in pockets in individual departments with no access to outside agencies, let alone private sector, research institutions or students. There is also duplication of data collection activities resulting in duplicate costs. A number of reports published under various projects are reportedly unavailable beyond the implementing agency.

The approach proposed in this strategy is, as a first step towards facilitating research, to establish a mechanism whereby existing and new data and information could be shared for research purposes. There are two options. First, the information itself can be physically distributed in various locations but a single catalogue located in the research coordinating institution will provide the details and methods of access to the data. Second, the information can be digitally or physically pooled together into the coordinating institution and made available for research activities. Any research conducted thereafter will be mandated to submit a copy of the research to the main repository.

Objectives

The objectives of managing knowledge and accessing information are to facilitate research, avoid duplicate data collection, collaboration in data collation and reduce costs for collection and management.

The expected outcome is a state-of-the-art knowledge management system which will facilitate climate change research.

Existing activities

There are a number of ongoing activities designed to create data collections. Some of these are summarized below:

- National Geographic Information System (NGIS): A GIS system is being designed to be made accessible Government wide for storage, retrieval and undertaking spatial analyses. The information that can be stored in this system is strongly associated with spatial data.
- Department of National Planning (DNP) statistical database: DNP is the agency responsible for collecting statistical data of the Maldives. They currently have digital and printed publications. They are the Government agency responsible for archiving and publishing socio-economic data.
- Thesis collections by Department of Higher Education: Attempts at collecting theses of students who have completed graduate studies are ongoing but with limited success. The objective of this programme is to provide access to research students with studies on Maldives.
- Thesis collections by National Library: A similar attempt has been undertaken by the National Library but again with limited success.
- The ICCRRIP Project: The project is planning to consolidate research data into a single web portal to be made accessible for research use.

Options

1. The proposed Climate Change Centre will establish the knowledge management system
2. The Ministry of Environment and Housing, under its ICCRRIP Project will implement the climate change knowledge portal
3. The National Library in collaboration with the Maldives National University library will jointly serve as the knowledge base with public access.
4. The existing data distribution systems like the NGIS will be used for knowledge management.

3.2.4 Developing Capacity

Approach

Lack of capacity was identified as a key limitation in the agencies designated for conducting research. Human resource development has been the catalyst for resolving many of the capacity issues in the past. This strategy recognizes the need to continue in investing in human resource development in order to facilitate research activities at a local level, especially in the agencies designated for research.

Objectives

The objectives of developing capacity are to facilitate locally relevant research, increase the quantity of local research and improve the quality of research.

The expected outcome is the proper functioning of research institutions in Maldives and publication of locally relevant research.

Options

1. Develop the skills for critical thinking at the school level by incorporating them in the curriculum of existing subjects.
2. Develop research skills and research enthusiasm at the school level.
3. Increase funding for human resource development in the existing research agencies to bring them to a functional level.
4. Facilitate national level research capacity development through various skills developments programmes
5. Acknowledge significant research contributions at the national level through awards and recognition schemes.
6. Cultivate scientific and critical thinking skills from primary level onwards. Revise and update the science curriculum to accommodate this approach.

3.2.5 Underpinning regulatory framework

Statement of need

There are hindrances to the facilitation of research in Maldives which may have to be adjusted through new regulatory requirements. Issues in data sharing, copyrights, research ethics and publications require some level of legal backing to attract researchers and sustain it through a business model. Resolving data sharing issues are particularly important at the Government level as identified during the consultations (see Appendix 1). It is also essential in establishing a critical mass of information to advance the climate change field. The current intellectual copyright law in Maldives is very new and a culture of understanding the importance of honoring copyright needs to be established. The current copyright laws also need to be expanded to include areas such as industrial copyrights for new inventions. At present there are no national ethical guidelines to conduct research in Maldives.

Approach

Rapid introduction regulatory controls without proper functioning of the research activities may be meaningless. It is proposed to introduce regulatory controls over time as the need arises. Immediate requirements such as copyrights and data access facilitation could be progressed immediately.

Objective

The objective of the regulatory controls are to facilitate research activities by providing more guarantees for data sharing and copyrights, and establish standards for conducting research and collecting data .

Options

Legislation covering the following aspects is suggested based on the consultations

- Coordinating research activities through compulsory research authorizations by a central institution
- Data sharing and data publication standards for all research conducted with authorizations.
- Submission of final research output where research was conducted in Maldives – this is to facilitate knowledge management.
- Regulatory controls to ensuring ethical issues are addressed to specific standard.
- Provide more guarantees by strengthening research related intellectual copyrights.
- Mandating international research partnership agreements with Government of Maldives to include “value added” component for developing research activities in the Maldives.
- Provisions for a task force with international membership within National Research Foundation to establish and oversee a code of conduct for research activities.

3.3 Linking decision makers and facilitating change

Statement of need

It is essential that an ongoing dialogue exists between researchers and policy makers or developers so that decisions by each party are aligned and address the challenges and opportunities of climate change. In addition, knowledge produced by researchers needs to be conveyed to the public and private decision makers to ensure that climate change knowledge is incorporated into development activities and policies.

At present, the interactions between researchers and decision makers are very limited. Moreover, research publications are very rarely used to guide public and private decisions. There is a major gap between the two and is visibly hindering the facilitation of change. The longer the issue goes unaddressed, the higher the chances of decisions contrary to the best interest of climate change management are undertaken at the private and national level.

Approach

The approach proposed in this research strategy is to gradually bridge the gap between decision makers and researchers or research publications. It would be difficult to enforce links between the two in short timeframe since it requires a culture of research appreciation and usage for the process to be effective.

Objectives

The objective of linking decision makers and facilitating change is to ensure that policy and investment decisions are taken with the full benefit of scientific knowledge on climate change and ways to manage and live with the change.

The expected outcome is that policy decisions, community activities and private sector investment decisions are taken with the backing of scientific knowledge on climate change.

Options

1. The agency responsible for coordinating climate change research will hold regular or periodic seminars and forums for decision makers and technical staff to convey the latest relevant research findings.
2. Provide access to research publications through physical mails or through internet based mailing lists.
3. Provide regular forums for researchers and students to present their theses or research papers. There are a number of students who have completed research work but has published on conveyed the findings of the research to the public.
4. A periodic television programme or radio programme dedicated to conveying latest research project could be useful to disseminate information to island communities.
5. Advocacy of critical findings related to climate change to decision makers, both at the national and local government level.
6. Establish a process to gradually revise and strengthen the key regulatory environmental checks such as the Environment Impact Assessment (EIA) to include climate change impact analysis for each project.

4. CONCLUSIONS

Climate change poses a unique challenge for a country like Maldives which is already riddled with planning and development complications due to its physical and socio-economic setup. The Maldives is predicted to be one of the first countries to become uninhabitable due to climate change. The nature of climate change and its impacts require planners and decision makers to rely on scientific projections and analyses across numerous fields such as physical science, economics, social science and engineering, to name a few. Furthermore research findings needs to be specific to a given local setting. The scientific research and development planning processes in Maldives, at present, is not geared towards a coherent approach towards understanding and living with climate change. Hence, the Maldives needs to organize itself and prepare to strategically approach building knowledge, enabling research and finding ways to link research with all key decisions taken on the future of Maldives.

This strategy is a major and critical first step to nationally coordinated research, development and timely dissemination of information that will lead to a holistic approach towards sustainable development in high climate risk nation. There is a high level political will in the Maldives towards mainstreaming climate change into development and it is essential they continue to support strategic approaches to facilitate a change for the future. There have been a number of activities and plans in the past, like the proposal National Research Foundation, which needs to be realized in order to systematically plan towards national research activities.

In managing climate change, it is important that the Maldives take into account the inter-relationships between building knowledge, enabling research and linking decisions makers to facilitate change. The national research priorities identified in this strategy are flexible enough to accommodate a wide range of key research areas. The five broad priority research themes for the next 10 years are:

1. Understanding climate change
2. Understanding implication of climate change
3. Becoming carbon neutral – managing emissions
4. Living with climate change – towards climate resilient islands
5. Understanding how we can communicate risks

Concurrently a number of improvements need to be made to enable research including defining short- and long-term funding, establish institutional setups, establish mechanisms and systems to manage knowledge, build capacity and streamline regulatory framework. Among these, the establishment of a proper institutional setup and knowledge management system is of utmost importance. In addition, the knowledge gained will have to be efficiently and effectively disseminated to decision makers and planners to have the desired beneficial effects on living with climate change in the Maldives.

Climate change is impacting on the Maldives.
The Government agencies and organizations with responsibilities and interests need to act on this research strategy to ensure that all stakeholders are best equipped to manage the opportunities and challenges associated with climate change.

REFERENCES

CHURCH, J. A., GREGORY, J. M., HUYBRECHTS, P., KUHN, M., LAMBECK, K., NHUAN, M. T., D. QIN, P. L. W., ANISIMOV, O. A., BRYAN, F. O., CAZENAVE, A., DIXON, K. W., FITZHARRIS, B. B., FLATO, G. M., GANOPOLSKI, A., GORNITZ, V., LOWE, J. A., NODA, A., OBERHUBER, J. M., O'FARRELL, S. P., OHMURA, A., OPPENHEIMER, M., PELTIER, W. R., RAPER, S. C. B., RITZ, C., RUSSELL, G. L., SCHLOSSER, E., SHUM, C. K., STOCKER, T. F., STOUFFER, R. J., WAL, R. S. W. V. D., VOSS, R., WIEBE, E. C., WILD, M., WINGHAM, D. J. & ZWALLY, H. J. 2001. Changes in Sea Level. In: HOUGHTON, J. T., DING, Y., GRIGGS, D. J., NOGUER, M., LINDEN, P. J. V. D., DAI, X., MASKELL, K. & JOHNSON, C. A. (eds.) Climate Change 2001: The Scientific Basis, Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

GIORGI, F. & FRANCISCO, R. 2000. Uncertainties in regional climate change prediction: a regional analysis of ensemble simulations with HadCM2 coupled AOGCM. Climate Dynamics, 16, 169-182.

HAY, J. E. 2006. Climate Risk Profile for the Maldives. Male', Maldives: Ministry of Environment Energy and Water.

HOEGH-GULDBERG, O., MUMBY, P. J., HOOTEN, A. J., STENECK, R. S., GREENFIELD, P., GOMEZ, E., HARVELL, C. D., SALE, P. F., EDWARDS, A. J., CALDEIRA, K., KNOWLTON, N., EAKIN, C. M., IGLESIAS-PRIETO, R., MUTHIGA, N., BRADBURY, R. H., DUBI, A. & HATZIOLOS, M. E. 2007. Coral Reefs Under Rapid Climate Change and Ocean Acidification. Science, 318.

IPCC 2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment. Report of the Intergovernmental Panel on Climate Change. In: SOLOMON, S., QIN, D., MANNING, M., CHEN, Z., MARQUIS, M., AVERYT, K. B., TIGNOR, M. & MILLE, H. L. (eds.). Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

KENCH, P. S., MCLEAN, R. F. & NICHOL, S. L. 2005. New model of reef-island evolution: Maldives, Indian Ocean. Geology, 33, 145-148.

KHAN, T. M. A., QUADIR, D. A., MURTY, T. S., KABIR, A., AKTAR, F. & SARKAR, M. A. 2002. Relative Sea Level Changes in Maldives and Vulnerability of Land Due to abnormal Coastal Inundation. Marine Geodesy, 25, 133–143.

KITOH, A., YUKIMOTO, S., NODA, A. & MOTOI, T. 1997. Simulated changes in the Asian summer monsoon at times of increased atmospheric CO2. Journal of Meteorological Society of Japan, 75, 1019-1031.

LAMB, S. 2005. Global Warming: Paradise (Soon to be) Lost. Spiegel Online.

LEAN, G. 2006. Disappearing world: Global warming claims tropical island. The Independent.

MINISTRY OF HOME AFFAIRS HOUSING AND ENVIRONMENT 2001. First National Communication of Maldives to the UNFCC. Male: Ministry of Home Affairs Housing and Environment.

MORNER, N.-A. 2004. The Maldives project: a future free from sea-level flooding. Contemporary South Asia, 13, 149-155.

MORNER, N.-A., TOOLEY, M. & POSSNERT, G. 2004. New perspectives for the future of the Maldives. Global and Planetary Change, 40, 177-182.

SINGH, O. P., KHAN, T. M. A., AKTAR, F. & SARKER, M. A. 2001. Recent Sea Level and Sea Surface Temperature Changes Along the Maldives Coast. Marine Geodesy, 24, 209–218.

UNDP 2006. Developing a Disaster Risk Profile for Maldives, Male', United Nations Development Programme and Government of Maldives.

UNDP 2009a. A review of the safer islands programme and cost-benefit study of mitigation and adaptation measures in three islands of Maldives. Male': UNDP.

UNDP 2009b. Volume 3: Hithadhoo Island Report. Detailed Island Disaster Risk Assessment of Eleven Islands in Maldives. Male', Maldives: United Nations Development Programme.

WOODROFFE, C. D. 1993. Morphology and evolution of reef islands in the Maldives. Proceedings of the 7th International Coral Reef Symposium, 1992. Guam: University of Guam Marine Laboratory.

ZAHIR, H., CLARK, S., AJLA, R. & SALEEM, M. 2002. Spatial and Temporal Patterns of Coral Recruitment Following a Severe Bleaching Event in the Maldives. CORDIO.

Wilkinson C (2000) Status of Coral Reef of the World: 2000. Global Coral Reef Monitoring Network, AIMS, Australia 363 pp

UNEP-WCMC (2006) In the front line: shoreline protection and other ecosystem services from mangroves and coral reefs. UNEPWCMC, Cambridge, UK 33 pp

Appendices

Appendix 1 – Summary of one-to-one discussions with selected stakeholders

Appendix 2 – Key findings from national consultations

Appendix 3 – Key findings from policy level discussions

Appendix 4 - Review of existing laws, regulations, guidelines, policies and activities

Appendix 5 – Questionnaire used for stakeholder meetings

Appendix 6 – A partial bibliography of climate change studies on Maldives

APPENDIX 1 – SUMMARY OF ONE-TO-ONE DISCUSSIONS WITH SELECTED STAKEHOLDERS

Ministry of Environment and Energy – Climate Section

- The climate section mainly uses published research information published at the international level.
- Uses research information to mainstream climate change at the national level through various technical and policy level meetings. Also uses existing knowledge for climate information advocacy. They are also involved in ensuring that climate change adaptation and mitigation recommendations are included in various Government funded projects.
- Research information also directly used for various awareness and training activities at national and island level.
- The main guiding document is the National Adaptation Programme of Action (NAPA).
- They do not undertake research themselves and do no not have in-house research capacity. However, they do outsource research activities. Some of the current activities are:
  - Climate change project
  - Climate mapping project
  - Climate change feasibility studies
  - Preparation of 2nd National Communication to UNFCCC
  - Cost-benefit analyses for climate adaptation
  - EU Trust Fund related activities, including scaling up of renewable energy project and energy sector investment plan.
- Their financial resources for acquiring published research are limited. Mainly uses free documents from Government and UN agencies.
- Difficulties in preparing in-house reports and awareness programmes due to lack of access to paid-publications.
- A climate change information portal is being developed in the Ministry under the ICCRRIP project. This portal will provide access to climate change related research information.
- Priority research areas are climate science and climate change impacts.

- Identified data sharing between different agencies as a serious issue as most agencies are unwilling to share their data.

Environment Protection Agency (EPA)

- At present they do not undertake major climate change research activities. In general, research activities have also been limited over the last few years due to a change in the mandates and research capacity.
- Climate change relevant data collected by EPA include:
  - Coastal change monitoring data
  - Monitoring data for sensitive terrestrial areas
  - Terrestrial vegetation cover – a specific project funded by Maldives Environment Management Project.
  - Monitoring data of sensitive marine areas
- Collected data are rarely analysed or researched in detail.
- Collaborative data collection activities are carried out with international institutions, particularly in the area of climate change observation. A climate change observatory is established in Hanimaadhoo which is involved in continuous data collection.
- Issues in conducting research are:
  - Lack of budget or financial resources
  - Lack of skilled human resources
  - Unavailability of time beyond the normal operations of EPA
- Priority research areas for EPA are:
  - Climate science – Sea level rise, local climate modeling etc..
  - Impacts of coastal engineering practices on islands and future climate change impacts
  - Determining cost effective and appropriate mitigation measures.

Department of Meteorology (DoM)

- DoM does have a mandate to undertake climate related research activity
- Their activities are at present limited due to lack of staff, funding and equipment. They are only able to undertake day-to-day meteorological observation and interpretation tasks. At present, there is no specific funding for research activities and every year their proposed research budget gets slashed by the Ministry of Finance.
- They currently have a collaboration programme with SAARC meteorological Research Centre in Bangladesh. This is an alternative source of funding but their research is at a more regional level. There also other occasional multinational collaborations for regional level research.
- They are also involved in the Indo-Ex Research programme but little data is received locally at present. The Hanimaadhoo Observatory data is available to DoM on request.
- DoM identified issues in sharing data. At present it is supplied free of charge, but with no copyright controls there are risks associated with such sharing. They would like to see a more financially sustainable model of data collection and sharing especially since the equipment used for data collection is very expensive and needs maintenance. There also need to be a data transfer standard.
- There are no planned research programmes for the next few years.
- At present some data are shared only upon request due the cost and time involved in processing and sharing.
- Their priority research needs are:
  - Advancing climate science at a local level
    - Long term predictions
    - Climate impact studies
    - Climate risk assessments – droughts, swell waves etc..
    - Sea level rise
    - Reducing global climate models to a local level
  - Data collection is also a priority including climate variables, oceanographic parameters and trans-boundary pollution.
- In their present condition, they are unable to contribute to climate science research and will need a commitment from the Government to develop DoM as a key climate research centre.
- Identified data sharing between different agencies as a serious issue as most agencies are unwilling to share their data.

President's Office (PO)

- They do not undertake any research activities but uses new findings in climate change research for policy development.
- The PO is in a position to observe all international interactions relating to climate change activities.
- Some of the new international developments in the Maldives in relation climate change are:
  - Establishment of Marine research facility as a Biccoca-Milano University outpost in Faafu Atoll
  - Establishment of a Madanjeeth Climate Change Foundation.
  - An interest by the University of Scotland to undertake ongoing marine assessments in the Maldives.
  - A number of international energy companies have

signed MoUs with Utilities companies including Suzlon in Addu Atoll, Ganesha in Thaa/Laamu Atoll, and Star Group in Gaafu Dhaalu Atoll.

  - Studies by Mr. Mike Mason in Maalhos Island.
  - Carbon Audits and Carbon Neutral Plan is being prepared by Be-Citizen.
  - Oxford University is interested in research collaborations in Maldives.
  - Iceland University has expressed interests in undertaking renewable energy studies.
  - The Maldivian Government in association with UNDP is discussing to develop a Climate Change Centre for Low Carbon Adaptation.
- Their immediate research priorities are practical actions that could be taken for adaptation and becoming carbon neutral.

Ministry of Environment and Energy – Land Use Planning Section

- They do not undertake any research activities but uses new findings in climate change research for policy development. New findings reach to them via presentations from research related to specific projects and staff knowledge gained during undergraduate or graduate level.
- They have no plans to undertake in-house research in the future.
- Priority research areas are:
  - Research required to develop an robust land use planning guideline
  - Future climate risk reduction by adopting good development practices at present, such as land reclamation and harbor development. Research on land reclamation and harbor development impacts is needed immediately.
  - Understanding urban carrying capacity for island communities
  - Urban environment issues and mitigation measures
  - Climate and hazard risks
  - Urban health risks
  - Effects of sewerage systems and suggestion on best practices and most appropriate systems
- The focus at present is on getting enough research information to promote the resilient island policy
- They are more interested in tested practical research which provides them with proper planning options. Research reports themselves serve little purpose unless it is narrowed down to practically implementable options.
- Identified data sharing between different agencies as a serious issue as most agencies are unwilling to share their data.

Ministry of Fisheries and Agriculture

- Most of the research work is carried out by MRC.
- Specific research is also undertaken by Fisheries Management Authority (FMA)
- Main research areas tuna fishery, bait fishery, reef fishery and marine resources in general.
- FMA mainly interested in economic assessments such as shark fishery alternatives and costs and earnings surveys
- They collect fisheries statistics and publish them regularly.
- There is a heavy reliance on international research and publications especially for tuna fisheries.
- Identified data sharing between different agencies as a serious issue as most agencies are unwilling to share their data.
- Priority research areas:
  - Bait and tuna fisheries
  - Aqua culture
  - Fish aggregating devises for tuna and bait fishery
  - Mariculture - mainly for bait fishery
  - Economic assessments of fishing changes and alternative marine resource extraction activities
- There are some general issues in promoting research
  - Research is not a priority in the Maldives, particularly at a political level.
  - Research activity itself is too commercialized so some key priority areas are being missed
  - Failure to retain Bodumohorra as a research outpost is a set back
  - The MRC may be dismantled in the future and their tasks transferred to the University. There is a fear that research priority will shift to more academic needs rather than practical and focused knowledge we are seeking.

State Electric Company - STELCO

- They do not undertake any research activities but are currently involved in projects where partner energy firms are undertaking renewable energy research. These mainly include wind and solar energy.

- There is a major deficiency in Maldives related to the renewable energy sector information and baseline data. New investors have to start studying from scratch.
- Research priority is mainly on starting data collection at various location across Maldives to gather information wave, wind and solar conditions.
- Research on renewable energy options and their cost-effectiveness at local island level is also essential.

Villa College

- Villa College has plans to begin the marine research centre in Sun Island Resort soon, but it's a plan in progress. They intend to undertake coral reef studies in the centre both in-house and with collaborations from international institutions.

Department of Higher Education

- Discussions were held specifically regarding thesis collection programme.
- The department conducted a theses collection programme from Maldivian students who had studied from abroad. The purpose if this project was to create a theses collection which could be accessed by students undertaking graduate studies.
- The programme has been unsuccessful so far but there are plans to renew the effort.

The National Library

- Discussions were held specifically regarding thesis collection programme.
- The library also conducted a theses collection programme from Maldivian students who had studied from abroad. The purpose if this project was to create a theses collection which could be accessed by students undertaking graduate studies and the general public.
- The response rate for the request for theses submission was low and the programme has been shelved for the moment.

APPENDIX 2 – STAKEHOLDER WORKSHOP – TECHNICAL LEVEL

List of Participants

1. Mr. Abdul Muhsin, Director, Maldives Meteorological Services
2. Ms. Jimzeena Musthafa, Environment Analyst, Ministry of Tourism, Arts and Culture
3. Ms. Salfiyya Anwar, Deputy Director, Hulhumale' Development Cooperation
4. Mohamed Anil, Research Officer, SAARC Centre
5. Mohamed Nishan, Engineer, Ministry of Environment and Energy
6. Amir Musthafa, Assistant Environmental Engineer, Ministry of Environment and Energy
7. Mohamed Muthalib, Senior Research Officer, Ministry of Fisheries and Agriculture
8. Ibrahim Mohamed, Assistant Research Officer, Ministry of Fisheries and Agriculture
9. Ibrahim Mohamed, Assistant Research Officer, Ministry of Foreign Affairs
10. Ali Shareef, Assistant Director, Ministry of Environment and Energy
11. Mohamed Inaz, Assistant Research Representative, UNDP
12. Ahmed Iyaz, Senior Surveying Officer, MTCC
13. Aishath Niyaz, Environmental Officer, Live and Learn Environmental Education
14. Ilham Mohamed, Environment Analyst, Ministry of Environment and Energy
15. Hassan Azhar, Environment Analyst, Ministry of Environment and Energy
16. Miruza Mohamed, Assistant Director, Ministry of Environment and Energy
17. Hussain Naeem, Technical Officer, ICCRRIP
18. Fathuhulla Siyaad, Director, Ministry of Environment and Energy
19. Hussain Zahir, Director, Lamer Group Pvt Ltd
20. Moosa Athfal, Environmental Analyst, Seamarc Pvt Ltd
21. Abdulla Thasleem, Executive, MTCC
22. Musthag, Senior Computer Programmer, Department of National Planning
23. Ibrahim Naeem, Director, EPA
24. Moosa Waheedh, S.P.Director, NDMC
25. Moosa Zameer Hassan, Deputy Director General, Ministry of Tourism

APPENDIX 3 - STAKEHOLDER WORKSHOP – POLICY LEVEL

List of Participants

1. Shaheema Abdul Sathar, Marine Research Center
2. Ali Shareef, Maldives MET Services
3. Farooq Mohamed Hassan, Ministry of Home Affairs
4. Mohamed Imad, Department of National Planning
5. Aminath Shaufa, CCHDC
6. Ilham Mohamed, Ministry of Environment and Energy
7. Mohamed Inaz, UNDP
8. Wadeefa Thaufeeq, Faculty of Education
9. Mareer Mohamed Husny, Ministry of Environment and Energy
10. Ibrahim Naeem, EPA
11. Sugene Ramuharan, Maldives National University

Summary of Main Discussion Points

Discussion on the national climate change research priorities

1. In general, there was agreement over the priority areas proposed in the document. In addition the following comments were made.
2. Mr. Faroog, Minister of State for Home Affairs commented on the lack of health related research proposed in the research strategy. The consultant explained that it is broadly covered under the 'understanding climate impacts' and 'living with climate change' research themes. It was agreed to explicitly state health related research sub-themes into the document.
3. Ms. Athifa from the Housing Ministry commented on the inclusion of practical research as a research priority. She commented that planners need to know well researched sustainable practices to mainstream them into planning activities. She commented that the present CC strategy does not capture this aspect thoroughly. It was agreed to include this aspect as a sub theme.

Discussion on strategies for enabling research

1. The general categorization of research facilitation themes into funding, institutional arrangements, knowledge management and regulatory requirements were accepted. There was and additional proposal to consider capacity building as a theme.
2. Mr. Faroog from Ministry of Home Affairs noted the existing regulatory frameworks and policies needs to be discussed in the document as per the Terms of the Reference of the project. It was agreed with the project management team that the regulations would be added as a appendix. The consultant explained that there are no specific regulations for research but that there are policies in place which are related to research.
3. Mr. Faroog also advised to have an extensive look at the Science and Technology Master Plan (STMP) prepared by the previous administration. He noted that the document contains a lot of the elements being proposed in the Climate Change Research Strategy, particularly in the 'enabling research' section. He specifically highlighted the national research fund and institutional frameworks as strongly relevant. He reiterated the need to place the CC research strategy in the context of a broader national level research strategy. For example the fact that the CC research strategy identifies 0.5% of the national budget for research activities is in conflict with STMP's suggested 1% of the national budget for research. The consultant noted that since the Government changed in 2008, the STMP was shelved, and none of the people consultant recommended using the document as a basis. However, it was agreed to acknowledge the existence of the document and explain the key aspects of the plan in the proposed CC strategy.
4. Ms. Athifa is of the view that the main organization proposed for research activity should not be located under a single Ministry since Ministries could be dissolved or reassigned depending on policy shifts.
5. Mr. Inaz from UNDP noted that a CC strategy should look beyond the local aspects and include aspects such as aid coordination and international level resource mobilization. This may therefore need to include the roles of the Foreign Ministry and Aid Coordination Committee to channel research activity funding in Maldives. This aspect is not covered in the CC research Strategy.
6. Mr. Inaz also recommended expanding more on the pros and cons of various options proposed for 'enabling research' in the document. The consultants noted that all aspects related to enabling research can only be specified by the Government and political commitment will be needed to make it work. The consultants agreed to include explanations and recommendations for the options suggested in the strategy.
7. Mr. Eugene from the Maldives National University highlighted that the document has missed upon a key element – developing capacity to conduct research, particularly human development. He also noted that there is a need to improve the observational capacities and establish a knowledge seeking society right from the school age before we can expect to conduct research and use research information for everyday planning and decision making. He suggested using the pressure-state-response model to seek the pressures for research activities and establish appropriate response to those pressures, rather than the current state.

8. Mr. Inaz also commented in the term carbon neutral as being inappropriate a for 10 year strategy as the policy might change. He suggested keeping it relevant over time by using terms like emissions reduction. However, the consultant noted that this document needs to be owned by the Agencies and the present government for it to be effective. The document could be changed over time to reflect the terminologies used by then existing Government, but the fundamental basis of research priority areas could remain the same.

Discussion on linking research with development

1. The existing options were accepted.
2. There were suggestions to include research aspects into every development project, which could include delivery of monitoring data or contribution to a research fund or activity.
3. Ms Athifa also emphasized the need for focus on advocacy decision makers, more so than the technical groups, because it is ultimately the decision makers who have the final say on any plans or fund allocations.

General discussions points

1. The participants were generally disappointed with the lack of political commitment on the project since no political level members were present in this critical meeting. There was a general fear that this strategy may end up on paper like the National Research Foundation report.

APPENDIX 4 - REVIEW OF EXISTING LAWS, REGULATIONS, GUIDELINES, POLICIES AND ACTIVITIES

This section summarizes the finding from the review of existing literature, regulations, guidelines, policies and activities related to general research and climate change research in the Maldives.

Laws

There are no specific laws designed to facilitate national level research across various fields. The only laws which explicitly facilitate and regulate research activity the Fisheries Act 5/87 and the Maldives National University Act 3/2011. Fisheries Act is mainly concerned with regulating and coordinating marine resource related research, particularly fisheries related research. The University act mainly defines the provisions for conducting research as an academic activity within the context of university development.

The key laws that facilitate research activities are summarized below.

1. Fisheries law 5/87

The Fisheries Law is generally concerned with regulating marine resources of Maldives. However, the following articles provide explicit provisions for conducting, coordinating and regulating marine research activities in the Maldives.

a. Article 4: Provides a mandate to the Ministry of Fisheries to conduct research related to fisheries and collect statistical data from all parties involved in fishing activities.
b. Article 9: All fisheries related research has to be coordinated and regulated by Ministry of Fisheries, including approvals and collection of research reported.

2. The Maldives National University Act 3/2011

The Maldives National University Act was formed to establish and, define the purpose, responsibilities and mandates of the University. There are a number of articles in the law which establishes provisions for conducting, publishing and, use of research activities and findings for commercial purposes. However, there is no clause which mandates the University to coordinate or undertake national level research important to the Maldives.

The objectives of the University have specific provisions to undertake research activities. These include:

a. Article 4(b)(iii) Undertake scientific research and publish research information by relevant means to facilitate knowledge dissemination.
b. Article 4(b)(v) Establish links and collaborations with other international educational Institutions.

The powers assigned to the university in Article 5 include:

a. Conduct research
b. Conduct research activities using a commercial model, which includes providing research services and selling copyrights for research data and inventions.
c. Fund research activities

The powers assigned to raise and spend financial resources under Articles 36 to 39 include:

a. Raise financial resources for University activities both through the Government and private sector.

b. Spend financial resources to achieve the objectives of the University, including funding research activities.

3. The Environmental Protection and Preservation Act 4/93

The Environment Act does not have specific provisions or links to research activity. However, regulations issued for EIA does have some provisions for acquiring research data and information (see next section).

4. Land Law 20/98

Similar to the Environment Act, the land law has no direct articles to facilitate research. However, it provides provision for lease of islands for research related activities. Such leases do not require a bidding process as required for other leases (see regulations section below).

Regulations and Guidelines

There are clear regulations and procedures to undertake research activities related to marine resources and socio-economic statistical surveys. The marine research activities cover a broad range of research activities from coral reef, fish and aquaculture. The Statistical Regulation of Maldives covers a broad range of surveys and research activities but is mainly geared towards regulating socio-economic data collection, usage and publication.

1. Fisheries Regulation

The fisheries regulation explicitly defines clauses to regulate and manage marine research activities in the Maldives. The Section 8 of the regulation identifies list of requirements for conducting research in natural and physical science fields related to the marine environment. The relevant clauses of section 8 could be summarized as follows:

a. All parties wishing to conduct research must submit an application form to the Ministry to get approval. The form specifies a number of information relating to the project.

b. The parties submitting the proposal shall be acceptable to the Government of Maldives.

c. The Ministry of fisheries will consult other agencies such as Ministry of Defence, and Ministry of Home Affairs before making a decision.

d. Specifications and guidelines for sampling are provided in the regulation.

e. There are provisions to submit a copy of the report for knowledge management purposes. If the party has not supplied the document, they will not be eligible for approval for future research activities.

2. Aquaculture Regulation

The aqua culture regulation is currently in its draft form. The purpose of this regulation is to regulate and monitor the aquaculture development and research activities in the Maldives. Part III of the regulation specifies the procedures for conducting aquaculture research including application procedures, evaluation and inspection procedures before a research project can be commissioned.

3. Statistical Regulation of the Maldives

This Regulation defines and regulates all activities related to collection, compilation, publication and utilization of statistical data. This included both qualitative and quantitative methods of data collection. Although, the regulation does not explicitly state it, this regulation is mostly applicable for social and economic surveys involving interviews or interactions with the public. In practice, other scientific surveys for example in physical and biological sciences are generally not considered as requiring permission under the Statistical Regulation.

a. The agency responsible for implementing this regulation is the Department of National Planning (DNP).

b. The purpose of this regulation is to standardize the data collection, compilation, publication and utilization of statistical data in the Maldives. In addition, this regulation is meant to ensure the confidentiality of information, minimize respondent burden and avoid overlap of data collection operations

c. The method of data collection, material used in the collection and timing should all be approved by DNP.

d. DNP maintains a registrar of surveys to minimize overlaps and duplicate data collection activities, especially those undertaken by Government Agencies.

e. Statistics included in the national level data Statistical data collection list can only be collected by DNP or parties designated by DNP.

f. The regulations also define methods of compilation, use, publication and maintaining confidentially of the information.

4. EIA regulation 2007

The EIA regulation, in itself, does not have clauses to regulate research activities. However, there is a provision which mandates the collection of monitoring data and preparation of periodic monitoring reports as part of the EIA process. The monitoring activities can include aspects related to environmental change and climate change if needed. At present, components such as coastal changes and emissions measurements requirements, which are embedded in the monitoring programmes prescribed in the decision note, mandates the provision of periodic research and monitoring information

5. Regulation on leasing islands

The new draft guidelines for leasing uninhabited island have provisions for leasing islands specifically for research related activities. The draft as well as the old guideline has special provisions for leasing islands for research without requiring bidding. Applications for lease have to be lodged to the Ministry of Fisheries and Agriculture but the decision on the project is made by the National Planning Council (NPC) housed in DNP, and the final approval for leasing an island is made by the cabinet.

General Guidelines and Procedures

a. Explicit guidelines to undertake research activity can only be found for marine research activities issued by Marine Research Centre and for statistical surveys issued by Department of National Planning.

b. At present, the National Planning Council approves all development projects including projects which have a major research component embedded in a development project. The NPS also gives the preliminary approval for allocating an island for a proposed research activity. An application, along with a project proposal based on a defined template, needs to be submitted to the Department of National Planning before a project can be approved.

c. The Cabinet gives the final approval for allocation of uninhabited islands for any activity, including research activity. Submissions to the Cabinet are made through NPC and line Ministries.

Policies and Guiding Documents

1. "Aneh Dhivehi Raajje" The Strategic Action Plan (SAP) – National Framework for Development 2009 -2013

The strategic action plan is the main guiding document for the Government policies proposed for the period of 2009 to 2013.

The document highlights research needs and options for facilitating research in a number of key sectors but it does not identify an initiative to manage or coordinate research at the national level. Research activities, relevant capacity building and institutional strengthening strategies have been proposed for sectors like health, drug prevention, protection of Islamic faith, strengthening judiciary; and economic sector development such as tourism, fisheries and agriculture, environment, science and technology, disaster risk reduction and energy.

Climate change related research activities, capacity building and institutional strengthening have been proposed for energy, environment, disaster risk reduction, fisheries and agriculture. However, the key policies with direct relevance to a Climate Change Research Strategy (NRS) are coastal erosion mitigation, carbon neutral and the resilient island policies. Together they encompass the major planning initiatives and climate related policies. The proposed research strategy addresses these strategic policies by having a framework that incorporates all these aspects. The key research priorities in the SAP are covered in the broad categories defined in the NRS. The facilitation of research is less clear due to some conflicting institutional setups proposed in the SAP. A key institution proposed for coordinating research and development activities is the Science Foundation, which is yet to be formed. There is a strong focus in the SAP towards information dissemination and incorporating research information, particularly on disaster risk and coastal erosion, into planning process.

The policies and strategies with direct bearings on a CC research strategy include the following:

- Environment Sector - Policy 4: Strengthen adaptation and mitigation responses for beach erosion and develop a system to assist communities where livelihood and property are affected by beach erosion.
  - Develop and introduce guidelines for coastal modification to prevent erosion
  - Implement measures for erosion control in severely affected islands
  - Establish a financing mechanism for beach erosion and coastal protection
  - Protection of settlements by coastal protection measures on selected islands
  - Conduct further research into viable alternative protection measures with a greater appreciation of more cost effective softer measures
  - Establish a climate research body or intensify Maldives Meteorological Services (MMS) with a specific mandate to gather weather data, and model climate impacts for the Maldives
  - Develop guidelines for settlement planning for, inter alia, building codes, land reclamation, harbour development, and land use, to ensure that any development is sustainable and resilient to climate change
- Environment Sector - Policy 5: Strengthen technical, financial and human resources capacity for water and sanitation sector
  - Establish mechanisms to conduct research on wastewater disposal technologies and assess the

health and environmental impacts of using treated wastewater for different purposes, including recharging aquifers

- Energy Sector - Policy 2: Achieve carbon neutrality by the Year 2020
  - Develop plans for the energy sector to include forecasts of energy usage by different sources, GHG emissions and status of carbon neutrality.
  - Promote carbon capture and sequestration (CCS) by conducting research and development of CCS projects necessary for the reduction of GHG emissions
- Energy Sector - Policy 3: Promote energy conservation and energy efficiency to reduce costs
  - Develop the capacity for research on energy production, distribution and usage via various training programs
  - Develop resources necessary to carry out energy efficiency audits and designs and certification mechanism for energy efficient buildings
- Energy Sector - Policy 5: Promote Renewable Energy Technologies
  - Facilitate and promote research opportunities for locals and international parties by informing about the potential RE resources within the country
  - Develop human resource capacity for RE throughout the country by introducing RE - related courses into the national college system
  - Conduct R&D and technology transfer program for innovative Ideas
- Communication, Science and Technology - Policy 6: Foster, promote and sustain the development and coordination of science and technology relevant to the needs and circumstances of the country
  - Formulate a National Development Program in accordance with present developments in science and technology
  - Establish a Science Foundation that will coordinate nationwide research and development programmes and activities
  - Enlist the participation of the private sector in developing science and technology in the country
  - Establish an environment conducive to research and encourage scientific research in the country and by Maldivians abroad
- Disaster Risk Management - Policy 2: Make Maldivians safe and secure from natural disasters through information, monitoring, dissemination and coordination of national early warning
  - Make available national and local risk assessments based on hazard data and vulnerability information including risk assessments for key sectors
  - Analyse social and institutional impacts of relevant hazards
  - Establish systems to monitor, archive and disseminate data on key hazards and vulnerabilities
  - Assess transboundary risks
- Disaster Risk Management - Policy 3: Use knowledge, innovation and education to build a culture of safety and resilience at all levels in the country.
  - Ensure availability of information on disasters at all levels, to all stakeholders (through networks, development of information sharing systems etc
  - Incorporate disaster risk reduction and recovery concepts and practices into the national curriculum and create education material
  - Develop and strengthen research methods and tools for multirisk assessments and cost benefit analysis
- Disaster Risk Management - Policy 4: Reduce the underlying risks to life and property from natural or man-made hazardous events.
  - Incorporate disaster risk reduction in environment related policies and plans, including for land use natural resource management and adaptation to climate change
  - Ensure social development policies address vulnerability of populations most at risk
  - Economic and productive sectoral policies and plans to incorporate the vulnerability of economic activities
  - Integrated disaster risk reduction measures into post disaster recovery and rehabilitation processes
  - Procedures in place to assess the disaster risk impacts of major development projects, especially infrastructure
- Disaster Risk Management - Policy 5: Strengthen disaster preparedness for effective response at all levels
  - Procedures to be in place to exchange relevant information during disasters and to undertake post-event reviews
- Disaster Risk Management - Policy 6: Integrate disaster risk reduction in climate change adaptation and vice versa

- Policy framework (NAPA, SNAP) for integration of DRR and CCA
- Institutional capacity building

- Fisheries - Policy 5: Promote research in fisheries and introduce fish breeding and productivity.
  - Facilitate/establish research centres/outposts in collaboration with foreign universities and research organizations

Other strategies and policies in the SAP relating to research could be summarized as below.

Affordable and Quality Health care for all

Policy 3: Build a competent, professional health service work force

Develop capacity of health professionals to engage in academic and research work, including establishing linkages and networks between tertiary hospitals and international institutions

Policy 4: Build a culture for evidence-based decision making within the health system

Develop local capacity for health research by health system development, development of laboratory facilities and strengthening capacity of FHS research training

Prevention of Narcotics Abuse and Trafficking

Policy 5: Enhance capacity and coordination among all stakeholders to address the various aspects of the problem

Compile and conduct research to enable appropriate and timely interventions

Good governance: Rule of Law and Justice

Policy 11: Strengthen academic institutions and create a public research unit to develop knowledge for informed development and conduct awareness programs.

Establish an information based research unit to identify shortcomings and weaknesses within the law enforcement agencies, legal sector and judiciary and give recommendations

Social Justice: Protection of Islamic Faith

Policy 2: Promote moderate Islam, tolerance and respect for diversity and cultural differences through information, education and communication.

Conduct research on socio-religious issues for timely and informed decision-making.

Social Justice: Strengthening Family Ties (Child & Family Protection)

Policy 1: Strengthen Child and Family Protection service delivery at central and provincial levels

Conduct research, evaluation and need analysis on child and family protection programs including the establishment of the National Resource Centre on Family and expanding of CFPS database to atolls

Policy 6: Establish a juvenile justice system and institutionalize its operations

Conduct research and evaluation on juvenile crime and justice

Social Justice: Information, Arts and Culture

Policy 2: Conserve linguistic heritage of Maldives

Research and document diverse dialects in the different regions of the country through text and electronic media

Facilitate linguistic research and dissemination

Policy 4: Develop cultural and archaeological heritage of the Maldives

Compile an inventory and national audit of the cultural and heritage sites and research their historical significance, and manage the sites in a manner that generates revenue from visitors

Increase the capacities and the facilities for research at the national Centre for Historic and Linguistic Research and affiliate the centre with the proposed university

Economic Development: Tourism

Policy 3: Develop and maintain supporting infrastructure required for the growth of the tourism industry

Establish a National Institute for Tourism Research and Development

Policy 4: Ensure environmental sustainability in development and operation of all tourism products, and strive for global excellence in environmentally-responsible tourism

Conduct health checks of reefs and marine protected areas in partnership with Marine Research, EPA and other stakeholders

Policy 5: Continue to brand Maldives as a unique destination with innovative products and retain Maldives positioning as a top ranking destination in traditional and emerging source markets

In partnership with National Centre for Linguistic and Historical Research conduct a national audit of cultural and heritage sites

Economic Development: Fisheries

Policy 5: Promote research in fisheries and introduce fish breeding and productivity.

Streamline and reorganize the Marine Research Center's research mandate

Establish and develop a fisheries research facility at Maniyafushi.

Identify alternative bait harvesting methods practiced elsewhere in the world and explore their applications in the Maldives

Introduce alternative data collection mechanisms to increase the validity of statistics

Economic Development: Agriculture

Policy 1: Strengthen commercial agriculture to reduce reliance on imported food and attain food security

Identification and introduction of new crops that can be grown and cultivated in the Maldives and develop a suitable irrigation management system through adaptive research and efficient extension networking

Policy 5: Strengthen the institutional capacity to support the growth of agricultural sector

Develop agricultural centres at regional levels with private sector participation, as dynamic resource centres for agrarian research, training, technology generation and dissemination

Affiliate with regional universities for capacity building for efficient agriculture training, research and extension

Economic Development: Energy

Policy 4: Increase national energy security by diversifying energy sources

Monitor the oil market and pricing issues in practice and evaluate the need for adopting regulation of the petroleum product prices

Policy 5: Promote Renewable Energy Technologies

Introduce and demonstrate new renewable energy technologies applications projects

Promote Renewable energy sources and its advantages to the public via mass media (TV, internet), various workshop and disseminate information to the public through a RE information center

Economic Development: Communication, Science and Technology

Policy 6: Foster, promote and sustain the development and coordination of science and technology relevant to the needs and circumstances of the country

Promote interest in science and technology among children

Facilitate the use of new technology to increase productivity, efficiency and more effective service delivery

2. National Adaptation Plan of Action (NAPA)

NAPA is one of the key guiding documents for climate change related projects, particularly adaptation projects. NAPA was developed to communicate the most urgent and immediate adaptation needs of the Maldives and was published in 2006.

The NAPA document was prepared through and extensive consultative process, which could be describes as an essentially bottom-up approach to adaptation planning.

The NAPA process identified over 50 adaptation strategies and 30 priority adaptation strategies. Most of the strategies were directed at enhancing physical adaptation and adaptive capacity. Most of these projects have some element of research involved in it but only a few were explicitly defined for research activities. The list of priority adaptation strategies are listed in order below and the strategies with explicit research elements are highlighted in bold.

1. Build capacity for coastal protection, coastal zone management and flood control.
2. Consolidate population and development.
3. Introduce new technologies to increase local food production
4. Acquire support for the speedy and efficient implementation of Safer Island Strategy.
5. Develop coastal protection for airports and development focus islands.
6. Integrate climate change adaptation into national disaster management framework.
7. Strengthen tourism institutions to coordinate climate response in the tourism sector.
8. Improve building designs to increase resilience and strengthen enforcement of building code.
9. Acquire appropriate sewage treatment and disposal technologies to protect water resources.
10. Incorporate climate change adaptation measures to upcoming resorts
11. Promote healthy lifestyles, healthy islands and healthy buildings.

12. Enhance the capacity for waste management to prevent pollution of marine environment.
13. Provide alternatives to coral and sand as construction materials and enforce the ban on coral mining.
14. Integrated reef fishery management.
15. Streamline the planning of healthcare services and strengthen medical emergency response.
16. Increase safe rainwater harvesting.
17. Develop measures to protect coral reefs from development activities
18. Undertake recharging of aquifers and other measures to reduce salinisation from saltwater intrusion and storm surge flooding.
19. Undertake research and disseminate information on climate change related diseases.
20. Strengthen the capacity for healthcare delivery.
21. Strengthen capacity for planning and design of ports, harbours and jetties.
22. Develop climate change adaptation policy and strategy for tourism.
23. Protect house reef to maintain natural defense of islands.
24. Protect and preserve natural water catchment areas.
25. Experiment new and alternative species and breeding methods for livebait.
26. Enforce and strengthen quarantine and integrated pest control to prevent pests and diseases.
27. Strengthen regulatory and institutional capacity for vector control.
28. Protect beaches and tourist infrastructure.
29. Review the marketing strategy of tourism to diversify the tourism product and reduce over-dependency on coral.
30. Acquire desalination technologies appropriate for small islands.

Based on these priorities 20 projects were proposed and prioritized for the short- to –medium term adaptation requirements. Almost all these project have objectives and proposed activities relevant to climate change science, impact, mitigation and communication research activities. The list of proposed projects with research components are as follows:

1. Strengthening coastal zone management in Maldives to enhance climate change resilience.
2. On-the-ground demonstration of safer islands and integration of future climate change scenarios in the safer island strategy to adapt to sea level rise and extreme weather risks associated with climate change.
3. Increase the resilience of local food production through enhancing the capacity of farmers, local communities and institutions to address food security issues caused by climate change and climate variability.
4. Coastal protection of airports and focus islands to reduce the risk from sea induced flooding and projected sea level rise.
5. Accumulate knowledge and communicate practical information to raise public awareness and increase political commitment to adapt to the health risks to the Maldivian population from climate change
6. Mainstreaming climate change adaptation into development planning and National Disaster Management Framework to accommodate adaptation measures in future development and disaster management plans.
7. Enabling adaptation of tourism businesses and tourism dependent communities to projected climate change and variability.
8. Improve resilience of Island communities to climate change and variability through sustainable building designs.
9. Enhance adaptive capacity to manage climate change related risks to water resources through increasing knowledge, strengthening regulatory framework and adoption of appropriate new technologies.
10. Promotion of health, creation of effective structures and implementation of policies and measures to reduce health vulnerability to climate change.
11. Accumulate knowledge and communicate practical information to raise public awareness and increase political commitment to adapt to the health risks to the Maldivian population from climate change.
12. Build the information base on vulnerability of reef fishery to the predicted impacts of climate change and variabilities to determine adaptation measures required for integrated reef fishery management.
13. Improve rainwater harvesting to secure availability of safe water and reduce vulnerability to changes in precipitation caused by climate change.
14. Increase resilience of coral reefs to reduce the vulnerability of islands, communities and reef dependant economic activities to projected climate change.
15. Improve the design and construction of access infrastructure in Maldives to increase the resilience of access infrastructure and island beaches to climate change.
16. Investigating alternative livebait management, catch, culture and holding techniques in the Maldives to reduce vulnerability of the tuna fishery sector to the projected climate change and variability.
17. Improve the health status of the population, particularly children, by the prevention and management of vector-borne diseases caused by changes in temperature and flooding due to extreme rainfall.

Since, the NAPA has come through an extensive process of community consultation, this Climate Change Research Strategy relied heavily on NAPA for establishing national research priorities, particularly adaptation research priorities.

3. First National Communication to the UNFCCC

The Maldives is a party to the United Nations Framework Convention on Climate Change (UNFCCC) and had signed and ratified the convention on 12th June 1992 and 28 October 1992 respectively. Maldives is required to submit periodic national communications to UNFCCC on the progress towards implementation of the convention.

The first national communication (FNC) includes an inventory of the GHG emissions and options for mitigating GHG emissions, an assessment on how climate change and associated sea level rise would affect various sectors of the nation and suggestions on possible adaptation options for the Maldives.

It addresses a key requirement in a convention which related to the research and systematic observation of climate change and its impacts. The FNC highlights the following research priorities:

- Understanding general climate change and sea level rise impacts on Maldives, particularly through extensive studies of oceanographic and meteorological parameters.
- Research to understand the process contributing to beach erosion in the Maldives and how to effectively manage such problems.
- Other research areas include the effect of climatic variation on fishery and affects of climate change on human health.

FNC report also highlights public awareness and education as an important requirement in the Maldives.

These aspects have been considered in the preparation of the National Research Strategy.

4. National Environment Action Plan 3 (NEAP III)

The NEAP 3 sets out the agenda for environmental protection and management in the Maldives for the five year period: 2008 – 2012. There are five strategic results targeted in NEAP 3: safer islands and communities; rich and resilient ecosystems; clean and healthy islands; safe water; and environmental stewardship.

The document provides the basis for environmental planning, budgeting, performance measurement, and accountability. Every year, annual performance targets and indicators are presented in the budget request made to the Parliament. The performance against these goals and targets are reported in the subsequent Annual Reports on environmental protection.

The principles set out in NEAP 3 directly supports research activities. It highlights informed decision making (principle 6) and continuous learning and improvement (principle 8) as two of the important principles of the plan.

There is a specific research focus in the document on aspects such as climate change adaptation, natural disaster risk reduction, biodiversity management and environmental management

The following results and associated goals are explicitly targeted for research activities.

Result 1 - Safer islands and communities

Goal 2: Protect human settlements

Objective 2.2: Integrate climate change concerns in safer island development

Goal 3: Increase the resilience of coral reef systems to climate change

Objective 3.1: Increase the knowledge base and understanding of the natural adaptation process in coral reefs.

Goal 4: Reduce climate-related risks to tourism sector

Objective 4.1: Strengthen capacity of the tourism sector to develop policy and plan for, and implement, adaptation activities

Goal 6: Build resilience of fisheries and food production to climate change

Objective 6.1: Enhance the knowledge on bait use and utilization, alternative livebait, catching methods and improved holding techniques.

Objective 6.2: Assess community knowledge and practices on local plant species used for food production in the context of climate change.

Goal 7: Natural disaster preparedness and mitigation

Objective 7.2: Strengthen the information base on hazards and disasters to better inform, educate and protect the public

Result 2 - Rich and resilient ecosystems

Goal 8: Improve scientific knowledge and access to information for biodiversity conservation.

Objective 8.1: Improve the knowledge base for biodiversity conservation by identifying and monitoring status of biodiversity; identifying the economic value of biodiversity; understanding threats to biodiversity; and monitoring effectiveness of management.

Objective 8.2: Verify, and make accessible existing knowledge and information on biodiversity

Objective 8 .3: Increase the public awareness and

understanding of the concept of biodiversity and the actions that can be taken to conserve species, ecological communities and ecosystems

Goal 10: Protect and restore coral reefs

Objective 10.5: Develop the capacity of national organizations to manage coral reef environment.

Result 5 - environmental stewardship

Goal 26: Environmental research

Objective 26.1: Support the development of a culture of information based decision making

Goal 27: Environmental information

Objective 27.1: Strengthen knowledge services to improve organizational performance

Past policies and documents

The Science and Technology Master Plan

The Science and Technology (S&T) Master Plan was prepared between Mid-August 2000 and April 2001 through the former Ministry of Communications, Science and Technology (MCST) and was funded by the Asian Development Bank (ADB). This was biggest endeavor in Maldives to analyze the science and technology needs of the country to lay path towards a scientifically advances economy and society.

The key objects of the Plan were numerous and can be summarized as follows:

- To provide, administer, and regulate all telecommunication services in line with international conventions to which Maldives is a signatory and to develop telecommunication services within the country in association with international organizations;
- To administer and regulate postal services so as to protect the government, the people, and local, national, and international companies providing such services;
- To introduce environmentally sound technologies on energy that will have a positive impact on the socio-economic development of the country;
- To introduce new technologies that are suitable and appropriate to the development needs of the country, and to administer and regulate the introduction, adoption and use of new technologies in the country (including the establishment of goals and objectives for this process);
- To promote the use and application of computer technology as a means of accelerating the improvement in the nature, quantity, and quality of provided services;
- To standardize the use and application of computer systems within the country and especially among government units;
- To establish effective links among government offices via computer networking; and
- To promote and develop information technology as a means of promoting education, information, and business in the country.

The final plan covered wide ranging aspects from a Government physical computer network to the telecommunication systems of the Maldives. Some of the outputs of the plan such as the Government high speed network and a centre to coordinate the hardware and software systems used in the Government are in operation today.

One of the key outputs relevant to research activities is the focus on developing research and development through capacity building, institutional strengthening, legal framework strengthening and coordinating national wide activities. Much of the research related activities were prescribed in the proposed National Research Foundation (see next section).

The Science and Technology (S&T) Master Plan was developed based on the former Maldives' Vision 2020 framework and the Sixth National Development Plan. Both of these documents have since been discontinued following a change in the Government. For this reason, it is unlikely that the MasterPlan would be followed any further, although elements of the plan are still used in planning the National Centre for Information Technology.

The National Research Foundation

1. The creation and effective operation of a National Research Foundation (NRF) was identified as an essential component in the Science and Technology (S&T) Masterplan's vision of how research can benefit the Maldives. The S&T Master Plan focused on the technologies by which information is stored, retrieved and disseminated. They needed a mechanism to use this technological setup to derive improved information about social, cultural and economic conditions in the Maldives. The NRF was identified as the catalyst for this process.
2. The NRFs idea was that it would support a broad range of research endeavors, inclusive of traditional physical and informational science applications and cultural, historical and legal research.

3. The proposed financing model for NRF was have a dedicated share of Government revenue as its budget target, and specific procedures for recruiting private sector and individual contributions. The government share of funding would begin at 0.2% of the national budget in year one and increase 0.02% each year until it reaches the fixed level of 1.0% of Government revenue. This financing structure would allow the Foundation to encourage and support a substantial expansion of research on a widely defined range of issues. Private funds (supplemented by those from regional and international organisations) were to be solicited to extend the resource base of the Foundation and to encourage greater responsiveness to private sector and international research interests.
4. The NRF planned to have four main functions: (a) research funding; (b) maintenance of a computerised research archive; (c) operation of a clearinghouse on research funding opportunities; and (d) research advocacy.
5. The internal organization was to have Governing Board comprising 4 government and 3 private sector representatives. The set up was proposed within the former Ministry of Communications, Science and Technology (MCST), who were to provide the Director and secretariat for the NRF. The members of the Governing Board and Technical Review Panels of the NRF were to be selected from the research community of the nation. These would be voluntary and part-time positions; membership on the Governing Board is envisioned as including a balance of public and private sector participation.
6. The S&T Masterplan suggested four areas for initial research grants:
    - An Innovation and Technology Transfer Fund – To permit Maldivians to discover new applications of existing science and technology and to adapt emerging technologies to the specific, and often unique, needs of the nation.
    - Presidential Research Grants – A set of special topics identified as of urgent and immediate need (the goal here would be for effective response to current policy issues and to establish a basis for longer term research that might be continued under the NRF or some other financing programme).
    - Young Researcher Awards – Special funding for Maldivians (age 35 and under) who have returned from training and wish to continue or extend their previous research.
    - Unsolicited Grants – Most major research funding agencies reserve a portion of their financial awards for topics proposed by researchers themselves.

    1. Quality standards were proposed for certain research activities to ensure that the research fund is utilized efficiently.

2. The work on NRF was a substantial effort to establish national level research coordination, prioritizing research and enabling wider research. It's model and suggestions remain valid today for a national level research activities. However, the organizational arrangement proposed for the original NRF is irrelevant today.
3. The current Strategic Action Plan of the Government has highlighted the policy of establishing a National Science Foundation, which is similar to the original NRF, although their funding model may be radically different. Nonetheless, the proposed NRF and the Science Foundation appear to be good alternative options for the lead institution in setting up the institutional framework.

APPENDIX 5 – QUESTIONNAIRE USED FOR STAKEHOLDER MEETINGS

Relevance of research information

1. Do you regularly use climate change related research information published by researchers or yourself?
2. What are your organizations main functions? Does it have any relevance to climate change?
3. How and when do you use it? Planning, project development, decision making etc..

Research Activities

1. Do you undertake any inhouse house or outsourced climate change related research work?
2. What are the research projects which you are currently undertaking?
3. What are your planned research projects or areas?
4. Do you have an allocated budget for research activities?
5. How much do you spend on research work - either inhouse works or purchase of published information?
6. What are your current sources of research information?
7. Do you publish your information? Where and who has access to them? What type of information – data or research reports?
8. Do you have a mechanism to disseminate information to public and research organizations?
9. What is your source of funding for research activities and acquiring published research?
10. What are the challenges?

Research Capacity

1. Do you have in house staff for research activities? How many?
2. Do you have access to research facilities? Libraries, online sources, outside contacts etc…
3. Do you have the necessary equipment for undertaking research? Please provide a list.
4. Do you plan to introduce or expand in house research capacity in the future? What are the plans?

Climate Change Research Needs

1. Which of the following activities are you involved in: Research · Adaptation · Mitigation· Communication · Monitoring
2. What are you research needs for the next 5-10 years?
    a. Research
    b. Adaptation
    c. Mitigation
    d. Communication
    e. Monitoring
3. What do you think are the research needs for Maldives for the next 10 years
4. Would you benefit from a National Research Strategy

APPENDIX 6 - A PARTIAL BIBLIOGRAPHY OF CLIMATE CHANGE STUDIES IN MALDIVES

Climate science

Climate parameters

HAY, J. E. 2006. Climate Risk Profile for the Maldives. Male', Maldives: Ministry of Environment Energy and Water.

KHAN, T. M. A., QUADIR, D. A., MURTY, T. S., KABIR, A., AKTAR, F. & SARKAR, M. A. 2002. Relative Sea Level Changes in Maldives and Vulnerability of Land Due to abnormal Coastal Inundation. Marine Geodesy, 25, 133–143.

MORNER, N.-A. 2004. The Maldives project: a future free from sea-level flooding. Contemporary South Asia, 13, 149-155.

Murari Lal, H. H., Kiyoshi Takahashi (2002). "Future climate change and its impacts over small island states." Climate Research 19: 179–192.

SHEPPARD, C. R. C. 2002. Island Elevations, Reef Condition and Sea Level Rise in Atolls of Chagos, British Indian Ocean Territory. In: LINDEN, O., D. SOUTER, D. WILHELMSSON, AND D. OBURA (ed.) Coral degradation in the Indian Ocean: Status Report 2002. Kalmar, Sweden: CORDIO, Department of Biology and Environmental Science, University of Kalmar.

SINGH, O. P., KHAN, T. M. A., AKTAR, F. & SARKER, M. A. 2001. Recent Sea Level and Sea Surface Temperature Changes Along the Maldives Coast. Marine Geodesy, 24, 209–218.

Goda, Y. (1988). Causes of high waves at Male' in April 1987. Male, Maldives.: Dept. of Public Works and Labour.

UNDP (2006). Developing a Disaster Risk Profile for Maldives. Male', Maldives: UNDP and Government of Maldives.

Woodworth, P. L. (2005). "Have there been large recent sea level changes in the Maldive Islands?" Global and Planetary Change 49(1 - 2): 1 - 18.

Ahmed, Y. (2006). Variability of rainfall over Maldives. Rain o Shine: 18-25.

C4 (2000), "C4 - INDOEX Final Report". California: University of California.

Climate change and natural response of islands and reefs

WOODROFFE, C. D. 1993. Morphology and evolution of reef islands in the Maldives. Proceedings of the 7th International Coral Reef Symposium, 1992. Guam: University of Guam Marine Laboratory.

KENCH, P. S., MCLEAN, R. F. & NICHOL, S. L. 2005. New model of reef-island evolution: Maldives, Indian Ocean. Geology, 33, 145-148.

MORNER, N.-A. 2004. The Maldives project: a future free from sea-level flooding. Contemporary South Asia, 13, 149-155.

Kench, P. S., & Brander, R. W. (2006). Response of reef island shorelines to seasonal climate oscillations: South Maalhosmadulu atoll, Maldives. Journal of Geophysical Research, 111(F01001, doi:10.1029/2005JF000323).

BELOPOLSKY, A. & DROXLER, A. 2003. Imaging Tertiary carbonate system-the Maldives, Indian Ocean: Insights into carbonate sequence interpretation. The Leading Edge, 22, 646-652.

KENCH, P. 2010. Coastal Monitoring, Reef Island Shoreline Dynamics and Management Implications. Male': Environment Protection Agency, Maldives.

Boehlert, G.W. (1987), "A Review of the Effects of Sea Mounts on Biological Processes", Geophysical Monograph 43:405.

Climate Impacts

Adam, M. S. and R. C. Anderson (1996). Skipjack tuna Katsuwonus pelamis in the Maldives. Expert Consultation on Indian Ocean Tunas, 6th Session, Colombo, Sri Lanka.

Alasdair J. Edwards, S. C., Hussein Zahir, Arjan Rajasuriya, Abdulla Naseer and Jason Rubens (2001)."Coral Bleaching and Mortality on Artificial and Natural Reefs in Maldives in 1998, Sea Surface Temperature Anomalies and Initial Recovery " Marine Pollution Bulletin Volume 42(1): 7 - 15.

Edwards A.J., Clark S., et al. (2001). Coral bleaching and mortality on artificial and natural reefs in Maldives in 1998, sea surface temperature anomalies and intial recovery. Marine Pollution Bulletin. 42.

Brown, B. E., & Dunn, R. P. (1988). The environmental impact of coral mining on coral reefs in the Maldives. Environmental Conservation, 15(2), 159-166.

Harangozo, S. A. (1992). Flooding in the Maldives and its implications for the global sea level rise debate. Geophysical Monograph, 69(11), 95-99.

Kench, P. S., Parnell, K. E., & R.W. Brander. (2003). A process based assessment of engineered structures on reef islands of the Maldives. Paper presented at the Proceedings, Coasts and Ports Australasian Conference 2003.

Pernetta, J., & Sestini, G. (1989). The Maldives and the impact of expected climatic changes. Nairobi: UNEP.

KENCH, P. S. 2001. Maldives erosion assessment and management. Report prepared for UNDP as part of the Republic of Maldives Climate Change Enabling Activity Project. MDV/95/G32/A/1G/99. Male': UNDP and Ministry of Home Affairs, Housing and Environment.

NASEER, A. 2003. The integrated growth response of coral reefs to environmental forcing: morphometric analysis of coral reefs of the Maldives. PhD, Dalhousie University.

OCHA (2007). Maldives: Coastal flooding OCHA Situation Report No. 3. ReliefWeb Report.

UNDP 2009. Detailed Island Disaster Risk Assessment of Eleven Islands in Maldives. Male', Maldives: United Nations Development Programme.

Goes J, I., Thoppil P.G., et al. (2005). "Warming of the Eurasian landmass is making the Arabian Sea more productive." Science 308: 545-547.

Moosa, S. (2006). Climate Change Vulnerability and Adaptation Assessment of Human Health in Maldives. Maldives Climate Change Policy Research Working Papers. Male', Ministry of Environment, Energy and Water.

Naseer, A. (2006). Vulnerability and Adaptation Assessment of the Coral Reefs of Maldives. Technical Papers to Maldives National Adaptation Plan of Action for Climate Change. Male', Ministry of Environment, Energy and Water.

KENCH, P. S. 2001. Maldives erosion assessment and management. Report prepared for UNDP as part of the Republic of Maldives Climate Change Enabling Activity Project. MDV/95/G32/A/1G/99. Male': UNDP and Ministry of Home Affairs, Housing and Environment.

ZAHIR, H., CLARK, S., AJLA, R. & SALEEM, M. 2002. Spatial and Temporal Patterns of Coral Recruitment Following a Severe Bleaching Event in the Maldives. CORDIO.

Ali, M. and Manik, M.H. (1989), "Sea Level Rise: A Coral Atoll Perspective on Terrestrial Environment and Marine Resources". Unpublished Report.

Edwards, A.J. (1989), "The Implications of Sea Level Rise for the Republic of Maldives". Commonwealth Secretariat.

Manik, A.A. (2001), "Flood risk assessment: appropriateness of a GIS based approach for small island states such as the Maldives". Unpublished Masters Dissertation. University of Portsmouth, United Kingdom.

Shaheem, I and Afeef, A (1999), "Dengue and Dengue Haemorrhagic Fever and its Control in Maldives". Dengue Bulletin - Volume 23 pp: 30-33.

Woodroffe, C. (1989), "Maldives and Sea Level Rise: An Environmental Perspective". Australia: University of Wollongong.

Adaptation

Adam, M. S. (2006). Climate Change Vulnerability and Adaptation Assessment of the Fisheries Sector of Maldives. Maldives Climate Change Policy Research Working Papers. Male', Ministry of Environment, Energy and Water.

Clark, S., & Edwards, A. J. (1995). Coral transplantation as an aid to reef rehabilitation: evaluation of a case study in the Maldive Islands. Coral Reefs, 14(4), 201-213.

Clark, S., & Edwards, A. J. (1999). An evaluation of artificial reef structures as tools for marine habitat rehabilitation in the Maldives. Aquatic Conservation: Marine and Freshwater Ecosystems, 9(1), 5-21.

Moosa, S. (2008). "Adaptation measures for human health in response to climate change in Maldives." Regional Health Forum 12(1): 49 - 55.

Readshaw, J. S. (1994). An Evaluation of Coastal Engineering Issues and Requirements in the Republic of Maldives. Male', Maldives: Hatfield Consultants Limited.

SHAIG, A. 2009. Settlement planning for natural hazard resilience in small island states: The Population and Development Consolidation Approach. PhD, James Cook University.

SHAIG, A. 2006a. Climate Change Vulnerability and Adaptation Assessment of the Land and Beaches of Maldives. Technical Papers of Maldives National Adaptation Plan of Action for Climate Change. Male', Maldives: Ministry of Environment, Energy and Water.

SHAIG, A. 2006b. Vulnerability and Adaptation Assessment of the Coastal Infrastructure of Maldives. Technical Papers of Maldives National Adaptation Plan of Action for Climate Change. Male', Maldives: Ministry of Environment, Energy and Water.

SHAIG, A. 2011. Survey of Climate Change Adaptation Measures. Male', Maldives: Ministry of Environment and Energy.

VENTON, C. C., VENTON, P. & SHAIG, A. 2009. Cost Benefit Study of Disaster Risk Mitigation Measures in Three Islands in the Maldives. Male', Maldives: United Nations Development Programme Maldives.

Government of Maldives, Ministry of Environment, Energy and Water (2006) National Adaptation Programme of Action – Maldives. Malé: Ministry of Environment, Energy and Water

Guzman E. (2009) Development of the Strategic National Action Plan for Disaster Risk Reduction and Climate Change Adaptation in the Maldives. Asia Pacific, UNISDR

TOMPKINS, E. L., NICHOLSON-COLE, S. A., HURLSTON, L.-A., BOYD, E., HODGE, G. B., CLARKE, J., GRAY, G., TROTZ, N. & VARLACK, L. 2005. Surviving Climate Change in Small Islands – A guidebook, Norwich, UK, Tyndall Centre for Climate Change Research, Available online at http://www.tyndall.ac.uk/publications/surviving.pdf.

JAMEEL, A. 2007. Model to integrate the management of hazards and disasters in the national sustainable development planning of the Maldives. MSc MSc thesis, University of Canterbury.

Mitigation

THE CARBON ADVISORY SERIVE LTD 2009. Maldives Framework Zero Carbon Building Guidance. London: Imperial College.

Stobbe, Morten and Andersen, Nick, 2003. Technical Report: Energy Supply and demand. Assessment of Least-cost, Sustainable Energy Resources, Maldives. Project INT/99/R11-02 MDV 1180.

Stobbe, Morten and Andersen, Nick, 2004. Technical Report: Action Plan. Assessment of Least-cost, Sustainable Energy Resources, Maldives. Project INT/99/R11-02 MDV 1180.

BERNARD, F., KHELIL, T. B., PICHON, V. & TISSOT, L. 2010. The Maldives' 2009 Carbon Audit. London: BeCitizen.

UNDP 2006. Energy and Poverty in the Maldives: Challenges and the Way Forward. Male': United Nations Development Programme.

MINISTRY OF HOME AFFAIRS HOUSING AND ENVIRONMENT 2004. Maldives Sustainable Energy Plan. Male' Ministry of Home Affairs Housing and Environment.

RENNÉ, D., GEORGE, R., MARION, B., HEIMILLER, D. & GUEYMARD, C. 2003. Solar Resource Assessment for Sri Lanka and Maldives. Golden, Colorado: National Renewable Energy Laboratory.

Other

MEE. 2011. National Climate Change Research Strategy – Draft Final Report, Male', Maldives: Ministry of Environment and Energy.

Government of Maldives, Ministry of Housing, Transport and Environment (2009) Maldives National Capacity Self Assessment Report and Action Plan for Global Climate Change , Biodiversity and Land Degradation Conventions: Final Report. Malé.

Government of Maldives, Ministry of Housing, Transport and Environment (2009) Maldives National Strategy for Sustainable Development. Malé: UNEP.

Government of Maldives (2009). National Framework for Development 2009 - 2013. Male'.

World Bank (2006) Building a Disaster Resilient Maldives. Working Paper.

MEC (2004). State of the Environment Maldives 2004. State of the Environment Maldives. Male', Ministry of Environment and Construction.

MFAMR (2006). Agriculture Development Master Plan Maldives (2006-2020) Final Draft. Male', Rep. of Maldives, Ministry of Fisheries, Agriculture and Marine Resources.

MHAHE (2001). First National Communication of the Republic of Maldives to the United Nations Framework Convention on Climate Change. Male', Ministry of Home Affairs, Housing and Environment.

MHAHE (2002). National Biodiversity Strategy and Action Plan of the Maldives. Male', Ministry of Home Affairs, Housing and Environment.

IPCC 2001. Climate Change 2001: Impacts, Adaptation, and Vulnerability, Cambridge, United Kingdom and New York, NY, USA, Cambridge University Press.

IPCC 2001. Climate Change 2001: The Scientific Basis, New York, Cambridge, United Kingdom and New York, NY, USA.

IPCC 2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment. Report of the Intergovernmental Panel on Climate Change. In: SOLOMON, S., QIN, D., MANNING, M., CHEN, Z., MARQUIS, M., AVERYT, K. B., TIGNOR, M. & MILLE, H. L. (eds.). Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

IPCC 2007. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. In: PARRY, M. L., CANZIANI, O. F., PALUTIKOF, J. P., LINDEN, P. J. V. D. & HANSON, C. E. (eds.). Cambridge, UK: Cambridge University Press.

MINISTRY OF HOME AFFAIRS HOUSING AND ENVIRONMENT 2004. Maldives Sustainable Energy Plan. Male' Ministry of Home Affairs Housing and Environment.

IPCC (1998), "The Regional Impacts of Climate Change, An Assessment of Vulnerability". Watson, R.T., Zinyowera, M.C. and Moss, R.H. (eds). New York: Cambridge University Press.

MHAHE (1999), "Second National Environment Action Plan". Malé: Ministry of Home Affairs, Housing and Environment.

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