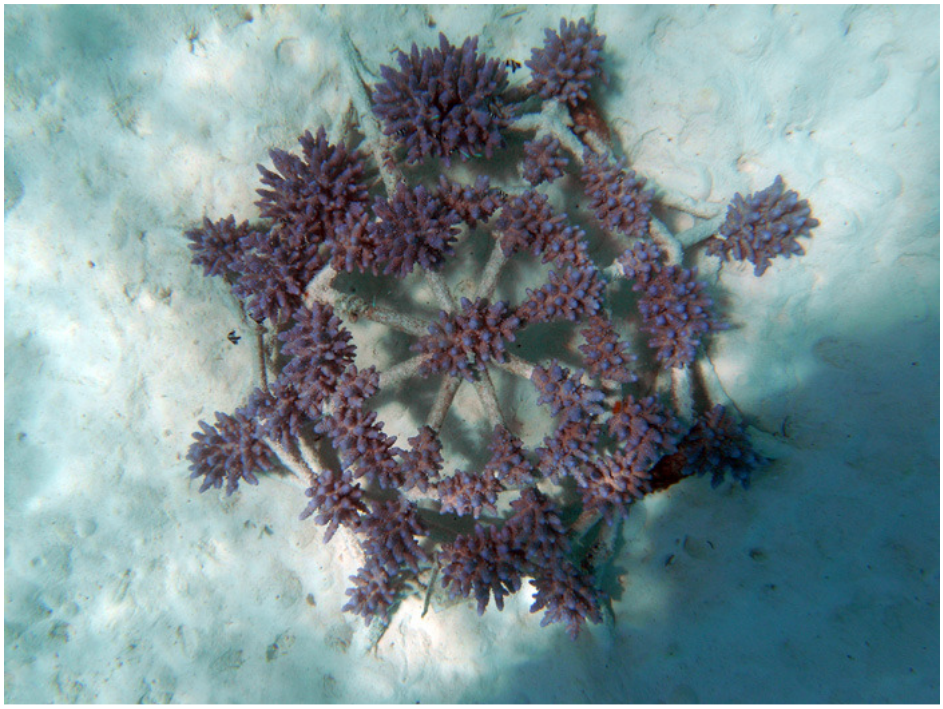
Initial Environmental Examination
for a Coral Frame project



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Proposed by:
Beach House Manafaru

Signature:

SEAMARC
Systems Engineering
And Marine Consulting

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1. Executive Summary

The potential environmental impacts of the development of a coral propagation project on the island of H.A. Manafaru are assessed. Manafaru is leased to Beach House Maldives and is operated by the Waldorf Astoria collection of the Hilton group.

The assessment exposes the solutions and preferred alternatives as well as mitigation measures to minimize any negative impacts whilst trying to derive the maximum positive impacts from the project.

Manafaru has very little coral cover after being degraded by the 1998 bleaching event. As it is important to be proactive in reef restoration, the resort management wishes to enhance the value of the island by propagating corals using the coral frame technique.

The frames will be installed near the water villas and sparsely on the house reef. Coral fragments will be attached by a marine biologist and will develop into full colonies within a few years.

Coral fragments from the house reef will provide a small number of fragments and will heal rapidly. Preference will be given to damaged colonies.

136 frames of 1m2 will be initially deployed, and after the first batch, the existing frames will provide fragments for transplantation.

The project will start as soon as approval is granted, and as this is a long term project, it could span several years before completion.

The island of Manafaru is located inside the northernmost atoll of the Maldives, and is subject to high winds and warming waters, which may be a cause of low coral survival.

As the island is located in the middle of the atoll, the waves reaching its shores are diffraction of swells, and wind waves.

As the energy encountered are of second magnitude, and the reef does not form a proper crest, the waves reach the island with less obstruction than most areas.

Sand displacement depends on the predominant influence during different monsoons, forming a bulging beach rather than a sand tip.

Possible reasons for relatively low coral cover in northern atolls include frequent warm temperature events, higher exposure to effects of cyclonic storms and higher prevalence of crown of thorns starfish.

Recruitment may also be limited due to distance limitations of planulae from the South.

16 transects photographic transects were used to assess the benthic cover of each site, where each picture is analyzed using 25 point grids to obtain quantitative substrate cover data of morphological characteristics of the reef community.

Results show a clear dominance of bare substrate in the house reef of Manafaru, with only 10% coral coverage.

Though coral cover is quite constant around the island, 3 of the transects displayed lower cover than average and 2 transects exhibited relatively better coverage.

46% of the transect points showed bleached coral, and a trend is apparent where the percentage of bleached coral increases with live coral cover.

72% of points were classified as pavement. Regardless of this abundance of suitable substrate, it is clear that corals are not recruiting naturally, thus coral transplantation is a viable option to increase coral cover.

For the fish community survey, data was collected using the methodology outlined by FishWatch Maldives, where 3 x 15 minute fish counts were made at 4 sites, with 3 transects for each site. Surveyed area is a band of 2.5m on either side of the recorder and 5m up the water column.

45 of the 78 FishWatch target species were recorded, where the mean density was generally less than 1 individual per 15 minute survey.

Lutjanus gibbus and *Chaetodon collare* were found in highest densities, both having clumped distributions around particular reef features.

A possible reason for the poor fish life on the reef of Manafaru may be due to limited shelter and habitat due to lack of live corals. Schooling fish were more abundant.

Of the groupers, *Cephalopholis argus* and *Variola louti* were most abundant. The high number of small sized *C. argus* is not readily explained as fishing has been banned for several years in the resort house reef.

During public consultations, the Ministry of Tourism, Arts and Culture reminded that an EIA should be prepared in accordance with the Ministry of Housing, Transport and Environment, and that there should be no damage to the reef done. At the scoping meeting, the Marine Research Centre noted that the amount of coral fragment envisaged was low. The ministry of Home Affairs was not consulted as the corals will be taken from the resort house reef.

Disturbance to the sea bed will be minimal as coral frames will mostly be installed on a rocky substrate and will be elevated 6 feet.

Coral frames are made of 12mm thin iron bars, which creates very little drag for water flow, and once the corals grow larger, their width is limited, and do not form a significant barrier for wave action.

In the past, it has been noticed that coral frames attract and recruit a lot of fish life and increases the complexity of the reef. It is anticipated that this will also be the case in Manafaru, eventually developing into a more productive reef.

The chemical reaction during calcification releases CO2 in the short term, but this is a process that has been occurring for millions of years and in the long term, coral skeletons are a carbon sink.

This work will directly improve the aesthetics and the reef complexity of the area, which will also improve the recreational value of the area.

If frames are not pruned and transplanted properly or the location is unsuitable, corals may die, though in most of the previous projects, this has not been encountered, and the yield has been found to be very positive.

As possible death of fragments and donor colonies are the only problem that need to be mitigated, if necessary, they will both be monitored as part of the study.

When choosing donors, priority will be given to those corals that have already been damaged by natural or anthropological activities, and eventually the corals grown on the frames will be used to provide fragments.

The do nothing scenario will probably lead to more decrease in coral cover, and the aesthetics of the reef will not improve. The resort may also lose some of its public relations benefits as they will not be seen as being proactive in its environment restoration.

2. Introduction

2.1. Project

The present report assesses the potential environmental impacts associated with the development of a coral propagation project using the coral frame technique in different areas on the shallow reef around the island of H.A. Manafaru. For the purpose of the IEE, the totality of the reef system was considered, even though a very small part of it will actually be concerned.

2.2. Proponent

The island of H.A. Manafaru was originally leased by the Ministry of Tourism of the Government of Maldives to Beach House Maldives at Manafaru and is now operated by the Waldorf Astoria Collection of the Hilton group.

2.3. Need and justification

The island of Manafaru, as much of the northern atolls, has very little coral cover. Snorkelling around the island is poor and therefore, it is desirable to increase the attractiveness of the resort in this respect. The success met by this technique in other parts of the Maldives has prompted the resort to replicate and improve on the project done elsewhere. In addition, when Maldives is in the limelight for the threats to its coral, it is important for Beach House Maldives to be proactive in restoring its reef back to health.

The coral reef in Manafaru has been very degraded by the 1998 bleaching event, which had hit the north of the Maldives more than the south. It seems the distance to the source of coral planulae in the south has been a factor decreasing recruitment, and the corals have not yet recruited massively to this area. The overall live coral cover is low, and there is a distinct lack of branching corals. Other tabular and digitate shapes, in particular acroporids and pocilloporids only seem to come back 12 years after the event.

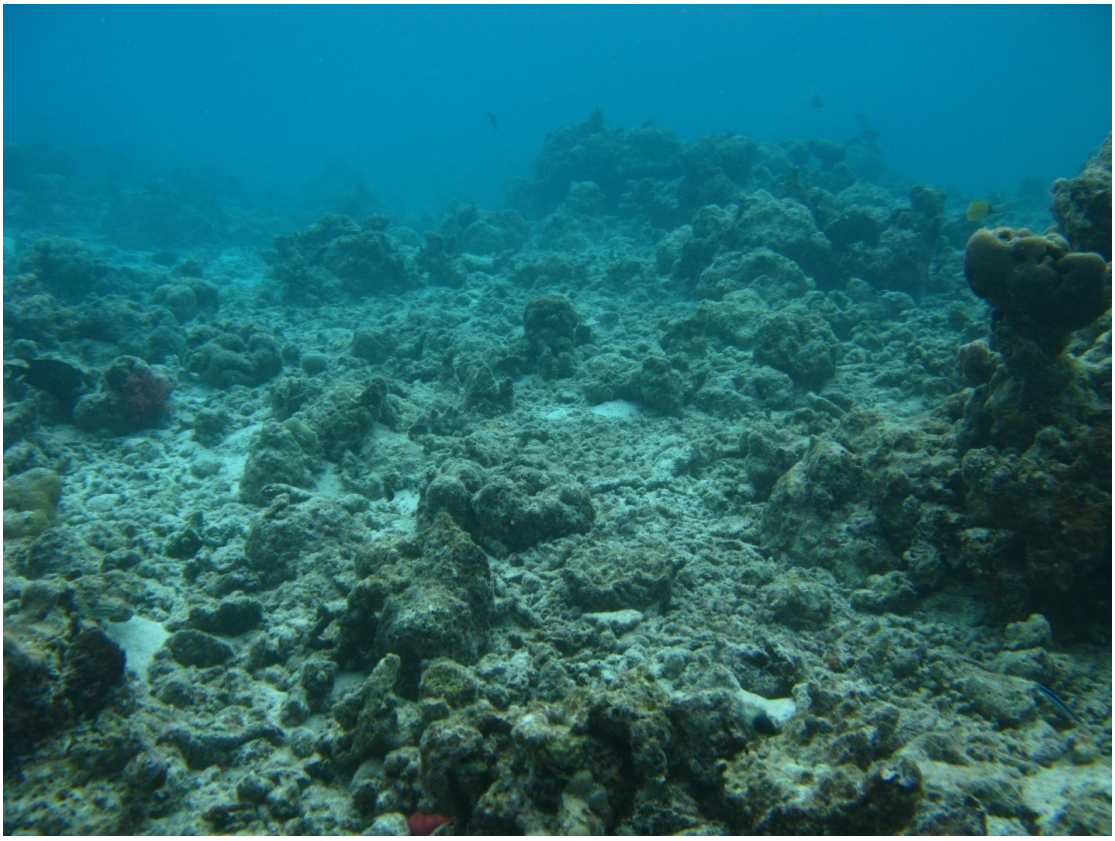

Figure 1: A typical reef edge at HA. Manafaru, coral cover is poor indicating a poor recovery since 1998

The resort management now wishes to enhance the aesthetic and recreational value of the property by propagating corals around certain water villas, using a technique already demonstrated in the Maldives; the coral frames.

2.4. Executing arrangements

The proponent contracted Seamarc Pvt. Ltd. to carry out the survey and Initial Environmental Examination (IEE) for the project. After the scoping meeting, the terms of reference for the project were discussed with the Environmental Protection Agency of the Ministry of Housing, Transport and Environment. These are included in the appendix.

The assessment of the impacts to the environment investigates the activities proposed as part of the project and analyses the environmental conditions at the site in order to forecast the impacts. The IEE then proposes solutions and preferred alternatives as well as mitigation measures to

minimize the negative impacts while trying to derive the maximum positive impacts from the project.

3. Project Description

3.1. Location map

Manafaru is located in the central part of Ihavandhippolhu (72.94º E, 6.99º N) (Figure 2).

Figure 2: Location of H.A. Manafaru

3.2. Resort site plan

The following figure shows the site plan of the resort. The coral frames will be deployed near the water villas

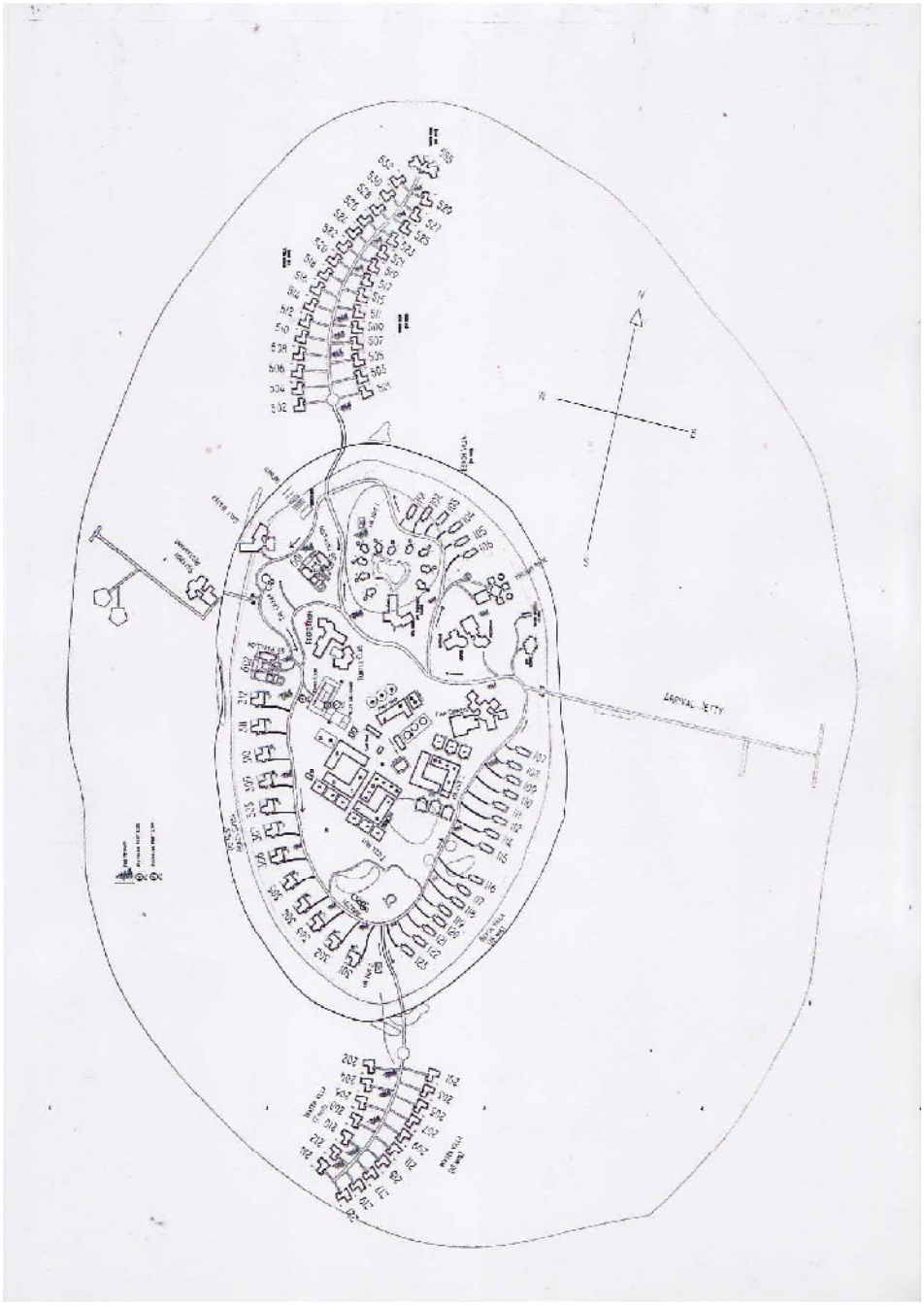

Figure 3: site plan of the resort

3.3. Project boundaries

The following scaled aerial picture shows the boundaries of the project areas as well as those of the survey carried out. The survey has been carried out on the totality of the house reef of Manafaru, whereas the coral frames will be installed sparsely on the house reef and in particular near the water villas.

Figure 4: boundaries of project area and survey area

3.4. Coral propagation program using coral frames

The coral frame technique involves putting welded iron rebar structures coated in resin, on the sea bed, such as the one depicted below (fig. 6)

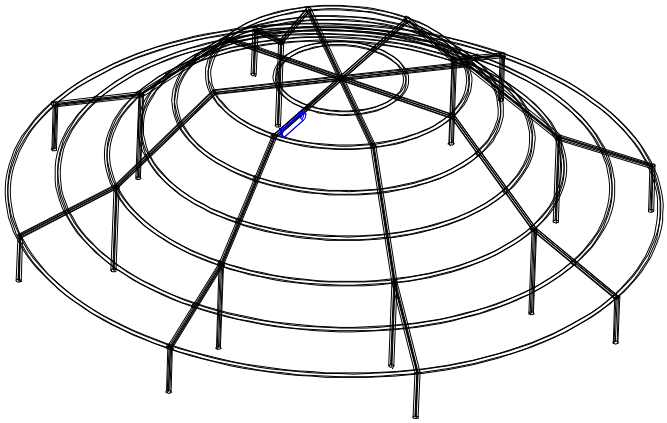

Figure 5: Example of a coral tray structure

Coral fragments are later attached appropriately to the structure using cable ties. The fragments later develop into full grown colonies within a few years, as can be seen in the pictures provided below.

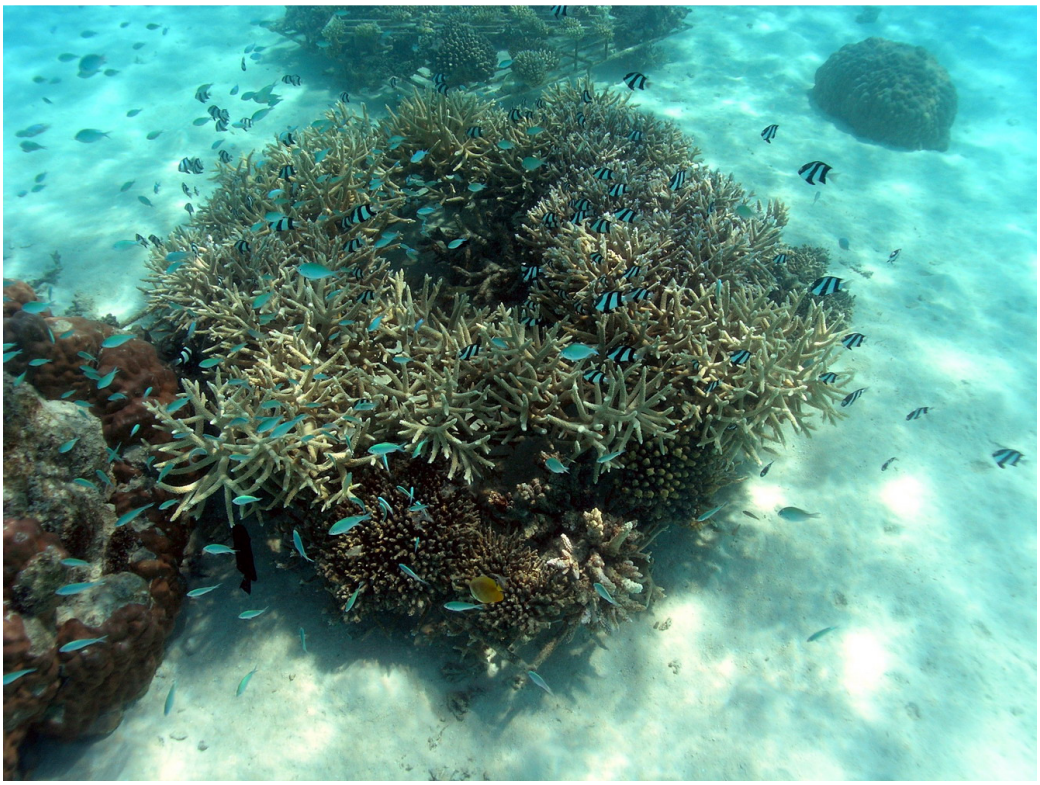

Figure 6: Coral frames after two years growth

3.5. Work Plan of Activities

The coral trays are welded on the island of B. Fulhadhoo and brought to H.A. Manafaru. Once on the island, the structures are deployed in the required areas before a marine biologist transplants coral fragments onto them.

The coral fragments are initially taken from the house reef, and brought near the empty structures in quantities that enable one or two persons to work at a time. Colonies pruned will only provide a small number of fragments and will heal rapidly. A preference will be given to already damaged colonies, whether partly grazed, toppled over, subjected to sedimentation or broken by storm or trigger fish.

After the first batch, the grown colonies on the existing coral frames will provide the source of corals for subsequent transplantation. Care is taken to not harvest the grown coral trays beyond the transplanting capacity for any given day.

Over time, the quantity of coral frames deployed could increase to over 1000, but initially, the resort will deploy 136 coral frames of 1 m2 (small frames). The quantity of coral fragments required to carry out the project is estimated at around 30 fragments per square meters. After the first year, it is expected that the grown colonies will yield enough fragments to not require taking fragments from the natural environment.

3.6. Project duration

The project will start as soon as approval is granted. The development of a coral frame project is long term, as coral growth is slow and therefore the investment will be spread in time. The project could therefore span several years before completion of the surfaces considered.

4. Existing Environment

4.1. Hydrodynamic regime

The island of H.A. Manafaru is located inside the northern most atoll of the Maldives. As such, it is located closest to the tropic and more prone to experience high wind from cyclones than other parts of the country. The waters are also getting warmer in these areas, which may be the cause for the poor survival of corals in the area.

The reef system of the island is mostly round in shape and is exposed to oceanic swells entering the atoll lagoon through a few openings on the atoll rim, in particular the Mulhadhoo Kandu to the east of the island and the Farukolhu Kandu to the west. The different influences of the swells and wind waves dominate the different openings and eastern waves are dominant during the northeast monsoon.

As the island is in the middle of the atoll, the waves reaching the shores of Manafaru are diffraction of the oceanic swells and the wind waves have a relatively short fetch except for those coming from the eastern direction, which are passing north of the Thiladhunmathee atoll island of Kelaa.

As such, the energy encountered are of second magnitude, and the reef does not exhibit a well formed reef crest and reach the island with less obstruction and energy loss than in more areas. Depending on the predominant influence during the different monsoons, the sand is displaced around the island, but do not form a sand tip but rather a bulging beach more characteristic of round islands. The situations during different monsoons are shown in the following pictures (Fig. 7, 8, 9 and 10).

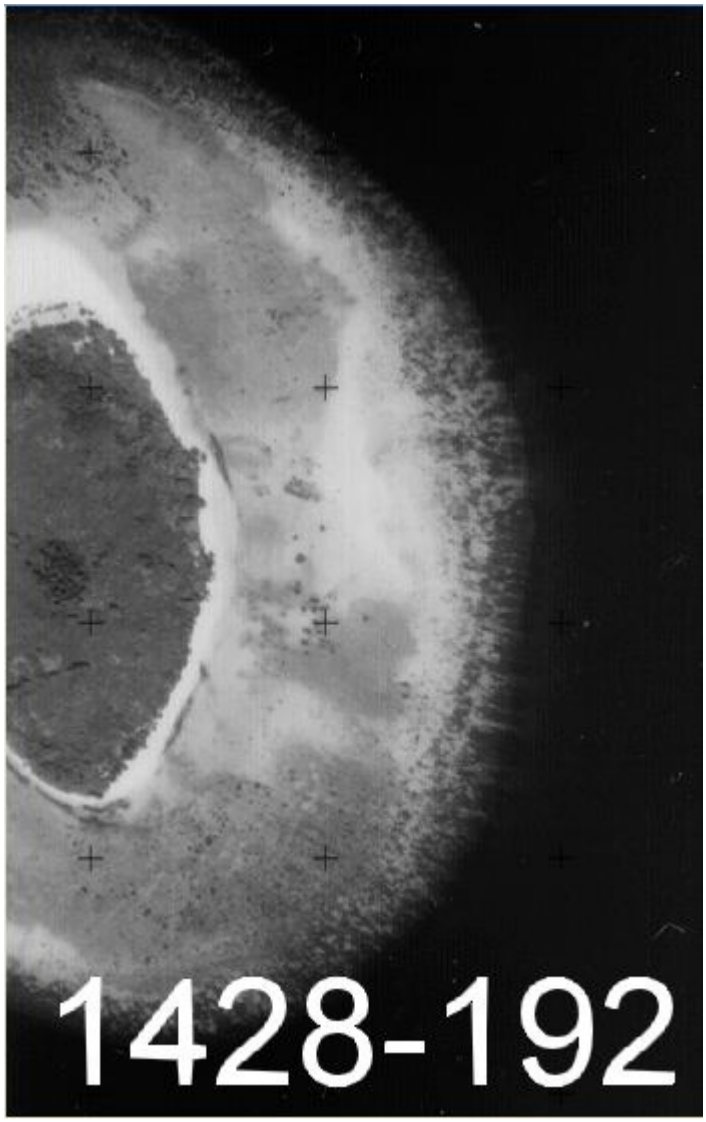

Figure 7: Available aerial picture from March 1969

The aerial from March 1969 (Fig. 7) shows erosion taking place on the eastern side, while the beach on the northern western side seems to extend very far north. Unfortunately, the picture from the RAF does not have the totality of the island. The satellite picture from June 2001 (Fig. 8) shows the situation early on in the southwest monsoon, where most of the sand has already migrated to the eastern side of the island. The satellite picture from March 2005 shows the typical situation during the northeast monsoon, which is similar to that of March 1969, but less extreme and with sand all around the island, even though the bulges are located on the southwestern and northwestern side. Finally, the satellite picture from 2005 (Fig.9) shows the situation at the end of the southwest monsoon. It is possible that erosion was felt on the western side that year.

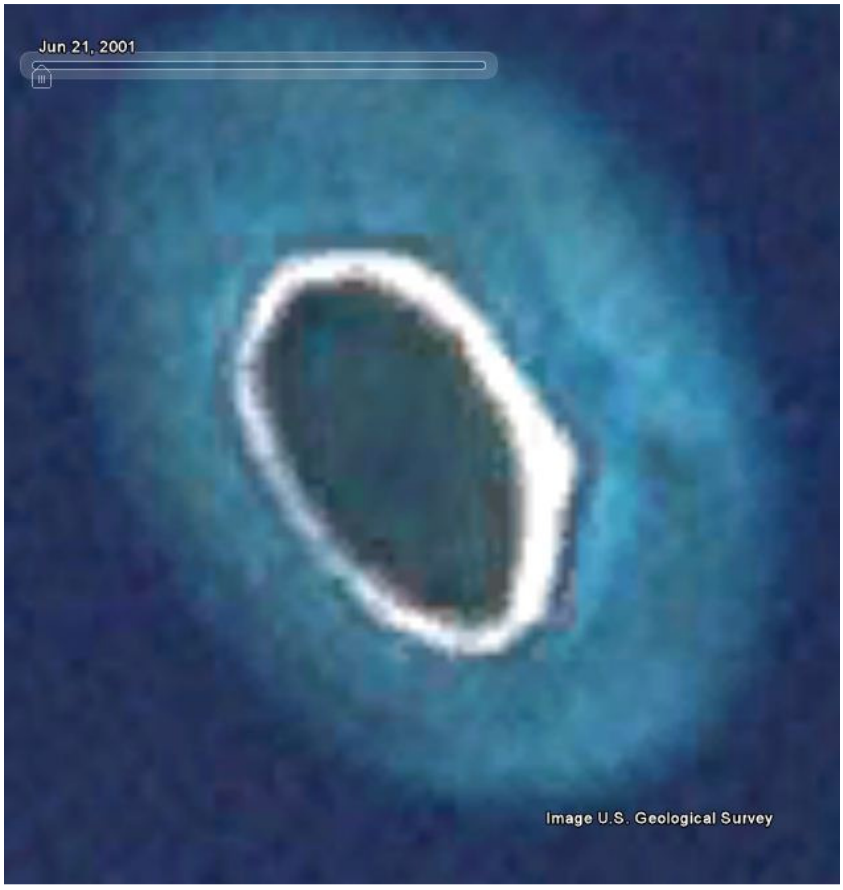

Figure 8: Satellite picture from June 2001

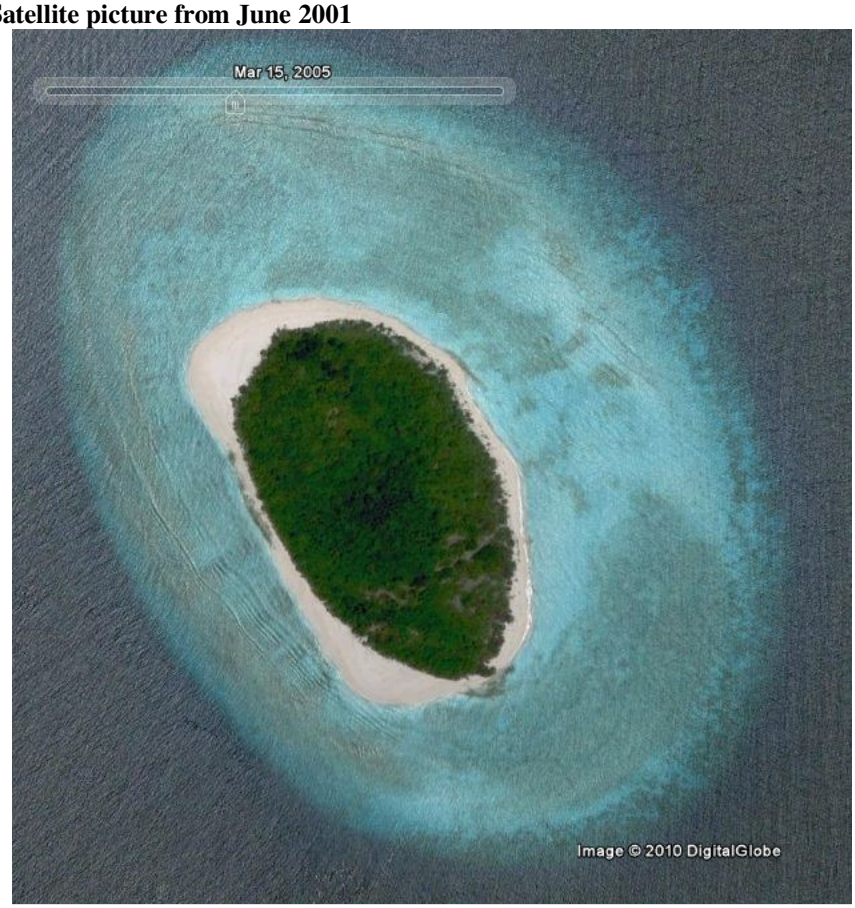

Figure 9: Satellite picture from March 2005

Figure 10: Satellite picture from December 2005

4.2. Marine environment

4.2.1. Introduction

Historically, the reefs of the northern atolls exhibit less coral cover than those of the central and southern atolls of the Maldives. There may be several reasons for this, which at this point are only work hypotheses. One reason could be that the warm temperature events are more frequent, as the reef is located further north, and satellite data show that the sea surface temperatures is often higher there. Second, there may be more effect from cyclonic storms as this region is closer to the tropic. Third, there is, despite a lower coral cover, more crown of thorns sea stars hindering the development

of coral colonies. Last, the planulae of coral colonies from the south may not reach these higher latitudes and therefore coral recruitment is limited.

The marine environment of Manafaru is that of a reef having trouble recovering from the impacts of the 1998 bleaching and the reef is mostly dead 12 years after this event, which is the major contributor to the current situation of the reef in the Maldives.

4.2.2. Seawater

At the time of the survey, the Public health laboratory was not performing many of the tests required, and therefore, no water quality analysis was carried out.

4.2.3. Benthic substrate

4.2.3.1. *Methods*

The reef assessment used photographic material of the substrate. At each site, 5 high resolution pictures were selected to assess the benthic cover of each site. Each picture is analyzed using 25 points grids to characterize each site with a sample of 125 points per transect. Quantitative substrate cover data of the morphological characteristics of the reef community was obtained using this method and could be repeated over time to assess variations.

Figure 11: Photographic operator carrying out a transect

5.1.1.1. *Survey plan*

For the assessment of the house reef of Manafaru, 16 transects have been carried out. These are shown in the following figure (Fig.12), and the associated geo-coordinates in table form (Table 1)

Figure 12: Map of the benthic survey realized in June 2010

Table 1: Geo-coordinates of the transects at Manafaru

Transects	Latitude (° N)	Longitude (° E)
Transect 01	6.9983	72.9438
Transect 02	6.9996	72.9433
Transect 03	7.0002	72.9426
Transect 04	7.0009	72.9414
Transect 05	7.0013	72.9383
Transect 06	7.0008	72.9373
Transect 07	6.9996	72.9371
Transect 08	6.9986	72.9373
Transect 09	6.9977	72.9372

Transect 10	6.9965	72.9376
Transect 11	6.9952	72.9384
Transect 12	6.9940	72.9396
Transect 13	6.9939	72.9430
Transect 14	6.9952	72.9439
Transect 15	6.9965	72.9441
Transect 16	6.9974	72.9439

5.1.1.2. ***Results***

The results obtained on the different transects is given in the table below (Table 2) as well as in bar chart form (Fig. 13)

Table 2: Transect results

MAJOR CATEGORY (%)	T1	T2	T3	T4	T5	T6	T7	T8	T9
CORAL	8	10.4	24.8	10.4	13.6	11.2	4	2.4	5.6
OTHERS	0	2.4	0	4.8	4	0	0	4	0
ALGAE	3.2	3.2	2.4	3.2	4.8	3.2	2.4	2.4	4.8
SAND, PAVEMENT, RUBBLE	74.4	82.4	71.2	61.6	77.6	85.6	92.8	90.4	77.6
DEAD CORAL	14.4	1.6	1.6	20	0	0	0.8	0.8	12
TAPE, WAND, SHADOW	0	0	0	0	0	0	0	0	0
	T10	T11	T12	T13	T14	T15	T16	MEAN	STD. DEV.
CORAL	18.4	9.6	12.8	8.8	9.6	11.2	9.6	10.7	5.3
OTHERS	0	0	0.8	4	0.8	14.4	8.8	2.8	4.0
ALGAE	0	8	1.6	7.2	1.6	1.6	5.6	3.5	2.1
SAND, PAVEMENT, RUBBLE	78.4	68	66.4	79.2	88	71.2	76	77.6	8.8
DEAD CORAL	3.2	14.4	18.4	0.8	0	1.6	0	5.6	7.4
TAPE, WAND, SHADOW	0	0	0	0	0	0	0	0.0	0.0

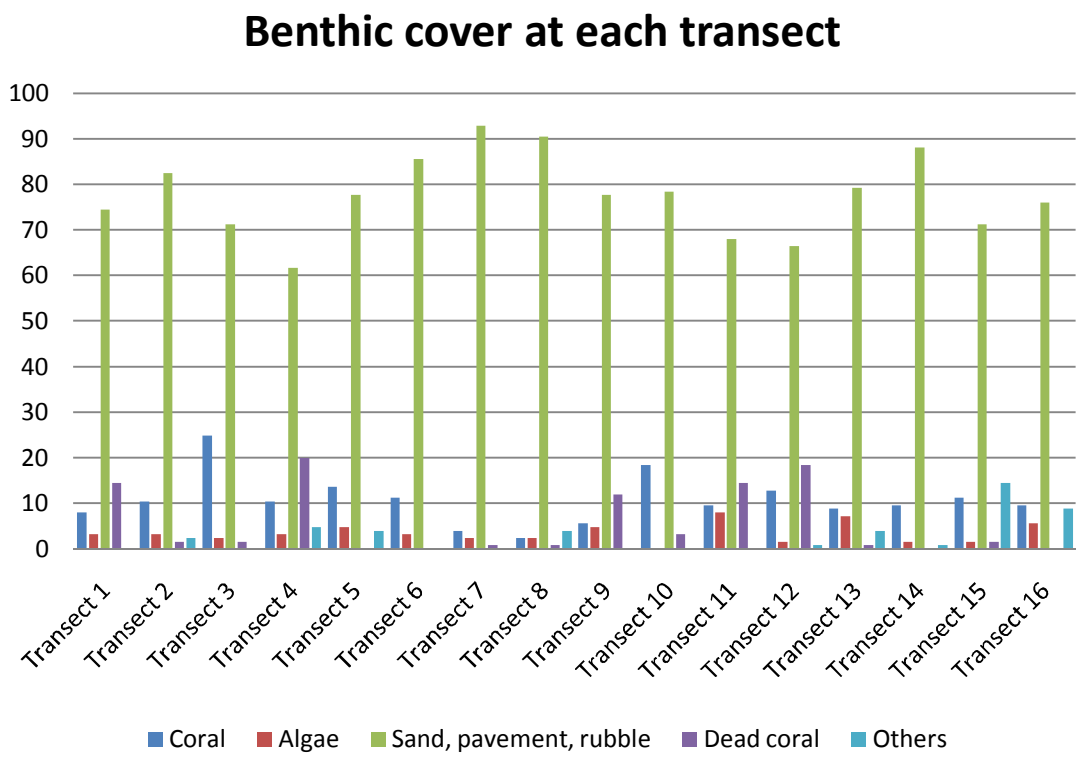

Figure 13: Percentage of the major categories of benthic cover per transect and general mean, H.A. Manafaru

The general results from the benthic survey of H.A. Manafaru show a clear dominance of bare substrate with only around 10% of coral cover (Fig. 14).

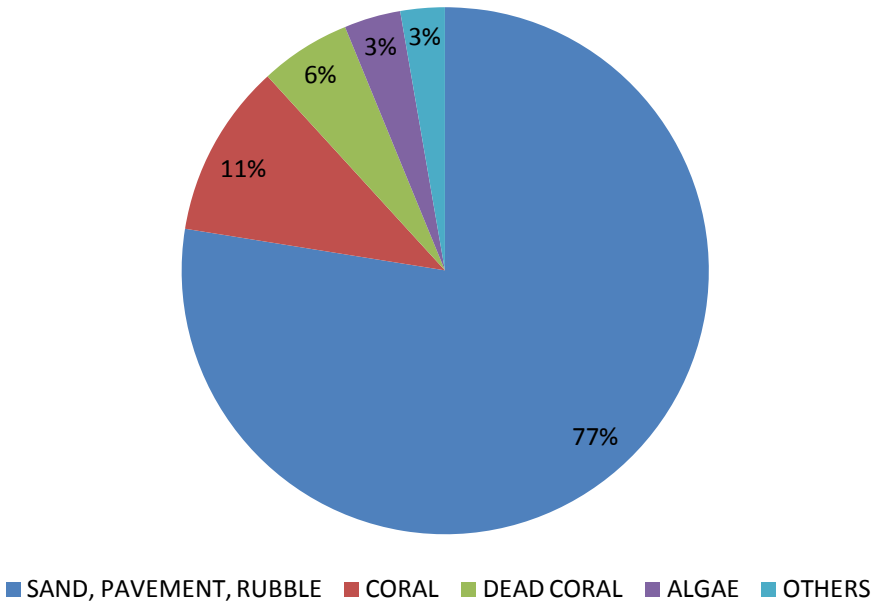

Figure 14: Percentage of the major categories of benthic cover in H.A. Manafaru

The coral cover is quite constant all around the island (Fig. 15), except in the area of the transect 7, 8 and 9 where it is lower than around the rest of the island. Transect 3 and 10 exhibited somewhat better coral cover. Among the coral points on all the transects, 46 % (± 27 %) are bleached corals.

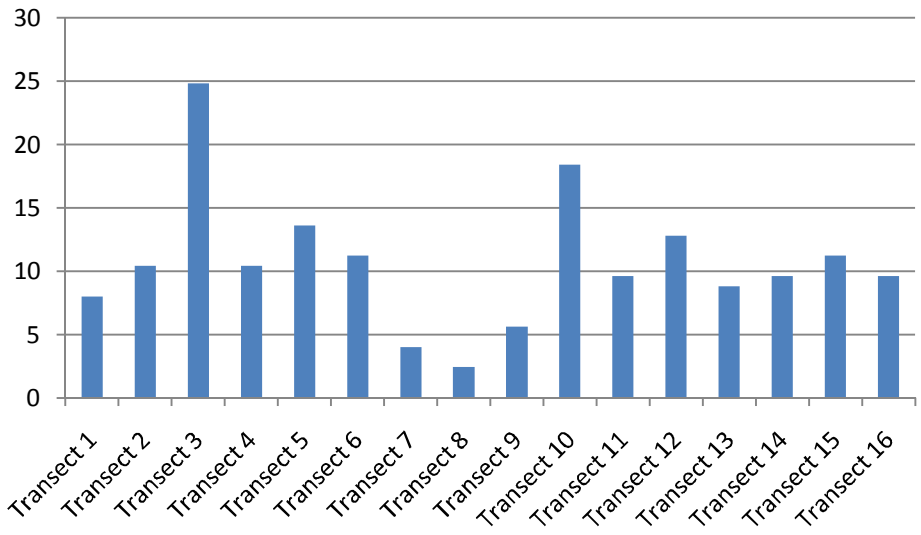

Figure 15: Percentage of live coral cover on the different transects

The following figure (Fig. 16) shows that the percentage of bleached corals increases with the live coral cover.

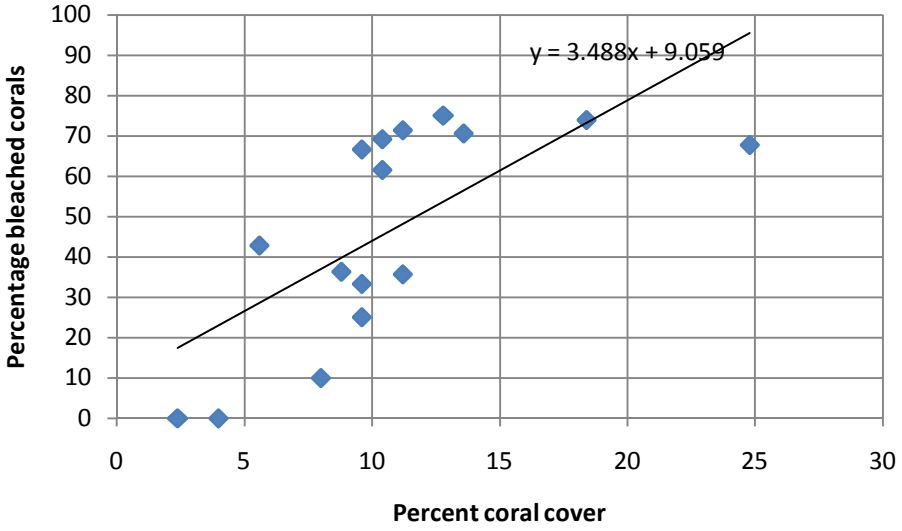

Figure 16: linear regression between bleached coral and live coral cover among the 16 transects

For this study, pavement has been considered for all points which appeared stable, even if they were colonized by short turf algae. The percentage covered by sand, pavement and rubble are displayed in Figure 17 and 18.

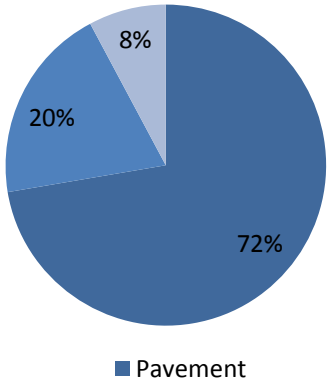

Figure 17: Details of the percentage of sand, pavement and rubble in HA Manafaru

These results also demonstrate that corals do not recruit naturally even in presence of available substrate, and that transplanting corals is therefore a viable option to increase coral cover at the site

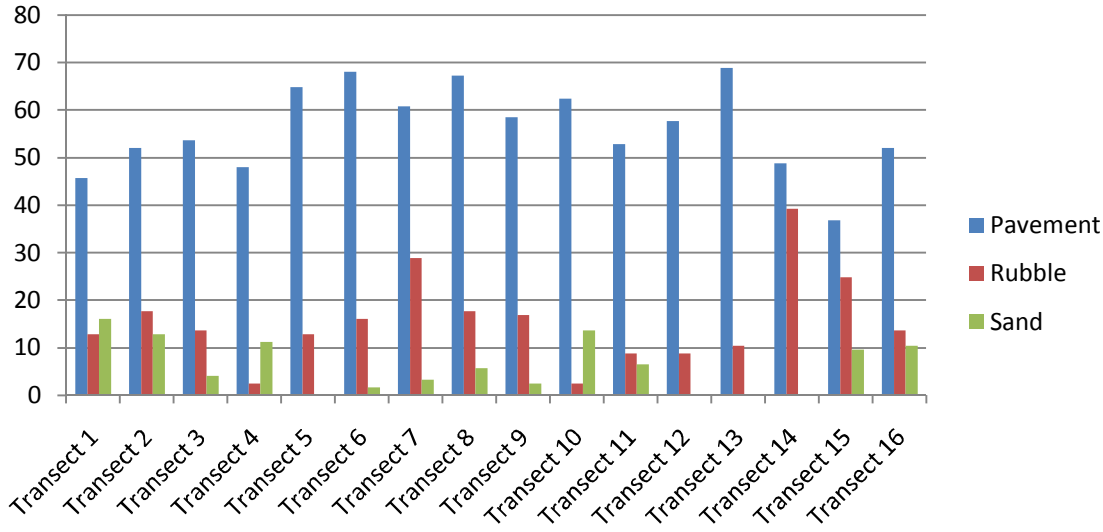

Figure 18: Details of the percentage of sand, pavement and rubble

The pavement cover is a bit more important on the western side of the island than on the eastern side and the sand cover following the opposite pattern. This could be related to the monsoon with more important wave energy on the western part of the island.

5.1.2. Fish communities

5.1.2.1. *Methods*

For the fish community survey, the data has been collected following the methodology of FishWatch Maldives, a nationwide project to monitor coral reef fishes. Fishes are recorded during timed swims. Each timed swim is exactly 15 minutes long. The target is 3 x 15 minute fish-counts per dive. The area surveyed is a band 2.5m either side of the recorder, and also 5m up in the water column. Surveys were carried out at 4 sites; with 3 transects completed at each site (Fig. 19), all at 5m depth. The geo-coordinates for each transect are displayed in Table 3. Each 15 minute survey was 5m wide and estimated to cover 300 m in length.

Fishwatch includes a range of species that are targeted for the aquarium trade or for food. Their habitat preferences vary, and not all would be expected to occur on the House Reef, which is sheltered within the atoll.

5.1.2.2. *Survey plan*

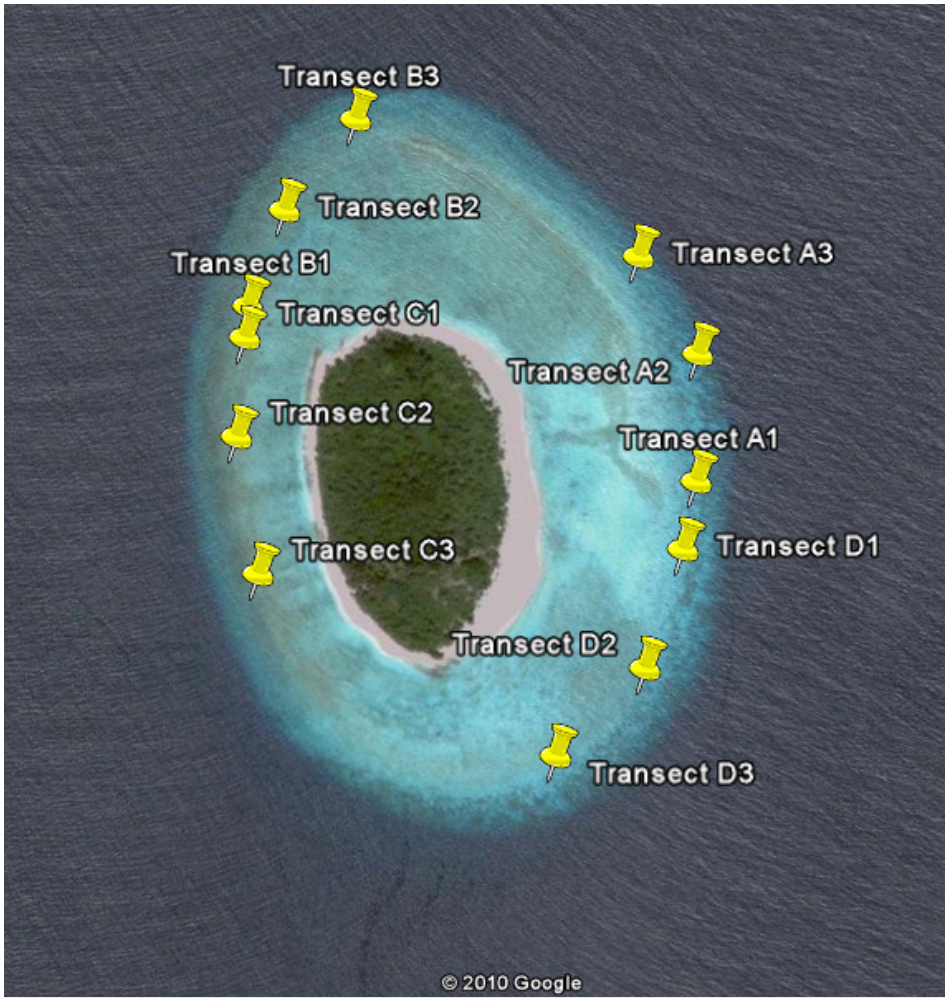

Figure 19: Fish community survey plan realized in June 2010

Table 3: Geo-coordinates of the fish watch transects carried out at Manafaru

Transects	Latitude (° N)	Longitude (° E)
Transect A1	6.9982	72.9437
Transect A2	6.9998	72.9431
Transect A3	7.0008	72.9418
Transect B1	6.9981	72.9372
Transect B2	6.9995	72.9372
Transect B3	7.0010	72.9376
Transect C1	6.9977	72.9373
Transect C2	6.9964	72.9377
Transect C3	6.9948	72.9387
Transect D1	6.9973	72.9439
Transect D2	6.9956	72.9441
Transect D3	6.9941	72.9434

5.1.2.3. ***Results***

45 of the 78 Fishwatch target species were recorded (Table 4) (those not recorded are in grey type). The mean numbers of each recorded species are displayed in Figure 20.

Mean density was generally less than 1 individual / 15 minute survey.

The species on the target list with the greatest density are as follows: *Lutjanus gibbus* (29.5), *Chaetodon collare* (8.25), *Zanclus cornutus* (6.33) *Plectorhinchus vittatus* (4.3), *Cephalopholis argus* (3.92). Both *L. gibbus* and *C. collare* had 'clumped' distributions, typically occuring in aggregations around particular features on the reef.

Table 4: Mean number recorded / 15 minute survey

Acanthuridae	Acanthurus bariene	0.00
Acanthuridae	Acanthurus leucocheilus	0.00
Acanthuridae	Acanthurus maculiceps	0.00
Acanthuridae	Paracanthurus hepatus	0.00
Acanthuridae	Zebrasoma desjardinii	2.83
Balistidae	Balistoides conspicillum	0.50
Balistidae	Pseudobalistes fuscus	0.00
Balistidae	Rhinecanthus aculeatus	0.00
Balistidae	Rhinecanthus rectangulus	0.00
Carangidae	Caranx ignobilis	0.08
Carangidae	Caranx lugubris	0.08
Carangidae	Caranx melampygus	2.08
Carangidae	Caranx sexfasciatus	0.00
Carangidae	Elagatis bipinnulata	0.00
Carangidae	Gnathodon speciosus	0.00
Carangidae	other jacks & trevally	0.08
Chaetodontidae	Chaetodon auriga	1.58
Chaetodontidae	Chaetodon collare	8.25
Chaetodontidae	Chaetodon falcula	0.75
Chaetodontidae	Chaetodon interruptus	0.17
Chaetodontidae	Chaetodon madagaskariensis	0.67
Chaetodontidae	Chaetodon meyeri	0.17
Chaetodontidae	Chaetodon xanthocephalus	1.67
Chaetodontidae	Heniochus monoceros	0.17
Chaetodontidae	Heniochus pleurotaenia	0.08
Chaetodontidae	Heniochus singularis	0.00
Cirrhitidae	Oxycirrhites typus	0.00
Cirrhitidae	Paracirrhites arcatus	0.00
Diodontidae	Diodon liturosus	0.08

Gobiidae	Amblyeleotris aurora	0.00
Gobiidae	Stonogobiops dracula	0.08
Haemulidae	Plectorhinchus chaetodontoides juv	0.00
Haemulidae	Plectorhinchus chaetodontoides adult	0.00
Haemulidae	Plectorhinchus vittatus juv	0.08
Haemulidae	Plectorhinchus vittatus adult	4.33

Note: *Plectorhinchus vittatus* is commonly named *Plectorhinchus orientalis* in Maldives.

Labridae	Cheilinus undulatus juv	0.00
Labridae	Cheilinus undulatus adult	0.00
Labridae	Cirrhilabrus exquisitus	0.00
Labridae	Coris aygula	0.00
Labridae	Coris aygula	0.00
Labridae	Coris cuvieri	0.33
Labridae	Coris cuvieri	0.00
Labridae	Coris frerei	0.00
Labridae	Coris frerei	0.00
Labridae	Paracheilinus mccoskeri	0.00
Lethrinidae	Lethrinus erythracanthus	0.00
Lutjanidae	Aprion virescens	0.17
Lutjanidae	Lutjanus bohar	9.00
Lutjanidae	Lutjanus gibbus	29.50
Lutjanidae	Macolor macularis	0.00
Lutjanidae	Macolor niger	2.42
Microdesmidae	Nemateleotris decora	0.00
Microdesmidae	Nemateleotris magnifica	0.67
Monacanthidae	Oxymonacanthus longiristris	0.00
Ostraciidae	Ostracion cubicus	0.00
Ostraciidae	Ostracion cubicus	0.00
Ostraciidae	Ostracion meleagris	0.00
Ostraciidae	Ostracion meleagris	0.00
Pomacanthidae	Apolemichthys trimaculatus	0.00
Pomacanthidae	Apolemichthys xanthurus	0.00
Pomacanthidae	Pomacanthus imperator	0.00
Pomacanthidae	Pomacanthus imperator	0.92
Pomacanthidae	Pomacanthus semicirculatus	0.00
Pomacanthidae	Pomacanthus semicirculatus	0.00
Pomacanthidae	Pomacanthus xanthometopon	0.00
Pomacanthidae	Pomacanthus xanthometopon	0.00
Pomacanthidae	Pygoplites diacanthus	2.67
Pomacentridae	Amphiprion nigripes	0.67
Scorpaenidae	Dendrochirus zebra	0.00
Scorpaenidae	Pterois antennata	0.25

Scorpaenidae	Pterois miles	0.25
Scorpaenidae	Pterois radiata	0.08
Serranidae	Aethaloperca rogaa	1.00
Serranidae	Anyperodon leucogrammicus	0.25
Serranidae	Cephalopholis argus	3.92
Serranidae	Cephalopholis miniata	0.17
Serranidae	Cephalopholis sexmaculata	0.50
Serranidae	Epinephelus caeruleopunctatus	0.17
Serranidae	Epinephelus flavocaeruleus	0.00
Serranidae	Epinephelus fuscoguttatus	0.17
Serranidae	Epinephelus polyphekadion	0.00
Serranidae	Epinephelus spilotoceps	0.42
Serranidae	other groupers 30cm +	0.67
Serranidae	Plectropomus areolatus	0.67
Serranidae	Plectropomus laevis	0.50
Serranidae	Plectropomus pessuliferus	0.67
Serranidae	Variola albimarginata	0.00
Serranidae	Variola louti	1.75
Tetraodontidae	Canthigaster valentini	1.42
Zanclidae	Zanclus cornutus	6.33

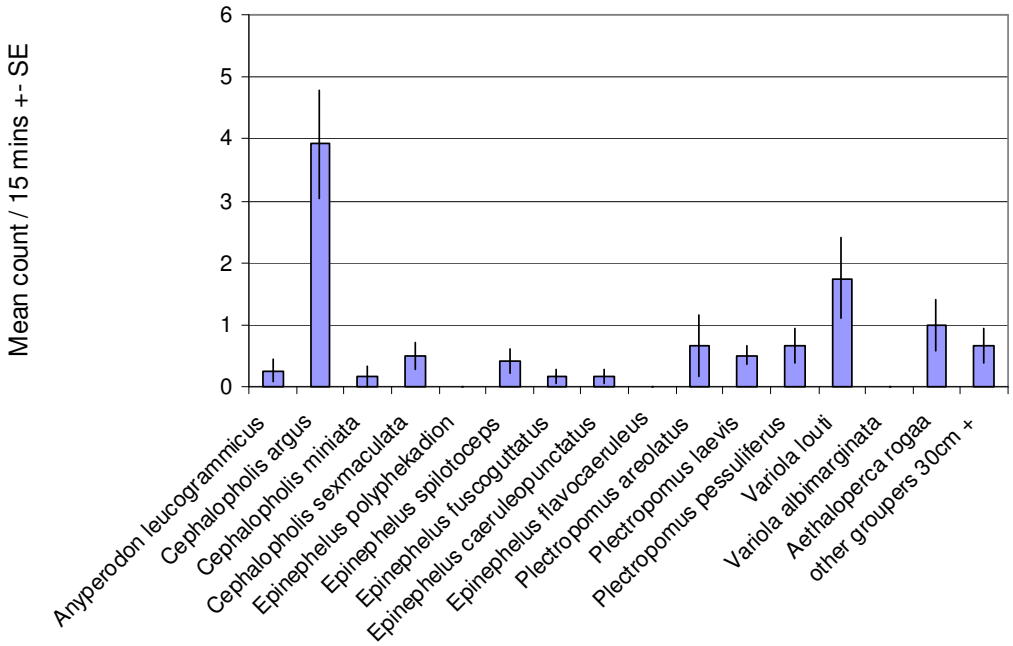

Figure 20: Mean numbers of recorded species

The fish life is quite poor on the reef of Manafaru, maybe because of the lack of shelters encountered, due to lack of live corals. Most of the more abundant fish have a schooling habit. Out of the groupers, *Cephalopholis argus* (Fig.21) and *Variola louti* (Fig.22) common on most reefs were the most

abundant. Small sized *Cephalopholis argus* were the most numerous (Fig. 21), even though this is not readily explained as the resort house reef has been banned from fishing for a few years. It is possible that the size of such species increases in the years to come.

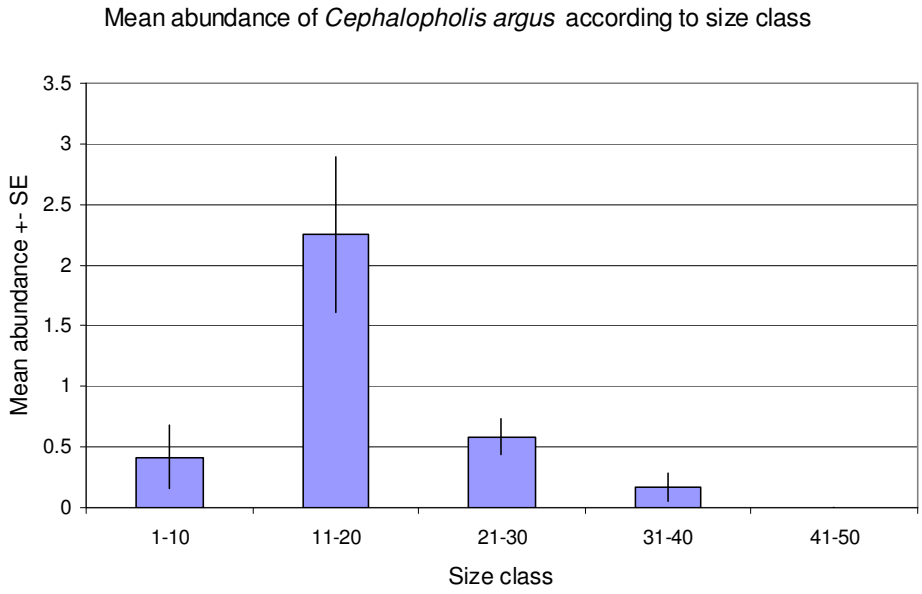

Figure 21: Mean abundance of *Cephalopholis argus according to size class*

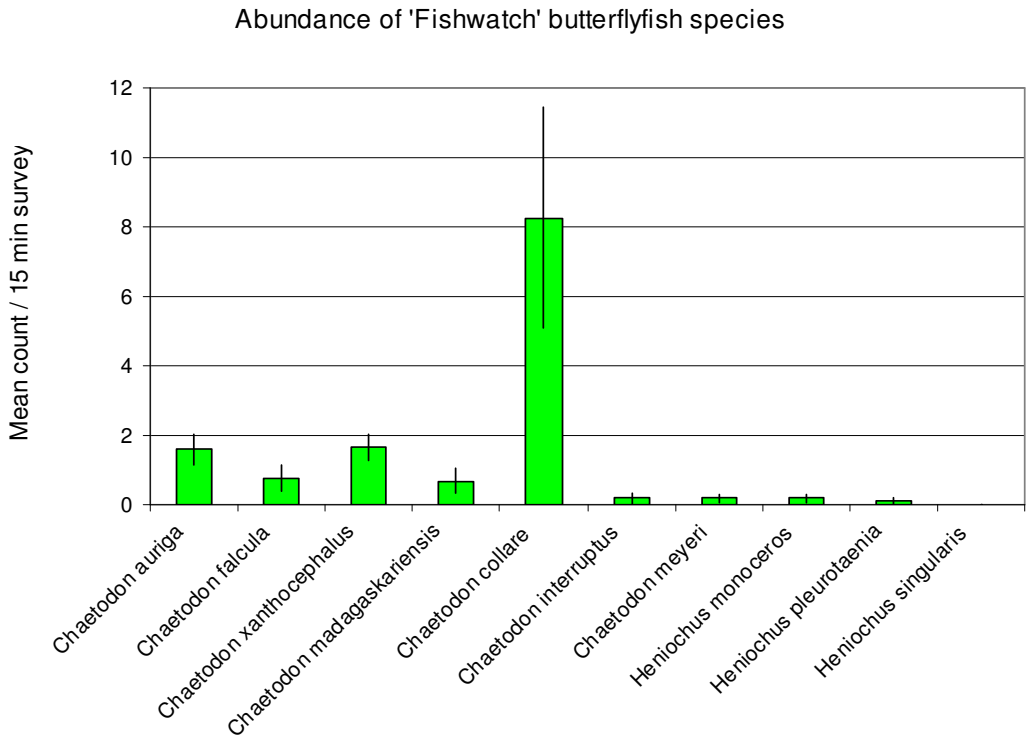

Figure 22: Mean abundance of 'Fishwatch' butterflyfish species

6. Public Consultation

6.1. Ministry of Tourism, Culture and Arts

The official from the Ministry of Tourism stated that the EIA should be prepared in accordance with the approved Terms of Reference from the Ministry of Housing, Transport and Environment. Their concern was that all components of the project must abide by the relevant environmental legislation, existing plans, policies and guidelines as well as international conventions pertaining to the development of the project. It should especially take into consideration the Maldives Tourism Act (Law 2/99) and all regulations under the said Act.

They were also concerned that no reef should be damaged when obtaining live coral for the project.

6.2. Ministry of Fisheries and Agriculture

The Ministry of Fisheries was requested for a comment on the coral frame project at Manafaru and we were not able to get any comments from them within a 3 week period. While a solid confirmation has not been received by the Ministry, the Marine Research Centre expressed their concerns during the scoping meeting regarding the coral fragments that will be taken during the initial phase of the project. They were in agreement with the amount of corals that should be taken from the reef.

6.3. Ministry of Home Affairs

Initially, it was planned to collect coral fragments from the backreef of Hoarafushi. However, it was decided that the fragments will only be collected from the Manafaru housereef itself and therefore a comment from Ministry of Home Affairs was not sought.

7. Environmental Impacts

7.1. Description of Impacts on the Natural Environment

7.1.1. Disturbance of sea bed

The disturbance to the sea bed will be minimal as the coral frames will be mostly installed on a rocky substrate. In addition, the frames are elevated on 6 feet, therefore contact with the existing substrate is limited.

7.1.2. Alteration to water flow and sediment transport

The coral frames are made of 12mm thin iron bars, which creates very little drag for water flow. When the corals are grown into larger colonies, they stay below the surface and their width is limited and they do not form an important barrier for wave action. In addition, the usual processes occurring for natural reef also apply. These include increase in sediment creation and overall calcification of the reef. In addition it has to be noted that coral cover used to be more important in the past and that even if the project was carried at much larger scales, the coral cover would still remain less than what used to be the case at the site previously.

7.1.3. Creation of new habitats

The coral frames have increased the complexity of the reef and created habitat for fish life. It has been noticed that they attract and recruit a lot of fish life in the areas where they have been installed. It is expected that this will be again noticed around the coral frames in Manafaru. Eventually, the reef flat should then be more productive than what it is at present as the reef flat itself sustains very little fish life.

7.1.4. Green house gas emissions

Calcification chemical reaction liberates CO2 in the atmosphere in the short term, but is a natural process that has been occurring in the Maldives over millions of years and continues nowadays whether this calcium carbonate is precipitated by shells, coralline algae or foraminifera. This will remain very limited, and in the long term the skeletons of corals are a carbon sink.

7.1.5. Increased aesthetic

The area considered is a major recreation area for the guests and the entire work will directly improve the aesthetics of the areas, by providing colourful living reefs.

The fish life will further improve the recreational value of the reef, in particular for snorkelers.

7.1.6. Death of fragments and donor colonies

In case the frames are not transplanted properly or are deployed in an unsuitable location, fragments could die, which would present a loss of coral polyps. Donor colonies could also be weakened if the fragments are not pruned properly. It has to be noted that this has not been encountered in most of the projects carried out so far, and that overall, the yield in coral polyps is very positive.

7.2. Impacts rating

The anticipated impacts arising from the project during the construction and operation phases are discussed below and the direct and indirect impacts are summarized in Table 5. These show the ratings of the impacts before and after mitigation and are presented at the end of the next sections on mitigation.

8. Mitigation Measures

As most of the possible impacts encountered above are negligible or positive, the only one that needs to be mitigated is the possible death of fragments and donor colonies.

8.1. Impacts to be mitigated

8.1.1. Death of fragments and donor colonies

Both the fragments and the donor colonies (if necessary) will be monitored as part of the study. In fact, it is not expected that healthy colonies will need to be pruned as part of the project, as there are enough fragments found lying on the reef broken either by snorkelers or different fish species such as the titan trigger fish (*Ballistoides viridescens*) or coral colonies half eaten by crown of thorns starfish (*Acanthaster plancii*).

Eventually, the grown colonies will be used to provide fragments for the subsequent frames, making collection of corals from the wild unnecessary.

8.2. Summary table of impacts and ratings

Table 5: Environmental Impacts expected to arise from coral frame project

Activity	Site of Impact	Component	Impacts	Rating	Mitigation	Final rating
Deployment of coral frames	Deployment area	Disturbance of sea bed	Disturbances to the sea bed will affect fish life and invertebrates	negligible		negligible
Alteration of water flow and sediment transport	Beach in front of coral frames	Obstruction of flow	Erosion	negligible		negligible
Creation of new habitat	Deployment area	Increased reef complexity	Provides shelter for fish and invertebrates	++		++
Greenhouse gas emission	Atmosphere	Calcification reaction	Liberates CO2 from the water column	negligible		negligible
Increased aesthetics	Deployment area	Coral and fish life	Provides living coral patches	++		++
Death of fragments and donor colonies	House reef	Corals	Loss of coral cover	-	The frames are moved to more suitable areas, collection of already broken fragments and already damaged colonies	negligible

The mitigation measure proposed for the negative impacts arising from the project are summarised in Tables 4.

9. Alternative Options

9.1. The do-nothing scenario

The do nothing scenario will not increase the aesthetics of the area and will not provide the resort with a better snorkelling area. The reef will continue to evolve naturally and given the current situation will probably exhibit less and less live coral cover.

The resort will not be seen as proactive in the restoration of the environment and lose some of the public relations benefits it could otherwise derive from the project.

9.2. Alternative deployment area

In case the frames are not performing as expected in the areas initially thought about, they will be moved to more suitable locations.

9.3. Deploy more coral frames

Given the positive environmental impacts which will be derived from the project, and if this is confirmed in the field, many more frames should be implemented on this largely dead reef.

10. Conclusions

Given that the house reef of H.A. Manafaru is largely devoid of coral life due to the bleaching event of 1998 and poor recovery since; the present report concludes that the coral frame project envisaged by Beach House Manafaru will be largely positive. It is expected that the project will provide the resort with a better reef and snorkelling area, while at the same time enabling the resort to communicate on their proactive stance on an environmental point of view.

At the same time, the risks associated with the project are limited as the project will make use of ailing fragments and colonies which are to be found on the house reef, whether these be present due to natural or anthropogenic causes.

11. Declaration of the Consultant

I certify that the statements made in this Initial Environmental Examination study are true, complete and correct.

Name: Mariyam Rozlyn Saleem

Signature:

Date: 05/08/2010

APPENDICES

بسم الله الرحمن الرحيم

Environmental Protection Agency
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Environmental Protection Agency

Ministry of Housing, Transport and Environment
Male', Republic of Maldives

Terms of Reference for the Initial Environmental Examination for the Proposed Coral Propagation Project at Beach House Maldives, Ha Manafaru

The following is the TOR for undertaking the IEE of **the proposed Coral Propagation Project at Beach House Maldives, Ha. Manafaru** based on the scoping meeting held on the 25th May 2010.

The IEE report shall be carried out in accordance with this TOR.

1. Introduction - *Identify the development project to be assessed and explain the executing arrangements for the environmental assessment. Describe the rationale for the development and its objectives*

2. Study Area - *Specify the boundaries of the study area for the assessment.*

3. Scope of Work - *The following tasks will be performed:*

Task 1. Description of the Proposed Project –.

a) *Project location*
b) *A scaled site plan showing the location of proposed activity.*
c) *Details of processes and methods used.*
d) *Quantified project outputs (e.g. quantity of coral frames deployed) and inputs (e.g. manpower and number of fragments)*
e) *The Source areas for fragments*
f) *Project duration and scheduling*

Task 2. Description of the Environment – include a description of the existing environmental conditions of the project site with photos of the site where relevant. Consideration of likely monitoring requirements should be borne in mind during survey planning, so that data collected is suitable for use as a baseline. As such all baseline data must be presented in such a way that they may be usefully applied to future monitoring.

Specific emphasis should be placed on (but not limited to) the following environmental aspects of the project:

- *Describe the environment around the island and the project area*
- *Description of the environment of the source area for fragments*

Description of the environment should include description of the impact areas as well as a control sites. As such the following field investigations must be considered for baseline data collection:

- *Sea water quality parameters shall specifically include; dissolved oxygen, salinity, pH, temperature and turbidity, sulphate, nitrates, COD and BOD*
- *Condition of the marine environment in the proposed areas and source areas including coral communities and fish communities.*
- *Hydrodynamic regime at the project area*

All survey locations shall be referenced with Geographic Positioning System (GPS) including sampling points, reef transects, vegetation transects, manta tows and soil sampling sites. All water samples shall be taken at a depth of 1m from the mean sea level or mid water depth for shallow areas. At least two benchmarks shall be used when undertaking the baseline assessments. The report should outline the detailed methodology of data collection utilized to describe the existing environment.

Task 3 Determine the Potential Impacts of the Proposed Project – The IEE report should identify all the impacts and shall determine and analyze all the significant impacts for the proposed redevelopment. Particular attention shall be given to impacts associated with the following:

- *Impacts on coral reef, reef flora and fauna due to the new artificial habitat.*
- *Changes in hydrodynamics and sediment transport in the area and around the island, with long term forecast outcomes.*

Task 4. Mitigation measures - Identify possible measures to prevent or reduce significant negative impacts to acceptable levels. Details of practical actions to mitigate or compensate for the significant impacts Mitigation measures must also be identified for both construction and operation phase and provide cost of the mitigation measures, equipment and resources required to implement those measures. The confirmation of commitment of the developer to implement the proposed mitigation measures shall also be included.

Task 5. Alternatives - Identify alternative sites for source materials. Determine the best practical environmental options giving justifications. If alternative site is proposed, existing environment of this site must be examined.

Task 6. Stakeholder Consultation – Consultations must be done with Ministry of Tourism, Ministry of Home Affairs and Ministry of Fisheries and Agriculture. Consultations must be done and any approvals needed must be obtained regarding collection of source materials and copies of the approvals attached with the EIA report.

Presentation - The environmental impact statement report, to be presented in print and digital format, will be concise and focus on significant environmental issues. It will contain the findings, conclusions and recommended actions supported by summaries of the data collected and citations for any references used in interpreting those data. The environmental assessment report will be organized according to, but not necessarily limited by, the outline given in the Environmental Impact Assessment Report, 2007.

Timeframe for submitting the EIA report – The developer must submit the completed EIA report within 3 months from the date of this Term of Reference.

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Environmental Impact Assessment Team

The EIA for the construction of a seawall and development of the Coral Tray project was carried out by Seamarc Pvt. Ltd. with an experienced professional team lead by Ms Mariyam Saleem (EIA Consultant No. EIA05/07). Following are the Curriculum Vitae of the team members:

CURRICULUM VITAE of MARIYAM SALEEM

PERSONAL DETAILS

Name: Mariyam Rozlyn Saleem

Nationality: Maldivian

Gender: Female

Date of Birth: 1st of September 1974

Marital Status: Married with two children

Languages for communication: Dhivehi, English and French

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EDUCATIONAL QUALIFICATION

SECONDARY EDUCATION: 1991-1993 Woodstock School, Mussoorie, U.P, India

High School Diploma

May 1993 - **Advanced Placement**
1981-1991 Aminiya School, Malé
Republic of Maldives
GCE O' level

TERTIARY EDUCATION: **Bachelor of Science** (Marine Biology)
July 1996 - June 1997 - University of the South Pacific, Fiji
July 1997 - July 1999 - James Cook University, Australia
Conferred in August 1999

Master of Applied Science (Protected Area Management)
James Cook University February 2002 – April 2004
Conferred in May 2004

EMPLOYMENT HISTORY

28.06.00 – ongoing	Environmental Manager	Seamarc Pvt. Ltd.
08.05.04 – ongoing	Senior Research Officer	Marine Research Centre Min. of Fish, Agri. & Mar. Res.
28.07.99 – 08.05.04	Research Officer (Grade 3)	Marine Research Centre Min. of Fish, Agri. & Mar. Res.
29.11.94 - 30.06.96	Research Assistant	Marine Research Section Min. of Fish, Agri. & Mar. Res.
23.08.93 - 28.11.94	Marine Biology Trainee	Marine Research Section Min. of Fish, Agri. & Mar. Res.

WORKSHOPS AND SEMINARS ATTENDED

Workshop held on the "Introduction of Reef Resources Management Handbook", Vaavu & Meemu Atoll, 1994

Involved in the International Coral Reef Initiative Workshop 1995, Bandos Island Resort.

Workshop on Integrated Reef Resources Management 1996, MCSE, Malé.

CORDIO Workshop on Survey Design and Data Analysis 23-30 January 2000, MRC, Malé'.

Workshop on Monitoring the Social, Economic and Environmental Impacts of Tourism in the Maldives 27 January 2000, Nasandhura Palace Hotel, Malé.

Introduction and demonstration of Marine GIS to conduct the spatial analysis for fisheries and oceanographic data 27 March 2000, MRC, Malé.

Training Workshop on Climate Change Vulnerability and Adaptation Assessment 17-27 April 2000, Bandos Island Resort, Maldives.

GCRMN Training Workshop on Coral Reef Survey Design and Data Analysis 1-8 May 2000, Chennai, India

First Regional Workshop on Conservation of Biodiversity 15-18 July 2000, AA. Mahibadhoo, Maldives

Third Regional Workshop on Conservation of Biodiversity 25-26 August 2000, Seenu Gan, Maldives

Fourth Regional Workshop on Conservation of Biodiversity 15-16 September 2000, Baa Eydhafushi, Maldives

Fifth Regional Workshop on Conservation of Biodiversity 13-14 October 2000, Meemu Muli, Maldives

9th International Coral Reef Symposium 23-27 October 2000. Bali, Indonesia

Sectoral Workshop on Conservation of Biodiversity 6-7 November 2000, Hulhulé, Maldives

GCRMN Evaluation Meeting Phase II March 2001, Male', Maldives

GCRMN Database Evaluation Meeting June 2001, Colombo, Sri Lanka

National Workshop on Conservation of Biodiversity September 2001, Male', Maldives

Workshop on Protected Areas: IUCN categories November 2001, Male', Maldives

Workshop on Code of Conduct for Responsible Fisheries January 2004, Male', Maldives

10th International Coral Reef Symposium 28 June – 2 July 2004, Okinawa, Japan

Technology Needs Assessment for Climate Change: First Workshop on Technology Needs Assessment Methodology 22 – 24 November 2004, Hulhule', Maldives

Inception workshop on the "Preparation of National Adaptation Plan of Action" (NAPA) Project 25 November 2004, Hulhule', Maldives

Inception workshop on AEC – AEC Baa Atoll Project July 2005, Hulhule', Maldives

First Workshop on the Development of a National Waste Management Strategy December 2005, Hulhule' Island Hotel, Maldives

Second Workshop on the Development of a National Waste Management Strategy May 2006, STELCO Seminar Room, Male', Maldives

National Biodiversity Strategy and Action Plan (NBSAP) and National Development Plan 7 Review Retreat – Atoll Ecosystem Conservation Project and National Climate Change Project, July 2006, Paradise Island, Maldives

NAPA Workshop on Identifying and Prioritisation of Adaptation Measures, September 2006, Bandos Island Resort, Maldives

Roundtable on Coastal Erosion and Disaster Risk and Vulnerability, September 21, 2006 - Male, Maldives

Regional Resource Coordination and Mobilisation Workshop for the Long-term Management and Conservation of MCPAs in South Asia, September 2006, Colombo, Sri Lanka

Environment and Disaster Risk Assessment of Islands in the Maldives, December 2006, Hulhule' Island Hotel, Maldives

SAARC Expert Group Consultation on Coastal Zone Management, April 2007, Dharubaaruge, Male', Maldives

Workshop on the Development of a Grouper Management Plan, April 2007, Dharubaaruge, Male', Maldives

National Consultation on the Fisheries Sector Master Plan, May, Islamic Centre Conference Hall, Male', Maldives

WORK EXPERIENCE

Was involved in the Integrated Reef Resources Management Programme, MRS & BOBP. This project was carried out in Vaavu, Meemu, Faafu and Dhaalu atolls and was focused on working with the communities to develop sustainable reef resource management. Importance was given to environmental awareness and community involvement in the process of management.

Was involved in the National Turtle Conservation Program and my main task was to liaise with the researchers at the turtle hatchery at Vaadhoo resort, Male' Atoll.

Was involved in setting up a system for regulating and monitoring coral and sand mining in the Maldives. My task was to give expert advice on the coral reef environment in the development of the Regulations.

Carried out the environmental component of two bids for resort development at Hudhufushi Island, Lhaviyani Atoll. The emphasis of my work was on Ecological values and relationships as well as conservation.

Carried out the environmental component of the Proposed Information Technology Project in the Maldives for ADB. My task was to analyse and discuss the existing marine environment and the predicted impacts from the proposed development as well as mitigation measures and monitoring.

Annual monitoring for resorts: Velavaru Island and Reethi Beach Resort where my main responsibility is to carry out the monitoring of the marine environment including field work and report writing.

Carried out the Environmental Impact Statement for Thari Village Resort for the Harbour enhancement Project and my area was to assess the marine environment as well as the terrestrial environment and associated impacts.

Project Manager, GCRMN Socio-economic Monitoring Project, MRC, Maldives. My main task was to carry out the field work including interviews with the community and coordinating the project.

GCRMN Coral Reef Database Development Project, Seamarc Pvt. Ltd., Maldives. My main tasks were testing the database, preliminary data entry, developing the help file and the data entry guide.

National Coral Reef Monitoring Program (Global Coral Reef Monitoring Network) team member. My main task within this project was to collect field data which contributes to the National Coral Reef Database.

CORDIO (Coral Reef Degradation in the Indian Ocean) Project team member. My main responsibility was to collect field data on coral reef recovery and compile it. I was also in charge of data collection for the project carried out to assess the impacts of the 1998 Coral Bleaching on Tourism in the Maldives. This involved questionnaire based interviews with departing tourists at the airport.

Maldives Climate Change Vulnerability and Adaptation team member. My area was to give expert advice on coral reef related issues.

Focal point for GEF Conservation of Coral Reefs in the Maldives Project, PDF B. My task was to give expert advice on coral reefs at the community workshops held in the atolls as well as report writing. I was also involved in the field data collection carried out in Baa Atoll.

Focal Point for TNA Climate Change Project. My task was to give expert advice on the marine environment associated with climate change issues.

Worked on the preparation of a report on the Status of the Shark Fishery in Maldives. This involved field trips to the northern and southern atolls of Maldives to collect socio-economic data on the fishery.

Worked on the preparation of a report on the Aquarium Fishery of Maldives. This involved compilation and analysis of export data and interviews with exporters.

Preparation of report on Cost Estimation and Willingness to pay for waste management in Baa Atoll as National Consultant for AEC project.

Presently working on the Management of the Aquarium Fishery of the Maldives.. It involves working closely with the exporters and Maldives Customs Services to develop tools and guidelines for monitoring and management.

ADDITIONAL SKILLS

Computer literate - Fluent in Microsoft Windows
Languages spoken - Fluent in Dhivehi (mother tongue) and English
French (intermediate)

REPORTS & PUBLICATIONS

Anderson, R.C. & M.R. Saleem. (1994). Seasonal and Regional Variation in Livebait Utilization in the Maldives. In: *Rasain,* M. H. Maniku (ed.), Vol 14. Ministry of Fisheries and Agriculture. pp: 162-182.

Anderson, R.C. & M.R. Saleem. (1995). Inter-annual Variations in Livebait Utilization in the Maldives. In: *Rasain*, M. H. Manik (ed.), Vol 15. Ministry of Fisheries & Agriculture. pp: 194-216.

Ahmed, H., Mohamed, S. & M.R. Saleem. (1996). Exploitation of Reef Resources - Beche-der-mer, Reef Sharks, Giant Clams, Lobsters and Others. In: Workshop on Integrated Reef Resources Management in the Maldives, D.J. Nickerson and M.H. Maniku (eds.), Bay of Bengal Programme, Madras. pp: 137-165.

Ahmed, H. & M.R. Saleem. (1999). *Marine Flora and Fauna of the Maldives*. Biodiversity theme paper prepared for the Ministry of Home Affairs, Housing and Environment. Unpublished manuscript.

Ahmed, H., Le Berre, T. & M.R. Saleem. (2000). Environmental statement for Thari Village Beach reclamation and associated harbour development project. Unpublished report.

Ahmed, H., Le Berre, T. & M.R. Saleem. (2000). Annual environmental monitoring report – Velavaru Island Resort, Maldives. Unpublished report.

Ahmed, H., Le Berre, T. & M.R. Saleem. (2000). Annual environmental monitoring report – Reethi Beach Resort, Maldives. Unpublished report.

Cesar, H., Waheed, A., Saleem, M. & D. Wilhelmsson. (2000). Assessing the impacts of the 1998 Coral Bleaching on Tourism in the Maldives and Sri Lanka. Report prepared for CORDIO Programme.

Ahmed, H., Le Berre, T. & M.R. Saleem. (2001). Initial Environmental Examination for Proposed Information Technology Project in the Maldives. Report prepared for ADB.

Jameel, A., Hameed, F., Shakeel, H., Ahmed, H., Shareef, H.A., Shareef, M., Saleem, M., Aslam, M., Faiz, M., Zuhair, M., Hassan, M.Z. and S. Saeed. (2002). *National Biodiversity Strategy and Action Plan of the Maldives*. Ministry of Home Affairs, Housing and Environment, Male', Maldives.

Zahir, H., Clark, S., Rasheed, A. and M.R. Saleem. (2002). Spatial and temporal patterns of coral recruitment following a severe bleaching event in the Maldives. In: O. Linden, D. Souter, D. Wilhelmsson and D. Obura (eds.) *Coral Reef Degradation in the Indian Ocean: Status report 2002*. CORDIO, Sweden. 125-134 pp.

Saleem, M.R. (2004). Monitoring management effectiveness of Kuda Huraa Dive Site, North Male' Atoll, Maldives. Report submitted for the degree of Master of Applied Science in TESAG, James Cook University, Australia.

Saleem, M.R. and M.S. Adam. (2004). Review of the Aquarium Fishery of the Maldives. Unpublished report.

Saleem, M.R. and M.S. Adam. (2004). Status of the Shark Fishery of Maldives. Dhivehi report prepared for the Fisheries Advisory Board of Maldives.

Saleem, M. R. and M. Hameed. (2006). Willingness to Pay for Waste Management in Baa Atoll. Report prepared by Seamarc for the AEC Baa Atoll Project.

REFEREES

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32 y. o

Married

2 children

Main Compétences

- **Trilingual** (french (mother tongue) / english (fluent) / divehi (maldivian)), **bicultural** french-maldivian.
- Environmental consultant, coastal oceanography, Programming (Delphi)
- Worked overseas (Maldives, Australia).

Education

1995 -1998 **Engineering Diploma (ENSTA, Paris),** a 3 year-formation, admission after preparatory classes, ending Baccalaureat + 5 years. Participated in two exchange programs with KTH, Stockholm, Sweden (6 months in second year), studies in groundwater management and fluid mechanics, and JCU, Townsville, Australia (1 year in third year), studies in environmental engineering, coral reef geology and fluid mechanics.

1992 -1995 **Mathematic superior and special : Preparatory classes for selective examination to the french engineering schools (major in Physics and Chemistry)** Lycée Chateaubriant, Rennes. This is to prepare the selective examination to enter the french “Grandes Ecoles”.

1992 **Baccalauréat C (Math-Physics, distinctions)**. Lycée Lesage, Vannes.

French equivalent to A-levels

Professionnal experience

1999 - 2008 **Setup and run an Environmental Consultancy in the Maldives - Seamarc Pvt. Ltd.** (Systems Engineering and Marine Consulting)

The major contracts in which I was involved were:

- Environmental Impact assessment and design for coastal development of Vabboa Huraa (Four Seasons Resort, HPL)
- Coral Monitoring of T. Vilufushi, which was undergoing major dredging operations, dredging works and consultancy for Boskalis International.
- Environmental Impact Assessment for the development of a fisheries project in Addu Atoll, for MIFCO (Maldives Industrial Fisheries Company)

- Environmental Impact Assessments for the development of Herethere as a tourist resort, for MTDC (Maldives Tourism Development Corporation).
- Work as national consultant for the development of the Integrated Climate Change Strategy. Includes GEF (Global Environmental Facility) NAPA (National Adaptation Plan of Action) project, NCSA (National Capacity Self Assessment) project and TNA (Technology Need Assessment) project. Remains member of the National Climate Change Technical Team.
- Environmental Impact assessment and design for coastal redevelopment of Kuda Huraa (Four Seasons Resort, HPL)
- Environmental Impact Assessment and coastal designs for the redevelopment of K. Kandooma. redevelopment works not yet started (Leisure Hollidays, HPL Maldives)
- Erosion control at Baa Landaa Giraavaru (upcoming Four Seasons resort, LGPL) (on going).
- Coral translocation as a mitigation measures for development impacts at Baa Landaa Giraavaru (upcoming Four Seasons resort) (on going).
- Setting up of a fish laboratory to breed *Amphiprion nigripes* and other ornamental species at Baa Landaa Giraavaru (upcoming Four Seasons resort) (on going).
- Supervising clearing of 45 hectares plot in L. Gan for the French Red Cross utilizing man power from the IDP camps and villages in L. Gan.
- Constructed a 50 feet boat in the Maldives in order to carry out research and tourism activities. Subsequently managed this activity (on going).
- Bid documents for a number of resort islands, regularly obtained among top ranking for environmental concepts.
- Local Environmental counterpart for BCL (Bangladesh Consultant Limited) for a IDB funded project for the government of Maldives about Focus Development Islands.

- Research on *Amphiprion nigripes* (Maldives clownfish for aquarists) and export of 500 individuals maricultured by the Marine Research Center of the Government of Maldives.
- Bid document and Environmental Impact Assessment for the development of a hotel/marina in H.A. Dhonakulhi for Turquoise Pvt. Ltd.
- Environmental and research programs for restoration and rejuvenation of reefs affected by global warming and bleaching using Reef Balls, for Four Seasons Resort (on going).
- Consultancies for the dredging operations and coastal works at Medhufinolhu (One and Only at Reethi Rah).
- Database design and programming for coral reef resources management for the governments of India, Sri Lanka, and the Maldives, for IOC/UNESCO through the GCRMN (Global Coral Reef Monitoring Network)
- Analysis of salinity and temperature profile data at the mouth of the Herbert and Burdekin River in North Queensland, Australia, for James Cook University.
- Environmental auditing of tourist resorts for Velavaru (Turtle Island Resort) and Fonimagoodhoo (Reethi Beach Resort) since 2000.
- Feasibility study for power generation with wind mills in the Maldives.
- Translation into French of books pertaining to the Maldives (Marine Life of the Maldives, by Neville Coleman, Dive Maldives, by Tim Godfrey).