

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE DEVELOPMENT OF A DOMESTIC AIRPORT ON KOODDOO, GA. ATOLL

FINAL REPORT

**PREPARED FOR
BONAVISTA (MALDIVES) PRIVATE LIMITED
SINGAPORE**

**M. SHIHAM ADAM (EIA01/07)
CDE TECHNICAL TEAM**

October 2011

TABLE OF CONTENTS

1	NON TECHNICAL SUMMARY	8
2	INTRODUCTION	11
2.1	BACKGROUND.....	11
2.2	PROJECT SETTING	11
2.3	EIA REPORT.....	13
2.4	METHODOLOGY	13
3	DESCRIPTION OF THE PROJECT	16
3.1	INITIAL MOBILIZATION AND SITE CLEARANCE	16
3.2	CONSTRUCTION OF A TEMPORARY LANDING AREA	16
3.3	HEAVY EQUIPMENTS AND ITS DEPLOYMENT	18
3.4	LEVELLING AND COMPACTIN OF AIR-STRIP	18
3.5	SOURCING FILL MATERIAL FOR BASE LAYERS.....	19
3.6	CONSTRUCTION OF BUILDING AND STRUCTURES	20
3.7	POWER HOUSE	22
3.8	WATER PLANT	22
3.9	STORM WATER AND FLOOD CONTROL.....	22
3.10	CONSTRUCTION OF ROADS	22
3.11	FENCING AIRPORT BOUNDARY	23
3.12	DEVELOPMENT SCHEDULES	23
4	REGULATORY CONSIDERATIONS	24
4.1	CIVIL AVIATION ACT OF THE MALDIVES	24
4.2	CONVENTION ON CIVIL AVIATION	25
4.3	ENVIRONMENTAL LAW.....	25
4.4	EIA REGULATION OF THE MALDIVES – 2007	26
4.5	REGULATION ON CUTTING DOWN TREES.....	26
4.6	TRANSPORT MASTER PLAN	27
5	EXISTING ENVIRONMENTAL CONDITIONS.....	28
5.1	EXISTING INFRASTRUCTURE ON THE ISLAND	30
5.2	OBJECTIVES	30
5.3	METHODOLOGIES.....	30
5.4	STUDY AREA AND SURVEY LOCATIONS.....	32
5.5	METEOROLOGY AND CLIMATE.....	32
5.5.1	<i>Monsoons</i>	32
5.5.2	<i>Winds</i>	33
5.6	HYDROLOGY	35
5.6.1	<i>Waves</i>	35
5.6.2	<i>Tides</i>	36
5.6.3	<i>Surface Currents</i>	37
6	TERRESTRIAL ENVIRONMENT	38
6.1	ASSESEMETN OF SOIL	38
6.2	GROUNDWATER ASSESSMENTS	39
6.3	VEGETATION COVER	39
6.4	WATER QUALITY TEST	44
7	MARINE ENVIRONMENT	45
7.1	PHOTO QUADRAT SURVEY.....	45
7.2	FISH CENSUS.....	47
7.3	BEACH PROFILES	48
7.4	MARINE WATER QUALITY TESTS.....	48

8	SOCIO-ECONOMIC ENVIRONMENT.....	53
8.1	GEOGRAPHIC CONTEXT	53
8.2	POPULATION STRUCTURE	53
8.3	FISHERY	54
8.4	TOURISM ACTIVITIES.....	56
8.5	MAIN OBSERVATIONS.....	56
9	POTENTIAL IMPACTS AND MITIGATION MEASURES	58
9.1	IMPACTS AND MITIGATION MEASURES	58
9.1.1	<i>Impacts from Mobilization of Equipment and Labour</i>	<i>58</i>
9.1.2	<i>Water Contamination (Marine Water and/or Ground Water)</i>	<i>60</i>
9.1.3	<i>Noise, Vibrations and Air Pollution.....</i>	<i>60</i>
9.1.4	<i>Loss of Flora and Fauna.....</i>	<i>61</i>
9.1.5	<i>Greenhouse Gas Emissions.....</i>	<i>62</i>
9.1.6	<i>Impacts from Waste.....</i>	<i>62</i>
9.1.7	<i>Impacts from Dredging</i>	<i>63</i>
9.1.8	<i>Impacts from Temporary Landing Site.....</i>	<i>64</i>
9.2	POTENTIAL POSTIVE IMPACTS.....	64
9.3	SITE CLEARANCE.....	64
9.4	IMPACTS FROM WATER AND POWER PLANT	66
9.5	OPERATIONAL PHASE IMPACTS	67
10	ALTERNATIVES.....	68
10.1	NO DEVELOPMENT OPTION	68
10.2	DEVELOPMENT OPTION	68
10.2.1	<i>Use of the Existing Fishery Harbour.....</i>	<i>68</i>
10.2.2	<i>Temporary Landing Site for Mobilization of Heavy Equipment.....</i>	<i>68</i>
10.2.3	<i>Location of Source Material for Base Layers.....</i>	<i>69</i>
11	MONITORING.....	70
11.1	MONITORING COSTS.....	71
12	STAKEHOLDER CONSULTATION	72
12.1	SUGGESTED RECOMMENDATIONS	74
13	CONCLUSIONS	76
14	REFERENCES.....	77
15	ANNEXES	78

LIST OF FIGURES

Figure 1: Map to show the existing and planned airports in the Maldives. Closed red circles are ones in operation and the crossed square are the planned. Kooddoo Domestic Airport is shown in open circle. Fuvahmulah, Dharavandhoo, Thimarafushi airport works are ongoing.	12
Figure 2: A general flow-chart of the EIA process that is followed in the Maldives.	14
Figure 3: Some of the heavy machinery that will have to be used for the construction work and that would require to be deployed to Kooddoo Island. Asphalt paving machine (left), Jaw-crusher (right)	16
Figure 4: Area to showing the proposed landing area on the north of the island that will be used during the construction of the airport.	17
Figure 5: Section of the air-strip (runway) to show the three layer that will be required for the construction of the air-field.....	18
Figure 6: Rock aggregate base layers (bottom) with porous asphalt layer on top required for the air-field. Image extracted from Naeem et. al, 2008.....	19
Figure 7: Suggested borrow area for material for the base-layers of the air-field. Also see Annex 4. .	20
Figure 8: Layout of the reception terminal and the administrative and staff accommodation and power house building (inset to show the complete area including the arrival area)	21
Figure 9: Indicative schedule of the work and its current progress.	23
Figure 10: Location of map of Kooddoo Island on the eastern border of the Ga. Alifu Atoll.....	28
Figure 11: Close up image to show Kooddoo Infrastructure.	29
Figure 12: Kooddoo in 1964 [left panel] and Kooddoo in 2008 [right panel].	29
Figure 13: Study area and Survey locations (An enlarged figure is given in Appendix Annex 5). For the Marine Transects, start and finish points for each photo transect are given. T1_A and T1_B are Transect #1, deep and shallow respectively.	32
Figure 14: Monthly frequencies of wind direction in southern Maldives based on Gan Meteorological Centre 10 year data (Extracted from Naseer, 2003).....	34
Figure 15: Twenty four year (medium term, 1985- 2009) wind frequency recorded at Gan Meteorological Center	35
Figure 16: Mean daily wind speed and direction recorded at Gan Meteorological Center. Arrows indicate dominant wind direction (After Naseer, 2003).....	35
Figure 17: Soil profiles of Kooddoo Island (9th September 2011, for locations see Annex 5).....	38
Figure 18: Soil profile location, For GPS Coordinate the location see Figure 18).	39
Figure 19: Images of vegetation profiles seen from the main road running along the long-axis of the island.	40
Figure 20: Spatial (linear) distribution of the vegetation seen on three transects that was done for ground truthing.....	41
Figure 21: Classification of the vegetation on Kooddoo Island using the satellite imagery.....	43
Figure 22: Summary Substrate cover for the Site #1. For complete analysis of the cover, see Annex 8.	45
Figure 23: Summary substrate cover for Site #2. For complete analysis of the cover see Annex 8.	45
Figure 24: Summary Substrate Cover for Site #3. For complete analysis of cover please see Annex 8.	46
Figure 25: Summary Substrate Cover for Site #4. For complete analysis please see Annex 8.	46
Figure 26: Summary Substrate Cover for Site #5. For complete analyses please see Annex 8.....	47
Figure 27: No of fish families and corresponding fish species recorded at each site.	47
Figure 28: Summary of fish census, 5 sites combined showing the frequency of families recorded. ..	48
Figure 29: Profile #1. For location of the profile on the island see Figure 13 and Annex 5.....	49
Figure 30: Images of the Profile #1. For locations see Figure 13 and Annex 5.....	49
Figure 31: Profile #2. For location of the profile on the island see Figure 13 and Annex 5.....	50
Figure 32: Images of the Profile #2. For locations see Figure 13 and Annex 5.....	50
Figure 33: Profile #3. For location of the profile on the island see Figure 13 and Annex 5.....	51
Figure 34: Images of the Profile #3. For locations see Figure 13 and Annex 5.....	51
Figure 35: Profile #4. For location of the profile on the island see Figure 13 and Annex 5.....	52
Figure 36: Images of the Profile #4. For locations see Figure 13 and Annex 5.....	52

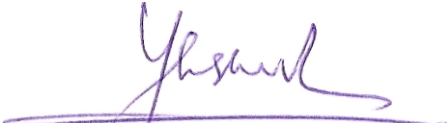
Figure 37: Tuna catch by species for GA, GD and GA+GD. Around the peak catches more about 50% of the recorded landings were from Huvadho Atoll. Source: MoFA Fisheries Statistics. SKJ = Skipjack, YFT = Yellowfin tuna, KAW = Kawakawa, and FGT = Frigate Tuna.	54
Figure 38: Number of Registered Fishing Vessel at MoFA by TWO-YEAR bins, Note 2011 data is exclude (source: MoFA)	55
Figure 39: AVERAGE Size of fishing vessel in Huvadho Atoll, Source: MoFA	55
Figure 40: Map showing the islands where community consultation were undertaken.	72
Figure 41: Community Consultation at the islands; Top row; Villingili (right), Dhaandho (left), Bottom row; Nilandho (right) and Maamendho (left).....	74

LIST OF TABLES

Table 1: General Meteorological Information about the Maldives.....	33
Table 2: Summary of general wind conditions from Gan Meteorological Center.....	34
Table 3: Tidal variations at Malé International Airport.	36
Table 4: Current speed and Direction Measures on Kooddoo Island, See Figure 13 for details.	37
Table 5: Ground water quality test results.	39
Table 6: Summary of the counts in 4x (100x100m) lots.....	42
Table 7: Estimated number of trees from the satellite imagery.	42
Table 8: Ground water quality tests results – summary. *G1 and G2 indicated in Annex 5.	44
Table 9: Population by sex and number of households including annual population growth in in 2006. Data from Census 2000 and 2006 (extracted from Website of Department of National Planning, accessed October 2011).	53
Table 10: No of schools and student population in GA and GD Atolls. Source (Department of National Planning Statistics, Accessed October 2011).	54
Table 11: Resort development activities in the Huvadho Atoll. A total 16 islands have been earmarked for development around 2008/2009, but only 3 resorts are in operation. Data from MoTAC and Official Atalas of the Maldives.....	56
Table 12: Impacts of mobilization of labourers, machineries and equipment.	59
Table 13: Impacts of site clearance.....	65

Declaration of the Consultant:

I certify that the statements made in this Environmental Impact Assessment are true, complete and correct to the best of my knowledge and available information at the time of writing this report.



M. Shiham Adam (EIA01/07)
25 October 2011

Acronyms used in the text

BOD	Biological Oxygen Demand
BOH	Back of the House (all the utility function and its services on the resort)
CDE	Commerce Development and Environment Pvt Ltd.
COD	Chemical Oxygen Demand
DNP	Department of National Planning
EPA	Environmental Protection Agency
KFMP	Kooddoo Fisheries Maldives Private Ltd
EPAA	Environmental Protection and Preservation Act
MBR	Membrane Bioreactor
MHTE	Ministry of Housing, Transport and Environment
MoFA	Ministry of Fisheries and Agriculture
MoFT	Ministry of Finance and Treasury
MoHE	Ministry of Housing and Environment
MoTAC	Ministry of Tourism, Arts and Culture
MPL	Maldives Ports Limited (a state-owned enterprise)
MRC	Marine Research Centre
MSL	Mean Sea Level
NPC	National Planning Council

1 NON TECHNICAL SUMMARY

1. Kooddoo Island is located on the eastern boarder of Huvadho Atoll, Ga. Atoll, just south of Villingili. The island has a fresh tuna collection, freezing and storage facility owned by the state-owned enterprise – Maldives Industrial Fisheries Company Ltd (MIFCO). MIFCO was re-structured early 2011 and the Kooddoo operation was made a separate business entity under the name of Kooddoo Fisheries Maldives Private Ltd.
2. Plans for development of a domestic airport in Gaafu Alifu (GA) Atoll have been a government priority for some time. The initial plan was to have the airport on GA Villingili. A large area of the Villingili on the north eastern side was reclaimed in 2005 to provide land for housing and infrastructure developments. However, the size and shape of the reclaimed area was found to be not sufficient or appropriate for the 1200 x 30 m long aerodrome required for the domestic flights. Additional land has to be reclaimed if the airport is to be constructed on Villingili as planned, costing additional financial resources to be allocated.
3. Two uninhabited islands in region are being developed as tourist resorts and one of them - Falhumaafushi Resort - is now close to completion. Falhumaafushi Resort is expected to be officially open in early 2012. The construction of the second island Dhigurah is expected to the start very soon. These islands were tendered and developed in the hope the domestic airport on Villingili will be operational by the time of their opening. The need for a domestic airport for guest transfer is now essential to make the resorts economically viable as originally expected.
4. In order to fast tract the development of the domestic airport, the National Planning Council (NPC) in consultation with the major stakeholders in the region (i.e., Atoll and Island Councils, Members of Parliament and the Regional Administrative Offices) decided that a best possible and practical option is to have the airport on Kooddoo.
5. The developer of the airport is Bonvavista (Maldives) Private Limited, a property developer and resort owner based in Singapore. The agreement has been that the developer gets the GA. Dhigurah Island (not far from Kooddoo) for long term lease including some concession in rent for some initial period in return for the investment costs of domestic airport on Kooddoo Island. The contractor for the project is Keong Hong Construction Private Limited of Singapore.
6. At the scoping meeting the developer requested that EIA be submitted in two parts; the first one focusing only on the initial deployment of machinery, labourers and the clearance of the area required for the development. It was agreed that the second and complete EIA be submitted within the validity of the ToR (see Annex 1) and before the construction work begins. This first report therefore focused only on the initial mobilization and clearance of vegetation. The report is approved and the Decision Note issued (see Annex 2).
7. The surveys required for the EIA has been undertaken on 4-10 September 2011. Two separate trees surveys were done; one by total enumeration on randomly selected 4 x 100 x 100 m plots and the other by image analysis using a high resolution satellite imagery combined with ground truthed data undertaken as a separated survey at the same period.
8. The satellite image was classified to nine categories; “agricultural crops”, “bush vegetation”, “coastal bush vegetation”, “coconut grove”, “developed area”, “mixed

woody vegetation”, “modified woody vegetation” and “open area and strand vegetation”. Highest cover was found to be in Mixed Vegetation type which through ground truth surveys were found to be *Midhili*, *Uni* and *Kandhu*¹ and some few palm trees. For each category a range of number of trees were provide. Image analysis estimated that number of coconut trees would be in the range of 3,600 – 5,800.

9. The enumerated survey assumed that density and distribution of trees are same across the entire island. Furthermore it also assumes the random quadrats (4 in nos.) are also representative of the floral composition of the island and their location does not create additional biases. While sound in theory in practice it may not be. The result of this simple averaging method was found to be quite different from results of the image analysis. While also acknowledging biases in the image analysis the true numbers of major trees type would probably in the range the values estimated.
10. All mature trees and coconut palms will be uprooted under the guidance and supervision to ensure that trees are in good condition for transport and replanting. The developer has identified five main potential islands; Villingili, Falhumaafushi, Vilivaru, and the newly reclaimed island of Gulhifalhu, where trees will be transported. Separate arrangement will be made by the contractor to ensure the safe transport and re-planting of tree in those islands. Experience elsewhere shows that replanted trees survive well provided that watering and enough care is given in the initial stages, particularly in uprooting and transporting. A target survival rate has been estimated at 70% and means to ensure this would be monitoring and reporting.
11. Surveys and assessment show the deployment of heavy equipment and machinery will be problematic. It was found to be almost impossible to use lifting equipment to unload the heavy machinery from barges over the quay wall. Following procedures practiced in similar projects in the Maldives, it was suggested to create a temporary landing site north of the island. An entrance to the reef already exists there but the area requires scrapping ~0.3 - 0.4 m off the substrate close to the beach area to allow flat-topped barges to move close to the beach.
12. Land and soil survey of Kooddoo showed presence of loose humus soil up to the water table at 1.4 - 1.5 m. This result was the same in locations surveyed. Laying out the air-field require two compacted aggregate base layers before the porous asphalt layer can be laid on top. These are 0.35 m thick compacted base-layer and 0.15m thick crushed aggregate course on top of the base-layer. These two layers require about 20,000m³ aggregate materials which will be sourced from local house reef. Exploring of alternatives suggests the most practical and cost-effective way to obtain the material is by dredging the house-reef. An area of about 300m x 70m x 1m on the eastern side of the reef flat will be dredged to source the required material. In all earlier airport construction projects the base layer material has been sourced from the local reef.
13. Overall the significant negative environmental impacts of the development project were found to be three; i) sourcing fill material from local reef, ii) clearance over 40% of Kooddoo area off vegetation and iii) creation of a temporary landing site for unloading/loading of construction equipment. Dredging reef flat may have immediate to medium term impacts that could potentially cause unintended erosion / accretion of the island. But shore-stabilization structures are not proposed at this stage. It was noted that significant areas of north eastern reef of Villingili was also dredged which may have potential long term impacts to the region including Kooddoo reef flat. Post-

¹ Scientific names are given in Table 6

development monitoring will help to better understand the impacts to Kooddoo and provide reasonable time frame to address any remedial or mitigation measure that will have to be implemented in a timely manner.

14. Vegetation clearance will have direct loss of habitats and potential agricultural land. Both are important in the context of the green and carbon neutral concept. However, in the long term, the construction and operation of the airport outweighs any potential of loss of ecological habitat and agricultural land. In summary significant negative impacts include loss of top soil, potential degradation of ground water quality, loss of significant area of vegetation and potential death of the significant number of trees and likely shift of ecological regime of the island in the medium to long term. Positive impacts include opportunities for economic growth and development of the region, the local aviation industry and further increase of tourism potential in GA and neighbouring area.
15. Alternatives have been proposed for project activities only. The decision to have the airport on Kooddoo is an executive high level government decision which may supersede findings of the assessment on suitability of the site. Areas of potential impacts have been clearly identified and ways of mitigation have been suggested. The developer and contractor are fully aware of these issues and are committed to be responsible for implementing these measures during the construction of the airport and its facilities.
16. The operational arrangement of airport is not yet clear. It is envisaged that some of the services of Kooddoo Fisheries Maldives Pvt Ltd will be used for the management and day-to-day running of the airport. In this case separate arrangements will have to be made by the airport operator and the Kooddoo Fisheries Maldives.
17. Additional land surveys for levelling the air field and specification of the construction are being sought by professionals in the field.

+++

2 INTRODUCTION

2.1 BACKGROUND

The Republic of Maldives is an archipelagic nation in the tropical central Indian Ocean. The country comprises of about 1190 island dispersed over wide geographic area. While the east-west spread of the atoll chain is only 100 km, the north-west extension spans from 7°N to 1°S close to 800km in length. Some of the atolls are separated by large channels spanning 100 km in between. Efficient and effective transport is crucial for economic development of the country.

The two major drivers of Maldivian economy are tourism and fishing. Development and expansion of the tourism industry has always been a priority of the Government since its inception in the early 1970s. Over 100 resorts are now in operation and some 60 islands have been allocated for resort development and many are in various states of development. Most of the resorts developed since 2003 are in atolls in extremes of south and north. Access to these islands depends on an effective transport system. Although Canadian Twin-Otter air-taxi services have championed tourist transfers to resorts, their services are effectively limited within the 50-60km distance from the centre of its operation – Malé. Access to the islands in the far south and north has not been practical on a routine basis.

Development of the inhabited island in the outer atolls is also linked to its access and ease of transport. Some of the major inhabited islands are still too far away from the existing domestic airports which hinder development of commerce and trade. The islands in the western boarder of the Huvadho Atoll (GA. Atoll) are particularly at a disadvantage. The high speed sea transfer (over 32 km/hr) takes about an hour and the trip becomes prohibitively difficult in rough seas experienced during the southwest monsoon. In such cases the guest transfers are almost impossible and alternative arrangements have to be made until the weather is cleared.

Aside from the main international airport (Ibrahim International Airport) there five domestic airports currently in operation; Hanimaadhoo in HDh Atoll in the north, Maamigili in the ADh in the west central, Kahdhoo in Laamu Atoll, Kaadehdhoo in GDh Atoll and Gan Island in the south. Of these Maamigili is a private airport operated by Villa Group (Figure 1).

The Government has plans for six more domestic airports including the Kooddoo. They are Dharavandhoo in Baa Atoll, Maafaru in Noonu Atoll, Kudahuvadho in Dhaalu Atoll, Thimarafushi in Thaa Atoll and Fuvahumulah in Gn Atoll. Fuvahmulaku airport is expected to be open by the end of October 2011 and works of Thimarafushi and Dharavandhoo airport are in progress. The locations of airports are given in Figure 1.

2.2 PROJECT SETTING

Kooddoo is a large-sized island with an area of 73.4 Hectares² (0.734 km²) on the eastern boarder of GA. Atoll in the south Maldives. Located in between the famous tuna fishing islands, Villingili in the north and Maamendhoo in the south, Kooddoo is a tuna fish collection, freezing and storage facility. Until early this year, the island has been part of one

² The official atlas of the Maldives, Ministry of Planning and National Development, 2008

of the oldest state-owned enterprise – Maldives Industrial Fisheries Company Ltd. (MIFCO). Under the restructuring plan of the MIFCO, Kooddoo was made an independent company names as Kooddoo Fisheries Maldives Ltd, in early 2011.

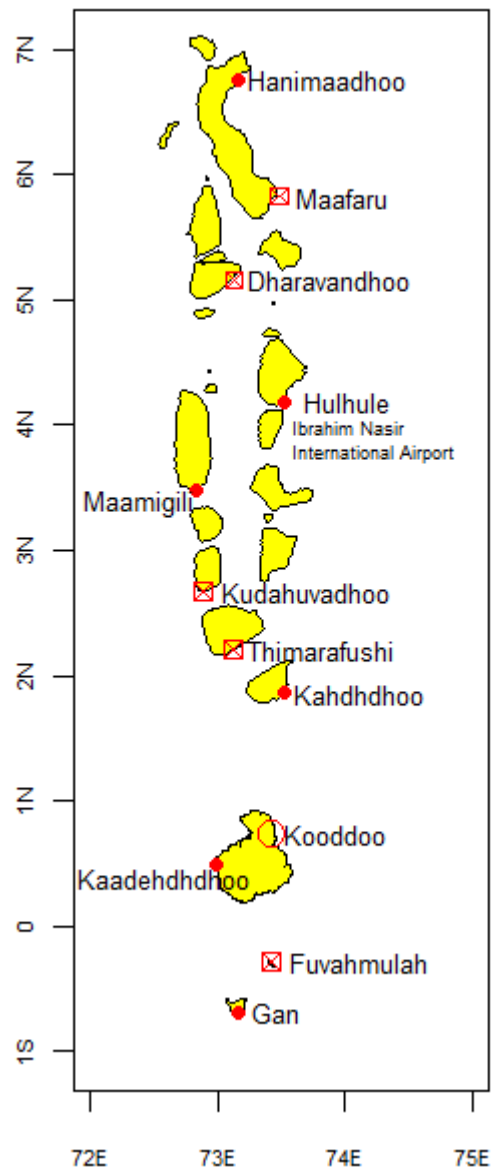


Figure 1: Map to show the existing and planned airports in the Maldives. Closed red circles are ones in operation and the crossed square are the planned. Kooddoo Domestic Airport is shown in open circle. Fuvahmulah, Dharavandhoo, Thimarafushi airport works are ongoing.

Kooddoo Fisheries Maldives Ltd occupies a small section of the island, on the north western side of the island. The facility essentially consists of the harbour, quay wall, freezing/cold storage facilities, and accommodation and utility buildings. Roughly 10-15% of the total area of the Kooddoo Island is taken up by Kooddoo Fisheries Maldives Ltd. There are no developments on the remainder of the island – the area is left almost unattended. The area has dense vegetation typical of uninhabited island with a significant number of coconut palm trees.

The Strategic Action Programme formulated under the MDP³ pledges to “make airports and regional ports more sustainable by seeking public private partnerships in the development and operation”. As such locations of new domestic airports and avenues and means financing have been a key activity of the Government. Kooddoo was chosen to construct the second domestic airport in Huvadho Atoll by the National Planning Council⁴.

The developer of the airport is Bonavista Maldives Private Limited, a property developer and resort owner based in Singapore. The agreement has been that the developer gets the GA. Dhigurah Island (not far from Kooddoo) for resort development for long term lease including some concession in rent for some initial period in return for the investment costs of domestic airport on Kooddoo Island. The contractor for the project is Keong Hong Construction Private Limited of Singapore. The specification of project including scaled drawings, locations are given in Annex 3 and Annex 4.

2.3 EIA REPORT

Like most the projects taking in place in the Maldives, the contractor has strict time frame for completion of the project. This is, in part, dictated by the government requirement deadlines, but also of cost cutting measure due to the nature of the way the project is financed. The agreement between the developer and the government is that the airport should be developed not more than 24 months.

In order to start the work of the development as soon as possible it was agreed that EIA may be done in two parts. The first part of the EIA focuses on the works relating to initial mobilization and vegetation clearance. The second part of the EIA is to include all of the elements of the development project.

The first part of this EIA has been submitted, reviewed and the Decision Note has been issued (see Annex 2).

In general the objective of an EIA report is to address the environmental concerns of the development project. The EIA will help to achieve efficient planning, aid in identifying impacts and their potential mitigation measures. The EIA report will also help to promote informed environmental and sound decision making during the development of the project.

2.4 METHODOLOGY

The EIA methodology followed in the Maldives has evolved to an internationally recognized standard. Started in Maldives around 1995/1996 the EIA Regulations underwent a major revision in 2007. The EIA Regulation⁵ stipulates the complete process including EIA screening, scoping, review and issuing of decision notes, including the registration of the EIA consultants.

³ Aneh Dhivehi Raajje” The Strategic Action Plan, National Framework for Development 2009 – 2013 The Government of Maldives

⁴ The National Planning Council (NPC) is under Department of National Planning which is under the portfolio of the Ministry of Finance and Treasury. NPC is chaired by the President.

⁵ Environment Impact Regulations, 2007. Ministry of Environment, Energy and Water, Malé, Maldives, 74 pages.

The EIA process in the Maldives is in many respects similar to international best practice. The process is shown in Figure 2. What has been lacking in the Maldives is strategic environment assessment which gives directions for environmental management including spatial planning and development strategy.

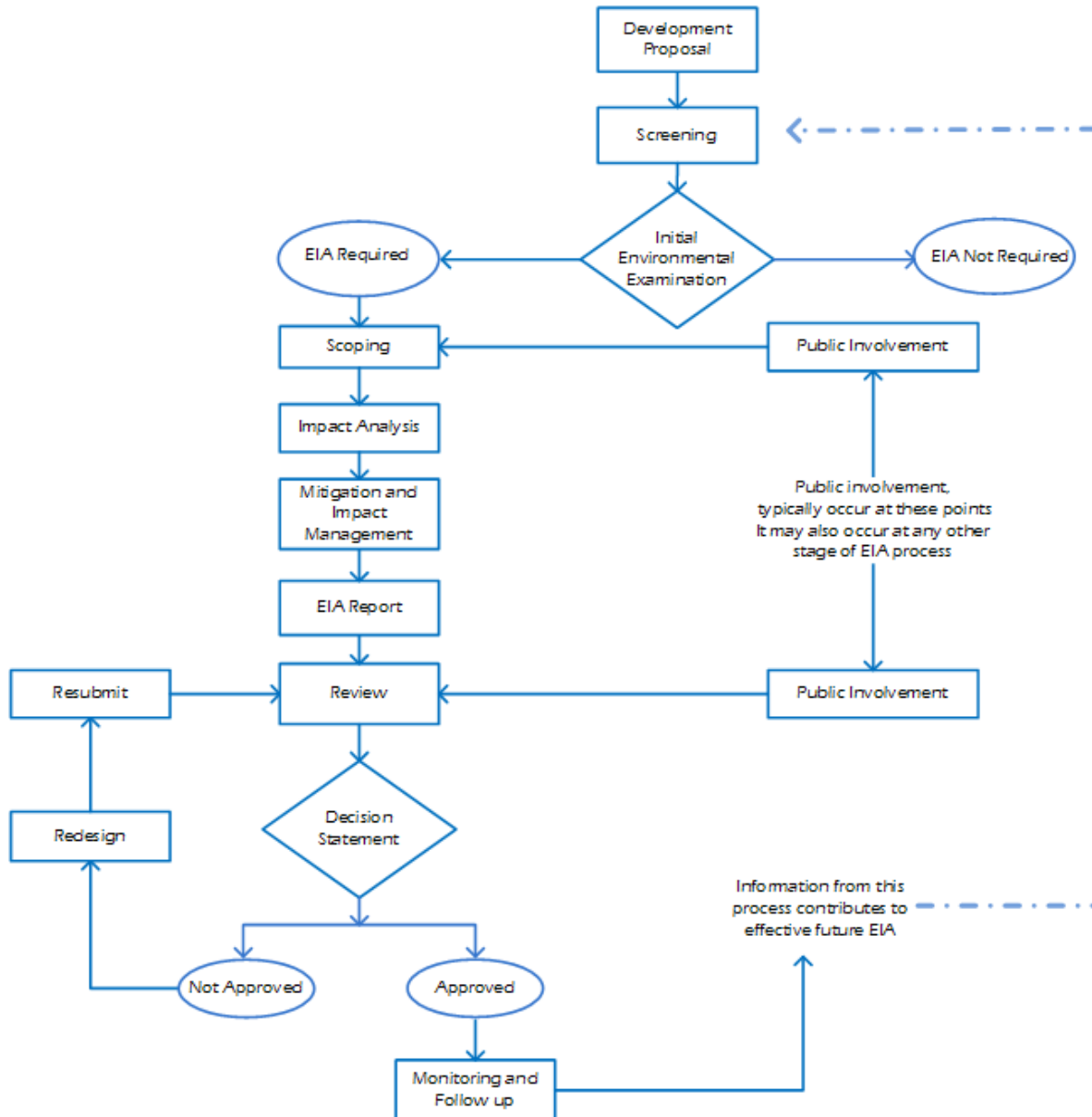


Figure 2: A general flow-chart of the EIA process that is followed in the Maldives.

The EIA process starts with the screening where following an initial environmental examination⁶, a decision is made whether the project requires an EIA or not. If an EIA is required a full scoping of the project takes with stakeholder consultations.

Following the issuance of a Terms of Reference (ToR) of a project, the EIA consultants will undertake the field work to examine the baseline conditions or existing environmental

⁶ Initial Environmental Examination technically involves the Screening Form, Schedule #1, Development Proposal Screening Form, page 30, EIA Regulations, 2007.

conditions to determine the impact analysis. The report is peer-reviewed anonymously by the two reviewers and comments and issues will be addressed before the decision statement is issued.

Post-development monitoring of EIA is most neglected in the Maldives, partly because due to lack of enforcement measures from the authorities. The ToR for the complete EIA is given in Annex 1.

3 DESCRIPTION OF THE PROJECT

The development project involves the construction of an aerodrome and associated infrastructure of an airport for domestic use. The main development activities of the project are:

1. Initial mobilization and vegetation clearance of the development footprint.
2. Construction of the aerodrome; 1200m x 30m, including the apron and passenger terminal (reception of arrival and departure waiting area; departure gates), control tower, means of weighing the baggage, means of baggage flow of arrivals and departures, passenger security equipment.
3. Establishment of basic services (power supply with backup, adequate water supply with means of disposal of sewage, drainage system with particular attention to apron area, fencing as required and administrative office)
4. Construction of passenger facilities (food and beverage and wash rooms)
5. Aircraft refuelling system if required
6. Provision of ground support equipment (two truck, carts and dollies)

An area in the existing Kooddoo harbour and jetty will be allocated for use by the passengers. The exact specific of this arrangement is yet to be determined by the Government and Kooddoo Fisheries Maldives Pvt Ltd and the airport operator. The initial and agreed understanding is that complete access of the Kooddoo jetty / quay wall area will be made available during the initial deployment and during the construction phase of the Project.

3.1 INITIAL MOBILIZATION AND SITE CLEARANCE

Report #1 of this EIA specifically dealt on this subject. The report has been and approved and the Decision Statement has been issued (Annex 2).

3.2 CONSTRUCTION OF A TEMPORARY LANDING AREA

The construction of airport requires use of heavy machinery and special equipment. Some of these include jaw cutters, asphalt laying machinery, excavators, lorries, trucks, loaders and the like (Figure 3). Inspection of the existing harbour and quay wall area shows it would require quay cranes or very heavy cranes for unloading the equipment from barges that may be used for transporting them to Kooddoo.



Figure 3: Some of the heavy machinery that will have to be used for the construction work and that would require to be deployed to Kooddoo Island. Asphalt paving machine (left), Jaw-crusher (right)

A practical solution would be to create a small landing area where a flat top barges or roll-on-roll-offs with the machinery can reach close to the beach (Figure 4). An approach that is commonly used is to create a sand bed from the beach to the deck of the barge. The heavy machinery can then simply drive over the bed on to the island.

Site clearance (vegetation clearance) and de-mobilization of the equipment would also require the same set up for loading the equipment and heavy machinery. During the site clearance phase large number of trees would also have to be loaded on to barges for transporting to the replanting sites. Again, inspection of winches at the Kooddoo harbour suggests that they could not be used for the purpose. The fishery harbour will be constantly in use for unloading fish from the fishing vessels and would not be a practical solution.



Figure 4: Area to showing the proposed landing area on the north of the island that will be used during the construction of the airport.

It is therefore proposed to construct a temporary landing area on the northern side of the island. Fortunately a channel already exists in the area that is wide enough for the barges to move. There is also a sandy beach area which will be ideal for the suggested landing site. However, the area is only 0.2 – 0.3m deep and would require deepening for effective

operation (Figure 4). It is difficult at this stage to know exactly the volume of material that would have to dredged. But the developer is suggesting that

While acknowledging that this may have to be a separate activity, it is worth noting that sand that may require to be dredged could in principle be used to replenish the area when the project is complete and following decommissioning of construction equipment. It is therefore proposed that any material that may be removed from the area will be used for this purpose. This issue is addressed in the section on Alternatives, including its impacts and the mitigation measures.

3.3 HEAVY EQUIPMENTS AND ITS DEPLOYMENT

As have been mentioned in sub-heading 3.2 heavy machinery is required for airport construction. These would be jaw crushers, heavy lorries, excavators, loaders, concrete mixers, asphalt laying machines, chain-saws etc. Use of temporary landing site as described in Section 3.2 will be required to unload the machine onto Kooddoo Island. Additional clearing and widening of existing roads may be required for transporting them to the project site. Some of these issues were addressed in Report #1 of this EIA.

3.4 LEVELLING AND COMPACTIN OF AIR-STRIP

The most important project activity is the construction of the air-strip. First the area needs to be clear off vegetation. The Report #1 of the EIA specifically dealt with pre-deployment activities and vegetation clearance. Second, the area has to be levelled. Surveys have shown that island has thick black soil all the way up to the water table which is about 1.4 – 1.5 m deep

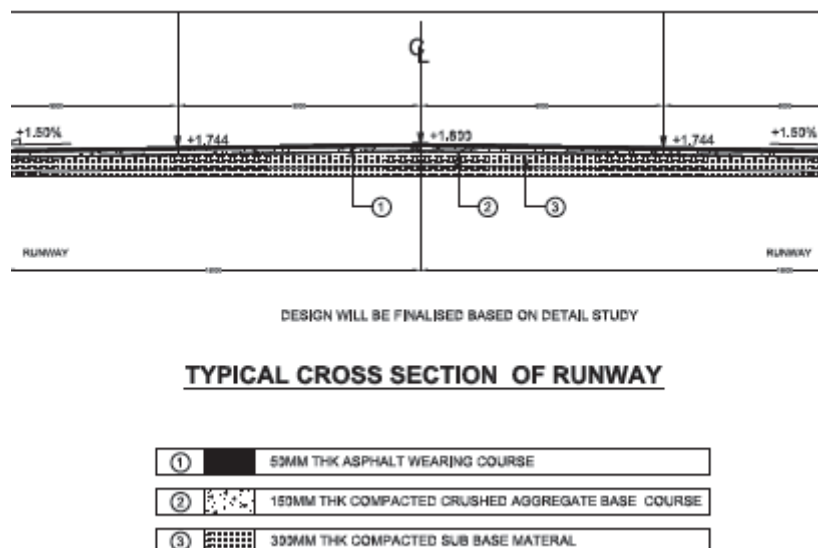


Figure 5: Section of the air-strip (runway) to show the three layer that will be required for the construction of the air-field.



Figure 6: Rock aggregate base layers (bottom) with porous asphalt layer on top required for the air-field. Image extracted from Naeem et. al, 2008.

Construction of the air-field requires a compacted base layers before the asphalt can be laid out. Two base-layers are required; 30cm sub-base compacted layer and a 15cm compacted crushed layer. In total about 20,000 m³ of fill material is required for the construction of the air-strip.

Various options will be discussed to obtain the fill material for the base layer. The proposal however, has been to dredge an area on the shallow reef flat in the eastern area. To this end an excavator will be used that would excavate material up to a maximum of the 1m. A jaw-crusher will be used to produce the gravel of the required size for the base-layer of for the air strip.

3.5 SOURCING FILL MATERIAL FOR BASE LAYERS

Construction of the air-strip requires material for the base-layer and sub-base layer before the strip can be paved with asphalt. In the Maldives, material used for base layer and sub-base layer is rock/rubble sourced always locally from house reef/reef flat the airport island itself. For instance, in the case of Fuvahmulah it was possible, thanks to the uneven land surface of the island and the material present at the sub-surface just below the top soil. There the material was rock/rubble ideal for use as base layers without even having use a jaw-crusher machine. The cut and fill that was required made it possible without having to borrow additional material elsewhere (Mahureen, pers. Comm., October 2011). In the case of the Thimarafushi a large area was reclaimed specifically for the airport. The rock boulders and rubble taken from there was used for the base layers. Similar approach was adopted in the case of Dharavandhoo where a large area was reclaimed and large boulders and rock retrieved are being used for compacting the air-field.

Similar approach was also used for the airports were constructed earlier, e.g., Hanimaadhoo, Kahdhoo, and Kaadehdhoo . In all the cases, the source material for the base layer was sourced from local reefs.

For the case of Kooddoo, survey of the soil condition showed they are of loose humus soil without any rock / rubble all the way up to fresh water lens at 1.4 – 1.5m deep (see Section 6.1). In this case it is proposed to obtain the material from local house reef on the western side of the island (Annex 4). A complete description of the environmental impacts, its

migration measures and alternative have are discussed below in Section 9.1. As have been mentioned earlier, a total of about 20,000 m³ of material is required. Material will be excavated from western side of the reef flat using an excavator. An area about 300 x 70 m will be dredged up to about a meter to obtain the required material (Figure 7). It is likely there the actual material that will be required may be slightly less as some excavated material will also be there from landing site.



Figure 7: Suggested borrow area for material for the base-layers of the air-field. Also see Annex 4.

3.6 CONSTRUCTION OF BUILDING AND STRUCTURES

The airport building and structures will be placed within the airport area but inside the fenced area of the airport (Figure 8). They are located close to the existing roads that are already being used by the Kooodoo Fisheries Maldives Pvt. Ltd.

The buildings (canteen, power house, admin building and staff accommodation) are all placed inside the fenced area and so access to these buildings will be through the check post. The following buildings, structures and facilities will be constructed for the airport use.

1. Terminal building
2. Control tower
3. Power house
4. Well for source of water for fire fighting
5. Access roads (only minor)
6. Canteen
7. Soak-pits for sewerage system
8. Fuel tank
9. Desalination plant

Approximately 2.5 hectares of the land area adjoining the airport runway will be used for buildings. The construction layout ensures the minimum construction of road surface is required. All buildings will be single storey low elevation buildings.



Figure 8: Layout of the reception terminal and the administrative and staff accommodation and power house building (inset to show the complete area including the arrival area)

Power and data cables will be laid underground in trenches, including storm drains and sewerage pipes. If the excavated material for the construction of trenches prove positive to presence of acid sulphate soil, then imported acid free fill material will be used for back fill for the service trenches to prevent corrosion of electrical and data cables. Marker tapes (traceable tapes for cables) will be placed along the cables above the half depth of the backfill to prevent accidents during repair and maintenance of services.

A sewage system will be soak pits type as commonly used in the islands. The soak pits will be connected to the existing sewage system on Kooddoo Fisheries Maldives Pvt. Ltd. Given that only 40-50 people will be working at the airport, the quantity of sewage and grey water that will be produced is not significant. Assuming the 200 litre/person/day it is expected that only 9 m³ of sewage water will be generated per day.

Fuel tanks will be constructed for storage of fuel require for the refuelling of air-craft and the airport vehicles. The fuel tank capacity will be 4,000 litres and would be constructed and sighted in consultation with technical experts. Two such tanks will be constructed. They will be bunded to accommodate for accidental spills.

The material and methodologies used for construction of the buildings, structures and facilities will be standard material used for construction in the Maldives. Imported aggregate, cement river sand and timber will be used for all civil works and buildings. Standard methods practiced for construction will adopted.

3.7 POWER HOUSE

According to the arrangements between the government and the developer, it was agreed that source of power for the airport would be from Kooddoo Fisheries Maldives Pvt. Ltd. Initial discussion indicated there is enough capacity in the existing power generation system on Kooddoo. However, the developer is proposing a small back-up power house for the airport. At this stage it is not clear of the exact specification of the plant.

Power house would be constructed using the standard procedures to meet the regulation required by the Energy Authority of the Maldives. Also given that the power house would have to be registered it constructed to meet the environmental standards and compliance required by the Authority. These include, among other things lightening rods, fire fighting equipment, sound attenuators, and appropriate height of chimney.

3.8 WATER PLANT

Similar to the energy requirements the plan is to supply water form Kooddoo Fisheries Complex. Again initial assessments have indicated that water plant on Kooddoo have the capacity to produce water requirements of the airport. However, a small plant will be constructed as an emergency back-up system. The specification and production capacity is not clear at this stage. But will be small plant that would cater for about 100 -200 people per day, including catering facilities at the airport.

Source water will be drawn from seas on the western side. Similarly brine out flow will also be located on the western side. Appropriate measures, i.e., chlorination including regular water testing will be done to ensure the production is safe for drkinging. A storage tank of about 4,000 litres will be constructed from form steel re-enforced concrete. The construction and installation of the plant will be to the standards and guidelines stipulated by the EPA – the authority currently responsible for registration of the water production plants.

3.9 STORM WATER AND FLOOD CONTROL

Storm water from the runway will be managed through a drainage system consisting of concrete payments and gutter on both sides of the runway. The concrete gutter system will be connected to the drainage pits underground on both sides of the runway. The drainage pits will be laid approximately within every 25-30m and connected to each other by underground culverts and overflow pipelines leading to the sea on the eastern side in case of heavy downpour and flooding in the drainage pits. It is planned to use porous asphalt for runway overlay for better drainage within the runway. The types of equipment that will be used for construction for the drainage system include excavator, concrete machines and truck.

3.10 CONSTRUCTION OF ROADS

Access roads to the airport from the Kooddoo harbour including on the green area on the western side of the airport will be constructed. Roads will be constructed using conventional methods and material. Porous asphalt will be used (where necessary) for road surface for better drainage. Concrete payment and road drainage will also be constructed on both sides of the road for storm water management as required. The layout of the airport has been such that only minimal road construction work is required (cf. Figure 8).

3.11 FENCING AIRPORT BOUNDARY

Safe zone around the aerodrome is required under the Maldives Civil Aviation Act. The airport will be demarcated and fenced for safety of the aerodrome operation and to prevent public access. Entry to the airport areas and designated areas is required to be controlled under aerodrome rules in the local and international civil aviation rules. The area between the Kooddoo Fisheries Maldives operation will be demarcated and fenced included the full boundary area in the eastern side. At the time of this writing administrative arrangements are being made by the relevant government agencies and the Kooddoo Fisheries Maldives on the exact coordinates of this boundary. Once the boundary is established, security gates will have to be erected.. The fence will be constructed using GI iron pipes and wire mesh as have been done in other airports in the Maldives.

3.12 DEVELOPMENT SCHEDULES

Under the agreement between the Government and the developer, the airport is to be completed within 24 months. Additional three months were given to complete the EIA and administrative clearances. An indicative schedule of activities is given in **Error! Reference source not found.**

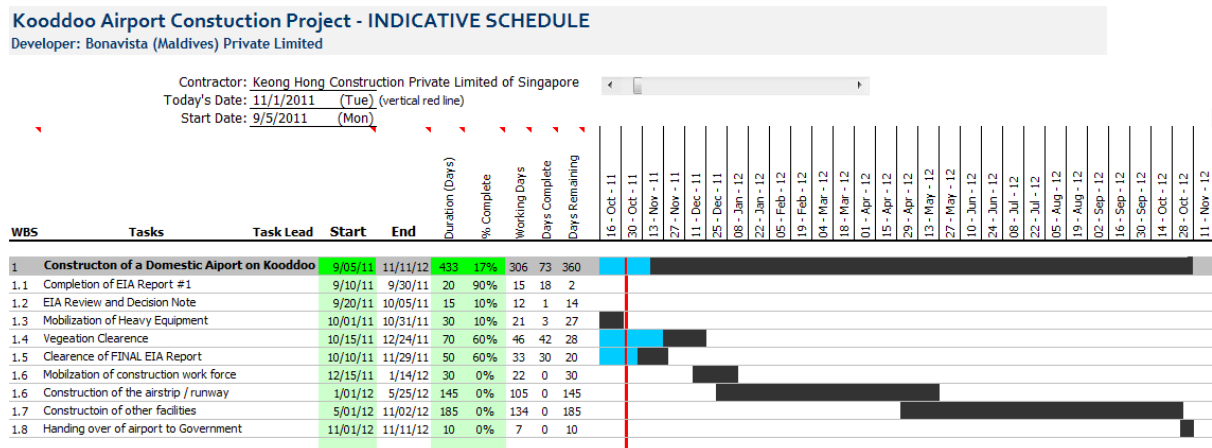


Figure 9: Indicative schedule of the work and its current progress.

The contractor is targeting to complete works and hand over by end 2012.

4 REGULATORY CONSIDERATIONS

Development activities during development and operation of the Kooddoo Domestic Airport will be carried out in accordance with existing plans, policies, guidelines, laws and regulations of Maldives including relevant international regulation on development and use of airport.

The Government's objective is to enhance the contribution of aviation to the development of the country and to provide aviation in safe, orderly and economic manner. The aviation policy of Maldives is based on the convention on International Civil Aviation (the Chicago Convention).

The Civil Aviation Act 02/2001 stipulates that all relevant rules regulations have to be at or above that promulgated in the Annexes to the Chicago Convention Standards and Recommended Practices (SARPs). Each contracting state is audited to ascertain the level of compliance with ICAO Annexes under the Universal Safety Oversight Programme (USOAP)

Local regulations will also have to reflect the aviation security conventions (Tokyo, Hague, Montreal and any subsequent protocols) and amendments that may be issues to annex 17 (Security) to the Chicago Convention. The ICAO Universal Security Audit Programme (USAP) is an initiative to establish a global aviation security system and provides for the conduct of universal, mandatory and regular audits of the aviation security system in all ICAO member states. Maldives was audited under this programme in 2006 and corrective action plan had been sent to ICAO in October 2006. Maldives has concluded 28 Air Service Agreements (ASA). The country also has signed 12 Memorandum of Understanding (MOU) or interim ASAs.

4.1 CIVIL AVIATION ACT OF THE MALDIVES

This Act makes provision in respect of the registration and operation of civil aircraft in the Maldives; construction, registration, operation and use of civil aerodromes; other matters relating to civil aircraft and aerodromes; and safety of civil aviation in the Maldives. Following major and relevant areas are dealt in the Act

- Supervision of matters relating to aviation
- Registration and construction of aerodrome and safety issues around the aerodrome
- Construction and installation and use of various structures associated with operation and use of the aerodrome
- Maintenance standards and safety zones
- Procedures on provision of air-transport services.
- Inspection and safety measures of aerodrome and aircraft.
- Investigation of accidents
- Compliance with international conventions

For the purposes of this development project it is understood the developer's responsibility is to ensure the aerodrome and facilities at the airport are to the standard as prescribed in the Civil Aviation Act, and rules and regulation that followed there in including any international rules that may have to be followed.

It is also understood the operation of the airport may be Government of Maldives in which case the standard rules and procedures will be apply. The state agency for responsible for the regulating the construction and operation of the airport is the Ministry of Transport and Communication.

4.2 CONVENTION ON CIVIL AVIATION

The International Convention on Civil Aviation (Chicago Convention) was signed at Chicago on 7 December 1944 and came into force on 4 April 1947 and now there are 179 contracting states including Maldives. The Convention concerns international civil aviation. However, the contracting states are recommended to follow the Annexes of the Convention on domestic and internal aviation through International Civil Aviation Organization (ICAO). ICAO is specialized agency of the United Nations, created with signing of International Convention on Civil Aviation. ICAO is the permanent body charged with the administration of the principles laid out in the Convention. Annex 14 in particular relates to aerodrome safety certification. As of 1 November 2001 it is recommended that all aerodromes open for public use must be certified.

4.3 ENVIRONMENTAL LAW

The Environmental Protection and Preservation Act of the Maldives (Law 4/93) (EPPA) or the Environmental Act was enacted by the People's Majlis in April 1993. The Environment Act encompasses the management of most environmental matters in the Maldives. The law provides provisions for the sustainable use of natural resources and their protection and conservation. Under Article 5(a) of EPAA of Maldives, Environmental Impact Assessment (EIA) is mandatory for any project that may have the potential to harm the environment. This report has to be submitted to the EPA for approval before commencement of a project.

In addition to the provisions for the EIA process, the articles of the EPPA address the following aspects of the environmental management:

- ❖ Guidelines and advice on environmental protection shall be provided by the concerned government authorities
- ❖ Formulating policies, rules and regulations for protection and conservation of the environment in areas that do not already have a designated government authority already carrying out such functions shall be carried out by MoHE.
- ❖ Identifying and registering protected areas and natural reserves and drawing up of rules and regulations for their protection and preservation.
- ❖ An EIA shall be submitted to MoHE/EPA before implementing any developing project that may have a potential impact on the environment.
- ❖ Project that has any undesirable impact on the environment can be terminated without compensation
- ❖ Disposal of waste oil, poisonous substances and other harmful substances within the territory of the Maldives is prohibited. Waste shall be disposed only in the areas designated for the purposes of the Government.

- ❖ Hazardous / toxic or nuclear waste shall not be disposed anywhere within the territory of the country. Permission should be obtained for any transboundary movement of such wastes through the territory of the Maldives.
- ❖ The penalty for breaking the law and damaging the environment are specified
- ❖ The government of the Maldives reserves the right to claim compensation for all damages that are caused by activities that are detrimental to the environment.

At present the new Environmental Bill is being drafted. The bill has been placed for public comments in 2010 and is presently due to be debated in the Parliament (People's Majils). This revised bill is expected provide a more comprehensive legal framework for the line ministries and law enforcement agencies. It provides an added emphasis on protected areas and its management. In the meantime, new rules and regulation are being passed by the MoHE and the most recent on was in February 2011 on the Assessing and Valuing of Environmental Damage. The regulation provides an objective was to assess the environmental data so as to impose fines more objectively.

4.4 EIA REGULATION OF THE MALDIVES – 2007

The most important regulation is Environment Impact Regulations, 2007 enforced under Environment Protection and Preservation Act (Law No. 4/93). The Clauses of Environment Protection and Preservation Act address the following that relate to the proposed project development and implementation.

- ❖ An impact assessment study shall be submitted to the relevant Government authority before implementing any development project that may have a potential impact on the environment
- ❖ The relevant Authority of Government shall formulate the guidelines for environmental impact assessment and shall determine the projects that need such assessment as mentioned in above.
- ❖ The Termination of projects. The relevant Government Agency has authority to terminate any project that has any undesirable impact on the environment. A project so terminated shall not receive any compensation
- ❖ Waste Disposal, Oil and Poisonous Substances. Any type of waste, oil, poisonous gases or any substance that may have a harmful effect on the environment shall not be disposed within the territory of the Maldives
- ❖ Government of Maldives reserves right to claim compensation for all the damages that area caused by the activities that are detrimental to the environment.

In addition to EIA regulations, other relevant regulation will be followed in development and implementation of the proposed project. These regulations include ban on coral mining. Coral mining from house reef and atoll rim reef has been banned since 1990. Sand mining from any island has also been banned since March 2000. Coral or sand will not be used for any purpose for the proposed project.

4.5 REGULATION ON CUTTING DOWN TREES

Cutting down and relocating of mature trees is regulated in Maldives under the By-law on Cutting down, Uprooting, Digging out and Export of Trees and Palms from One Island to

Another. In the preamble of the law, made in pursuant to Law No. 4/93⁷, it states the purpose of the law is to educate citizens and developers about the importance of trees including sound management to maintain trees and provide standards for the preservation of trees in the Maldives.

Under the law certain tree are prohibited to remove from island. They include:

- The coastal vegetation growing around the islands extending to about 15m into the island
- All trees and palms growing in mangroves and wetlands spreading to 15m of land area
- All trees in Government protected areas
- Trees that are being protected by the Government in order to protect species of animal / organisms that inhabit on such trees
- Trees / palms those are unusual in nature.

The law states that prior permission must be obtained for removal and/or relocation of 10 or more trees or palms. For indiscriminate removal and land clearances and EIA and Decision Note is required. The size of the trees and palms that are allowed to be relocated should have more 15feet from lowest point to the crown spread for palms and 8 feet from the lowest point to the trunk to tip of the highest branch for trees other than palms.

The law also states that cutting down and uprooting of the trees shall be made under supervision of the island / atoll offices (in the current context Atoll / Island Councils).

4.6 TRANSPORT MASTER PLAN

The (draft) Transport Master Plan highlights the issues of scattered geography and the limited transport opportunities that further add to remoteness and isolation of the island communities from the more developed centres and that isolation is an important element of poverty in many atolls.

Access problem were reported by half of the atoll population due to problems with harbours, absence of jetties, or enclosed nature of the islands by the coral reefs. These factors greatly contributed the unbalanced development in the atolls compared Male' For the past three decades public investment in Male' was more than 50% higher than in atolls.

Recognizing the problem of this unbalanced development the government shifted its development strategy to the atolls to stimulate regional development in five regional growth centres; north, north-central, central, south-central and south of the country which will facilitate balanced provision of economic and social services. The Transport Master Plan emphasizes regional development and provision of basic infrastructure which includes harbours and airports that will connect regional centres and surrounding islands with Male'.

According to the Transport Master Plan having an efficient and effective transport network that systematically link Male', the regional centres and the surrounding atoll will be the key to ensuring that socio-economic development of the country is distributed equitably.

⁷ Law 4/93 is the Environmental Protection and Preservation Act of the Maldives.

5 EXISTING ENVIRONMENTAL CONDITIONS

Kooddoo Island is located on the north eastern rim of Gaafu Alif (Ga) Atoll (Figure 10). The island is separated from Villingili to the north and Maamendhoo to the south by deep narrow channels. The island is somewhat rectangular in shape, with its length oriented in north-south direction. The island is 1.48 km long, and roughly 0.5 – 0.3 km wide, at the southern end the island protrudes out roughly 0.2 km eastward towards the ocean.

There appears to be no official records of earlier use of the Kooddoo Island. However, remnants of ancient burial grounds are present on the island as evidence of early settlements on the island. The island was officially allocated to MIFCO in early 1992 and the works on fish collection and storage facility started in 1983. The development work, financed by development partners IDA/WB, was completed in 1995. Kooddoo fish collection and storage facility was officially opened in 1996 (Figure 10).

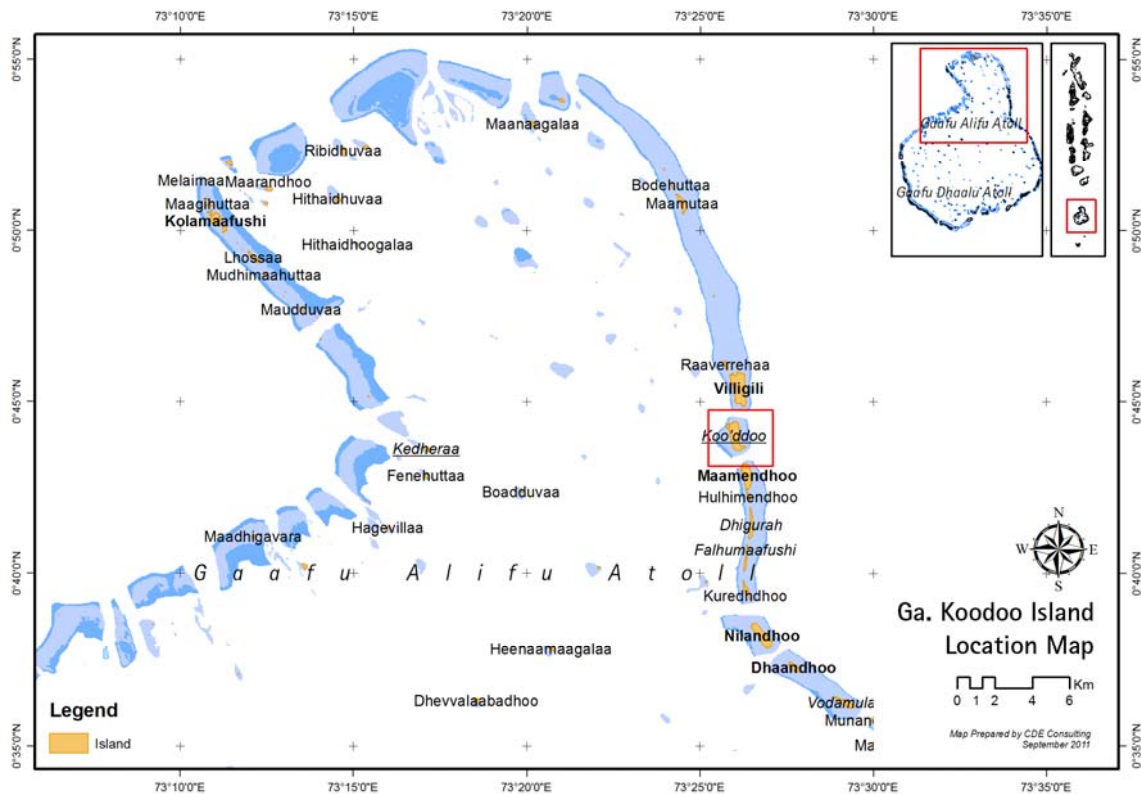


Figure 10: Location of map of Kooddoo Island on the eastern border of the Ga. Alifu Atoll.

Kooddoo is surrounded by a shallow lagoon (depth varying between 1 – 0.5 m) that terminates at the ocean and atoll-ward reef edge. Width of the lagoon area varies: average width of the lagoon on the eastern side of the island ranges between 0.45 – 0.3 km from the shoreline to the reef edge. To the north the lagoon width is roughly 0.38 km. The lagoon is widest to the west measuring 0.68 km from the shoreline.

Comparison of aerial photo of Kooddoo in 1969 and at present (2008) shows some significant morphological changes have occurred in the southern and northern tips. Whether these are related to the harbour development of Kooddoo in the early 1990s or whether they gradual

shifts are not clear. Accretion in the southern tip and erosion on the northern end is clear (Figure 12).



Figure 11: Close up image to show Kooddoo Infrastructure.



Figure 12: Kooddoo in 1964 [left panel] and Kooddoo in 2008 [right panel].

5.1 EXISTING INFRASTRUCTURE ON THE ISLAND

The existing infrastructure on the island is essentially structures related to vessel reception (quay walls), collection, freezing and storage (**Figure 11**). Specifically they consist of

1. Brine Freezing System with capacity of 240 mt / day
2. Cold storage with capacity of 2,000 mt
3. Quay wall, Harbour (-8m deep) to accommodate 2800 DWT vessels
4. Cranes on the quay wall for easy discharge of fish from the vessels.
5. Ice plant 50mt/ day capacity
6. Katusubushi plant (built in 2000); able to process 30mt
7. Power house
8. Accommodation blocks
9. Storage facilities, kitchen and canteen
10. Guest House
11. Office Block

5.2 OBJECTIVES

The main aim of surveys and assessments was to establish the existing baseline environmental conditions of Kooddoo Island. Environmental monitoring during construction and operation phase of the islands ensures the changes in environment are captured and remedial actions for the observed negatives impacts are addressed in a timely manner. The objectives of the present assessment were:

1. To determine the type and density of flora present in the project area
2. To determine the general soil characteristics of the project area
3. To determine the quality of groundwater of the project area
4. To determine the coastal conditions near the project area

5.3 METHODOLOGIES

Terrestrial flora Surveys: Remote sensing technology was used to map and classify the main groups of flora that occur on the island. High resolution satellite image was used to classify the main vegetation groups of the island. Additional information on algorithm and other details were provide in Supplementary Notes provided following review of the Report #1 (Annex 6). Subsequently ground-truthing surveys were carried out on the island; in the form of vegetation transect surveys. All flora observed along transects were recorded with their frequency of occurrence.

In addition to the image analysis an enumerated tree counting was also done on randomly chosen 4 plots of 100mx100m. The survey was done under instruction employing people who know the trees. To aid the tree identification a list of trees and forms were sent. The instruction for this survey is provide in **Annex 7**.

Groundwater Assessments: Water samples were collected in clean 1.5 L PET bottles after washing them with water to be sampled. Parameters tested for ground water quality assessments were physical appearance, temperature, pH, electrical conductivity, total

suspended solids, Biological Oxygen Demand. All parameters were analyzed at the Maldives Water and Sewerage Company laboratory.

Marine Environment Assessment: State of coral reef was assessed using standard LIT Intercept Techniques (English et. al (1997)). A total of the 5 sites were chosen to assess the reef (Figure 13). At each site two depths were chosen to assess the benthic cover to provide a total of 10 LIT surveys. At each site, series of high density photographic images were taken in sequence by keeping the camera at horizontal plan. An image was taken at each two-fin kicks until about 50-60 m (linear distance) was covered in the transect. The deeper transect was around 7-8 m deep while the shallow transect was around 4-5m deep.

Data analysis was done using Coral Point Count with Excel Extension Software⁸ (CPCe). A total of 20 images (frames) were selected for each transect and 25 points were randomly chosen from each frame totalling 500 random points on each transect. Pre-determined substrate category falling on each point was identified and relative cover was summarised using the standard CPCe procedures A total of 16 substrate categories were identified. These were:

1. Coral (LC)
2. Sand, silt (CR/S)
3. Coral rubble (RK)
4. Broken coral colony
5. Bleached coral
6. Rock
7. Sponge
8. Zoantharian
9. Macro Algae (MA)
10. Turf algae (TA)
11. Tunicata
12. Soft coral
13. Corallinacea
14. Bivalvia
15. Unknown coral
16. Unknown other

Corals were also identified to species level. The categories with the abbreviations were generally highest and were used to provide summary cover (see Section 7.1).

Fish Census: Visual assessment of fish fauna was undertaken at each Transect where LIT was done. They were of standard swims lasting for about 10-15 minutes. Abundance categories of conspicuous species were noted as Rare [R], Abundant [A], Common [C] and Schools [S].

⁸ <http://www.nova.edu/ocean/cpce/>; Kohler, K.E. and S.M. Gill, 2006. Coral Point Count with Excel extensions (CPCe): A Visual Basic program for the determination of coral and substrate coverage using random point count methodology. Computers and Geosciences, Vol. 32, No. 9, pp. 1259-1269, DOI:10.1016/j.cageo.2005.11.009

5.4 STUDY AREA AND SURVEY LOCATIONS

The study area covers the terrestrial environment of the island is given in Figure 13 below shows the specific study area and survey locations with their respective GPS co-ordinates.

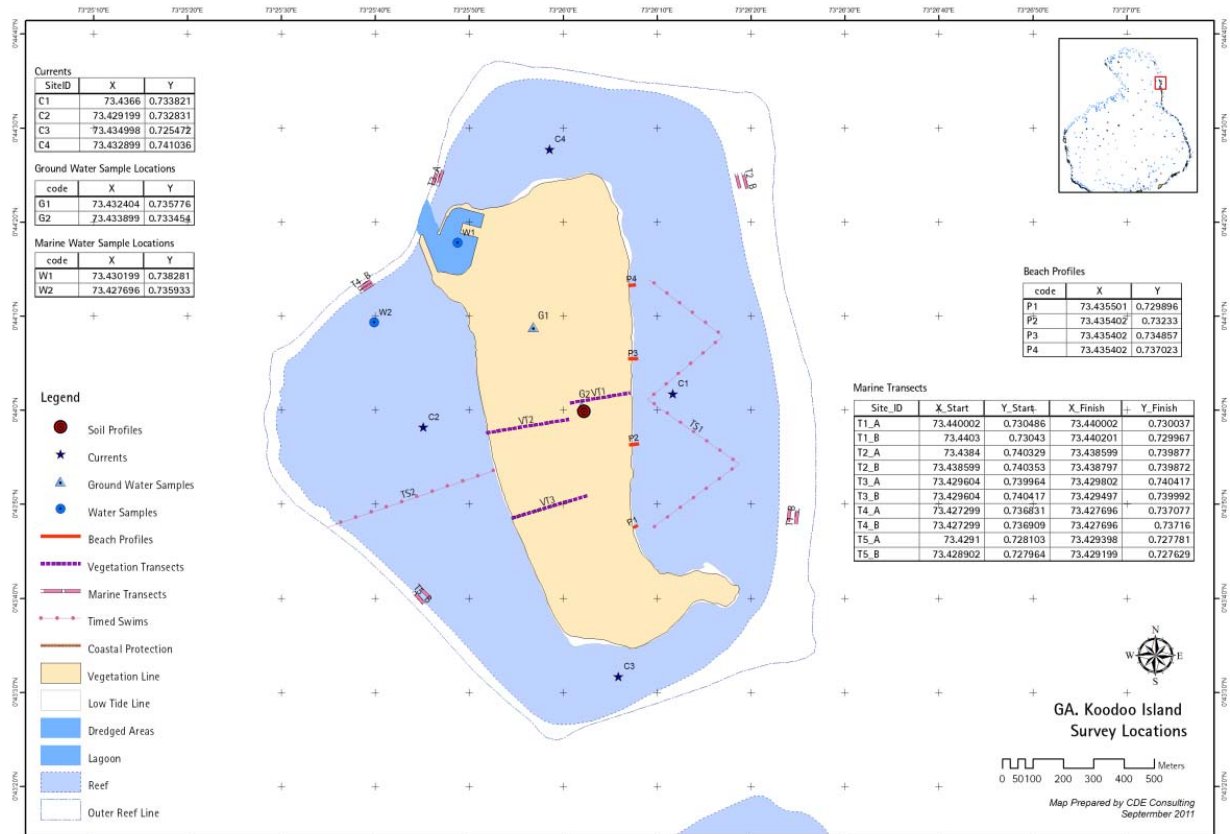


Figure 13: Study area and Survey locations (An enlarged figure is given in Appendix Annex 5). For the Marine Transects, start and finish points for each photo transect are given. T1_A and T1_B are Transect #1, deep and shallow respectively.

5.5 METEOROLOGY AND CLIMATE

The climate in Maldives is warm and humid, typical of the tropics. The average temperature ranges between 25°C to 30°C and relative humidity varies from 73 – 85%. The annual average rainfall is approximately 1,950 mm⁹. As Maldives lies on the equator, Maldives receives plenty of sunshine throughout the year. Significant variation is observed in the climate between the northern and the southern atolls. The annual average rainfall in the southern atolls is higher than the northern atolls. In addition, greater extremes of temperature are also recorded in the southern atolls. On average southern atolls receive 2704 hours of sunshine each year. Table 1 provides a summary of key meteorological findings for Maldives.

5.5.1 Monsoons

The climate of Maldives is characterised by the monsoons of Indian Ocean. Monsoon wind reversal significantly affects weather patterns. Two monsoon seasons are observed in

⁹ National Meteorological Centre, Maldives; <http://202.21.178.203/mms/>, accessed October 24, 2011

Maldives: the Northeast (Iruvai) and the Southwest (Hulhangu) monsoon. The parameters that best distinguish the two monsoons are wind and rainfall patterns. The southwest monsoon is the rainy season while the northeast monsoon is the dry season. The southwest monsoon occurs from May to September and the northeast monsoon is from December to February. The transition period of southwest monsoon occurs between March and April while that of northeast monsoon occurs from October to November.

Table 1: General Meteorological Information about the Maldives.

Parameter	Data
Average Rainfall	9.1mm/day in May, November 1.1mm/day in February
Maximum Rainfall	184.5 mm/day in October 1994
Average air temperature	30.0 C in November 1973 31.7 C in April
Extreme Air Temperature	34.1 C in April 1973 17.2 C in April 1978
Average wind speed	3.7 m/s in March 5.7 m/s in January, June
Maximum wind speed	W 31.9 m/s in November 1978
Average air pressure	1012 mb in December 1010 mb in April

5.5.2 Winds

The winds that occur across Maldives are mostly determined by the monsoon seasons. The two monsoons are considered mild given that Maldives is located close to the equator. As a result, strong winds and gales are infrequent although storms and line squalls can occur, usually in the period May to July. During stormy conditions gusts of up to 60 knots have been recorded at Malé.

Wind has been uniform in speed and direction over the past twenty-plus monsoon seasons in the Maldives (Naseer, 2003). Wind speed is usually higher in central region of Maldives during both monsoons, with a maximum wind speed recorded at 18 ms⁻¹ for the period 1975 to 2001. Mean wind speed as highest during the months May and October in the central region. Wind analysis indicates that the monsoon is considerably stronger in central and northern region of Maldives compared to the south (Naseer, 2003).

Winds recorded at Gan meteorological centre indicates that heavy windy conditions occurred during south-west monsoons. Wind gusts of 35 mph to 45 mph were occasionally recorded when effects of cyclones from Arabian Sea were felt in the country. Direction of wind changes predominantly from north-east in the northeast monsoon to west and south-west in the southwest monsoon and variable direction of wind are experienced in the monsoon transition periods.

Table 2 summarises the wind conditions in southern Maldives throughout a year. Medium term meteorological data from Gan meteorological center (see Figure 14 - Figure 15) and

findings from long-term Comprehensive Ocean-Atmosphere Data Set (COADS) are used in this analysis.

Table 2: Summary of general wind conditions from Gan Meteorological Center.

Season	Month	Wind
NE - Monsoon	December	Predominantly from NW-NE. High Speeds from W
	January	
	February	
Transition Period 1	March	From all directions. Mainly W. High Speeds from W.
	April	
SW - Monsoon	May	Mainly from W. High Speeds from W.
	June	
	July	
	August	
	September	
Transition Period 2	October	Mainly from W. High Speeds from W
	November	

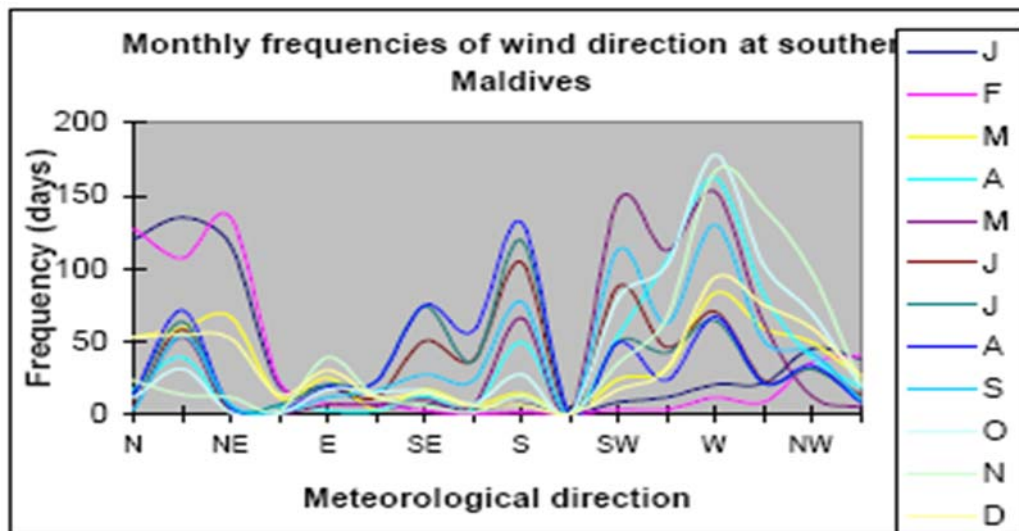


Figure 14: Monthly frequencies of wind direction in southern Maldives based on Gan Meteorological Centre 10 year data (Extracted from Naseer, 2003).

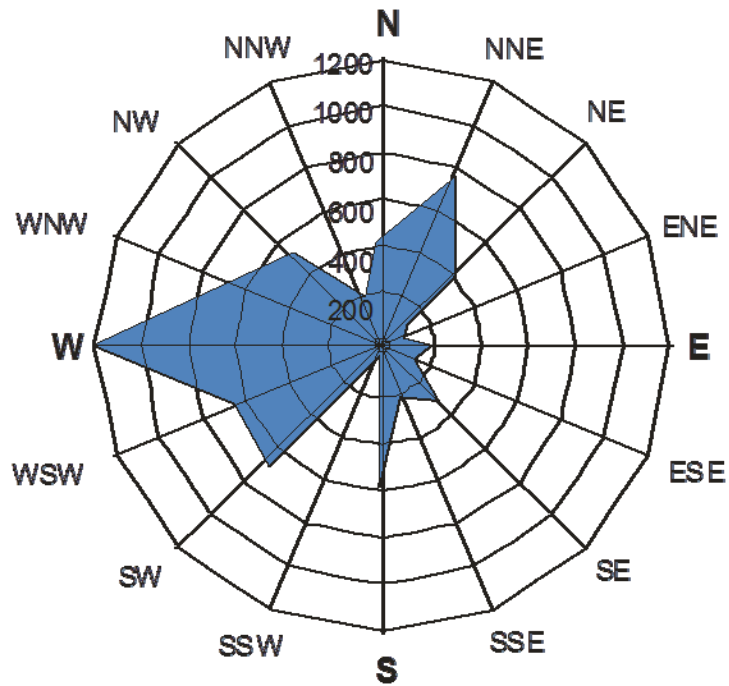


Figure 15: Twenty four year (medium term, 1985- 2009) wind frequency recorded at Gan Meteorological Center

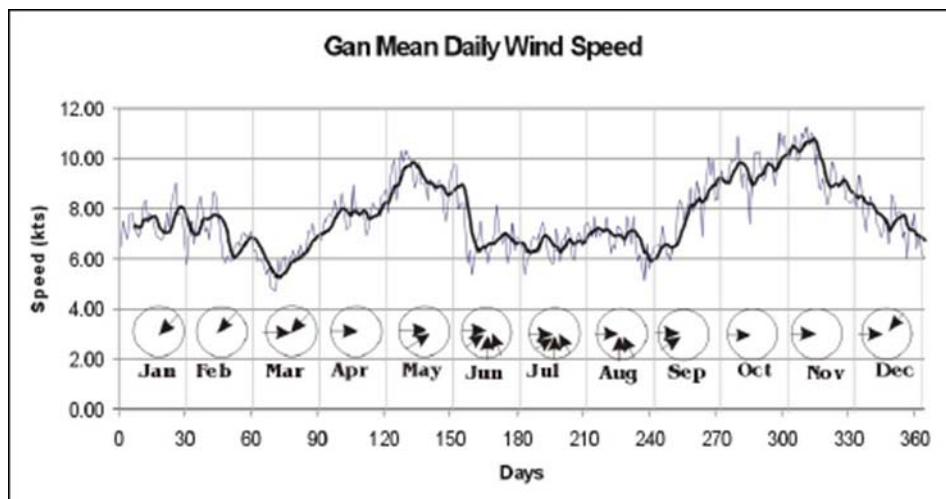


Figure 16: Mean daily wind speed and direction recorded at Gan Meteorological Center. Arrows indicate dominant wind direction (After Naseer, 2003)

The project site is not expected to receive regular annual strong winds except for a brief period at the peak of northeast monsoon and during transition periods. However, it is highly likely that wind may increase beyond normal northeast monsoon peaks at times of severe weather such as those resulting from localised storms. There are reports of winds reaching 96 km/h in Gan during storm events.

5.6 HYDROLOGY

5.6.1 Waves

Two major types of waves are observed along the coast of Maldives. The first type is wave generated by local monsoon wind with a period of 3-8 seconds and the second type is swells generated by distance storms with a period of 14-20 seconds (DHI, 1999). The local monsoon

predominantly generates wind waves which are typically strongest during April-July in the south-west monsoon period.

Maldives experiences occasional flooding caused by long distance swell waves that are generated by South Indian Ocean storms (Goda 1988). The swell waves of height 3 metres that flooded Malé and Hulhumalé in 1987 are said to have originated from a low pressure system off west coast of Australia. More recently in May 2007 swell waves that originated from the south western side of the Indian Ocean caused flooding in 35 inhabited islands across 13 atolls, including Addu atoll.

In 2004 Maldives was subject to earthquake generated tsunami reaching heights of 4.0m on land (UNEP, 2005). Historical wave data from Indian Ocean countries show that tsunamis have occurred in more than 1 occasion, most notable been the 1883 tsunami resulting from the volcanic explosion of Karakatoa (Choi et al., 2003). More recently 2004 tsunami, originated in Ache, Indonesia, cause serious damage, although minor to the southern atolls, including Huvadho Atoll.

5.6.2 Tides

Tides experienced in Maldives are mixed and semi-diurnal/diurnal. Typical spring and neap tidal ranges are approximately 1.0m and 0.3m, respectively. Maximum spring tidal range in the central and southern atolls is approximately 1.1m. There is also a 0.2m seasonal fluctuation in regional mean sea level, with an increase of about 0.1m during February to April and a decrease of 0.1m during September to November. Like in most other atolls, semidiurnal tides are experienced in Huvadho Atoll - that is two high tides and two low tides a day. The tide varies from place to place, depending on the location and on the shape and depth of the basin, channels and reefs and also time of the year. Tidal variations in Maldives are presented in Table 3.

Table 3: Tidal variations at Malé International Airport.

Tide Level	Referred to MSL
Highest Astronomical Tide (HAT)	+0.64
Mean Higher High Water (MHHW)	+0.34
Mean Lower High Water (MLHW)	+0.14
Mean Sea Level (MSL)	0.00
Mean Higher Low Water (MHLW)	-0.16
Mean Lower Low Water (MHLW)	-0.36
Lowest Astronomical Tide (LAT)	-0.56

Astronomical tides are related to the motion of the earth-moon-sun system, and have a range of periodicities. The highest astronomical tide was recorded as 0.64 m above the mean sea level and the lowest astronomical tide was recorded as 0.56 m below the mean sea level. Tidal variation of 1.2m from lowest to the highest tide levels were recorded in the country.

5.6.3 Surface Currents

Currents that affect the reef system of the proposed site can be caused by tidal currents, wind-induced currents and wave-induced currents. It is presumed that generally current flow through the country is defined by the two-monsoon season winds. Westward flowing currents are dominant from January to March with the change in current flow pattern taking place in April and December. In April the westward currents become weak while the eastward currents start to take over. In December the eastward currents are weak with the westward currents becoming more prominent. Surface current measurements taken around Kooddoo Island are presented in the table below. Current measurement locations are presented in Figure 13.

Table 4: Current speed and Direction Measures on Kooddoo Island, See Figure 13 for details.

Site	Speed (m/s)	Direction	GPS co-ordinate
C1	0.6	North west	X 73.4366, Y 0.7338
C2	0.1	North east	X 73.4292, Y 0.7328
C3	0.5	West	X 73.4350, Y 0.7255
C4	0.3	West	X 73.4329, Y 0.7410

6 TERRESTRIAL ENVIRONMENT

6.1 ASSESSEMETN OF SOIL

A hole was dug till the groundwater level (1.5 m depth), and soil samples were collected down the hole (pit) where distinct variations in sediment size and colour was observed. Five distinct layers were observed (Figure 17 and Figure 18 **Error! Reference source not found.**): top two layers were made up of humus or dark soil (35 cm thick). Thick humus layer is representative of a well-established vegetation system. The following three layers were made up of coarse white sediment, the size of the sediment particles appear to increase down the profile. Groundwater level is observed approximately 150 cm from the top layer.



Figure 17: Soil profiles of Kooddoo Island (9th September 2011, for locations see Annex 5)



Figure 18: Soil profile location, For GPS Coordinate the location see Figure 18).

6.2 GROUNDWATER ASSESSMENTS

Groundwater samples were collected from two locations of the island. The water table is approximately 1 - 1.5 m below ground level at MSL, and is subject to vary with tidal fluctuations. Table 5 below shows the parameters tested and the results.

Groundwater sample 1 (G2) was collected from a freshly dug well, away from the developed area; while groundwater sample 2 (G1) was collected from an existing well in the developed area. Thus apparent differences in total suspended solids and electrical conductivity can be observed between both the samples.

Table 5: Ground water quality test results.

Parameter	Groundwater sample 1 (G2*)	Groundwater sample 2 (G1*)
Physical appearance	Yellow color with suspended particles	Clear
Temperature (°C)	23.1	22.8
pH	7.02	7.52
Electrical Conductivity (µS/cm)	599	1582
Total Suspended Solids (mg/L)	906	2
Biological Oxygen Demand (mg/L)	7.76	5.16

*G1 and G2 as marked on the study area map (see Figure 13 and Annex 5)

6.3 VEGETATION COVER

Terrestrial flora surveys of the island revealed typical vegetation comprising of a coastal strip of Magoo (*Scaevola taccada*) and Velan'buli (*Cassitha filiformis*) with an inland community dominated by Ruh (*Cocos nucifera*). Figure 19 shows examples of vegetation encountered along the main road of the island. Apart from Ruh and Dhiggaa the following were the most predominant species that were observed during the vegetation surveys:

- Kandhu (*Hernandiapeltata*)

- Dhuburi (*Ochrosiaborbonica*)
- Boa-kashikeyo (*Pandanustectorus*)
- Uni (*Guettardaspeciosa*)
- Midhili (*Terminaliacatappa*)

Spatial distribution of vegetation species encountered along the vegetation transect surveys are shown in Figure 20.



Figure 19: Images of vegetation profiles seen from the main road running along the long-axis of the island.

In addition trees were counted at four locations of the island each area measuring 100 m x 100 m. On an average most frequently observed tree was Ruh (72 trees) and Dhuburi (57 trees). Results are presented in Table 6.

Table 6: Summary of the counts in 4x (100x100m) lots

Name of the Tree	Scientific name	Lot#1	Lot#2	Lot#3	Lot#4	Average
Madhoshi	<i>Citrus medica</i>	37	08	0	0	11
Midhili	<i>Terminaliacatappa</i>	08	49	04	18	20
Uni	<i>Guettardaspeciosa</i>	0	08	20	38	17
Hithigas	<i>Azadirachtaindica</i>	01	0	0	0	0
Kandhu	<i>Hernandianymphaeifolia</i>	38	17	49	24	32
Anbu	<i>Mangiferaindica</i>	02	0	0	0	1
Babukeyo	<i>Artocapusaltilis</i>	04	0	0	0	1
Dhigga	<i>Hibiscus tilaceus</i>	05	06	11	41	16
Dhuburi	<i>Orcrosiaoppsoitifolia</i>	08	118	60	41	57
Ruh	<i>Cocosnucifera</i>	41	08	77	162	72

High resolution satellite imagery was used to map and classify vegetation cover. GIS application was used to classify vegetation based on colour variations. Samples of classified zones were verified using ground-truthed data. The map shown in Figure 21 shows the vegetation classification map generated from the satellite image. Predominant vegetation species in the classified areas of the map are given below:

1. Agricultural crops: *Rotating crop vegetation*
2. Bush vegetation: *Boakashikeyo, Magoo, Dhunburi, Dhigga*
3. Coastal bush vegetation: *Magoo, Velan'buli*
4. Coconut grove: *Ruh*
5. Developed area: *Ruh, Madhoshi*
6. Mixed woody vegetation: *Midhili, Uni, Kandhu, Ruh (in small quantities)*
7. Modified woody vegetation: *Introduced species*
8. Open area

Table 7 shows the estimated number of trees, at each classified area of the map. Estimations are given within a range between low and high. All agricultural crops and coconut grove areas will be affected due to this project.

Table 7: Estimated number of trees from the satellite imagery.

Classification	Total Area (m ²)	Est. no of trees (low – high range)	Percentage affected
Agricultural crops	25,918.05	648 - 1036	100
Bush vegetation	46,574.30	1164 - 1862	50
Coastal bush vegetation	40,794.47	1019 - 1632	80
Coconut grove	143,711.23	3593 - 5748	100
Developed area	80,034.58	NA	NA
Mixed woody vegetation	284,020.45	7101 – 11,361	83
Modified woody vegetation	51,707.23	1292 - 2068	15
Open area	19,759.66	NA	NA
Strand vegetation	7686.14	192 - 307	100

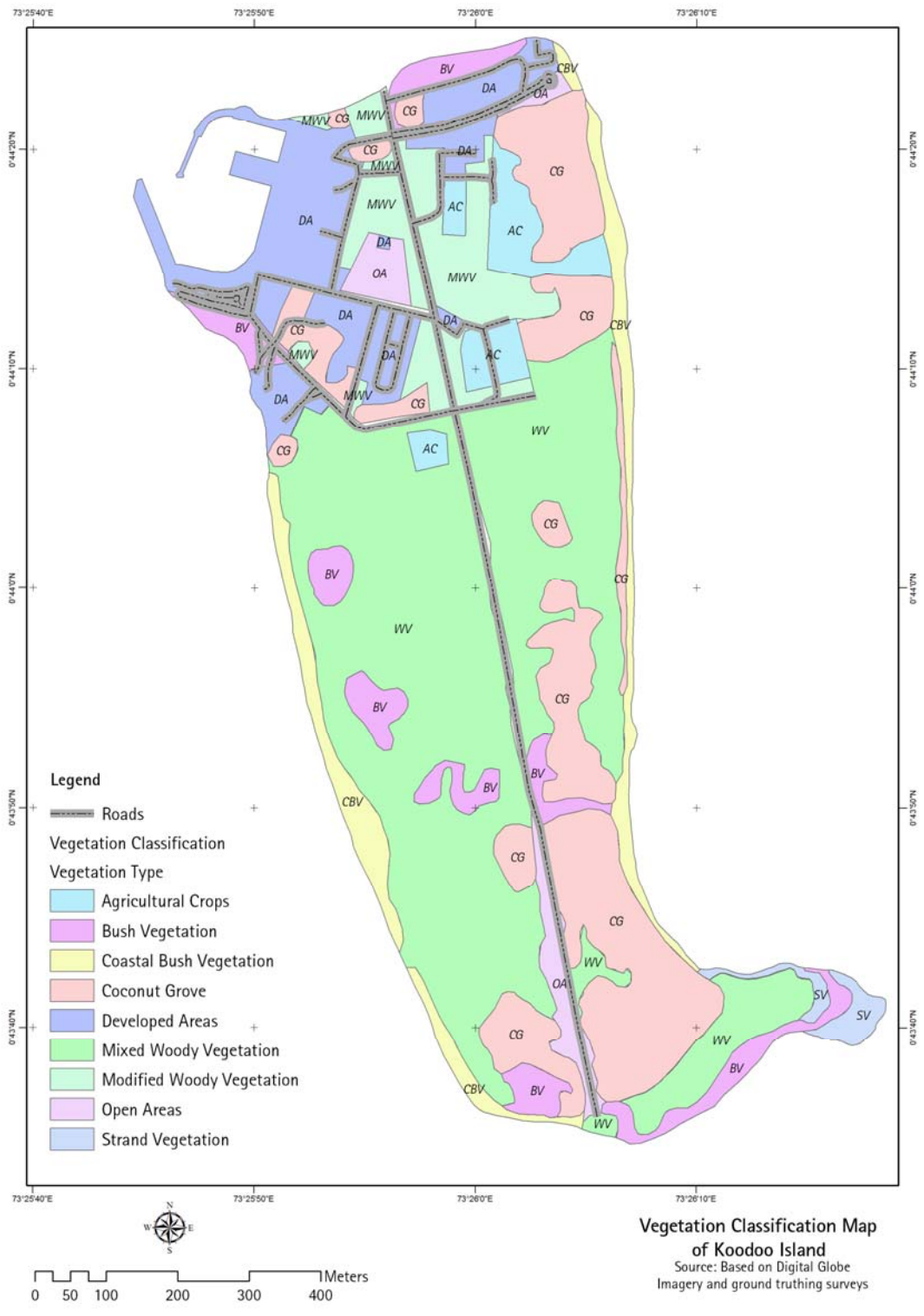


Figure 21: Classification of the vegetation on Kooddo Island using the satellite imagery.

6.4 WATER QUALITY TEST

Groundwater samples were collected from two locations of the island. The water table is approximately 1 - 1.5 m below ground level at MSL, and is subject to vary with tidal fluctuations. Table 5 below shows the parameters tested and the results. More complete results are given in Annex 11.

Groundwater sample 1 (G2) was collected from a freshly dug well, away from the developed area; while groundwater sample 2 (G1) was collected from an existing well in the developed area. Thus apparent differences in total suspended solids and electrical conductivity can be observed between both the samples.

Table 8: Ground water quality tests results – summary. *G1 and G2 indicated in Annex 5.

Parameter	Groundwater sample 1 (G2*)	Groundwater sample 2 (G1*)
Physical appearance	Yellow color with suspended particles	Clear
Temperature (°C)	23.1	22.8
pH	7.02	7.52
Electrical Conductivity (µS/cm)	599	1582
Total Suspended Solids (mg/L)	906	2
Biological Oxygen Demand (mg/L)	7.76	5.16

7 MARINE ENVIRONMENT

Marine surveys were carried out on 09 September 2011; fish and benthic substrate composition at five selected locations of the reef was assessed.

7.1 PHOTO QUADRAT SURVEY

Site 1: Photo quadrat survey at site 1 reveals that dominant substrates are rock (25 - 60%) and live coral (20.25 – 27.25%). Algae cover is lower along the deeper transect line (17.25%) compared to shallower transect line (47.25%). Sand and coral rubble is very low (0.25 – 1.75%)



Figure 22: Summary Substrate cover for the Site #1. For complete analysis of the cover, see Annex 8.

Site 2: The dominant substrate at this site is rock (34 – 52%). Percentage cover of turf algae along both transects laid at site 2 is high (22 – 27%), in addition amount of Corallinaceae cover is comparatively higher at this location making up 4.5 – 14% of the survey area. Live coral coverage is also high making up 20 – 23% of the survey area. The amount of sand and coral rubble observed is very low (0.5 – 1%).

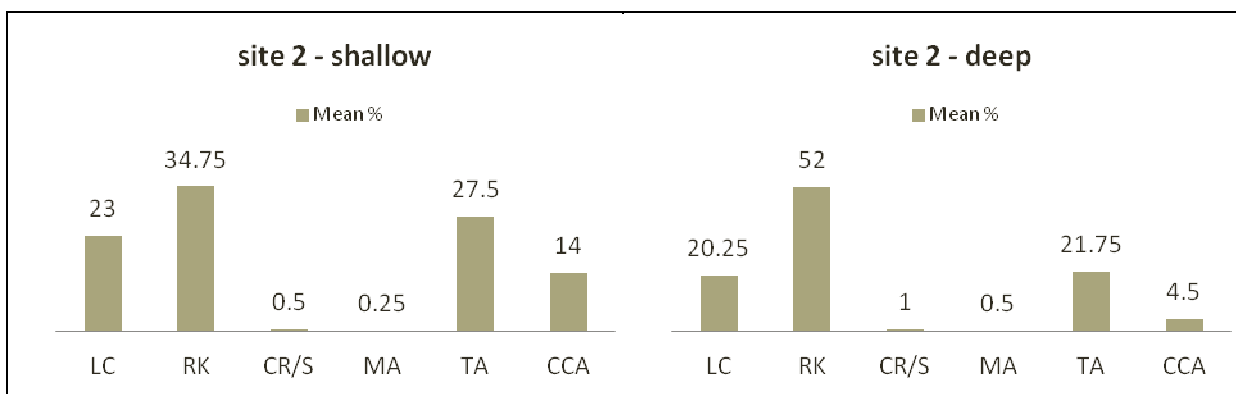


Figure 23: Summary substrate cover for Site #2. For complete analysis of the cover see Annex 8.

Site 3: The percentage cover of coral rubble and sand is slightly higher at this site compared to site 1 and 2; making up 4.5 – 12.5% of the survey area. However the dominant substrate

categories are similar: Live coral (16 – 24%), Rock (31 – 36%) and Turf algae (28 – 35%). Apart from turf algae, all other algae categories recorded at this site is very low.

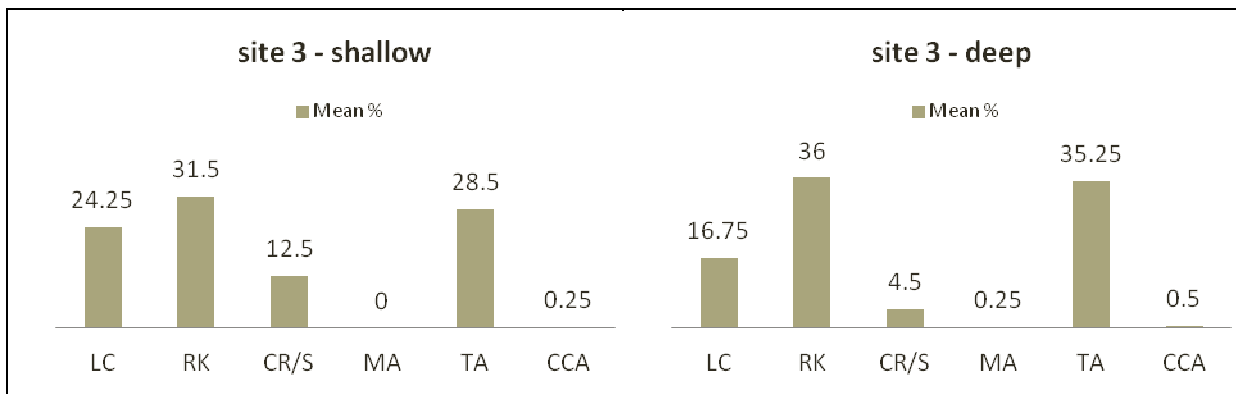


Figure 24: Summary Substrate Cover for Site #3. For complete analysis of cover please see Annex 8.

Site 4: Main substrate categories observed at site 4 are: live coral (14 – 38%), rock (28 – 41%) and turf algae (28%). Coral rubble and sand cover is similar to site 3 making up 2 – 13%. of the survey area.

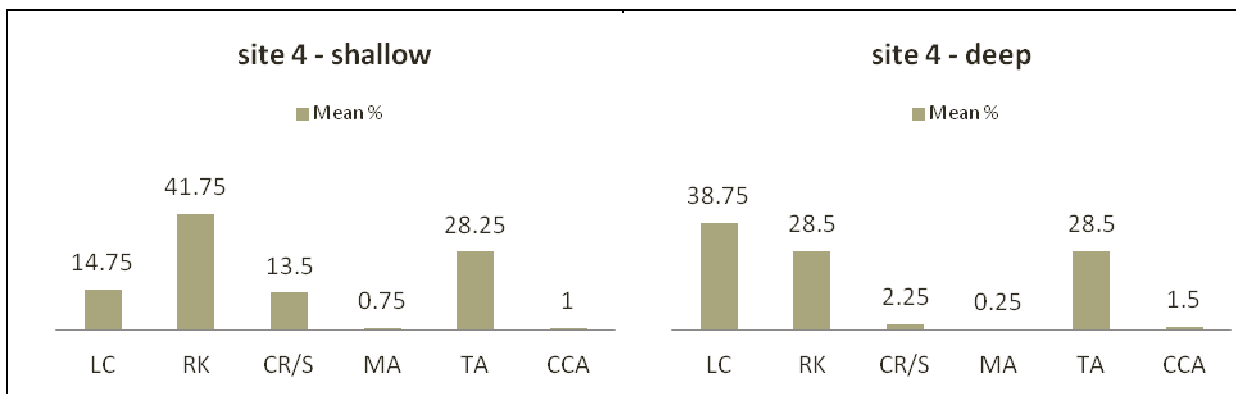


Figure 25: Summary Substrate Cover for Site #4. For complete analysis please see Annex 8.

Site 5: Live coral cover is highest at this site compared to the other four sites (29 – 50%). Percentage cover of rock is lower compared to other sites (19 – 22%). Algae cover is high making up between 5 - 4%, of the survey area of these; turf algae were the dominant form of algae making up 22 – 31% of the survey area.

In general it can be said coral cover in Kooddoo reef is in reasonably good condition. On average the live coral cover is more than 26% with some sites, especially on the western side is has more than 50% coral cover. The result is in broad agreement with the recent review of the coral reef monitoring data by the Marine Research Centre, which in broad terms state the reef in the southern Maldives are still in pretty good condition and reefs in western side of Maldives is recovering (Zahir, et. al, 2010). A more comprehensive result of the LIT analysis, including cover of coral species is given in Annex 8.

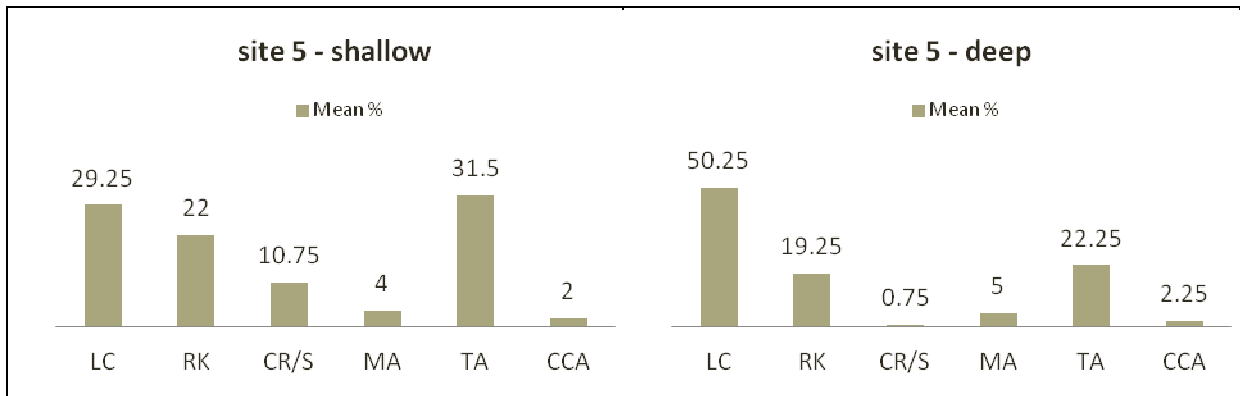


Figure 26: Summary Substrate Cover for Site #5. For complete analyses please see Annex 8.

7.2 FISH CENSUS

A total of 15 fish families were recorded at from all the sites. Most number of fish families was recorded at site 1 and least from site 5. **Figure 27** shows the number of fish families and corresponding fish species that were recorded at each site during the fish census.

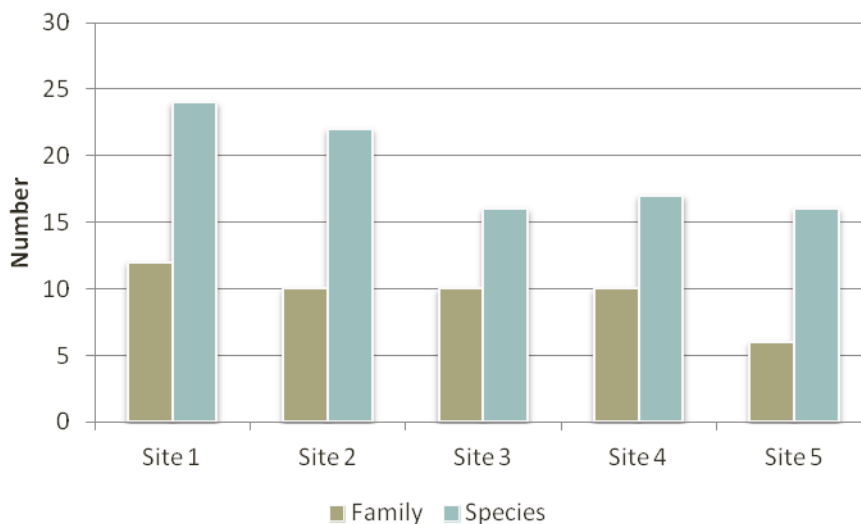


Figure 27: No of fish families and corresponding fish species recorded at each site.

Most number of fishes was recorded from families Acanthuridae, Pomacentridae and Chaetodontidae. **Figure 28Error! Reference source not found.** shows summary results of the frequency of fish families recorded from all five sites. Most number of fishes was recorded from genus from Acanthurus, Chaetodon and Scarus.

There is no reason to believe that Kooddoo reef is any different from a typical reef in the Maldives. It should be noted that visual census are only a crude observation of the faunal composition on a reef. They can be highly subjective; depends on the person, time of the day and actual methodologies followed during the visual census. Nevertheless they prove a broad perspective of the main species that occur in the area.

The complete list of the fish species observed by site is given in Annex 9.

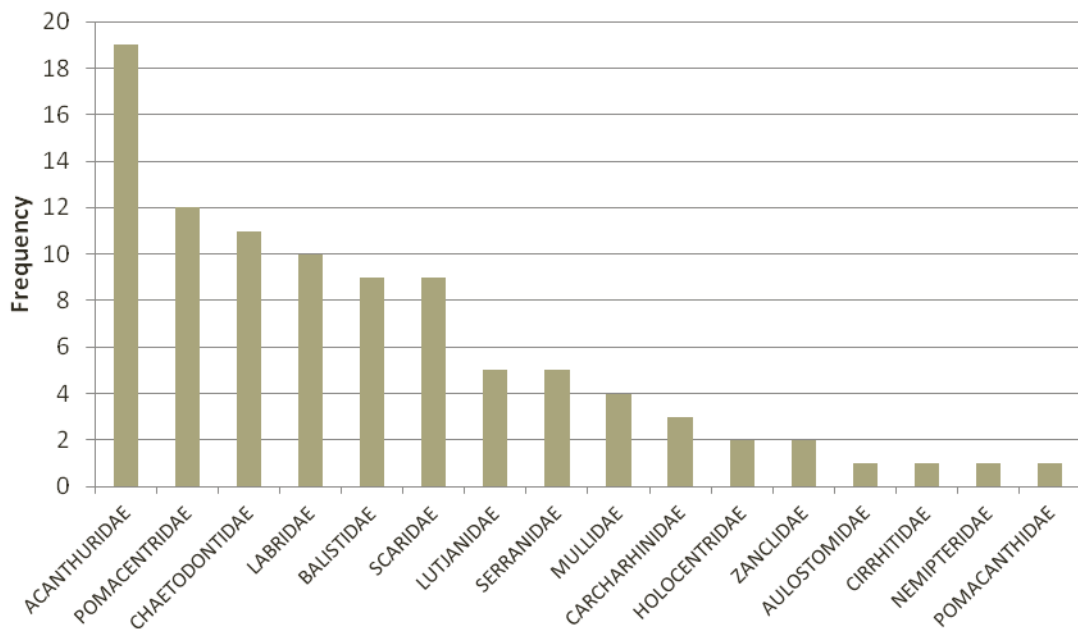


Figure 28: Summary of fish census, 5 sites combined showing the frequency of families recorded.

7.3 BEACH PROFILES

A series of beach profiles were taken on the south eastern side of the island. The profiles are from the eastern side of the island. Although there is no obvious sign of erosion the berm width of the profiles are found to be narrow, most of them less than 5m. In some areas the beach berm was poorly developed.

The beach formation and grain size in the area shows that the area is of moderate energy where medium to coarse grains are deposited. The sand gets coarser in the south eastern section of the island. Figure 29 to Figure 36 shows the profiles and the respective image of the area.

7.4 MARINE WATER QUALITY TESTS

Marine water samples were collected from two locations; one from the harbour and the other from outside (in the lagoon). The results of are shown in Annex 11.

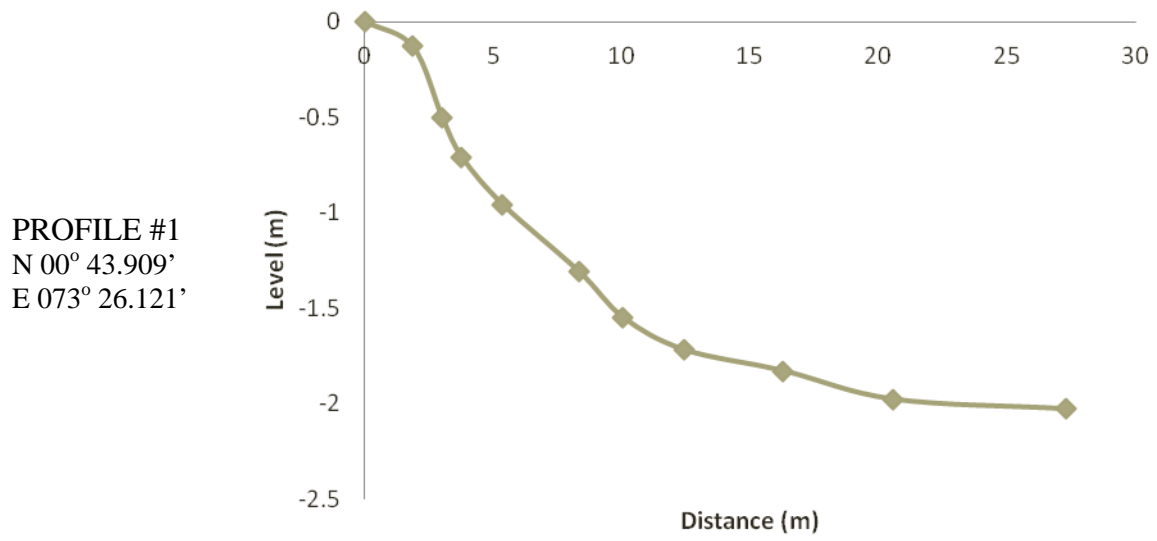


Figure 29: Profile #1. For location of the profile on the island see Figure 13 and Annex 5



Figure 30: Images of the Profile #1. For locations see Figure 13 and Annex 5

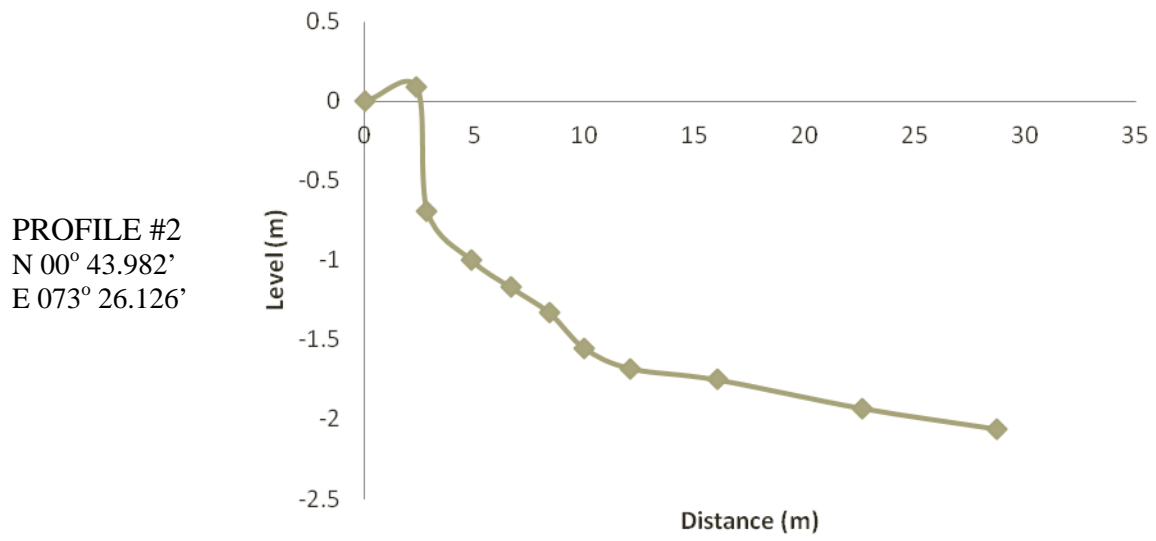


Figure 31: Profile #2. For location of the profile on the island see Figure 13 and Annex 5



Figure 32: Images of the Profile #2. For locations see Figure 13 and Annex 5

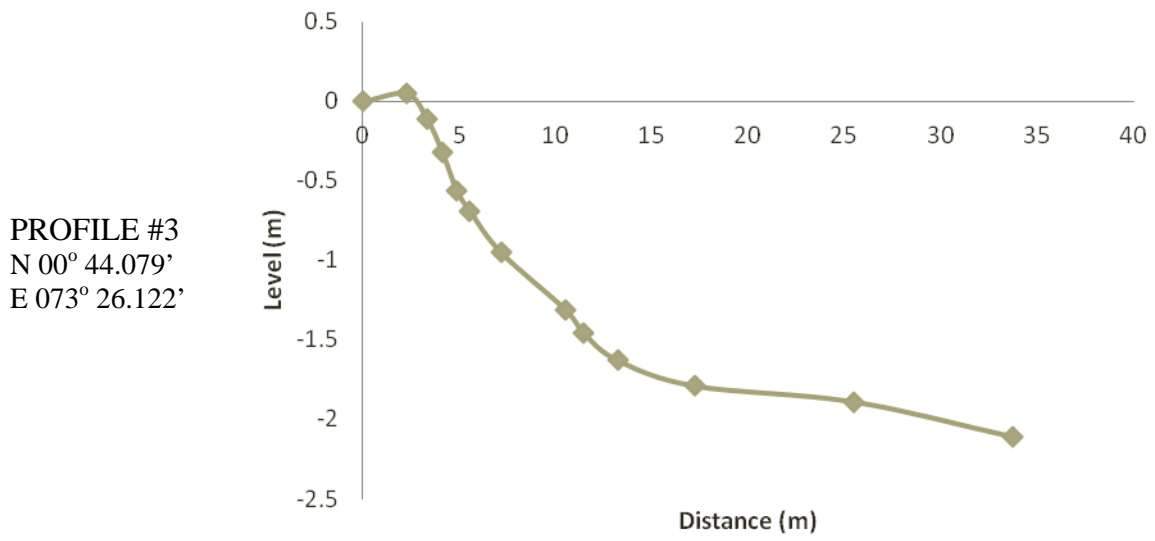


Figure 33: Profile #3. For location of the profile on the island see Figure 13 and Annex 5



Figure 34: Images of the Profile #3. For locations see Figure 13 and Annex 5

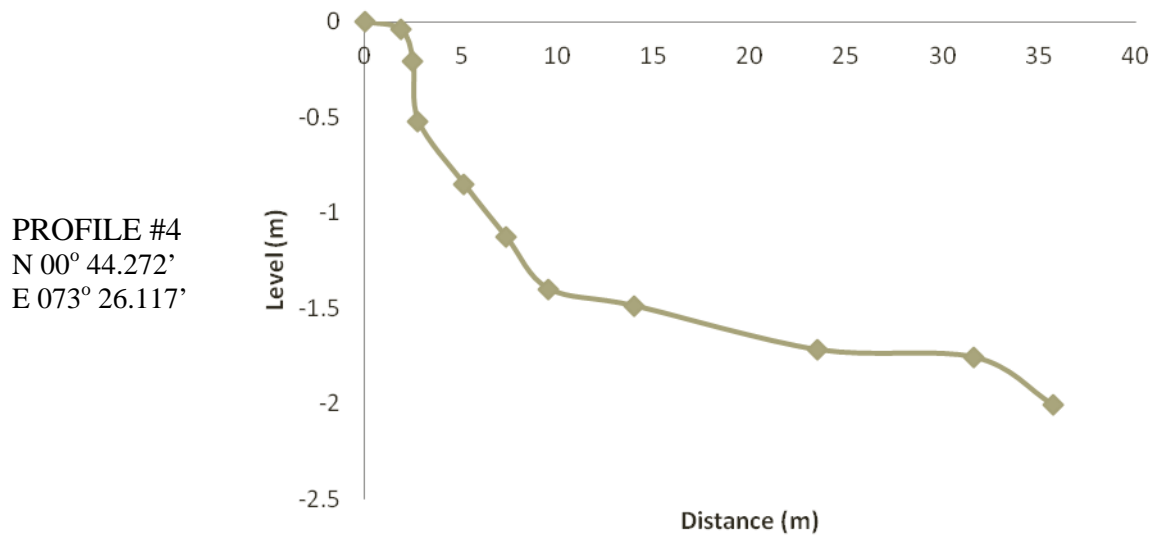


Figure 35: Profile #4. For location of the profile on the island see Figure 13 and Annex 5



Figure 36: Images of the Profile #4. For locations see Figure 13 and Annex 5

8 SOCIO-ECONOMIC ENVIRONMENT

8.1 GEOGRAPHIC CONTEXT

Huvadhu atoll is the largest natural atoll of the Maldives. Administratively it is divided into two; Gaafu Alifu (GA) and Gaafu Dhaalu (GD) atolls. A total of the nine inhabited islands are in GA Atoll and eleven in GD atoll. Relatively large number of uninhabited islands exists in both the atolls. For instance, there are 84 islands identified as uninhabited in the GA atoll, which is about 90% of the total islands. Uninhabited islands are more in GD Atoll. A total of 150 islands have been identified as uninhabited which 93% of the total islands¹⁰.

Most of the islands in Huvadhu atoll are located on the atoll rim, although some major islands (e.g., Dheevadhoo) are located in the atoll basin.

8.2 POPULATION STRUCTURE

Summary data for the most recent two censuses are shown in Table 9. The population of the GA atoll was stable around 8,300 in the two periods, with zero exponential growth rates.

Table 9: Population by sex and number of households including annual population growth in 2006. Data from Census 2000 and 2006 (extracted from Website of Department of National Planning, accessed October 2011).

	2000					2006					Annual Growth rate (exp)
	Both sexes	Malé	Female	# Househ odls	Avg House Hold Size	Both sexes	Malé	Female	# Househ odls	Avg House Hold	
North Huvadhu Atoll (GA)	8249	4123	4126	1412	6	8262	4185	4077	1472	5.6	0
Kolamaafushi	1139	560	579	184	6	1087	542	545	189	5.8	-0.8
Villingili	2261	1129	1132	364	6	1976	951	1025	346	5.7	-2.2
Maamendhoo	886	427	459	160	6	1000	508	492	188	5.3	2
Nilandhoo	432	214	218	82	5	534	258	276	94	5.7	3.5
Dhaandhoo	1150	556	594	189	5	1113	534	579	186	6	-0.5
Dhewadhoo	588	301	287	124	5	480	254	226	105	4.6	-3.4
Kodey	260	133	127	49	5	213	95	118	52	4.1	-3.3
Dhiyadhoo	139	71	68	27	5	79	34	45	25	3.2	-9.4
Gemanafushi	899	448	451	163	6	1082	533	549	183	5.9	3.1
Kanduhulhudhoo	375	172	203	69	5	443	225	218	92	4.8	2.8
Industrial Island and other	120	112	8	1	120	255	251	4	12	21.3	12.5
South Huvadhu Atoll (GD)	11886	5725	6161	2177	5	11013	5395	5618	2145	5.1	-1.3
Madaveli	939	462	477	186	5	1065	508	557	198	5.4	2.1
Hoadehdhdhoo	523	241	282	127	4	668	324	344	140	4.8	4.1
Nadalla	659	307	352	134	5	614	289	325	122	5	-1.2
Gadhdhoo	1701	779	922	343	5	1439	729	710	328	4.4	-2.8
Ratahfandhoo	610	307	303	134	5	492	249	243	126	3.9	-3.6
Vaadhoo	733	335	398	146	5	662	319	343	147	4.5	-1.7
Fiyori	847	388	459	168	5	673	316	357	160	4.2	-3.8
Faresmaathodaa	0	-	-	-	-	936	471	465	193	4.8	0
Maathodaa	485	238	247	98	5	-	-	-	-	-	-
Fares	450	238	212	97	5	-	-	-	-	-	-
Thinadhoo	4893	2387	2506	742	7	4442	2168	2274	728	6.1	-1.6
Industrial Island and Other	46	43	3	2	23	22	22	0	3	7.3	-12.3

¹⁰ The number of islands has been counted from the Official Atlas of the Maldives, Ministry of Planning and National Development, Republic of Maldives, published in 2008.

The number of households slightly increased from 2000 to 2006 indicating the establishment of new family units on the islands. The sex-ratio was roughly 50/50 with the slight decline in proportion of females in the latter period.

Looking at the table, including the population of the two atolls, it may be a fair assessment to say that there is net decline in population Huvadho Atoll. This can be explained due to emigration of the people to Malé and central Maldives where job opportunities and economic prospects are higher.

Table 10 shows the number of schools and student enrolment in the GA and GD atoll. Proportionate increase of student population, relative to total population is seen in GD Atoll indicating same level of enrolment probably also consistent with other atolls.

Table 10: No of schools and student population in GA and GD Atolls. Source (Department of National Planning Statistics, Accessed October 2011).

Locality	Schools				Students			
	Total	Government	Private	Community	Total	Government	Private	Community
GA	17	9	6	2	3,015	2,545	375	95
GDh	24	10	12	2	3,846	3,051	713	82

8.3 FISHERY

Fishing is the most important economic activity in the Huvadho Atoll. In the early 1980s atolls in the north caught more fish relative to Huvadho atoll. However, the pattern is opposite now. Mechanization facilitated to harvest fish from the rich fishing ground in Huvadho Channel (*Sato Raha*) and in the south (*Addu Thila*) and in western side of the atoll. This resulted rapid increase in catch and economic benefit to the community. Bigger boats and powerful engines meant they are fully exploring the rich fishing grounds in the area. In fact the largest sized boats are now most common in Villingili (GA) and Thinadhoo (GD).

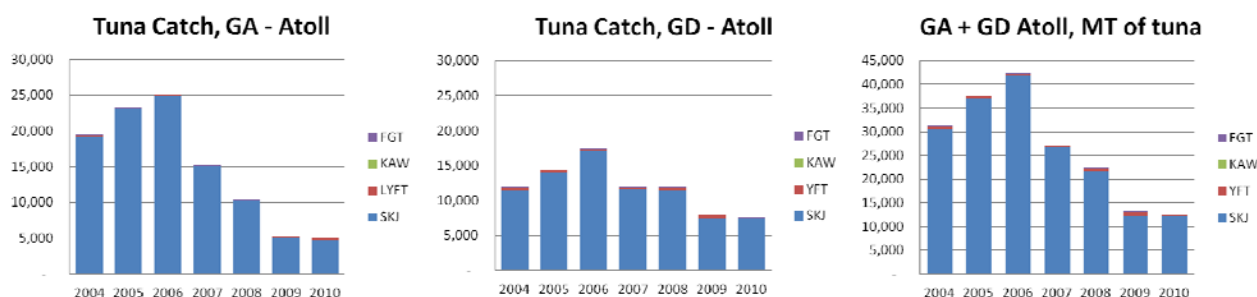


Figure 37: Tuna catch by species for GA, GD and GA+GD. Around the peak catches more about 50% of the recorded landings were from Huvadho Atoll. Source: MoFA Fisheries Statistics. SKJ = Skipjack, YFT = Yellowfin tuna, KAW = Kawakawa, and FGT = Frigate Tuna.

Similar to the national trends, the total tuna catches rose to a peak, with dramatic increase in fishing efficiency (larger boats, with powerful engines and large bait holding capacity with the possibility of multi-day fishing). Catches rose to a peak in 2006 declining rapidly.

Nationally recorded tuna catches were around 135,000 t 2006 and in 2010 the figure dropped to 59,000 t. During the 2006 close to 50% of the total tuna production came from Huvadhoo Atoll. Thanks to larger number of vessel being registered (Figure 38) and increasing size of the fishing vessels (Figure 39) in the area.

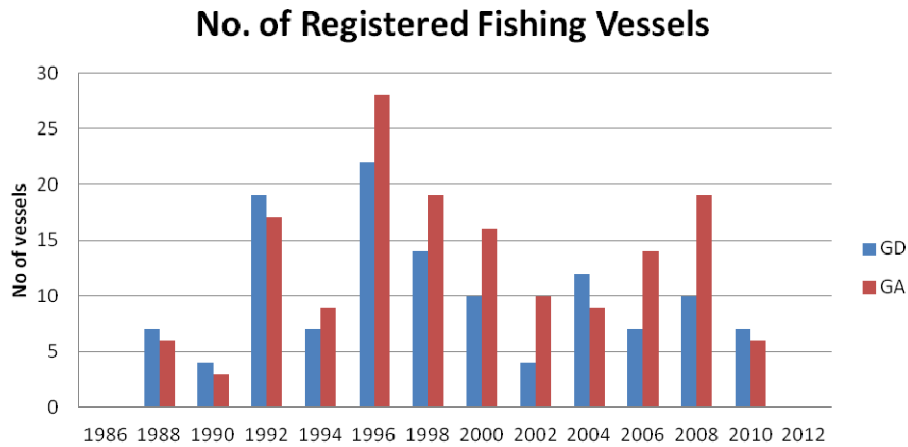


Figure 38: Number of Registered Fishing Vessel at MoFA by TWO-YEAR bins, Note 2011 data is exclude (source: MoFA)

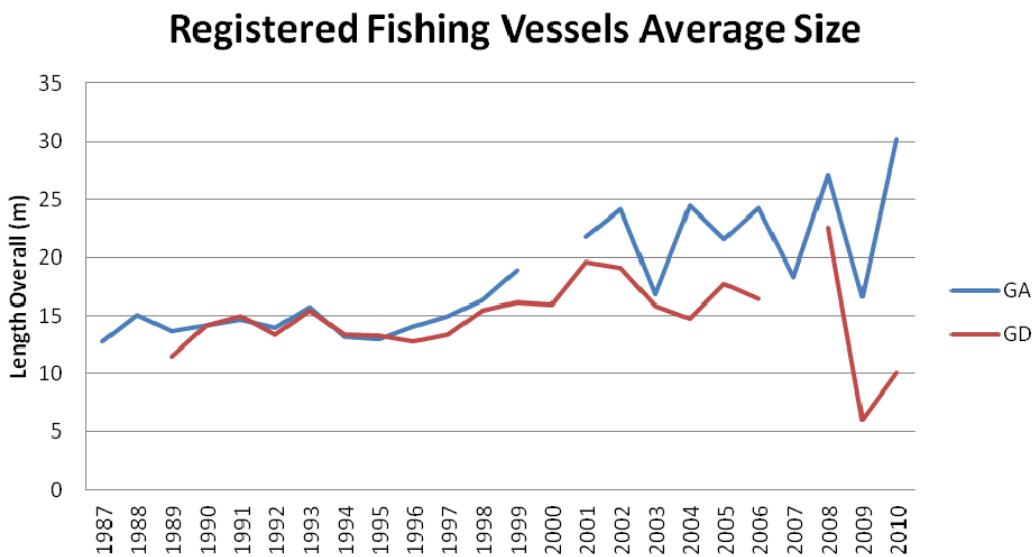


Figure 39: AVERAGE Size of fishing vessel in Huvadhoo Atoll, Source: MoFA

The declining tuna catches and catch rates have been a major concern for all communities in Huvadhoo Atoll. For island likes to Villingili, which depends on tuna fishing, the declining catches have hit to the community.

The boat owners and crew of large vessels (>85 feel LoA) have been hardest hit. The overheads and fixed costs are higher. It has been said about 2.5 – 3.0 mt of catch would be required for day of fishing in order to make the trip economically viable.

Recently government announced the ‘back to longline fishing’ programme where vessel owners and captains are being encouraged to uses of the large vessels for longlining. In the early part of 2011 longline training has been conducted targeted on modified pole-and-line vessels. The economic impact however, has yet to be seen.

An alternative use of these large pole-and-line vessels has been to use as large yellowfin handline vessels. Large, > 80cm total length, yellowfin tuna are caught from surface school using scads (*rimmas / mushimas*) which are sold to fresh exporters. Current rates of large yellowfin range from MVR 40-60 MVR per kg. Data shows that handline yellowfin tuna fishing are more popular in GD Atoll (cf. Figure 37).

8.4 TOURISM ACTIVITIES

An alternative economic activity in the region has been the tourism. It has been fortunate that poor fishing coincided with the start of the tours in the island. It is believed the reasonable amount of young fishermen left to work on resorts. Presently there are three resorts in operation with a reported bed capacity of 324.

Table 11: Resort development activities in the Huvadho Atoll. A total 16 islands have been earmarked for development around 2008/2009, but only 3 resorts are in operation. Data from MoTAC and Official Atalas of the Maldives.

Atoll	Name	Operation / Status	Bed Capacity
GA	Hadahaa	Yes	100
GA	Funamaudua	Yes	150
GA	Meradhoo	Yes	74
GA	Dhigurah	Planned 2012/2013	?
GA	Falhumaafushi	Opening soon	200
GA	Kerehdhoo	No	?
GA	Vodamula	No	?
GA	Munandhuvaa	No	?
GA	Mahahdhoo	No	100
GA	Kodeymatheelaabadhoo	No	?
GD	Kaashidhoo	No	?
GD	Odagalla	No	?
GD	Lonudhuhutta	Construction (?)	?
GD	Magudhuvaa	No	200
GD	Vatavarehaa	No	?
GD	Konotta	No (?)	100

A total of the 16 islands have been ear-marked for resort development. However, today only 3 resorts are in operation. Falhumaafushi is likely to be opened later in the year or early 2012.

8.5 MAIN OBSERVATIONS

Tuna fishing is the most important economic activity in the region. Declining trend in the total population suggest there is net emigration of population, particularly youth to Malé and central region for better economic opportunities. Public infrastructure development

activities¹¹ and start of tourism has helped to offset the economic loss of poor fishing in the region.

The construction of airport will be a necessary and important project for the long-term development of the GA Atoll. During filed visit it was observed that Falhumaafushi, which is just few island south of Kooddoo Island is about to be completed and is expected to officially open later in the year. Similarly resort development work on Dhigurah is also planned by Bonavista (Maldives) Private Limited. Therefore economic conditions are ready for development of the domestic airport which has been planned for some time.

¹¹ Isles website maintained by President's Office; <http://isles.egov.mv/>, accessed October 2011.

9 POTENTIAL IMPACTS AND MITIGATION MEASURES

Impacts on the environment from various activities of the proposed development work (constructional impacts) have been identified through a consultative process with the project development team, field surveys, observations and assessment, as well as based on field experience of similar development projects in the country. Other sources of information have been used wherever possible since the use of such data is applicable and less time consuming.

Possible negative impacts on the environment have been considered in worst-case scenario to recommend mitigation measures in the best possible ways so that these impacts would be minimized and perhaps eliminated in both constructional and operational phases.

This report of the EIA identifies the significance of adverse impacts on the environment from the proposed project. Impacts on the environment were identified and described according to their location/attribute, extent and characteristics (such as short-term or long term, direct or indirect, reversible or irreversible) and assessed in terms of their significance according to the following categories:

- **Negligible:** the impact is too small to be of any significance
- **Minor adverse:** the impact is undesirable but accepted
- **Moderate adverse:** the impact give rise to some concern but is likely to be tolerable in short-term, or will require value judgment as to its acceptability
- **Major adverse:** the impact is large scale giving rise to great concern; it should be considered unacceptable and requires significant change or halting of the project

This section of the report discusses the potential impacts and possible mitigation measures that can be taken during the initial mobilization of labourers; machineries/equipment's and site clearance. The operation stage of the project is covered in a separate EIA to be submitted later.

9.1 IMPACTS AND MITIGATION MEASURES

9.1.1 Impacts from Mobilization of Equipment and Labour

Influx of workers to the island would inevitably have negative impacts on the terrestrial environment. Lack of awareness or concern to preserve the environment may lead to deliberate or inadvertent damages to the trees in order speed up their work. Disposal of hazardous waste and sewage may be a concern if not appropriately dealt with. If proper attention is not paid such a large number of workers in the island could easily disturb the island fauna.

Since the island already contains a separate investment, the incoming new workers may come into conflict with the existing workers and the management of the fish processing plant. This effect may be most prominent if the resources are shared between the two groups.

Construction of temporary accommodation will require additional land clearing and establishment of facilities for water sourcing, sewerage and waste management. The contractor is planning to have the temporary accommodation within the area to be cleared so as to minimize or avoid clearance areas other than what is absolutely necessary.

Mitigation Measures:

- Areas should be clearly marked for construction activities.
- A specific area should be designated in the coastal area for landing and material loading/unloading.
- Vegetation that needs to be retained must be clearly marked and communicated to the construction workers.
- Signs should guide workers to proper environmental care.
- Avoid sharing facilities with the existing investment unless explicitly agreed or unavoidable.
- A portable desalination plant should be installed for potable water
- Special arrangements should be made to use the existing harbour for loading and unloading.
- The supervisor should check compliance of the workers to the environmental guidelines set for the project including avoidance of removal of unmarked vegetation, proper waste management, marine water pollution and ground water pollution.

Table 12: Impacts of mobilization of labourers, machineries and equipment.

Impacts	Causes	Significance	Mitigation measures
Degradation of existing groundwater	<ul style="list-style-type: none"> - Increased abstraction of groundwater for the use of labourers. - Oil spillage from vehicles (lorries, excavators) - Mishandling of solid (non-biodegradable) waste - Vegetation clearance to make roads 	<ul style="list-style-type: none"> - Minor adverse 	<ul style="list-style-type: none"> - Fuel handling should be done under careful supervision and regular monitoring - All waste oil should be handled carefully and transported in sealed containers to designated areas in properly banded vehicles/vessels - Litter bins should be kept at easily accessible locations with proper warning signs to reduce littering and dumping waste on the island
Shift in existing ecological regime of the island	<ul style="list-style-type: none"> - Disturbances to the existing fauna on the island by the labourers (e.g. collection of turtle eggs, birds etc., increased noise and vibration levels) - Lack of awareness or concern to preserve the environment may 	<ul style="list-style-type: none"> - Minor adverse 	<ul style="list-style-type: none"> - Areas should be clearly marked for tree clearance area - Vegetation that needs to be retained should be clearly marked and communicated to the workers - Signs should be placed to guide the

lead to deliberate or inadvertent damages to the existing flora and fauna of the island	workers on proper environmental care - Project managers should control the workforce and confine their activities to the project area
---	--

9.1.2 Water Contamination (Marine Water and/or Ground Water)

Vegetation removal work will require the operation of heavy machinery which may involve accidental spill of oil and toxic substances. Such an event will contaminate the marine and/or groundwater.

In the Maldives, groundwater contamination is an irreversible impact due to the absence of impermeable layers to separate the freshwater lens in independent reservoirs. Accordingly, any point sources of pollution would cause the contamination of the entire island groundwater resources. If human consume such contaminated groundwater, it may lead to serious health risks leading to increased public and private health costs. Furthermore, contamination of groundwater will force the Kooddoo Fisheries Maldives Ltd to rely on rainwater or desalinated water that will also be costly (rainwater can be costly due to the need for increased storage capacity). Therefore, special care should be taken when handling oil, solid waste and hazardous waste to entirely avoid any accidental spills and leakage.

On the other hand, clearing of vegetation will also lead a faster recharge since water loss of water due to vegetation cover and evapotranspiration may be lower.

Mitigation measures:

- All paints, lubricants, and other chemicals used on site will be stored in secure and bunded location.
- Oil, solid waste and hazardous waste will be handled carefully and transported in sealed containers in properly bunded vehicles/vessels
- Construction activities will be carried out under the supervision of a suitably experienced person.
- Vessels, equipment and machinery used for the work should be properly maintained at all times during the operation.
- Littering and accidental disposal of any construction wastes can be avoided by pre-planning modalities for waste disposal or re-use wherever possible. Careful planning of the work activities can also reduce the amount of waste generated.

9.1.3 Noise, Vibrations and Air Pollution

During the mobilisation of equipments and operation of heavy machinery for vegetation removal, it is anticipated that significant noise will be generated. Furthermore, noise vibrations may alter species behaviour. In addition, dust and emissions from vehicle and machinery exhausts will degrade the air quality. However, these adverse impacts will be short term and can be mitigated to avoid nuisance to the existing fish processing plant. With proper mitigation measures, it is unlikely that noise and air pollution impacts will cause long term effects such as human health risks leading to increased public and private health costs.

Mitigation measures:

- All construction works will be carried out during day time to minimise nuisance to the fish processing plant workers and disturbances caused to nocturnal fauna such as birds and fruit bats that uses auditory communication.
- All vehicles and machinery will be tuned and well maintained to minimise air pollution
- To minimize dust from construction works close to the fish processing plant, ground/soil will be kept damp.

9.1.4 Loss of Flora and Fauna

- Vegetation clearing is one of the most significant impacts of the proposed project. It is anticipated that between 5,000 and 7,000 coconut palms and roughly 5,500 – 11,500 other species mainly, *Midhili*, *Uni*, *Kandhu*, *Ruh*, *Madhoshi* and *Dhigga* will be cleared. A total of over 40,000 – 50,000 trees (including small bushes) may have to be removed. This loss is irreversible as the area has to be left cleared for the rest of the airport operation period.
- Loss of vegetation means, loss of fauna that depend on those vegetation. Such species include birds, rats, fruit bats and invertebrates.
- Degradation of the topsoil due to exposure to sunlight and heavy rainfall.
- Changes to the vegetation regime of the island. The dominant species on the island will be replaced by busy vegetation, grass and creeper varieties.
- Equipment mobilisation for the proposed project is substantial. This may require additional vegetation clearance on the sides of the roads, noise pollution and dust pollution on the island.
- Dredging will completely denude epi-fauna, borrowing and sedentary organism on the substrate. Mobile fauna, such as fish will swim away and will not be affected.

Mitigation measures for loss of species:

- Most of the large and mature trees removed will be made available for the neighbouring Villingili Island, Ga. Falhumaafushi, K. Vilivaru¹² for replanting in the newly reclaimed areas. Trees may also be made available for other reclaimed islands such as Thinadhoo and Gadhoo. The transport arrangements should be negotiated between the two parties. Removal of trees will be undertaken with to ensure that it could be replanted.
- The developer plans to replant large tree lost from the activity. Extensive revegetation activity will be carried out in the newly reclaimed areas Villingili Island in coordination with the island council. New trees may also be planted on other islands with newly reclaimed land.
- Measures are taken to ensure at least 70% of the relocated trees will survive at the replanted sites. Monitoring of these sites will have to ensure that the target is achieved.

¹² Vilivaru is being re-developed including a substantial reclamation (Adam, MS 2010).

- Vegetation clearing will be only done for the trees that will require clearing. Any trees that can be retained will be retained.
- Strict guidelines and construction monitoring is required during the vegetation removal stage to ensure that every single large tree could be replanted.
- All clearing works will be carried out during day time to minimise disturbances caused to nocturnal fauna such as birds and fruit bats that uses auditory communication, turtles nesting on the eastern side and to the fish processing plant workers.

9.1.5 Greenhouse Gas Emissions

Vegetated areas are known to act as carbon sinks for greenhouse gases particularly carbon-dioxide. The proposed project involves clearing of vegetation during site preparation. However, the removed large trees are planned to be replanted in other islands.

Mitigation Measures:

- All mature trees will be re planted where possible.
- Only vegetation that is absolutely necessary to be removed will be cleared.
- Waste will be properly stockpiled temporarily on site and disposed at a designated disposal site.

9.1.6 Impacts from Waste

A significant volume of green waste will be generated from the project. These need to be managed to avoid major environmental problem on Kooddoo. Managing this waste should be a priority in the construction stage.

Solid waste, waste water and sewage generated by the workforce may affect the groundwater and general terrestrial environment of the island.

Mitigation measures:

- The primary method of handling the large trees is to replant them in the newly reclaimed areas of Villingili. This activity will be undertaken with the assistance of the relevant Island Councils. Hence, all large trees are expected to be replanted if they are in conditions to do so. Care will be taken during the removal to ensure that they can be replanted.
- All small trees, where possible will be replanted.
- Replanting in other islands will be carried out according to the natural pattern of vegetation occurrence. The coastal vegetation will be the first layer of vegetation close to the newly created shoreline. This will comprise mainly of *Magoo* and *Kuredhi*. The second layer will be a mix of medium to large trees. The third and the largest layer will be coconut trees.
- Trees in access to the requirements of the reclaimed inhabited islands will be made available for transport to other islands including nearby resorts and resort sin other atolls.

- The coconut leaves of the damaged coconut trees will be made available for nearby island to be reused for thatch weaving.
- All other waste which cannot be used for replanting will be collected to a designated point or points. Amongst these people from other islands would be allowed to carry material of use to them, such as firewood, wood and coconuts. This will be done under the supervision of the site supervisor.
- Sale of coconuts to Malé is being considered as an option.
- All remaining waste will be incinerated on site. Incineration will be phased and controlled to ensure minimal air pollution to the fish processing plant.
- The green waste shredder or equivalent will be used to shred the larger and stronger material for disposal.

9.1.7 Impacts from Dredging

Reef flats are natural areas of protection to the island and so the deepening of the area within the reef flat will have a negative impact to the ecological habitat in the area and to the island. Given below are relevant impacts that should be considered

1. Loss of ecological habitat: The effect of this would be in the immediate to medium term with the loss of substrate and its fauna. In the long-term it may be expected coral recruitment would occur and reef will re-grow. The area proposed for dredging does not have much coral and so the loss of corals would be minimal.
2. Disturbance to the area during dredging activity: Normal procedure for dredging using excavator involves creating temporary causeway or beds to move the excavator to the required site. This involves shifting of material to several places to transfer the material. Release of sediments and potential loss of the faunal composition underneath sediment material will undoubtedly occur.
3. Dredging an area would mean permanent change in physical attributes of the area and therefore potential change in the flow patterns. Tidal flows can be quite significant on the shallow reef flats and deeper areas will dampen the flow. The unexpected outcome may be erosion or accretion of the island or coastal areas.

Mitigation Measures: It is almost impossible to precisely predict the actual impact from such dredging. A range of possible outcomes is expected as have been mentioned. The most important mitigation measure is to monitor the area and respond to the changes in the coast line. The airport operator should be aware of this and should be prepared to for potential shore-protection and stabilization measures in the future.

In order to minimize the impact from sediment, dredging should be completed in shortest time possible. Dredging ought to take place during low tides or slack tides to minimize the release of sediment to the area.

9.1.8 Impacts from Temporary Landing Site

The depth at the proposed temporary landing site is around 0.3 – 0.4 m. Assuming equipment and machinery will be transported on flat-topped barges the actual depth that may be required for barges will be minimal. The barges have shallow draft. Barges at Maldives Ports Ltd (MPL) are around 0.6 – 0.8m and so only a minimum amount of the substrate would be required to remove. For practical purposes the area that required deepening will be close to the beach..

Possibilities of accident exist when manoeuvring large barges close to the reef area. It could potentially be risky to undertake the work in bad and rough weather. During the inter-monsoon periods the area gets rough as the winds would be in direction across the harbour wall. Grounding of the barge in bad weather could cause significant damage to the coral reef.

Excavation or dredging of the area will damage and obliterate the bottom substrate. This will be unavoidable. Dredging will also release sediments into the water columns which may cause stress to the coral if remained for long periods of time.

Mitigation Measures:

- Employ experienced personal in handling barge in coastal areas and on coral reef. Ensure the entire operation is supervised
- Avoid period of rough weather to unload the equipment
- Excavate /dredge in low tide or slack tide to coincide the dredging period to lowest water movement.
- If the time period between unloading of heavy equipment including loading of trees and final completion of project is long, remove the clear the landing area.
- Any material that is left has to be spread out on the beach areas that may require replenishing.
- Alternatively excess material may be used to base-layer filling of the air-strip requiring less material to develop from the borrow area.

9.2 POTENTIAL POSTIVE IMPACTS

The most significant positive impact from the proposed development will be generation of employment opportunities for nearby islands. In addition, the improvement in small business sales and marine transport services in Villingili and nearby islands due the presence of the workforce is considered a key benefit.

The availability of trees removed from the project is a good opportunity to re-vegetate the barren recently reclaimed land in Villingili Island and Falhumaafushi resort in the south.

9.3 SITE CLEARANCE

Approximately 40% of the land area of Kooddoo Island is planned to be used for the airport. Thus a large portion (approximately 75% of the existing vegetation) of the island need to be cleared. This will inevitably lead to permanent loss of habitat for the existing fauna of the

island, disrupt many ecological processes as well as degrade the soil, water and air of the island.

Clearance of vegetation will destroy habitats, and force the fauna of the island to seek habitat elsewhere. As a large portion of islands vegetation will be removed, there will be a significant reduction in the islands biodiversity.

Removal of vegetation will create potholes on the ground, loosen the soil and significantly reduce the amount of nutrients supplied to the soil in the form of dead leaves, fruits, dead insects and animals. In addition without shade of large vegetation top soil layer will be exposed to direct sunlight, which will further degrade the quality of the soil and make it prone to erosion.

The net amount of carbon dioxide emitted to the atmosphere will inevitably increase if such a large amount of trees are removed. Even though the number of trees cleared for this project is small in a global context, this will contribute to increase in CO₂ emission and subsequently global warming. Hence, special precaution needs to be taken to reduce the number of trees that killed during the clearance process, and these trees need to be replanted at a suitable location.

Table 13: Impacts of site clearance.

Impacts	Causes	Significance	Mitigation measures
Loss of habitat for existing fauna	<ul style="list-style-type: none"> - Large scale vegetation clearance will force existing fauna to find new habitats - Production of excessive and constant noise would affect the existing fauna on the island. 	- Moderate adverse	<ul style="list-style-type: none"> - Effort should be made to retain/not harm as much as vegetation that is outside the project boundaries - Vegetation clearance areas should be clearly marked and informed to the workers
Degradation of top soil	<ul style="list-style-type: none"> - Removal of vegetation, exposure of soil to direct sunlight, and loosen the soil which will be more prone to erosion - Disruption in nutrient cycle , by the reduction of nutrient supply 	- Moderate adverse	- None
Loss of terrestrial resources	- Removal of coconut palms, and other trees	- Moderate adverse	<ul style="list-style-type: none"> - Efforts should be made to replant the fruit bearing plants at another suitable location - It is expected that 70% of replanted trees will survive at the replanted sites
Global warming	- Removal of vegetation will increase the net amount of Carbondioxide	- Moderate adverse	- Special precaution need to be taken to ensure that larger plants are not

released into the atmosphere.	killed during removal process.
	- Replanting the large trees at suitable locations

9.4 IMPACTS FROM WATER AND POWER PLANT

Impacts water production plant would be related to intake, brine outfall, noise and issues relating to water quality. Each issue is dealt below.

Intake: The proposed method for water intake is direct from the sea. The intake from sea requires expensive maintenance and additional load to membranes – expensive maintenance due to bio-fouling and additional load to the membranes due sediment concentration.

Brine outfall: An inevitable by-product of reverse osmosis is the concentrated brine which is high in salt content. In most cases brine outflow is located in harbour in to a place where there is reasonable amount of water flow. It is unlikely that brine discharge to seas would cause any noticeable detrimental impact as the concentrate becomes immediately diluted on release. On Kooddoo it is proposed that brine outfall be on the western side, just off the lagoon.

Noise: Similar to the power generation facility water production facility generated noise from the electric motors. It is recommended that noise level immediately outside the facility be maintained below 65dBA.

Water Quality: A number of precautions have been proposed to be put in place to ensure water quality is maintained to the highest standards. Chlorination and UV filtration before the being store or released to the main pipeline ensure that water is safer. To ensure the quality is maintained regular water testing is required and should keep logs of these records.

The construction, installation, distribution and use of power plant would ensure the power generation facility is safe and secure and that environmental standards are met in the operational phase. Operational aspects that are likely to cause environmental impact would be noise, exhaust fumes, transport and use of fuel, handling of waste oil, safety and security of the operation of the power house, and maintenance of distribution network.

Noise: Power generation facilities Kooddoo will operate in wide open space. Therefore the location and operational aspects of the power house should not be a problem with regards to noise. Use of duct splitter type sound attenuators are common and should be used to keep the noise levels around 65 dBA in the immediate surroundings (3-5 m distance from the power house).

Exhaust: The diesel engine exhaust is a mixture of hundreds of constituents in either gas or particle form. Among the gaseous hydrocarbon components of diesel engine exhausts that are individually known to be of toxicologic relevance are the aldehydes (e.g., formaldehyde, acetaldehyde, acrolein), benzene, 1,3-butadiene, and polycyclic aromatic hydrocarbons

(PAHs) and nitro-PAHs. It is known that emissions vary significantly in chemical composition and particle sizes between different engine types (heavy-duty, light-duty), engine operating conditions (idle, accelerate, decelerate), and fuel formulations (high/low sulphur fuel).

Given these observations the exhaust fumes would have to be released to a high enough, ideally above the canopy of the Kooddoo, so that fumes will be quickly carried out by the wind. Use of the high-grade fuels and appropriate filters would minimize the release of these substances. Regular service of the engine is equally important as the minimizing the release of these substances.

Transport and use of fuel: Environmental impacts relating to fuel transport and usage during the construction phase is understandably high as permanent storage and transport services are not in place. It is recommended that arrangements from Kooddoo be made for supplying fuel to the power house of the airport.

Waste oil: The waste oil should be disposed to site used by the Kooddoo Fisheries Maldives Pvt Ltd.

Safety and Security: It is common practice to have the standard safety equipments in the power house. These include fire fighting equipment (liquid carbon dioxide, fire blankets) hard hats, and ear plugs for those who on service duty. In addition earth-rods are required to comply for power plant registration.

9.5 OPERATIONAL PHASE IMPACTS

Impacts of operation phase will be minimal. These include:

- Impacts relating to increased transport traffic: It is inevitable that additional transport traffic will increase due to arrival and departures of the passengers and also of the commuting staff who may be based in nearby islands. Impacts included congestion at the existing harbour on Kooddoo and potential inconvenience to passengers. If this is going to be an issue this will have to be dealt with the airport operator and the Kooddoo Fisheries Maldives Pvt. Ltd.
- Impacts relating to operation of airport. In the short term it is unlikely that air-traffic will be of any significance. However, given the landing path is not too far from Villingili, particularly Kooddoo Fisheries Maldives Pvt Ltd minor disturbance may occur.

10 ALTERNATIVES

10.1 NO DEVELOPMENT OPTION

With the current pace of development it is highly unlikely that a domestic airport will not be developed in the southern region. The catchment of Kaadhehdhoo Airport is limited to the eastern side of the Huvadho Atoll. Resorts being developed on the western side (e.g., Falhumaafushi and Dhigurah) and emerging need for guest transfer necessitates having a domestic airport in the region. Earlier the plan was to develop the airport on the Villingili Island, just north of the Kooddoo. A large area on the Villingili was reclaimed on the north eastern side of the island. However an airstrip of minimum 1200m would be require additional reclamation with increase in costs.

A strategic approach the government has been using recently is give concessions on the land for resort development in lieu with the national infrastructure developments. The island of Dhigurah was allocated for Bonavista Maldives Private Limited. in return for investments of the airport.

Under no-development scenario tourists will have to undertaken the one hour high speed journey from Kaadhehdhoo to Falhumaafushi or Dhigurah. During the southwest monsoon season the journey is rough and often will require abandoning the trip of arrange alternative for the guests. This will not be acceptable and therefore the no-development option will not hold.

10.2 DEVELOPMENT OPTION

Having decided and followed the development option for airport construction on the island of Kooddoo one has to consider the alternative options in Kooddoo that would have least environment impact. Following have been considered for the alternatives.

10.2.1 Use of the Existing Fishery Harbour

During the community consultation a strong recommendation that came from the community was to have a separate harbour / jetty area in the south or an exclusive harbour for the airport. However, the development option have been to use the existing harbour and double it as airport harbour as well as the fishery harbour.

It may be necessary do delineate area(s) of the quay wall and harbour area for exclusive use of the airport passengers, crew and airport staff. This arrangement will be made between the airport operator and Kooddoo Fisheries Maldives Pvt. Ltd. The use of existing harbour area will be the least impact option.

10.2.2 Temporary Landing Site for Mobilization of Heavy Equipment

Airport construction requires the deployment of heavy equipment as have been described in Section 3.3. This is expected and should be catered for given the decision to develop the airport Kooddoo Island. Also having considered the option of using exiting harbour the question then remains how the heavy equipment may be unloaded. With the possibility of

transporting the equipment on flat-topped barges to the harbour area it would require heavy cranes to unload them. Assessments show that lifting the equipment will be a costly exercise requiring mobilizing heavy cranes which does not overcome the original issue.

Considering this it has decided a temporary landing area would be made. The temporary landing area is north of the island where an entrance and a beach area exist (cf. Figure 7). Both these features make it an ideal area for creating the temporary landing area.

The developer does not wish to dredge or deepen the area unless it is absolutely necessary. It is planned the equipment will be transported on flat-topped barges which normally has a shallow-draft (0.4 - 0.5m).

The plan is to create a sand-bed from the beach to the level of the barge where equipment will be driven over. Once the work is complete the area will be cleared. Any excess material will be spread out on the beach area as required or used as filling material for the air-strip.

10.2.3 Location of Source Material for Base Layers

There could be three options for obtaining the material for the base layer

1. Importing aggregate from nearby country
2. Transporting material from the dredging area (ongoing dredging project)
3. Sourcing material locally

Importing aggregate is the most expensive option, but this is also the best in terms of aggregate quality. However, this may be prohibitively expensive given the limited amount agreed to complete the investment.

Transporting material from a dredging area may be feasible, but depends on the distance and also if the dredged material is not going to be used for project activities. It is often the case the material is always used for reclamation. For all practical purposes the sourcing material from different project is also not feasible and.

The third option which is sourcing material from the local house reef is the most economical, practical and probably the only means to effectively obtain material. Given that about 20,000 m³ is the required amount, varying the size of the borrow area and depth at which the area will be dredged could help to mitigate some of the negative environmental impacts.

11 MONITORING

Environmental monitoring is essential to ensure that post-construction and operational impacts are known and eliminated in a timely manner. Dealing with impacts earlier would save money and also help planning and operationalize the process.

The parameters that are most relevant for monitoring the impacts that may arise from the proposed project are included in the monitoring plan. These include ground water (pH, dissolved oxygen, electrical conductivity, total oil (Hydrocarbon) and faecal coliforms), water quality (turbidity, dissolved oxygen, phosphates, nitrates and BOD), sediment deposition. Also are the shoreline changes that may occur due to the medium to long term impacts from the changes in coastal processes.

Shoreline, Beach Profiles and Coastal Process:

Parameter	Indicators	Baseline / Reference Values	Method / Technique	Frequency
Shorelines (high / low tides)	Sediment distribution	Baseline to be re-established immediately after construction is complete	Differential GPS	Bi-annually in the first two year and yearly thereafter
Beach profiles	Rates of accretion / erosion	Requires to re-establish the baseline following the construction	Beach profile surveys	Bi-annually in the first two year and yearly thereafter
Currents	Nearshore currents	Baseline to be collected immediately constructions are over, especially on western side	Drogue survey	Bi-annually in the first two year and yearly thereafter

Reef Surveys:

Parameter / Method	Frequency of Monitoring	Purpose
Benthic cover by major life forms (live, dead, rock rubble and sand)	Annually	Indicative of the changes in the live coral cover
Fish population / visual census	Annually	To assess broad scale change in the ecological status of the coral reefs (increase / decrease of herbivores, etc)

Water Quality:

Type	Parameters	Locations	Frequency
<i>In situ</i> monitoring / sampling and testing from a laboratory	Dissolved oxygen Turbidity (NTU) Nitrates	All locations marked	Bi-annually

11.1 MONITORING COSTS

It is understood that costs of monitoring be borne by the airport operator. It is also understood the mitigation measures would be accommodated in the contract costs. A commitment from the proponent is given Annex 10.

12 STAKEHOLDER CONSULTATION

It is important to note that the domestic airport development projects are entirely driven by the Government. The decision on project location and modality of financing has been executive decisions of the National Planning Council where President himself chairs the meeting. As mentioned earlier the site ear-marked for the particular domestic airport was Ga. Villingili. But later, on the grounds of cost effectiveness, government decided to change the site to site Kooddoo. Appropriate political level consultations with the stakeholders, at the national and regional level, were undertaken before the decision was reached. Therefore the stakeholder consultation undertaken for this EIA is merely the community consultation at the lower level required to fulfil the ToR for this EIA report decided at the Scoping Meeting.

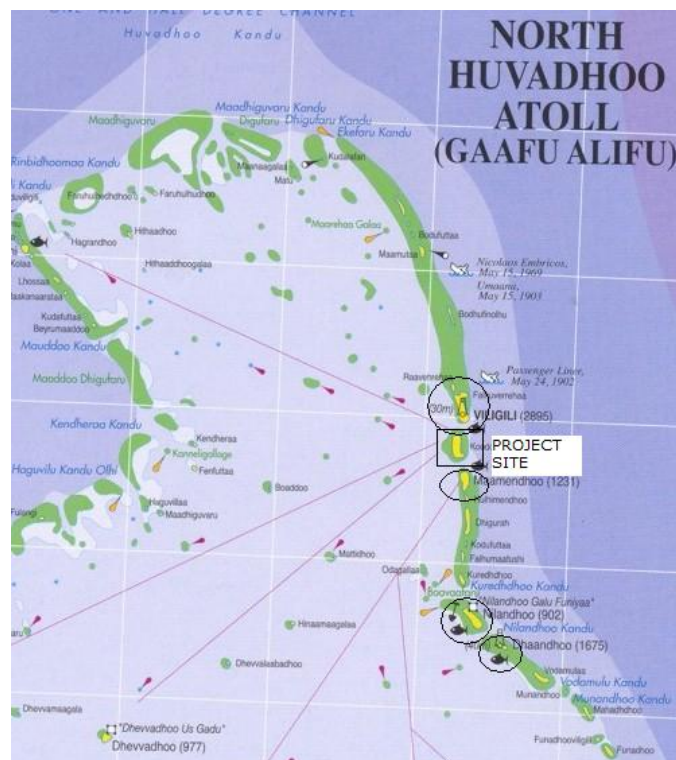


Figure 40: Map showing the islands where community consultation were undertaken.

For this particular consultation, four islands were chosen; GA. Villingili, GA. Maamendhoo, GA. Dhaandhoo and GA. Nilandhoo (**Figure 40**). The procedure adopted for the consultation was that first a letter was first sent to the respective political appointee of the island explaining the project and requirement for the consultation (Annex 12). It was through this contact point the meetings were organized in various islands.

Meetings were held in each island and the invitation to attend the meeting was open to everyone interested in the development project. It is therefore assumed NGOs and community groups attended the meeting. The full list of participants at the meetings is in Annex 13. At the meeting, the project was introduced and plans for construction were presented. Following that, the floor was opened for the questions and questions were responded, either with the help of political appointees or by the Consultant's team.

Notes were kept for the each meeting. However for the purposes of presentation the combined issues are presented here. They were:

1. The public was not consulted on the matter of the proposed construction of the airport on Kooddoo, and they only learn about the project during the EIA phase of the project.
2. Development of an airport in Kooddoo could lead to demolition of existing fisheries infrastructures, and cessation of fisheries operations on the island.
3. Concerns were raised on what will happen to the existing jobs at the Kooddoo Fisheries Maldives Pvt Ltd.
4. Area proposed for construction of the runway is very fertile and suitable for use as agricultural land.
5. Major deforestation from this project may give way for natural disasters to take a huge toll on the island.

No direct responses for these major issues given at the meeting. However, some explanation of the various options was provided. Some of the responses that were given at the meetings were follows. The explanation is given in the chronological order in which they are given above.

1. The general response given on the issue was that the decision for airport was finalized at the executive level at the NPC meeting after consultation with the political appointees in the region. While the community consultation is an important aspect of EIA process stipulated in the guidelines of EPA, it is almost the case the community consultation takes place after decision is made.
2. It was communicated that fish collection activity taking place on Kooddoo island can actually co-exist along with the operation of the airport. Since fish collection activity started in early 1990s the activity has not expanded and additional land was not required since then. Thus the infrastructure remains more or less the same at time of start of the operation. At this stage it is not entirely clear who would actually operate the airport. It is likely that airport operation will have to be shared, or of some involvement with the Kooddoo Fisheries Maldives Ltd. This is an issue that government would have to address before the operation of the airport starts.
3. Given the scenario of the continued operation of the Kooddoo operation no job shedding is expected to occur as a result of the airport project. In fact it may be that additional jobs would be created attached to the Kooddoo operation depending on the how airport will be operated.
4. Kooddoo is a mature island and therefore the land is potentially usable for the kind of agriculture that takes place in the Maldives. At present there are no targeted agricultural activities or investments on the island. There appears to be no plans for agricultural investments on the island. It was communicated that the project should be looked from a different economic perspective, on the medium to long term benefits that will be bring to the region and to the specific

constituencies that consultation took place. Airports are necessary investment for the tourist and development trade. Area of unexpected economic spill-over could be huge. When looked this broader context, using that land for agriculture is economically less beneficial than the development of airport.

5. Deforestation or vegetation clearance will take place only in the air-strip only. No coastal clearance would be required and so overall impact to the coastal areas would be negligible. A different way of looking at these issues to observe the islands where regional airports have been done; Hanimaadhoo, Kahdhoo, Kaadeddhoo. There have not been significant environmental or natural disasters. Vegetation clearance and operation of airport are unlikely to influence likelihood natural disasters.



Figure 41: Community Consultation at the islands; Top row; Villingili (right), Dhaandhoo (left), Bottom row; Nilandhoo (right) and Maamendhoo (left).

12.1 SUGGESTED RECOMMENDATIONS

Some communities were particular about making sure certain things are developed or certain services were started. Following are the major requests that came out from the meeting.

1. Direct ferry access to the airport from all the islands
2. A harbor on the south western side of Kooddoo, will make it easier for islands on the southern side of the atoll to closer access to the airport
3. Fair job opportunities for all islanders.

At the time of this writing the Government's view is that no additional access to the island would be developed. The existing fishery harbour will be used for provide the transfer and access to the airport. As have been suggested earlier, it is likely that some form of formal arrangement with the Kooddoo Fisheries Maldives will have to be made before the airport becomes operational.

If over time, a separate access to the island is required, and proper assessment will have to be made and the environmental issues will have to be dealt with separately. The agreement between the Government and the developer of the airport is very clear on what should be developed as part of the domestic airport (Annex 3). It is unlikely an additional harbour would be developed.

There is no doubt that job opportunities will be created. It is likely that 40-50 new jobs will be created with scope of additional opportunities of employment due to spill-over effect of the airport.

13 CONCLUSIONS

The environmental impact assessment study for the construction and operation of Kooddoo Domestic Airport Project on Kooddoo Island shows there are three main activities that would cause significant negative environmental impacts. Those, in order of significance, are:

1. Dredging of 300m x 70m x 1m area on the western side, on the shallow reef flat for borrow material for the base layer of the air-field.
2. Clearance of vegetation of more than 40% of the island for construction of the air-field.
3. Creation of temporary landing site on the north western side of the island, close to the main harbour

Of these a long term impact would be dredging of reef flat. Fortunately the dredging area is not too extensive. However, impacts on the coastline of the island (potential erosion/accretion) are likely in the medium to long term. These impacts would be cumulative occurring over long period of time and so can be managed through proper monitoring and addressing them in a timely manner. Based on the scale of infrastructure and development and reclamation work projects that is taking place in Maldives at the time of this writing, impacts associated with this dredging on Kooddoo reef flat is insignificant.

Clearance of vegetation is significant in terms of loss of ecological habitat, including large and mature trees and potential agricultural land. It is expected that 70% of the relocated trees will survive provided that suggested measures in uprooting, transporting and replanting are followed. However, the positive economic impacts from the airport outweigh the loss of habitat and agricultural land.

Creation of temporary landing site is a necessary, but a minor, activity in terms of the impacts. The impacts from this would be short term and **minor adverse**. The positive effects of this would be replenishment of beach area that is currently eroding in front of the Kooddoo Guest House.

14 REFERENCES

- Adam, MS (2010). Environmental Impact Assessment for the Proposed Resort Redevelopment Project on K. Vilivaru, South Malé Atoll. Parallax Venture Partners 120 pages.
- Aleem, I, A, Jameel, A. Zahid, & A. Latheefa (2008). Environmental Impact Assessment for the Development of Domestic Airport and Transit Hotel on Dharavandhoo, Baa Atoll, Maldives. 115 pages + Appendices.
- Choi, B. H., Pelinovsky, E., Kim, K. O. & Lee, J. S., 2003. 'Simulation of the Trans-Oceanic Tsunami Propagation Due to the 1883 Krakatau Volcanic Eruption'. *Natural Hazards and Earth System Sciences*, 3, 321-332.
- DHI 1999, Physical modelling on wave disturbance and breakwater stability. Fuvahmulah Port Project, Port Consult, Denmark
- English, S., C. Wilkinson, and V. Barker (1997). Survey Manual for tropical marine resources. Australian Institute of Marine Science, ASEAN – Australian Marine Science Project. Fein JS, Stephens PL (1987) *Monsoons*. Interscience Publication. John Wiley and Sons. NY 632 pp.
- Goda, Y., 1988. Causes of High Waves at Male' in April 1987. Department of Public Works and Labour, Male, Maldives.
- Naeem, I, H. Naeem, H. Rasheed, H. Shamee, & M. Musthafa (2008). Environmental Impact Assessment Report. Gn. Fuvahmulah Domestic Airport Development, Gnaviyani Atoll, Republic of Maldives, 142 pages + Appendices
- Naseer A (2003) The integrated growth response of coral reef to environmental forcing: morphometric analysis of coral reefs of the Maldives. PhD Dissertation, Department of Biology, Dalhousie University, Halifax, NS. Canada.
- UNEP, 2005. Maldives: Post-Tsunami Environmental Assessment. United Nations Environment Programme.
- Zahir, H, N. Quinn and N. Cargillia (2008). Assessment of Maldivian Coral Reefs in 2009 after Natural Disasters, Marine Research Centre, 64 pages. Available at http://www.mrc.gov.mv/files/publications/Zahir_etal_2010.pdf, accessed October 2011.

15 ANNEXES

Annex 1: Approved Terms of Reference of the project

Annex 2: Decision Note for the EIA Report #1

Annex 3: Preliminary specification for the construction and operation of the domestic aerodrome at Kooddoo, Gaafu Alifu (Ga) Atoll.

Annex 4: Layout drawing for the Kooddoo Domestic Airport, including road layout, demarcation of Kooddoo Fisheries Maldives and Airport area and material borrow site for base-layers of the air-strip.

Annex 5: Survey areas and locations of sampling, Note on “Marine Transects” two transects were made; a shallow one and deeper one, A is the deeper one and B is the shallower one. The points are start and end points of the transect as obtained from GPS (GeoXplore XT).

Annex 6: Supplementary Notes provided following review of Report #1.

Annex 7: Instructions given to the field team for enumerated tree survey on Kooddoo Island

Annex 8: Line Intercept Transect Survey (Photo-Quadrat) Data Analysis – 5 Sites x 2 Transect Each

Annex 9: Fish Census summary by site (for 5 sites)

Annex 10: Commitment Letter from the Developer

Annex 11: Water Test Results from NHL and MAC

Annex 12: Sample letter sent to political appointees for initiating community consultation

Annex 13: List of participants by island, attended at the Community Consultations.