

Part III

KEY ENVIRONMENTAL ISSUES



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3.1 CLIMATE CHANGE AND SEA LEVEL RISE

The Maldives being a fragile low lying small island ecosystem, it is very vulnerable to climate change and its associated impacts especially the predicted sea level rise. Although the Maldives contributes minimally to the global greenhouse gas emissions: 0.001% (MHAHE 2001), it is among the most susceptible to impacts of the changes in climate.

The Intergovernmental Panel on Climate Change (IPCC) in its Third Assessment Report estimates a projected sea level rise of 0.09m to 0.88m for 1990 to 2100 (IPCC 2001). With about three-quarters of the land area of Maldives less than a meter above mean sea level, the slightest rise in sea level will prove extremely threatening. This is further aggravated by the variation of the tide. Many islands already suffer inundation and shoreline erosion because of its low elevation. The inundation often leads to freshwater shortages and disease outbreaks. The magnitude of rise in sea level projected in the IPCC Third Assessment Report threatens the very existence of life and livelihood in the Maldives.

Impacts of sea level rise on Malé

A scenario depicting impact of sea level rise presented at the seventh Conference of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC) based on a Case Study conducted during the preparation of the National Communication to the UNFCCC. Using a Digital Terrain Model (DTM) of Malé (Map 3.1) and a set of sea level scenarios published by the Intergovernmental Panel of Climate Change, the following findings in terms of area that would be inundated are revealed:

Scenarios	% Inundated	Map
2025 (High) Scenario	15	3.1a
2050 (Low) Scenario	15	3.1a
2050 (High) Scenario	31	3.1b
2100 (Low) Scenario	50	3.1c
2100 (High) Scenario	100	3.1d

Source: MHAHE, 2001



Map 3.1: Elevation contour map and street map of Malé overlaid.



Map 3.1a: Map showing areas that would be inundated in 2025 (high) scenario. That is 0.84m (19.7cm + 64cm*). The same map also applicable to year 2050 (low) scenario. That is 0.84m (19.9cm + 64cm)



Map 3.1b: Map showing areas that would be inundated in 2050 (high) scenario. That is 1.04m (39.7cm + 64cm*).



Map 3.1c: Map showing areas that would be inundated in 2100 (low) scenario. That is 1.13m (48.9cm + 64cm*).



Map 3.1d: Map showing areas that would be inundated in 2100 (high) scenario. That is 1.58m (94.1cm + 64cm*).

* Highest astronomical tide for Maldives (Woodroffe, 1989)

Of particular concern for the Maldives is the impact of climate change on the groundwater availability. In the islands rainwater lenses lie atop salt water. As sea level rises, the thickness of the freshwater lens decreases, and the volume of freshwater decreases. Also sea level rise would increase the likelihood of storm over wash of the islands, causing increased incidence of saltwater contamination of the freshwater lenses.

The tourism industry relying heavily on the marine ecosystems is also under threat from the impacts of climate change. An increase in temperature can very easily bring the reef growth and reef ecosystems to an alarmingly poor status. Although almost all the reefs have recovered from the coral bleaching event of 1997, the impacts of bleaching were felt on around 90% of the reefs of Maldives, bleaching them totally or partially (Naeem et al 1998). The corals already growing at highest tolerable temperatures (approximately 30°, Celsius) have a very grim possibility of survival given the predicted rises in temperature of 1.4 to 5.8°C for the period of 1990 to 2100 (IPCC 3rd Assessment Report).

The islands of Maldives are reef-based and coral reefs serve as natural breakwaters. With damage to the coral reefs comes the bigger danger of losing the natural protection of the islands from the waves and currents. An island with a degraded reef is more open for coastal damages such as beach erosion and more susceptible to inundation by uncontrolled waves reaching the shore.

Fishery is also expected to suffer from the impacts of climate change. Tuna fishery is the main fishery and tuna is a migratory species. A possible change in temperatures can drive the tuna stock to more favourable temperatures. This can lead to a decline in the fisheries industry as the fishermen lose their fishing grounds. The tuna fishery is based on pole and line method using bait fish. Any changes to the availability of bait fish caused by damage to the reefs would also affect the tuna fishery.

A major concern in the country related to the climate change phenomenon is the lack of knowledge and awareness on the issue as well as the lack of necessary resources to properly assess the possible impacts. There is a need for research on localised climate changes and its impacts. There is also an urgent need for the development of resources to adapt to possible impacts of climate change.

El-Nino events and other climate variations also have considerable pressures on the fragile ecosystem of the Maldives. One of the major threats to coral reef biodiversity is coral bleaching associated with increased seawater temperature. The Maldives experienced large-scale coral bleaching during 1998 El-Nino event. Reef monitoring show that live coral cover decreased to a mean of 2.1% from pre-bleaching levels of 30-45% (MRC 1999). Subsequent observations in 1999 showed early signs of recovery with recruitment of highly affected varieties such as acroporids and pocilloporids (Edwards et al 2001). The study states that "despite the severity of mortality, recovery appears to be proceeding much faster in the Maldives than in the species poor eastern Pacific after the 1982-1983 ENSO warming event".

3.1.1 Natural Disasters and Episodic Events

In April 1987, a storm centre in the southern Indian Ocean resulted in long-distance wave transmission that passed through much of the Maldives archipelago. The waves caused enormous economic losses through damage to infrastructure, land and vegetation. Malé and the International Airport were among the worst hit with extensive flooding and erosion.



While the rehabilitation work on this damage was still in progress, the country again was faced with storm surges in June and September the same year. Although these surges were less extensive than the one in April that year, many of the agricultural fields were inundated by seawater and some causeways linking islands were badly damaged.

The island of Thulhaadhoo faced inundation in 1988. This was caused by high SW waves (2-2.5m high; duration 12-15 seconds) in association with a high spring tide and south-westerly winds.

The most severe recorded storm event in the Maldives so far was on 30th of May 1991. During the storm, the atmospheric pressure fell down to 997 hpa and the maximum squally winds reached 90 kts per hour (DoM, 2001). The most severe weather from this storm was experienced in the southernmost atoll, Addu Atoll. However, most parts of the country were affected, with 4,081 houses in 13 atolls damaged (SAARC 1992).

The resort island of Bolifushi was hit by similar but a very much more localised freak storm in 2000. This storm lasted about 12 hours and caused US\$ 1.2 million worth of damages

Coastal flooding has been experienced in the past and the risks of flood damage resulting from high tides have not reduced in recent years. The degree of severity of some of these events has been thought to have increased due to improper coastal zone management and construction of poorly designed coastal structures. Proper management methods of the coastal zone are now gradually being introduced in the Maldives, and some research and consultations are now carried out in the construction and design of seawalls and coastal structures, as well as in the reclamation of land. The country still needs to increase its capacity in such research and design.

With the prediction by the IPCC of possible increase in extreme events of weather, there is a growing need for enhancing the local capacity in predicting such events as well as for preparedness to face them.

Photos of 1988 sea swells to be included here. And the 1991 High Winds in Addu.

3.1.2 Beach Erosion

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.



Since, almost all human settlements, vital infrastructure and industry lie very close to the beach, coastal erosion threatens to damage houses, schools, and other infrastructure. According to records kept by the Ministry of Home Affairs Housing and Environment, at present nearly 50 percent of all inhabited islands and nearly 45 percent of tourist resorts suffer varying degrees of coastal erosion (MHAHE 2000). Resorts that have reported severe beach erosion is listed in table 3.1, and islands that have reported severe beach erosion since 1990 are given in table 3.2.



Table 3.1: Resorts that have reported severe beach erosion

South Thiladhunmathi Neykurendhoo Nolhivaranfaru	Faadhippolhu Felivaru Gaaerifaru Kurendhoo Maafilaafushi Vavvaru	Mulakatholhu Kolhufushi Mulaku Naalaafushi Raiymandhoo	Hadhdhunmathi Kalhaidhoo Kunahandhoo Mundoo
North Miladhunmadulu Bilehfahi Firubaidhoo Funadhoo Komandoo	Malé Atoll Thulusdhoo Guraidhoo Huraa Maafushi Villigilli	North Nilandhe Atoll Biledhdhoo Bodu Finolhu Feeali Magoodhoo Nilandhoo	North Huvadhu Atoll Dheevadhoo Kanduhulhudhoo Kolamaafushi Kooddoo Villigili
South Miladhunmadulu Holhudhoo Kuredhivaru Maalhendhoo Velidhoo	North Ari Atoll Bodufolhudhoo Himandhoo Mathiveri Rasdhoo Thoddoo Ukulhas	South Nilandhe Atoll Meedhoo	South Huvadhu Atoll Hoadedhdhoo Nadallaa Rathafandhoo
North Maalhosmadulu Angolhitheemu Fainu Inguraidhoo Maduvvari Meedhoo Vahfushi	South Ari Atoll Dhangethi Dhigurah Hangnaameedhoo Maamigili Mahibadhoo Omadhoo	Kolhumadulu Buruni Dhiyamigili Gaadhiffushi Guraidhoo Hirilandhoo Kandoodhoo Kibidhoo Madifushi Omadhoo Thimarafushi Vandhoo Veymandoo Vilufushi	Fuvahmulah Fuvahmulah
South Maalhosmadulu Dhonfanu Eydhafushi Hithaadhoo Kamadhoo Kendhoo Kihaadhoo Kudarikilu Maalhos	Felidhe Atoll Felidhoo Fulidhoo Thinadhoo		Addu Atoll Feydhoo Hulhudhoo

Table 3.2: Islands that have reported severe beach erosion

North Maalhosmadulu Pearl Island	Ihuru Tourist Resort Makunudhu Island Resort Olhuveli View Hotel	Ari Beach Resort Athurugau Island Resort Lily Beach Resort
South Maalhosmadulu Coco Palm Resort Kihaadhuffaru Tourist Resort Reethi Beach Resort	Paradise Island Resort Fun Island Resort Reethirah Resort Rihiveli Beach Resort Taj Lagoon Resort Tari Village	Mirihi Island Resort Moofushi Island Resort Sun Island Resort Thundufushi Island Resort Vilamendhoo Island Resort
Faadhippolhu Kanuhuraa Beach and Spa Resort Komandoo		Felidhe Atoll Alimatha Aquatic Island Dhiggiri Tourist Resort
Malé Atoll Banyan Tree Club Rannalhi Emboodhoo Village Fun Island Resort Hembadhoo	North Ari Atoll Nika Hotel Velidhu Island Resort Gangehi Island Resort Veligandu Island Resort Maayafushi Tourist Resort South Ari Atoll Angaga Island Resort	Mulakatholhu Hakuraa Huraa
		South Nilandhe Atoll Vilu Reef Resort

3.1.3 Major Policy Responses and Initiatives

In order to reduce the emission of greenhouse gases, the Maldives has started pilot projects on alternate sources of energy. Solar power has been used to power telecommunication sets, navigational aids and government office buildings and mosques in the islands. The main constraint to the widespread use of solar energy is the lack of technical backup and high installation costs. While wind is a regular feature of the Maldives, existing wind speeds are considered marginal for electricity generation, unless high towers are erected at high capital cost. Supplementing conventional energy supply by alternate energy sources, wherever viable, has been included in the energy sector objective and strategy in the National Development Plan.

As the Maldives is very vulnerable to the predicted climate change and sea level rise, attention is given to adaptation measures. Various programmes have been designed and implemented in areas such as coastal protection, freshwater management and coral reef protection. The Government has taken very important measures to protect the coral reefs by reducing import duty on construction materials and prohibiting use of coral for government buildings and tourist resorts and by banning of coral mining from house reefs.

The flooding in 1987 triggered concern in the Maldives about the possible impacts of climate change. President Maumoon Abdul Gayoom played a pivotal role in bringing the issue of climate change and sea level rise and the vulnerability of small island states, to the attention of the international community. He has addressed at numerous important international gatherings, including Commonwealth Heads of Government meetings the UN General Assembly, the Earth Summit in Rio in 1992, the UN Millennium Summit in 2001, as well as regional SAARC Summit meetings. On the request of the President, the Commonwealth and the SAARC established expert groups to study the impacts of greenhouse effect and global warming. A United Nations Environment Programme mission visited the Maldives and recommended training of local personnel to monitor and evaluate impacts of expected environmental changes and the development of strategies that would permit sustainable development.

The Maldives has played a leading role in encouraging the small island states to band together to devise a unified stance on global climate change problems among small island states. In 1989, with the help of the Commonwealth Secretariat, the Maldives hosted the Small States Conference on Sea Level Rise at Ministerial Level, the outcome of which was the Malé Declaration on Global Warming and Sea Level Rise. This declaration called

for negotiations for a framework convention on climate change to start as soon as possible after the adoption of the interim report of the IPCC. It also called upon all states to reduce or limit the emission of greenhouse gases and called upon the international community to assist small states to tackle environmental problems.

The Maldives participated in the Second World Climate Conference in 1990 and was instrumental, along with other small island states, in ensuring that the resulting Ministerial Declaration mentioned the special problems faced by small states. The Declaration notes that the present rate of climate change "could even threaten survival in some small island states" and recommends that "adequate and additional financial resources should be mobilised and best environmentally sound technologies transferred expeditiously in a fair and most favourable basis."

The Maldives was instrumental in the formation of the Small Island Action Group that eventually at the Second World Climate Conference in Geneva, in 1990, became the Alliance of Small Island States. The Alliance of Small Island States commonly known as AOSIS is a group of developing countries that share common objectives on environment and sustainable development. The group comprises of small island and low-lying coastal developing countries which are members of island regional groupings or organisations. The members of AOSIS are particularly vulnerable to the adverse consequences of climate change such as sea level rise, coral bleaching and the increased frequency and intensity of tropical storms.

The Maldives is a party to the United Nations Framework Convention on Climate Change (UNFCCC). The Maldives signed the Convention on 12th June 1992 and ratified the same on 9th November 1992. The Maldives played a very important role with AOSIS in the negotiation process that started in Berlin and culminated in Kyoto. The Maldives, though disappointed with the low targets agreed for in the Kyoto Protocol, looks for early implementation of the Protocol. The Maldives was the first country to sign the Kyoto Protocol on 16th March 1998 and it ratified the Protocol on 30th December 1998. The first National Communication of the Maldives to UNFCCC was submitted at the 7th Session of the Conference of the Parties to UNFCCC held in Marrakesh in 2001. The National Greenhouse Gas Inventory, National Mitigation Plan, Vulnerability Assessment and Adaptation Options are included in the national communication of Maldives.