State of the Environment
Maldives, 2004

Ministry of Environment & Construction
Malé, Maldives

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Chapter 3: Climate change and sea-level rise- Mizna Mohamed, Ahmed Jameel
Chapter 4: Access to safe drinking water- Aminath Latheefa, Mizna Mohamed
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The Ministry of Environment and Construction would like to thank the following individuals and organizations who have contributed to the preparation of State of the Environment 2004.

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ISBN: 99915-91-00-1

FOREWORD

Honourable Abdullah Kamaludeen
Minister of Environment and Construction (Acting)

It is with great pleasure that I present State of the Environment (SOE) 2004. The report is published with the objective of presenting in a clear and timely manner, an analytical overview of the state of the environment focusing on issues, policies and strategies of the key environmental challenges confronting us today. Efforts have been made to widen the information and data covered in this report and to include most recent updates. The report highlights that with the increase in population and socio-economic development, the challenge of implementing sustainable development lies in the difficult trade off we are faced with where the society has to find a balance between economic growth, social equity and the conservation and protection of the environment. Key to a sustainable development path depends on the integration of social, economic and environmental goals. Our ability to understand how they are related to one another depends on identifying, analyzing and dissemination of accurate and timely information.

While the country moves forward, achieving economic growth and social development, unique environmental challenges confront us. SOE 2004 emphasizes the work that has been initiated and undertaken to address these environmental challenges, in particular protection and conservation of biological diversity, climate change, sea level rise and land degradation, management of fresh water resources, waste management and air pollution.

Being a small island developing nation comprising of approximately 1190 tiny low lying coral islands, the Maldives is amongst one of the most vulnerable to the peril of sea level rise due to climate change. SOE stresses that one of the government's policy and strategy is to continue to work in the wider international context due potential threats posed by externally generated problems and the collective responsibility for sustainable development at the global level. Climate observatory established in Hdh Hanimaadhoo is such an endeavor initiated to study the Asian Brown Cloud and to monitor the atmospheric pollution through a collaborative research project. The project will also promote regional capacity building and will facilitate the interaction between science and policy making.

Just before SOE was sent to print on 26th December 2004 Maldives declared a state of emergency after a tsunami wave deluged the Maldives leaving thousand homeless. Waves of about 1-3.7m high had reached the islands which do not measure more than 1.5m above sea level. Huge waves lashed onto the beaches of these small low lying islands demolishing houses, destroying livelihoods and leaving thousands homeless. Preliminery reports stated 102 people are feared dead or missing out of which 76 is confirmed dead. In addition 13,311 people are homeless and 8,352 people are displaced, (National Disaster Management Centre, 3rd January 2004). At present government is assessing the damage and providing aid and temporary as well as permanent shelter to the people of the far flung islands of the archipaelago. The flooding were triggered by an earthquake that struck Asia leaving trails of damage causing widespread devastation through out the region. This catastrophic event again blatantly demonstrated the vulnerabilty of the Maldives to natural calamities.

The spirit of cooperation and shared responsibility of both the government and the private sector in providing responses to preservation and protection of environment is well reflected. The commemoration of the World Environment Day 2003 marked the Year of Freshwater. The World Environment Day 2004, was commemorated focusing on our oceans and seas. The two days were celebrated as peoples event with colorful activities, essays and poster competitions in schools, tree planting, and clean-up campaigns. The World Food Day 2004 highlighting the theme 'Biodiversity for food security', emphasizes the vital role of biodiversity in ensuring enough diversified food for all people in the world. Maldives celebrated the World Food Day in Sh. Feevah which is well- known for its horticultural activities.

Broadly, our agenda is to create and broaden awareness on environmental issues. It is my hope that SOE would continue to provide decision makers and planners with meaningful data and information necessary to make their own informed decisions in addressing current and emerging environmental complexities. It is also my sincere hope that this analytical overview of our environment will stimulate innovative thinking and increase knowledge of all the stakeholders of our environment.

Contents

Overview

The Ministry of Environment and Construction initiated the publication of the State of the Environment (SOE) to assess the issues and development of the environment. The aim is to make environmental information easily accessible to all the stakeholders of our environment. The publication is a precise reference pertaining to the environment within the scenario of information available in the country.

Similar to SOE 2002, SOE 2004 addresses 5 key environmental issues which are also identified as key action areas in the National Environmental Action Plan II (NEAP). They are climate change and sea level rise, fresh water resources, waste management, air pollution and biodiversity conservation. SOE also highlights the socio-economic status of the country with the aim of providing a backdrop against which to view the change in the state of the environment because they serve as the impetus of environment change.

Socio-economic development

Maldives has undergone unprecedented social and economic change over the past years. Within the last 5 years the overall population has increased by 10 percent while the urban population increased more than that of the rural population, increasing the demand for housing. According to the statistics the total number of households has increased by 19 percent while that of Male' increased by 22 percent. The better social services and infrastructure has resulted in a pull toward the economic centre where some 28 percent of the total population reside. The increase in population resulted in the increase in demand for housing, resulting in shortage of land area. Consequently, housing plots decreased in the size with continuation of subdivision of existing housing plots. Expansion and intensification of land use has its effect on the environment leading to over extraction of groundwater and contaminated aquifer. Lack of space for housing, social services and recreation has resulted in social strains. To alleviate the problem associated with over crowding and congestion resulted from the scarcity of land and housing led to the reclamation and housing programs.

Similar to Male' in many of the islands the demand for housing is on the increase. Today 24 slands do not have additional land for housing while R.Kadholhudhoo and Lh.Hinnavaru have a higher population density than that of Male'. These islands do not have the infrastructure and services of Male'. The extreme level of over crowding has placed great stress on vulnerable ecosystems, risk to infection and other social problems.

The Population Development and Consolidation Program was initiated with the aim of minimizing the serious diseconomies of scale faced by the country in the provision of socio-economic services by promoting economically viable population concentration on large islands. The strategy is to encourage the inhabitants of the small and remote islands to voluntarily move to larger islands where the socio-economic services and employment opportunities are in place. The Regional Development Project was initiated as part of the Population Development and Consolidation Program which target HDh Kulhudhuffushi and S. Hithadhoo as the growth centres of North and South.

The Gross Domestic Product totaled to US 644 million in 2003 while per capita GDP reached US $ 2262. From 2002 to 2003, GDP per capita increased by 6.8 percent. Primary sector forms 9.8 percent of GDP with fishing accounting for 6.6 percent .Fisheries remains the principal livelihood to the majority of the atoll population providing forward and backward linkages in sectors such as boat building and fish processing. Equally important is the tourism sector which accounts for 32.7 percent of GDP. Tourism sector is the largest sector providing economic benefits to transport, communication, distribution and construction sector. During November 2004, Economic and Social council of the United Nations endorsed the graduation of Maldives from the group of least developed countries. With the graduation becoming effective three years after the General Assembly decision to take note of the recommendation. During the three years period, the country would remain on the list of least developed countries and would maintain the advantages associated with membership.

Climate Change and Sea-level rise

The issue of climate change and sea level rise is detailed in Chapter 2. Based on past trend climate models predict future scenarios of increase in global surface temperatures and a rise in sea-level. The IPCC Third Assessment Report estimates a predicted sea level rise of 0.09 m to 0.88 m for years 1990-2100 using the best estimates (IPCC 2001). More than 80% of the islands in Maldives are less than a meter above mean sea –level rise. The average island size of the inhabited islands in Maldives range around 0.1 to 0.3 square km with largest inhabited island being less than 5.2 square km. The small sizes of the islands force human settlement and vital infrastructure to be located near the coast and thus at high risk from climate change and predicted sea level rise.

The first Green House Gas (GHG) inventory for the Maldives was done for the baseline year 1994 using IPCC reference approach with emission of CO_2 from energy sector being taken as the main GHG for the energy sector. The inventory estimated that the energy sector emissions of CO_2 for Maldives is 0.13 MT which is only 0.0012% of the global emissions form the energy sector. The per-capita emission of CO_2 for Maldives is 0.54 t which is consistent with the values from other small island countries in the Pacific. The estimated CH_4 emission from disposal of municipal solid waste was 1.142Gg The mitigation options identified include use of high efficiency generators, increase awareness on the use of high energy efficient appliances, use of solar energy for desalination and increase use of renewable energy sources. The transport sector has banned import of reconditioned vehicles, with high import duty on vehicles. Development of public ferry transport system was also planned as mitigation options.

The vulnerability to climate change and sea-level rise is revealed through the indicators obtained from the SOE survey. Twenty four islands have already exceeded their withholding capacity and do not have additional land for housing. Housing and other infrastructure is reaching closer to the shoreline. At present more than 73 percent of the inhabited islands have building less than 100 ft away from the shoreline, with 2 percent of the islands having buildings right at the shoreline while 55 percent of the islands have building less than 50 ft away from the shoreline. During May 2004 more than 57percent of the inhabited islands from 18 atolls reported damages by the severe weather incident. During this episode 71 inhabited islands were flooded causing over 102 million US dollars worth of damage. On an average this is over 1 million US dollars worth of damage per island. Other vulnerabilities due to sea surface warming includes coral bleaching and mortality events, salt water intrusion, inundation of land impacting on the availability of fresh water, impact on human health, vulnerability to changes in productivity of agricultural lands beyond our borders due to our dependency on imported food and other items.

Adaptative measures include solid protection structures such as sea wall where vital infrastructure and human settlement are at immediate risk. This requires enormous financial investment estimated at US dollars 6 billion for 200 islands in addition to technical capacity to undertake such protection works.

The environmental policies are based on the need to take an integrated approach and working in the wider international context because of the potential threat posed by externally generated problems and the collective responsibility of sustainable development at the global level. Maldives played a key role in highlighting the special vulnerability of low-lying small island developing states to the predicted climate change and in getting the attention to this issue in international forums. Maldives is a party to the United Nations Framework Convention on Climate Change and is the first country to sign the Kyoto Protocol. A National Implementation Strategy for Climate Change was adopted in 2001.Activities undertaken include establishment of an energy agency, formulation of National Adaptation Plan of Action, undertaking of technology need assessment and to actively participate in international forums to advocate the special vulnerability of small island developing states. In 2004 preparation of National Adaptation Plan of Action began in 2004 to explore the feasible adaptation options to address the predicted climate change and associated sea level rise. A National Climate Change team has been established to undertake this assessment. A technology need assessment is being implemented as to enable Maldives to further strengthen its capacity to participate and contribute to the implementation of UNFCC and to deal with climate change and its adverse impacts. The National Capacity for Self Assessment will identify national priorities for capacity building focusing on cross cutting issues and synergies in the capacity development needs.

Access to Safe drinking water

Accessing safe drinking water is a major limitation faced by the people of the Maldives. Until 1985, the people of Maldives have been dependent on the shallow ground water aquifer for their groundwater requirement, including drinking. Scarcity of freshwater is aggravated by the saltwater intrusion and pollution of groundwater resulting from release of sewage industrial effluents and poor agricultural practices. Today all houses, institutional and commercial establishment in Male' have been provided with desalinated water while rainwater harvesting is practiced by all the island communities of the country.

According to the data collected in 54 percent of the islands, ground water is not suitable for drinking and limitation is imposed by the quality of water rather than its quantity. In the atolls R.Kadholhudhoo and Sh Kommandoo are the only inhabited islands that are served with desalinated water. To cater for the increasing demand for fresh water, private companies are providing mineral water in the country. With the rising demand, the number of bottled water imported into the country increased from 1996-2002. However from 2002 to 2003 a downward shift has been observed reflecting that the domestic supply of bottled water is catered for a larger share of the local as well as the tourist market.

Access to safe water is one of the major targets of the health sector. The Ministry of Health has outlined two main strategies. They are formulation of a plan to provide safe water and identification and promotion of sustainable systems that are appropriate for small islands for water production and distribution. Due to high investment cost today the policy is to encourage community initiatives in the provision of desalinated water. Developments in the areas include the formulation of regulations for the installation and operation of desalination plants, necessitating the submission of Environment Impact Assessment to the MEC. Awareness campaigns are also carried out by MWSA through UNICEF and WHO assisted programs.

Waste Management

Solid and hazardous waste management has recently emerged as one of the greatest environmental challenges in the Maldives. According to available estimates the average rate of generation of waste in Male' is approximately 2.48kg per capita per day while in the atolls waste generation ranges between 0.70- 0.79 kg per day while in the resort the figure is 7.2 kg. In Male', sources of waste are domestic waste, commercial waste and construction and demolition waste. Two separate collection yards are established in Male'. The collection and transfer of waste in Male' is carried out by Male' Municipality and other private parties while some household transfer it by themselves. The bins which have been placed in the periphery of Male' have been removed due to odour and nuisance and anaesthetic sights. Waste is segregated at the collection yard with a small area allocated to deposit reusable waste but segregation is not undertaken at the source. Thilafushi is the municipal landfill site where waste is segregated by paper, plastic box, tins, and aluminium. Electric materials, HDPE plastic, vegetable basket, wooden box, fibre, used oil, dry batteries, coconut husk, furniture and tile. Waste is burnt openly and wholesale causing odour and smoke nuisances. Wind blown litter enters the marine environment.

In the atolls there is little provision of waste collection services. Similar to Male' waste is not segregated at source but backyard composting is practiced to a certain extent. Usually, the women carry the waste in wheel barrows to the disposal site. In only 1.97 percent of the island an established fee system exists for collection and transfer from households. All inhabited islands have a designated disposal site designated by the government authority. Due to distance and lack of awareness, random disposal of waste is a common practice. From 2003 onward waste disposal sites are in operation in HDh. Kulhudhuffushi and S. Hithadhoo under the Regional Development Project.

A well organized system exists in the resort for waste disposal required under their operation license. Waste treatment equipments are installed. However, it is reported that due to insufficient capacity to deal with the waste generated, creates localized nuisances relating smoke and odours in some larger resorts.

Ministry of Environment and Construction is mandated to design and formulate a national policy on waste disposal and treatment and implement measures required to carry out such a policy. In addition the Environment Section of the MEC is responsible for waste management in the atolls while the Waste Management Section of Construction Section of MEC is responsible for the waste management in Male'. Male' Municipality is responsible for providing waste collection services within Male'. MEC is in the process of developing a National Solid Waste Management Policy.

Maldives is a party to the Basel Convention on the Trans-boundary Movement of Hazardous Waste and their disposal. Under the Environment Protection and Preservation Act of Maldives, disposal of hazardous waste within the territory of Maldives is prohibited.

Air Pollution

Air pollution refers to the contamination of atmosphere by the discharge of harmful gases mainly oxides of carbon, sulphur and nitrogen. Its adverse effects are pervasive and are disaggregated at 3 levels; local pollution confined mainly to pollutants emitted from vehicles, regional, pertaining to trans-boundary transport of pollutants and global related to build up of greenhouse gases.

As indicators of local air pollution; the number of vehicles and number of construction of building, import of fuel and respiratory diseases all show an increasing trend with air pollution reaching levels of concern. Being an emerging environmental issue, MOTCA, MSCT as well as MEC aim to reduce air pollution through their respective sectors polices and strategies. Transport sector has identified reducing traffic congestion in urban areas as one of its policies.

MEC policy is based on an integrated approach developing meaningful principals and procedures for environmental protection. An important policy is finding solutions to the environmental protection by contributing to international efforts to find solutions to global environmental threats including air pollution. The Asian Brown Cloud project was formulated as a second phase of the INDOEX project. The project features a strategically located ground based observation in the Indo-Asian and Pacific region to monitor atmospheric pollution. As such a surface climate observatory is being established and in operation at Hdh. Hanimaadhoo. The objective is to document changes in aerosol content, optical depth, chemical composition, aerosol radioactive forcing and cloud properties and to document changes in pollutant gases and some green house gases. The Male' Declaration on control and prevention of air pollution at its likely effects for South Asia was signed in 1998 between 8 South Asian countries. In 1999, an action plan was formulated highlighting control of air pollution through a combination of legislation, regulation, voluntary initiatives and economic instruments.

The MSCT policy is to introduce new technology applicable to the national development of Maldives and set standards and goals and formulate guidelines to achieve it. The organization also aims to explore the applicability of energy producing sources that are suitable to the Maldivian environment and to expedite such resources which will assist in reducing air pollution. To facilitate future implementation of renewable energy projects the organisation is working with internationals organization to identify and assess the renewable energy resources available in the country. The main areas that are of potential interest are solar wind wave biomass and bio-digestive material.

Conservation of Biological Diversity

Biodiversity or the variability among the living organisms in the Maldives is greatest among the coral reefs. Pressures at the local level include coral and sand mining, destructive fishing, waste disposal of non-biodegradable imported products on the reefs, pollution and intensive use of reef through SCUBA diving and snorkelling. Loss of coastal habitats, particularly on sea grass beds, mangroves and coral reefs are associated with dredging of harbour, reclamation as well as grounding of vessel. Data collected revealed that demand for coral has decreased by many folds due to stringent measures applied and the availability of alternative building material. Sand as well as coral aggregate are collected and used as construction materials to build wells, beams and sheet piles of the houses.

In the Maldives the population is reliant in one way or another on the coastal resources. The tourism industry created new demands for the reef resources which led to the development of an organized reef fishery. By 1997 the reef fishery in the Maldives was reported to be expanding rapidly even to the extent of overexploitation of certain species. As conservation and management measures, 9 marine species have been prohibited for fishing or collecting and 15 marine products are prohibited for exports. In addition, 25 marine areas are declared as protected dive sites. Lack of data on abundance and distribution of species such as sea-cucumbers, aquarium fish, shark, grouper, and lobster as well as bait fishery has hindered in the monitoring procedures. Monitoring is mostly undertaken relying on export data which is a major setback in implementing timely enforcement measures.

Pressures on the terrestrial biodiversity includes introduction of plant pathogenic micro organisms, insect pests and diseases as a major pressure on terrestrial biodiversity. An influx of planting material and fruits and vegetables from neighbouring countries without proper quarantine procedure is leading to rapid build up of these pests and diseases. MOFMR has recorded a number of pests and diseases that have been identified as harmful. A number of planting material of unknown background are also being introduced to the country as ornamental plant, the risk of such material becoming a pest is a real threat though no such incidence have been recorded. In the face of build-up of invasive species and the spread of disease more and more people are relying on the use of fertilizers and hazardous pesticides for their control which contaminates soil, harvest products and the environment in general. About 20 percent of imported fertilizers are inorganic fertilizers such as mineral or chemical fertilizers. Seven types of household pesticides are also being used which are on an increasing trend. Removal of vegetation also reduces habitat diversity and coastal biota. Today 25 islands of the 202 islands does not have any areas for new housing indicating that the natural vegetation of these islands are already cleared for housing and service infrastructure.

Protection of biodiversity is embedded in the policies and strategies of the various government sectors of the country. Strategies adopted by MOEC include implementation of the National Biodiversity Strategy and Action Plan to ensure sustainable use of extractive and non-extractive resources. Recent activities undertaken include Maldives Protected Areas Systems Project implemented for the purpose of establishing replicable and sustainable systems of protected area management. A model site Eidhigali Kulhi of S. Hithadhoo was selected and numbers of activities were undertaken. The site was declared as a protected area site on November 2004. As a planned activity Atoll Ecosystem based conservation of globally significant biological diversity in the Maldives' in another significant project to be implemented 2005-1010. The objectives being, mainstreaming biodiversity conservation objectives into sectoral policies and programs and reinforce multi-sectoral institutions and relieving livelihood-related pressure on biodiversity of enabling local people to pursue more sustainable alternative livelihoods. The tourism sector also highlights promotion of sustainable tourism through encouraging responsible planning and managing practices consistent with the management practice. To attain this policy the strategy is promotion of eco-tourism development, revise and implementation of management plan for marine protected areas and encouraging greater co-operation. Since 1997, the most environmentally outstanding tourist resort was awarded with the Green Resort Award. Similarly the Ministry of Fisheries, Agriculture and Marine Resources has its policy towards developing and managing the marine resources of the country in a sustainable manner.

WORST ENVIRONMENT DISASTER IN THE HISTORY OF MALDIVES, ASIAN TSUNAMI OF 26TH DECEMBER 2004

The tsunami generating as a result of the 9.0 magnitude earthquake off the west coast of northern Sumatra has led to disastrous effects in the Asian region. Maldives was among the many hit by the Asian tsunami. This incident showed the vulnerability of the low lying islands to such events. Almost all islands were affected causing flooding of entire islands. Preliminary reporting indicate more than 34 percent of inhabited islands were completely flooded, while more than 26 percent of inhabited islands were one third flooded. More than 90 percent of infrastructure and belongings were destroyed in severely affected islands. People from more than 18 islands had to be temporarily moved to other islands as their homes were destroyed.

The total death toll estimated by the end of 2004 remained 75 with 30 people still unaccounted for, totaling to 105. More than 60 percent of the fatalities and missing were children under the age of 10 years. Although the total number of fatalities and missing is a small number compared to other nations affected, this loss represents about 0.03 percent of the total population of Maldives.

This incident would lead to a number of environmental and public health concerns. Waste disposal has always been a major issue in the Maldives. With the islands being so small, in most islands the waste disposal site is near the beach area. Waste disposal sites on almost all affected islands were destroyed and the collected waste was scattered all across the islands including homes. Public health is greatly at risk from this distribution of waste on islands. Leeching of waste into the groundwater lens is of concern as groundwater is used as the main source for bathing, washing and general use except drinking in islands.

The groundwater is not only affected by waste, but also by oil pollution from destruction of many barrels of stored diesel for power generation in the islands. A much greater concern is salt intrusion into the groundwater. Many islands have already started to notice an increase in salinity of the groundwater, especially in the seriously affected areas. The long term impacts cannot yet be determined. Availability of safe freshwater would be a grave concern in Maldives.

Due to the flooding of salt water in the islands, much of the vegetation on the islands has been affected. The long term effects are not yet known, but even now some of the larger trees like breadfruit (Artocarpus Altilis), water apple (Syzygium Aqueum) and other local fruit trees show signs of yellowing and wilting leaves. Only the coconut palms seemed to remain unaffected yet. Some species of plants being totally wiped out is of concern. There is also great concern for the loss of vegetation especially that around the perimeter of the island which functions as a protection for the island. In addition, there is a great fear of the agriculture sector of Maldives being severely impacted.

Although the total extent of damage is not known, preliminary assessments show that a lot of damage has been caused to the coastal infrastructures on the islands. Some islands have reported severe land loss, especially in the reclaimed areas. Maldives already is very vulnerable to erosion and land loss, but the loss from this incident would have to be yet determined. The destruction to the coral reefs, the natural protection to the islands has yet to be determined. It is anticipated that there would be a huge physical and ecological damage to the marine ecosystem. Preliminary observations indicate that large amounts of fish, marine species and other coral debris were washed ashore by the incoming waves, and these had been collected in the cleaning process of the islands.

It is not only the inhabited islands that have been affected but tourism sector has also been very seriously affected. According to the Ministry of Tourism updates, more than 21 percent of resorts are still not operational. It is anticipated that this incident would cause an immense impact on tourism in Maldives.

This incident has left the nation devastated, with the need for a reconstruction of the whole nation. Much of the coastal infrastructure, including breakwaters acting as defense mechanisms have been destroyed. This event highlights the vulnerability of Maldives to such events. It highlights the need for strengthening our disaster preparedness mechanisms and also the need for focusing on protection of the islands.

1. THE MALDIVIAN SETTING

1.1 Geography and Land

The Maldives consists of a chain of coral atolls, 80-120km wide, stretching 860km from latitude 706'35"N to 0042'24"S, and lying between longitude 72033'19"E to 73046'13"E. These coral atolls are located on the 1600km long Laccadives-Chagos submarine ridge extending into the central Indian Ocean from the south-west coast of the Indian sub-continent. The Maldives shares boundaries of its Exclusive Economic Zone (EEZ) with Sri Lanka and India on the northeast and the Chagos Islands on the south.

It is believed that the Maldives was formed about 65 –225 million years ago in the Mesozoic Era (Maniku, 1990). There is more than a single theory on how the Maldives was formed, and one of them suggests that the Maldives grew above foundered continental crustal segments (Maniku 1990). Gardiner (1902, 1903) hypothesises that the main Maldives plateau was formed by current erosion and then subsequently atolls were formed by the growth of organisms on this plateau.

There are 26 geographic atolls in the Maldives and they vary enormously in shape and size. The largest atoll is Huvadhu Atoll with an area of approximately 2800km^2 (MPND 2000) and the smallest atoll Thoddoo Atoll has an area in the order of 5.4km^2 (MHAHE, 2001). The characteristics of the atolls, reefs and reef islands vary considerably from north to south. The northern atolls are broad banks, discontinuously fringed by reefs with small reef islands and with numerous patch reefs and faros in the lagoon (Woodroffe, 1989). In the southern atolls, faros and patch reefs are rarer in the lagoon, the continuity of the atoll rim is greater, and a larger proportion of the perimeter of the atolls is occupied by islands.

A total of 1192 islands are found in the chain of 26 geographic atolls, and the islands differ depending on location, form and topography (Woodroffe 1989). The islands vary in size from 0.5 km^2 to around 5.0 km^2 and in shape from small sandbanks with sparse vegetation to elongated strip islands. Many have storm ridges at the seaward edges and a few have swampy depressions in the centre. The largest island is Gan in Laamu Atoll with an area 5.16 km^2 (MPND 2000). A detailed land survey of the entire Maldives has not been undertaken yet and according to rough estimates, the total land area of the Maldives is about 300 km^2. The distribution of inhabited islands by island size is shown in Error! Reference source not found. and the ten largest islands in the Maldives are given in Table 1.1.

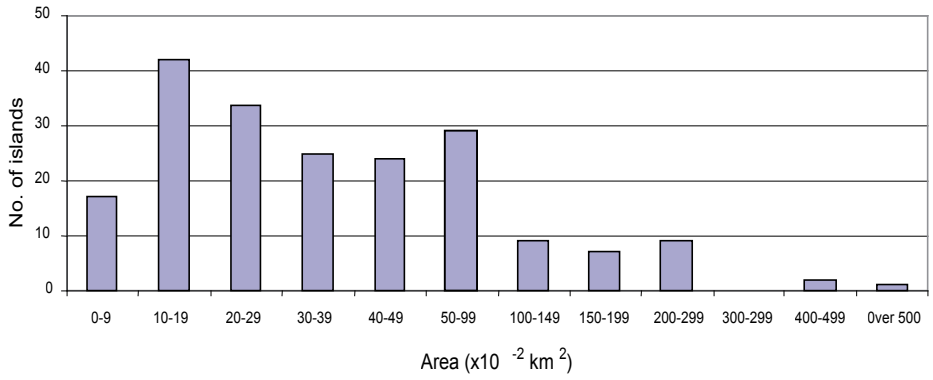

Figure 1.1: Distribution of inhabited islands by size

Table 1.1: Ten largest islands of the Maldives

Atoll	Island Name	Area (km2)	Population (2000)
1. Laamu	Gan	5.166	2244
2. Seenu	Hithadhoo	4.673	9461
3. Gnaviyani	Fuvah Mulah	4.200	7528
4. Laamu	Isdhoo	2.937	1432
5. Kaafu	Kaashidhoo	2.765	1572
6. Seenu	Gan*	2.649	-
7.Gaafu Dhaalu	Gan**	2.636	-
8. Haa Dhaalu	Hanimaadhoo	2.595	1009
9. Haa Alifu	Baarah	2.488	1270
10. Haa Alifu	Filladhoo	2.256	659

** - industrial / airport*

*** - uninhabited*

The maximum height of land above mean sea level within the Maldives is around 3 meters and around 80% of the land area is less than 1 meter above mean high tide level (MHAHE, 1999).

The 26 geographical atolls in the Maldives are grouped into 20 administrative regions. These administrative regions are also referred to as atolls. The capital, Malé forms a separate administrative unit (Table 1.2). Out of the 1192 islands 199 are inhabited (MPND 2000) and 87 have been developed as tourist resorts (MoT 2002).

Table 1.2: Administrative Regions, Atolls and Islands

Code of Atolls	Atoll Name	Alternative Atoll Name	Inhabited Islands	Industrial Islands	Airports	Resorts (2002)
A	Thiladhunmathi Uthuru Buri	Haa Alifu	16	2		
B	Thiladhunmathi Dhekunu Buri	Haa Dhaalu	16	7	1	
C	Milandhunmadulu Uthuru Buri	Shaviyani	15	5		
D	Milandhunmadulu Dhekunu Buri	Noonu	13	4		
E	Maalhosmadulu Uthuru Buri	Raa	15			1
F	Maalhosmadulu Dhekunu Buri	Baa	13	4		5
G	Faadhippolhu	Lhaviyani	5	8		4
H	Malé	Kaafu	9		1	43
U	Ari Atholhu Uthuru Buri	Alifu Alifu	8			11
I	Ari Atholhu Dhekunu Buri	Alifu Dhaalu	10	1		16
J	Felidhe Atholhu	Vaavu	5			2
K	Mulakatholhu	Meemu	9	1		2
L	Nilandhe Atholhu Uthuru Buri	Faafu	5	1		1
M	Nilandhe Atholhu Dhekunu Buri	Dhaalu	8	1		2
N	Kolhumadulu	Thaa	13	5		
O	Hadhdhunmathi	Laamu	12	7	1	
P	Huvadhu Atholhu Uthuru Buri	Gaafu Alifu	10	1		

Q	Huvadhu Atholhu Dhekunu Buri	Gaafu Dhaalu	10	2	1	
R	Fuvahmulah	Gnaviyani	1			
S	Addu Atholhu	Seenu	6		1	
T	Malé (Capital)		1			
	MALDIVES		199	49	5	87

1.2 Climate

The Maldives has a warm and humid tropical climate. The weather is dominated by two monsoon periods: the south-west (rainy) monsoon from May to November; and the north-east (dry) monsoon from January to March when winds blow predominantly from either of these two directions. The relative humidity ranges from 73% to 85%.

Daily temperatures of the country vary little throughout the year with a mean annual temperature of 28ºC. The mean daily minimum temperature recorded for Malé during 2003 was 25.4ºC and the daily mean maximum temperature for the same year was 31.1ºC. The highest temperature ever recorded in the Maldives was 36.8ºC, recorded on 19 May 1991 at Kadhdhoo Meteorological Office. Likewise, the minimum temperature ever recorded in the Maldives was 17.2ºC, recorded at the National Meteorological Centre on 11th April 1978.

Rainfall patterns are measured throughout the country by eight rainfall stations and it is evident that there are variations in rainfall from north to south through the atoll chain, with the north being drier and the south wetter. Average monthly and annual rainfall for Malé are 162.4mm and 1,948.4mm respectively. There has been considerable inter-annual variation in rainfall from 1,407mm to 2,707mm over the last 30 years. Figure 2.6 shows average annual rainfall for Malé and Gan over the last 30 years. The wettest months are May, August, September and December, and the driest January to April. The highest rainfall ever recorded in the Maldives with in 24 hour period was recorded on 9th July 2002 at Kaadedhdhoo Meteorological Office and amounts to 219.8mm of rainfall.

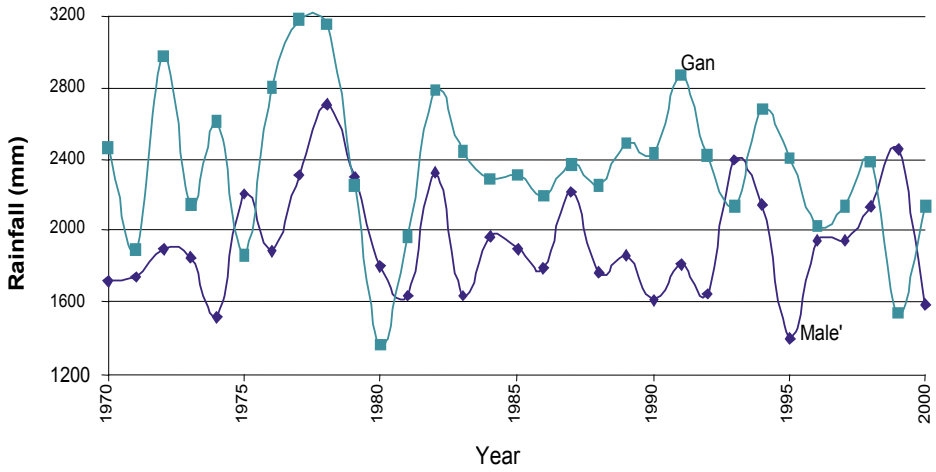

Figure 1.2: Mean rainfall for Malé and Gan 1970-2000

The current regime in the Indian Ocean is strongly influenced by the monsoon climate. In the region of the Maldives the currents flow westward during the Northeast monsoon period, and they flow eastward during the South-West monsoon period. The ocean currents flowing through channels between the atolls are driven by the monsoon winds. Generally, the tidal currents are eastward in flood and westward in ebb.

The swells and wind waves experienced by the Maldives are conditioned by the prevailing biannual monsoon wind directions, and are typically strongest during April-July in the south-west monsoon period. During this season, swells generated north of the equator with heights of 2-3 m with periods of 18-20 seconds have been reported in the region.

However, the Maldives also experiences swells originating from cyclones and storm events occurring well south of the equator. It is reported that the swell waves from south-east to south-south-east occur due to strong storms in the southern hemisphere in the area west of Australia with direction towards the Maldives. The swell waves that reached Malé and Hulhule in 1987 had significant wave heights in the order of 3 metres (JICA, 1987). Local wave periods are generally in the range 2-4 seconds and are easily distinguished from the swell waves.

Hydrographically the Maldives is characterised by a seasonal fluctuating mixed layer of relatively saline water from the Arabian Sea (360/00) and less saline water from the Bay of Bengal (340/00). A rapid downward decrease in temperature to below 20°C occurs at 90 –100 metres depth. The sea surface temperatures (SST) do not vary much through out the year. Average monthly SST generally ranges between 28-29°C with maximum temperatures rarely over 30°C. Mean monthly SST rises from a low in December/January to high usually in April/May. In the central atolls the average seasonal rise is about 1.3°C. However, during May 1998 mean monthly SST was 1.1°C above the highest mean monthly SST (30.3°C) expected in any 20 year period (Edwards et al 2001).

1.3 Marine and coastal areas

The dominant natural environment of the Maldives is the marine environment. Outside the atolls the deep ocean covers a large area, and the Exclusive Economic Zone (EEZ) and the territorial waters of the Maldives cover an area of 859,000km^2 and 115,300km^2 respectively. Lagoons, reefs and to a lesser extent sea grass and wetland areas make up the marine environment inside the atolls. The lagoon and reef areas make up about 21,300 km^2 (MPHRE, 1998).

The water depth varies considerably within the Maldivian waters. Lagoon waters within the atolls have depths ranging from 30 – 80m with the depth generally increasing from northern to southern atolls. Most lagoons of the atolls open into the Indian Ocean, and channels through the atoll margin are in some instances as deep as the lagoon itself. At the outer margins of the two atoll chains the ocean floor falls abruptly to great depths measuring up to 2000m or more. However, at the inner side of the two atoll chains the ocean floor has less depth. The main channel separating the eastern and western chain of atolls is generally between 250 and 300m deep. The east-west channels that separate the atolls are deeper with depths more than 1000m.

Atoll lagoons enclose a variety of reef structures including faros, micro-atolls, patch reefs and knolls. Faros are ring shaped reefs emerging during tidal low water, each with their own sandy lagoon and a rim of living coral consisting of branched and massive corals. Deep channels surround these reefs and faros are unique to the atolls of the Maldives. Patches rise to 30m above the lagoon floor the top of which have robust wave-breaking corals. Knolls do not reach the surface and often support profuse coral growth (Naseer, 1997).

The reefs associated with islands have the general characteristics described by Bianchi et al for the fringing reef around Alimatha island (Risk and Sluka, 2000). The island itself is sand, changing to coral rubble as the reef edge is approached. The outer slopes are very steep and area down to about 15m is covered with lush coral on a healthy reef. The outer reef slope is characterised by a series of reef terraces at depths of 3-6m, 13-30m, and a deeper one at 50m representing past sea level still strands. The modern coral growth is veneer over older reef rock , but the existing community is constructional down to a depth of at least 50m. In the upper levels reef building is by zooxanthellate corals. In deeper zones reef building is sometimes by azooxanthellate branching coral. Boring organisms found in Maldivian corals include several species of Lithophaga , various polychaete worms and several species of boring sponges. The blue boring sponge Cliona schmidtii is very common in the Maldives.

A geochemical analysis of the reefs emphasized the relatively pristine nature of the Maldives marine environment. Analysis of coral skeletons for common heavy metals showed values that were below detection limits in all cases. Values for extraneous organics in coral tissues were found to be typically low except for hydrocarbon residues found in corals near an island which stores fuel (Risk and Sluka 2000).

The white sandy beaches and the vegetation found on the island periphery are very important in the Maldives island ecosystem. They form an important protection for the housing and infrastructure near to the shore, and are the main source of income for the tourism industry. Of the tourists visiting the Maldives, it has been identified that 70% visit primarily for beach holidays.

Beach erosion is now among the most serious environmental issues facing the islands of Maldives. On many islands, the sand at the beach and shoreline are being washed off at a greater rate than it is accreted. The process of coastal erosion and accretion is extremely complex with interrelations to climatic, geological, oceanographic, biological and terrestrial processes affecting the growth and stability of the reefs and island structures. As the beach systems are highly dynamic in nature, the prevailing seasonal conditions may gradually shift the shape as well as the position of the island by strong beach erosion and accretion on either side of the island. The general and natural movement of sand and sediment is that during one monsoon the sand and sediments are gradually washed off (eroded) from one side of the island and are carried along the shoreline to the other end of the island. This process reverses during the next monsoon with sand being deposited (accreted) at the previously eroded side of the island.

1.4 Biodiversity

The extent of biological diversity including flora and fauna present in the islands of the Maldives is not yet adequately documented or thoroughly researched. Therefore, the degree of understanding on biological diversity in the country is restricted to the information available.

The main types of ecosystems found are coral reefs, islands, sea grass, swamps and mangrove areas. Coral reefs are the major type of ecosystem that exists in the Maldives in terms of area as well the diversity of life that exists in the system. This diversity is amongst the richest in the region and the corals reefs of the Maldives are significant on a global scale as well, being the 7th largest in the world, covering a total area of 8,920 km^2 and contributing 5% of the worlds reef area (Spalding et al. 2001).

1.4.1 Terrestrial

As the Maldives is an island nation, the extent of terrestrial biological diversity is much confined to the small island environments. The floral composition is considerable taking into account the absence of diverse terrestrial ecosystems and the poor and infertile nature of the soil. Islands in the south, particularly Fuvahmulah and Hithadhoo, demonstrate a richer diversification of plants than the north. The terrestrial faunal diversity is generally poor in the Maldives and is understandable in the absence of huge landmasses, forests and associated ecosystems. Webb (1988) noted that islands of the Maldives are not known for their abundant wildlife.

The close proximity of all land to the sea results in comparatively high soil salinity and as a consequence the natural vegetation contains a high proportion of salt tolerant species, both shrubs and trees. Based on published plant species lists and vegetation descriptions, 583 species of plants are found in the Maldives and, of these 323 are cultivated species and 260 are native or naturalized species (Adams, 1984). Over 300 plant species are known to have medicinal values, (ERC, 2001) and are utilized for traditional medicinal practices.

Webb (1988) described some constituents of the Maldivian reptilian fauna including: 2 gecko (Hemidactylus spp) commonly seen throughout the country; 2 agamid lizard including the common garden lizard or blood sucker, Calotes versicolar, the snake skink, Riopa albopunktata, and 2 species of snakes including the common wolf snake Lycodon aulicus and Typhlops braminus. One species of frog is known, the short-headed Rana breviceps, and a larger toad, Bufo melanostictus has also been found. During a study co-ordinated by Holmes on fruit bats and birds of the Maldives, a collection of insects, arachnids and mollusk specimens were made and spiders were found to be particularly rich. In the same study four species of bumblebees, which were very much a feature of the islands, were also collected (Holmes, 1993).

The only native mammals endemic to the country are the two subspecies of fruit bats, Pteropus gigantus ariel and Pteropus hypomelanus maris. The latter one is very rare and has only one record from the Maldives from Addu Atoll (Holmes, 1993). The other mammals, all probably introductions, are the house mouse, black rat, Indian house shrew and cats (Webb, 1988).

Over 190 bird species have been recorded from the Maldives including seabirds, shorebirds and terrestrial birds (Zuhair and Shafeeg 1999): most of which are seasonal visitors, migrants, vagrants, introductions, and imported as pets. Very few reside in the country most of which are seabirds. Terrestrial birds are very minimal compared to other tropical islands and most are probably introductions. A complete study on the ornithology of the Maldives has not been undertaken, however, some information is available regarding the distribution and status of a few species from researches undertaken by foreign and local experts.

Seabirds are widely seen throughout the country and are extremely important to the local communities as they have been keeping a very close relationship with them. Most of them are directly related to fishing in the Maldives. Tuna schools chase small fish and other marine life such as shrimps up to the surface where they are preyed on by several species of seabirds, and as many as 90% of the tuna schools are located this way (Anderson, 1996). At least 40-50 species of seabirds are seen in the Maldivian waters, of which only 13-15 are known to nest and breed in the country. Some of them are terns Sterna sumatrana, S. albifrons, S. anaethetus, S. dauglli, S. bergi, S. bengalensis, and S. fuscata, S. saundersi; two species of noddies Anous stolidus and A. tenuirostris, the white tern Gygis alba monte which is known to breed only in Addu Atoll (Anderson, 1996). Others such as frigate birds, white-tailed tropic birds, boobies and some shearwaters are also known to breed in the Maldives (Shafeeg 1993). Most of the shorebirds found are common winter visitors to the Maldives; however, there are some resident and immigrant species.

1.4.2 Marine

In contrast to the terrestrial biological diversity found in the country, marine biological diversity shows an outstanding richness, especially in the coral reefs, making the area one of the world's most diverse marine ecosystems (Pernetta 1993). However, documented information on the species diversity is limited (Ahmed and Saleem 1999). Available literature record relatively few species compared to the high diversity that exists in the marine environment.

The two groups of marine lives that are most studied are the fishes and the corals. Most recent accounts recognize 187 species of stony corals recorded in the Maldives (Sheppard 2000). To date a total of 1090 fish species have been officially recorded (Anderson et al. 1998 and Adam et al. 1998).

Marine algae including some 21 species of Cyanophyceae (blue-green), 163 Rhodophyceae (red), 83 Chlorophyceae (green) and 18 Phaephyceae (brown) have been recorded in the country (Hackett,. 1977). Other groups include; 36 species of sponges (Thomas et al 1991 & 1992), a little over 400 species of molluscs (Smith 1906, Coleman 2000), about 350 species of marine crustaceans (Borradaile 1903a, Borradaile 1903b, Borradaile 1903c, Borradaile 1906a, Borradaile 1906b Wolfenden 1906, Walker 1906, Alcock 1906, MRS 1995 and Nomura 1996) and over 80 species of echinoderms (Joseph 1991 and Coleman 2000).

There are 5 species of turtles all of which are endangered, including loggerhead turtle Caretta caretta, green turtle Chelonia mydas, Hawksbill turtle Eretmochelys imbricata, Olive Ridley turtle Lepidochelys olivacea, and leatherback turtle Dermochelys coriacea (Frazier et al., 1984). Marine mammals recorded include 7 species of dolphins and 9 species of whales (MRC, 1998).

1.5 Environmental management and legislation

Although the birth of a discrete legal corpus designed or frequently applied, specifically with the aim of preventing or resolving environmental problems is of recent origin, law as the instrument by which society is moulded and transformed always has been a significant factor in shaping the natural and physical environment.
We can all protect the environment by making simple changes in our lifestyles like turning the tap off when we brush our teeth and walking instead of going on a motorbike. We do not need legislation for this. But, we do need legislation to prevent activities causing significant environmental harm.

The environment protection policy of the Maldives is articulated in the National Environment Action Plan (NEAP). The inception of NEAP was in 1989 and it addressed environmental planning and management needs of the country and represented a combined approach to managing and solving the problems pertaining to the environment and subsequently finding ways of overcoming these problems.

The aim of NEAP is to protect and preserve the environment of the Maldives and to the sustainable management of its resources for the collective benefit and enjoyment of the present and future generations. The onus of aiding the government to maintain and improve the environment of the country falls within the ambit of the NEAP objectives.
It is expedient to make legal provisions in order to maintain clean and healthy environment by minimizing, as far as possible, adverse impacts likely to be caused from environment degradation on human beings, animals, plants, nature and physical objects; and to protect the environment with proper use and management of natural resources, taking into consideration that sustainable development could be achieved from the inseparable inter-relationship between the economic development and environment protection;

An Act was thus formulated by the People's Majlis to provide for the protection of the environment in 1993 which is called the Environment Protection and Preservation Act. This Act established a framework upon which regulations and policies can be developed to protect and preserve the natural environment and resources for the benefit of present and future generations. The Act was passed to support and promote the protection, enhancement and prudent use of the environment while recognising the following goals:

(a) Maintaining environmental protection as essential to the integrity of ecosystems, human health and the socio-economic well-being of society;
(b) Maintaining the principles of sustainable development, including
    i. The principle of ecological value, ensuring the maintenance and restoration of essential ecological processes and the preservation and prevention of loss of biological diversity,
    ii. the precautionary principle will be used in decision-making so that where there are threats of serious or irreversible damage, the lack of full scientific certainty shall not be used as a reason for postponing measures to prevent environmental degradation,
    iii. The principle of pollution prevention and waste reduction as the foundation for long-term environmental protection, including
        a. The conservation and efficient use of resources,
        b. The promotion of the development and use of sustainable, scientific and technological innovations and management systems, and
        c. The importance of reducing, reusing, recycling and recovering the products of our society,
    iv. The principle of shared responsibility of all Maldivians to sustain the environment and the economy, both locally and globally, through individual and government actions,
    v. The linkage between economic and environmental issues, recognizing that long-term economic prosperity depends upon sound environmental management and that effective environmental protection depends on a strong economy, and

vi. The comprehensive integration of sustainable development principles in public policy making in the country;

(c) The polluter-pay principle confirming the responsibility of anyone who creates an adverse effect on the environment to take remedial action and pay for the costs of that action;

(d) Taking remedial action and providing for rehabilitation to restore an adversely affected area to a beneficial use;

(e) Government having a catalyst role in the areas of environmental education, environmental emergencies, environmental research and the development of policies, standards, objectives and guidelines and other measures to protect the environment;

(f) Encouraging the development and use of environmental technologies, innovations and industries;

(g) Providing a responsive, effective, fair, timely and efficient administrative and regulatory system, recognizing that wherever practical, it is essential to promote the purpose of this Act primarily through non-regulatory means such as co-operation, communication, education, incentives and partnerships, instead of punitive measures.

Among modern environmental statutes environmental impact assessment (EIA) laws crystallize a preventive approach to environmental protection, because they integrate environmental considerations in decision making processes. Generally, EIA laws require the preparation of an environmental impact assessment for any proposed development activity, to review and assess its environmental impacts. The requirement can be applicable to a broad array of actions, and may include issuance of a permit or prior authorization, the funding of a project, and the adoption of a new statute or policy. The environmental assessment may be required to identify appropriate mitigation measures, or alternatives to the proposed action, that minimize environmental impacts.

The Government has thus given due diligence to the formulation of these statutes to regulate environment policies, laws and institutions to deal with all the environmental issues that the country is faced with. The Environment Section was formed in 1996 in The Ministry of Home Affairs. The onus of enforcing the Environmental Laws and Regulations was given to the Environment Section. Two years later The Environment Section was transferred to The Ministry of Planning and Development, which went on to become The Ministry of Planning And Environment giving the Environment Section the status of Ministry. Subsequently, Ministry of Planning, Human Resources and Environment was formulated in 1993. The mandate for environmental protection and management was transferred to The Ministry of Home Affairs, Housing and Environment which was formed in November 1998. The Environment Research Unit which functioned under the Ministry of Planning, Human resources and Environment was elevated to the status of Environment Research Centre which functioned under the ambit of government legislation, and was brought under the Ministry of Home Affairs, Housing and Environment. In September 2004, The Ministry of Home Affairs, Housing and Environment went through a series of changes, in that, Ministry of Home Affairs and the Environment Section became two separate entities. They now function as two separate Ministries, namely, Ministry of Home Affairs and Ministry of Environment and Construction.

1.6 Maldives in the International Arena

The Maldives gives high importance to taking part in the international agenda. Maldives is a member of many international organisations. Some of these organisations include the United Nations (UN), World Meteorological Organisation (WMO), World Health organisation (WHO), South Asia Co-operative Environment Programme (SACEP), International Maritime Organisation (IMO), International Civil Aviation Organisation (ICAO) and South Asian Association for Regional Cooperation (SAARC). The Maldives is also Party to a number of international agreements and treaties. Table 1.3 gives a listing of environment related conventions, treaties and agreements signed and ratified by the Maldives.

Table 1.3: Some of the environmental conventions signed and ratified by the Maldives.

Treaty/Convention/Agreement	Accession (A)
Ratification (R)	
International Convention for the Prevention of Pollution of the Sea by Oil (1954)	10 April 1982 (A)
United Nations Convention on the Law of the Sea (1982)	7 September 2000 (R)
Vienna Convention for the Protection of the Ozone Layer (1982)	26 April 1988 (A)
Montreal Protocol on Substances that Deplete the Ozone Layer (1987)	16 May 1989 (R)
The London Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (1990)	31 July 1991 (R)
The Copenhagen Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (1992)	27 September 2001 (R)
The Montreal Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (1997)	27 September 2001 (R)
The Beijing Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (1999)	3 September 2002 (A)
Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal (1989)	28 April 1992 (A)
Convention on Biological Diversity (1992)	28 October 1992 (R)
The Cartagena Protocol on Biosafety	2 September 2002 (A)
United Nations Framework Convention on Climate Change (1992)	9 November 1992 (R)
The Kyoto Protocol to the United Nations Framework Convention on Climate Change (1998)	30 December 1998
United Nations Convention to Combat Desertification (1992)	3 September 2002 (A)

During the last five years Maldives have been actively implementing activities related to the obligations of the following conventions:

- Vienna Convention and Montreal Protocol
- Convention on Biological Diversity
- The Cartagena Protocol on Biosafety
- United Nations Framework Convention on Climate Change (UNFCCC).

1.6.1 Vienna Convention and Montreal Protocol

The government has taken various steps to regulate ozone depleting substances (ODS) to comply with obligations under the Montreal Protocol. Some of the identified steps include:

- Introducing a license to import any form of ODS into Maldives (1 April 2002)
- Banning the import of certain ODS into Maldives (1 January 2003)
- Banning of all equipment using CFC-11 and CFC-12 (1 January 2004)
- Introducing a Refrigerant Management Plan (RMP) to control, regulate and manage all ODS in the country.

In addition an ODS phase-out schedule has been developed for the Maldives. Under the plan, it is planned to phase-out production and consumption of CFCs and Carbon tetrachlorides by 2010. It is planned to phase-out consumption of HCFCs by 2040 (Source: ERC).

1.6.2 Convention on Biological Diversity

A National Biodiversity Strategy and Action Plan of the Maldives (NBSAP) and the Nation Country Report to the Convention on Biological Diversity were undertaken under an Enabling Activity. The Country Report was submitted to the convention in 2002. The first full standing project implement the NBSAP is now being implemented. This project; Atoll Ecosystem Based Conservation of Significant Biological Diversity is implanted under funding from the Global Environment Facility (GEF)

1.6.3 The Cartagena Protocol on Biosafety

Preparation of a Biosafety Framework for the Maldives is being undertaken by the Environment Research Centre (ERC). The framework is being developed under a consultative process including stakeholders from government, private sector and NGOs.

1.6.4 United Nations Framework Convention on Climate Change

Being a small island state, Maldives has been very actively voicing the concerns of climate change and sea level rise. Maldives is a party to the UNFCCC and was the first country to sign the Kyoto Protocol and has been actively participating since its inception and throughout the IPCC processes. Maldives has undertaken the initial Climate Change Enabling Activity to prepare the First National Communication of the Maldives to the UNFCCC. The report was submitted to the UNFCCC in 2001. Maldives is presently undertaking work on preparing the National Adaptation Plan of Action, Technology Needs Assessment for Climate Change and a National Capacity Self Assessment. These three projects are being implemented under an integrated climate change strategy.

2. Socio-Economic Development

2.1 Introduction

Maldives has undergone unprecedented social and economic change over the past years. These socio-economic developments provide the backdrop against which to view changes in the state of the environment because they serve as an impetus to environmental change. Often socio-economic forces and circumstances create incentives for more activities that put pressure on the environment and create disincentives for more sustainable behaviour. The three pillars of sustainable development being the society, economy and the environment, the challenge of implementing sustainable development lies in the difficult trade offs we are faced with where the society have to find a balance between economic growth, social equity and the conservation and protection of the environment.

2.2 Social developments

2.2.1 Demographic change

Figure 2.1 reveals the increasing trend of the population within the last 89 years, from 72,000 in 1911 to 270,101 by 2000.

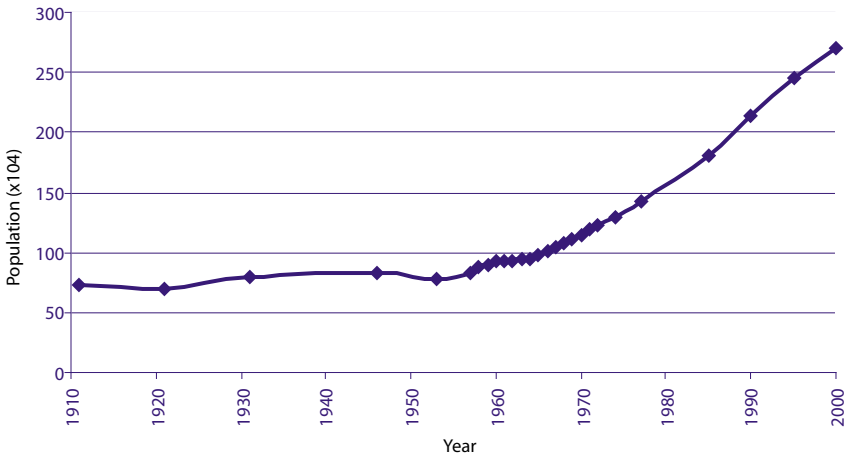

Figure 2.1: The population of Maldives 1911-2000

Source: Statistical Year Book, MPND, 2004

Comparison of the 1995 population figures with year 2000 figures reveals that the population has increased from 244,814 in 1995 to 270,101 in 2002. As can be seen from Table 2.1 between 1995 and 2000 total population has increased by 10 percent. The population growth rates have declined from 2.73 percent in 1995 to 1.96 percent in 2000 with significant atoll/island variations. The decrease in growth rate could be attributed to the declining fertility and mortality levels. Fertility levels have fallen from 5.3 in 1995 to 3 per woman in 2000. The crude death rate has also fallen from 5 in 1997 to 4 per thousand since then. Similarly, the infant mortality rate also declined from 21 in 2000 to 14 per 1000 by 2003 while mortality rates declined to 18 by 2003. (MPD, 1995, 2000).

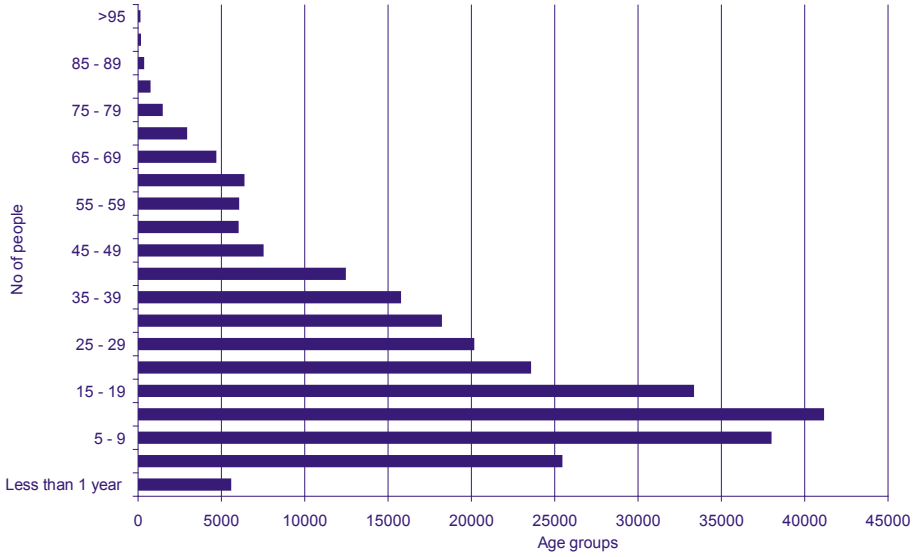

Figure 2.2: Population by age group, 2003

Source: Statistical Year Book, MPND, 2004

Age distribution of the population reveals that the country has a youthful population with 40 percent less than 15 years old and 35 percent of the population between the ages of 15-35.

This reflects that a larger number of workers would be available for work even reflecting negative socio- economic implications such as high unemployment as well pressures of population growth.

Table 2.1: Demographic change between 1995 - 2000

	1995	2000	% increase
Total population	244814	270101	10
Population-Malé	62519	74069	18
Population- Atolls	182295	196032	8

Source: Statistical Year Book, MPD, 2004

The increase in the population of Malé is 18 percent as compared to the 8 percentage increase in the atolls. Malé being the capital is the economic centre of the Maldives with some 28 percent of the total population. The better social services and other infrastructure have resulted in greater inward migration that has placed unsustainable demands on the resources resulting in a population density that exceeds 37000 per square km making it one of the most densely populated cities in the world.

Over the years, the increase in population of Malé has directly affected the use of resources and their degradation. Population growth in Malé has associated with the growth of resource consumption and degradation, expansion and intensification of land use, and exploitation of marginal lands. Over-extraction of groundwater has severely depleted and contaminated the aquifer resulting in irrecoverable damage. Lack of space for housing, social services and recreation has resulted in social strains.

The geographical dispersion of the island population is distributed unequally with population density differing greatly across the country. Table 2.2 and Table 2.3 highlights the ten most populated islands and 10 least populated islands and its densities illustrating that the population has ranged from over 74000 in Malé to 108 in Lh.Maafilaafushi.

Table 2.2: Ten most populated islands and densities

Atoll/ Island	Population	Densities (persons/ha)
Malé	74069	383.77
Hithadhoo	9461	20.25
Fuvahmulah	7528	17.92
Kulhudhuffushi	6581	38.22
Thinadhoo	4893	84.22
Naifaru	3707	259.78
Hinnavaru	3212	443.65
Feydhoo	2829	60.61
Dhidhdhoo	2766	54.63
Kadholhudhoo	2717	617.5

Source: Statistical Year Book, MPD, 2004

Table 2.3: Ten least populated islands and densities, 2000

Atoll/Island	Population	Densities (persons/ha)
Lh.Maafilaafushi	108	2.20
AD. Dhidhdhoo	113	8.43
V.Thinadhoo	114	12.53
M.Madifushi	122	11.19
Ha. Berinmadhoo	124	8.50
Ga. Dhiyadhoo	139	2.85
B. Fehendhoo	149	7.23
Ha.Hathifushi	150	36.59
HDh.Faridhoo	159	6.83
M. Raiymandhoo	171	7.92

Source: Statistical Year Book, MPND, 2004

2.2.2 Demand for housing

With the increase in population, demand for housing also increased, putting additional pressure on the environment. Table 2.1 compares the increase in the number of households for the year 1995 and 2000.

Table 2.4: Change in the number of households from 1995 - 2000

Year	1995	2000	% increase
Total households	34435	40912	19
Households - Male	6758	9700	22
Households -Atolls	27677	31212	13

Source; Statistical Year Book, MPD, 2004

Holistically, the number of houses has increased by 19 percent of which, the increase of households in Malé represents 22 percent while that of the atolls is 13 percent. The increase in households is higher than the increase in the population. This reflects the change in life style with a preference of nuclear families increasing the demand for housing as reflected from the decrease in the average household size from 9 in 1995 to 8 in 2002. With the shortage of land area, size of housing plots also decreased and the registered number of housing plots keep on changing as a result of continuous subdivisions of existing housing plots. Malé municipality regulations restrict heights of the building to 10 floors or 30.48 m and subdivision are limited to 55.75 m^2. Though subdivisions are limited to 55.75 m^2 people are forced to live in smaller sub divisions. In Malé today housing plots are very small consisting of narrow buildings with rising floors.

According to MHUDB, by 2002, 60 percent of the households live at more than 2.5 people per sleeping room; and 46 percent at 3 or more people per sleeping room compared to 30 percent of all households living at 2.5 percent per living room in 1983. The survey also revealed that 69 percent of households live with less than 5 square meters per person; 19 percent have less than 2.5 square meters per person.

With the increase in population and the subsequent increase in demand for housing led to land reclamation programs and housing projects. Following is the area of land reclaimed and levelled on a yearly basis from 1979 to 1986.

Table 2.5: Area of land reclaimed, 1979-1986

Year	Area Reclaimed (in 000's of square feet)
1979 from April	26
1980	1458
1981	906
1982	907
1983	1342
1984	136
1985	796
1986 [1]	829
1 Estimated	

Source: Department of Public Works and Labour, 1985, Ministry of Environment and Construction

The Malé Housing Project was also initiated in 1988 to combat the problem associated with the overcrowding and congestion resulted from scarcity of land and lack of housing. Six housing blocks, with 161 flats were constructed in Malé and Vilingili to cater for the increasing demand for housing.

Table 2.6: Number of Units constructed under Malé Housing Project

Phases	No. of 2 bedroom units	No. of 3 bedroom units	No. of 4 bedroom units	Total flats
Phase 1	12	8	4	24
Phase 2	12	8	4	24
Phase 3	5	10	5	20
Phase 4	13	20	0	33
Phase 5	18	18	0	36
Phase 6	8	10	6	24
Total	68	74	19	161

Source: MHUDB, 2004

The Vilingili Settlement Program began in 1993 to accommodate the increasing population in Malé. By 2004, 4291 people have settled in Vilingili compared to the 300 people that settled in Vilingili in 1995. The 3991 increase over the five year period reveals the increase in demand for and housing in Malé.

In May 2004 human settlements in Hulhumalé began and at present 280 flats and 222 plots of land are occupied. Under the Hulhumalé project 1.88 square meters of land were reclaimed. Hulhumalé has a capacity of 8920 houses and 280 flats providing accommodation for 100, 0000 people.

Similar to Malé, in many of the other islands in the Maldives demand for housing is on the increase. Today 25 islands do not have additional land for housing. Moreover, R. Kadholhudhoo, Lh. Hinnavaru have a higher population density than that of Malé while Lh.Naifaru has a population density more than 200. These islands do not have the infrastructure and services of Malé. The extreme level of over crowding causes great stress on vulnerable ecosystems, risk to infection and other social problems.

The Population Development and Consolidation Program was initiated with the aim of minimizing serious diseconomies of scale faced by the country in the provision of socio-economic services by promoting economically viable population concentration on large islands. The strategy is to encourage the inhabitants of small and remote islands to voluntarily move to larger islands where the socio-economic services and employment opportunities are in place to enable them to enjoy a better standard of living. The Regional Development Project which was initiated in 2000 is also part of the Population Development and Consolidation Program which targets the Hdh. Kulhudhufushi and S. Hithadhoo as the growth centres of the North and South to support balance development of the country easing pressure off Malé. Focus islands were identified primarily on the basis of population where implementation of development could be the most cost-effective.

2.3 Economic Developments

2.3.1 The Economy

Gross Domestic Product totalled to US$ 644 million in 2003, with per capita GDP reaching US$ 2261. From 2002 to 2003, GDP per capita increased by 6.8 percent. During November 2004, the Economic and Social council of the United Nations endorsed the graduation of Maldives from the group of Least Developed Countries. The graduation will become effective three years after the General Assembly decision to take note of the recommendation. During the three year period, the country would remain on the list of Least Developed Countries and would maintain the advantages associated with membership.

As illustrated in table the primary sector consist of agriculture, fishing and coral and sand mining which forms 9.8 percent

of the GDP. Fishing is the major economic activity of the primary sector forming 6.6 percent of the GDP.

Table 2.7: Percentage share of GDP by kind of activity, 2000-2003

	2000	2001	2002	2003
Primary	9.4	9.5	10.4	9.8
Agriculture	2.8	2.8	2.7	2.6
Fishing	6.0	6.1	7.1	6.6
Coral/Sand mining	0.6	0.6	0.6	0.6
Secondary	14.4	15.1	15.6	15.5
Manufacturing				
(fish preparation)	8.0	8.1	8.8	8.3
Electricity and water supply	3.2	3.4	3.5	3.6
Construction	3.2	3.5	3.3	3.6
Tertiary	80.1	79.3	77.9	78.7
Tourism	33.0	31.9	30.9	32.7
Others	47.1	47.4	47	46

Source: Statistical Year Book, 2004

Manufacturing, electricity water supply and construction form the secondary sector accounting for 15.5 percent of GDP. Manufacturing including fish preparation and is the largest economic activity under the secondary sector and accounts for 8.3 percent of the GDP.

The tertiary sector is the largest sector accounting for over 78 percent of GDP in 2003. Tourism share is 32.7 percent and is the largest sector. Tourism and fisheries is the mainstay of the economy. Together they account for 39.3 percent of the total GDP. Fisheries remain the principal source of livelihood to the majority of the atoll population. The sector also provides backward and forward linkages such as employment in the boat building, and fish processing. Equally important is the tourism sector providing employment opportunities in other sectors such as transport, communication distribution and construction.

2.3.2 Fisheries

In 2003, fishing has contributed 6.6 percent to GDP and is the sixth largest sector in terms of contribution to GDP. Over the last eight years the share of fisheries in GDP is stable ranging from 6.0 percent in 2000 to 7.8 percent in 1995 (Figure 2.3). The government policy is focused on encouraging private sector investments in the post harvest component of the tuna fishery resulting in production and export of smoked dried tuna and export of fresh chilled yellow fin. More recently, privatisation of state owned fish collection, processing and exporting company led to increased private sector participation.

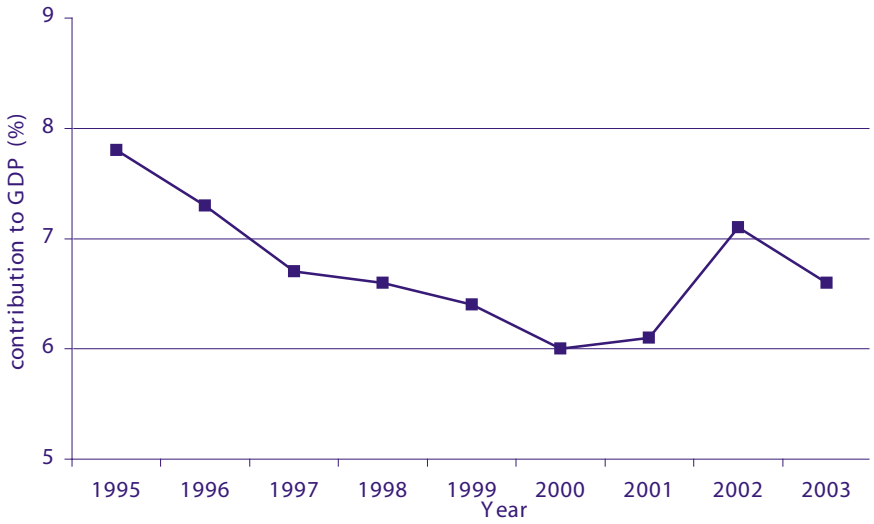

Figure 2.3: Contribution of fisheries to GDP, 1995-2003

Source: Statistical Year Book, MPD, 2004

In terms of employment, fishing is significantly important to all the regions of the country and is one of the highest generators of employment in the atolls. In 2003, over 14000 are employed as fishermen providing direct employment opportunities.

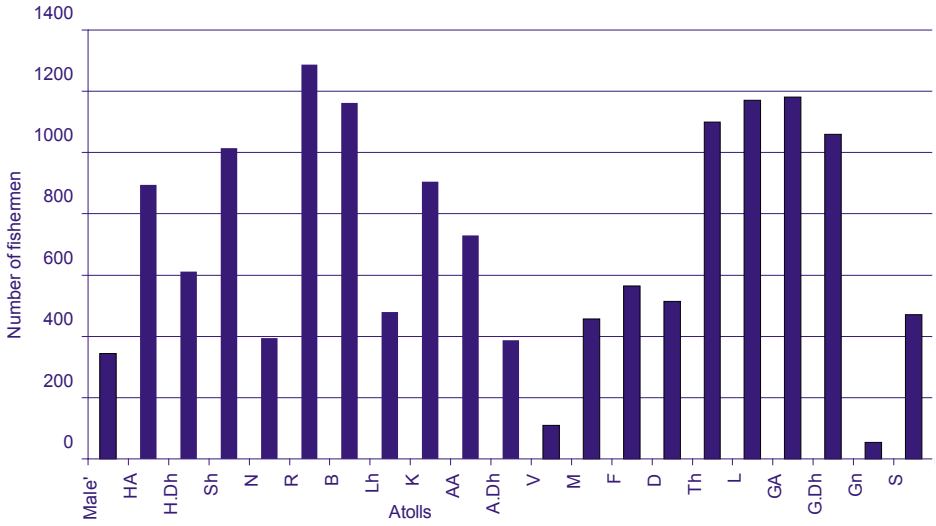

Figure 2.4: Number of fishermen, 2003

Source: Statistical Year Book, MPND, 2004

Though tuna constitutes over 89 percent of the fish caught using the method of tuna pole and line fishing, the opportunities for different types of reef fishing have become more lucrative during recent years with the development of tourism sector.

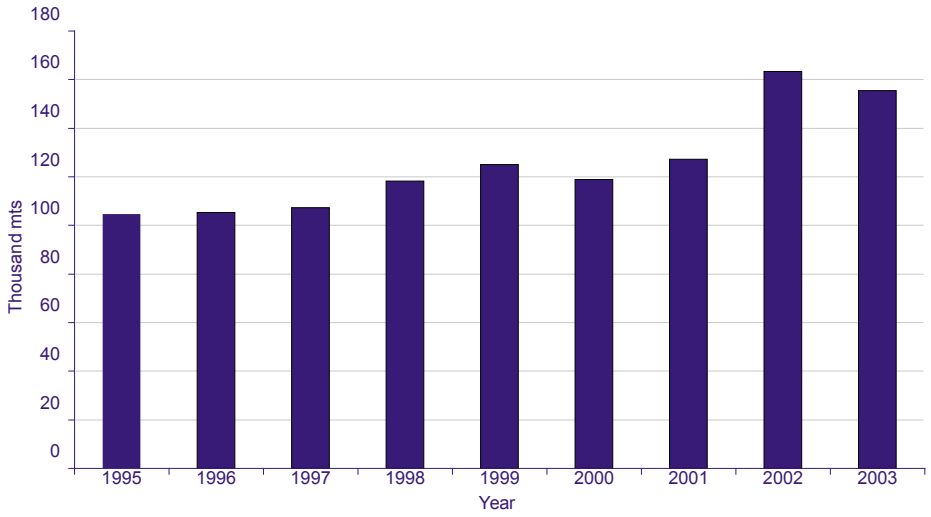

Figure 2.5: Fish catch in thousand mts (metric tonnes) 1995-2003

Source: Statistical Year Book, MPD,

Total recorded fish catch in 2003 is 155.4 thousand metric tons which is a 5 percent decrease over the previous years catch of 163.4 thousand metric tons. Export consists of 72 percent of the total catch in 2003, and the exporting earnings reached Rf 506630 thousand in 2003.

2.3.3 Agriculture

From the primary sector, the contribution of the agriculture sector's to GDP in 2003 was 2.7 percent. As illustrated in Figure 2.6 from 1995 to 2003 the contribution of the agriculture sector to GDP is on a declining trend.

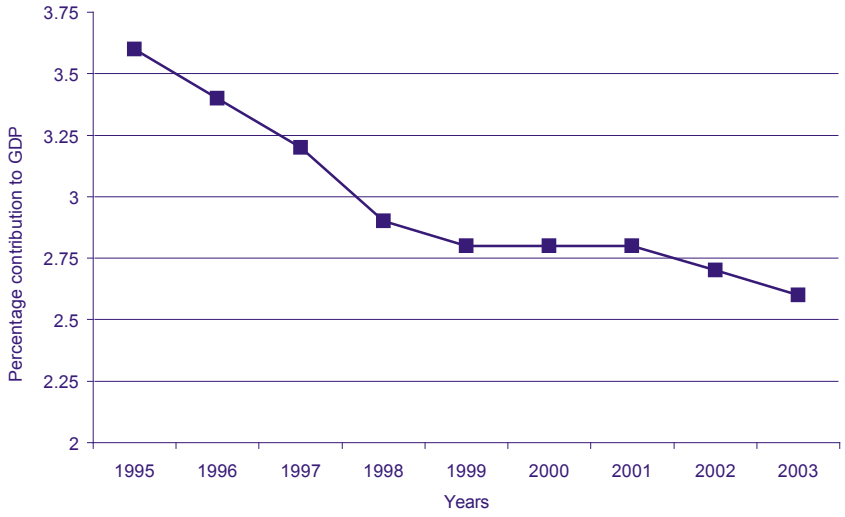

Figure 2.6: Contribution by the agriculture sector to GDP, 1995-2003

Source: Statistical Year Book, MPND, 2004

Generally, agriculture tend to become disadvantaged at the local level when there are alternative sources of income, given the amount of work they entail to become successful. In many cases agriculture is being practiced as a home gardening activity and in such cases would likely to be more of a casual nature in terms of allotment of time, not reflecting it as an employment activity. The extent of the employment in the agriculture sector varies across the country with employment being most dominant in the islands in the North which are further away from the atoll capital where employment opportunities in the secondary and tertiary sectors are relatively more limited compared to other islands. Coconut is

the most widely harvested agricultural product in the Maldives. The total coconut production reached over 73 thousand by the year 2003. In recent years horticulture crops production such as cucumber and water melons have increased significantly.

With the development of the tourism industry demand for fresh agriculture products are also on the increase. Consequently, agriculture is being developed as a commercial venture in islands that are leased for long period of time. Agricultural production has increased during recent years with the development of these ventures and by 2003 such agricultural islands are being developed in eight atolls of Maldives. The production from these agricultural islands was over 815 mts in year 2003. The total agricultural products traded in Male' market was over 5 thousand mts and in valued term reached over Rf 44 million. Despite the increase in production the supply of local production does not meet the demand of the tourism sector. Hence many fruits and vegetables are imported.

2.3.4 Tourism

Tourism in the Maldives is the largest industry, which accounted for 32.7 percent of GDP in 2003. The tourism industry, which began in the Maldives in 1972, has rapidly expanded. By 2003, 87 resorts are in operation with a total bed capacity of 18447.

Table 2.8: Total registered bed capacity, 2000-2003

Type	2000	2001	2002	2003
Resorts	15914	16318	16400	16444
Hotels	744	688	670	670
Guest houses	356	367	282	360
Safari vessels	1716	1392	1475	1636
Total	18730	18765	18827	191100

Source: Statistical Yearbook MPD, 2004

Between 2000 to 2003 the percentage share of tourism revenue has ranged from 29.4 to 32.9 while the sectors total earnings show an increasing trend reaching Rf 899.65 million by 2003. The development of the tourist arrivals is illustrated in Figure 2.7 where total tourist arrival reached 563,593 in 2003.

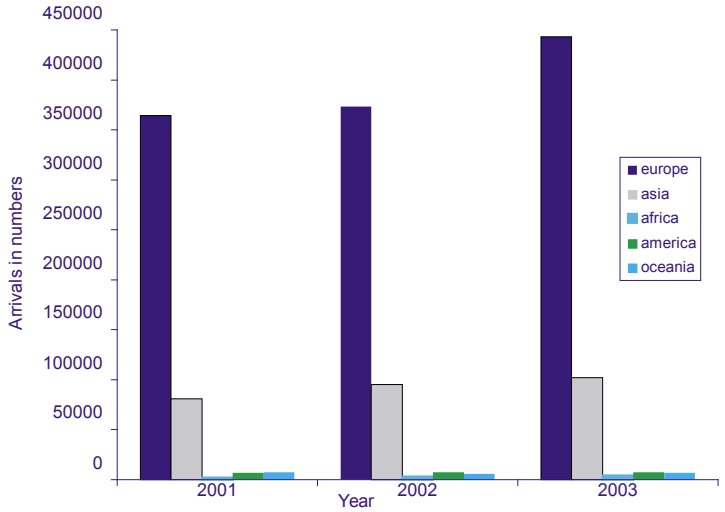

Figure 2.7: Flow of tourist arrivals in Maldives by nationality, 2000-2003

Source: Statistical Year Book, MPD, 2004

The occupancy rate also shows an increasing trend as illustrated in Fig 2.8

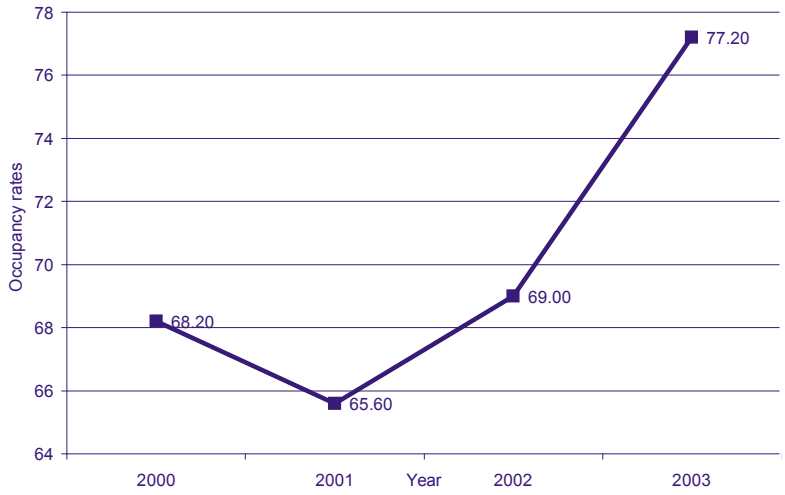

Figure 2.8: Occupancy rates, 2000-2003

Source: Statistical Year Book, MPD, 2004

Employment in sector representing the tourism industry totalled to over 17000 out of which 56.5 comprises of local employment. As the majority of the tourist resorts are being located near Malé. Employment from the tourism sector is concentrated in Malé and regions around Malé. On a minor scale, the sector has provided employment to all the regions of the country. In terms of tourism development the government policy is to direct tourism towards those regions which at present have regional airports. The Government of Maldives represented by the Ministry of Tourism has announced the development of an additional 1600 beds in the 11 designated islands. When the new 11 islands are developed as resorts it would ensure an additional 1600 beds to the tourism industry which will ensure that each atoll from which the island originates will have 200 tourist beds.

Tourists are attracted to Maldives due to the physical and geographical features of the coral reefs. The beauty of the underwater at reefs, crystal clear water in the lagoon and the white sandy beaches, and the tropical climate are the main features that lure the tourists to Maldives. Big game fishing and sport fishing are also additional attractions that are becoming popular. Tourists stay in the Maldives on an average duration of eight days.

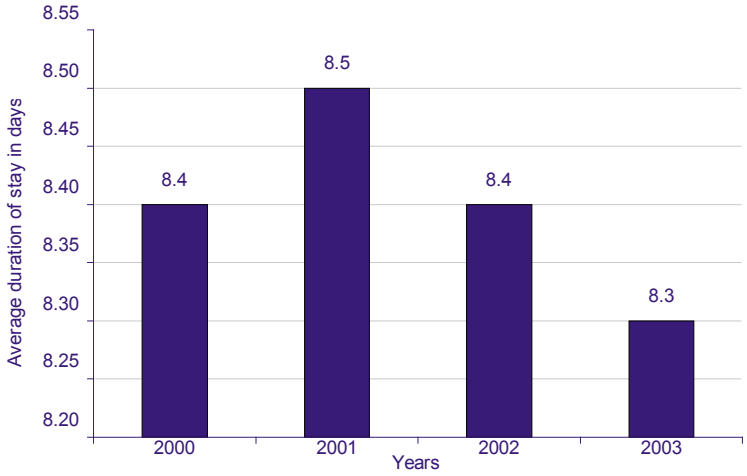

Figure 2.9: Average duration of stay by tourists for the period 2000-2003

Source: Statistical Year Book, MPD, 2004

2.3.5 Coral and sand mining

From the primary sector, mining of coral and sand is not a country wide commercial activity and is carried out at a minor scale compared to other employment activities. The use of bricks as building material has limited the demand for coral and such employment within the industry is directed towards collecting sand. Moreover, coral and sand mining from the beaches are banned, restricted to lagoons and monitored through the island office and atoll offices limiting the scope of primary sector in terms of employment.

3. Climate Change and Sea Level Rise

3.1 Introduction

The issue of climate change and predicted sea level rise is of high global significance. According to the Third Assessment Report of Working Group I of the Intergovernmental Panel on Climate Change (IPCC, 2001), the best estimate for the global average surface temperature over the last 140 years show that it has increased by 0.6 ± 0.2 C. This increase is both due to natural variability and human activity (IPCC, 2001). Concentrations of atmospheric greenhouse gases have continued to increase largely due to human activities such as fossil fuel burning and land use change. According to IPCC, recent evidence and also taking into account the uncertainties, the observed atmospheric warming over the past 50 years can be attributed to the increase in greenhouse gas concentrations.

Based on past trends, climate models predict future scenarios of increase in global surface temperatures and a rise in sea level. The IPCC Third Assessment Report estimates a predicted sea level rise of 0.09m to 0.88m for years 1990 to 2100 using the best estimates (IPCC, 2001).

With such projections, it is small island states like the Maldives which are the most susceptible. More than 80% of the islands in Maldives are less than a meter above mean sea level (MHAHE 2001). The average island size of the inhabited islands in Maldives range around 0.1 to 0.3 square kilometres with the largest inhabited island being less than 5.2 square kilometres (SOE 2002). The small sizes of the islands force human settlements and vital infrastructure to be located near the coast and thus at high risk from climate change and predicted sea level rise.

3.2 Existing Situation and Impacts of Climate Change

Maldives submitted the First National Communication to the United Nations Framework Convention on Climate Change (UNFCCC) in 2001. The work for completing the First National Communication was undertaken as a Climate Change Enabling Activity funded by the Global Environment Facility (GEF). Under this Enabling Activity, the National GHG Inventory was completed for the baseline year 1994. Options for mitigating GHGs were identified and a vulnerability and adaptation assessment was undertaken. In addition, a National Implementation Strategy for addressing climate change was developed.

3.3 National GHG Inventory and Mitigation of GHG Emissions

The first GHG inventory for the Maldives was done for the baseline year 1994 using the IPCC Reference Approach. The lack of data available prevented using the sector approach to estimate the emissions of the major three GHGs; carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O); from all sectors. Therefore emission of CO_2 from the energy sector has been taken as the main GHG for the Maldives. It was estimated that 129 Gg of CO_2 was emitted by the energy sector (MHAHE 2001). Emissions of CH_4 from landfill have also been estimated depending on available data. The estimated CH_4 emission from disposal of municipal solid waste was 1.142 Gg (MHAHE 2001).

Table 3.1: Relative CO_2 emissions from the energy sector

	Population (millions)	CO2 emission per capita (t)	Total CO2 emission (Mt)
Kiribati	0.08	0.23	0.19
Tuvalu	0.01	0.50	0.01
Maldives	0.24	0.54	0.13
Cook Island	0.05	0.69	0.03
Marshall Islands	0.04	3.64	0.16
World	5624.4	4.02	22620.46
OECD	1092.3	11.09	12117.05

The Inventory estimates that the energy sector emissions of CO_2 for Maldives are 0.13 Mt, which is only 0.0012% of the global emissions from the energy sector. The per capita emission of CO_2 for Maldives is 0.54M t, which is consistent with the values from other small island countries in the Pacific.

Maldives being a non-Annex I party to UNFCCC, is not obliged to implement mitigation measures. But implementing mitigation measures would be a step towards achieving long term sustainable development. The main option for mitigating GHG emissions was identified as lowering the demand for imported fossil fuel by increasing the efficiency in generating and utilising energy and improving the efficiency of the transportation mechanisms. Thus, some of the identified mitigation options for the energy and transportation sector are given below.

Table 3.2: Identified mitigation options for the energy and transport sectors

Energy Sector	Transportation Sector
Use of high efficiency generators	Banning the import of reconditioned vehicles
Increase awareness on the use of high energy efficient appliances	High import duty on vehicles
Use of solar energy for desalination	Mitigation for land and sea transport sectors
Increase the use of renewable energy sources	Development of a public ferry transport system

Most of the identified mitigation options from the energy sector are being undertaken from the Ministry of Communication Science and Technology (MCST), which is the government authority mandated with the management of the energy sector.

The Ministry of Transport and Civil Aviation (MTCA) is in the development stage of the Maldives Transport Master Plan. The development of this Master Plan includes plans for the development of inter-atoll and inter-island ferry systems. In addition MTCA is also looking into feasibility of public transport systems in Male'. Better management of transport systems would help to contribute to mitigate GHG emissions.

3.4 Vulnerability to Climate Change

Although Maldives contribution to global GHG emissions is less than 0.01%, Maldives is in fact one of the most vulnerable countries to climate change and sea level rise. In addition to the low lying nature, the fact that the island ecosystem is based on coral reefs makes the Maldives very vulnerable. A Vulnerability Assessment was conducted for Maldives under the Climate Change Enabling Activity, and under this the major vulnerability areas were identified.

3.4.1 Beach Erosion and Damage to Human Settlements and Infrastructure

With much of the land less than a meter below mean sea level, the islands are very vulnerable to inundation and beach erosion. The beach systems found on the islands are highly dynamic and have directional shifts within the shoreline in accordance with the prevailing seasonal conditions. In addition to natural erosion, effects of human induced erosion from such activities as coastal modification also play a role in the changing beach dynamics.

With the continuing increasing population there is increasing demand for housing and associated pressures on the islands. At present 24 islands have already exceeded their withholding capacity and do not have additional land for housing. Thus with the housing and other infrastructure reaching closer to the shoreline, this makes them more vulnerable to effects of sea level rise.

Figure 3.1 and Figure 3.2 show the reported distance between the high tide line and the closest building of the inhabited islands in Maldives (MEC 2004). According to the figures, more than 73 percent of the inhabited islands have buildings less than 100 feet away from the shoreline. 2 percent of the islands have building right at the shore line. This is largely due to the small size of the islands and the increasing pressure from the growing population. As seen in Figure 3.2, more than 55 percent of the islands have buildings less than 50 feet from the shoreline.

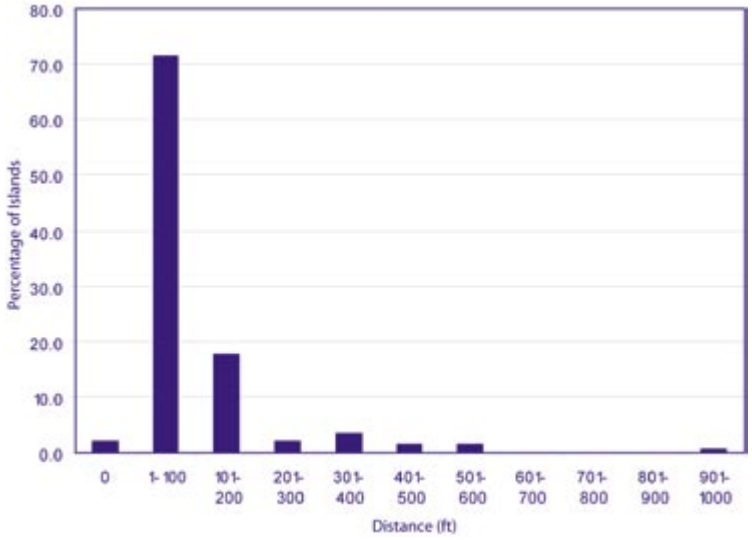

Figure 3.1: Reported distance between high tideline and closest building in inhabited islands of Maldives

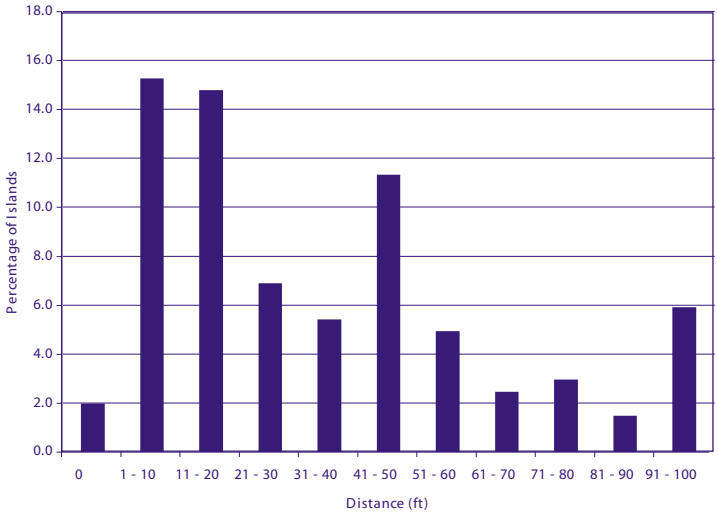

Figure 3.2: Reported percentage of inhabited islands with less than 100 feet between mean high tide and closest building

According to Maniku (1990), inundation of parts of islands, usually accompanied by high waves or heavy rainfall is experienced in Maldives. Even today it is common place to see flooding of parts of islands from the tide coming ashore during the stormy weather. According to IPCC 2001, the intensity and frequency of future extreme weather and climate events are very likely to change with adverse impacts on the biophysical systems (IPCC 2001).

Maldives also experiences its share of stormy weather, especially during the southwest monsoon. Reported incidences and impacts of severe weather show that most severe weather events occur between May to July (MEC 1). Most of the reported damage is caused by flooding tides and strong winds.

More than 57 percent of inhabited islands from 18 atolls reported being affected by the severe weather incident occurring in May 2004, to the Ministry of Environment and Construction. During this episode 71 inhabited islands were flooded causing vast amounts of damage to these islands. A cost analysis of the reported damage from this event showed that over 10.2 million US dollars worth of damages was caused.

Table 3.3: Reported number of Inhabited islands affected by severe weather events of May 2004

Atoll	Total no. of islands	no. of islands affected	no. of flooded islands
Haa Alif	16	16	7
Haa Dhaal	16	15	5
Shaviyani	16	9	4
Noonu	13	4	0
Raa	15	10	3
Baa	13	4	4
Lhaviyani	5	5	2
Kaafu	9	4	2
Alif Alif	8	3	3
Alif Dhaalu	10	4	4
Vaavu	5	4	4
Meemu	9	6	6
Dhaalu	8	5	5
Thaa	13	8	4
Laamu	12	3	3
Gaaf Alif	10	6	6
Gaaf Dhaal	10	7	7
Seenu	6	3	2
Total	197	116	71

(Source: MEC)

Note: Faafu atoll and Gn atoll are not reported

Resorts in Maldives as dictated by the national tourism regulations are developed on uninhabited, small, low-lying, coralline islands. Most of the tourist bungalows and tourist facilities are located around the island with an average setback of about 5m from the vegetation line. Some of the water based resort concepts have their tourist facilities over the lagoon on stilts. Other support facilities are located in the middle or separated on one end of the island. The location of these facilities alone renders them highly vulnerable to predicted future sea level rise due to the low elevation and the narrowness of the islands.

In an average tourist resort with 200 beds the investment is over US$ 13 million and investment for a modern 700 bed resort US$ 4.3 million (MHAHE 2001 and MoT, 2001). Therefore, loss of beaches and infrastructure due to accelerated sea level rise will devastate the Maldivian economy.

3.4.2 Coral Reef Ecosystems and Impacts on the Economy

Coral reefs play an important role in the lifestyles of Maldivians as well as the formation of the islands. Not only do the reefs provide the islands with natural protection, but it is also the foremost resource for the Maldivian economy. The tourism industry and fisheries industry which are the major economic driving forces in Maldives are very much dependent on the coral reef ecosystems.

According to IPCC, impacts of climate change on coral reef ecosystems depend upon the rate of sea-level rise relative to growth rates and sediment supply, space for and obstacles to horizontal migration, changes in the climate-ocean environment such as sea surface temperatures and storminess, and pressures from human activities in coastal zones.
One of the major stresses to coral reefs is from sea surface warming. Sea surface warming is often associated with El Nino Southern Oscillations (ENSO) events. Many climate projections predict more El Nino-like mean conditions in the tropical Pacific (IPCC, 2001) Effects of such events in the Pacific is also felt throughout up to the Indian Ocean.

Effects of sea surface warming on coral reefs in Maldives can be seen by the increase in incidences of coral bleaching and mortality events associated to the elevated sea surface temperature rise in the Indian Ocean. Coral bleaching events have been observed in Maldives in 1977, 1983, 1987, 1991, 1995, 1997 and 1998, with the 1998 incident associated with ENSO, being the most severe (MHAHE, 2001). This severe coral bleaching in 1998 impacted all most all the shallow reefs in the country with devastating results.

The Figure 3.3 depicts the status of the coral reefs before the bleaching event of 1998 and the slow recovery of the coral reefs from this impact. The average live coral cover before and after the bleaching was recorded as approximately 45% and 5% respectively. The trend line shows that there is a slow recovery from this impact. It is likely that the coral reefs will take decades to recover to its original status. The continuation of this recovery process will highly depend on future such impacts. If Maldives were to experience such an event in the future the recovery of the coral reef systems in the country will be further prolonged.

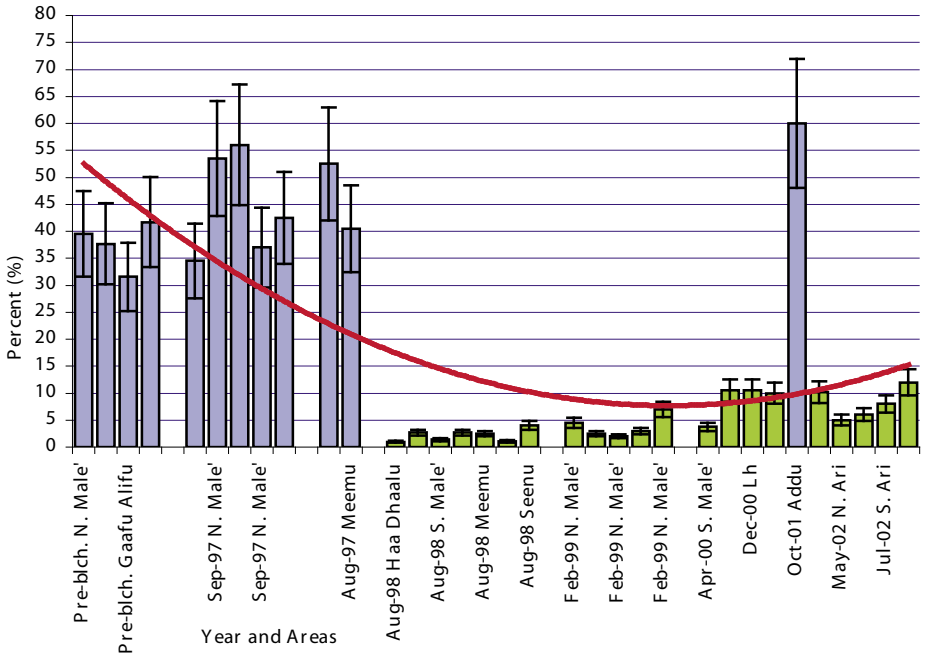

Figure 3.3: Live Coral Cover in Maldives before and after coral bleaching event of 1998

Source: Naeem

If the observed global trend in temperature rise continues, there will be an increased probability of such recurrences as the 1998 bleaching event. Being a nation based on a coral reef ecosystem, Maldives and its economy is very vulnerable to climate change and associated sea level rise.

3.4.3 Other Vulnerabilities

As rainwater and groundwater are important sources of freshwater in Maldives, water resources are an important area which is vulnerable to climate change and its impacts. The islands of Maldives being very low lying, the freshwater lens found on the islands is very thin. With a rise in predicted sea levels, the islands of Maldives are very likely to get inundated and thus the freshwater lens is very susceptible to salt water intrusion caused from inundation of land.

Changes to the temporal and spatial patterns of rainfall as a result of climate change are believed to have impacts on the available water resources of Maldives (MHAHE, 2001).

Intrusion of saltwater into the freshwater lens would also affect the little agriculture practiced by rural farmers in the islands. Salt water intrusion of groundwater will affect deeper rooted trees with low salt tolerance on the island. Particularly affected will be trees such as mango, banana and breadfruit.

Most of the food requirements except fresh fish and coconut are imported from other countries; perishable foods by air and non perishable by sea transport. Most of our main food items such as rice, wheat flour and sugar are imported from countries such as India, Thailand and even as far off as Germany. Thus the vulnerability of Maldives to climate change extends to the agricultural vulnerability in other countries. The predicted climate change for the South and South East Asia has indicated a reduction of rice production (Sinha, 1989). Maldives is vulnerable to the changes in productivity of agricultural lands beyond our borders and will have to compete on the international market for access to the food products produced elsewhere.

Climate change also has significant impacts on human health. Increase in physical injuries and spread of epidemics are more likely to be caused during extreme weather events such as heavy rainfall. Increase in heavy rainfall in the country causes flooding of many islands in Maldives. Each year, numerous flooding incidents are reported to MEC during heavy rainfall incidents. Flooding incidents may easily cause more outbreaks of water borne disease. This combined with the poor sanitation systems in most islands make these islands easy prey to water borne diseases.

3.5 Adaptation to Climate Change

Although, adaptation has the potential to reduce adverse impacts of climate change, it will not prevent all likely damages. Adaptation options in low-lying islands are limited and much so in the case of Maldives where, the elevation of the majority of islands is less than a meter below mean sea level. Most adaptation options would be costly. Adaptation options for Maldives has been identified in two contexts; adaptation activities targeted to specific sectors and secondly, enhancing the capacity to adapt.

3.5.1 Adaptative Measures

The three response options recognized by the Coastal Zone Management Subgroup (CZMS) include retreat, accommodation or protection. However, when responding to land loss and beach erosion in tiny islands of Maldives where physical space is already very scarce and the land is very flat and low lying, adaptation measures such as retreat, raising of the land and the use of building setbacks may not be viable solutions as these involve abandoning the coastal zone and shifting the associated ecosystems inland.

Hence, application of solid protection structures such as seawall may seem the only realistic option along well-developed

coasts, where vital infrastructure and human settlement are at immediate risk. A seawall has been constructed along the coast of Male' with the assistance of Japanese Government, to protect the high investments and the resident population living in Malé. Similar protective structures will be needed in almost all the inhabited islands or in most populated islands to protect the rest of the population. This will require enormous financial investments, and technical capacity to undertake such protection works, which will have to be obtained from international aid agencies and donors. The initial cost estimate has been projected at some US$ 1.5 billion for 50 of the inhabited islands (Gayoom, 1998) and this would mean US$ 6 billion for 200 inhabited islands (MHAHE, 2001).

Other adaptative measures for various sectors have been identified in the National Implementation Strategy for Climate Change (MHAHE, 2001), which was developed under the Climate Change Enabling Activity.

3.5.2 Capacity to Adapt

Though possible adaptation strategies have been identified, Maldives lacks the capacity to adapt both financially and technically. Hence, for the Maldives to respond successfully and implement appropriate adaptation strategies, financial resources and technological capability including human resource development and institutional strengthening in various fields are urgent requirements.

Human resources capacity building in all major sectors is identified as a critical component in successfully responding to the impacts of climate change. Other important areas identified are research and systemic observation and public awareness.

Understanding general climate change and sea level rise impacts on Maldives, requires extensive study of oceanographic and metrological parameters. Presently Maldives has only 3 stations that measure sea level. Several stations to measure sea surface temperature (SST), sea level and salinity need to be placed at various locations in the Maldives. There are also 5 meteorological stations that measure only the basic parameters required for general weather forecasting.

Rainfall patterns vary greatly at different locations in the Maldives. Therefore more stations need to be set up to study the patterns in rainfall and their spatial variation. Research to understand the process contributing to beach erosion in the Maldives and how to effectively manage such problems are a very important to facilitate adaptation of these problems. Research and monitoring also need to be done to study the growth patterns of coral reefs and how they adapt to the rise in sea level and changes in SST.

3.6 Policies and Strategies

Current national environmental policies are based on the need to take an integrated approach to managing of the environment and to work towards the goal of sustainable development. This is reflected in the Second National Environment Action Plan (NEAP II), which is the main guiding document for developing national environmental polices. The NEAP-II has set its strategies and priorities with the aim to "protect and preserve the environment of the Maldives, and to sustainably manage its resources for the collective benefit and the enjoyment of the present and future generations."

The Maldives has continued to work in the wider international context because of the potential threats posed by externally generated problems and the collective responsibility for sustainable development at the global level. The Second National Environment Action Plan (NEAP II) emphasises climate change and associated sea level rise as a primary concern of the Maldives. Thus, Maldives has played a key role in highlighting the special vulnerability of low-lying small island developing states to the predicted climate change and in getting the attention to this issue in international forums. The Maldives is a party to the United Nations Framework Convention on Climate Change (UNFCCC), and is the first country to sign the Kyoto Protocol.

A National Implementation Strategy for Addressing Climate Change was adopted in 2001 to accommodate the main policy elements to integrate the issue of climate change into the national planning process. The National Implementation Strategy ensures to have local benefit from the agreements, such as the Clean Development Mechanism and other mechanisms, resulting from the international climate change negotiations. A number of activities has been initiated as to implement the National Implementation Strategy for Addressing Climate Change. These include the establishment of the Energy Agency, formulation of a National Adaptation Plan of Action, undertaking of technology needs assessment and to actively participate in the international forums to advocate the special vulnerability of the small island developing states and least developed countries to the climate change.

The work for the preparation of National Adaptation Plan of Action (NAPA) began in 2004 to explore the feasible adaptation options to address the predicted climate change and associated sea level rise. A national Climate Change Team has been established to undertake this assessment. This team consists of stakeholder agencies from the government, private sector as well as NGOs.

The Seventh Conference of the Parties to the UNFCCC resolved to support the work programme for least developed countries to prepare and implement NAPAs, including meeting the agreed full cost of preparing the NAPAs. The NAPAs will communicate priority activities (including projects, integration into other activities, capacity building and policy reform) addressing the urgent and immediate needs and concerns of LDCs relating to the adverse effects of climate change. The rationale for developing NAPAs rests on the low adaptive capacity of LDCs, which renders them in need of immediate and urgent support to start adapting to current and projected adverse effects of climate change. Activities proposed through NAPAs are those whose further delay could increase climatic vulnerability, or lead to increased costs at a later stage.

A Technology Needs Assessment (TNA) is being implemented as to enable Maldives to further strengthen its capacity to participate in, and contribute to, the implementation of the UNFCCC and to deal with climate change and its adverse impacts through the promotion of the integration of climate change concerns into the national development planning process. These will assist Maldives in narrowing the expertise gaps that currently exist between the country and most of its neighbours in the region in the field of climate change. The TNA will provide the basis for well-informed policy choices which direct and guide selection, adoption, implementation and use of sustainable technologies that will assist the Maldives to address concerns related to climate change.

Work has also been initiated to assess the national capacity in addressing global environmental issues (in particular biological diversity, climate change and land degradation/ sustainable land management) in an integrated manner, with the aim of catalysing domestic and externally assisted action to meet those needs. The National Capacity Self-Assessment (NCSA) will identify national priorities for capacity building focusing on cross-cutting issues and synergies in the capacity development needs of the various thematic areas under the Rio Conventions.

4. Access to safe drinking water

4.1 Introduction

Maldives being a nation of coral islands with 99 percent comprising of sea, has very little in terms of fresh water resources. Hence, accessing safe drinking water is a major limitation faced by the people of Maldives. Until 1985 the people of Maldives have been dependent on the shallow groundwater aquifers for all their freshwater requirements, including drinking. Scarcity of freshwater is aggravated by the saltwater intrusion and pollution of groundwater resulting from release of sewage, industrial effluents and poor agricultural practices. Consequently, use of desalinated water and rainwater became necessary. Today all houses, institutional and commercial establishments in Malé have been provided with desalinated water, while rain water harvesting is being practiced by all the island communities of the country.

Table 4.1: Indicators - Access to water

Indicator	2001	2002	2003
No. of customers connected to desalination water	11444	12403	13122
Population with access to desalination water	75594	75594	78311
No. of islands with public water pipes	2	2	2
No. of inhabited islands with access to desalination water	2	2	3
Supply of desalination water to Malé (thousand mts)	1199	1292	1370
Cost of producing and distribution of desalination water Malé (Rf/ m3)	50. 65	37.66	39.92
Import of mineral water (thousand liters)	60.4	64.3	59.2

Source:

1.Statistical Year Book, MPD, 2004

2. Island Fact Sheet, MOA, 2004

3. Ministry of Health, 2004

4. Maldives Customs Service, 2004

4.2 Sources of water

4.2.1 Rainwater

Due to the scarcity of available groundwater and surface water, rainwater is an important source of freshwater for Maldivians. Harvested rainwater is being used in many islands as the main source of drinking water. Rainwater is harvested by individuals from roofs of houses during rain showers. The harvested rainwater is collected and stored in storage tanks.

Rainfall characteristics

Maldives rainfall is mainly determined by the two seasons: the northeast monsoon and the southwest monsoon. The southwest monsoon prevailing from May to November is the rainy season and the northeast monsoon from January to March is the dry season.

Average monthly rainfall from 1994 to 2003 (Figure 4.1) shows that February is the driest month for the southern stations while in Hulhule and Hanimaadhoo, March is the driest. The southern stations show the highest mean rainfall for this dry period while Hanimaadhoo has the least rainfall.

The average monthly rainfall shows a maximum during May for most stations. For the north most station, Hanimaadhoo, the peak rainfall is occurring during July. There is increased rainfall in October and the south station in Kadhdhoo shows its peak rainfall of 307.17 mm during October. Long term records of rainfall at Hulhule and Gan show that rainfall in Maldives increases from north to south (MHAHE 2001).

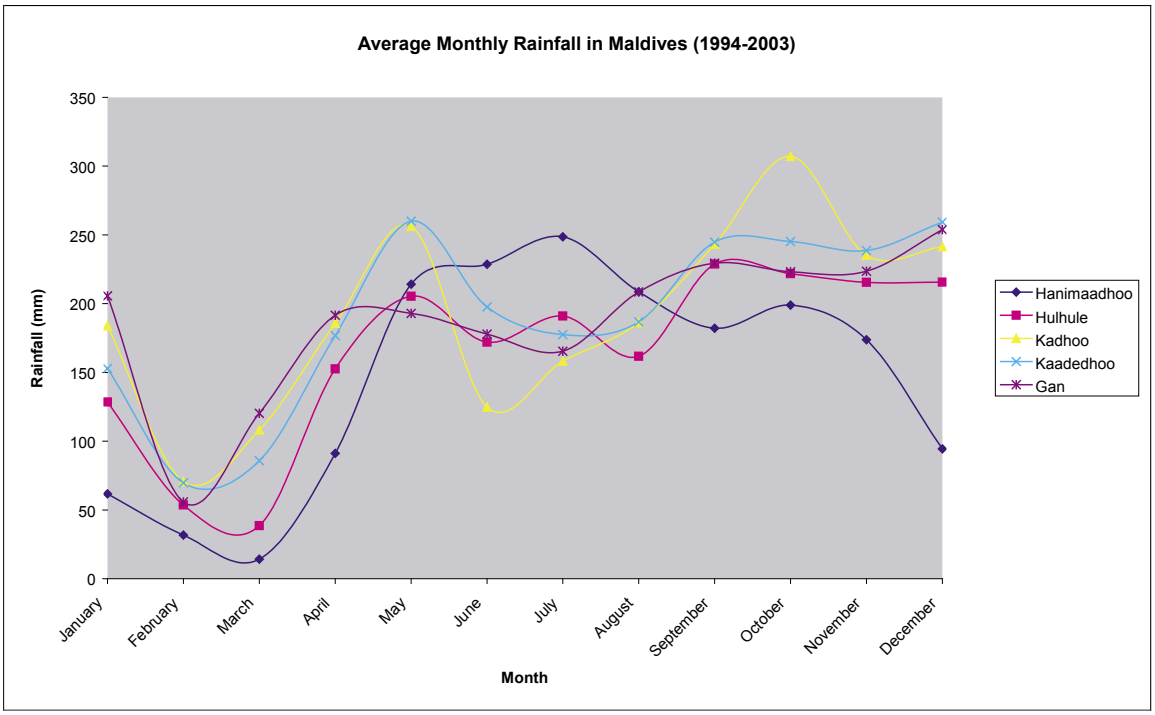

Figure 4.1: Average monthly rainfall (1994-2003)

Source: Department of Meteorology

1.2.1.1 Rainwater harvesting

From an historical perspective, the first concrete decision to provide safe drinking water to the people of the Maldives was made in 1904. Between 1906 and 1909, the government of Maldives constructed two rainwater tanks. According to a study carried out in 1974, only 15 percent of the 2600 households in Malé had private rainwater tanks. However, following the frequent outbreaks of cholera and shigellosis throughout the country, the government of Maldives began to promote and invest in rainwater harvesting. Gradually people in Malé began to construct their own private rainwater tanks.

In 1985, the government of Maldives launched the first major water supply and sewerage project in the Maldives. The project allocated more than 2.5 million US Dollars; roughly 33 percent of the total project cost, for the construction of steel tanks with a total storage capacity of 9900 m3 and the construction of 1154 private rainwater tanks in 1116 households providing a total storage capacity of 4157.5 m3. The private tanks were provided on cost recovery basis, payable over a period of 5 years. To provide freshwater for the rural population, the GoM, with financial assistance from UNICEF, constructed 1925 Ferro cement tanks with a total capacity of 19, 3000 for community use in 200 islands, serving a population of 234,008. In addition, 222 households have been provided with construction materials for the construction of private rainwater storage tanks. Since 1994, the program has focused on providing high density polyethylene (HDPE) tanks instead of the Ferro cement tanks.

The HDPE tanks, because of its durability, ease of handling and mobility, are proving to be more acceptable and popular among the rural population

By 2004 MOH has provided 7464, HDPE tanks with a total storage capacity of over 18931000 litres equivalent to an average of 85 lutes per person. Additional schemes are conducted by the Ministry of Planning, Ministry of Atolls Administration and UNDP to provide HDPE tanks to the islands.

Table 4.2: Water tanks and capacities by atoll-2004

Atoll	Water tanks 1500 litres	Water tanks 2000 litres	Water tanks 2500 litres	Water tanks 5000 Litres	Total capacity (litres)	Litres per person	Pop.
Ha	21	64	289	86	1312000	72	18,214
HDh	6	27	231	73	1005500	49	20,486
Sh	7	29	109	52	601000	40	15,087
N	7	29	212	59	893500	86	10,377
R	16	61	470	114	176000	13	13,865
B	13	26	247	84	1109000	126	8782
Lh	12	20	147	93	890500	105	8,446
K	7	37	434	46	1399500	91	15,382
AA	3	11	63	17	269000	56	4,827
ADh	7	42	200	26	724500	109	6,635
V	1	9	23	28	217000	154	1410
M	7	34	79	53	541000	108	5026
F	4	10	310	39	996000	270	3,695
Dh	6	24	169	54	749500	152	4,924
Th	2	38	136	111	974000	105	9,280
L	11	46	161	16	591000	53	11,075
GA	20	122	509	32	1706500	151	11313
GDh	32	166	591	58	2147500	123	17397
Gn	7	24	170	36	663500	72	9,256
S	104	198	489	38	1964500	73	26,996

Source: MOH, 2004

1.2.2 Ground water

Groundwater aquifers formed by the accumulation of the recharged rainwater on top of the saltwater are found in all islands. These aquifers normally lie at a depth of 1-1.5 meters below the surface. The thickness of an aquifer is normally dictated by several factors including net rainfall recharge, size of the island and permeability of the water through the soil column. Since these parameters vary from island to island, the quality of the aquifer also varies from island to island. Moreover, the proximity of the aquifers to the surface also makes them highly susceptible to pollution and contamination from human activities as well as possible salt water intrusion due to soil erosion. Thus, the availability of the groundwater as a freshwater resource is also limited.

Table 4.3 highlights the percentage of islands where ground water is used for drinking. As depicted in 162 islands ground water is not suitable for drinking and this limitation is imposed by the quality of water rather than its quantity.

Table 4.3: Quality of water in the islands

Indicators	
No of islands with water suitable for drinking	39
No of islands with water not suitable for drinking	162
Percentage of islands where ground water is not suitable due to salt water intrusion	54
Percentage of islands where ground water is not suitable due to pollution	46

Source: Island Fact Sheet, 2004

4.2.3 Desalinated water

Fresh water being a scarce resource in Malé, the government from 1985 has been providing desalinated water to people in Malé. Since its introduction the use of desalinated water has been on the increase. By 2003 desalinated water consumption in Malé (including Vilingili) has increased to 1370.8 thousand metric tons. With a population of 72230, this reflects that 18 metric tons of water is being utilized on a per person basis while on a household basis 143 metric tons of water is utilized annually. Figure 4.2 depicts the increasing trend of the use of desalinated water consumption in Malé over the nine year period. During the period the rate of increase on a yearly basis is 23 percent highlighting the rise in demand for safe water.

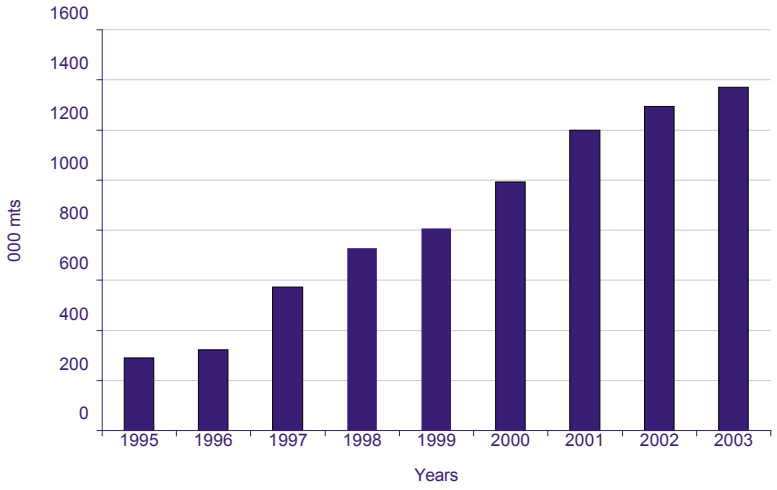

Figure 4.2: Billed water consumption in Malé, 1995-2003

Source: Maldives Water & Sewerage Company

From 2001 to 2003 daily records show that residents of the four wards in Malé used an annual average of 1253 thousand metric tons of desalinated water while people in nearby Vilingili, the fifth ward of Male` used an average of 34 thousand metric tons. The rate of increase on a yearly basis during this three year period was 11 percent for Malé and 34 percent for Vilingili.

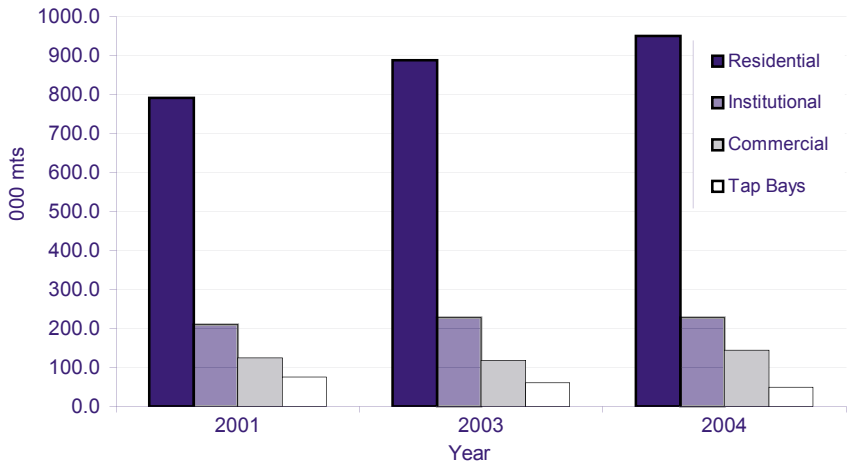

Figure 4.3: Water consumption in Malé 2001-2003

Source: Maldives Water & Sewerage Company

Figure 4.3 depicts the details of the water consumption in Malé (including Vilingili) by type of dwelling for the period 2001-2003.

The household consumption of water shows an increasing trend. Over the three year period an annual average of 876 thousand metric tons of water was supplied to households in Malé (including Vilingili) From 791.1 metric tons in 2001 the consumption has increased to 949.6 metric tons depicting a 20% increase.

While the household demand is on in an increasing trend demand for water from public taps are on a decreasing trend. Public taps are running across Male` in 15 areas facilitating free water to people who cannot afford it to fulfill basic needs such as drinking and cooking. In 2001, 74.8 metric tons of water was consumed while this figure decreased to 49.4 metric by 2003 which is equivalent to 33 percent decrease by 2003

At present all houses, institutional and commercial establishments in Malé have been provided with piped water. The total production and the basic cost of production and distribution of water have varied over the years as depicted in table.

Table 4.4: Water production in Malé 1996-2003

Year	Production	Cost of Production and Distribution
1996	978.7	64.59
1997	1411.53	64.49
1998	1801.32	50.55
1999	2208.95	44.25
2000	2717.31	42.09
2001	3220.21	50.65
2002	3478.48	37.66
2003	3684.72	39.92

Source: MWSC, 2003

Although desalination is now a major source of freshwater, especially for Malé- the capital of the Maldives, it is still considered far too expensive to be considered as an economically viable source of freshwater for most small island communities.

At present only two out of the 202 inhabited islands; R. Kadholhudhoo and Sh. Kommandhoo are the only other inhabited islands that are served with desalinated water. With the connection of desalination water to these two communities the percentage of the population of the Maldives having access to desalinated water reaches 28 percent. Similar to many islands of the country both these islands have been confronted with problems of accessing safe water for drinking and for other consumption purposes prior to the installation of desalination plants.

4.2.4 Bottled water

To cater for the increasing demand for fresh water, private companies are producing mineral water in the country. From 1995, Maldives Aerated Water Company distributes at a large scale for the local market as well as for the tourist resorts. In 2002, International Beverages Company has started producing to cater for some of the tourist resorts. Maldives Water and Sewerage Company have also made plans to produce water in the near future.

Another important indictor which illustrates the rising demand for water is the quantity of water imported into the country. As illustrated in the figure 4.4, the number of bottles imported to the country is on an increasing trend from 1996 - 2002. Within this period the annual increase is 31 percent. However, from 2002 to 2003 a downward shift has been observed reflecting that the domestic supply of bottled water is catering for a larger share of the local as well as the tourist market.

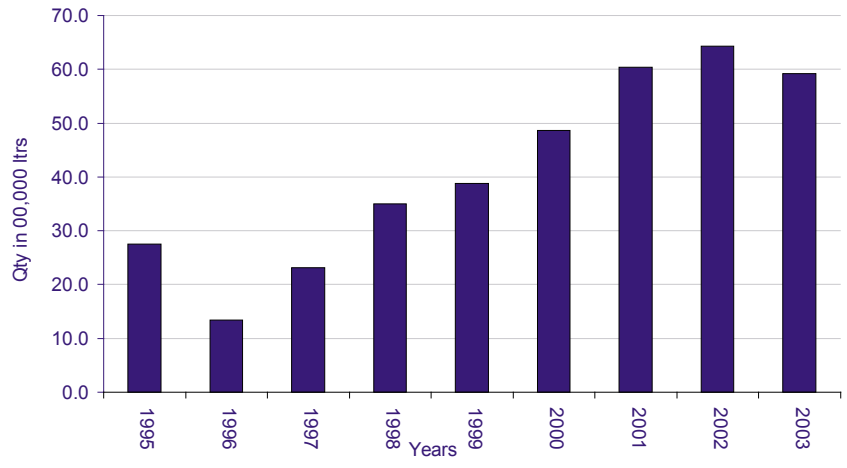

Figure 4.4: Import of mineral water, 1995-2003

Source: Maldives Customs Services

4.3 Major Policy Responses and Initiatives

Access to safe water is one of the major targets of the health sector. The Sixth National Development Plan 2001-2005 highlights that the provision of adequate water supply to all the islands of the country and to ensure the availability of safe drinking water as its major policies.

In order to provide adequate water supply to all the islands of the country two main strategies; formulation of a plan to provide safe water and identification and to promote sustainable systems that are appropriate from small islands for water production and distribution have been proposed. Accordingly, in 1998 Ministry of Health has formulated a Health Master Plan 1996-2005 outlining details of the water resources as part of the health sector. In addition a technical working paper: Water Action Plan for Male' has been formulated in 1993 which is being used as a working document. To promote sustainable systems that are appropriate for small islands for water production MWSA highlights the successful Sh. Komandoo Community initiated water project which has been undertaken by the community of Sh. Komandoo. The requirement of enormous financial investment to supplying every community with adequate freshwater facilities is a major limitation confronted by the government, in the provision of water supply. Due to high investment cost today the policy is to encourage such community initiatives in the provision of desalinated water.

To ensure the availability of safe drinking water throughout the country a number of strategies were outlined in the National Development Plan, 2002-2005. Many of these strategies are ongoing activities undertaken by the Ministry of Health and MWSA. These strategies include preparation of strategic plans for the development, improvement and construction of public water supplies, encouraging and promoting community participation in water management, banning of use of harmful materials for roofing gutter, pipe works for storage tanks. Enforcing guidelines and standards and addressing complaints regarding mis-use of water, continuing monitoring of the quality of drinking water in all islands are also included as part of an ongoing strategy.

Monitoring by periodic inspection, sampling and analysis all water supply undertakings are also undertaken on a regular basis Regulating and controlling abstraction and dewatering, and strengthening the regulator to enforce standards and monitor compliance are also major components for ensuring the availability of safe drinking water throughout the country. Through social marketing approaches, increasing community and individuals' interest in rainwater harvesting is another important strategy .Formulating and enforcing regulations standards and guidelines for the design and construction and maintenance of water supply services is an important aspect that has been outlined to ensuring safe drinking water.

To reinforce and strengthen the policies, a number of activities were undertaken. Following the development of the regulation of installation and operation of desalination plants in 2003, desalination plants are installed and operated

in the country with written permission from MWSA. MWSA grants the permit after consultation with Ministry of Environment and Construction.

This regulation necessitates the submission of an Environment Impact Assessment to the Ministry of Environment and Construction. The regulation highlights for desalination plants to be installed in inhabited island the plant should have the capacity to produce 150 liters per person per day. This capacity is to be estimated for population forecasted for 5 year period. For a tourist resort the capacity to produce is extended to 250 liters per person, while for agricultural island the capacity is 60 liters per square meter on a daily basis or as required by the MWSA. The required capacities for the production of water for the industrial islands are to be determined by the MWSA based on the needs analysis.

From 2002 onwards awareness campaigns are also carried out by MWSA through a UNICEF and WHO assisted program known as the Participatory Hygiene and Sanitation Transformation (PHAST). During its first phase creating awareness was the focus and was targeted to nine islands of Shaviyani atoll. In 2003 the program was developed to include technical surveying and has been incorporated as a regular monitoring program.

In 2004 hydrological surveys were conducted in specific islands under UNICEF assisted program. Water quality surveys are a major component of the survey. The islands survey included Himmafushi, Gadhdhoo, Velidhoo, Manadhoo and Holhudhoo. The islands were identified based on the peoples needs.

The Maldives Water and Sanitation Authority are also in the process of formulating GIS based database. UNICEF has provided equipment with WHO has assisted in training of the staff. The activity has been delayed due lack of funding. Lack of Water Resource Assessment and lack of skilled manpower are other obstacles identified in carrying out this activity.

World Environment Day 2003- " Water –two Billion People Are Dying For It"

World Environment Day, commemorated each year on 5 June and was celebrated prominently in the Maldives too. A number of activities were undertaken by the Ministry of Home Affairs Housing and Environment in association with other organization to mark the World Environment day 2003 focusing on the slogan "Water -Two Billion people are dying for it" Awareness programs were broadcasted by Radio Maldives and telecasted by the Television Maldives. Special supplements consisting of messages of the President, Deputy Ministry and the UNEP Director on actions that need to be taken in order to contribute to a better environment, were published and disseminate with the local newspapers. Photos highlighting the theme "Water for life" were displayed from 6th to 7th June. Environmental information was also provided during the display focusing on the theme. Message board were also displayed at various locations giving short messages on actions that need to be taken in order to contribute to a better environment. Environmental information dissemination mobile unit was active throughout the day. The unit - provided information on biodiversity and other environmental issues to the general public as part of the information dissemination programme. The unit proceeded along the main roads of Malé stopping at prominent locations. In addition a short drama to convey messages related to the environment was presented in all schools nation wide on the Environment Day.

The day was marked by in all the island as well as tourist resorts. Activities undertaken include tree planting programs, information dissemination, special assemblies, competitions and campaigns on environmental issues.

Sh.Kommandoo water works project

For the past 5 years the community of Komandoo has been faced with the problem of increasing salinity in the groundwater of the island. On investigation by the Maldives Water and Sanitation Authority in the years 2001 and 2002, it was found that the groundwater of the island was unfit for human consumption. Another research conducted in 2001 by a UNDP financed project had shown similar results.

To ease the problem of access to safe water for drinking and other consumption purposes, the IDC has assisted individual households to install rainwater tanks. To date the community has spent approximately Rf 1 million for the purpose of installing rainwater tanks. However, the present rainwater storage capacity is insufficient to meet all the water consumption needs of the locality.

The solution identified by the afore-mentioned investigations and in community meetings is the installation of desalination machines that will produce sufficient water for the purpose of washing, cooking and other home-consumption needs. The work undertaken to satisfy the need for safe water by the local community has resulted in the Government providing a grant of Rf 547,500 for the purchase of the desalination plant. The community has also prepared and submitted a proposal to the UNDP assisted project "Atoll Development for Sustainable Livelihoods" to the value of Rf 151,825 for building some of the infrastructure and support facilities of the desalination plant. Additionally the community has allocated Rf 550,855 from its Community Fund for the purpose of establishing the water distribution network. Source: Ministry of Atolls and Development, 2004

5. Waste Management in Maldives

5.1 Introduction

Solid and hazardous waste management has recently emerged as one of the greatest environmental challenges in the Maldives. The worsening waste management situation is attributed but not necessarily limited to; the rapid growth in population which is unevenly distributed within the inhabited islands, changing consumption patterns, limited land area and the wide distribution of the islands within the maritime area of 859,000 km^2 of the Maldives.

The worsening situation may cause irreversible damage to the environment through pollution and even now, is a serious threat to public health throughout the Maldives. This growing problem may ultimately threaten the economic development which is intrinsically linked to the tourist and fishing industries and the overall sustainable development of the country.

The average rate of generation of waste in Malé is approximately 2.48kg per capita per day (Pacific Consultants International and Environmental Technology Consultants Co. Ltd 1999). In the atolls average rate of generation of waste ranges between 0.79 kg (Homavazir 2001) and 0.70 kg per person per day (RDP Phase II). In the resorts the average rate of waste generation per guest per day is 7.2 kg (Pacific Consultants International and Environmental Technology Consultants Co. Ltd 1999).

5.2 Situation analysis

5.2.1 Existing situation in the capital, Malé

The major sources of waste in Malé (the capital city) are domestic waste, commercial waste and construction and demolition waste. There are two separate collection yards in Malé with one for construction & demolition (C&D) waste and one for domestic and other sources of waste including the commercial sector. Vilingili also has a dedicated waste collection yard similar to that in Male'. Despite the considerable volume of C&D waste and the significant problems associated with its transportation and disposal, no fee is levied for this service.

Figure 5.1 shows the average number of trucks and associated weight of waste that is carried to Thilafushi from Malé per year. On average approximately 103,201 tonnes of waste is transferred to Thilafushi every year from Malé alone (Waste Records 2003 - 2004, Waste Management Section, MEC).

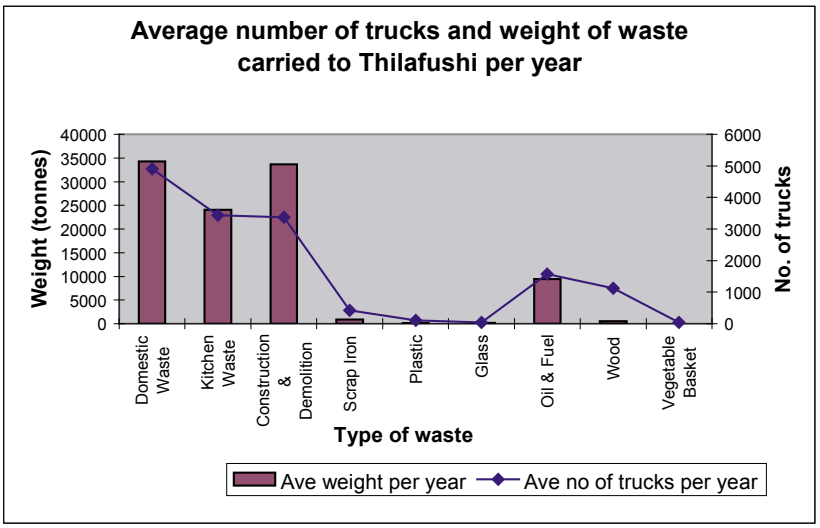

Figure 5.1: Average number of trucks & weight of waste carried to Thilafushi per year from Male'

Source: Waste Records 2003 - 2004, Waste Management Section, MEC

Collection and transfer of waste in Malé is carried out by Malé Municipality and other private parties. However, some households and other sectors do it by themselves. As shown in Figure 5.2 majority of households and sectors do not pay for waste collection and hence use their own methods.

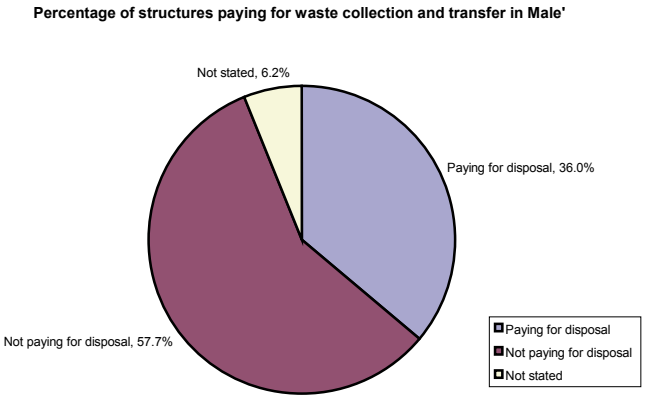

Figure 5.2: Percentage of households paying for waste collection and transfer in Malé

Source: Population and Housing Census of Maldives 2000, MPND.

About ten roadside bins used to be in place on the periphery of Malé. However, these have been removed due to odour nuisances and anaesthetic sights. These bins are still present in two locations of Male' as an option for householders to deposit their waste. Alternatively, householders can deposit their waste directly at the domestic waste collection yard free of charge. According to Figure 5.3 in 81.6% of households in Malé, waste is disposed of daily.

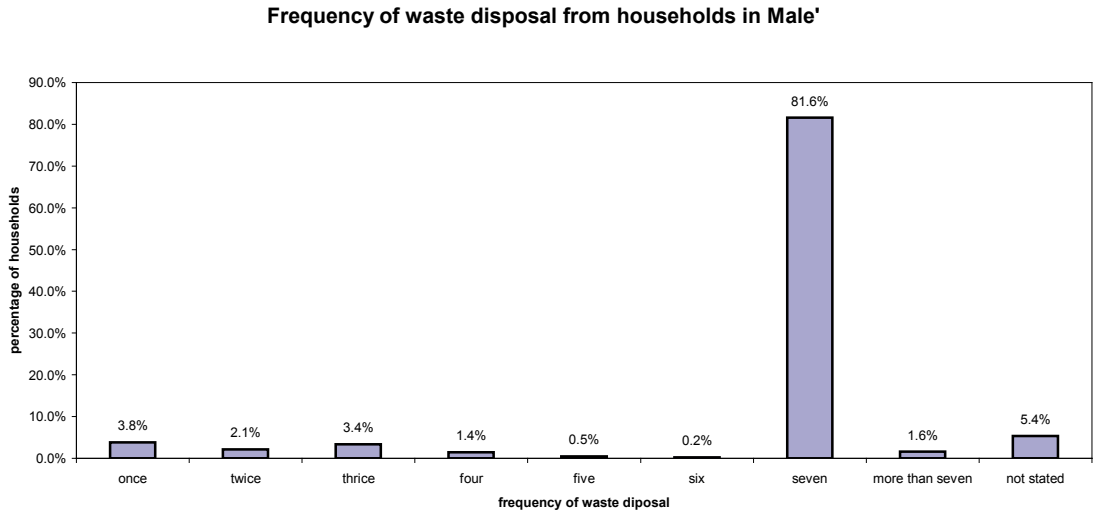

Figure 5.3: Frequency of waste disposal from households in Malé

Source: Population and Housing Census of Maldives 2000, MPND

Waste is segregated to some extent at the collection yards and a small area is dedicated to deposit reusable waste at this site. However, as there is zero segregation at the source, all types of waste are deposited together making sorting at the domestic collection yard a time-consuming and difficult task.

The waste is removed from the collection yards and placed on a barge to transfer to the municipal landfill site known as Thilafushi. Municipal waste is transported in large static compactor units, while C&D waste is transported by tipper trucks;

At Thilafushi waste taken from the collection yards are further segregated as much as possible and stockpiled in open areas. The usual categories of segregation are paper, plastic box, tins, aluminium, electric materials, HDPE plastic, vegetable baskets, wooden box, fibre, used oil, dry batteries, coconut husk, furniture and tiles.

There is very little export of waste that is implemented. Most of the waste is burnt openly and wholesale causing odour and smoke nuisances. In the absence of any composting initiatives, green and organic waste is routinely burnt. Windblown litter, such as plastic bags, packaging and paper, enter the marine environment.

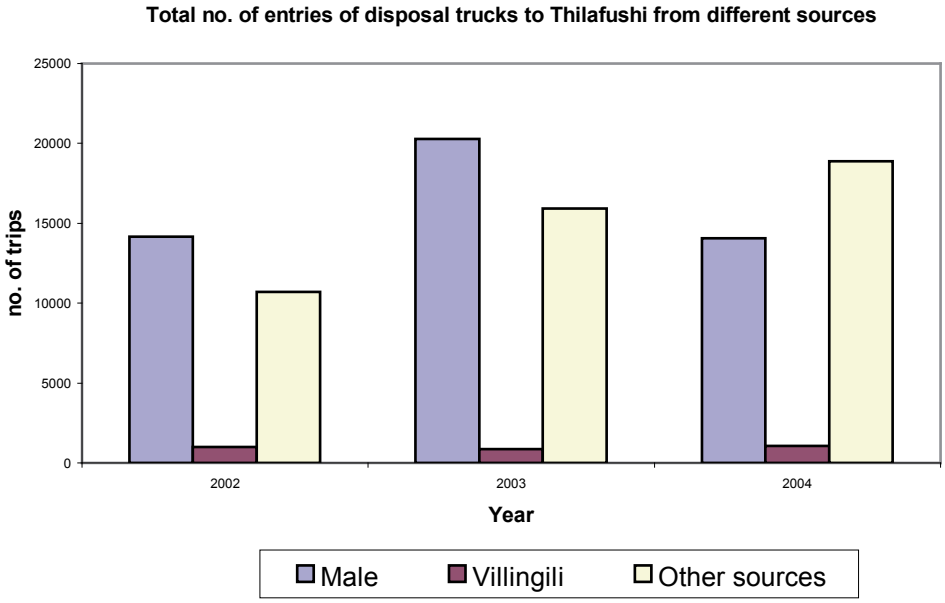

Figure 5.4: Total no. on entries of disposal trucks to Thilafushi from different sources

Source: Waste Records 2003 - 2004, Waste Management Section, MEC

In addition to Malé, Thilafushi receives waste from Vilingili, the satellite island of Malé, the Malé international airport, Hulhumale, resorts and inhabited and industrial islands. On average 32,307 trucks of waste are received at Thilafushi per year from these different sources.

5.2.2 Existing Situation in the atolls

The major type of solid waste generated in the islands varies from that of Malé. In the islands, the composition of organic waste which includes kitchen waste and green waste is relatively higher than any other categories of waste. There is little, if any, waste segregation practiced at household level (Cowing, 2004). However, backyard composting is still a common practice at households. Therefore, organic waste is usually separated from any other types of municipal waste.

Generally, there is little provision of waste collection services throughout the islands. Consequently, householders are required to carry their waste to disposal sites. Usually the women of the household carry the waste in wheel barrows to the disposal site. According to Figure 5.5, in 83.2% of the inhabited islands, collection and transfer of waste is carried out by householders themselves. Approximately, 8.4% of inhabited islands have an additional fee system. This maybe private parties operating with a single vehicle or individuals carrying waste on a weekly or monthly basis for a fixed fee. Only in 1.97% of the islands an established fee system exists for

collection and transfer from all households (Waste Management Survey of Inhabited Islands, MEC 2004). Collection and transfer systems that exist in the islands are operated by private parties. The fee collected ranges from MRF 5 to MRF 80 depending on population density of the island.

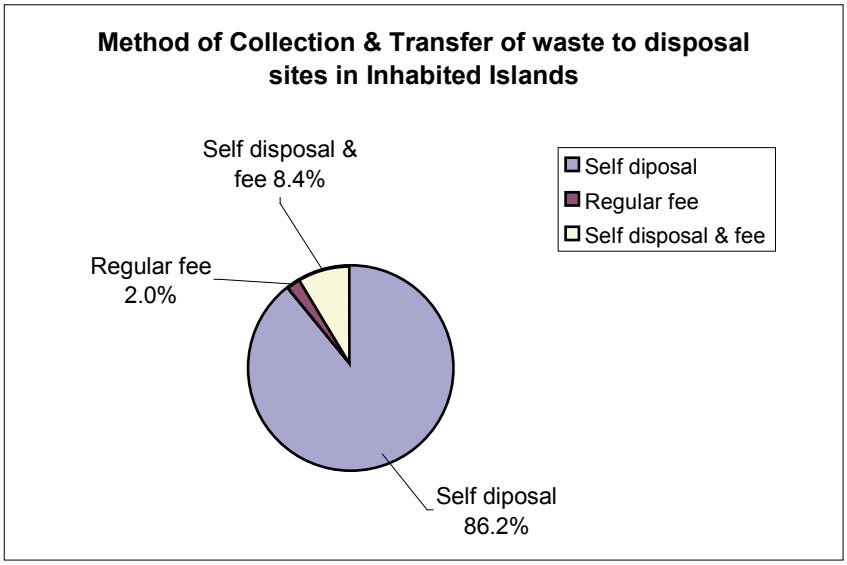

Figure 5.5: Method of waste collection and transfer

Source: Waste Management Survey of Inhabited Islands, MEC 2004

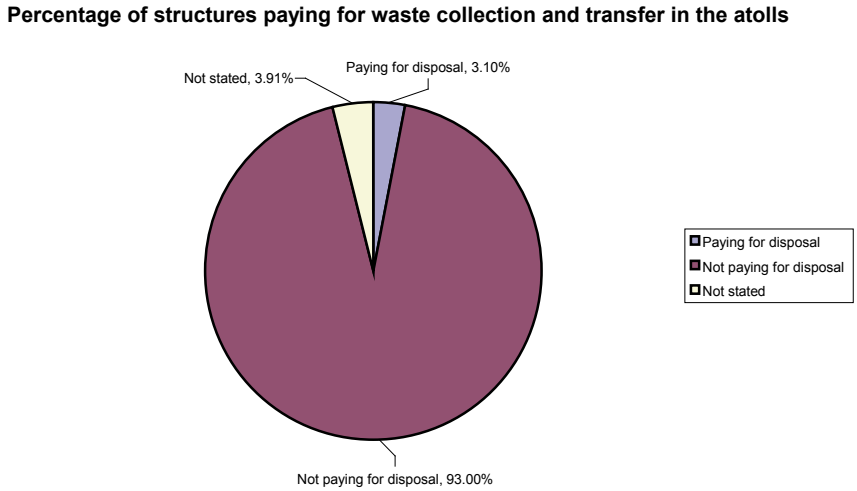

Figure 5.6: Percentage of structures paying for waste collection & transfer in the atolls

Source: Population and Housing Census of Maldives 2000, MPND

In the atolls, approximately 93% of the structures including households, shops etc. do not pay for waste collection and transfer as shown in Figure 5.6.

In 59.9% of households in the islands, waste is disposed of daily as shown in Figure 5.7.

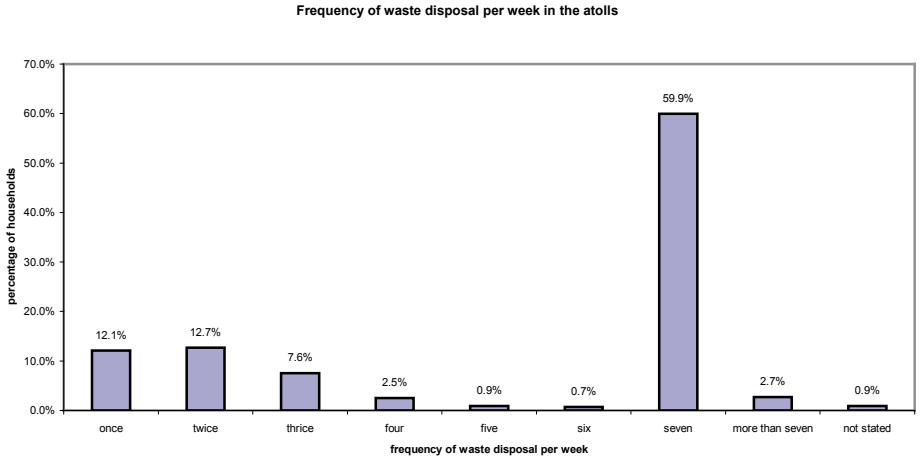

Figure 5.7: Frequency of waste disposal per week in the atolls

Source: Population and Housing Census of Maldives 2000, MPND

Public spaces in the islands are cleaned and maintained by the Women's Development Committee but often their task is hindered by lack of resources. For example, in some of islands the women have to use their own funds to pay for the transfer of waste that is accumulated through the cleansing activities, to be transported to the designated disposal sites.

In all the inhabited islands designated disposal sites exist. Usually the disposal sites are designated by a government authority such as a relevant ministry or the island or atoll office. Stakeholder consultations representing the different sectors of the community are conducted prior to relevant ministries designating sites. However, due to lack of efficient and affordable collection systems, greater distance between households and disposal sites and low level of awareness, random disposal of waste is a common practice.

The standard of disposal sites varies from open areas to waste management centres (WMCs) that are equipped to some extent. In the island of Kulhudhufushi, Haa Dhaalu Atoll and Hithadhoo, Seenu Atoll waste management centres were established under the Regional Development Project Phase I implemented by Ministry of Planning and National Development. These two centres have been in operation since 2003.

Due to absence of proper collection and disposal facilities segregation of waste is very low. As illustrated by Figure 5.8 only in 36.4% of the islands waste is segregated to different streams. Usually the segregation is limited to combustible and non-combustible waste. This is because the common practice to reduce the volume of waste is open-burning owing to the lack of other disposal options.

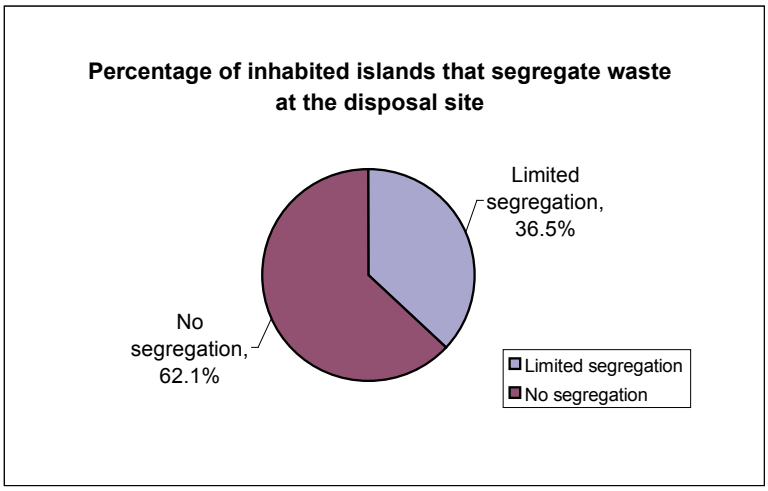

Figure 5.8: Percentage of inhabited islands that segregate waste at disposal site

Source: Waste Management Survey of Inhabited Islands, MEC 2004

The normal practices of waste disposal in the islands are open burning usually with little segregation, random dumping in the bush or shoreline or in the sea. In most of the islands the disposal site or sites are located close to the shoreline and usually enclosing an area of the lagoon with the intention of reclaiming land by land filling. As a consequence windblown litter, such as plastic bags, packaging and paper frequently enter the marine environment. Further, leakage of waste from such locations has the potential to cause irreversible damage to the marine environment.

The inhabited islands do not have the option of transferring waste to a landfill site such as Thilafushi. For most of the islands, the distance is too great and costs too high for the community to undertake transfer of waste to Thilafushi. As Figure 5.9 shows, only 5.4% of the islands are able to transfer waste to Thilafushi. Usually these are islands within Malé atoll or close by. Many of the resorts assist islands in transferring waste to Thilafushi occasionally. Only a limited number of the islands have the option of transferring waste to the landfill island of Thilafushi.

Figure 5.9: Percentage of islands that transfer waste to Thilafushi

Source: Waste Management Survey of Inhabited Islands, MEC 2004

5.2.3 Existing situation in resorts

Tourism sector has a much higher rate of waste generation in comparison to Male' and inhabited islands. However, problems relating to waste management are relatively small due largely to better waste management facilities.

Resort staff regularly collects solid waste from the sources of generation, such as the guest rooms, restaurants and public areas. Further, beaches and open areas are swept on a daily basis to keep them free of litter. Most, if not all, resorts have a central waste handling area where the various waste categories are sorted for processing and final disposal.

All resorts are required, under their operational licence, to have appropriate waste treatment equipments such as bottle crusher, metal compactor and incinerator. However, a number of the incinerators presently in use are coming to the end of their operational life and need replacing. It is reported that these factors have combined to create localised nuisances to tourists relating to smoke, and odours on some resorts (Cowing 2004).

Food waste, generated within the kitchens, restaurants and bars is routinely disposed of at sea. This practice is usually undertaken at night, to minimise concerns to the tourists, and usually some distance from the island.

Other waste, such as packaging, metal containers, and green waste generated from maintaining the grounds, is transported by boat, often on a daily basis, to the central disposal site on Thilafushi. A charge is paid at the disposal site which relates to the size of the vessel carrying the waste. The size of the vessel generally ranges from 40 to 100 feet in length (Waste Records 2003 - 2004, Waste Management Section, MEC).

The average number of entries of waste transfer vessels to Thilafushi from the resorts is approximately 478 per month (Waste Records 2003 - 2004, Waste Management Section, MEC).

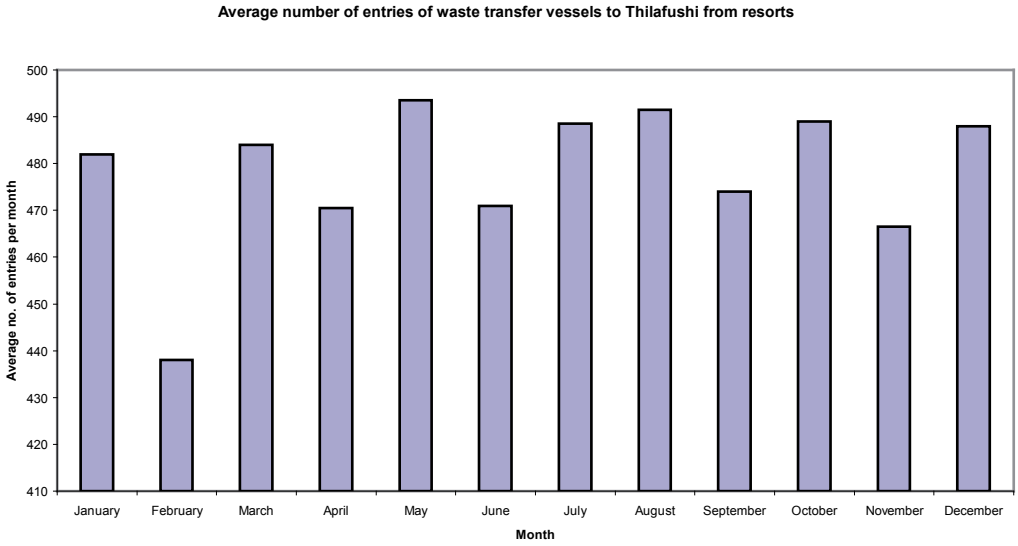

Figure 5.10: Average no. of entries of waste transfer vessels to Thilafushi from resorts

Source: Waste Records 2003 - 2004, Waste Management Section, MEC

Inspections are undertaken by officers of the Ministry of Tourism to ensure that individual resorts comply with licence conditions and specifications. It is reported that each resort is visited on at least an annual basis.

5.3 Policies and Strategies

Ministry of Environment and Construction (MEC) is mandated to design and formulate a national policy on waste disposal and treatment and implement measures required to carry out such a policy. In addition, the Environment Section of MEC is responsible for waste management in the atolls while the Waste Management Section of Construction Section of MEC is responsible for the waste management in Male'. Male' Municipality is responsible to providing waste collection services within Male'.

The National Environment Action Plan II (NEAP II) requires for the assessment of solid waste disposal problems in inhabited islands, tourist resorts and industrial islands which is being conducted continuously by the Environment Section of MEC. Further, the MEC is in the process of developing a National Solid Waste Management Policy (NSWMP) as required by the Sixth National Development Plan (6th NDP) which is highlighted in Section 1.5 of this chapter. Under this NSWMP, development and implementation of appropriate policy and regulatory measures for the reduction of waste, safe and efficient management of solid waste, proper management of disposal sites, import of environment-friendly products and better involvement of private sector will be addressed as according to NEAP II and 6th NDP. The NSWMP will also address country-wide public awareness related to waste management.

The general approach taken in NSWMP is to work on a local as well as regional basis as emphasized in the 6th NDP. The WMCs established and operating in Hithadhoo, Addu Atoll and Kulhudhuffushi, Haa Dhaalu Atoll are designed to operate on a regional basis. Currently the WMC at Hithadhoo, Addu Atoll is operating on a regional basis serving the Southern Development Region.

Maldives is a party to the Basel Convention on the Trans-boundary Movement of Hazardous Waste and their Disposal. Under the Environment Protection and Preservation Act of Maldives (Law 4/93), disposal of hazardous waste within the territory of Maldives is prohibited. If disposal of such waste within the territory of Maldives is absolutely necessary permission has to be obtained from the Ministry of Transport and Shipping at least three months in advance.

Ministry of Tourism has formulated and implements law and regulations specific to disposal of garbage in the tourism sector. Under these laws and regulations tourist resorts are required to dispose waste in a manner that would not cause any damage to the environment. Further, tourist resorts are required to have incinerators, compactors and glass crushers to be able to operate. Dumping of garbage into the sea is allowed however it has to be done as far away into the sea as necessary in order to ensure that it does not get washed on to any islands with the current. Plastic and polythene bags have to be incinerated and if they are thrown into the sea a fine can be imposed on the resort.

The primary barriers preventing sustainable improvements in the delivery of waste management in Maldives have been identified through a project titled 'Preparatory Assistance for a Solid Waste Management Project' which was funded by UNDP. These gaps are highlighted below.

- Within the islands and atolls there is insufficient funding of waste management infrastructure, equipment and practices. It is noted that this is not the case within Malé.
- The lack of investment outside of Malé is exacerbated by, or is possibly a function of, an absence of appropriate cost recovery mechanisms.
- Inadequate institutional capacity within key government agencies, coupled with a lack of clear roles and responsibilities, has resulted in an absence of clear leadership or co-ordination on the subject.
- Inadequate level of public education and raising awareness amongst the public resulting in uncertainties regarding available options.
- Weak legislative and regulatory framework which hinders monitoring and regulatory functions.
- Limited opportunities for the involvement of the private sector in service delivery.

A number of activities have been undertaken to strengthen the waste related activities. In early 2004, a Preparatory Assistance for a Solid Waste Management Project was initiated.

The objective of developing the framework for the future development of a National Solid Waste Management Policy (NSWMP)-

Existing barriers preventing the delivery of efficient waste management services were identified, and appropriate interventions were recommended for their removal. Seven islands in four different atolls were visited where site inspections were undertaken in conjunction with stakeholder consultations. In addition, relevant government stakeholders were visited to assist in the identification of barriers to waste management. Based on these, a broad framework for the NSWMP has been developed.

Under the Regional Development Project, Phase -I which was implemented in 2001, Waste Management Centres were established in HDh. Kulhudhufushi and S. Hithadhoo.

Addu Atoll Waste Management Centre

The Waste Management Centre (WMC) at Hithadhoo, Seenu Atoll provides the service of solid waste management to the four inhabited islands in the Southern Development Region. Namely- Hithadhoo, Maradhoo, Maradhoo-Feydhoo and Feydhoo. The WMC occupies an area of 4 hectares and receives waste from the households and the industrial activities. Equipments at the WMC include pick-up trucks, landfill compactor, green waste shredder, front- end loader and recyclables bailer. The Centre has dedicated areas to receive green waste, metals, non-degradable waste and hazardous waste. Currently, the collection of waste and operation of the WMC is implemented by a private party.

Source: Regional Development Project Phase II

Kulhudhuffushi Waste Management Centre

The Waste Management Centre (WMC) at Kulhudhuffushi provides services to the island only. However, it has the potential to operate as a regional WMC. The WMC occupies an area of 2 hectares but is currently being expanded with controlled land filling as recommended in Regional Development Project Phase-I. The facilities include landfill compactor, green waste shredder, loader and recyclable bailer. The WMC also has special facilities to receive and store hazardous waste. The WMC is being operated by private party including household collection of waste.

Source: Regional Development Project Phase II

In addition, a well-engineered waste management site has been established in Noonu Atoll Velidhoo. The set up of similar sites in two other inhabited islands of the atoll, namely Manadhoo and Holhudhoo are ongoing. These sites are being established with foreign aid.

Velidhoo, Noonu Atoll

The island of Velidhoo has a good engineered disposal site provided with concrete walls, wire fence and lockable gates. The WMC also has designated disposal areas for separate storage of non-combustible waste streams.

Open burning of combustible waste is carried out on a raised metal structure. Burning of the combustible waste including green waste and plastics represent a waste of resources and causes smoke nuisances to nearby houses.

Without options for further treatment or transfer, the stockpiled waste such as cans and bottles, allows accumulation of water within the containers leading to mosquito breeding problems.

Provision of waste processing equipment such as compactors, green waste shredders and glass crushers are vital for the site.

Source: Michael Cowing 2004 'Development of a National Solid Waste Management Policy', Ministry of Environment and Construction, Rep. of Maldives

6. AIR POLLUTION

6.1 Introduction

Air pollution refers to the contamination of atmosphere by the discharge of harmful gases mainly oxides of carbon, sulphur, and nitrogen. Its adverse effects are pervasive and may be disaggregated at three levels:

a) Local, pollution confined mainly to pollutants emitted from vehicles
b) Regional, pertaining to trans-boundary transport of pollutants and
c) Global, related to build up of greenhouse gases.

The characteristics and scale of air pollution even at the local level have not been researched and evaluated in Maldives similar to other developing countries due to the complexity of the contributory factors.

Most of the islands in Maldives are small and can be circumnavigated on foot in less than an hour or so. Therefore, except in Malé land transport is not high in demand and as such local air pollution is negligible. However, Malé the capital is already very congested with approximately 75 to 80 thousand people at any given time. The burgeoning population of vehicles has already made Malé the most congested island in the country. In Malé, in addition to air pollution from emissions from vehicles, to certain extent power generation and construction related activities are also on the increase. Available indicators of air pollution at the local level are- increase in number of vehicles, quantity of imported fuel, trend in the recorded cases of respiratory diseases and the number of buildings constructed over the years.

6.2 Indicators of local air pollution

6.2.1 Vehicles

The growing vehicle population in Malé is a major contributor to air pollution. Vehicles are classified as a primary source of air pollutant that is responsible for emitting pollutants such as carbon monoxide, hydrocarbons, other volatile organic compounds, oxides of sulphur, oxides of nitrogen and particulate matter including dust, smoke and compounds of lead, directly into the atmosphere. Table 6.1 depicts the composition of vehicle fleet of October 2004 in numbers and percentages.

Table 6.1: Registered vehicles according to type - October 2004

Type of vehicle	No. of vehicles	Percentages
Motor cycle	13759	77.21
Car	1674	9.39
Bus	35	3.83
Pickup	682	2.34
Lorry	417	2.38
Van	424	1.36
Jeep	242	.20
Ambulance	7	.04
Bouser	14	.08
Crane	58	.33
Truck	118	.66
Forklift	99	.56
Excavator	84	.47
Dump truck	58	.33
Tractor	97	.54
Reach stacker	2	.01
Back hoe loader	11	.06
Loader	37	.21
T-type tractor	3	.02

Source: Ministry of Transport and Civil Aviation, 2004

As illustrated in the table, cars and motor cycles account for over 80 percent of the total fleet. The growth rate of cars and vehicle are illustrated in Table 6.2, which reveals that rising incomes combined with more desire for personal mobility has increased automobile ownership of cars and motorcycles resulting to an annual growth of 17 percent. With a population density of 317 per hectare and with the roads as well as streets congested, air pollution is reaching levels of concern.

Table 6.2: Growth rate of motor cycles and cars - 1996-2002

	1996	1997	1998	1999	2000	2001	2002
Car	787	967	1172	1545	1860	1937	1948
Motorcycle	5319	6087	7542	9394	10880	12647	14248
Total	**6106**	**7054**	**8714**	**10939**	**12740**	**14584**	**16196**
Annual increase %		16	24	26	16	14	11

Source: Ministry of Transport and Civil Aviation, 2004

6.2.2 Construction of buildings

The urban air quality is also being worsened due to construction related activities taking place in Malé. Due to lack of space and increased congestion construction of high rise buildings are on the increase as illustrated in Figure 6.1 From 2000 to 2003 an average of 500 buildings have been authorised each year, out of which over 200 building were completed. As a result dust from cement and coral blocks used in the construction is emerging as an additional source of air pollution.

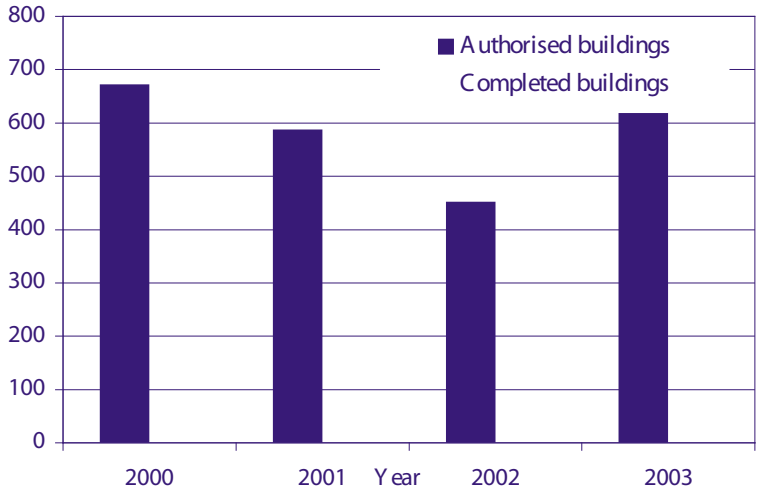

Figure 6.1: Number of buildings authorised for construction and completed between 2000-2003

Source: Statistical year book MPD, 2004

6.2.3 Import of fuel

Another indicator for air pollution is the trend in the import of fuel. Table 6.3 highlights some of the imported fuel from 2000-2003.

Table 6.3: Import of fuel 2002-2003

Description	Unit	2000	2001	2002	2003
Marine Gas Oil (Diesel)	M/T	138,760	143,297	180,501	165,233
Aviation Gas	M/T	9,519	22,164	12,678	12918
Kerosene Oil	M/T	5,114	979	4,152	4,860
Lamp Fuel	Litre	1,723,995	1,584,142	177,739	151,329
Petroleum Ether(For industrial use)	Litre	21	8	45	1
Liquid Fluid (Petroleum Naphtha) (Lighter Fuel)	Litre	32	129	109	298
Propane Liquefied	M/T	2,653	2,559	5,056	3,558
Butane	M/T			0	3
Propylene, Liquefied	Litre	96	19	19	126
Petrol	M/T	8,962	10,706	13,800	12,212

Source: Maldives Customs Services, 2004

From 2000 to 2003 over 150, 000 mts of marine gas and oil, including diesel, were imported annually. Similarly, aviation gas, lamp fuel and petrol were imported in large quantities.

In Maldives, diesel is the main source of energy used. Given the lack of environmentally friendly energy alternatives, Maldives has had to depend on electricity generated by the burning of fuel oil supplemented by some minor use of solar power.

Uncontrolled diesel fuel engines emit approximately 30 to 70 times more particulates than gasoline-fuelled engines equipped with catalytic converters and burning unleaded fuel. Virtually all these particles are small and respirable (less than 2.5 microns) and consists of a solid carbonaceous core on which a myriad of compounds absorb. (World Bank, 1999)

6.2.4 Respiratory diseases

Though the precise contribution of emission from automobiles to respiratory tract irritation is not clear it is well known that one of the adverse effects of emission from automobiles is on the increase in cases of respiratory diseases. According to the statistics published by Department of Public Health in 2003 10.86 percent or the third highest cause of death is due to respiratory diseases.

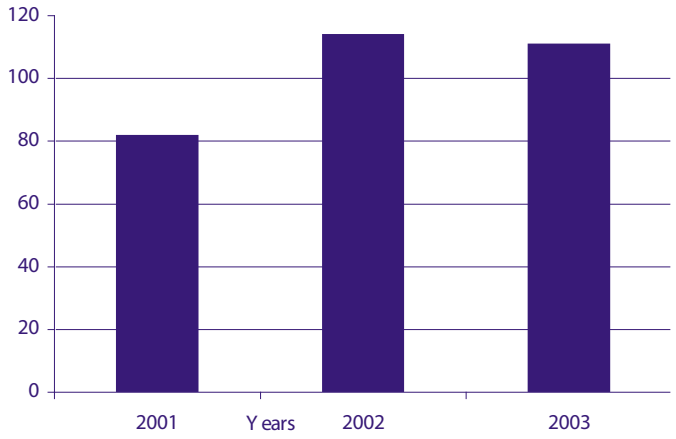

Figure 6.2: Deaths caused due to respiratory diseases. 2001-2003

Source: Ministry of Health, 2004

Over the three year period more than 100 deaths per year were caused by diseases of the respiratory system. The increasing trend of respiratory diseases is further highlighted in Figure 6.3, which shows that by 2003 over 52 thousand cases have been recorded in Malé.

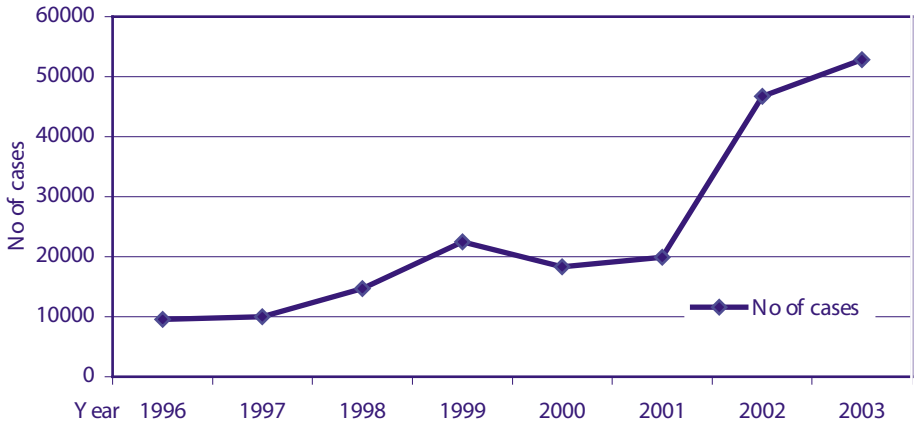

Figure 6.3: Reported cases of Acute Respiratory Infections from Malé 1996-2003

Source: Department of Public Health, 2004

6.3 Trans-boundary air pollution

Trans-boundary air pollution is known as cross boundary pollutants that can be generated in one country and felt in others which require international actions and collaboration to control their formation and effects. Trans-boundary air pollutants can survive for periods of days or even years and can be transported hundreds or thousands of miles before they affect the air we breathe. Trans-boundary air pollutants cause a number of different problems: e.g. formation of particles, ground level ozone which are hazardous to health, the formation of acid rain which can damage buildings and sensitive ecosystems and some that are toxic to human health and the environment.

Trans-boundary pollution became known in Maldives in 1997, when large parts of the country were affected by haze caused by forest fires in Indonesia. The Indian Ocean Experiment (INDOEX) has revealed that this haze is transported far beyond the source region, particularly during the dry season. The discovery of the so-called Asian haze by INDOEX scientists, a 3 kilometres thick brownish layer, hovering over most of the tropical Indian Ocean, South, Southeast and East Asia, is a clear evidence of the magnitude of the problem. The haze consists of sulphates, nitrates, organics, black carbon, fly ash amongst several other pollutants. Its most direct effects include a significant reduction in the solar radiation reaching the surface; a 50 to 100%increase in solar heating of the lower atmosphere; suppression of rainfall; reduction in agricultural productivity; and more importantly adverse health effects.

6.4 Policies and strategies

Being an emerging environmental issue, MOTCA, MCST and MEC aims to reduce air pollution through their respective sectors' policies and strategies. More specifically, the transport sector has outlined that reducing traffic congestion in urban area as one of its policies. The strategy is to review the mechanism of authorizing the import of motor vehicles into the country with a view to setting limits on the allowable maximum to improve traffic flow on the streets and improving the local air pollution. Accordingly, in 2000, import of reconditioned motorcycles which have an engine capacity of less than 150 cubic meters and import of cars more than 5 years old were banned. Traffic lights were also installed in number of areas to bring order to roads and traffic.

At the same time MEC has highlighted air pollution as an emerging issue in the protection of the environment. The policy is promoting integrated planning and administrative practices by developing meaningful principles and procedures for environmental protection. MEC continues to contribute to international efforts to find solutions to global environmental threats including air pollution. Under this policy researching, data collection and awareness creation is one of the strategies. The INDOEX was such an endeavour undertaken in 1998. The INDOEX which studied the effects of aerosols on the climate was one of the successful research projects that were undertaken in collaboration with Scripps Institute of Oceanography of University of California. Based on the finding of the project, a second project the Asian Brown Cloud project was formulated. The project features a system of strategically located ground-based observatories in the Indo-Asian and Pacific region to monitor atmospheric pollution. Under this project a surface climate observatory was established and is in operation at Hdh. Hanimadhoo. The project is a collaborative research project funded by UNEP. The objective is to document changes in aerosol content, changes in pollutant gases. The project will also promote regional capacity building and will facilitate the interaction between science and policy making.

The Malé Declaration on Control and Prevention of Air Pollution and its likely trans-boundary effects for South Asia

signed in 1998 between 8 South Asian countries, is a network that strengthens such research projects with constructive interaction between science and policy making at the working level. Following the Malé Declaration, in 1999, the government entered into an agreement with UNEP/ Environment Assessment for Asia and Pacific to prepare a baseline to study air pollution and to formulate national action plan with the aim of establishing a necessary framework for addressing air pollution to protect the environment of the Maldives. In 1999, the action plan was formulated highlighting that the Government of Maldives will achieve this aim through a combination of legislation, regulation, voluntary initiatives and economic instruments. Finding effective ways of preventing air pollution in the Maldives requires commitment and concerted action from all Maldivians, our regional neighbours and the international community.

Work undertaken in the Hanimaadhoo Climate observatory, particularly, capacity building and training of local personnel addresses some of the objectives outlined under the agreement.

The MCST policy is to introduce new technology applicable to the national development of Maldives and set standards and goals and formulate guidelines to achieve it. The organisation also aims to explore the applicability of energy producing sources that are suitable to the Maldivian environment and to expedite such resources which will assist in reducing the air pollution. To facilitate future implementation of renewable energy projects, the organisation is working with international organizations to identify and assess the renewable energy resources available in the country. The main areas that are of potential interest are solar, wind, wave, biomass and bio-digestive materials.

7. CONSERVATION OF BIOLOGICAL DIVERSITY

7.1 Introduction

Biodiversity or the variability among living organisms in Maldives is greatest among the coral reefs. The life on the reefs is characterized by high diversity and low abundance. Reef-based activities principally fishing and tourism, provides economic livelihoods for the Maldivians.

Terrestrial biodiversity on coral islands is limited. The natural vegetation of the islands are relatively uniform and follows a common pattern: salt tolerant bushes at the island edges and larger trees and coconut palms further inland. The natural vegetation on some of the more mature and larger islands is cleared to create agricultural land.

Northern islands of the Maldives are characterized by mangroves and associated small wetland areas. Sea grass beds fringe many islands but are most pronounced and lush on inhabited island.

7.2 Pressures to biodiversity

Loss of biodiversity both marine and terrestrial has been recognized as a threat to the fragile coral reef ecosystems of Maldives. The root cause being the increased demand on natural resources due to population expansion and rapid economic growth leading to over exploitation. Socio-economic forces and circumstances tend to creates incentives for activities that cause pressure on biodiversity and generate disincentives for more sustainable behavior.

Management and monitoring of the resource is hindered due the lack of data on abundance and distribution of the resources, which is a major setback in implementing timely enforcement measures. Some of the indicators of biodiversity loss are reviewed to understand the status of biodiversity loss occurring at the local level at present.

7.2.1 Pressures on the marine biodiversity

7.2.1.1 Demand for coral, sand and branched coral

Coral reefs are not only economically important to the Maldives in terms of the ecosystem services they provide. They also represent strategic natural offshore sea-defense acting as buffer to shorelines from wave action and other oceanic forces. They are important as habitat for baitfish. Prior to 1992 corals were extensively mined from shallow coral flats

around reef islands for construction purposes. Coral mining was recognized as a serious threat to the sustainability of coral reef habitats and reef life. The activity threatened the mere existence of low lying coral islands. Awareness on the degradation of the environment and the effects on low lying islands has increased dramatically in recent times highlighting the importance of coral reefs.

In 1992 regulations were reviewed and strengthened to include specific clauses which severely restricted coral mining. According to the present regulations, mining cannot be carried out on island house reefs, (a term used to defined the reef around an island) or on an atoll rim reefs and common bait fishing reefs. Applications for coral, sand and coral aggregates from the beaches and reefs of uninhabited islands are processed by the Ministry of Fisheries, Agriculture and Marine Resource (MOFAMR). Ministry of Environment and Construction (MEC) plays an advisory role in selection of mining sites. The island offices are also required to keep records of amounts mined.

Records of the demand for coral, sand and coral aggregates are kept by MOFAMR. Today the demand for coral has decreased by many folds due to the stringent measures applied and the availability of alternative building materials. Nevertheless it is important to interpret these figures with caution as lack of compliance against the mining regulations would have resulted in under-reporting leading to under-estimation.

From 2000-2003 the average demand for coral per year is estimated at over 33000 cubic feet. (Table 7.1). This is a dramatic change compared to 0.5 million cubic feet mined in the early eighties (Brown and Dunne, 1986). Over the four year period only 7 atolls has applied for permissions for coral mining. According to the application for request the demand for coral by the private sector is for construction purposes while the demand from government is for construction of jetties, groynes and breakwaters.

Table 7.1: Demand for Coral -2000-2003 cu ft

Atolls	2000	2001	2002	2003	Total
Hdh	4657	5933	9370	6398	26358
R	38400	8600	1911	1900	50811
B	1800			18500	20300
V	30000				30000
Ga	880			700	1880
L	2866		300		2866
Au	200				200
	78803	14533	11581	27498	132415

Data provided by MOFAMR

Table 7.2 illustrates the demand for sand for the period 2000-2003. Over the 4 year period an average over 90,000 bags were demanded annually. In the eighties t 62000 m3 of sand were mined annually in the eighties. (Brown, 1997) Sand is usually collected from shallow reef lagoons and from beaches. Sand generated from reclamation projects in some atolls

are sometimes used as construction materials and lands fill. Data collected by MOFMAR shows that in 2000 -2003 only 7 atolls have requested for sand during the period under study.

Table 7.2: Demand for sand 2000-2003 (in bags)

Atoll	2000	2001	2002	2003	Total
Sh	9900			1000	10900
N	15330	17950	95283	27900	156463
R	12580	28020	10000	1600	52200
B	20300	20000	1300	950	42550
Lh	3000	44830	17400		65230
Gdh	15960	400	9200	8550	34110
Th		100	200	1580	1880
Total	77070	111300	133383	41580	363333

Data provided by MOFAMR

Records of sand collected for Baa atoll for the period 1993-2000 was analyzed to understand the trend in sand collection at the atoll level. As illustrated in Figure 7.2 the amount of sand mined has increased dramatically since coral mining regulations were implemented in 1992. Sand is used to build concrete blocks which have replaced coral in almost all construction work through out Maldives. Field observations conducted during field trips undertaken for the formulation of Atoll Ecosystem Based Conservation project revealed that the locations and amount of coral mined are not properly recorded in many islands and sand is often mined from the island beaches permitted either by the Atoll Office or the Island Office.

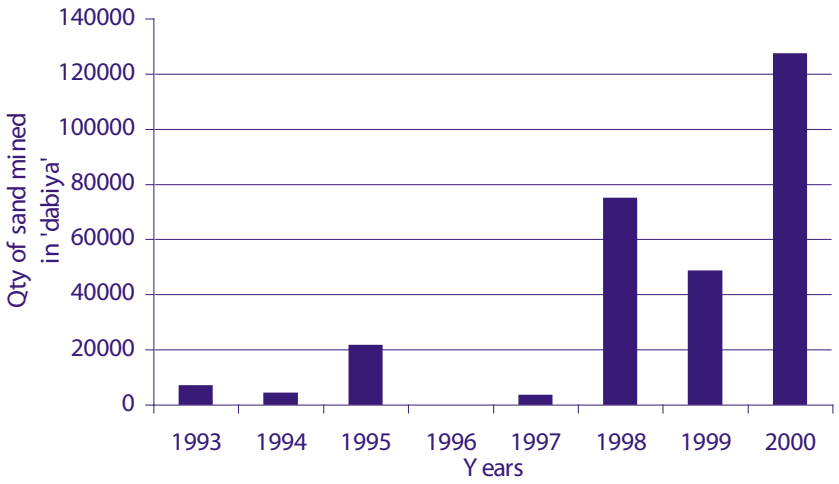

Figure 7.2: Amounts of sand mined in Baa Atoll 1993-2000

Source: MEC

Demand for coral aggregate is another important indicator for pressures on biodiversity. Usually collected from shingle ramparts on the seaward edge of outer atoll reef flats or from shingle berms around islands on the atoll edge where fragments can be collected from the beach, they are used as aggregates in the construction of foundations. As Table 7.3 illustrates during the period 2000-2003 demand for rubble was 145,598 bags per year. According to MOFMAR today branched coral are used in the islands to build wells, beams and sheet piles of the houses.

Table 7.3: Demand for branched coral 2000-2003 (in bags)

Atoll\Year	2000	2001	2002	2003	Total
Ha	13425	24010	12170	14720	64325
HDh	1000	120	1020	370	2510
Sh	700	870	5120	11276	17966
N	5510	9126	4120	2570	21326
R	41155	18970	47430	39372	146927
F	16500	10050	9690	5910	42150
B	11666	13651	6120	1120	32557
K	4900	2360	2160	1270	10690
ADh	2400	2440	2500	1620	8960
V	2500	680	1480	120	4780
M	18460	7120	10530	8920	45030
F		240		120	360
D	40250	1220	7140	8885	57495
Th		420	276	9860	10556
L	12300	13810	6670	4810	37590
Ga	3550	5070	7600	20560	36780
GDh	7300	6840	9160	12470	35770
AU	2300	2540	1660	120	6620
	183916	119537	134846	144093	582392

Data provided by MOFAMR

The demand for coral aggregate is highest from R. atoll. As many of the inhabited islands in Raa atoll are crowded without beaches or lagoons, scarcity of coral, sand and rubble is more pronounced in R atoll. Consequently illegal mining is limited thereby requests or demand to mine sand, coral and branched coral from suitable location tend to be higher than from other atolls

7.2.1.2 Demand for reef fish

In the Maldives the population is reliant in one way or another on the marine resources. The introduction of tourism and mechanization of fishing fleet in the early seventies brought rapid economic and social development to the country. The tourism industry created new demands for the reef resources which led to the development of an organised reef fishery. By 1997 the reef fishery in the Maldives was reported to be expanding rapidly even to the extent overexploitation of certain species. As conservation and management measures 9 marine species have been prohibited for fishing or collecting and 15 marine products are prohibited for export. In addition 25 marine areas are declared as protected dive sites. Lack of data on abundance and distribution of species has hindered in the monitoring procedures. Monitoring is mostly undertaken relying on export data which is a major setback in implementing timely enforcement measures.

Table 7.4: List of marine protected areas in Maldives

Atoll	Area
1 North Maalhosmadulu	Vilingili Thila
2 South Maalosmadulu	Dhigali Haa/Horubadhoo Thila
3 Faadhipolhu	Fusheevaru Thila
4	Kureddhoo Kandu Olhi
5 Male' Atoll	Makunudhoo Kandu Olhi
6	Rasfaree and the enclosed reef
7	Thamburudhoo Thila
8	Gaathugiri/Ad'dhashugiri
9	Giraavaru Kuda Haa
10	Dhekunu Thilafalhuge Miyaruvani
11	Kollavaanee in the centre of Gulhifalhu
12	Emboodhoo Kandu Olhi
13	Guraidhoo Kandu Olhi
14	Lankan Thila
15 Ari Atoll	Mayaa Thila
16	Orimas Thila
17	Mushimasmigili Thila
18	Kudarah Thila
19	Karibeyru Thila
20	Faruhuruvalhibeyru
21	Miyaru Kandu
22	Vattaru Kandu
23 Mulaku Atoll	Lhazikuraadi
24 North Nilandhe Atoll	Filitheyo Kandu
25 South Nilandhe Atoll	Fushi Kandu

Source:MOFAMR

Table 7.5: List of marine animals prohibited for fishing and collection

1	Black Coral
2	Conchs
3	Giant Clams
4	Berried and small lobsters
5	Turtles
6	Napolean Wrasse
7	Dolphins
8	Whale Sharks
9	Whales

Table 7.6: List of marine products prohibited for exports

1	Black Coral
2	Stony Coral
3	Titon Shell
4	Pearl Oyster
5	Lobsters
6	Turtles
7	Turtle shell
8	Eel
9	Puffer fish
10	Parrot fish
11	Skate and ray
12	Bigeye scad under 15 centimeters
13	Bait fish used in tuna fishery
14	Dolphin
15	Whale

Table 7.7: List of marine products prohibited for exports

+	English Name
1	Whimbrel
2	Glossy Ibis
3	Yellow Wagtail
4	Tree Pipit
5	Red Throated Pipit
6	Cattle Egret
7	Ruddy Turnstone
8	Grey Plover
9	Common Ringed Plover
10	Kentish Plover
11	Lesser Sand Plover
12	Greater Sand Plover
13	Black Headed Gull
14	Pallass's Gull
15	Curlew Sandpiper
16	Common Greenshank
17	Black tailed Godwit
18	Marsh Sandpiper
19	Jack SnipeBlack Winged Stilt
20	Western Reef Bittern
21	Black Crowned Night Heron
22	Masked Boody
23	Brown Boody
24	Red Footed Boody
25	Gargancy
26	Ferruginous Pochard

27	Northern Shoveler
28	Purple Heron
29	Black Headed Heron
30	Eurasian Spoonbill
31	Eastern Goldern Plover
32	Spot Billed Pelican
33	Greater Flamingo
34	Wilson's Storm Petrel
35	Water cock
36	House Sparrow
37	Great Egret
38	Caspian Tern
39	Common Moor Hen
40	Northern House Martin
41	Common Coot
42	Crab Plover
43	Whiskered Tern

Sea –cucumber fishery

Export figures indicate that that there is an increasing trend in the export of dried sea-cucumber (Figure 7.2). Between 2000 to 2003 over 180 MTS dried sea-cucumbers were exported annually.

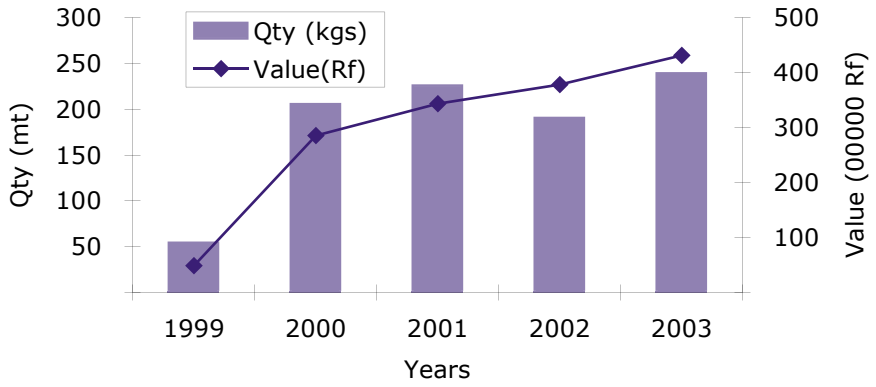

Figure 7.3: Export dried Sea Cucumber 1999 - 2003

The sea-cucumber fishery started in 1985, yet due to difficulty in enforcement of reporting procedures MOFAMR was only able to start collecting sea-cucumber catch and its value only from 2002 onwards. It is believe that these figures are also under-reported due to the dispersed nature of the fishing effort. Since sea-cucumber fishery started, 9 species of sea-cucumber were caught and exported, over fishing some valuable species. Protective measures were undertaken in 1993 limiting the depth at which sea –cucumbers may be harvested and banning the use of SCUBA diving gear for sea-cucumber. However enforcing these measure are difficult due to the geographical dispersion of the fishing effort.

Aquarium fisheries

The marine aquarium trade of Maldives started around 1979 expanding reaching a peak of over 300,000 numbers in quantity in 1996 (Figure 7.4). Export values show an increasing trend with its value reaching over Rf 7 million in 2003.

The aquarium trade has been closely monitored through the export data since commencement of the fishery. An export quota of 100,000 fish was set by the government in 1988 and 1989 later expanded to include a species based quota for species identified as over exploited.

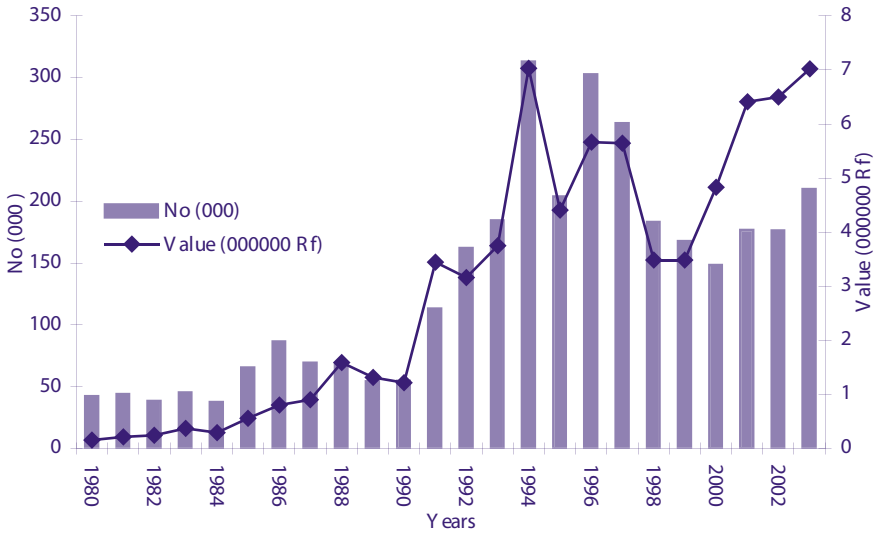

Figure 7.4: Export of live tropical fish - quantity and value 1980-2002

As a conservation measure all destructive methods of fish collection in the aquarium fishery have been banned by the government. Use of hand nets have been normal practice for collection since inception of the fishery. When moxy nets were used for fishing in 1995, the technique was banned as it was found to be harmful for the fish.

Shark fishing

Fishing for reef sharks started in 1980's as a result of exporting opportunities. Table 7.5 illustrates the export of shark products; quantity and value for the period 1999-2003. As shown in the table the shark products exported include dried shark fins, fresh chilled shark, salted dried shark, frozen shark fins, salted dried shark fins and shark liver oil. Within this period an average of Rf 16, 000,000 were earned annually by exporting shark products. Salted dried shark and dried shark fins were exported the most. Due to over-exploitation of reef and near shore pelagic shark stocks, in 1995 and in 1999 government introduced regulations aimed at promoting shark conservation by banning all types of shark fishing inside and within 12 miles of atolls in the main tourism zone and in certain specified zones. In addition whale sharks are prohibited for fishing.

Table 7.5: Qantity and value of shark products exported 1999-2003

Product		1999	2000	2001	2002	2003
Dried shark fins	Qty (kgs)	15454.70	22243.04	19305.10	11856.75	18956.90
	Value (Rf)	7446332.87	18028171.91	12368595.02	6568041.29	10432221.47
Fresh chilled shark	Qty (Kgs)	16363.01	942.86	2,485.52	755.64	834.32
	Value (Rf)	58148.13	63,767.59	166751.69	53448.49	50847.94
Salted dried shark	Qty (Kgs)	351346.98	457939.36	442336.00	371437.83	371344.69
	Value (Rf)	3713546.96	5210644.95	5103290.40	3674848.91	2159.00
Frozen shark fins	Qty (Kgs)			667.80	1,941.00	951606.75
	Value (Rf)			62610.54	1789516.70	2550.00
Salted dried shark fins	Qty (Kgs)				2,356.20	237,564.37
	Value (Rf)				2,291,667.07	
Shark liver oil	Qty (Kgs)				2,881.00	
	Value (Rf)				249,890.73	

Source: MOFAMR

Table 7.6 : Atolls in which there is shark fishery moratorium

1	South Maalosmadulu
2	Faadhippolhu
3	Male' Atoll
4	North Ari Atoll
5	South Ari Atoll
6	Felidhu Atoll
7	Addu Atoll

Source: SOE 2002

Grouper fishery

Similar to other reef fisheries grouper fishery was initiated and developed due to commercial opportunities which opened up during 1990's. Since 1992 the fishery has expanded with indications of over fishing. Reviewing the export of figures from 1999-2003 revealed that groupers are export in two forms; fresh and chilled grouper and live groupers. Over the five year period an average of 260 mts of fresh/ chilled grouper and over 244000 thousand live groupers were exported annually earning an annual income of over Rf17 million and Rf20 million respectively.

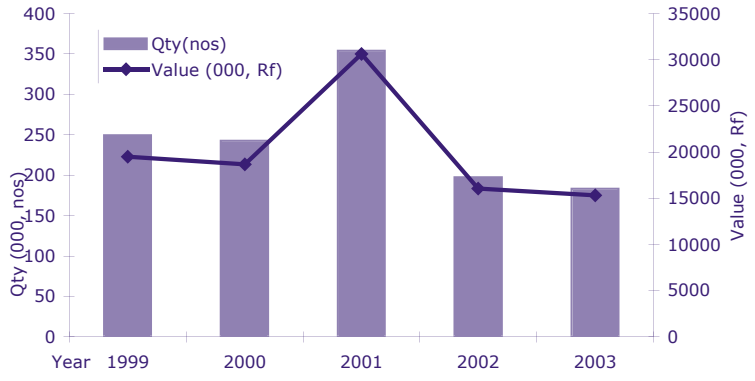

Figure 5: Export of live grouper 1999-2003

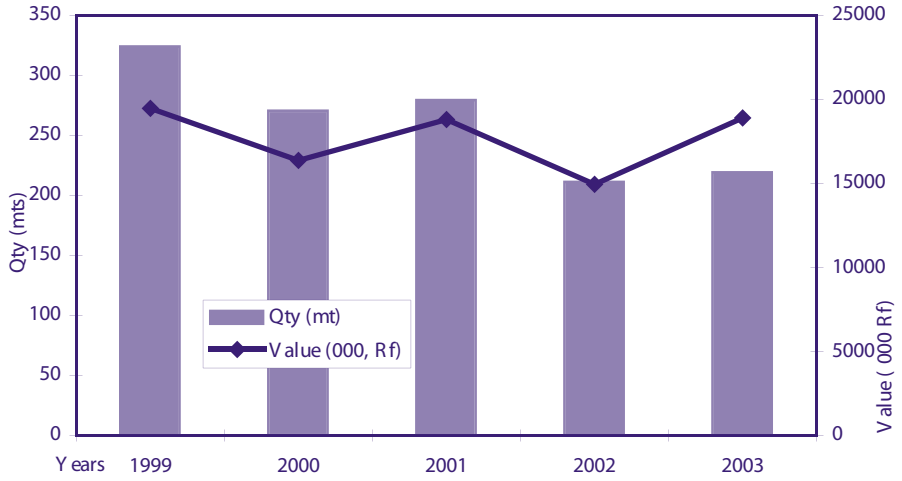

Figure 7.6: Export of fresh chilled grouper 1999-2003

For sustainable management of the grouper fishery assessing the stock of the resources in an urgent priority.

Lobster fishery

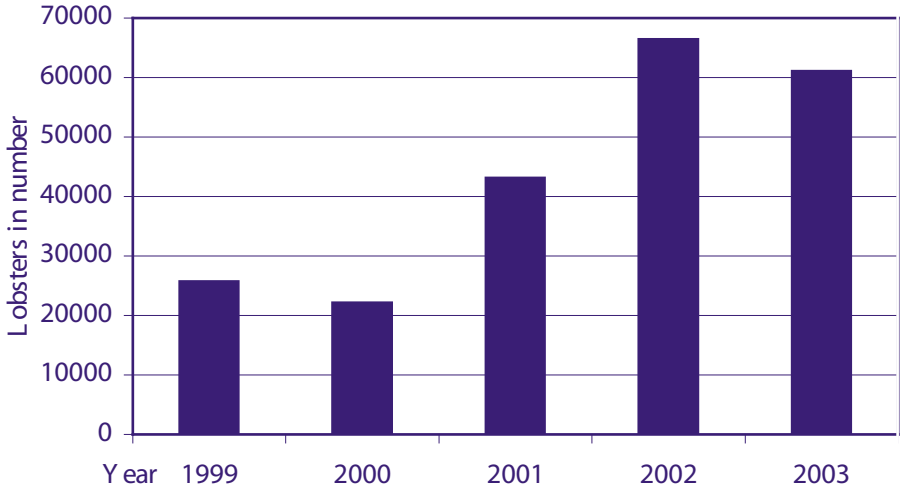

Figure 7.7: Lobster catch from 1999-2003

The lobster fishery gained momentum due to opening up of tourist resorts in the country. Five species of lobsters are harvested in the Maldives. As illustrated in Figure 7 there is increasing trend in the harvested, reported lobsters. Atoll wise lobster catch reveals that lobsters are harvested country wide of which the highest is being reported from Shaviyani atoll. As conservation measure harvesting of berried lobsters and lobsters below length of 25 cm are prohibited. Lobsters fishing is seasonal confined to calm weather as it involves diving and snorkeling in the reef. Moreover the reef topography provides a natural habitat protection therefore over-exploitation may not occur. However with the tourism sector expanding the demand for lobsters are on the increase.

Bait fishery

Integral part of pole and line fishing is the availability of bait fish. It is estimated that the bait catch would be in the order of 18,000 MT annually, (Adam, 2004). At the local level, bait fishing using lights and occasional use of household chemicals damage the coral reefs. Anchor damage to the reef through intensive collection at certain points or concentration of

boats on a reef over a period of days or even weeks occurs. Bait fish resource are also affected by waste water from sea cucumber fishery.

7.2.2 Other pressures on marine biodiversity

Other pressures include waste disposal of non biodegradable imported products on the reefs, pollution and intensive use of reefs through SCUBA diving and snorkeling. Loss of coastal habitats, particularly sea grass beds, mangroves and coral reefs are associated with dredging of harbours reclamation, as well grounding of vessels.

7.3 Pressures on the terrestrial biodiversity

7.3.1 Invasive pests and diseases

The MOFAMR highlights introduction of plant pathogenic microorganisms, insect pests and diseases as a major pressure on the terrestrial biodiversity. An influx of planting materials and fruits and vegetables from neighboring countries without proper quarantine procedure is leading to rapid build up of these pests and diseases. The isolated and scattered nature of the islands is no longer an effective barrier against import of alien species into the Maldives.

MOFMAR has recorded a number of pests and diseases that have been identified as harmful and have caused loss of terrestrial biodiversity.

Pests that have been identified as harmful and have caused loss of terrestrial biodiversity.

Citrus canker causing bacterium, Xanthomonas campestris pv.citir
Invasion of an extremely aggressive strain of the bacterium during the 1980's killed majority of the local lime variety Citrus aurantifolia, which plays a major role in atoll agriculture. The consequence has been a six to ten fold increase in the price of lime fruit in local markets and an increasing dependence on imported fruit. Maldives was self sufficient in lime in the 1970, but now however lime import has increased tremendously since 1988. To date, rehabilitation programs have not been successful and this variety of lime is threatened with extinction.

Stem borer, Batocera rufomaculata (De Geer)
Stem borer was introduced to the country in the early 1990's first attacking breadfruit trees and now to be found in every island of the Maldives. Larvae of this beetle bore into the stems and branches of the trees and kill the tree. Breadfruit was a common tree in every household of the Maldives during the 1990's however, it is considered rare today. Due to the pest an estimated 60% of breadfruit trees, an important seasonal staple form of food, have already died. Symptoms of pest attack have also been observed from mango trees.

Spiralling whitefly, Aleurodicus dispersus (Russ)
In 1989, a heavy infestation of spiraling whitefly developed on various ornamental and fruit trees. The insect caused extensive damage to at least 24 host plant species including fruit trees such as mango, papaya, guava, breadfruit, banana etc, which are of high economical importance. Two parasitoid natural enemies; Encarsia haitensis, and Encarsia sp. were introduced from Fiji in 1990 and good control has been achieved. At present the pest is widespread in the Maldives but does not cause serious damage.

Giant African Snail, Achatina fulica (Ker)
The Giant African Snail was first observed during the early 1980's and became a serious pest of many crop species. Control was achieved using the flatworm Platydemus manokwari imported from Guam.

Rhinocerous beetle, Oryctes rhinoceros (Linneaus)

Although the beetle is believed to have originated from South and Southeast Asia it is not native to the Maldives. It appears to have arrived in the Maldives sometimes in the 1970's and severely affected coconut production. Until early 1980s, the rhinoceros beetle population in the Maldives was controlled by collection of adult beetles and by filling gaps in palm crows with pebbles to prevent beetle attacking the growing points. In view of the importance of coconut as a cash crop in the Maldives, FAO launched a biological control campaign, which resulted in introduction of the baculovirus control agent in 1984. This resulted in 25% decline of coconut infestation and a correspondent 10% yield increased within a year (Watson et al 1995).

Fringed nettle grub, Darna nararia (Moore)

This pest introduced in late 1990's damaged coconut palms within a very short period of time. Early control measures and management efforts initiated by the assistance from Food and Agriculture Organization (FAO) of the United Nations minimized the spread of the pest in the country.

Source: MOFMAR

7.3.2 Invasive plant species

A number of planting materials of unknown background are being introduced to the country as ornamental plants. The risk of such materials becoming a pest is a real threat, but so far no such incidence has been recorded. There maybe many species of invasive alien plants unidentified in the Maldives

7.3.3 Use of fertilisers, herbicides and pesticides

In the face of build-up of invasive species and the spread of disease more and more people have to rely on the use of fertilisers and hazardous pesticides for their control which contaminates soil, harvested products, and the environment in general with its residues.

Figure 7.8: Import of fertilisers 2001-2003 illustrates the quantity of fertilisers imported into the country from 2001 to 2003. As illustrated there is 33 percent increase in the imported fertiliser in 2003 compared to 2000. Around 20 percent of imported fertilisers are inorganic fertilisers such as mineral or chemical fertilisers. Organic fertiliser imported into the country includes cow dung and other manure, which is required to be used in larger amounts compared to the inorganic fertilisers. Inorganic fertilisers though used in smaller amounts contaminate soil and is a threat to the biodiversity.

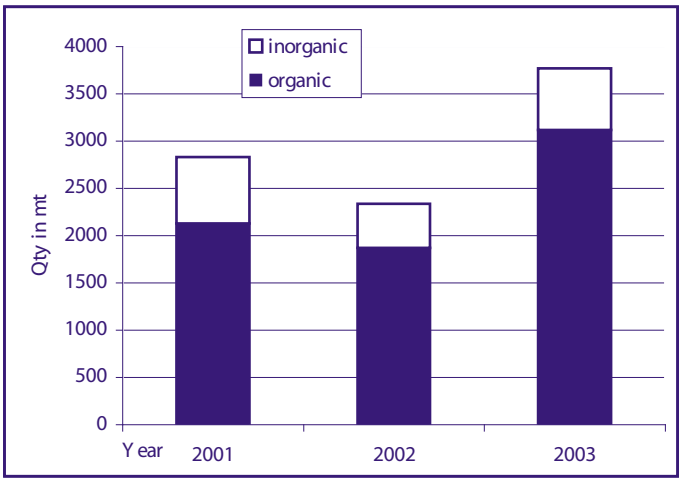

Figure 7.8: Import of fertilisers 2001-2003

Table 7.8: Import of agricultural pesticides 2001-2003

Type	unit	2001	2002	2003
HOUSEHOLD PESTICIDES				
Mosquito coil and Mosquito repellent	kg	93770.3	52937.3	57430.2
Napthalene (Moth Balls)	kg	16702	24869.9	21934.2
Dettol Cream and Glove powder	kg	124.76	216.83	42
Antiseptic, Disinfecting or sterilizing solution	ltr	9824.26	12237.4	128
Dettol	ltr	15145	22146.4	3968.25
AGRICULTURAL PESTICIDES				
Insecticides, nes	ltr	70718.9	70160.7	78328.9
Insecticide	no	886789	701163	1481285
Fungicides	ltr/kg	953	1049.37	1839.54
Plant Growth Regulators	ltr	2000	107.56	0.6
Herbicides & Algaecides	kg	100.5	5	150.71
Weed killer	kg	20	0.47	0.6
Disinfectant		4133.23	3388.55	22921.1
Rodenticides & similar products	no	2400.15	5379.43	3996.52
Rodenticides and similar products , put up for retail sale, nes	no	1628	2621	5682.63

Table 7.8 shows the quantity of pesticides imported into the country. As revealed from the table, seven types of agricultural pesticides are imported into the country while additional household pesticides are also being used. Almost all of these products are on an increasing trend indicating detrimental impact to the biodiversity. The total value of fertilisers and pesticides imported into the country from 2001 to 2003 increased by 22 percent and 14 percent respectively.

7.3.4 Removal of vegetation

Reduction of habitat diversity and coastal biota also occurs due to removal of vegetation. Due to the increasing population, demand for land is on the increase, thereby clearing vegetation for house construction is a continuous increasing trend As illustrated in table 9 today 24 of the 202 island does not have any area for new houses indicating that the natural vegetation of these island are already cleared for housing and service infrastructure.

Table 7.9: Islands without land for additional housing

Sh .Kommandoo	Adh. Kuburudhoo
N. Miladhoo	Adh.Mandhoo
N.Magoodhoo	Adh.Fenfushi
N.Holhudhoo	Adh. Maamigili
R. Kadholhudhoo	V.Rakheedhoo
R.Maduvaree	M.Kolhufushi
Lh.Nairfaru	Dh.Meedhoo
K.Dhiffushi	Th.Dhiyamigili
K. Thulusdhoo	Th.Guraidhoo
K.Huraa	Th.Thimarafushi
K.Gulhi	S.Feydhoo
K.Maafushi	S.Maradhoo

Source: Island fact sheet, MAA, 2003

Reduction of natural vegetation is also due to removal of coconut and other woody trees for construction purposes from both inhabited and uninhabited islands.

Table 7.10- 7.12 provides the details of demand for timber from uninhabited islands through MOFAMR under the regulations formulated by Ministry of Fisheries, Agriculture and Marine Resources under the Law No. 20/98 – "Law Governing the Uninhabited Islands of the Maldives. Under the regulations after felling coconut palms and other timber trees, in accordance to permit issued by Ministry of Fisheries, Agriculture and Marine Resources, it is mandatory to plant 2 for each tree felled.

The demand for timber is reviewed for the period 2000-2003 in order estimate the rate of trees logged. It is important to highlight that these figures need to be interpreted cautiously as lack of compliance with logging regulations and firewood collections would have resulted in under-reporting leading to under-estimation. Moreover although these figures indicate an estimate of timber logged, without a proper assessment of the plant population of the country, it would be difficult to predict the sustainability of the resource.

Table 7.10: Demand for coconut timber for housing 2000-2003 (no. of trees)

	2000	2001	2002	2003	Total
Ha	10				10
Hdh	18				18
Sh	10				10
N	33	48	20	40	141
R	7				7
B	8				8
Lh	4				4
K	29				29
Dh		81	113	85	113
Th	47	40	26		477
L	25	131	216	105	221
Ga		24	48		279
Gdh	36	58	105	22	72
Total	227	382	528	252	1389

Data provided by MOFAMR

According to the tablexx over the four year period, MOFAMR authorized permission for felling 1389 coconut trees for the purpose of house construction. On a yearly basis over 300 palms were removed for the purpose.

Timber is also demanded for the construction of vessels. Table 11 illustrates the details of these figures. As can be seen on an yearly basis an average of over 500mts of timber and over 30 coconut trees were logged for the construction of vessels. Additional trees of other timber species were also logged for the purpose preparing other parts of fishing vessels.

Table 7.11: Demand for timber for the construction of fishing vessels 2000-2003

Year	Timber in mt	Part of fishing vessel (nos.)					Coconut trees (nos)
		Kunbuvah	Budu vah	faivah	Lhis	Rihdhandi	
2000	474	6	462	1974	27099	30	40
2001	927	4	647	2769	23989	74	32
2002	332	2	401	1602	16480	36	24
2003	642	2	826	3123	19810	44	42

Data provided by MOFAMR

Demand for firewood as illustrated in the table reveals that it is on a continuous decreasing trend which is the direct result of use kerosene and gas for cooking. Also as the market for dried fish decreased demand for firewood lessened. Firewood was widely used through out the country to boil and smoke the fish prior to the operation of the collector vessels.

Table 7.12: Demand for firewood 2000-2003 (sticks and branches)

Atoll	2000	2001	2002	2003
Ha	170		200	20
N	350	25		
R	226			
B	1003	2109	330	
Lh	120	110	50	
Dh	1200			
Ga	320	800		
Gdh		260		
Total	3389	3304	580	20

7.4 Policies and Strategies

According to the Sixth National Development Plan 2001-2005 the protection of biodiversity is embedded in the polices and strategies of the various government sectors of the country.

The promotion of sustainable resource management through preservation of natural resource and biodiversity is one of the major policies of the MOEC. Strategies include continued implementing the National Biodiversity Strategy and Action plan to ensure sustainable use of extractive and non extractive resources. Promotion of use of alternative material for building to minimize damage to the physical and biological environment and strengthening polices and implementing procedure for protecting unique and vulnerable habitats and establishing protected areas management systems are additional strategies outlined under the policies.

A number of activities were undertaken for the protection and conservation of the biodiversity. To contribute in the protection of biological resources in the Maldives and thereby to support long-term sustainable development, the

Maldives Protected Area System Project was implemented from 2000 to 2003. The project was an AUSAID funded project, the purpose being to establish a replicable and sustainable system of protected area management. The major components of the project are institutional strengthening, protected area establishment, education and awareness. Under the project, as a potential model site Eidhigali Kulhi of S. Hithadhoo was selected and a number of activities were undertaken in relation to the major components of the project. At the end of the project period a number of assessment were undertaken, including, marine, terrestrial and socio-economic leading to a better understanding of the site, as well as identification of the constraints in developing management systems for protected areas in the Maldives. The site was declared as a protected area site on November 2004.

A national bio-safety framework is being developed under the Convention on Biological Diversity/Cartegena Protocol on Bio-safety which seeks to protect biological diversity from the potential risks posed by living modified organisms resulting from biotechnology. At the national level a committee representing the major stakeholders has been formed since 2003. To date a number of training and workshops have been undertaken at the local as well as regional level. The development of the framework will lead to a system of legal, technical and administrative instruments to address bio-safety for the environment, including the safety of humans, in the field of modern biotechnology.

As a planned activity the Atoll Ecosystem-based conservation of globally significant biological diversity in the Maldives is an another significant projects to be implemented 2005-2010 period. The major components are:

1) mainstreaming biodiversity conservation objectives into sectoral policies and programs and reinforce multi-sectoral institutional flora
2) conserve biodiversity in the water and on the ground by establishing protected areas and managing them through innovative national –local and public-private partnership in Baa atoll
3) relieving livelihood-related pressure on biodiversity by enabling local people to pursue more sustainable alternative livelihoods.

By the end of the project modified sectoral policies and programs will enable institutions to more effectively manage biodiversity. Government, local communities and the private sector will be partnering to secure the long term conservation of three protected areas in Baa atoll with local people applying new knowledge and accessing new source of finance in pursuit of alternative livelihoods.

Among its policies and strategies the tourism sector has highlighted promotion of sustainable tourism through encouraging responsible planning and management practice consistent with the conservation of the natural heritage of the Maldives. To attain this policy the strategies are promotion of eco-tourism development, revise and implement of the management plan for marine protected areas, encourage greater co-operation between the tourism industry and those responsible for the management and the protection of the country's fragile marine environment, enforcement of environmental impact assessment process to the tourism development to minimize the impacts of development on the natural environment and raising awareness regarding the environment impact on tourism.

Tourism ministry continues to play a significant role through the establishment of environment unit. Since 1997 the most environmentally outstanding tourist resort was awarded with the Green Resort Award. The selection criteria include initiation of environmentally beneficial projects, conservation of species and areas, and creating awareness on protection and sustaining the environment, and promotion of sustainable industries. As such many of the tourist resorts have undertaken research into biodiversity protection such as coral reef restoration, and protection of marine as well as terrestrial flora and fauna.

Similarly the Ministry of fisheries agriculture and marine resources has its policy towards developing and managing the marine resources of the country in a sustainable manner. Among the organization's strategies a unit is being established to support local management at the island and atoll level of reef and bait fish resources coral reef management and protection, Revising and implementing management plans of marine protected areas is highlighted as major strategy in the conservation of biodiversity. Along with this ensuring the availability of the most current scientific knowledge and advice to enable the conservation, sustainable management and development of marine resources and the habitats which sustain resources another important approach the organization has highlighted for the sustainable use of its marine resources.

Under the organization policy of ensuring sustainable socio-economic development MOFAMR has highlighted that establishment of good governance through community based system for sustainable management of marine resources and promoting sustainable use of fisheries resources at the grassroots level through formal and non-formal and adult education system. Works in the area include continuation of the rapid assessments of biodiversity of reefs and reef ecosystems of the ecosystems under potential threats.

Among its awareness activities targeted towards the aquarium fishery workshops were held in 2002 and 2003 for exporters and Customs officials involved in the trade to increase awareness of the fishery and to provide information on strengthening data collection and monitoring. Similar workshops were held in 2002 and 2003.

The agriculture sector of MOFAMR gives equal importance to the protection of the biodiversity through the sectors policies and strategies. One of their policies is to maximizing economic and social benefits from ecologically sustainable agri-business. Maldives is also facing the loss of biodiversity as endemic varieties of crops and plants are replaced by introduced hybrid varieties. As the country do not have facilities to conserve the endemic species in gene banks, MOFAMR continues to encourage the local communities to farm crop species that are endemic to the country so that these species can be conserved in vivo. MOFAMR had also catalogued the plant species and the pest and diseases found in the Maldives. Updating of the data base is an ongoing activity. Additional work related to biodiversity includes encouraging the use of biological control for pest/disease management and conservation of crop species that are endemic to the country to reduce the disappearance of natural enemies and other beneficial insects from the island ecosystem. Development of a quarantine system to minimize pest and diseases that come into the country from overseas also assists in the protection and conservation of biodiversity.

World Food Day 2003

This year's World Food Day theme, "Biodiversity for Food Security", highlights the vital role of biodiversity in ensuring enough diversified food for all people in the world. The message is with appearance of new pests and diseases there are fewer opportunities for growth and innovation in agriculture and less capacity for agriculture to adapt to environmental changes. According to FAO conserving biodiversity for agriculture will require efforts on many fronts including measures to preserve the environment, better education, increased research and government support.

At the national level MOFMAR implemented a program to mark the World Food Day at Sh. Feevah. Located in the North of Maldives the island is well-known for its agricultural production particularly in horticulture. All the edible local products available from the atoll will be on display providing the local communities an understanding on the diversification of the local biodiversity with regard to food security. In addition a workshop on pest and disease management was conducted. One of the important highlights of the day would be the display of model food security farm developed by the community of Sh. Feevah.

Environment Day 2004 - Wanted! Seas and Oceans- Dead or Alive?

World Environment Day, commemorated each year on 5 June is celebrated prominently in the Maldives and nations around the world. The World Environment Day theme selected for 2004 is Wanted! Seas and Oceans – Dead or Alive? The theme asks that we make a choice as to how we want to treat the Earth's seas and oceans. The theme calls on each and every one of us to act. Do we want to keep seas and oceans healthy and alive or polluted and dead?

A number of activities were implemented to commemorate this year's Environment Day in the Maldives. A special supplement was published with the daily newspapers on World Environment Day. The main event was the inauguration of the tree planting program in Hulhumale'. The event was organized by the Ministry of Atolls and Development in collaboration with Atolls Offices. Similar to the previous years, awareness programme were broadcasted and telecasted over the radio and TV. A song on the environment day theme was broadcasted through the TV.

In addition to the capital Male' in all the other islands and tourist resorts a number of activities were undertaken. These include cleanup campaigns, exhibition of useful things made of reused items, competitions and quiz programs related to environment, dissemination of information, clean up programs, tree planting programs and special assemblies.

8 Recommendations

Contribute to the international efforts to find solutions to global environmental threats, especially those pertaining to the vulnerable Small Island Developing Nations

- Utilize opportunities to address the international fora to call attention to the fragile nature and the vulnerability of Small Island Developing Nations.
- Continue the timely implementation of commitments by the Maldives under international conventions and organizations to which Maldives is a party.
- Promote wider participation of the community in research, data collection and awareness creation regarding the fragile environment of the Maldives.
- Develop long term mitigating and adaptive response strategies in dealing with the question of possible sea level rise and climatic change.
- Set up a National Task Force, equipped with appropriate expertise, to conduct international negotiations relating to the environment as they impinge on the interests of the Maldives.

Promote integrated planning and administrative practices by developing meaningful principles and procedures for sustainable resource use and environmental protection

- Strengthen the implementation of a comprehensive framework of laws pertaining to natural resources and environment, together with means for enforcement.
- Establish ownership of resources through establishment of property rights and the introduction of
- resource rent.
- Review the adequacy of institutional mechanisms and administrative arrangements and promote wider participation in the implementation of environmental policies and strategies.
- Incorporate the principles of sustainable regional development into the mandates and procedures of all institutions dealing with developmental planning and resource management.
- Strengthen the submission of proposed policies, development programs and projects for Environment Impact Assessment (EIA) procedures.

Ensure adequate water supply, sanitation, safe and environmentally sound management of sewage and solid waste disposal facilities to all islands

- Formulate a plan to provide safe water, sanitation and waste disposal to all islands with defined needs and priority actions
- Develop a national waste management strategy and facilitate its enforcement
- Encourage and facilitate private sectors to become more involved in providing sanitation and waste management services
- Promote the inclusion of sanitation issues not only in planning health services but also in planning and provision of education, infrastructure development and construction activities
- Promote land use planning to protect freshwater aquifers
- Continue to raise awareness on solid waste management
- Promote the use of cleaner technologies and encourage safe use and disposal of hazardous materials
- Develop and enforce guidelines and operational procedures for sewerage projects

Ensure the availability of safe drinking water throughout the country

- Prepare a strategic plan for the development, improvement and construction of public water supplies.
- Encourage and promote community participation in water management.

- Ban the use of harmful materials for roofing, gutters, pipe works and for storage tanks.
- Enforce guidelines and standards and address complaints regarding the misuse of water.
- Continue to monitor the quality of drinking water in all islands.
- Formulate and enforce regulations, standards and guidelines for the design, construction and maintenance of water supply services.
- License all water supply undertakings that supply water to more than 500 people and require such supplies to monitor the performance of the water supply system and to keep records of the monitoring process.
- Monitor all water supply undertakings by periodic inspection, sampling and analysis.
- Eliminate/ban the collection of rainwater from roofs with asbestos cement sheets.
- Regulate and control abstraction and dewatering.
- Strengthen the regulator to enforce standards and monitor compliance.

Develop and manage the marine resources of the country in a sustainable manner

- Strengthen the Ministry of Fisheries, Agriculture and Marine Resources (MOFAMR) to effectively co-ordinate the regulation and management of offshore and coastal fisheries.
- Explore the possibilty of assigning the responsibility for offshore fisheries licensing, monitoring control and surveillance to MOFAMR.
- Establish a unit in the MOFAMR to support local management, at the island and atoll level, of reef and bait fish resources, coral reef management and protection.
- Participate in regional fisheries management bodies to present the interests of Maldives a genuine stakeholder in the pelagic marine resources of the Indian Ocean.
- Revise and implement management plans for marine protected areas.
- Formulate and adopt an integrated marine policy that will harmonise policies and strategies formulated by different Government Ministries/Departments with respect to the marine resources and environment.
- Develop and strengthen the existing marine research centre.
- Ensure the availability of the most current scientific knowledge and advice to enable the conservation, sustainable management and development of marine resources and the habitats, which sustain those resources.

Promote environmentally sound disposal of solid waste

- License all solid waste collection and disposal undertakings that serve a community of more than 500 people.
- Require all solid waste undertakings to monitor the performance of the waste management system and to keep adequate records.
- Maintain surveillance of all solid waste undertakings by periodic inspection of facilities and records.
- Minimize import of non-biodegradable plastic products.
- Provide incentives for biodegradable packaging, composting and recycling, as well as utilization of innovative technologies.
- Designate waste disposal areas at atoll and island levels.

Ensure safe management of hazardous waste

- Develop and enforce appropriate environmental health codes as well as guidelines and operational
- procedures for collection, handling, sorting, use and disposal of solid waste.
- Monitor and control the movement of hazardous waste and prevent illegal traffic.
- Establish a national reporting system to report information on the generation and movement of hazardous waste.
- Empower a regulatory authority to oversee the disposal of hazardous waste.
- Develop institutional and technical capabilities by soliciting regional and international cooperation

- for training and technology transfer.
- Develop emergency procedures and measures to deal with accidental spills.

Recognise and protect the natural environment including the biological diversity of the regions identified for development

- Map the significant nature conservation areas in the regions and continue to maintain and update
- relevant data.
- Develop regional conservation strategies and facilitate conservation.
- Undertake detailed flora and fauna surveys of the regions, and use this information to develop management plans for vulnerable and endangered species and habitats.
- Develop lists of sites requiring re-vegetation and rehabilitation, and provide information on local trees and their suitability for different areas and landscape settings.
- Provide financial and technical assistance to NGOs, CBOs and other regionally active organizations involved in habitat management and rehabilitation activities.
- Promote the establishment of regional nurseries to produce locally occurring native trees for habitat rehabilitation programs.

Promote sustainable resource management through preservation of natural resources and biodiversity

- Continuously monitor and update the natural resources inventory including flora and fauna, in order to preserve the biodiversity of the nation.
- Implement an Integrated Resources Management Strategy to ensure sustainable use of extractive and non-extractive resources.
- Promote the use of alternative materials for economic and infrastructure development inorder to minimize damage to the environment.
- Strengthen policies and implementing procedures to protect and preserve the environment by establishing protected area management systems.
- Develop and implement a Forest Resources Management Strategy, which promotes reforestation schemes including agro-forestry.
- Develop and implement management plans to protect the productive capacity of mangrove areas, mass spawning marine habitats, roosting sites and such unique and vulnerable habitats.

9. Projects

Project Name:
APPRAISING COASTAL EROSION IN THE MALDIVES: LAYING THE FOUNDATION FOR ADAPTATION TO SEA LEVEL RISE AND CLIMATE CHANGE

This three-phase project is designed to address the issue of coastal erosion in the Maldives. The initial phases are aimed to enhance the capacity required to formulate a coastal erosion management strategy.

Project rationale and objectives:

The Maldives face severe constraints in adapting to increased erosion expected with the rising sea level. A major constraint is the lack of capacity to evaluate the magnitude of erosion and identify quantitatively the major causes of erosion. Without such knowledge, appropriate adaptation strategies cannot be formulated.

The aims of this project are to build capacity of the Environment Research to:

1. quantify the magnitude of erosion on islands in the Maldives;
2. determine the importance of natural vs. human induced erosion on islands in the Maldives; and
3. quantify changes in process mechanisms promoting erosion.

Expected outcomes:

1. A trained Environment Research Centre that has instigated a network of erosion studies and is actively assessing the magnitude and causes of erosion through- out the Maldives.
2. Technical summaries quantifying long-term rates and importance of natural vs human induced erosion on representative islands in the Maldives
3. Quantitative summaries of the process regimes (waves currents, sediment budgets) that characterise representative types of islands in the Maldives.

Planned activities and outcomes:

1. Provide Environment Research Centre with technical capacity to undertake erosion studies.
2. Train Environment Research Centre in design, implementation and analysis of erosion studies.

ERC to establish a network of monitoring sites that reflect differences in island morphology and undertake detailed studies to document changes in island morphology and the process controlling island change.

Project Name:
DEVELOPMENT OF PRACTICAL ADAPTATION MEASURES TO COMBAT EROSION IN THE MALDIVES

Project rationale and objectives:

A major constraint to effective adaptation to climate change and sea level is a lack of appropriate and tested practical solutions to coastal erosion. The history of erosion management in the Maldives is dominated by use of inappropriate hard engineering solutions designed without regard to natural processes. The aim of this project is to develop a range of practical solutions to combat coastal erosion on the islands of the Maldives. The specific objectives are to:

1. use systematically collected environmental data as a basis to design a range of environmentally appropriate solutions to manage coastal erosion;.
2 test and monitor each management tool to determine the effect of environmental processes and effectiveness in combating erosion; and

3. develop technical guidelines for the design and construction of different management tools and appropriateness for representative island types.

Expected outcomes:

1. Establishment of an Engineering Support Unit with joint membership from Environment Research Centre, Ministry of Construction and Public Works and Ministry of Atolls Administration, to provide technical guidance on design and construction of specific erosion management tools.
2. Identification of preferred hierarchy of solutions based on field tests and studies of the effects of each option on the environment.
3. Production of technical guidelines on range of options available, design considerations in different island settings and construction.

Planned activities and outcomes:

1. Formulation of an Engineering Support Unit to undertake investigations into appropriate erosion management techniques. The Engineering Support Unit will act in an advisory capacity alongside Environment Research Centre to assist evaluate erosion management problems and solutions.
2. Use process information on environment (generated by the Environment Research Centre) as a basis to design a range of non-structural and hard structural solutions to erosion.
3. Undertake physical trials on designed solutions on a limited number of islands. Trials will qualify the influence of management solutions (e.g.groynes) on coastal processes (waves, currents, sediment transport). Results will provide valuable information to feedback into the design phase. Field investigations of suitable sand aggregates for beach nourishment will be undertaken.
4. Develop technical guidelines that outline the range of solutions appropriate for erosion management in islands in the Maldives. The guidelines will also provide guidance on the actual design, construction and monitoring for different island settings.

Project Name:
COASTAL EROSION MANGEMENT STRATEGY FOR THE MALDIVES

Project rationale and objectives:

Effective erosion management in the Maldives is currently constrained by a weak evaluation process that is not mandatory. Improvement of the process must be based on development of a robust series of steps that is integrated within the existing legislative framework and which gains support of all stakeholders. The specific objectives of this project are to:

1. develop a Coastal Erosion Management Strategy that provides clear and practical guidance on steps that need to be undertaken to properly assess an erosion issue and formulate appropriate management solutions;
2. integrate the Coastal Erosion Management Strategy within existing environmental institutional framework and seek legislative support for the Coastal Erosion Management Strategy;
3. raise awareness of all stakeholders (government to community)of the importance of effective erosion management for sustainable economic development; and
4. implement the Coastal Erosion Management Strategy using planned regional networks in the Maldives

Expected outcomes:

1. Production of a Coastal Erosion Management Strategy to guide effective erosion management.
2. Government endorsement and support of the Coastal Erosion Management Strategy through legislative recognition of the strategy allowing mandatory enforcement of the strategy.
3. Increased awareness and support at all levels of government and community of the importance of appropriate erosion management.
4. An operational network of erosion management officers that co-ordinate the strategy at the regional atoll hubs.
5. Examples of where the Coastal Erosion Management Strategy has been successfully implemented.

Planned activities and outcomes:

1. Development of the Coastal Erosion Management Strategy. This strategy will largely be built on utputs of the previous two programmes and will identify linkages to specific agencies (Environment Research Centre and Engineering Support Unit)to facilitate effective management.
2. Training focused at a range of stakeholders (government agencies, private sector, and local community)to raise awareness of the erosion issue and advantages of following a consistent process for erosion management.
3. Train-the-trainer component so Environment Research Centre can deliver ongoing awareness programmes on erosion.
4. Identify and appoint a network of officers throughout the Maldives to act as liaison on erosion issues and who have the capacity to trig ger the process on the Coastal Erosion Management Strategy.
5. Provide subsidies for erosion works to 5 islands to trial the Coastal Erosion Management Strategy and monitor its success. Outcomes can be used to raise awareness of the issues and solutions

Project Name:
DEVELOPMENT OF FOOD SECURITY IN THE MALDIVES

Soil characteristics in the Maldives are major constraints towards the development of successful conventional agricultural production systems. Limited availability of arable land also sug gests that an alternative crop production system should be looked into. Hydroponics is one method that can increase the production of agricultural products.

Project rationale and objectives:

Hydroponics agriculture in the Maldives on a sustainable basis, at a commercial and household level can improve food security and reduce dependence on imports of various types of vegetables and fruits. It will also enhance income and employment opportunities for the new generation in rural islands, and direct domestic investment towards promoting food security.

Expected outcomes:

- Development of hydroponics production systems on a commercial scale; and
- Reduce dependence on imported vegetables and fruits to achieve accessibility and availability.

Planned activities and outcomes:

1. Train the staff already working in established hydroponics systems in Hanimaadhoo Agriculture Centre as trainers. The trainers will train the required staffs for the projects by using the training facilities in Hanimaadhoo Agriculture Centre.
2. Set up three greenhouses with hydroponics systems in three different regions of the country, each with a total built up area of 8,000 ft2 or 2 unit of greenhouse with similar built area but each unit having four compartments of 1000 ft2.

Project Name:
THE USE OF INFILTRATION GALLERIES TO SUPPLY GROUND WATER IN THE ISLANDS

Project rationale and objectives:

The groundwater in the islands of the Maldives is found in shallow and relatively thin water lens. In some islands, a large quantity of groundwater is pumped from a few wells in the island. Due to the high extraction rate and associated draw down effect, the pumped water becomes very saline. It becomes more saline in the dry periods as the demand for groundwater increases. Increasing the area available for extraction of groundwater can reduce the draw down effect and improve the quality of the supplied groundwater. To develop an appropriate design system for centralised infiltration galleries to supply the fresh groundwater to meet the water demands for the island communities through out the year.

Expected outcomes:

A properly designed, constructed and operating infiltration gallery for extracting large amounts of freshwater from the water lens of the islands.

Planned activities and outcomes:

1. Construction of a designed infiltration gallery in a densely populated island to supply groundwater.

Project Name:
CLIMATIC INFLUENCES ON THE SPREAD AND TRANSMISSION OF VECTOR BORNE DISEASES

Project rationale and objectives:

The vulnerability and adaptation assessment done on the effects of climate change on the health sector identifies vector borne diseases as an area where further research is required. Dengue and dengue hemorrhagic fever, both transmitted through vectors, have been identified as endemic in the country and in recent years morbidity has increased. Therefore, this project proposes to undertake a study with the main objectives to:

1. systematically collect and manage climatic and health data for use in a climate impact analysis; and
2. undertake a study on the effects of climate change on the spread and transmission of vector borne diseases based on the collected data.

Expected outcomes:

1. Enhanced capacity at the Ministry of Health to undertake an analysis of the climatic influences on the spread and transmission of vector borne diseases.
2. Continuous,short term and long term reporting on the status of vector borne diseases in the Maldives.

Planned activities and outcomes:

1. Provide Ministry of Health with the technical capacity to undertake such a study.
2. Train Ministry of Health personnel in design, implementation and analysis of such a study. Specific trainings to be given on the use of GIS,data analysis and background on climate change and vector borne diseases.
3. Establish and maintain a database of vector borne diseases in a climate change context.
4. Ministry of Health to establish a network with the Department of Meteorolog y, and other environment related agencies,to incorporate relevant climate information into the health database.
5. Produce short term and long term reports on the effects of climate change on vector borne diseases in the Maldives.

Project Name:
THE USE OF SOLAR DISTILLATION AS SOURCE OF FRESHWATER FOR OUTER ISLANDS AND MALÉ

This project is aimed at acquiring appropriate technology to provide freshwater to populated islands in the Maldives.

Project rationale and objectives:

Acquiring appropriate technology to provide portable freshwater to populated islands is a priority area identified in the NEAP II. The Maldives lies on the equator and receives on average seven hours of daily sunshine. Populated islands have limited space for harvested rainwater storage. The groundwater cannot meet the demand for water for these islands.

To acquire appropriate technologies for solar distillation for desalination as a source of freshwater, which can meet the demand in the dry season for the population of the islands.

Expected outcomes:

1. The islands will have desalinated water as a source of water even in the dry season.
2. The amount of GHG emission will be reduced
3. The risk of diesel polluting the groundwater will be reduced.
4. The production of water would be less vulnerable to the fluctuating price of diesel.

Planned activities and outcomes:

1. Carry out a study on the water demand in the medium densely populated islands.
2. Quantifying the water demand, taking into consideration the increase of demand for water for the predicted climate change for the region.
3. Identifying the appropriate technology for the Maldives and educating the communities for their acceptance for the new technology.

Project Name:
DEVELOPMENT OF SUSTAINABLE INTERISLAND SEA BASED MASS TRANSPORT TION SYSTEM

One of the main sectors, which contribute to CO 2 emission, is the transport sector. The sea transport system, which currently exist, is not operated on a scheduled basis. The National Development Plan identifies regions to be developed as regional centers in the Maldives. Establishing a mass transportation network between these regions can develop a sustainable transport system in the Maldives.

Project rationale and objectives:

The development of a scheduled transport system would reduce the need for the ad hoc movement and has the potential to reduce the emission of carbondioxide from the transport sector. Development of such network work would help to achieve the goals of sustainable development. The main objective of this project is to establish a mass transportation network for passengers and cargo between the regional centres in the country.

Expected outcomes:

1. Availability of goods and services to far away islands.
2. Reduction of GHG emissions in the transport sector.

Planned activities and outcomes:

1. Build up to nine harbours across the nation, with the capacities to handle cargo and accommodate passangers.
2. Establish a feeder service from neighbouring islands to the harbours using the existing fleet of small dhonis and vessels.
3. Select medium size vessels from the existing fleet to establish an intraharbour network
4. Obtain efficient, large,fast ferries to set up a national ferry service network.

Project Name:
DEVELOPMENT OF SEWAGE TREATMENT FACILITIES

The current system of sewage disposal constitutes a serious threat to prospects for sustainable development and,in many densely populated islands, it has become a critical problem. One of the few sewerage systems that exist in the Maldives is the sewerage system on Malé. This system consists of nine pumping stations that pump untreated sewage into the sea. Growing population pressures in Malé combined with the technical deficiencies in the present system, pose increasing serious threats to public health, ecologically fragile ecosystems and marine life in coastal areas.

Project rationale and objectives:

The present GHG inventory does not account for the production of methane from sewage treatment, as sewage is not treated in the Maldives. Sewage contributes to the emission of national GHG and the development of sewage treatment facilities would reduce the emission of GHGs.

The main objectives of this project are to review different technological alternatives for raw sewage treatment with methane recovery capabilities and to design the model that would provide the best longterm solution for sewage disposal for the islands of the Maldives.

Expected outcomes:

Establishment of proper sewage treatment facilities with methane recovery units in the densely populated islands.

Planned activities and outcomes:

1. Carry out a review of different technologies available for the sewage treatment for the Maldives.
2. Survey the densely populated islands to design an appropriate sewerage treatment facility.
3. Carry out an education campaign to address the issue of conserving water.

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