

# **Socio-economic assessment and monitoring of coral reef resources at Vaavu atoll, Maldives**

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**For  
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## INTRODUCTION

The Republic of Maldives is an archipelago of more than 1190 coral islands, out of which about 200 islands are inhabited (figure 1). The total area including sea and land is about 90,000km<sup>2</sup> and an estimated reef area of approximately 9000 km<sup>2</sup>. The dry land (all coralline islands) is approximately 300km. The length of the archipelago is some 823km, while it is 130 km at its greatest width. These small low-lying islands are formed into 26 natural atolls. The government has divided these natural atolls into 19 atolls for the ease of administration. The nearest neighboring country is India, 600 km NE of Maldives. The common features of the islands are tall coconut palms, white sandy beaches and crystal clear lagoons.

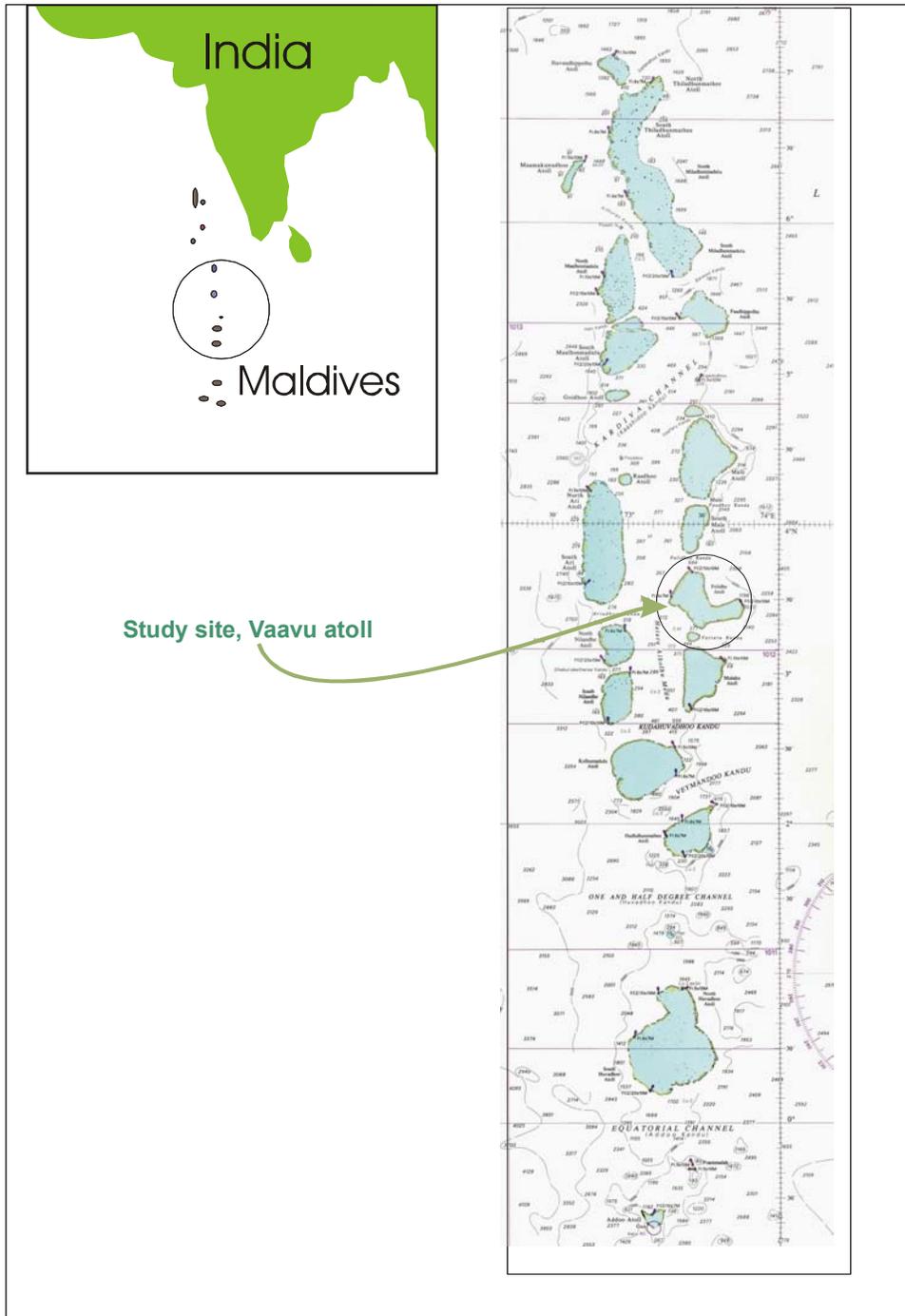
Each island of the archipelago is surrounded by a protective coral reef. These reefs are submerged underwater gardens, which is home for hundreds of multi-colored tropical fish and countless shape, and sizes of corals, shells etc. The climate is determined by two monsoons, namely the Southwest (from April to October) and Northeast (from December to March). The Southwest monsoon brings heavy rains while the Northeast monsoon remains dry.

The Maldivian tuna fishery is one of the most important economic activities in the country. It provides a major source of employment, export revenue, and protein for the Maldivian people. The last census gives a total of 20,560 full time fishermen, which is 20% of the total labour force of the country (National census 2000).

Tourism also shares some of the marine resources with fisheries. Divers are attracted to most of the reefs, which are used for bait fishing. Shark-watch diving is gaining popularity while shark fishery expands. The expansion of fisheries together with the need for resource sharing has resulted in over exploitation and conflicts among resource users. Although there is no sign of over exploitation in tuna and other tuna related species, some of the reef-associated species are threatened unless properly managed.

This project was implemented in Vaavu atoll, to report on the socio economic status of the island community as a demonstration monitoring site in the Maldives, where ongoing biophysical and coastal management projects have been initiated which lies 45 miles south from the capital Malé. It is relatively small, but is very diverse in reefs and high in reef resources users. There are only 5 inhabited islands with the main income is from tuna fishing/grouper fishing with tourism. There are three resorts in the atoll. Vaavu atoll is one of the GCRMN/National coral reef monitoring sites, and large number of biophysical information has been gathered from this atoll through out the project. But to understand the real impact of reef resource exploitation and how to manage the impacts it is important to understand the stakeholders who use and depend on reefs and the social and economic conditions and motivations associated with reef use.

Figure 1. Location map of Maldives



## **AIMS AND OBJECTIVES**

The main objective of the project is to establish a demonstration system of long-term socio-economic monitoring to obtain data relating to the status of local communities dependent on the reefs for their livelihood and to promote the use of this data in reef resource management.

Aims as stated in the project work plan:

- Adapt and implement a protocol suitable to local circumstances for obtaining socio-economic data from Vaavu atoll.
- Undertake a preliminary phase to review secondary data sources and consult with local stakeholders to identify priority resource use issues, monitoring parameters and appropriate methodology in order to focus monitoring activities.
- Help to incorporate reef users concern into management process.
- Assess the effect of current management measures on reef users.
- Make available the structure and design of monitoring activities and resultant information and recommendations to existing or planned coastal resources management, biodiversity and protected area projects in Maldives.
- Provide information and recommendations to on-going biophysical monitoring program.
- Raise community level awareness of status and value of coral reef resources and related management issues.

A socio-economic survey was carried out in Vaavu atoll, to establish a demonstration system of long-term monitoring to compliment biophysical monitoring and support reef resource management decision making in future.

The project was designed as follows:

A socio-economic training workshop was conducted in Vaavu atoll from 20-25 January 2001 by the Global coral reef Monitoring network. A total of 9 staff participated in the workshop from the Ministry of Fisheries, Agriculture and Marine Resources, Marine Research Centre and three islands of Vaavu atoll.

The objectives of the workshop:

- Establish a working partnership between Marine Research Centre, Ministry of Fisheries, Agriculture & Marine Resources and Vaavu Atoll Office for future GCRMN monitoring at Vaavu atoll.
- Identify coral reef uses and resource issues in Vaavu atoll
- Introduce concept of socio-economic monitoring of coral reef uses.

- Consider options for socio-economic monitoring data collection.
- Establish best options for socio-economic monitoring project at Vaavu atoll.

Activities carried out in the workshop:

- Provide information about GCRMN South Asia to participants.
- Introduction of current socio-economic project at MRC
- Defining and discussions on socio-economic assessment, monitoring and the goals of case study.
- Mapping the status and threats to coral reefs in Vaavu atoll.
- Presentations of group discussion
- Identify parameters, stakeholders and levels of participation for socio-economic monitoring at Vaavu atoll
- Carry out interviews with local people of V. Keyodhoo to collect information to aid planning of monitoring program.
- Formulate a plan to carry out the socio economic monitoring in Vaavu atoll.

### ***Data collection***

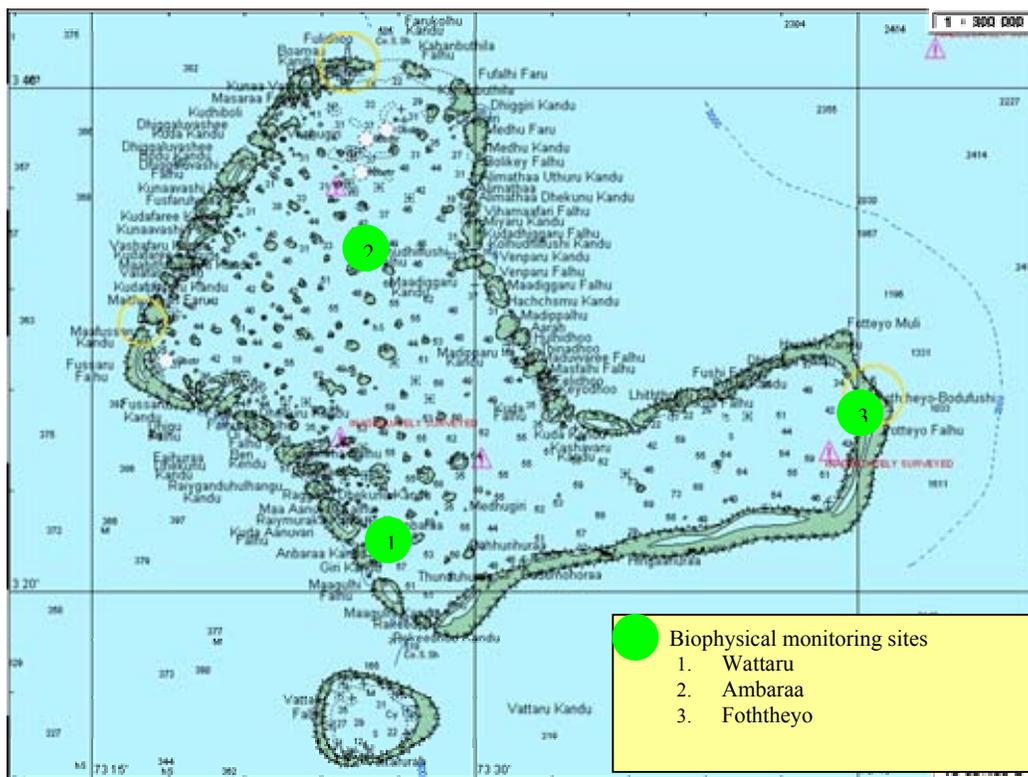
The socio-economic monitoring team spent a total of 10 days in Vaavu atoll in two filed trip s made to the Vaavu island communities, 5 days at each instance. Initial field trip to Vaavu atoll was made in October 2001 and the follow up filed trip was made in April 2002, spending one day at each of the five islands. A basic face-to-face interviewing was adopted to consult with local stakeholders to obtain data. A number of local stakeholders were consulted as primary source of data. These include reef stakeholders, civil servants and private parties. Secondary source of data was taken from the island offices respectively, which includes island demography, facilities and infrastructure. Information on biophysical monitoring was based on the reef monitoring by Marine Research Center. Resources use patterns environmental concerns were based on the information provided by the relevant stakeholders.

## ATOLL PROFILE

### General setting

Vaavu atoll is in the central part of the Maldives archipelago positioned on the eastern extreme of the atolls which form a double chain (figure 2) On to the west is central sea peripheral to 7 atolls and locally known as Hatharu atholhu medhu. Immediately north of Vaavu atoll is south Male atoll which is part of the Male atoll (north and south) where the capital of Maldives, Malé is situated (Southern tip of south Malé atoll). South of Vaavu atoll is Meemu atoll and on the west are Ari and Faafu atoll. All these atolls are separated by a narrow channel.

Figure 2. Location map of Vaavu atoll



Vaavu atoll is amongst the atolls which have the most number of reefs comparative to their sizes. Though there are many reefs, the number of island is relatively few islands. There are a total of 18 islands, 5 inhabited villages, 2 tourist resorts and the rest are classified as uninhabited island (no permanent human settlement, islands are leased either for agriculture (coconut plantation) or for firewood and the revenue from the lease is marginal.

## Felidhoo

Felidhoo island is located on the eastern side of the atoll. Land area is approximately 11.8 ha making it the biggest inhabited island in this atoll. Felidhoo is also the administrative capital of Vaavu atoll making it the second densely populated island. Peripheral reef around the island is small and relatively close to the shoreline from all sides (see appendix 1). The main coastal features of the island are also given in appendix 1. There are two proximal reefs on either side of Felidhoo, Masfalhi falhu on the north and Saalanfalhu on the southern side. Lagoon fishing is not common as part of a commercial activity, however fishing for Big eye scads (*Selar Kurufmanathalmus*) may be a seasonal activity when these fish aggregate as large schools in the lagoon and this fishery is often at subsistence level.

## Keyodhoo

Keyodhoo is the second largest populous village in the atoll with an area of approximately 7.3 ha, situated a few kilometers south of Felidhoo, the administrative capital of the atoll (Appendix 2). Significant coastal development of this island includes a recently built harbor facilitating a safe harbor for fishing and transport vessels. As a result of this harbor inter atoll transport vessels, especially vessels to and from Malé transit/ overnight here.

## Rakeedhoo

Rakeedhoo is smallest island with an area of approximately 4 ha. The island is situated on the southern side of the atoll. Major coastal features are given in appendix 3. Significant features of the coastline include extensive breakwaters and groynes at different locations to curb the coastal erosion. Large seagrass bed also occupies most of the near shore lagoon on the south and west of the island.

## Fulidhoo

Fulidhoo is located on the northern most extreme of the atoll with an area approximately 9.7 ha. Major coastal features of the island are provided in appendix 4. Fulidhoo has a large lagoon deep enough that is used as a natural harbor by many transport vessels and safari boat operator. Fulidhoo lagoon is also abundant with horse mackerels a common source of food at subsistence level.

## Thinadhoo

Thinadhoo is the least populous island with an area of 9.1 ha and is situated few kilometers north of the capital island Felidhoo. Major coastal features of the island are given in appendix 5.

## SOCIO ECONOMIC CHARACTERISTICS

### Demography

According to Island Offices, there were 2098 people living in Vaavu Atoll at the time of the last observation (in April 2002). Nearly a third (31%) of the total population of the Atoll lived on Keyodhoo followed by Felidhoo (24%), Rakeedhoo (18%), Fulidhoo (17%) and Thinadhoo (10%) (Table 1).

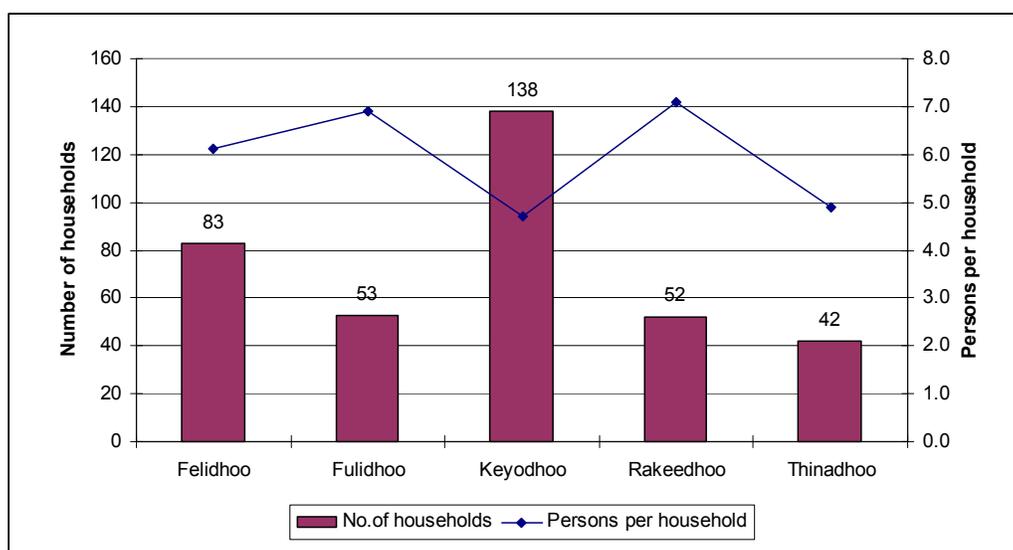
As a whole, at the Atoll level the number of males exceeds the number of females by 102 (10%). However, this imbalance was more pronounced, in percentage terms, in Felidhoo and Fulidhoo where the number of males exceeded the number of females by approximately 22% and 11% respectively. Keyodhoo had approximately 9% more males. In contrast, in Rakeedhoo and Thinadhoo the distribution of both sexes in the population was remarkably the same.

**Table 1. Demographic structure of the 5 islands in the atoll**

	<i>Felidhoo</i>	<i>Fulidhoo</i>	<i>Keyodhoo</i>	<i>Rakeedhoo</i>	<i>Thinadhoo</i>	<i>Atoll</i>
Total	511	365	649	368	205	2098
% of the total	24%	17%	31%	18%	10%	100%
Number of Males	281	192	339	185	103	1100
% of Males	55%	53%	52%	50%	50%	52%
Number of Females	230	173	310	183	102	998
% of Females	45%	47%	48%	50%	50%	48%
Male-Female Ratio	1.22	1.11	1.09	1.01	1.01	1.102

In April 2002 there were 368 households in the Atoll. The average size of the household was 5.7 persons. The average size of the household was largest in Rakeedhoo (7.1) followed by Fulidhoo (6.9) and the household size was smallest in Keyodhoo (4.7) followed by Thinadhoo (4.9) (figure 3).

**Figure 3. Household density relationship of the 5 island communities**



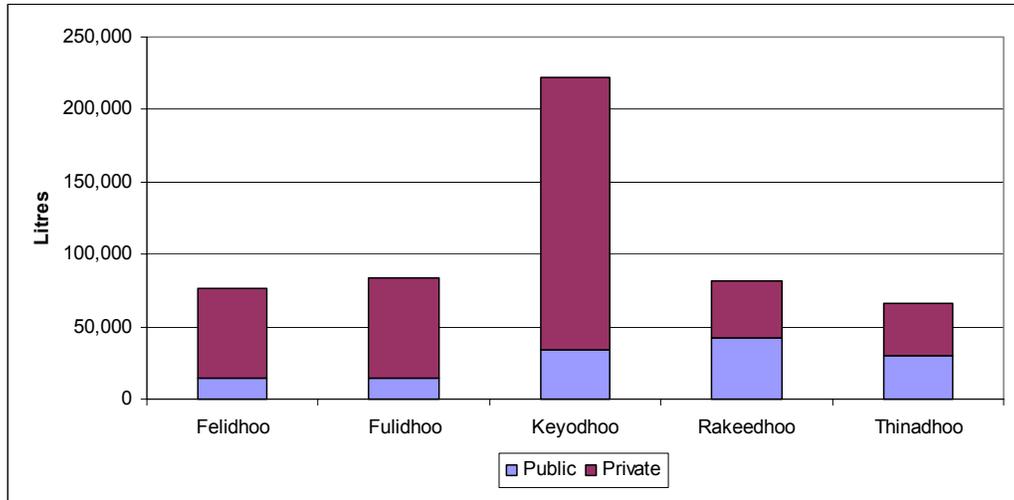
According to Island Chiefs, almost everyone in their islands had attained the *basic education standard* (meaning that they can read and write the Maldivian language, Dhivehi), the literacy rate for both sexes in the Atoll ranging between 98% and 100%.

Apparently there was regular intra-atoll and inter atoll movement of people. Except *Fulidhoo* there were daily and weekly trips between the other four islands of Vaavu Atoll. For *Fulidhoo* the frequency is bimonthly. There was weekly or at least bimonthly sea-transport between the islands and Male' (the capital city of the Republic), the exception being *Thinadhoo*. The inhabitants of *Thinadhoo* usually travel to Male' on monthly basis. The purpose of these inter Atoll journeys were to sell their produce (mainly fish and fish products) and acquire essential supplies for the islands.

### Drinking water and sanitation

There was adequate supply of drinking (rain) water available in the islands throughout the year. This was achieved by means of constructing relatively large cement water tanks or by installing adequate number of relatively large readymade PVC cylindrical tanks. Except *Rakeedhoo* much of the (between 55% and 85%) water holding capacity is privately owned (figure 4). In *Rakeedhoo* private households accounted for up to 48% of the total drinking water storage volume, the remaining 52% owned by the community (as public utility). According to the Island Chiefs there was no significant shortage of drinking water in recent years. However, residents of *Thinadhoo* still had to rely on well water (from a specific well in the community school) for drinking during the North East monsoon, when the rainfall is not so plentiful.

**Figure 4. Drinking water storage capacity**



All the islands except *Fulidhoo*, the households reportedly have adequate toilet facilities (table 2). Although 75% of the households in *Fulidhoo* have at least one toilet, the remaining 25% of the households still have no toilets. In the other four islands of the Atoll, households with no toilet were relatively insignificant (percentage of residences with no toilets ranging from approximately 1 to 8%). In most islands the toilet facilities rely on inland drainage or sea outfall systems for sewage disposal.

**Table 2. Sanitary status of the 5 communities**

	<i>Felidhoo</i>	<i>Fulidhoo</i>	<i>keyodhoo</i>	<i>Rakeedhoo</i>	<i>Thinadhoo</i>
No. of households	83	53	138	52	42
No. of households without toilets	1	13	7	4	1
% of households without toilets	1%	25%	5%	8%	2%

In three of the five islands (*Felidhoo*, *Rakeedho* and *Thinadhoo*) the island community as a whole was responsible for the management of solid waste disposal. In the other two islands (*Fulidhoo* and *Keyodhoo*) the women's committee was responsible.

In all the five islands there were specific areas for solid waste disposal. In *Felidhoo* and *Rakeedhoo* there was only one site for solid waste disposal, in *Fulidhoo* there was two and in *Thinadoo* there was four such sites. In *Keyodhoo* the solid waste was, apparently, used for land reclamation and land extension and to prevent coastal erosion to some extent. The people of *Rakeedhoo* also use solid waste to some extent to reclaim land. In contrast to the other islands in Vaavu Atoll, in *Thinadhoo* the solid waste was disposed to specified inland areas. According to the Island Chiefs the households generally respect and follow the waste disposal systems that exist in each island.

## Health and Education

Although there was no regional hospital located in the Atoll there was a government Health Centre located in *Felidhoo* (Table 3). The Health Centre provides the services of doctors and /or Community Health Worker. The Centre can also carryout some basic laboratory tests to help health workers to determine the nature and cause of the health problems. Pharmaceutical medicines were also available in *Felidhoo*.

In the other four islands basic health services were provided by Health Posts. The Health Post is generally headed by a Family Health Worker who is primarily responsible for the provision of basic health services within the island. At the time of the last observation there was a Family Health Worker in three of the five islands and a Midwife in four of the five islands. It is worth mentioning that *Thinadoo* had no Family Health Worker or a Midwife at the time of the last observation. There was at least one Local Practitioner (Maldivian traditional medicines) in each island. While there was at least one person who is certified by the authorities to carryout circumcision of boys in two of the five islands there was apparently no *Fandithaveriyaa* (traditional charmer/healer) in the Atoll.

When asked what the major health concerns of the islanders were the Island Chiefs of the four islands, where there was only a Health Post, listed the unavailability of the service of a doctor or a Community Health worker and unavailability of pharmaceutical drugs in their own islands as their main health concern. However, they did not regard this as a very serious problem since *Felidhoo* was relatively close to most islands.

**Table 3. Public health related infrastructure and capacity**

	<i>Felidhoo</i>	<i>Fulidhoo</i>	<i>Keyodhoo</i>	<i>Rakeedhoo</i>	<i>Thinadhoo</i>
Regional hospital	0	0	0	0	0
Health Centre	1	0	0	0	0
Health Post	0	1	1	1	1
Family Health Worker	1	1	0	1	0
Midwife	1	1	2	1	0
Fandithaveriya (traditional healer)	0	0	0	0	0
Local Practitioner	1	2	4	1	2
Person who perform circumcision	1	0	1	0	0

There was two Atoll Schools (Atoll Education Centers) in Vaavu Atoll (one in *Felidhoo* and one in *Fulidhoo*) which was funded by the government (table 4). These two schools have upper primary level education. The level and quality of education provided by these two schools may be considered higher and far more superior than the Island School in *Keyodhoo*, the traditional *Madharusaa* in *Thinadhoo* and the *Makuthab* in *Rakeedhoo*. These schools do not provide classes up to grade 10. Although these schools generally receive government assistance in terms of teachers and possibly some materials and funds they were owned by the community. Apart from *Thinadhoo* there were no organized Quran classes for the school age.

**Table 4. Educational facilities of the community**

<i>Type of school</i>	<i>Felidhoo</i>	<i>Fulidhoo</i>	<i>Keyodhoo</i>	<i>Rakeedhoo</i>	<i>Thinadhoo</i>
Atoll School (AEC)	1	1	0	0	0
Island School	0	0	1	0	0
Madhrasaa	0	0	0	0	1
Kiyavaage (Quran class)	0	0	0	0	1
Makthab	0	0	0	1	0

### Community-based organizations

Except *Felidhoo* all inhabited islands in the Atoll had social clubs or community organizations which were formed to assist the development efforts of their respective islands, social awareness and for sports and recreation (table 5). Between 4% and 49% of the people are members of these associations.

**Table 5. Social and recreational clubs and organizations**

	<i>Fulidhoo</i>	<i>Keyodhoo</i>	<i>Rakeedhoo</i>	<i>Thinadhoo</i>
Clubs/community organizations	Blue star	Rahvehi club	Baazee	Thinadhoo United Club
Period of operation (years)	22	22	22	6
No. of members	119	NA	25	180
Membership	23%	NA	4%	49%
Purpose	Development, sports and recreation and social awareness			

## Electricity

Except *Rakeedhoo* all the populated islands of Vaavu Atoll were supplied with 24 hour electricity, a service provided by the community, by and large, on const recovery basis (table 6). The price of electricity (measured in KWh) ranges from MRf. 4 per unit to MRf. 6 per unit (1 USD = 11.75MMRf)

**Table 6. Electric power generation and availability**

	<i>Felidhoo</i>	<i>Fulidhoo</i>	<i>keyodhoo</i>	<i>Rakeedhoo</i>	<i>Thinadhoo</i>
No of hours/day	24	24	24	18	24
Power provided by: [Government=1; community=2; Private=3]	2	2	2	2	2
Capacity (KW)	120	103	88	67	57
Rate/ unit(KWh) Rufiyaa/ unit	4	4	5	<30 units MRf 6 >30 units MRf 5	6

In each island there were at least two public telephone boots and there were no privately owned fixed line telephones in any of the populated islands. *Fulidhoo* was the only inhabited island which was in the reception range of the national mobile network. Consequently except a few residents of *Fulidhoo* there was no mobile phone communication in the Atoll.

The islanders receive both the regular national television broadcasts as well as the satellite television programs.

## ECONOMIC ACTIVITIES

Table 7 reports the reef related economic activities that were carried out in the populated islands of Vaavu Atoll. In all the islands the reef was used for collecting bait for tuna fishing, reef fishing, sand-mining and for tourism related activities. Although sand was mined for construction purposes there was no coral mining in the Atoll. This suggests that coral was no longer used for building construction. Rope making from coconut fibers and thatch weaving were carried out by the island communities, perhaps at a relatively smaller scale.

**Table 7. Major economic activities of the 5 island communities**

	<i>Activities</i>	<i>Felidhoo</i>	<i>Fulidhoo</i>	<i>Keyodhoo</i>	<i>Rakeedhoo</i>	<i>Thinadhoo</i>
1	Tuna fishing	√	√	√	√	√
2	Reef fishing	√	√	√	√	√
3	Coral mining					
4	Sand mining	√	√	√		√
5	Tourism	√	√	√	√	√
6	Thatch weaving		√		√	
7	Rope making	√	√		√	
8	Other	√	√	√	√	√

Between 11 percent and 36 percent of the men in the inhabited islands were involved in commercial exploitation of reef fish (table 8). It is believed a significant proportion of the community carryout subsistence fishing for their own consumption. In three of the five islands a significant proportion of the male population was also employed in reef related tourism activities. These include people working as crew in transport boats and dive safari boats, curio traders, etc.

**Table 8. Reef related economic activities and their population distribution**

<i>Activities</i>	<i>Felidhoo</i>	<i>Fulidhoo</i>	<i>Keyodhoo</i>	<i>Rakeedhoo</i>	<i>Thinadhoo</i>
Men involved in reef fishery	30	22	44	67	Only subsistence
% men involved in reef fishery	11%	11%	13%	36%	NA
Men involved in reef related tourism	51	25	14	1	20
% men involved in reef related tourism	18%	13%	4%	1%	19%

Dhiggiri and Alimatha were the closest tourist resorts that are located in the Atoll. The resorts in the past have contributed to the development efforts of the island communities. Recently, the management of Dhiggiri resort provided financial assistance to *Fulidhoo* community to build breakwater (seawall) to curb land erosion problems. The resorts also gave financial assistance to Keyodhoo community's powerhouse project.

The resorts arranged weekly excursion for tourists to neighboring Felidhoo, Fulidhoo and Keyodhoo. To cater for the visiting tourists a number of souvenir shops operate in Felidhoo (33), Fulidhoo (11) and Keyodhoo (8). There were relatively only a few Tourist excursions to Rakeedhoo and Thinadhoo and hence there were no established souvenir shops in these islands. However, in Rakeedhoo the islanders put up street stands to sell souvenirs to visitor.

There was no known coral mining operations in the Atoll. However, sand was mined for construction. There were four residents engaged in sand mining in Felidhoo while in Keyodhoo there were three people engaged in the activity. The residents of these two islands extract sand from the nearby Salaam Falhu. Only one person in Fulidhoo was engaged in sand mining. Apparently, demand for sand in Fulidhoo was relatively very high. So the sand miner had to make several trips a day to neighboring reefs.

## **CHARACTERISTICS OF STAKEHOLDER**

To evaluate the characteristics of reef resource stakeholders 12 residents were interviewed. Ten of the 12 were fishermen. Four were grouper fishermen, three were tuna fishermen and three were other reef fish fishers. Of the fishers two were engaged in both tuna fishing and grouper fishing and one person carried out both tuna fishing and other reef fish fishing. Most of the fishers were either master fishermen or boat crew. There was only one owner-master fisherman in the group. One person was both a sand miner and a shop owner and another person was a tourist shop owner.

Fishing was conducted using mechanized vessels. Generally, a reef fishing trip involved between three and six people whereas a tuna fishing trip involves between 10 and 14 people. While tuna was caught predominantly by pole and lines and some times using hand lines reef fishing was conducted using hand lines and snorkeling. While snorkeling, the fishers use a baited hand line to catch the fish. Sometimes they also catch the fish manually. The fishers generally carried out fishing operations six days a week. Most fishers were doing both tuna fishing and reef fish fishing.

The tuna fishers on average catch between 450 kg and 550 kg of tuna on a day trip. The fish was cooked, smoked and sun dried to produce *Maldivian fish* and the product was generally sold to Male' market for approximately MRf 20 per kg. Personal income of fishers from selling *Maldivian fish* ranged between MRf 1500 a month to MRf 3000 a month. For the fishermen, finding a suitable buyer of *Maldivian fish* was not a major problem.

The reef fish/ grouper fishers harvest approximately between 170 kg and 250 kg of reef fish a trip. Grouper was sold alive to collector at a price of approximately MRf 40 per kg. The prices of other reef fishes were substantially low, prices varying between MRf 5 and MRf 10 per kg. As a whole the reef fishers were earning approximately between MRf 2000 and MRf 8000 (average: MRf 4000) a month. For reef fish and grouper fishers finding an appropriate buyer was a major problem.

Most of the fishers were aware of the fisheries regulations concerning their activities.

Four of the 12 were living with their extended family, the size of which varies between 10 and 18. The other eight respondents lived with their own nuclear family, consisting of between three and eight members. All the families consumed tuna and reef fish as part of their normal diet. When asked what their main concerns were, most respondents said that inadequate education and health facilities were their main worry.

All the respondents considered coral reefs "very important" for them and their families and they were aware of the threats imposed by humans on the coral reefs. Most people get information about the environment from the visual media (TV) and from the print media (news papers and magazines) and for most people marine pollution and sand and coral mining were the main threats imposed by humans on the coral reefs.

### **Reef fishery resources**

Historically the only reef fisheries in the Maldives were live bait for the pelagic tuna fishery and the money cowry for export to Asia and Africa. The introduction of tourism in the 1970's and the mechanization of the fishing fleet and development of the export market for reef fishery products around the same time, together with the rapidly growing population, resulted in a rapid economic and social development to the country. The consequences of these developments include; over fishing of some reef resources, degradation to the coral reef environment and an increase in resource user conflicts.

Tourism created new demands for reef fisheries and this was expanded in the 1980's for export-orientated fisheries such as beche-de-mer, giant clams, shark fishing and aquarium fish. The livebait and money cowry fisheries have survived for centuries despite high levels of catch and effort. In contrast some of the newly developed export orientated fisheries such as beche-de-mer and

giant clam have reduced resources within a few years. The relatively new grouper fishery that started in 1993 to supply live or chilled grouper to the East Asia market has expanded rapidly. There is evidence that individual atolls are being overfished as the activity spreads from atolls close to Malé to more remote areas. Therefore selective fishing on coral reefs for single species such as groupers and sharks as practiced in recent years threatens the whole future of the two mainstays of the national economy, fishing and tourism.

Coral reef fisheries are based on long lived demersal species that cannot withstand unmanaged commercial fishing practices. The long tradition of pole and line fishing for pelagic tuna resources in Maldives has been sustained up to the present day due to the previous fishing strategies of using coral reefs for bait fish supply only. All other pole and line fisheries in the world have ceased due to the lack of bait fish from over exploitation of coral reefs. Maldives is unique in still retaining a coral reef habitat able to support bait fisheries. Pole and line caught tunas have a preferred status in international markets as the fishery is perceived to be sustainable and yield high quality product. Other forms of surface swimming tuna exploitation are industrial with high capital costs and low employment.

Currently grouper fishery has emerged as an export oriented highly valued fishery through out Maldives. In Vaavu atoll grouper fishing is done extensively for the past 15 years. Traditionally pole and line fishery using live bait has been the primary commercial/subsistence fishery in this atoll and all the island fishers are involved in this fishery throughout the season (both southwest and north east monsoons). Depending on the seasonality of the pole and line fishery, when it is poor the fishers focus on the grouper fishery. Fishers from other atolls in the vicinity such as Meemu, Faafu, and Dhaalu fish for grouper in this atoll making it the most heavily fished atoll for grouper. Fishery regulation of the Maldives allows fishing within any atoll and fishers commune to good fishery grounds within the archipelago, this is more true to recently developed fisheries such as grouper and sea cucumber fishery.

## **Tourism**

Maldives has developed a form of tourism that is appropriate for small island developing states. Tourism is entirely dependent upon the environmental quality and initially facilities were basic with a low impact on the environment. Recent expansion has developed a diverse range of options within a more elaborate infrastructure required to support the facilities. As a result a number of environmental issues have risen related to the construction of the resorts relating to coastal modification and their impacts. These include the use of coral and sand in the construction of sea defenses, breakwaters and jetties, coastal reclamation, disposal of sewage and solid waste etc.

Following the introduction of the main law on tourism in 1979 various regulations and standards have been specified, including important regulatory

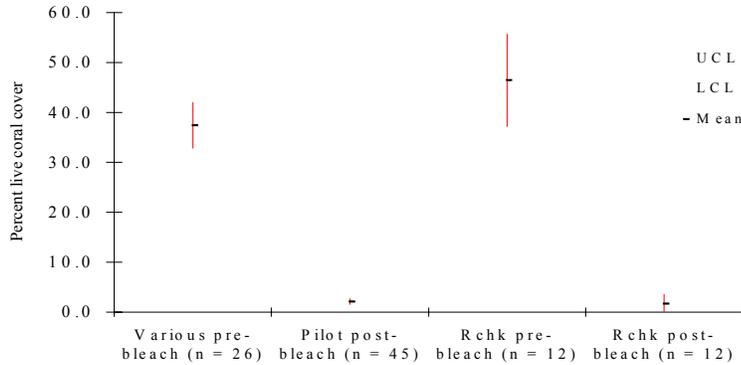
measures for building standards, sanitation, disposal of garbage carrying capacity and tourism behavior. Enforcement of these regulations through voluntary compliance is variable between resorts.

The regulations enforced on tourist islands are in general well received and respected and in many cases exceeded by responsible operators, realizing that part of their market is dependant on an image of protection of the fragile environment. However conflict exists where inhabited islands are adjacent to tourist islands and no regulations are applied to inhabited islands.

Vaavu atoll has two tourist resorts, namely Alimathaa and Dhiggiri on the eastern periphery of the atoll. Tourism in the Maldives been mainly focusing on the marine environment is quite popular for diving and sports fishing and this atoll is quite popular in this regard. Over 60% of the tourist visitor to the Maldives is generally scuba divers and scuba diving is popular in this atoll as elsewhere. Along with the island resort based tourism, live aboard safari boats equipped with scuba diving facilities commonly operate in this atoll making diving and snorkeling a popular sea sport.

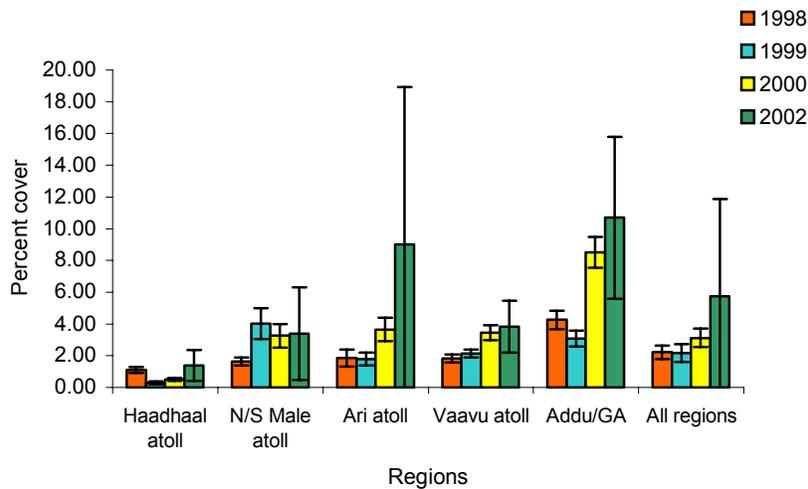
## **BIO-PHYSICAL MONITORING**

The mass coral bleaching event in 1998 was recorded as a severe natural event that degraded and changed the reef status of the Maldives. Investigations to report on the post bleaching impact on the reefs throughout the Maldives were carried out as a pilot biophysical reef monitoring project through assistance by GCRMN South Asia. Live coral cover at the monitoring sites (including 3 sites in Vaavu atoll was reported less than 2% throughout the Maldives. Very little information on the health of the reefs was available prior to 1998. These include various pre-bleaching surveys by Marine research Center (MRC), ReefCheck 1997 by MRC. Comparison of the pre and post bleaching status of the reefs are given in figure 5. It can be clearly seen that the live coral cover was significantly higher at various reef sites prior to 1998. Live coral cover was considerably lower after the bleaching and this has been reported in the pilot post bleaching surveys and the ReefCheck 1998. The ReefCheck 1997 (pre bleaching) and 1998 (post bleaching) results are directly comparable sites clearly demonstrating the severity of the mass bleaching event



**Figure 5. Estimates of live hard coral cover prior to and after the bleaching event plotted as mean bounded by upper and lower 95% confidence intervals on the mean. Pilot post-bleaching data from pilot project field work. Various pre-bleaching data from Coral Reef Research Unit, Riyaz et al (1998). Rchk = Reef Check data (Hussein, et al., 1998) from MRC Reef Check surveys in August 1997 (pre-bleaching) and August 1998 (post-bleaching).**

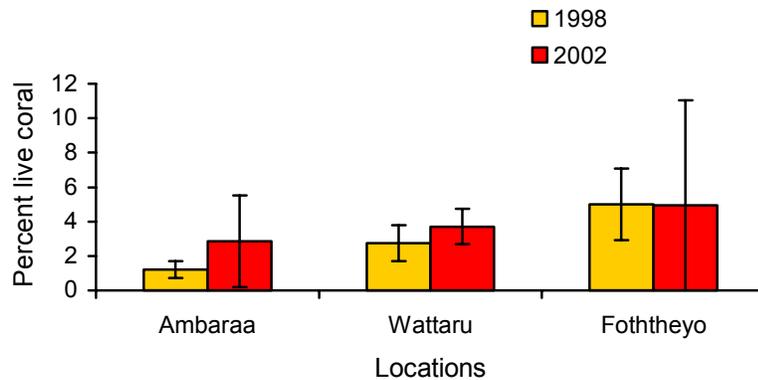
Marine Research Center has been the central institute in carrying out coral reef monitoring in the Maldives. Subsequent to the pilot reef monitoring study MRC has continued to survey the sites (15 sites throughout the Maldives) as part of the long-term reef monitoring program. Reef recovery from the bleaching impact has been slow and variable at all sites. The overall average live coral cover for all regions increased from 2% to 6% over the 4 years that reef surveys have been continued since 1998 (figure 6)



**Figure 6. Comparison of estimates of the cover of live coral obtained immediately following the bleaching event (1998) and yearly surveys since then**

to present (no data for 2001). Values are mean coral cover and the error bars are standard deviation of the means.

Live coral cover at the three sites in Vaavu atoll also show similar trends over the four years that reef monitoring has continued in this atoll. The overall live coral cover for the three sites has been reported approximately 5% and less than 6% in all sites (figure 7)



**Figure 7. Coral cover and reef recovery at the permanent reef monitoring stations at Vaavu atoll.**

## THREATS TO CORAL REEF RESOURCES

Human induce threats to the reef resources have been related to the socio economic needs of the community. Primary causes of degradation of the coastal reef resources are common throughout Maldives and Vaavu atoll is no exception.

Among the major anthropogenic impacts on reef resources are; over exploitation of the reef resources, coastal modifications (dredging and reclamation), coral and sand mining, coastal pollution (solid and sewage disposal to the shore)

A summary of the main threats and root causes/environmental concerns that are likely to arise directly or indirectly from development of physical infrastructure is given in Table 9.

**Table 9. Root causes and direct threats to coral reef resources – general overview (modified from UNDP GEF project, July 2001)**

Threats	Root causes	Consequence	
		Biological	Functions/Services
Loss of critical reef habitats & coastal/native vegetation.	<i>Coastal construction:</i> Inappropriate and unplanned coastal infrastructures and coastal modifications (harbor development, etc.), Lack of information for planning and technical know how; Non-compliance with environmental guidelines; Environmental quality/concerns not considered in planning; Poor maintenance & operational problems Lack of monitoring.	Destruction of nearshore reef habitat and loss of fauna. Reduction in reef fish and invertebrates. Indirectly, may reduce growth of corals nearby. Loss of nesting sites for birds/turtles.	Reduced biodiversity and productivity, reduces tourism and fishery value of reef resources. Reduced capacity of coral reefs for sea defense.
Increased erosion and loss of coastal habitat.	<i>Coastal alteration/remodeling:</i> Lack of information on coastal processes, Inadequate guidelines for site development and use. Sea walls, breakwaters, groynes increase vulnerability to natural erosion. No monitoring or enforcement of regulations.	Localized damage to reefs and associated fauna. Impairs growth & reproduction of corals.	Adversely affects on coastal processes (beach erosion and beach accretion patterns). Diminishes the role of reefs in fisheries production. Shift in community structure from corals to seagrass beds/macro algae.
Pollution and deterioration of nearshore environment.	<i>Increased sedimentation:</i> Sediment loading-physical smothering & chemical toxicity (dredging). Increase in nutrients entering marine system (i.e. landfill leachate); Inappropriate siting of sewage outflows, lack of guidelines for intake and outflow pipes.	Increased mucous production; may result in coral bleaching; localized reef degeneration, Dislocation of fish & mobile invertebrates.	Impairs reproduction/recruitment of corals, reduction in reef productivity. Phase shift to algal community.
Over-exploitation of natural resources - extraction of raw materials (i.e. coral, sand, akiri) for the construction industry.	<i>Coral &amp; Sand mining:</i> Demand for coral and sand mining for household use in atolls still exists. Large volumes of sand required for beach replenishment at resorts & block building industry. Increased use of <i>akiri</i> for aggregate.	Reduction or total loss of coral cover, diversity, reef topography and associated reef resources. Lack of recruitment on remaining rubble/sand substrate. Natural sediment transport mechanisms and budgets impaired.	Reduced capacity for sea defense and reef fisheries. Lack of sediment for beach accretion. Alteration of natural current movements. Natural reef recovery rates are very slow.
Inappropriate use of coastal margin for dumping of solid waste.	<i>Solid waste management:</i> Lack of planning & environmental guidelines for inhabited islands.	Direct impacts on corals and marine fauna. Increased nutrients promotes growth of	Long term alteration in physical coastal processes. Phase shift to algal dominated

	<p>Inadequate solid waste &amp; waste water disposal systems.          Limited land space, lack of funds to support disposal systems, Change in composition of solid waste &amp; increase in non-biodegradable products          Potential hazardous materials (not separated from domestic).</p>	<p>attached and planktonic algae; loss of coral communities &amp; change in fish populations.</p>	<p>community.          Contamination of ground water associated with human health problems.</p>
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## COMMUNITY CONCERNS

### Environmental degradation

In general the community is aware of the environmental issues. The fishers are particularly aware of the environmental degradation but fail to make possible links to the causes. Overall the fishers very strongly believe that the environmental quality (the sea and the land) was better in the past compared to the current status. This has been weighed on good catch returns, good fishery all season, less severe coastal erosion and cleaner lagoon etc. when asked about the bleaching event the fishers reflected their knowledge on this by informing the whitening of the corals but have little idea what may have caused it.

### Bait fishery

Fishers believe there is scarcity of bait fish species and abundance compared to olden days and relates this to overall environmental degradation. They also believe the fact that the numbers caught are much higher and this may be the reason low less abundance of bait fish species. The most popular baits fish species for the pole and line fishery are; sprats, fusiliers and cardinal fishes. Certain species of damsel fish (e.g. *Cromis viridis*) is a popular bait fish species for the reef fishery. However the fishers reported the scarcity of this in recent years and relate this to the lower environmental quality especially the reefs. This bait fish species inhabits in live branching coral species and the demise and habitat loss of this species after 1998 bleaching was severely impacted. Fishers are aware of the association between this bait and the branching corals and note that the branching corals are less abundant. They also report more algal growth and abundance on the shallow reef areas in the atoll.

## Grouper fishery

The main concern of the fisher community in this atoll is the number of grouper fishers operating in this atoll. People from other atoll operate in this atoll and fish for grouper in this atoll. It is the popular belief of this atoll community that Vaavu atoll area is among the best reef fishing area in the Maldives and the fact that people from other atolls come and fish from these reefs somewhat support this argument.

Fishers are aware of the spawning aggregation areas of grouper and reluctant to provide the exact locations. However, they report that such aggregation happens in certain channels such as Rakeedhoo channel and Foththeyo channel coinciding with first and last quarter of the moon every month. This has been evident by the large numbers of few adult species caught by a single trip in the spawning season. Fishers are not aware of the importance of the management of the spawning aggregation areas for the sustenance of this commercially important fishery. They have however reported that the overall size of the individual groupers are small than what it is used to be, especially in these aggregating areas.

## Waste disposal issues

The islands in the Maldives are often very small and scarcity of land is imminent. In over populous island this scarcity is exacerbated by the usage of all available land for house plots and other social needs than disposing waste. The scarcity of land often leads the island folks to turn to the alternative option of waste disposal, i.e. the lagoon and nearshore coastal areas. Coastal erosion in these oceanic islands also leads to disposal of domestic solid waste to the areas of erosion often thought as reclaiming what is been lost with much environmental considerations.

All the islands in Vaavu atoll are faced with this crisis to a varying extent. Waste disposal to the coastline has created varying level of environmental issues from high nutrient load to seagrass proliferation in the shallow lagoons surrounding the islands. In addition to the nutrient load waste debris wash away and become a considerable environmental pollution issue. Sewage effluents are commonly disposed using septic tanks. However, in densely populated island sea outfall by gravity flow have been chosen as the best available option to get rid of the waste. Most of the islands have a very low elevation and this gravity flow mechanism only allows short outfall and the outlets are located close to the shoreline. None of the islands have deeper reef slope outfalls where the effluents may be dispersed and diluted with favorable currents. All the island communities seek an immediate and a viable solution to get rid of the waste in a way less damaging the environment.

## CONCLUSIONS AND RECOMMENDATIONS

The socioeconomic analysis of the project site and bio-physical status of the reefs over the past few years have shed some light on the needs and perceptions of the community for sustainable management and conservation of the marine resources. Following are some of the principle components of a framework that may be adopted as part of an environmental management strategy.

- **Integrated Coastal and Marine Resource Management**

This is an extension to the existing Integrated Reef Resource Management (IRRM) project. It is based on an interdisciplinary and multi-sectoral approach that will be phased in to the overall project as capacity and skills increase. IRRM will incorporate adaptive management principals to respond to the Maldives's political, cultural and institutional at national and local level. The building blocks will be the outputs from fisheries, tourism and socio-economic/community-based components, which will feed directly into the IRRM plan.

The framework will provide effective mechanisms for co-ordination of existing sectoral legislation and policies. It will also facilitate mechanisms to allow participatory involvement in the planning process thereby increasing the capacity to manage coastal and marine biodiversity at national and local levels.

- **Establishing a coastal and marine biodiversity information database to be used in planning coastal and marine resource management.**

Accurate information on biophysical, geological, oceanographic and meteorological characteristics is an essential component of planning for conservation and sustainable use of coastal marine resources. This component will establish a framework for ensuring that up-to-date marine biodiversity information is available and used in all planning and development activities.

The first step in the process will be to design and implement appropriate coastal and marine surveys to acquire the necessary information. In parallel participatory appraisal surveys will provide information on traditional knowledge, sociological and economic considerations of the island communities. A database information system will be established that has the capacity to phase in GIS and remote sensing as human capacity and skills increase. Biodiversity profiles and an atlas of coastal marine resources and their uses will be developed to feed into all sectoral planning and management and the IRRM plans. Once the system is in place a monitoring programme will be established to ensure that information is updated regularly and adapts to the management needs.

- **Development of a solid waste management plan**

A plan solid waste management shall involve the development a technically and politically feasible, cost-effective, sustainable, environmentally beneficial and socially sensitive solution to waste management. It is essential to recognize that there is a need to analyze all aspects of waste management together, understanding the relationships between the different topics and the design and implementation of a new ISWM. All aspects are inter-related and alterations in one area can affect practices or activities in another. Critical components of an ISWM plan will include: 1) waste characterization; 2) management and planning, 3) training; 4) public education and 5) financing.

- **Coastal and Marine Protected Areas Management**

This component is a broad scale intervention that requires the full integration of the relevant sectors (i.e. fisheries, tourism, environment atolls administration and coast guard). An initial strategy will be prepared to provide the policy and directions needed for the planning process. This will evaluate a spectrum of management options ranging from pure development to conservation actions, focusing on the interaction between the private and public sectors. These steps will be compatible with strategies being developed by the existing MPAS project being implemented by the ministry of Home Affairs, Housing and Environment

- **Awareness on values of marine resources**

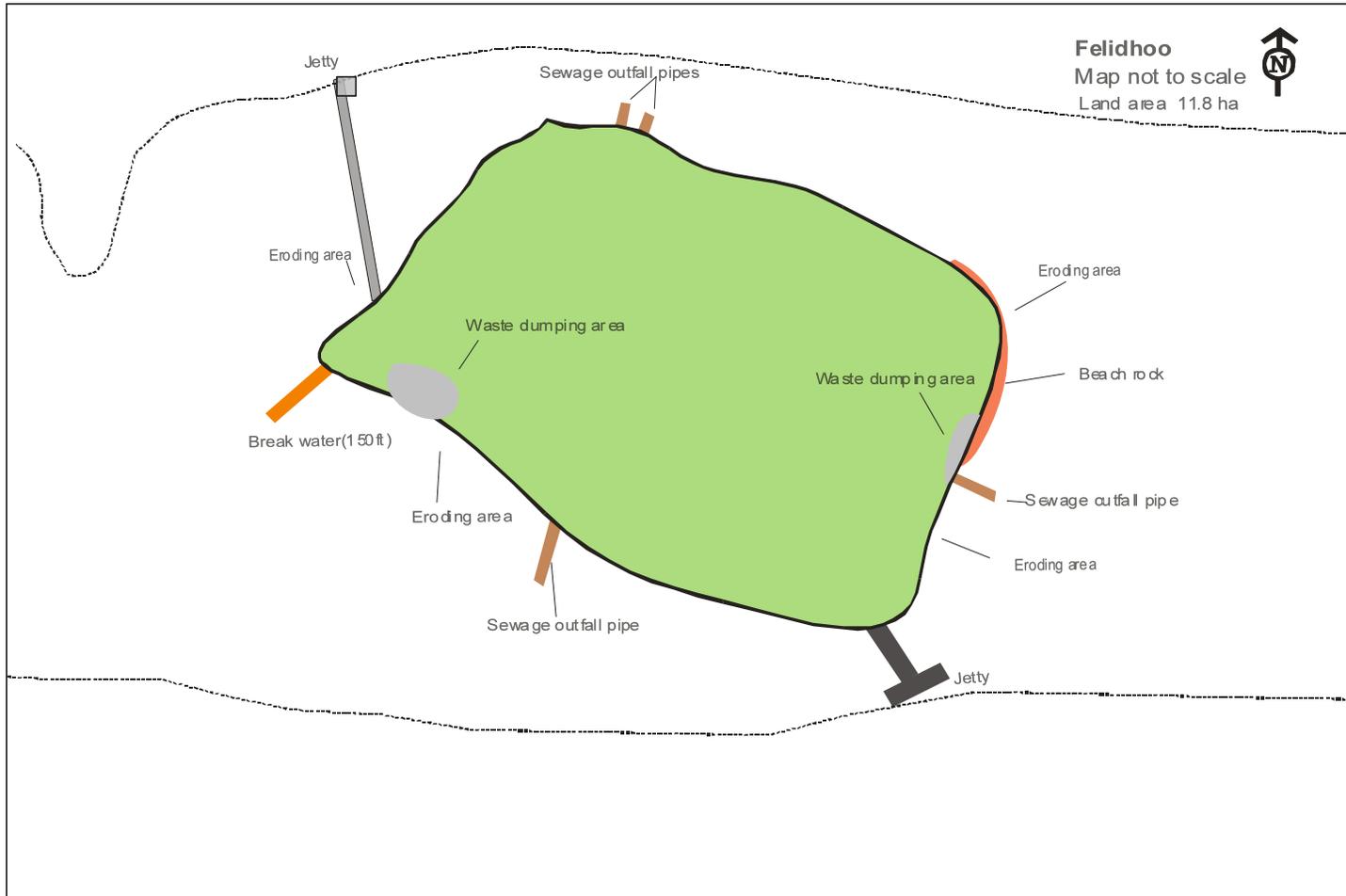
Rational use of marine resources will only occur if there exists an environmental “consciousness” among the government, private sector and public. This component will increase at all levels the need for, the benefits of, and how to, sustainably use and manage marine resources. This will facilitate a strategic approach to environmental education and public awareness to increase environmental understanding at all levels to ensure that marine resources are utilized in a sustainable manner. The plan will identify key target groups and the appropriate mechanisms for communicating with each. It will also develop capacity to generate basic awareness materials and develop materials in response to emerging needs. of the different stakeholders on these activities, particularly whether they were important or otherwise and how much they would participate in the implementation. Participants were split up into the following groups to discuss how the proposed project activities might impact different stakeholders and were also encouraged to provide additional comments they had on each activity.

On the basis of the above evaluation it is concluded that the activities proposed in this report adequately represent the needs of the various stakeholders and their needs for better management of reef resources.

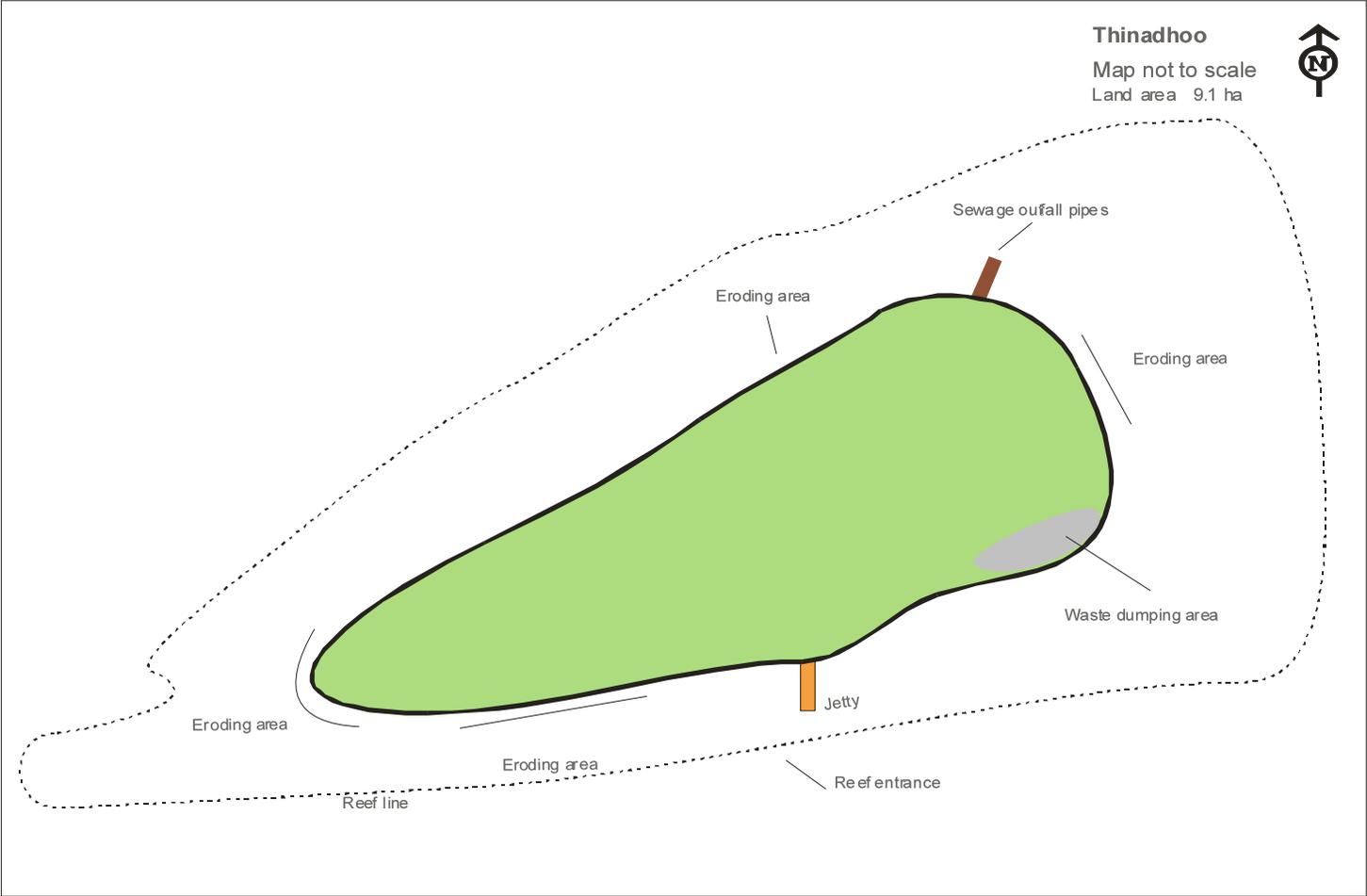
**Appendix 1 Coastal features of Keyodhoo**



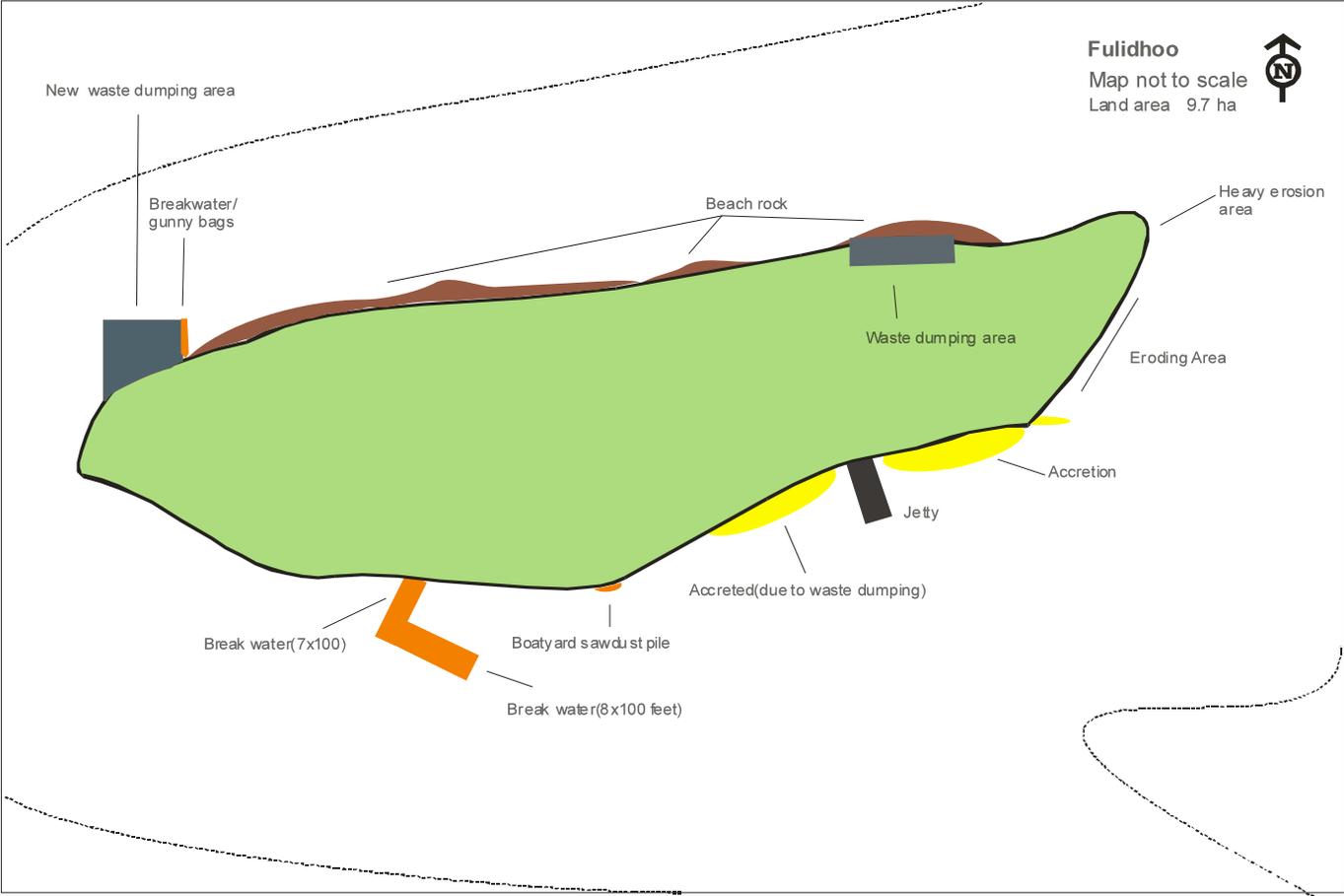
## Appendix 2 Coastal features of Felidhoo



**Appendix 3 Coastal features of Thinadhoo**



**Appendix 4 Coastal features of Fulidhoo**



## Appendix 5 Coastal features of Rakeedhoo

