

## **CHARACTERISTICS, STATUS AND NEED FOR CONSERVATION OF MANGROVE ECOSYSTEMS IN THE REPUBLIC OF MALDIVES, INDIAN OCEAN**

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**Summary:** Very little is known about the wetland ecosystems, particularly mangroves and inland *pond* ecosystems (*kulhi, faa, chasbin*) that occur on the islands of Maldives. It is estimated that 12 per cent of its 1,190 islands have mangrove ecosystems representing 12 true mangrove species. The mangrove ecosystems of the Maldives are unique in that they are not estuarine-based. Biophysical and geomorphological variations are also observed amongst mangrove ecosystems found on different islands. Mangroves are not only considered an important source of food, fuelwood, timber and medicine for Maldivians, but they also act as a buffer against the waves and reduce erosion on islands. The mainstays of the country's economy are fisheries and tourism, both of which are dependent on maintaining a healthy reef system. Mangroves of the Maldives may be pivotal to maintain the rich diversity of life in the marine environment. Despite these, the rapid developmental activities in the atolls are posing overwhelming pressure on these fragile ecosystems. There is enough evidence indicating that they are threatened and rapidly declining on many islands. Formulation and implementation of a mangrove management plan is of utmost importance. Maintenance of these ecosystems is not only important for their ecological and socioeconomic values but also for the sake of protecting the natural and cultural heritage of the Maldives.

### **Introduction**

The Republic of Maldives consists of 1,192 coral islands spread over a distance of 868km in a north-south direction in the Indian Ocean, covering an area of 90,000 km<sup>2</sup>. India and Sri Lanka are the country's nearest neighbors lying some 600km and 750km north and northeast of the Maldives, respectively. The islands form 26 natural atolls, which, for purposes of administration, are grouped into 20 units, also called atolls. Most of these low-lying islands are small, with few exceeding an area of one km<sup>2</sup>. The average elevation of islands is estimated to be only a meter above mean sea level.

The population of Maldives was estimated to be about 270,101 in 2000. This population is scattered over 199 inhabited islands. The remaining islands are

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uninhabited, although 86 of these islands have been developed as tourist resorts. Ninety per cent of the inhabited islands have a population of less than 1,000 and only four islands have more than 4,000 people. Around 26% of the nation's population live in Male, the capital island.

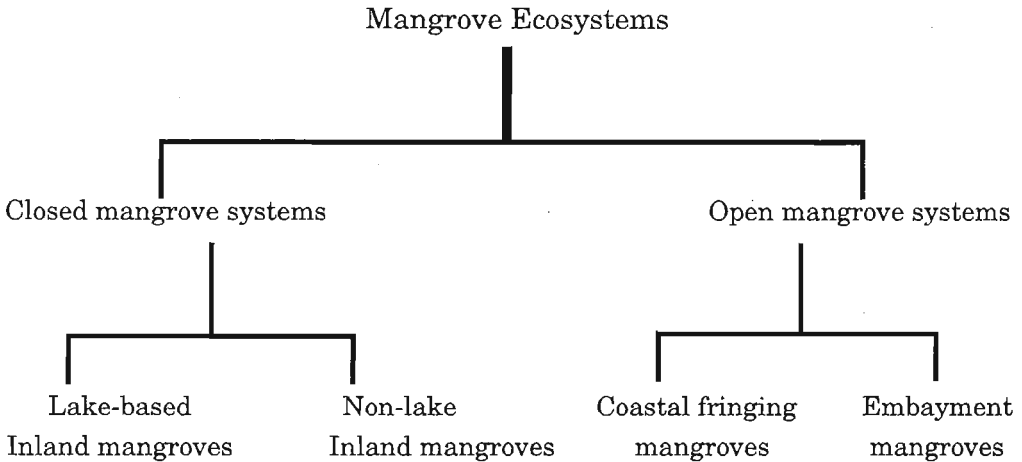
The climate of the Maldives may be described as tropical monsoon type with two pronounced monsoon seasons. The climate of the Maldives is regulated by the easterly and westerly monsoons. The westerly monsoon, which extends from April to November, brings much of the rain during the year. Monthly variations in rainfall are significant, ranging from 12.3mm in February to 250mm in May. The annual average rainfall during the period 1995-2000 was 1,870.3mm. While there are occasional gales (on average 12 days a year) and tropical thunderstorms (23 days a year), Maldives falls outside the main areas of tropical cyclones. Daily temperatures vary little throughout the year. The annual mean temperature is 28°C, with a maximum average of about 31°C and a minimum of 25°C. Relative humidity ranges from 73% to 85%. There are latitudinal changes in the critical environmental factors in the Maldives. For instance, the amount of rainfall increases towards the south, while the effect of storms are more frequent in the north.<sup>12</sup> Latitudinal variations in geomorphical and geophysical factors are also observed in the islands from the north to the south of the country.<sup>1</sup>

Due to the lack of studies and documentation, little is known about the biodiversity of the Maldives. The major ecosystems of the Maldives include, coastal vegetation, evergreen moist forests, mangroves, and inland pond ecosystems (including *kulhi*, *faa*, *chasbin*) seagrass beds and coral reefs. It has been estimated that in the terrestrial environment, 500 species of higher plants, 2 species of amphibians, 67 species of butterflies, 6 species of reptiles, 5 species of mammals and more than 130 species of insects exist on the islands. Of the estimated 200 species of birds, five have so far been identified to be endemic to the Maldives. The two species of bats found in the Maldives are endemic. The coral reefs of the Maldives are renowned for species diversity and support stocks of endangered species. Some estimates state that 250 species of branching corals, 1,500 species of fish, 5,000 species of mollusks, 200 species of sponges, 1,000 species of crustaceans and 12 species of mammals exist in the marine environment.

### **Characteristics of Mangrove Ecosystems of the Maldives**

Of the 1,190 islands of the country, mangroves are known to grow on at least 150 of them, which is about 12 per cent of the islands. Elsewhere in the world mangroves are generally found in estuaries. However, this is not the case with the mangroves of the Maldives. There are no freshwater lakes or rivers on the islands. Mangroves on these islands often tend to be found in enclosed or semi-enclosed brackish water bodies locally known as *kulhi*, or in muddy areas without standing water known as *chasbin*. The presence of mangrove vegetation on either of the two habitats is referred

to as *faa*. The size, shape, composition, and pattern of mangroves vary considerably from island to island. Chaudhury<sup>3</sup> divided mangrove formations of the Maldives into two broad distinct categories: *lagoon-based mangroves* and *depression-based mangroves*. However, it is perhaps more appropriate to classify the mangrove ecosystems as *closed systems* and *open systems* (Figure 1). This is exclusively based on the system's exposure to the sea. The closed mangrove systems could be further divided into *pond-based inland mangrove systems* and *non-pond based inland mangrove systems*.



**Figure 1: Classification of Mangrove Ecosystems of the Maldives**

*Pond-based mangrove:* In this case, the mangroves encircle a shallow brackish water pond (kulhi) found on an island (Fuvah Mulah). The depression floor, which is holding the standing water body, consists of forest litter and humus of 4-5 inches. In some cases, the island development processes, perhaps, can explain the formation of such systems. For instance, Hulhudhoo and Meedhoo in Addu Atoll were two separate islands that appear to have joined together with a central depression forming a pond.<sup>5</sup> However, how mangroves colonise around the pond need further investigation.

*Marsh-based mangrove:* These mangroves are found on muddy substratum and are not associated with a pond and therefore, are not directly subjected to daily flushing. They grow on part or most of an island depending on the island's surface form. In this case, silt and sand are likely to have accumulated in the depression by runoff, creating the mangrove habitat. The habitat receives saline water through its connections with the sea.<sup>3</sup> The wetting of the surface may therefore be closely related to the tidal regime. Examples of such mangrove systems are found on Fuvah Mulah and on the Keylakunu Island.

Similarly, two categories of open mangrove systems have been observed: fringing mangroves and embayment mangroves.

*Fringing mangroves:* In this case, mangroves are found at the shore and are fully exposed to the sea. The development of a fringing mangrove is likely to be possible only on the sheltered or rubblely coasts. Fringing mangroves are not so common in the country. This may be due to the dynamic nature of the islands' coasts resulting from seasonal and longterm changes. A typical fringing mangrove is found on Goidhoo Island, in Goidhoo Atoll.

*Embayment mangroves:* This is perhaps the most common mangrove formation in the country, where mangroves partially encircle a 'bay', which is subjected to daily tidal flushing. It is common to see the vegetation forming 'island-like' clumps in such systems. Mangroves of Huraa and Hirimaradhoo (H.Dh. atoll) are examples of this system.

It appears that the formations of closed and open systems are closely related to each other and to the islands' development processes. Shortterm storms may also induce changes to these systems. The process may be faster during the latter process or even spontaneous depending on the magnitude of the storm. The changes that occur to the vegetation structure and the ecology of the system when one transforms to the other may be worth investigating.

### **The Diversity of Flora and Fauna, and the Extent and Distribution of Mangroves in the Maldives**

Work to inventorise the mangrove species found in the entire archipelago is wanting. The studies carried out by Fosberg in 1949 and by Hackell in 1917 have indicated that only a few species are found in the Maldives. However, Jagtap and Untawala in 1991<sup>3</sup> reported 13 species from 9 genera in the Maldives in 1993. But in 1999, Jagtap and Untawala reported 12 species of mangroves, belonging to 7 genera, after surveying 19 islands in 4 atolls. In 1995, the Agriculture Ministry of the Maldives reported 8 species of mangroves. Based on some of the above work, at least 14 mangrove species are known to grow in the country (Table 1). Studies undertaken thus far also indicate that the number of species found in any single stand is limited to 4 to 5 species. Mangrove species found in such stands are often found in association with their allies forming thick and healthy vegetation (Table 2).

The South and Southeast Asia region is known to have some of the largest mangroves and the highest diversity of mangroves in the world and the Indo-Malayan region is believed to be the center of origin of the mangroves.<sup>11</sup> Accordingly, this may be the most likely source of the mangroves species found in the Maldives. Though Maldives is located in a mangrove rich region, lack of long, sheltered coasts and river estuaries have limited the size and the diversity of mangroves. However,

available data reveals that amongst the island groups of the Indian Ocean, the Maldives Islands appear to host the most number of mangrove species.

**Table 1: Mangrove Species of the Maldives**

Botanical Name	Family	Common Name	Local Name
<i>Avicennia marina</i>	Avicenniaceae	Mangrove	'Baru'
<i>Bruguiera cylindrica</i>	Rhizophoraceae	Mangrove	'Kandoo'
<i>B. gymnorrhiza</i>	Rhizophoraceae	Mangrove	'Bodavaki'
<i>Bruguiera sp</i>	Burma		
<i>Ceriops tagal</i>	Rhizophoraceae	Mangrove	'Kharnana'
<i>Derris heterophylla</i>	Fabaceae		
<i>Excoecaria agallocha</i>	Euphorbiaceae		'Thella'
<i>Heritiera littoralis</i>	Sterculiaceae		'Kaharuvah' gas'
<i>Lumnitzera racemosa</i>	Combretaceae	Black Mangrove	'Burevi' 'Randoo'
<i>Rhizophora mucronata</i>	Rhizophoraceae	Mangrove	'Makeha'
* <i>Rhizophora sp</i>	Rhizophoraceae		'Thakafathi'
* <i>Rhizophora sp</i>	Rhizophoraceae		
<i>Sonneratia caseolaris</i>	Sonneratiaceae	Crab Apple Mangrove	'Kulhlhavah'
<i>Xylocarpus moluccensis</i>	Meliaceae	Cannonball Tree	'Maru gas'

\* One of these is believed to be *R. apiculata*. This was, for the first time, identified in the Maldives during a field visit to Huraa, Male Atoll, by a team from the Environment Research Center on 10/9/2002.

**Table 2: Common Mangrove Associates of the Maldives**

Botanical Name	Family	Common Name	Local Name
<i>Tournafortia argentea</i>	Boraginaceae	Tree Heliotrope	'Boashi'
<i>Thespesia populnea</i>	Malvaceae	Milo	'Hirundhu'
<i>Scaevola taccada</i>	Goodeniaceae	Scaevola	'Magoo'
<i>Pandanus sp.</i>	Pandanaceae	Pandanus	'Kashikeyo'
<i>Hibiscus tiliaceus</i>	Malvaceae	Beach Hibiscus	'Dhiggaa'
<i>Pemphis acidula</i>	Lythraceae	Iron Wood	'Kuredhi'
<i>Barringtonia asiatica</i>	Lecythaceae	Fish Poison Tree	'Kinbi'

The diversity and abundance of fauna found in mangroves vary from island to island. During the surveys of mangrove of the Huraa Island, Male atoll, (a relatively small mangrove) 3 species of reptiles, several species of insects, 10 species of crabs, 4 species of fish, one species of shrimp, and 9 species of birds have been observed (Table 3). Similarly, in islands where the endemic Maldivian Pond Heron (*Ardeola grallator phillypsii*) is found, mangroves are found to be their most important breeding and feeding grounds. The role of the microorganisms is particularly important in the functioning of the mangrove ecosystems. In 1991 Untawala and Jagtap reported 37 species of marine fungi from decayed wood of Maldivian mangroves. A proper investigation of this area is necessary to understand the species and the role of microorganisms in these ecosystems.

Recent surveys undertaken by the Environment Research Centre show that mangrove ecosystems occur mostly in the northernmost and southernmost atolls. They are poorly represented on some and not represented at all on the other atolls of the central region (Figure 2). In the northern atolls, mangroves tend to be found on the islands located on the eastern side of the atoll, while in the southern atolls, mangroves tend to be found mostly on the islands on the western rim of the atoll. Further work in this area is needed to explain this trend. The average size of the mangrove ecosystems and species richness is greater in the north than in the south.

## Importance of Mangroves

Mangroves are important for economic, cultural, social and ecological reasons. Some of the important traditional uses of the mangroves include, use of timber from *Bruguiera cylindrica*, *B. gymnorhiza*, *Rhizophora mucronata* for boat building, construction, firewood, fencing, and the making of fishing poles. The locals consume the fruits of *Sonneratia caseolaris* and *Bruguiera cylindrica*. *B. cylindrica* is also used to make dyes for colouring the fishing lines and its bark is used in indigenous medicine. Direct uses of mangrove ecosystems also include the use of clay from the ponds for pot making in islands such as Kulhudhuffushi.<sup>10</sup> The ecological services provided by the mangroves are well known. However, no such studies have been undertaken in the Maldives. Accelerated erosion on islands caused by the removal of mangroves clearly indicates their importance for the protection of islands from the sea. By causing sediment to get stuck onto mangrove roots perhaps may not be the only way by which mangroves control erosion. Mangroves also act as barriers against storms and tidal surges. Mangroves are perhaps the single most important grounds for breeding, nesting, and roosting for numerous resident birds of the Maldives. Mangroves are also an important stopover for a large number of birds during their north-south and *vice versa* migrations. Mangroves also act as a breeding area for sharks.<sup>6</sup> They are important nursery areas for larval stages of shrimps and fish species. In addition to several species of finfish, mollusks, crabs and shrimps are commonly found in the mangroves. Mangroves such as *Sonneratia* and the associate *Barringtonia* are important food plants for the endemic fruit bat

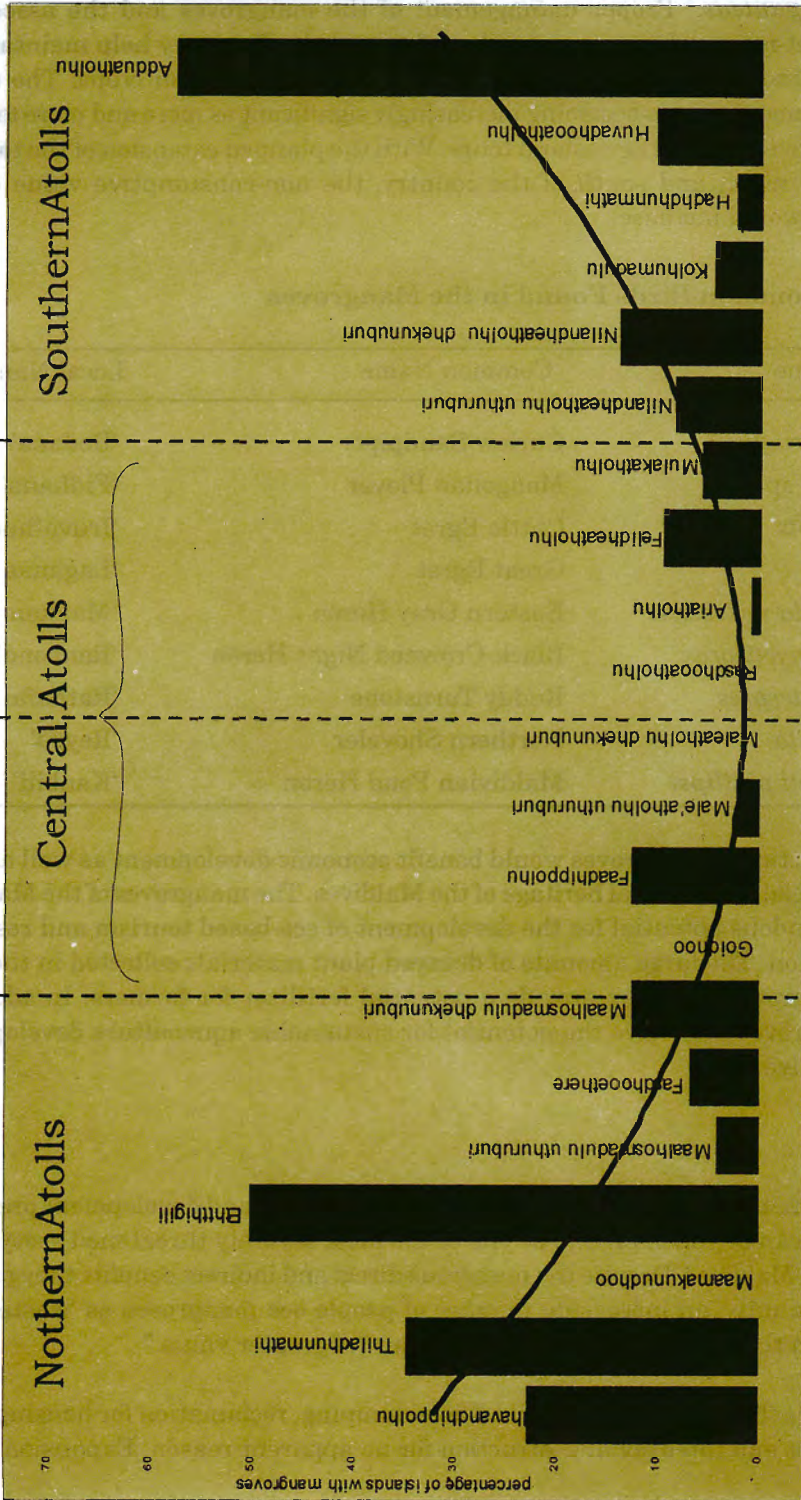


Figure 7: The Proportion of Islands with Mangroves in Different Geographical Atolls.

*Pteropus giganteus*.<sup>4</sup> Proper management of the mangroves and the associated environment may perhaps increase their food supply. This may help maintain the bat population while trying to deviate their attention on cash crops. The scenic value of the mangroves is becoming increasingly significant as more and more tourists visit mangroves during their island tours. With the planned extension of the tourism zone to the north and south of the country, the non-consumptive value of the mangroves would increase.

**Table 3: Common Birds Found in the Mangroves**

Latin Name	Common Name	Local Name
<i>Calidris ferruginea</i>	Curlew Sandpiper	'Bodana'
<i>Charadrius</i> sp	Mongolian Plover	'Fidhana'
<i>Bubulcus ibis</i>	Cattle Egret	'Iruvaihudhu'
<i>Ardea alba</i>	Great Egret	'Laganaa'
<i>Ardea cineria retrostris</i>	Eastern Gray Heron	'Maakana'
<i>Nycticorax nycticorax</i>	Black-Crowned Night Heron	'Raabondhi'
<i>Arenaria interpres</i>	Ruddy Turnstone	'Rathafai'
<i>Anas clypeata</i>	Northern Shoveler	'Reyru'
<i>Ardeola graii phillipsi</i>	Maldivian Pond Heron	'Kanbili'

Protection of mangroves would benefit economic development as well as augment the social and cultural heritage of the Maldives. The mangroves of the Maldives have tremendous potential for the development of eco-based tourism and research and education. The large amounts of decayed plant materials collected in the floor of the mangrove pond may provide a potential fertilizer for farmers. In addition, some mangroves may have the potential for sustainable aquaculture development in the Maldives.

## Threats

Given the small size, the natural fragility, and population and development pressure, mangroves can be considered to be one of the most severely threatened ecosystems found in the Maldives. Despite the numerous direct and indirect benefits they provide to the community, an increasing number of people see mangroves as 'wastelands' except when they are reclaimed for other uses "of greater value."

Severe threats arise from solid waste dumping, reclamation for housing, road development and intentional destruction for no apparent reason. Expansion of the

tourism zone is likely to have an impact on mangrove islands in the north and the south.

### **Ongoing Conservation Activities to Protect Mangroves**

The First National Biodiversity Strategy and Action Plan (NBSAP), 2001, recognized the importance of conservation of the wetland systems, in particular the mangrove ecosystem of the Maldives. In this regard, the following actions have been proposed with regard to the conservation of mangroves:

- Identify mangrove ecosystems important for conservation.
- Develop an economic valuation system for mangrove ecosystems.
- Set aside representative areas of mangrove ecosystems for biodiversity conservation.
- Undertake EIA before commencement of projects that involve mangroves.
- Undertake restoration programmes for ecologically important mangrove ecosystems that are endangered.
- Protect and conserve mangroves wherever possible from being land filled, or being developed without taking conservation into consideration.

Some efforts had been made to study and assess the mangrove ecosystems of the Maldives. The Environment Research Centre of the Ministry of Home Affairs, Housing and Environment is currently conducting research to assess the distribution of mangroves of the country. However, lack of technical expertise and financial resources in the country is hampering the efforts. Despite these difficulties, the government plans to undertake the following activities with regard to the conservation of mangroves in the country.

#### *Establishment of a field gene bank in the Huraa Island (North Male Atoll).*

Huraa is one of the two islands on which mangroves are found in the entire Male atoll. It covers an area of 18.8 hectares. The population of the island is about 550 according to the Census of the year 2000. Fishing and tourism are the most important sources of income for the inhabitants. As the island is located in the tourism zone, it is visited by several hundreds of tourists every year eager to experience the Maldivian way of life. One unique aspect of the Huraa Island is its mangroves, which cover almost one half of the island. Residential development occupies the other half of the island. Hence, there is enormous pressure to expand the residential area and to reclaim the mangroves. Huraa, being an inhabited island located in close proximity

to the capital, Male, and with easy access to the island, is experiencing pressure to develop its public facilities. The island is already hosting a soccer stadium developed with international donor assistance. Other proposed developmental activities include building a Youth Training Centre and Cadet Training Camp on the island. If allowed to proceed with the proposed developmental plan, the island would lose much of its remaining mangroves.

Due to the noticeable decline in mangrove ecosystems of the country and since not all of the species are found in any single island, the government is considering establishing a field gene bank in Huraa to conserve the mangrove genetic diversity of the Maldives. Four species of true mangroves have been identified in Huraa including *Bruguiera cylindrica*, *B. gymnorhiza*, *Rhizophora apiculata* and *R. mucronata*. The government is now considering the bringing about of necessary changes to the proposed land use plan so that the Huraa mangrove ecosystem could be conserved. Depending on the availability of financial assistance, it is also planned to build a narrow walkway around the area to enable visitors to enjoy the beauty of nature while safeguarding the vegetation and the surrounding natural environment. In addition to conserving the genetic resources of mangroves of the Maldives, it is hoped that this would attract more tourists to the island and would contribute to the socioeconomic development of its community. At present an average of 10 tourists visit the island everyday. Almost all the tourists visiting Huraa, take time off to visit its mangroves.<sup>9</sup>

**Table 4: Mangroves and its Associates Found in Keylakunu.**

Latin Name	Family	Local Name
<i>Bruguiera gymnorhiza</i>	Rhizophoraceae	'Bodavaki / Bodukandoo'
<i>B. cylindrica</i>	Rhizophoraceae	'Kandoo'
<i>Rhizophora mucronata</i>	Rhizophoraceae	'Thakafathi / Randoo / Makeha'
<i>Avicennia marina</i>	Avicenniaceae	'Baru'
<i>Excoecaria agallocha</i>	Euphorbiaceae	'Thella'
<i>Lumnitzera racemosa</i>	Combretaceae	'Burevi'
<i>Pandanus</i> spp.	Pandanaceae	'Maakashikeyo'
<i>Thespesia populnea</i>	Malvaceae	'Hirundhu'
<i>Hibiscus tiliaceus</i>	Malvaceae	'Dhiggaa'
<i>Pemphis acidula</i>	Lythraceae	'Kuredhi'

*Establishment of a biosphere reserve*

Keylakunu Island in H.Dh atoll hosts an extensive *Avicennia* forest. Large healthy *Avicennia* forests are perhaps not so common in the world today particularly on island environments. Some of the large trees of *Avicennia* in Keylakunu measure 100cm in diameter at breast height and reaches a height of 15m. Table 4 summarizes the mangrove species found in Keylakunu. Following the recommendations of the International Society for Mangrove Ecosystems (ISME) and realizing the fact that once destroyed, it would not be possible to regenerate such a forest, the Government is considering declaring the island, together with the adjacent reef area, as the first biosphere reserve.

**Table 5 (a): Mangrove Regeneration Activities Conducted in Kulhuduffushi, 2000.**

Qty	Material	Source	Percentage survived/germinated
1000	propagules & seedlings of <i>R. mucronata</i> and <i>B. gymnorrhiza</i>	H.Dh. Kumundhoo	70 50
300	seeds of <i>A. marina</i>	H.Dh. Keylakunu	0.6
10	fruits of <i>S. caseolaris</i>	H.Dh. Kumundhoo	1

**Table 5(b): Mangrove Regeneration Activities Conducted in Kulhuduffushi, 2001.**

Qty	Material	Source	Percentage survived/germinated
300	propagules <i>R. mucronata</i> and <i>B. gymnorrhiza</i>	HA. Baarah	90 50
200	seeds of <i>A. marina</i>	H.Dh. Keylakunu	40
10	fruits of <i>S. caseolaris</i>	H.Dh. Kumundhoo	2.5

**Table 5(c): Mangrove Regeneration Activities Conducted in Baarah, 2000.**

Qty	Material	Source	Percentage survived/germinated
500	propagules of <i>R. mucronata</i>	H.Dh. Kumundhoo	80

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**Table 5(d): Mangrove Regeneration Activities Conducted in Baarah, 2001.**

Qty	Material	Source	Percentage survived/germinated
200	propagules of <i>R. mucronata</i>	Baarah	.....
100	propagules of <i>C.tagal</i>	Baarah	.....

Based on data provided by Baba, S. 2002.

### *Experimental plantations*

Experimental plantations and raising nurseries of some mangrove species is underway in Baarah (HA. Atoll) and Kulhudhuffushi (H.dh Atoll). This project is being undertaken by the ISME in collaboration with the Ministry of Home Affairs, Housing and Environment. Under this project, two nurseries were set up in the above islands during September 2000. Work undertaken under this small project is summarized in table 5 (a) to (d). The experimental results will be useful for future mangrove conservation and regeneration activities in the Maldives.

### **Conclusions**

Mangrove ecosystems of the Maldives occur throughout the country, although they tend to be more concentrated in the northern and the southern atolls. The distinct geographical, topographical, and the geomorphological characteristics of these ecosystems make it unique and different from those found elsewhere in the world. However, rapid developmental activities in the country are posing overwhelming threats to these fragile ecosystems. Conservation of mangroves in the Maldives is further challenged by the lack of technical and financial capabilities in the country, population pressure, the natural vulnerability, the scattered nature and the smallness of these ecosystems. There is, therefore, an urgent need to draw up appropriate strategies and extend the ongoing conservation and management efforts for the management of mangrove ecosystems of the Maldives.

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