

REPUBLIC OF MALDIVES
Ministry of Environment, Climate Change and Technology

**The Project for Building
Climate Resilient Safer
Islands in the Maldives**

**DETAILED PLANNING SURVEY
REPORT**

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JAPAN INTERNATIONAL COOPERATION AGENCY

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Abbreviation Table

Abbreviation	Official name
AE	Acredited Entity
ADCPC	Asia Disaster Preparedness Center
ADRC	Asian Disaster Reduction Center
AFD	Agence Française de Développement
BML	Broadcast Markup Language
CATV	Cable TV
COD	Chemical Oxygen Demand
C/P	Counter Part
CVI	Coastal Vulnerability Index
DA2010	The Act on Decentralization 2010
DO	Dissolved Oxygen
EC	Electrical Conductivity
EE	Executing Entity
ECMWF	European Centre for Medium-Range Weather Forecasts
EE	Executing Entity
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EPA	Environmental Protection Agency
EWBS	Early Warning Broadcasting System
Fidelis	Fidelis Law Group LLP
F/S	Feasibility Study
GCF	Green Climate Fund
GDP	Gross Domestic Product
GII	Gender Inequality Index
GIS	Geographic Information System
GPS	Global Positioning System
H.W.L.	High Water Level
HDI	Human Development Index
HIES	Household Income and Expenditure Survey
HVI	Human Vulnerability Index
ICZM	Integrated Coastal Zone Management
IHDI	Inequality-adjusted Human Development Index
IPCC	Intergovernmental Panel on Climate Change
ISDB-T	Integrated Service Digital Broadcasting - Terrestrial
JET	JICA Expert Team
JICA	Japan International Cooperation Agency
KOICA	Korea International Cooperation Agency
LGA	Local Government Authority
M.S.L.	Mean Sea level
MERCY Malaysia	Malaysian Medical Relief Society:
MBC	Maldives Broadcasting Corporation
MECCT	Ministry of Environment, Climate Change and Technology
MEE	Ministry of Environment and Energy
MEEW	Ministry of Environment, Energy and Water
MHAHE	Ministry of Home Affairs, Housing and Environment
MLSA	Maldives Land and Survey Authority
M/M	Minutes of Meetings
MMS	Maldives Meteorological Service
MNBC	Maldives National Broadcasting Corporation
MNDF	Maldives National Defense Force
MNPHI	Ministry of National Planning Housing and Infrastructure
MPS	Maldives Police Service
NAPA	National Adaptation Programme of Action

NDMA	National Disaster Management Authority
NDMC	National Disaster Management Centre
NGO	Non Governmental Organization
NPO	Nonprofit Organization
OJT	On-the-Job Training
PDM	Project Design Matrix
PMU	Project Management Unit
PSIP	Public Sector Investment Program
PSC	Project Steering Committee
PSM	Public Service Media
SAARC	South Asian Association for Regional Cooperation
SDGs	Sustainable Development Goals
SIDS	Small Island Developing States
SLR	Sea Level Rise
SST	Sea Surface Temperature
TETRA	Terrestrial Trunked Radio
TSHD	Trailing Suction Hopper Dredger
UNDP	United Nations Development Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Fund
UNISDR/ UNDRR	United Nations International Strategy for Disaster Reduction/ United Nations Office for Disaster Risk Reduction

“the Project for Building Climate Resilient Safer Islands in the Maldives” Project Site Map (8 Islands, 4 Atolls)

Fonadhoo

Outcome1 Activity1-3
Outcome1 Activity1-4
Outcome2

Beach Nourishment (L=1600m)

Cross-section of Beach Nourishment

Maamendhoo

Outcome1 Activity1-4
Outcome2

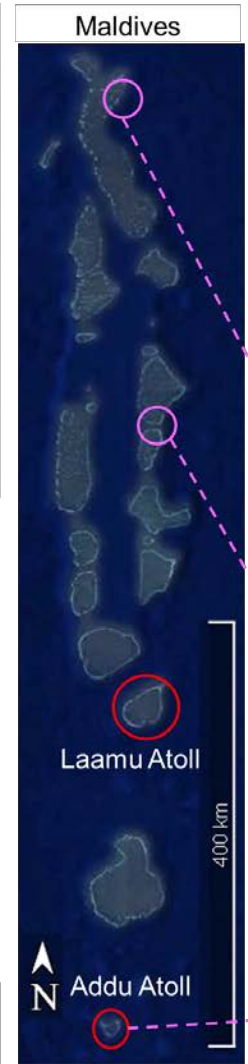
① Rubble-type Revetment(L=300 m)

① Cross-section of Reclamation and Revetment

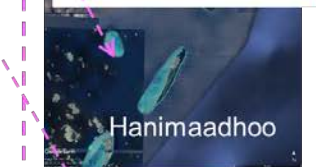
② Beach Nourishment(L=400 m), Groin L=50 m x 3

③ Reclamation(L=540 m, V=70,000 m³, 2.2 ha), Revetment

③ Cross-section of Rubble-type Revetment



Outcome3 (Wave Observation Location Map)



Outcome1 Activity1-4
Outcome2

Meedhoo

Beach Nourishment(L=1,600 m) Groin L=46.85 m x 1

Cross-section of Beach Nourishment and Groin

Outcome1 Activity1-4
Outcome2

Isdhoo

Rubble-type Revetment(L=400 m)

Cross-section of Rubble-type Revetment

Outcome1 Activity1-3
Outcome1 Activity1-4
Outcome2

Rubble-type Revetment (L=270 m)

② Beach Nourishment

Beach Nourishment V=3,000-5,000 m³

Cross-section of Rubble-type Revetment

Cross-Section of Beach Nourishment

Outcome1Activity1-3 : Study of ICZM plan on target inhabited islands
Outcome1Activity1-4 : Basic design and related studies on environmental impact assessment
Outcome2 : Establishment of a community-based coastal maintenance management system
Outcome3 : Establishment of a long-term monitoring system for waves, beaches, coral reefs, and land use

Maamendhoo



Gan



Fonadhoo



Meedhoo



Isdhoo



CHAPTER 1 INTRODUCTION

1.1 Background

The Maldives is located in the Indian Ocean southwest of Sri Lanka and consists of 26 geographic atolls (administratively divided into 20 atolls) and approximately 1,200 islands covering 90,000 square kilometers. Of these, 189 islands are inhabited by Maldivian citizens (hereinafter referred to as "inhabited islands"). The Maldivian land was formed by waves washing up coral sand and gravel on the fringes of atolls, so the land is low, flat, and narrow, with an average elevation of about 1-2 m above the water surface. In the Maldives, coastal erosion has been a remarkable phenomenon since the 1980s, mainly on inhabited islands. As of 2014, 116 out of the 189 inhabited islands were reported to be experiencing coastal erosion, with 38% of these islands having severe coastal erosion conditions (State of the Environment (2016), Ministry of Environment and Energy).

Even on beaches where beach erosion is not currently a problem, coastal erosion is expected to occur in the future due to sea level rise and increased wave forces reaching the coast as a result of climate change. In addition, climate change is expected to accelerate erosion on beaches where erosion is already progressing. In addition to the natural conditions described above, artificial change such as port construction in coastal areas and associated development such as navigation channel excavation on reefs, land reclamation, etc. have reduced natural wave protection and drainage functions and contributed to coastal erosion. Furthermore, these climate change and increased hazards caused by anthropogenic factors not only destroy coastal ecosystems, but also affect the fishing industry and water resources due to soil and vegetation degradation caused by flooding and sea level rise, which can cause significant damage to economic activities.

Under these circumstances, the Government of Maldives has identified "resilient communities" as one of its key priorities, with the goal of developing disaster risk management and planning that takes climate change into account, in Strategic Action Plan (2019-2023). In addition, land use plans are developed and implemented as specific regulations related to coastal management. However, strict regulations are not in place. Facilities and residences already exist within the coastal buffer zone established in the land use plan for inhabited islands. Moreover, awareness and strategy are lacking with regards to the impact of coastal development on the coastal environment and how development should coexist with the coastal environment. The coastal zone management system, which is necessary to maintain the protective functions of the reefs and beaches that have been maintained over the years, also has not been developed. Therefore, it is imperative to establish a basic wave observation system for the surrounding area and a monitoring system for the formation of the coastal area and land use conditions, to formulate a plan for regional development and disaster prevention based on the analysis of these results, and to implement maintenance and management measures for the inhabited islands based on this plan in order to achieve long-term and sustainable island resilience against future climate change. There is an urgent need to develop a plan for regional development and disaster prevention based on these analyses.

JICA had conducted the "Data Collection Survey on Building Climate Resilient Safer Cities" targeting the Maldives since 2019. In this survey, basic information on the risk of coastal disasters due to climate change, coastal conservation/protection measures, and the current status of coastal management was collected to capture the situations and analyze the issues. In addition, the study also designed four components and accompanying activities: (1) development of Integrated Coastal Zone Management (ICZM) plan, (2) implementation of coastal protection and conservation measures, (3) development of disaster information communication system, and (4) development of basic information and data collection and sharing system related to climate change. The four components and

accompanying activities were developed and compiled into a funding proposal for Building Climate Resilient Safer Islands in the Maldives Development to be submitted to the Green Climate Fund (hereinafter referred to as "GCF").

The funding proposal was adopted by the 29th GCF Board Meeting in July 2021, and JICA decided to implement the project proposed in the funding proposal as a GCF-contracted project. This JICA project for "Building Climate Resilient Safer Islands in the Maldives" covers a part of the GCF-contracted project.

1.2 Objective of Survey

The basic planning study for this project was conducted by JICA in late May 2021. Based on the study results, the Minutes of Meetings (hereinafter referred to as "M/M") were signed in May 2021, and the Record of Discussion (hereinafter referred to as "R/D") were signed in July 2021.

The objectives and contents of this survey are as follows

- (1) Discuss and agree on the details of the cooperation with the implementing agencies, etc.
- (2) Consider revising the Project Design Matrix (hereinafter referred to as "PDM") and the Plan of Operations (hereinafter referred to as "PO") as necessary, and conclude an M/M regarding the establishment of implementation structure for full-scale cooperation.
- (3) Collect and organize relevant information necessary for the implementation of full-scale cooperation.

1.3 Survey Members of JICA Expert Team

Table 1.3.1 shows the composition of the JICA expert team that conducted the detailed planning survey.

Table 1.3.1 Composition of Survey Members

No.	Position	Name	Organization	Work Period in the Maldives
1	Team Leader / Regional Planning	Shinichi FUKASAWA (Mr.)	Nippon Koei	i) 2021/12/1~12/14 ii) 2022/1/11~2/9 iii) 2022/5/10~5/18, 6/14~6/20 iv) 2022/7/30~8/29
2	Deputy Team Leader / Coastal Conservation Plan/ Integrated Coastal Zone Management (ICZM) 2	Shingo ICHIKAWA (Mr.)	Nippon Koei	2022/8/23~9/16
3	Coastal Conservation Plan/ Integrated Coastal Zone Management (ICZM) 1	Susumu ONAKA (Mr.)	Nippon Koei	2022/5/10~5/31
4	Coastal Engineering/Shoreline Change Analysis 1	Keisuke KUSUHARA (Mr.)	Nippon Koei	i) 2022/1/11~1/25 ii) 2022/5/10~5/20, 6/5~8
5	Coastal Management/Coastal Monitoring	Daiki TSUJI (Dr.)	Pacific Consultants	i) 2022/5/10~5/24, 6/3~9 ii) 2022/9/19~9/30
6	Oceanographic Investigation/ Survey 1	Tomohiro MORI (Mr.)	Nippon Koei	i) 2022/1/12~3/3 ii) 2022/5/10~6/1
7	Facility Design and Construction Plan/Cost Estimate	Yusuke TOYODA (Mr.)	Mitsui Consultants	i) 2022/1/11~1/25 ii) 2022/5/16~6/14 iii) 2022/8/23~9/17
8	Reef Environment Planning	Ken OKAJI (Dr.)	Nippon Koei	2022/8/2~8/8, 8/16~19
9	Regulatory System/Organizational Cooperation/ GCF Scheme	Ako OMARU (Ms.)	Nippon Koei	2022/5/10~5/27
10	Capacity Development/Training Plan	Chiaki SHIBAYAMA (Ms.)	Nippon Koei	2022/8/2~8/30
11	Environmental and Social Consideration/ Consensus Building/ Gender 1	Akihito SAKURAI (Mr.)	Nippon Koei	2021/12/1~12/14
12	Environmental and Social Consideration/ Consensus Building/ Gender 2	Mayumi GOTO (Ms.)	Nippon Koei	i) 2022/1/16~2/9 ii) 2022/5/15~6/4 iii) 2022/8/26~9/17
13	Coastal Engineering/Shoreline Change Analysis 2/ Coordinator 2	Shogo TOKUNAGA (Mr.)	Nippon Koei	i) 2022/5/26~5/31 ii) 2022/8/23~9/17
14	Oceanographic Investigation/ Survey / Coordinator 1	Koki MIYAGAWA (Mr.)	Nippon Koei	i) 2022/5/10~5/31 ii) 2022/7/25~8/22

Source: JICA Expert Team

1.4 Survey Schedule

The schedule for this survey is shown in Table 1.4.1. This survey is a detailed planning survey (Phase 1) of a two-stage planning study, but some of the work in the full-scale implementation phase (Phase 2) is also included at the same time, so the schedule in the table includes both the work in Phase 1 and Phase 2.

(1) 1st Field Survey (December 2021)

Members: Fukasawa, Sakurai

Table 1.4.1 Schedule of Detailed Planning Survey (1st Field Survey)

	Day	Fukasawa	Sakurai
Dec. 1	Wed.	Arrival at Male from Colombo	Departure from Narita
2	Thr.	AM: Discussion with MECCT PM: Discussion with JICA Maldives Office	Arrival at Male (via Doha)
3	Fri.	AM: On-line meeting with JICA HQ	
4	Sat.	Preparation of Kick-off Meeting	
5	Sun.	AM: Kick-off Meeting with MECCT, PM: Briefing to Embassy of Japan in the Maldives	
6	Mon.	Site visit to Laamu Atoll, Kick-off meeting with stakeholders in Laamu Atoll	
7	Tue.	PM: Discussion with EPA	
8	Wed.	Site visit to Addu Atoll, Kick-off meeting with stakeholders in Addu Atoll	
9	Thr.	PM: Interview to ENDhERI project	
10	Fri.	Team meeting, organizing documents	
11	Sat.	organizing documents	
12	Sun.	PM: Discussion with MECCT, Report to JICA Maldives Office	
13	Mon.	Departure from Male to Colombo	Departure from Male to Doha
14	Tue.	Arrival at Narita (via Colombo)	Arrival at Narita (via Doha)

(2) 2nd Field Survey (January to March 2022)

Members: Fukasawa, Goto, Kusuhara, Toyoda, Mori

Table 1.4.2 Schedule of Detailed Planning Survey (2nd Field Survey)

	Day	Fukasawa	Goto	Mori	Kusuhara	Toyoda	
January 11	Tue.	Departure from Haneda	/		Departure from Haneda		
12	Wed.	Arrival at Male		Departure from Narita, Arrival at Male	Arrival at Male		
13	Thr.	Discussion with MECCT		Move to Laamu Atoll			
14	Fri.	Organizing documents		Preparation for topographic survey			
15	Sat.						
16	Sun.	Discussion with MECCT	Departure from Nagoya, Arrival at Male	Topographic survey and bathymetric survey at Laamu atoll	Site visit to Maamendhoo island and Fonadhoo island		
17	Mon.	Discussion with MECCT			Site visit to Isdhoo island and Gan island		
18	Tue.	Discussion with MECCT, EPA			Organizing results of the site visit		
19	Wed.	AM: Move Addu Atoll			AM: Move Addu Atoll		
		PM: Discussion with Addu City Council			PM: Discussion with Addu City		

				Council			
20	Thr.	Site visit to Meedhoo island, and move to Male		Site visit to Meedhoo island, and move to Male			
21	Fri.	Organizing documents		Organizing documents			
22	Sat.						
23	Sun.	Information Organizing documents collection on ICZM	Information collection on EIA	Topographic survey and bathymetric survey at Laamu atoll			
24	Mon.			Organizing documents	Departure from Male		
25	Tue.			Departure from Male and Arrival at Doha	Arrival at Narita		
26	Wed.			AM: Discussion with MECCT PM: Courtesy call to Secretary, Ministry of Foreign Affairs, Maldives			
27	Thr.						
28	Fri.						
29	Sat.	Organizing documents		Organizing documents			
30	Sun.	Kick-off Meeting with MECCT and other concerned stakeholders					
31	Mon.	Discussion with MECCT		Topographic survey and bathymetric survey at Laamu atoll			
Feb. 1	Tue.	Briefing to Embassy of Japan in the Maldives					
2	Wed.	AM: Move to Laamu Atoll, Discussion with Laamu Atoll Council PM: Discussion with Fonadhoo Island Council					
3	Thr.	AM: Discussion with Isdhoo Island Council PM: Discussion with Gan Island Council					
4	Fri.	Organizing documents					
5	Sat.	AM: Discussion with Maamendhoo Island Council, PM: Move to Male		Topographic survey and bathymetric survey at Addu atoll			
6	Sun.	Discussion with MECCT					
7	Mon.						
8	Tue.	Departure from Male to Singapore					
9	Wed.	Arrival at Narita	Arrival at Nagoya				
- 15	- Tue.						
- 28	- Mon.					Topographic survey and bathymetric survey at Laamu atoll	
- Mar. 2	- Wed.					Discussion with MECCT	
3	Thr.					Departure from Male	
4	Fri.					Arrival at Singapore	

(3) 3rd Field Survey (May to June 2022)

Members: Fukasawa, Omaru, Onaka, Mori, Miyagawa, Goto, Toyoda, Tsujio, Kusuhara

Table 1.4.3 Schedule of Detailed Planning Survey (3rd Field Survey) (1/2)

	Day	Fukasawa	Omaru	Onaka	Mori	Miyagawa	Goto	Toyoda	Tsujio	Kusuhara	
May 10	Tue.	Departure from Narita and Arrival at Male	Departure from Haneda						Departure from Narita and Arrival at Male	Departure from Haneda	
11	Wed.	Discussion with MECCT, Briefing to JICA Maldives Office	Arrival at Male						Discussion with MECCT, Briefing to JICA Maldives Office	Arrival at Male	
12	Thr.	1 st JCC meeting				1 st JCC meeting					
13	Fri.	PM: Organizing documents		PM: Move to Addu		PM: Move to Addu					
14	Sat.	Organizing documents		Site survey at Meedhoo island, and meeting with stakeholders		Site survey at Meedhoo island, and meeting with stakeholders					
15	Sun.	Discussion with MECCT								Departure from Nagoya and Arrival at Male	
16	Mon.	Discussion with MNPHI		Move to Laamu Atoll		Discussion with subcontractor	Departure from Narita	Move to Laamu Atoll			
17	Tue.	Discussion with NDMA		Site survey at Fonadhoo island		Move to Laamu Atoll	Arrival at Male, move to Laamu Atoll	Site survey at Fonadhoo island			
18	Wed.	Discussion with MMS		Site survey at Gan island							
19	Thr.	Work in Sri Lanka for the other project	Discussion with subcontractor	Site survey at Maamendhoo island							
20	Fri.		Organizing documents	Organizing documents						Work in Bangladesh for the other project	
21	Sat.		Move to Laamu Atoll								
22	Sun.		Organizing documents								
23	Mon.		Site survey and stakeholder meeting at Isdhoo island								
24	Tue.		Site survey and stakeholder meeting at Maamendhoo island								
25	Wed.		Site survey and stakeholder meeting at Gan island								
26	Thr.		Site survey and stakeholder meeting at Fonadhoo island								
27	Fri.		Departure from Male	Move to Male							
28	Sat.		Arrival at Narita	Move to Addu							
29	Sun.			Site survey and preparation for stakeholder meeting at Meedhoo island							
30	Mon.			Stakeholder meeting at Meedhoo island							
31	Tue.			Departure from Male	Administration works	Move to Male					
			Arrival at Narita	Departure from Male	Organizing discussion result	Survey on unit-price					

Table 1.4.4 Schedule of Detailed Planning Survey (3rd Field Survey)(2/2)

	Day	Fukasawa	Omaru	Onaka	Mori	Miyagawa	Goto	Toyoda	Tsuji	Kusuhara					
Jun. 1	Wed.	Work in Sri Lanka for the other project			Arrival at Narita	Arrival at Singapore	Organizing discussion result	Survey on unit-price	Work in Bangladesh for the other project	Work in Bangladesh for the other project					
2	Thr.				Departure from Male	Arrival at Male	Organizing documents	Arrival at Male							
3	Fri.														
4	Sat.				Arrival at Nagoya	Survey on unit-price	Discussion with EPA	Arrival at Male							
5	Sun.														
6	Mon.				Discussion with MTCC				Discussion with MECCT						
7	Tue.				Discussion with Hevey Force				Discussion with MMS	Departure from Male					
8	Wed.				Discussion with Trading Company				Departure from Male	Arrival at Narita					
9	Thr.				Survey on unit-price				Arrival at Narita						
10	Fri.				Organizing documents										
11	Sat.														
12	Sun.				Discussion with MECCT										
13	Mon.														
14	Tue.				Arrival at Narita										
15	Wed.				Discussion with MECCT, planning for forthcoming activities										
16	Thr.														
17	Fri.				Organizing documents										
18	Sat.														
19	Sun.				Discussion with MECCT, Departure from Male										
20	Mon.	Arrival at Narita													

(4) 4th Field Survey (July to September 2022)

Members: Fukasawa, Shibayama, Okaji, Miyagawa, Nagasawa, Toyoda, Ichikawa, Vuthy, Tokunaga, Goto, Tsujio

Table 1.4.5 Schedule of Detailed Planning Survey (4th Field Survey) (1/3)

	Day	Fukasawa	Shibayama	Okaji	Miyagawa	Nagasawa	Toyoda	Ichikawa	Tokunaga	Vuthy	Goto	Tsujio
Jul. 25	Mon.	/	/	/	Arrival at Male	/	/	/	/	/	/	/
26	Tue.				Procurement							
27	Wed.				Move too Laamu							
28	Thr.				Collection/installat ion of wave hunters							
29	Fri.											
30	Sat.	Departure from Narita and Arrival at Male	Move to Male									
31	Sun.	Discussion with MECCT										
Aug. 1	Mon.	Departure from Delhi	Briefing to JICA Maldives Office									
2	Tue.	Briefing to JICA Maldives Office		Arrival at Male Briefing to JICA Maldives Office	Departure from Narita and Arrival at Male							
3	Wed.	Move to Addu, and discussion with Addu City Council										
4	Thr.	Site survey Meedhoo island and meeting with councils		Sand borrowing survey at Addu atoll								
5	Fri.	Organizing documents										
6	Sat.											
7	Sun.	Site visit at Addu atoll										
8	Mon.	Move to Laamu via Male,				Departure from Narita and Arrival at Male						
9	Tue.	Meeting with Laamu Atoll Council, site visit to Fonadhoo island and discussion with island council, move to Male (Shibayama)		Sand borrowing survey at Laamu Move to Male	Sand borrowing survey at Laamu atoll	Meeting with Laamu Atoll Council, site visit and discussion with island council						
10	Wed.	Site visit and meeting with councils at Isdhoo island		Quarantine		Site visit and meeting with councils at Isdhoo island						
11	Thr.	Site visit and meeting with councils at Maamendhoo island				Site visit and meeting with councils at Maamendhoo island						
12	Fri.	Move to Male				Organizing documents	Move to Male					
13	Sat.	Move to Manimadhoo		Organizing survey at Laamu atoll		Move to Manimadhoo						
14	Sun.	Site survey and meeting with MMS branch office at Manimadhoo island				Preparation of ICZM Seminar	Site survey and meeting with MMS branch office at Manimadhoo island					

15	Mon.	Move to Male			Move to Addu via Male	
16	Tue.	Discussion with MECCT			Site survey at Addu	
17	Wed.	Discussion with MECCT			Move to Male	
18	Thr.	Team meeting	Departure from Male	Team meeting	Departure from Male	
19	Fri.	Organizing documents	Arrival at Narita	Organizing documents	Arrival at Narita	
20	Sat.			Administration		
21	Sun.	Meeting with MNPHI		Departure from Male		
22	Mon.	Monthly Meeting		Arrival at Narita		
23	Tue.	Discussion with Minister, Discussion with NDMA				

Table 1.4.6 Schedule of Detailed Planning Survey (4th Field Survey) (2/3)

	Day	Fukasawa	Shibayama	Okaji	Miyagawa	Nagasawa	Toyoda	Ichikawa	Tokunaga	Vuthy	Goto	Tsujiro
Aug. 24	Wed.	Team Meeting	Discussion with EPA				Departure from Narita and Arrival at Male	Departure from Haneda				
25	Thr.	Briefing to State Minister, Discussion with MMS					Briefing to State Minister	Arrival at Male				
26	Fri.	Organizing documents					Organizing documents			Departure from Narita		
27	Sat.	Organizing documents					Organizing documents			Arrival at Male		
28	Sun.	1 st ICZM Policy and Planning Seminar					1 st ICZM Policy and Planning Seminar					
29	Mon.	Arrival at Narita	Departure from Male				Team meeting					
30	Tue.		Arrival at Delhi				Discussion with EPA					
31	Wed.						Preparation of meeting materials					
Sep. 1	Thr.						Discussion with Land Survey Dept.					
2	Fri.						Move to Laamu					
3	Sat.						Site visit and Stakeholder Meeting at Fonadhoo island					
4	Sun.						Site visit and Stakeholder Meeting at Isdhoo island					
5	Mon.						Site visit and Stakeholder Meeting at Gan island					
6	Tue.						Site visit and Stakeholder Meeting at Maamendhoo island					
7	Wed.						Discussion with Laamu Atoll Council					
8	Thr.						Stakeholder Meeting Follow-up					
9	Fri.						Move to Addu via Male					
10	Sat.						Site survey at Meedhoo island					

11	Sun.				Site visit and Stakeholder Meeting at Meedhoo island					
12	Mon.				Move to Male					
13	Tue.				Interview to contractors	Discussion with EPA			Stakeholder Meeting	
14	Wed.					Discussion with MECCT, Report to JICA Maldives Office				
15	Thr.				Departure from Male	Arrival at Narita	Departure from Male	Arrival at Narita	Departure from Male	
16	Fri.				Departure from Male	Arrival at Narita	Departure from Male	Arrival at Narita	Departure from Male	
17	Sat.				Arrival at Narita		Arrival at Singapore		Arrival at Nagoya	

Table 1.4.7 Schedule of Detailed Planning Survey (4th Field Survey) (3/3)

	Day	Fukasawa	Shibayama	Okaji	Miyagawa	Nagasawa	Toyoda	Ichikawa	Tokunaga	Vuthy	Goto	Tsujiro
Sep. 20	Tue.											Arrival at Male
21	Wed.											Meeting with MECCT
22	Thr.											Move to Addu
23	Fri.											Meeting with Addu City Council
24	Sat.											Site survey at Meedhoo island
25	Sun.											Move to Male
26	Mon.											Move to Laamu
27	Tue.											Meeting with Laamu Atoll Council
28	Wed.											Meeting with Fonadhoo island council members
29	Thr.											Site survey at Fonadhoo island
												Site survey at Maamendhoo island
												Meeting with Maamendhoo island council members
		Move to Male										
		Meeting with MECCT, move to Colombo										
		Arrival at Narita (via Colombo)										

1.5 Concerned Organizations

(1) Counterpart Organization

Ministry of Environment, Climate Change and Technology (MECCT)

(2) Other Concerned Organizations

Ministry of National Planning, Housing and Infrastructure (MNPHI),

Environmental Protection Agency (EPA),

Local Government Authority (LGA)

National Disaster Management Authority (NDMA)

Maldives Meteorological Service (MMS)

Laamu Atoll Council,

Addu City Council

Isdhoo Island Council

Gan Island Council

Fonadhoo Island Council

Maamendhoo Island Council

Meedhoo Town Office

(3) Other stakeholders

Embassy of Japan in Maldives

1.6 Summary of Survey Results

1.6.1 Outline of Results

In the detailed planning survey, JET discussed with the Maldivian counterpart, MECCT, and other relevant organizations on the project contents, project implementation structure, and JCC structure. Based on these results, the PDM and PO were revised where necessary. The 1st JCC meeting was held on May 12, 2022, and the Minutes on the Meeting of the 1st JCC meeting were signed by MECCT and JET.

Upcoming plan is as follows.

- Revision of Record of Discussion: February 2023

1.6.2 Main Discussion Results

(1) Structure and Schedule of the Project Implementation

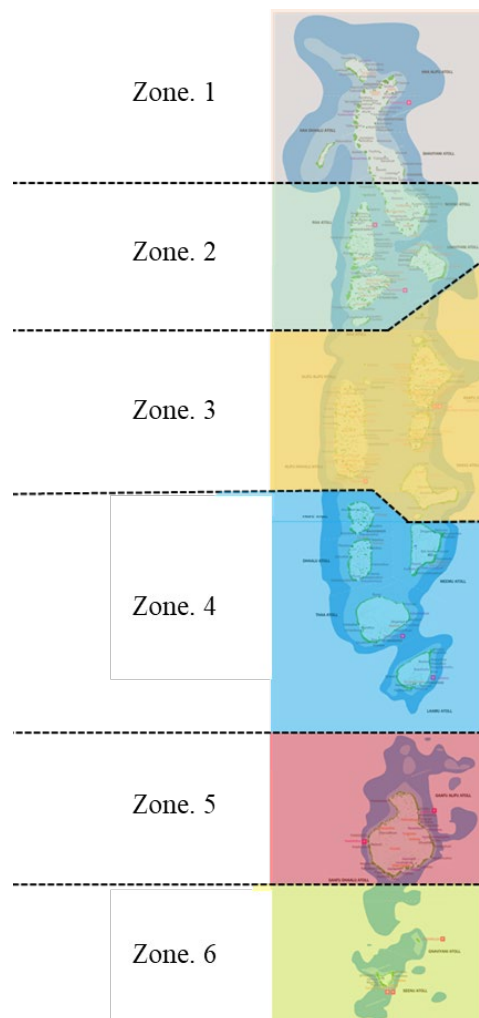
Outline of the Project including implementation structure and work schedules of the Project were explained by the JICA Expert Team (Team), and accepted in principle.

CHAPTER 2 Current Status and Issues of Coastal Conservation in Maldives

2.1 Overview of Maldives

2.1.1 Regional Characteristics

Maldives is a Small Island Developing State (SIDS) spanning an area of 115,300 km², stretching from north to south in the Indian Ocean, consisting of 26 atolls and about 1,200 islands. The land was formed by accumulation of coral sand and gravel due to wave, and is low-lying and narrow, with an elevation of about 1 to 2 m above the mean sea level. Figure 2.1.1 shows all land area of Maldives. In this figure, the atolls and islands are divided into six zones, which are based on the new administrative zones shown in the National Spatial Plan currently (as of September 2022) being prepared by MNPHI. Table 2.1.1 shows the regional classifications and administrative zones in each zone. The characteristics of atolls and reefs vary greatly from north to south depending on latitude. Atolls located in the north tend to have non-continuous margins and are composed of numerous ring-shaped coral reef formations called faroes, while atolls located in the south tend to have continuous islands and a smaller number of faroes.



Source: JICA Expert Team

Figure 2.1.1 All Land Area of Maldives

Table 2.1.1 Regional Classification and Administrative Districts

Regional Classification		Administrative Districts
Zone 1	Upper North	3 atolls Haa Alifu, Haa Dhaalu, Shaviyani
Zone 2	Lower North	4 atolls Noonu, Raa, Baa, Lhaviyani
Zone 3	Upper Central	4 atolls Kaafu, Alifu Alifu, Alifu Dhaalu, Vaavu
Zone 4	Lower Central	5 atolls Meemu, Faafu, Dhaalu, Thaa, Laamu
Zone 5	Upper South	2 atolls Gaaf Alifu, Gaafu Dhaalu
Zone 6	Lower South	2 atolls Gnaviyani, Seenu

Source: JICA Expert Team

2.1.2 Population and Major Industries

Maldives has a total population of 533,9411 in 2019, distributed among 189 inhabited islands. Despite its geographical limitations, Maldives has made remarkable progress in its national development. Maldives per capita Gross Domestic Product (GDP) reached USD10,541 in 2019, while the Human Development Index (HDI) for the last decade (2010-2019) has shown an average annual growth rate of 0.86 %. Thus, considerable progress in the areas of health care, education, utilities, and basic infrastructure is reflected in a score of 0.72 on the HDI, placing Maldives in 101st place out of 189 countries. This is supported by an increase in life expectancy at birth of 15.6 years, an increase in average years of schooling of 2.2 years, and an increase in income of 216.2 %.

In 2019, the nominal GDP of Maldives was MVR 812.8 billion at market prices. Real GDP growth was 7%, with growth led by the tourism industry and public administration; the tertiary sector accounted for about 70% of GDP, with tourism accounting for the majority. This is followed by the secondary industry at 11.7% and the major industry at 5.2%. According to the Household Income and Expenditure Survey (HIES), the employment services sector accounted for 75% of the total, followed by the industrial sector at 18% and the primary sector at 8%, with tourism being the highest employer, while the public administration sector was the second highest employer. In the tourism sector, 1.2 million tourists visited the country in 2014, with China (363,000), Germany (98,000), and the United Kingdom (88,000) in descending order (Japan was the eighth largest, with 38,000).

Table 2.1.2 shows key geographic, industrial, and environmental statistics for the six zones. Region 3 has the largest population despite having the fewest number of islands and the smallest land area. The region is home to the capital city of Male, the fifth most densely populated city in the world in 2019. Its overcrowding has hampered urban prosperity and led to depopulation and abandonment in other areas. As a result, major atolls are expected to lose nearly one-third of their population by 2050. The city of Male is also home to Verana International Airport, the largest airport in Maldives and gateway to the country. It has a single runway 3,200 m long and 45 m wide. The largest reef terrain and the largest number of resort islands make tourism a major industry. This also implies that the main resource in the tourism industry in Maldives is the coast, which forms the reef terrain.

Compared to the more populated Region 3, Region 5 has the largest island area but less than half the population and the lowest population density. Region 1 has the largest island area, although the number of islands is small, but the number of resort islands is the second smallest after Region 6, and the size of agricultural islands is the largest. Region 2 has the second largest population after Region 3, where the capital city of Male, is located, but the number of islands and area is larger than in Region 3. The industry is relatively similar to that of Region 3, with many resort

islands, but there are also a large number of inhabited and agricultural islands. When compared overall, Region 4 has the second largest number of islands and inhabitant islands in size overall, and since there are many resort and agricultural islands, both industries are conducted in comparison to other regions. Region 6 has the smallest size in terms of both number of islands and area, and the absence of agricultural islands indicates that agriculture is not practiced there.

Youth unemployment is relatively high at 7.3% (HIES 2019) with low rates of women participating in the workforce. Furthermore, although poverty is declining, 28% of the population is multidimensionally poor, with access to basic services identified as one of the key deprivations. A comparison of the number of inhabited, agricultural, and resort islands, an indicator of islands, shows a similar trend in the number of inhabited and agricultural islands, with the exception of Region 3, where more inhabited islands are also more agricultural.

Table 2.1.2 Key Statistics for Each Region (Geography, Industry, Environment)

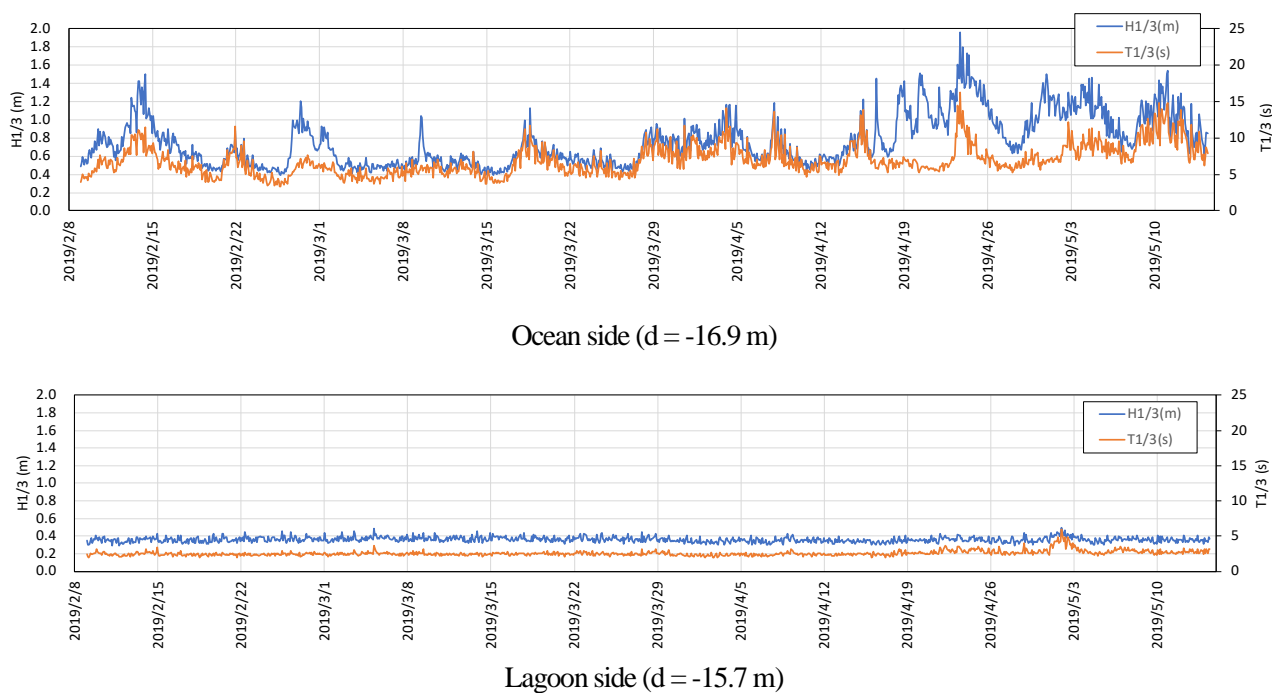
Region	Total Population	All Islands (Area: ha)	Inhabited Islands (Area: ha)	Agricultural Islands (Area: ha)	Reef (ha)	Resorts (Area: ha)	Airport (Domestic : D) (International : I)
Zone 1	54,670	132 (5,895)	41 (4,038)	7 (517)	56,851	21 (397)	D: 3 I: 1
Zone 2	68,900	384 (4,738)	45 (2,136)	23 (335)	60,729	100 (1,337)	D: 2 I: 1
Zone 3	73,761	300 (3,112)	35 (1,938)	3 (23)	125,219	109 (729)	D: 1 I: 1
Zone 4	50,072	329 (4,440)	43 (2,894)	10 (170)	95,553	51 (496)	D: 4
Zone 5	29,220	258 (3,228)	18 (1,279)	4 (151)	39,944	32 (327)	D: 3
Zone 6	35,638	37 (1,960)	7 (1,508)	0 (-)	3,940	9 (140)	D: 1 I: 1

Source: JICA Expert Team

2.1.3 Weather and Maritime Characteristics

The climate in Maldives is hot and humid, with an average temperature of 26 ~ 33 °C throughout the year. It is divided into two seasons: the northeast monsoon season from November to April, and the southwest monsoon season from May to October. Strong winds tend to be more frequent during the northeast monsoon season, and the rainy season (May to November), the southwest monsoon season, has more precipitation than the dry season (November to April), the northeast monsoon season. In addition, because Maldives is located near the equator, the probability of cyclones is extremely low, with only 11 occurring between 1877 and 2004, a period of 117 years. Most of these cyclones are concentrated north of 6 degrees north latitude. It is therefore considered that the occurrence of extreme high waves in Maldives is extremely rare. In coral reef areas such as Maldives, waves propagating from offshore go through the reef slope, break at the reef edge, and then propagate along the reef flat before reaching the shore. The wave characteristics change significantly both inside and outside the reef edge due to wave set-up and wave breaking. In addition, since the islands of Maldives are formed on the edge of atolls, the wave characteristics differ greatly between ocean side and lagoon side. In order to clarify these differences in wave characteristics between the reef topography and inside and outside the atolls, seabed-mounted wave gauges were installed inside and outside the atolls and inside and outside the reefs, and simultaneous wave and water level observations were conducted. Figure 2.1.2 shows the change over time of significant wave height (H1/3) and period

(T1/3) from February to May 2019 outside the reef on the ocean and lagoon side.



Source: JICA Expert Team

Figure 2.1.2 Time series of Significant Wave Height (H1/3) and period (T1/3)

The results show that wave heights on the ocean side fluctuate in response to meteorological disturbances, with $H1/3 = 0.5$ m in normal conditions and $H1/3 = 2$ m during high waves. The period is usually $T1/3 = 6$ to 8 s, but swells of about 15 s have been measured during high waves. On the lagoon side, on the other hand, there was no significant variation in both wave height and period, with $H1/3$ being about 0.4 m and $T1/3$ being about 2 or 3 seconds, almost constant.

2.1.4 Coral Reefs

Coral reefs form the basis of land in Maldives and support the main industries of tourism and fisheries. However, they are susceptible to stress due to rising sea temperatures caused by development activities and climate change. Prior to the major coral bleaching event of 1998, only partial bleaching was observed in three atolls in the central part of Maldives. However, in 1998, the most extensive coral bleaching event in recent years occurred in Maldives and throughout the Indian Ocean, and it is estimated that 90% of shallow water corals died as a result of the coral bleaching event throughout Maldives. As a result, coral coverage throughout Maldives is said to have declined from 50 % to 10 %. The degree of damage varied by species, with *Acropora* species declining while massive corals (e.g. *Porites*) and encrusting corals (e.g. *Pavona*, *Leptastrea*) survived. Thereafter, there were some events that affected coral growth, such as the mild bleaching event in 2010, the tsunami in 2014, and the outbreak of crown-of-thorns starfish in 2015, but overall, corals are recovering, and in 2014, coverage is said to have recovered to the status prior to the 1998 bleaching event. The tsunami in 2014 only reduced the degree of coral recovery and did not result in mortality as did the bleaching event. In addition to the bleaching event, development activities such as sand dredging for development and dredging and reclamation associated with coastal development have also increased damage to corals. However, El Nino of 2015-2016 and the subsequent sea surface temperature anomaly of 2016 caused the

first large scale coral bleaching event since 1998. Rising sea surface temperatures are the main stress that causes coral bleaching, and prolonged increases in sea surface temperatures accelerate coral bleaching. The survey conducted in 2017 found that 73 % of the 71 sites (11 atolls) surveyed had coral bleaching events. The degree of bleaching by depth showed that corals inhabiting depths between 7 and 13 m were more affected by bleaching than those inhabiting depths below 7 m. Comparisons between ocean side and lagoon side showed little difference in bleaching conditions.

2.2 Inventory Study on Coastal Conditions

2.2.1 Regional Characteristics

Inventory study was conducted to grasp the regional characteristics of coastal conditions and coastal disaster risk for 189 inhabited islands in Maldives. Table 2.2.1 shows categories and indicators used to grasp the regional characteristics. Zone categories (Zone 1-6) were referred to those of MNPHI which is presented in Chap. 2.1.

Table 2.2.1 Categories and Indicators used to Grasp Regional Characteristics

Category	Indicator	Source
Natural Condition	Wave height due to Cyclone Swell, Tsunami	ERA5
	Coastal erosion	Interview survey to Island Councils, VPA II (2004)
Geographical Condition	Average area of Island	Isles 2022
	Elevation of Island	Survey in this study, Japanese book on global warming and natural disasters (Kokon shoin, 2009)
Socio-economic Condition	Population density	Data provided by MNPHI (2022, confidential)
	No. of beds in resort Islands	
	Ratio of reclamation	
Environmental Condition	Ratio of reef area	

Source: JICA Expert Team

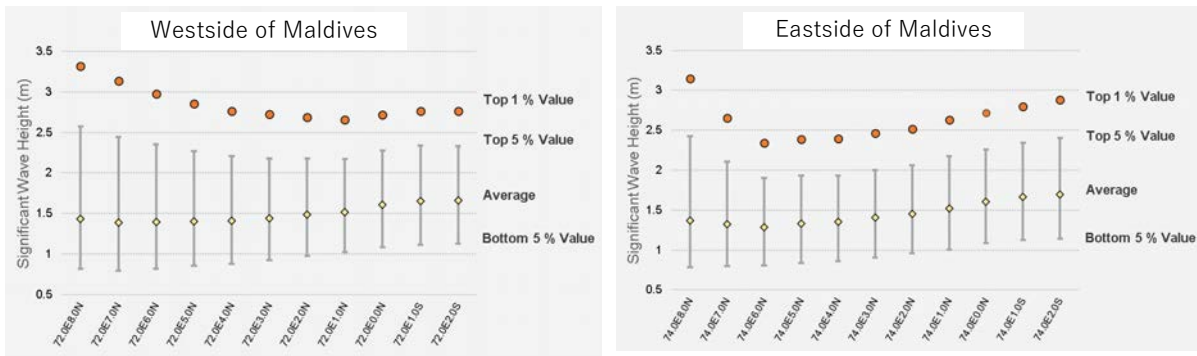
(1) Natural Condition/ Wave Height due to Cyclone, Swell, Tsunami

Offshore wave condition in Maldives, significant wave height and wave direction over 40 years were extracted from ERA 5 and organized and plotted in Table 2.2.2 and Figure 2.2.1, respectively.

Table 2.2.2 Top 5 % Average of Significant Wave Height

Latitude	West side	East side
8° N	2.57 m	2.43 m
7° N	2.44 m	2.11 m
6° N	2.35 m	1.90 m
5° N	2.27 m	1.93 m
4° N	2.21 m	1.93 m
3° N	2.18 m	2.00 m
2° N	2.18 m	2.06 m
1° N	2.17 m	2.17 m
0° N	2.28 m	2.26 m
-1° N	2.34 m	2.34 m
-2° N	2.33 m	2.40 m

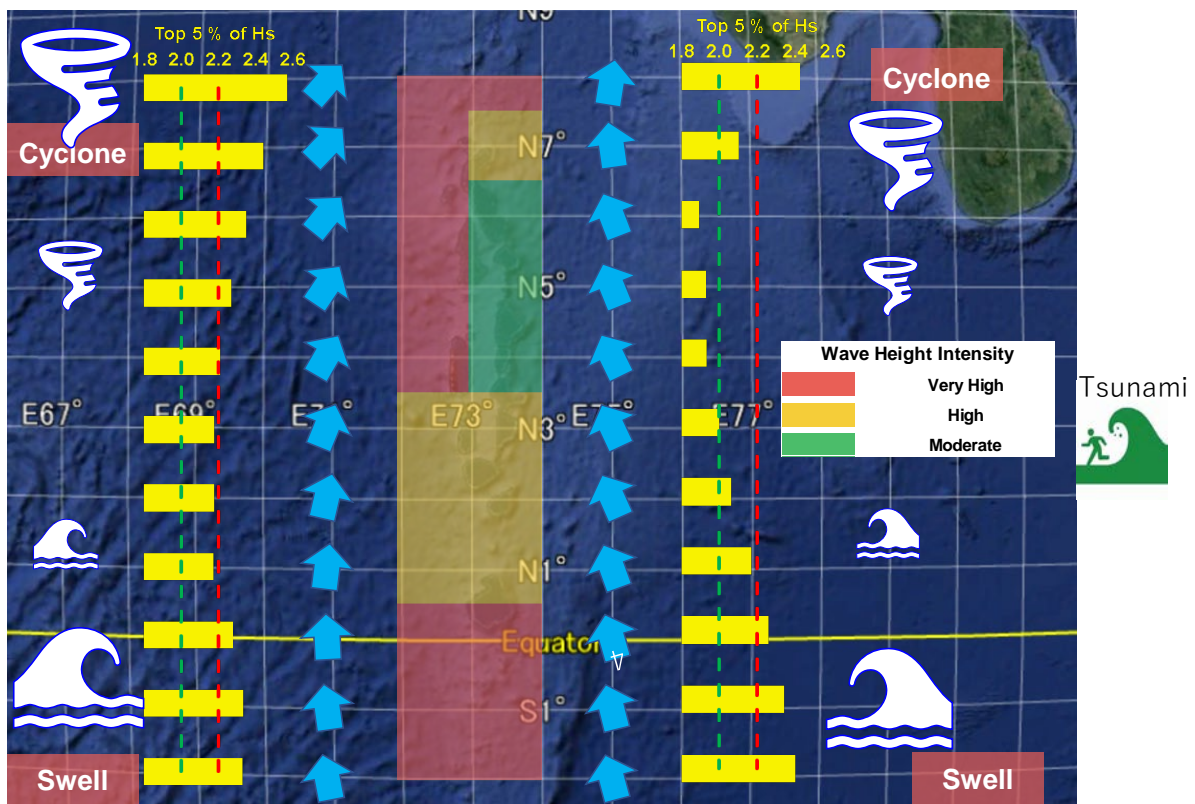
Source: Extracted by JICA Expert Team from ERA5



Source: Organized by JICA Expert Team from ERA5

Figure 2.2.1 Wave Height for West and East Side of Maldives by Latitude

Table 2.2.2 shows that in general wave height is higher in the North and South regions and is relatively smaller in the Central regions. In north regions top 1% or 5% average wave height is larger than the others while the normal average wave height is lower. This indicates that the northern regions are more affected by Cyclone, which is extreme but low-frequency event in Maldives. The south region near the equator, on the other hand, is much affected by the swell waves developed by SW monsoon.



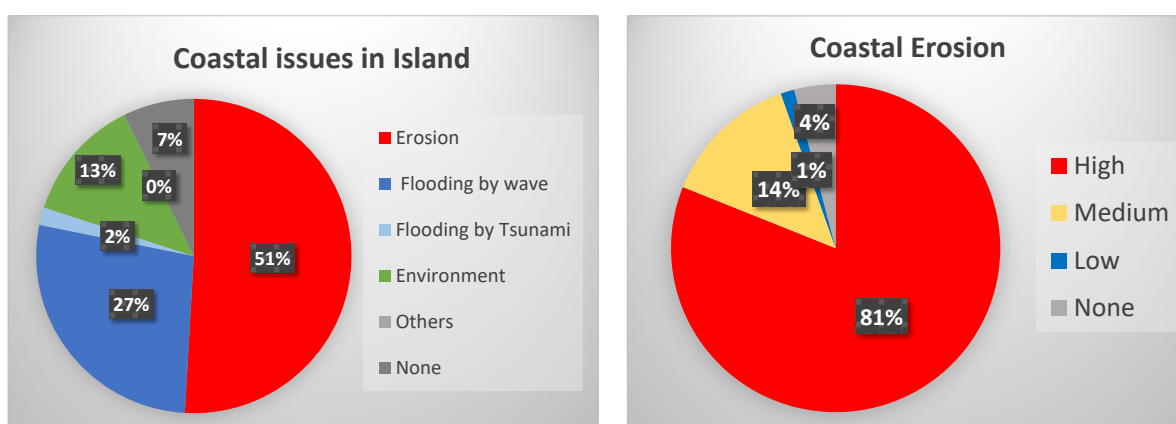
Source: Organized based on ERA5 by JICA Expert Team

Figure 2.2.2 Wave Height and Direction in Maldives

(2) Natural Condition/ Coastal Erosion

Questionnaire survey was conducted to grasp the situation of coastal erosion in Maldives. About 74 replies out of 189 from the Island councils were collected as of September in 2022. From the tentative results of the questionnaire shown in Figure 2.2.3 (left), more than 50 % of respondents replied that “coastal erosion” is the main coastal issue of the Island and “Flooding by Wave” and “Environment” shared with 27 % and 13 %, respectively.

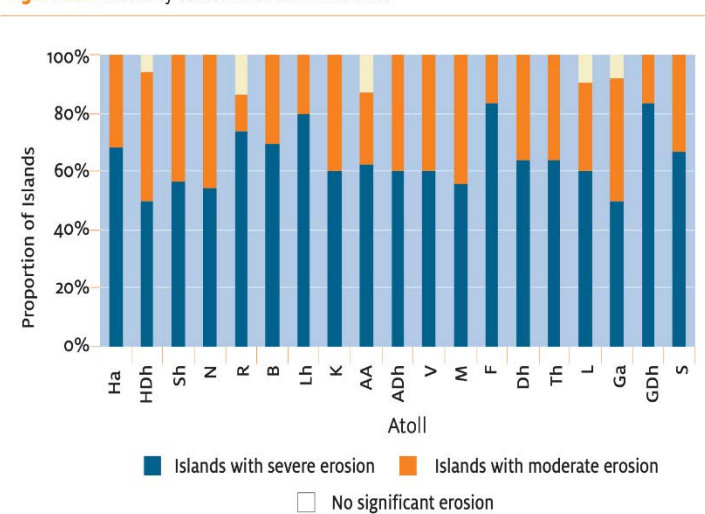
In Figure 2.2.3 (right), more than 80 % recognized that severity of coastal erosion is “high”. Figure 2.2.4 shows a similar questionnaire result conducted in 2004, in which the ratio who answered that “coastal erosion is severe in his/her Island” shared about 60%-70%. If allowing to compare these two results from the same perspective, it indicates that situation of coastal erosion is getting severer with 10 - 20 points in recent years. Regarding the situation of coastal erosion at Island, additional quantitative information such as MECCT’s monitoring data will be incorporated in the analysis to obtain more comprehensive results.



Source: JICA Expert Team

Figure 2.2.3 Questionnaire Survey Results: (Left) Coastal Issues at Island, (Right) Severity of Erosion

Figure 5.2: Extent of coastal erosion in Maldives



Source: VPA II (2004)

Source: VPA II (2004)

Figure 2.2.4 Investigation Survey on Coastal Erosion Conducted in 2004

(3) Geographical, Socio-economic Conditions

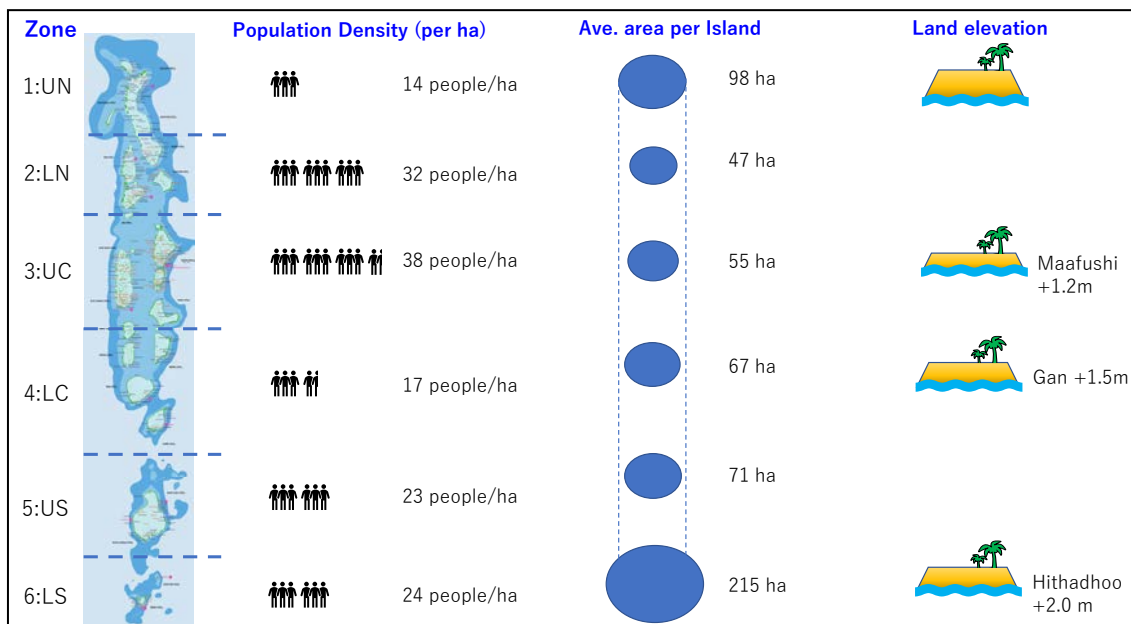
Regional characteristic in geographical and socio-economic aspects, which is mostly extracted from the MNPHI’s statistics, are summarized in Table 2.2.3 and Figure 2.2.5 and Figure 2.2.6.

Table 2.2.3 Summary of Regional Characteristics of Geographical, Socio-economic Conditions

Zone	Population Density	Ave. Area per Island	Elevation of Island	Ratio of Reclamation/Land	Ratio of Reef/Land	No. of Beds
1: UN	14 people/ ha	98 ha	MSL + 3.0 m	3 %	10 times	750
2: LN	32 people/ ha	47 ha	N/A	7 %	13 times	10,200
3: UC	38 people/ ha	55 ha	MSL + 1.2 m	15 %	40 times	18,600
4: LC	17 people/ ha	67 ha	MSL + 1.5 m	11 %	22 times	3,800
5: US	23 people/ ha	71 ha	N/A	13 %	12 times	1,800
6: LS	24 people/ ha	215 ha	MSL + 2.0 m	7 %	1 times	900

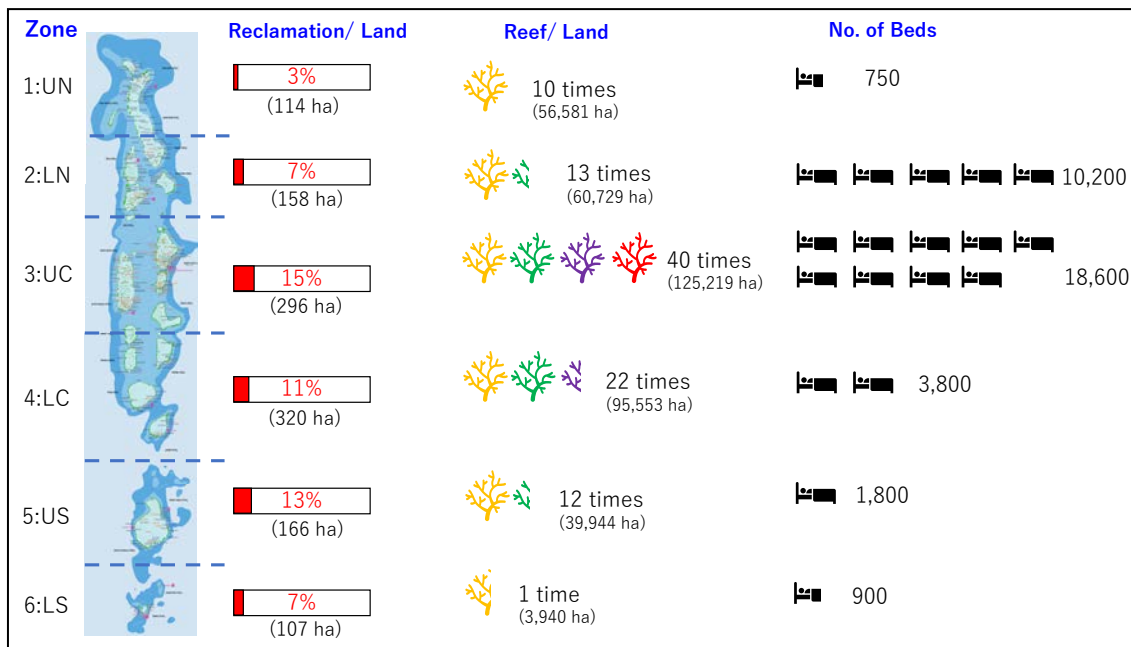
UN: Upper North, LN: Lower North, UC: Upper Central, LC: Lower Central, US: Upper South, LS: Lower South

Source: Organized by JICA Expert Team based on MNPHI data and Isles 2022



Source: JICA Expert Team

Figure 2.2.5 Comparison of Regional Characteristics 1/2 (population density, Ave. of land area and elevation of Island)



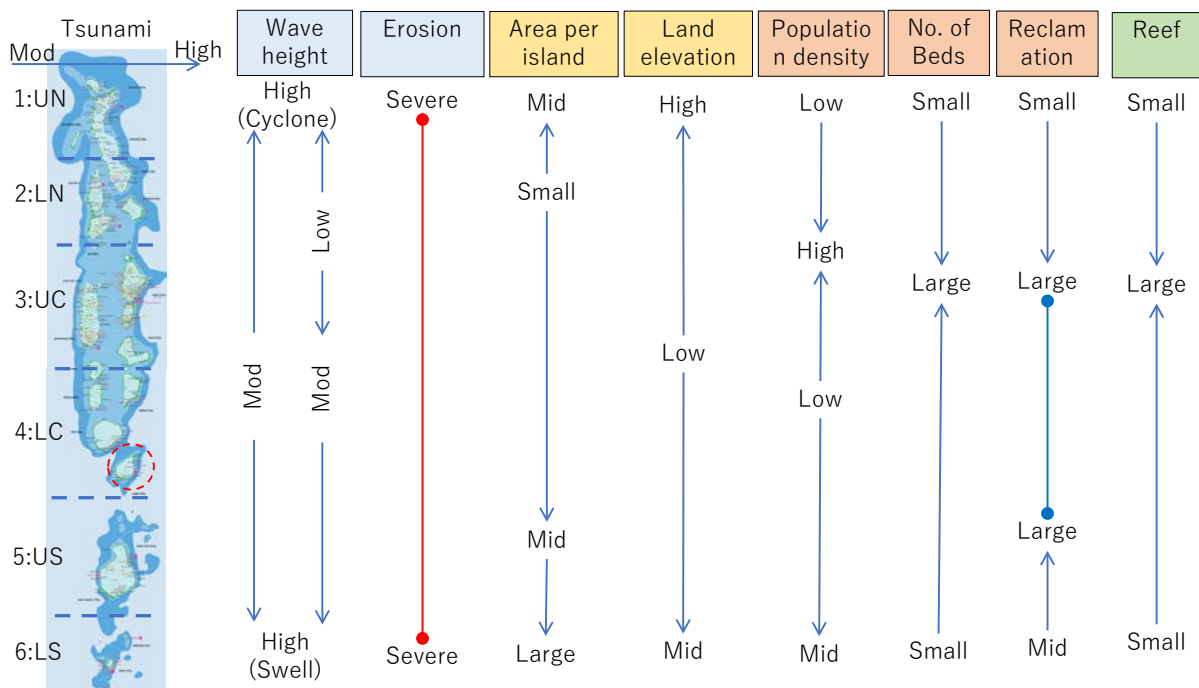
Source: JICA Expert Team

Figure 2.2.6 Comparison of Regional Characteristics 2/2 (reclamation ratio, ratio of reef area and No. of beds)

Regional characteristics are listed as follows and Figure 2.2.7 shows a schematic figure of the trend overall. These results show that regional characteristics in Maldives quite differs from north to south by zones in terms of natural, geographical, socio-economic conditions. This indicates that there are the islands which have different characteristics from Gan and Fonadhoo, which both are in Zone 4 and are the target Islands for ICZM concrete plan. Thus it is important to conduct a field investigation on these Islands to identify and incorporate their characteristics into ICZM plan to realize its broader utility of application to other Islands in Maldives.

- Population density: Zone 3, at which Male the capital of Maldives is located, shows the highest population density and Zone 2 in north region and Zone 5, 6 in south follows. Zone 1 has the lowest population density.
- Average area per island: Zone 6 in south region has the largest area, which is about twice of the second largest in Zone 1. The top three largest islands are listed below and it can be observed that islands with larger land area are mostly located at south region.
 - 1st largest Island Gan (Zone 4, Laamu Atoll): 596 ha (Isles 2022)
 - 2nd largest Island Hithadhoo (Zone 6, Addu Atoll): 527 ha (Isles 2022)
 - 3rd largest Island Fuvahmulah (Zone 6, Gnaviyani Atoll): 492 ha (Isles 2022)
- Land elevation: North region has the highest elevation and the south region follows, while the central region has the lowest land elevation. Considering that national land of Maldives had been formed by coral rock and sand transported by waves over the years, it is assumed that the distribution of land elevation shows similar trend of wave height (eg. higher land elevation has been formed by higher wave and vice versa). This indicates that the islands of Maldives originally have a function to follow the climate change such as sea level rise or high wave to a certain extent.

- Ratio of reclamation/ land: This indicator was referred as a degree of artificial development at coastal area. Zone 3 has the highest ratio with 15 % and Zone 4 has the largest reclamation area with 320 ha. On the other hand, Zone 1 has the smallest ratio with 3 % and Zone 2 and 6 are about 7 %.
- Ratio of reef/ land: This indicator was referred as a degree of richness of natural environment. Zone 3 shows the highest with 40 times (reef area: 125,219 ha), then Zone 4 follows with 22 times. Zone 1, 2 and 5 shows about 10 times and Zone 6 in south shows the smallest value with 1 time (reef area: 3,940 ha).
- No. of beds of resorts: This indicator was referred as degree of tourism economy of Atoll or Zone to which islands belong. Zone 3 and 2 has much larger number of beds than the others, especially comparing with Zone 1 and 6. Causes for this trend is considered as follows:
 - Resort islands in Zone 3 has the most convenient access from the International Airport for foreign tourists
 - Zone 3 and 2 are located at relatively calm wave region in Maldives
 - There is a lot of islands with small area which are suitable for resorts development at Zone 3 and 2 comparing to the other zones
 - Large and wide reef area exists in Zone 3 and 4 as an attractive destination for tourist






Source: JICA Expert Team

Figure 2.2.7 Overall Trend of Regional Characteristics in Maldives

2.2.2 Classification of Islands

With consideration of applicability of ICZM plan, inhabited Islands in Maldives were firstly classified into 3 types based on the degree of development of coastal area as shown in Table 2.2.4.

Table 2.2.4 Classification of Islands by Degree of Development of Coastal Area

Type-1 Lower developed	Type-2 Highly developed	Type-3 Intermediate
<ul style="list-style-type: none"> • Low population/ density • Natural coast and no or least reclamation 	<ul style="list-style-type: none"> • High population/ density • Reclamation and less natural beach (developed or protected) 	<ul style="list-style-type: none"> • Intermediate population/ density • Some natural coast remains
 <p>e.g. Mulhadhoo in Haa Alif Atoll</p>	 <p>e.g. Komandhoo in Shaviyani Atoll</p>	 <p>e.g. Fonadhoo in Laamu Atoll</p>

Source: Organized by JICA Expert Team based on Google Map

Table 2.2.5 shows the evaluation on necessity and urgency to adopt ICZM plan for each type of Island. Necessity to apply ICZM is evaluated as “high” for Type-1 and Type-3 because some natural coast remains in both types, which means there is a certain room to apply ICZM to coordinate with and control on coastal development in future. On the other hand, Type-2 was evaluated as “middle” because most of coastal area has been developed or protected, therefore, there would be less room for the application of ICZM, which could be limited only with ex-post measures such as maintenance and management work.

Urgency to apply ICZM is evaluated as “middle” for Type-1 due to the least development at coastal area. On the other hand, it was evaluated as “high” for Type-3 because coastal development is in progress in these islands, and it has a risk that whole coastal area will be mostly developed similar to that of Type-2 in near future without application of ICZM at early stage. In other words, there is a certain room for Type-3 to conserve coastal area by balancing protection, environment and beach use through ICZM policy and planning. Type-2 was evaluated as middle because most coastal area has been already developed and protected.

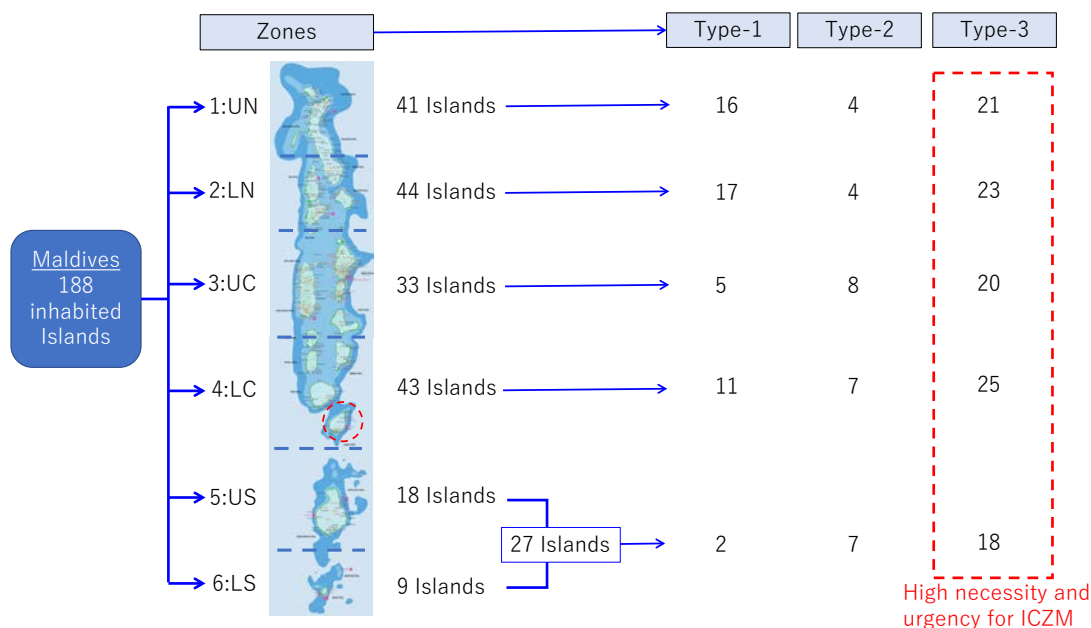
In this study, therefore, the Type-3 is the priority islands for ICZM to apply. Number of Islands for each type is shown in Table 2.2.5 and Gan and Fonadhoo Islands (ICZM target Islands) are classified into Type-3 as well.

Table 2.2.5 Necessity and Urgency for ICZM to Apply

	Type-1 Lower developed	Type-2 Highly developed	Type-3 Intermediate
Necessity of ICZM	High (Room to control development at coastal area)	Middle (Most coastal area developed)	High (room to control development at coastal area)
Urgency of ICZM	Middle (Least development progress)	Middle (Most coastal area developed)	High (Development in progress)
No. of Islands	51 Population > 1,000 and Population density < 3,000 (median value)	30 • Confirmed on development condition by satellite images • Referred to population and its density	107 Other than Type-1 and 2

Source: JICA Expert Team

Figure 2.2.8 shows the classification of islands with zones shown in Sec. 2.1.1 and with island’s types shown in the previous Table 2.2.6. When counting number of islands, Zone 5 and 6 were combined for convenience as the number of islands is smaller compared with the other zones. It is concluded that islands in Type-3 for each zone has higher priority to apply ICZM policy and planning.



Source: JICA Expert Team

Figure 2.2.8 Classification of Islands based on Regional Characteristics and Development Condition at Coastal Area

Furthermore, the Type-3 islands were classified into 4 categories by geographical and location conditions as shown in Table 2.2.6. Regarding with geographical condition, the area of island was evaluated as “large” or “small” based on the average of land area (0.75 km² or 75 ha) in Maldives. Since islands with large area have longer shoreline, the application area of ICZM, i.e. effectiveness of ICZM, will be also large for this case. On the other hand, island with smaller area in Type-3 has generally dense population near coastal area, therefore, benefit by applying ICZM is high even though the application area is limited.

Regarding with locations, it was classified as “ocean” or “lagoon”. In case of “ocean”, in general half of island’s shoreline is facing at ocean and the other half is facing at lagoon. Since natural condition such as wave and erosion and even development condition is quite different between ocean side and lagoon side, ICZM has to be formulated considering such characteristics carefully. In case of “lagoon”, though wave is smaller compared with that of ocean side, the shoreline is continuous in whole island, therefore, the impact of coastal development could spread all around of the island, which is one of the most important issues to be considered for ICZM for island located at lagoon.

Table 2.2.6 Classification by Area and Location of Island

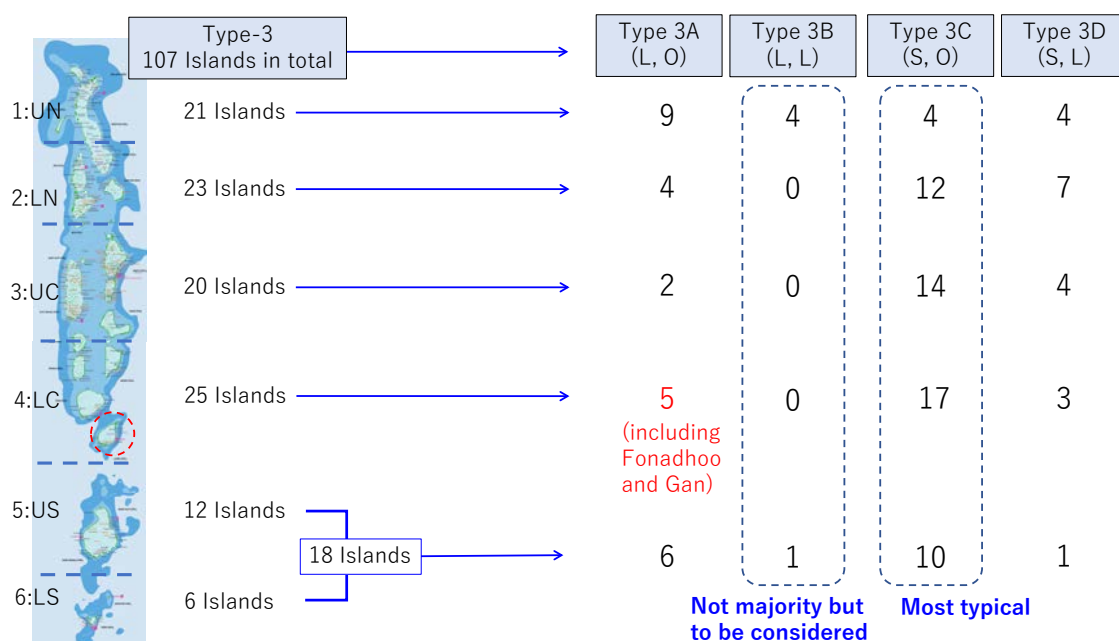
	Type-3A	Type-3B	Type-3C	Type-3D
Area of Island	Large	Large	Small	Small
Location	Ocean	Lagoon	Ocean	Lagoon
Reference	Fonadhoo, Gan (Laamu Atoll)	-	-	-

Source: JICA Expert Team

Figure 2.2.9 shows the classification results of Type-3 (107 islands) into the 4 categories (area and location). Fonadhoo and Gan in Laamu Atoll are classified into Type-3A, with large area and facing ocean.

Number of islands of Type-3B, with large area and located in lagoon, is the smallest among 4 categories, however, such islands can play an important role in residential and economic aspects, especially sea transportation, due to large land area and calm wave condition. Therefore, it is also important to understand the characteristics of these islands to reinforce the versatility of ICZM.

On the other hand, Type-3C, with small area and facing ocean, has the largest number of islands, which is the most major type of islands in Maldives. Since Type-3C in general is most vulnerable island against climate change impact, investigation survey to grasp typical characteristics is necessary for these types of islands.



Source: JICA Expert Team

Figure 2.2.9 Classification of Type-3 Islands in terms of Land area and Location

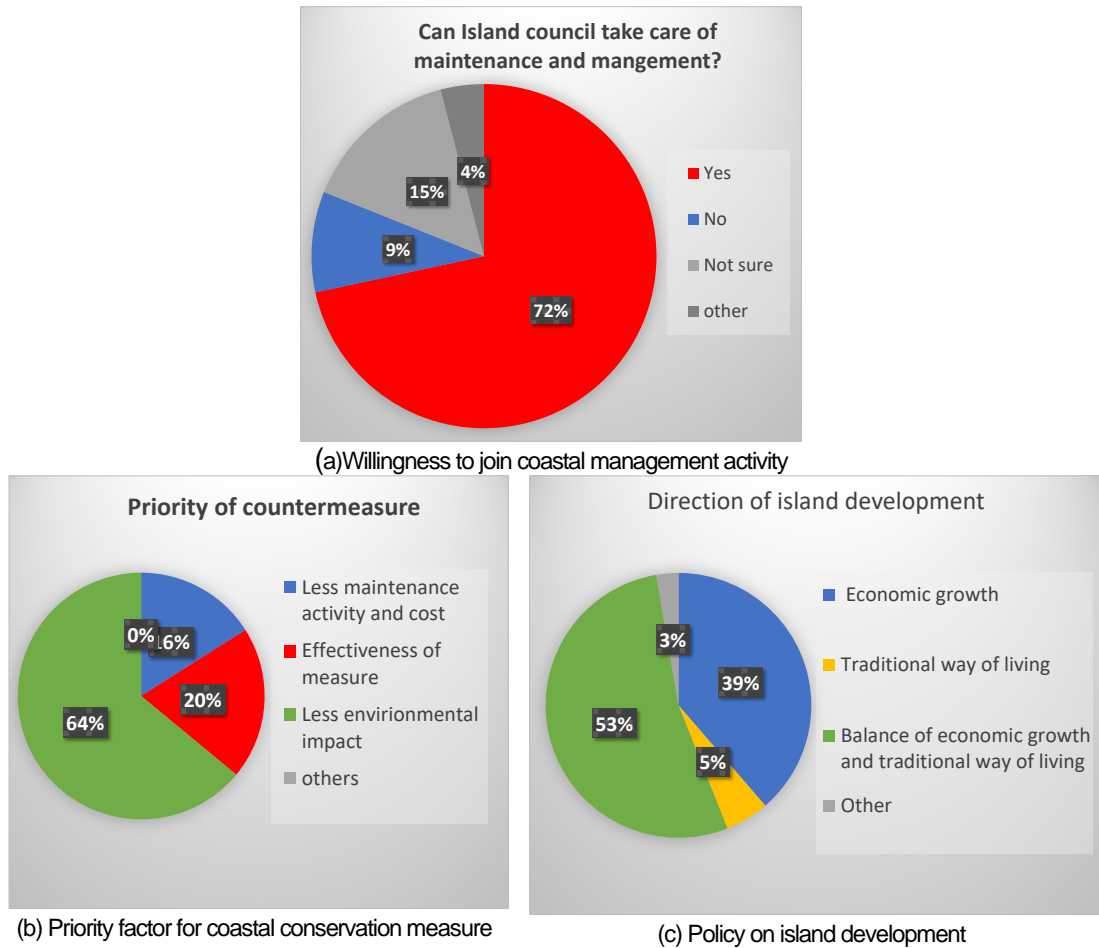
2.2.3 Selection of Candidate Island for Field Investigation Survey (in progress)

Among classified islands a few islands will be selected as candidates for field investigation survey. The selection will be conducted together with MECCT as a part of capacity development. Field investigation survey will be conducted after November 2022 together with MECCT. Idea for the selection criteria and candidate island were shown as follows.

Firstly, the candidate islands are selected from the different types of Gan and Fonadhoo, which were already selected as target islands for concrete ICZM plan, to reinforce the versatility of the plan (i.e. other than zone 4 and/or other than Type-3A). The following selection criteria is considered.

- Selection criteria 1: Policy on coastal development by Island Council
- Selection criteria 2: Willingness to participate coastal management activity by Island Council
- Selection criteria 3: Vulnerability against coastal disaster (degree of severity and frequency)

Regarding with the criteria 1 and 2, the questionnaire survey results on coastal conditions (implemented together with MECCT in this study and received sample number was 74 out of 189 as of September 2022) can be used. Figure 2.2.10 shows the tentative results of the questionnaire. As for the criteria 2, more than 70 % of respondents replied that they are willingly to join the coastal management activities as shown in Figure 2.2.10 (a). As for criteria 3, more than 60 % of respondents replied that to minimize environment impact is the factor of priority to select type of coastal conservation measures. As for policy on island development, 50 % of respondents put priority on balancing economic growth and traditional way of living while 40 % of them did only on economic growth. Since these aspects are important factors to realize the ICZM, it will be effective to select islands who showed positive and similar policy for ICZM activities.



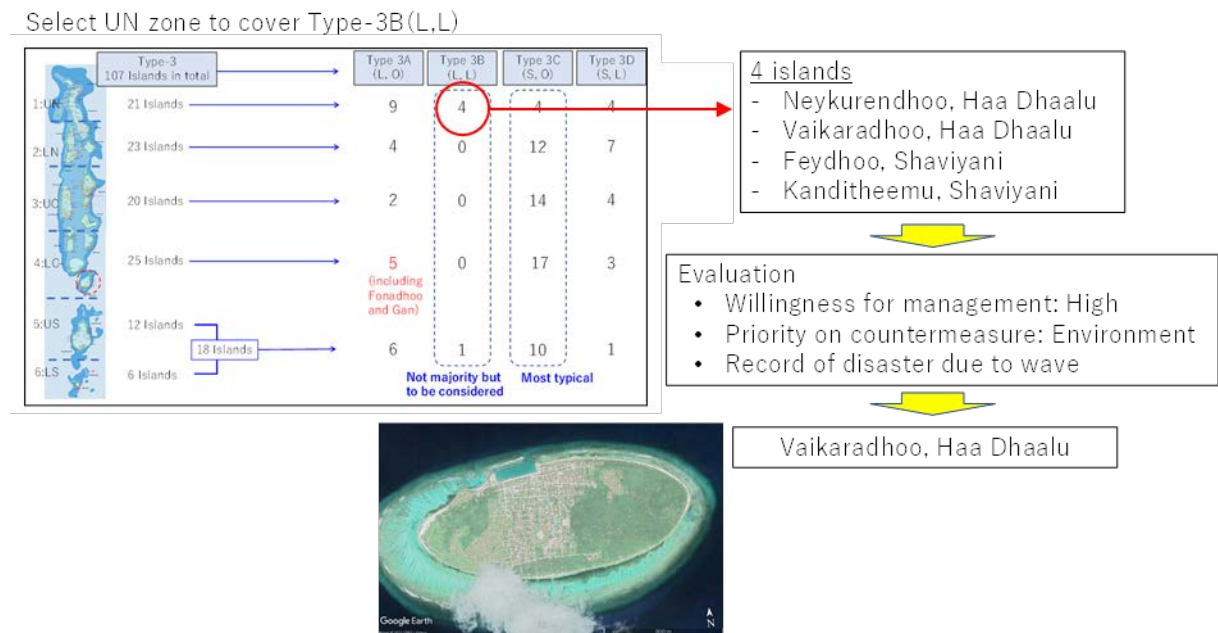
Source: JICA Expert Team

Figure 2.2.10 Questionnaire Survey Results on Coastal Conditions

< Case Examples of the Selection >

A case example to select island for field survey investigation is shown as follows. This example shows the case to select island from Type-3B.

Since Gan and Fonadhoo are located at southern part, northern part is selected as candidate area considering the difference in regional characteristics. There are four (4) candidate islands in northern part for Type 3B, which are Neykurendhoo, Vaikaradhoo, Feydhoo and Kanditheemu as shown in Figure 2.2.11. Regarding with selection criteria 1-3 abovementioned, Vaikaradhoo (Haa Dhaalu) is selected as 1) willingness for coastal management (criteria 1) is high, 2) putting priority for environment impact (criterial 2), and 3) the island suffered coastal disaster due to high waves recently.



Source: JICA Expert Team

Figure 2.2.11 Case Example to Select Island for Field Investigation Survey

2.3 Relevant Legislation, Policy and Plan of ICZM

2.3.1 Legislation

The legislations of the Maldives are mainly prepared by the national language, Dhivehi, and there are few English translated legislations available. Therefore, the data collection survey of laws and regulations on coastal zone management in Maldives was carried out by outsourcing to the Fidelis Law Group (hereinafter referred to as “Fidelis”), the Maldivian law firm, to study the legal system of the Maldives, collect laws and regulations regarding ICZM, prepare the table of contents and the summary and translate some parts of the collected laws and regulations. In this section, the laws and regulations regarding ICZM that needs to be considered in the Project and may be referred when considering the ICZM are identified by examining the collected and summarized information and understanding the outline of the legal system of the Maldives. The identified laws and regulations will be a base of the Phase 2 activity of the Project, in which ICZM Policy and Plan to be formulated through the discussions with the counterpart and relevant government agencies.

(1) Legal System of the Maldives

For the fundamental understanding of the legal system of the Maldives that require legislations on ICZM, the Constitution, legislation, law-making power, executive power, judiciary, decentralization, compositions and roles of the decentralized councils, and relation of the international treaties and domestic legislations are described in below.

a) Constitution and Legislation

Maldives is a sovereign, independent, democratic Republic based on the principles of Islam and is a unitary State known as the Republic of Maldives. The current Constitution of the Maldives (Constitution) was ratified on 7th August 2008. Constitution states that all the powers of the State shall be exercised in accordance with it. Islam is the State Religion and as such Islam is the basis of all laws of the Maldives and no law contrary to any tenet of Islam can be enacted in the Maldives. The current Constitution of the Maldives guarantees substantive democratic principles such as separation of powers, introducing a presidential governance system with a multi-party system, a parliament (called the 'People's Majlis') entrusted with law-making powers and strong oversight functions and an independent judiciary run by an independent commission.

A very central provision in the current Constitution is the introduction of the decentralized administration system of the Maldives. Article 230 (b) of the Constitution states that in order to provide for the decentralized administration, the President has the power as provided in law to create constituencies, posts, island councils, atoll councils and city councils.

Any amendment to the Constitution maybe introduced by a Bill in the People's Majlis which must be passed by a three quarters majority of the total membership of the People's Majilis. The Bill amending the Constitution passed by the People's Majlis shall come into force upon obtaining the written assent of the President. Furthermore, 'law' is defined in the Constitution as those statutes enacted by the People's Majlis and assented to by the President and those regulations which are authorized by and which fall within the ambit of those statutes. The Constitution states that every Bill assented to by the President shall be published in the Government Gazette on the day of assent and such law shall come into force when it is published in the Government Gazette or on such later date following publication stipulated in the statute.

Any bylaw or decision of a local authority is subject to Acts or Regulation of the People's Majlis. All statutes, regulations, government orders requiring compliance by citizens and government policies shall be published and made available to the public. All information concerning government decisions and actions shall be made public except information that is declared to be State secrets by a law enacted by the People's Majlis. Table 2.3.1 shows the type of legislations, organizations to enact/issue and procedure to entry in force for each type of legislations.

Table 2.3.1 Types of Legislation, Organizations to Enact/Issue and Entry in Force and Binding

Types of Legislation	Organizations to Enact/Issue	Entry in Force and Binding
Acts of Parliament	- Enacted by the Parliament	- After an Act has been passed via the required majority in the Parliament, the President needs to give assent to it and becomes law after it is published in the Government Gazette/or on a specific date if the Act mentions it. - It is binding law.
Presidential Decree	- Issued by the President by the Powers vested in him via the Constitution.	- It is published in the Government Gazette. - Not legally binding on its own.
Judicial Precedent	- Judicial Precedents are set by the Court. Lower Courts are obligated to follow the precedents set by the Higher Courts. - It is binding law.	
Regulation	- These are prepared by the relevant authorities such as the Ministries, Agencies, Offices and Institutions.	- The Regulations are developed and finalized by the relevant Government Agency.

Source: JICA Expert Team

b) Law-making power, Executive power and Judiciary

The law-making power of the Maldives is vested in the People's Majlis, a unicameral body of elected members from each constituency of the Maldives for a term of five years. The express powers of the Parliament enshrined in the Constitution includes the power to enact legislation, supervision of the exercise of the executive authority and ensuring that the executive authority is accountable for the exercise of its powers.

The legislative process in the Parliament starts with a Bill introduced by the members of the Parliament. Bills introduced by the ruling party is known as the government Bills and Bills introduced by the rest of the members are known as private Bills. However, any Bill that imposes tax or additional charge on citizens that require a direct expenditure from public funds can only be submitted by the Government.

The executive power is vested in the President of the Maldives as provided for in the Constitution and the law. The President shall be the head of the State, Head of the Government and the Commander in Chief of Armed Forces. The President shall only exercise Executive Authority as provided for in the Constitution and law. The President hold office for a term of five years and no person elected as the President pursuant to this Constitution shall serve more than two terms in office whether consecutive or otherwise. The President shall be elected directly by the people by universal and secret suffrage. Elections for the office of President shall be held one hundred and twenty days to thirty days prior to the expiry of the existing presidential term. The President shall be elected by over fifty percent of the votes. There is a Vice President of the Maldives who assist the President in the discharge of his duties and responsibilities.

The President has the discretion to establish all ministries required within the Government and shall determine their areas of jurisdiction. The President is required to submit all information relating to the Ministries and their areas of jurisdiction to the People's Majlis for approval. The Cabinet consists of Vice President, the Ministers given responsibility for the different Ministries and the Attorney General. The President is required to submit to the People's Majlis within seven days of making appointments to the Cabinet the names of the appointees to the Cabinet for approval of the People's Majlis. Table 2.3.2 shows a list of Government Ministries and Affiliated Agencies of the Maldives.

Table 2.3.2 Government Ministries and Affiliated Agencies of the Maldives

Attorney General	Ministry of Environment, Climate Change, and Technology
Ministry of Finance	Environmental Protection Agency
Ministry of National Planning, Housing, and Infrastructure	Maldives Meteorological Services
Ministry of Home Affairs	Utility Regulatory Authority
Ministry of Defense	Baa Atoll Biosphere Reserve Office
Ministry of Economic Development	National Centre for Information Technology
Ministry of Arts, Culture and Heritage	Communications Authority of Maldives
National Centre for Cultural Heritage	Ministry of Youth, Sports and Community Empowerment
Ministry of Transport and Civil Aviation	Ministry of Islamic Affairs
Maldives Transport Authority	Ministry of Fisheries, Marine Resources, and Agriculture
Ministry of Education	Maldives Marine Research Institute
Ministry of Higher Education	Ministry of Health
Ministry of Tourism	Local Government Authority
Ministry of Gender, Family and Social Services	

Source: Noo Raajje Legal & Policy Framework Assessment Report - 27th July 2021

The judicial power is vested in the Supreme Court, the High Court and such Trial Courts as established by law. The Supreme Court is the highest authority for the administration of justice in the Maldives. The Chief Justice shall be the highest authority on the Supreme Court. All matters adjudicated before the Supreme Court shall be decided upon by a majority of the judges sitting together in a session. The Judges are independent and only subject to the Constitution and the law. When deciding matters on which the Constitution or the law is silent, judges are required to follow Islamic Sharia.

c) Decentralization and Composition and Roles of the Councils

The Article 230 of the Constitution states that the administration of the divisions in the Maldives should be administered via decentralization, and in this regard, the President has the power by virtue of law to create constituencies, posts, island councils, atoll councils and city councils. The Act on Decentralization 2010 (hereinafter referred to as 'DA 2010') was passed in order to provide for the decentralized governance in the Constitution of the Maldives. Under the DA 2010, the Local Government Authority (LGA) was formed as the respective government body that was assigned with the main oversight function of the councils. The DA 2010 was centred around devolving the government and giving more powers to the atoll, island and city councils to enhance community empowerment and to bring public services closer to the people. Since the introduction of the DA 2010, it was always a piece of legislation that was always targeted by the government of the day and it has experienced a series of amendments that was introduced either to reverse the previous government's policy or introduce new policy changes. The DA 2010 saw a total of nine amendments that have been ratified up to date. The eighth and the ninth amendment to DA 2010 brought notable changes that was seen as the government's effort to pave the country's way towards a fiscal decentralization system in the Maldives.

The Article 3 of DA 2010 sets out the hierarchical structure of the councils: the island councils are accountable to the respective atoll council in the administrative division and the atoll and the city councils report directly to LGA. Councils have ownership of all resources and materials within their respective administrative division. Ownership of all other resources lie with the state. State can take back ownership of land, resources and materials within the

administrative division of council to undertake a development project. In this regards the state should compensate the council for any investments it had undertaken on those land and resources. State can utilize land, resources and materials within the administrative division of a council without any approval from the council for reasons of national security.

Composition of the councils are as in Table 2.3.3. One third of all local Councils (city, island and atoll) are reserved for women.

Table 2.3.3 Composition of the Councils

Type of Council	Council Member	President of Council	Vice President of Council
Island Council (Article 24 and 26 of DA 2010)	Election method: Secret ballot held within the electoral constituency of the island. - Population less than 3,000: 5 members - Population more than 3,000: 7 members	Election method: Secret ballot held within the electoral constituency of the island.	Election method: Secret ballot held amongst the elected members of the Council.
Atoll Council (Article 11 of DA 2010)	- Island council presidents of all islands in the administrative division and - Mayor of any city councils within the administrative division.	Election method: Secret ballot by constituents of the administrative division.	—
City Council (Article 41 and 42 of DA2010)	Election method: Secret ballot from the electoral constituency within the city. - Population between 10,000-30,000: 7 members - Population between 30,000-60,000: 13 members - Population more than 60,000: 19 members	Election method: Secret ballot from the electoral constituency within the city.	Election method: Secret ballot held amongst the elected members of the City Council

Source: The Act on Decentralization 2010

The DA 2010 lists specific responsibilities and the services provided by each type of the Councils. Major items are shown in the Table 2.3.4, Table 2.3.5 and Table 2.3.6.

Table 2.3.4 Responsibilities and Services Provided by the Island Councils

Responsibilities (Article 22 of DA 2010)	Services Provided (Article 23 of DA 2010)
<ul style="list-style-type: none"> • Administer and develop the island • Create development, land-use and financial plan of the island • Manage public resources and funds of the island • Seek loans from financial institutions as per the law to fund development activities and submit financial rights, interests and assets to the loan provider as security and create funds for other undertakings • Determine and collect fees for the services provided or facilitated by the Council • Provide the assistance and support needed by the state institutions and Government authorities established in the island. • Make productive use of the reefs, lagoons and other natural resources of the island 	<ul style="list-style-type: none"> • Maintain the jetty of the island, build and maintain wharf and operate the ferry terminal of the island • Take necessary measures to alleviate the land erosion problem and maintain the jetty and the breakwater of the island • Provide and maintain public utility facilities such as water, electricity and sewage systems • Provide primary health care and other basic health security services • Work with relevant government institutions to reduce disaster risks and increase preparedness at island level • Consult island women development committees to formulate island level policies and regulations as per the responsibilities of the island council • Gather and compile a registry of migrant workers working in the island and provide annual reports to relevant government institutions • Maintain a land register of the island and provide information required by the national and land registration authority • Municipal Service management • Issuing and cancellation of permits and registries that Government ministries provide through the island councils and on matters that fall within the jurisdiction of the island council.

Source: The Act on Decentralization 2010

One of the notable additions through the recent amendments was now the Ministries should execute Public Sector Investment Programs (PSIP) under MVR 5,000,000 (five million Maldivian rufiyaa) through Island Councils as per Article 69 (a) and (b) of the DA 2010.

Table 2.3.5 Responsibilities and Services Provided by the Atoll Councils

Responsibilities (Article 8 of DA 2010)	Services Provided (Article 9 of DA 2010)
<ul style="list-style-type: none"> • Govern the administrative division and work for the development of that division • Provide guidance and support in planning island development plans • Provide community recommendations to all relevant stakeholders in planning relevant development programmes for the respective administrative division as a whole • Coordinate the activities of the island councils and monitor the functioning of the island Councils • In accordance with the land Act and other laws, acquire, own, invest in, lease out or give to other parties' lands, reefs and lagoons for economic and social purposes and own such investments in the name of the Council • Seek loans from financial institutions within the limits stipulated in the Act to fund development activities and submit council assets as loan securities and create funds for other undertakings • Enter into contracts with business ventures for various parties in order to provide the services mandated to the Council at the level of administrative division • Determine and collect fees for services provided by the Atoll Council and services provided through the Council 	<ul style="list-style-type: none"> • Provide services that have to be rendered to more than one island in the administrative division and undertake tasks that have been mandated to the Council under various statutes • Provide assistance and cooperation required by the State institutions and Government Offices established in the administrative division • Establish and maintain a registration of islands and their lands falls within the administrative division and provide the information required by national land registration authority • Assist Island Councils in seeking technical and financial assistance

Source: The Act on Decentralization 2010

Table 2.3.6 Responsibilities of the City Councils

Responsibilities (Article 39 of DA 2010)	
<ul style="list-style-type: none"> • Administer and develop the wards of the city in accordance with the Constitution and the laws • Plan and implement development projects and formulate the budget as per the City Development Plan of the Council • Coordinate the activities carried out by the ward offices and monitor the administration of the ward offices • Acquire, own, lease, give and invest in land reefs and lagoons for economic and social use as per the land-use plan, development and the relevant laws 	<ul style="list-style-type: none"> • Seek loans from financial institutions to fund development activities and submit financial rights, interests and assets to the loan provider as security and create funds for other undertakings. • Enter into contracts and business ventures with various parties to provide basic services such as electricity, water and sewerage systems and to carry out other development activities.

Source: The Act on Decentralization 2010

The other items of the jurisdiction of the Councils are determined in DA 2010 as in Table 2.3.7.

Table 2.3.7 Other Jurisdiction of the Councils

Jurisdiction	Remarks
Article 70 (a): Discretion given for the Councils to engage in business ventures to raise revenue.	All business operations need to be conducted via the formation of a Local Authority Company.

	The share that the Local Authority Company hold shall not exceed 20 % of the total shares.
Article 79 (a) (1): The 5 % of the annual projected revenue of the central government should be allocated as block grant to the Councils. Article 79 (a) and (b): The central government should allocate 40 % of the rent to all the Councils from the lease of land, reefs and lagoons that are not under the jurisdiction of the Councils.	When determining the appropriate fiscal formula for the block grant, the Ministry of Finance should take into account the factors introduced in DA 2010. The factors include as follows. - Population of the city or the island council, - Land area that is being utilised by the council, - Number of islands in the administrative division, - Cost of the provision of services in the administrative division - Cost of the development projects undertaken The fund shall be allocated for the following functions. - Administrative costs of the council offices, expenses - Associated costs of the provision of services mandated by the councils - Development projects undertaken by the councils
Article 75: List of areas in which the Council charge fees and rent	—
Article 148: The power given to the Councils to formulate regulations on matters which fall within their jurisdiction with advice from the Local Government Authority.	Specific regulations that the Councils can formulate are listed as follows. - Keeping livestock and birds in the island - Waste management and disposal - Holding entertainment and recreational activities in public spaces of the island - Using loudspeakers and playing loud music - Putting up announcements and advertisement billboards on the roads - Protection of environment - Using motor vehicles and non-motor vehicles on the road and the regulation on parking on the road, using public parking spaces and the levying of parking fees - Anchoring and mooring of vessels at the jetty and harbour and levying of fees for such activities

Source: The Act on Decentralization 2010

d) Regional and International Treaties

According to the Article 93(a) of the Constitution of the Republic of Maldives, Treaties entered into by the Executive in the name of the State with foreign States and international organizations shall be approved by the People's Majlis and shall come into force only in accordance with the decision of the People's Majlis. Article 93(b) states that despite the provisions of Article 93(a), citizens shall only be required to act in compliance with treaties ratified by the State as provided for in a law enacted by the People's Majlis. For many international treaties, the government and the Majlis have not followed through with enacting the necessary domestic laws. This has been the traditional practice. However, there have been recent enactments or amendments to law that give effect to some international treaty obligations.

(2) Laws and Regulations relevant to ICZM Policy & Plan

To start identifying the laws and regulations necessary to review when examining ICZM in the Maldives, list-up of the relevant legislations that are supposed to form ICZM – mainly, coastal conservation, reef conservation, sediment budget control and land use, were requested to the legal department of MECCT. The total of 37 laws and regulations

listed up by MECCT were reviewed by Fidelis. Through the formal interviews and application for obtaining information to the government offices and informal interviews to the government officials and practitioners, relevancies among the listed legislations and technical descriptions were understood, availability of amendments and the other relevant legislations were confirmed, reviewed and compiled. After the preparatory work, the original documents were collected for the total 32 laws and regulations and final report for the data collection survey was prepared in English. The final report includes the table of contents and the summary of the collected laws and regulations, translation of a part of the collected documents which is considered to be closely related to ICZM and the collected original documents as Appendix.3.

In Table 2.3.8, the laws and regulations regarding ICZM that are considered to be necessary to review in the Project and may be referred when considering the ICZM are identified by examining the final report are listed.

Table 2.3.8 Laws and Regulations Considered to be Necessary to review in the Project

No.	Name of Legislation	Outline
1	Maldives Land Use Planning Regulation Authority in charge: MNHPI	<ul style="list-style-type: none"> Composed of the Part 1: Guidelines on how to prepare Land Use Plans and the Part 2: Standards to be followed in the preparation of Land Use Plans. The land use plan shall be formulated with the population projection for the next 20 years. It should comply with the national, regional and sectoral plans. The documents required to submit for approval of land use plan are; land use plan, the legend and the regulation, and planning report that includes details of the analysis of existing land use and the jurisdiction and rationale for the proposed land uses.
2	Regulation on Preparing Environmental Impact Assessment Reports (No: R-27/2012)3/6 Authority in charge: EPA	<ul style="list-style-type: none"> Purpose of this regulation is to provide detailed guidance for proponents, consultants, government agencies and general public on how to obtain approval in the form of and Environmental Decision Statement for a development proposal. This regulation includes, for example, contents of an Environmental Impact Assessment (EIA) Report, procedure of reviewing EIA report, structure of review format, frequency of environmental monitoring and submission of Environmental Monitoring Report.
3	Regulation on Reclamation and Dredging of Island and Lagoons (No: R-15/2013) Authority in charge: EPA	<ul style="list-style-type: none"> Provided for the guidelines on how to mitigate damages caused to the environment due to the dredging of lagoons and island reclamation. This regulation includes, for example, purpose and necessity of dredging and reclamation to be permitted, required documents to be submitted for permission, areas forbidden for dredging, maximum area and duration allowed for reclamation and dredging, exceptional circumstances and the measures taken when EPA recognize the negative impact to the environment. The required documents to be submitted are; description of the works to be undertaken, land use plan and details of the reason for reclamation or dredging, and a georeferenced scale chart showing the area before and after the completion of the reclamation and/or dredging. For the detailed standards for dredging and reclamation it is stipulated as “if there are any standards of dredging lagoons/island reclamation which have been developed and published by a government agency, then any work related to dredging lagoons/reclamation of land must be undertaken pursuant to such standards.”

4	Protected Area Regulation (No: R-78/2017) Authority in charge: EPA	<ul style="list-style-type: none"> • Provided for the guidelines for declaration and effective management of protected areas and procedures in establishing a sustainable mechanism to maintain a regulatory framework for protected areas. • This regulation includes different categories of protected areas and formulation of the relevant guidelines for the activities to be conducted in the protected area.
5	Sand Mining Act (No: 77/78) Authority in charge: EPA	<ul style="list-style-type: none"> • Stated that sand mining activities in any inhabited islands shall be undertaken with the required permit from the relevant authority. • This act was entered into force in 1977-1978 and it has not been amended or updated. • According to MECCT, legislative proposals on this area is currently underway.
6	Disaster Management Act Authority in charge: NDMA	<ul style="list-style-type: none"> • Purpose of the act is to protect the people from natural hazards and man-made disasters and, <ol style="list-style-type: none"> 1) To incorporate guidelines on disaster risk mitigation and preparedness 2) To reduce disaster risk and to adapt a preparatory national strategy, to identify responsible parties to manage disaster risk, and to identify their responsibilities 3) To provide assistance at emergency situations and to provide assistance on the relief efforts 4) To incorporate such guidelines to coordinate such assistance 5) To state the roles and responsibilities of the Councils in reducing disaster risk and mitigation in emergency situations 6) To create awareness among the people in reducing disaster risk and mitigation I emergency situations, and to incorporate guidelines to protect people from such dangers and enhance coping capacity 7) To incorporate disaster risk reduction guidelines and policies within the sustainable national development projects and to make the people responsible and accountable towards disaster risk reduction and mitigation.

Source: JICA Expert Team

Considering the application of these relevant laws and regulations within the framework of the ICZM Policy and Plan, there are several points that are considered as necessary to discuss in depth in each law together with the relevant organizations of the Project. The points that can be considered at this stage are described in below by corresponding to the numbers in Table 2.3.8.

- No.1 In considering the ICZM Policy and Plan for the Project, it is necessary to clarify the relationship between the Land Use Plan and the land considered in the ICZM. This includes direct use of the coastal land, as well as the land where indirect use, such as for reef conservation and sediment budget control.
- No.2 With regard to the EIA Report, it is not clear at this stage how the recommendations and comments provided by the report evaluator, relevant government agencies and the general public are examined in the process of determining the report assessment results and a final conclusion is reached. There may be provisions available within the EPA which have not been confirmed or obtained during this study period. Whether or not a technically valid verification has been carried out should be confirmed in the examination stage of ICZM Policy and Plan.
- No.3 In the Regulation on Reclamation and Dredging of Island and Lagoons, the exceptions to government project of inhabited island development, which state that generally prohibited sand extraction, reclamation and dredging are permitted if the results of a detailed study on biodiversity, flora and fauna,

and flood risk, as well as a plan for implementing the necessary measures, are approved. At present, detailed standards for dredging and reclamation have not been established. It is conceivable that the necessary provisions may be considered in the ICZM Policy and Plan, including detailed provisions in exceptional cases.

- No.4 In the Protected Area Regulation, areas internationally recognized as protected areas, strict nature reserves, wilderness areas, national parks, natural monuments, habitats/species managed areas, areas for sustainable use have been cited as the categories of protected area. The coastal area to be conserved in the Project could be considered to have a possibility to be a protected area for sustainable use.
- No.5 Regarding the Sand Mining Act, it is informed that the examination of the related legislation is ongoing. Since the name of the law is directly related to ICZM, it is considered that the ICZM Policy and Plan should be considered with a common understanding of whether the related legislation under examination is about the existing laws and regulations or preparing as a new law and/or regulation, and the progress of the examination.
- No.6 Disaster Management Act includes the purpose of reducing and preparing for disaster risks. This can be considered a pre-disaster measure. More detailed role of the government and the island council may be better to include in the legislation followed by, if not in the act. Since the ICZM Policy and Plan is considered to correspond to pre-disaster countermeasures, the role of central and local governments in ICZM should be examined in parallel within the framework of disaster management.

In Table 2.3.9, the laws and regulations regarding ICZM that may be referred when considering the ICZM are identified by examining the final report are listed.

Table 2.3.9 Laws and Regulations may be Referred when Considering the ICZM

No.	Name of Legislation	Outline
1	Regulation for the Determination of Penalties and Obtaining Compensation for Damages Caused to the Environment (No: R-9/2011) Authority in charge: EPA	<ul style="list-style-type: none"> • Purpose is to stop the violations under the Environment Protection and Preservation Act of the Maldives and to set out the procedures and guidelines on how to determine penalties and obtain compensation for damages caused to the environment. • If something happens that might cause damage to the environment or if a probability of causing damage to the environment has been discovered through the implementation of a project, the party shall immediately notify the EPA and take all actions reasonably possible to prevent and stop the action which is causing damage to the environment. • When the EPA receives such notification, investigate the matter and issue an order to take certain rectification measures or to stop the project depending on the harm foreseen to the environment.
2	Regulation on the Protection and Conservation of Environment in the Tourism Industry (20th July 2006) Authority in charge: Ministry of Tourism	<ul style="list-style-type: none"> • Purpose is to protect the environment in the Tourism Industry and to encourage and facilitate sustainable development of tourism. • Extraction of coral stones from any part of the lagoon or the reef of an resort islands for for renovation or repair of any jetty or breakwater built. • To preserve and maintain the natural environment of resort islands, at least 80% of the island shall be spared un-built.
3	Guideline on the Protection and Nourishment of Beaches in the	<ul style="list-style-type: none"> • Purpose is to protect and conserve the beaches of resort islands and lay out the procedures in sand mining in such islands to replenish and nourish

	Islands Issued for Tourism Purposes (18th December 2017) Authority in charge: Ministry of Tourism	<p>the beaches and inform the Ministry's officials engaging in implementation of this Guideline.</p> <ul style="list-style-type: none"> • The maximum area of the beach that can be used for nourishment and beach conservation of the resort islands are stipulated. • The proponent shall submit a proposal, including coastal modification application form, description of the works and details, three proposed areas for sand mining, approved concept plans of the proposed work by the Ministry of Tourism, entire concept plan depicted with work area and proposed areas for sand mining and time schedule, to the Ministry of Tourism for approval. • When the works are completed, the proponent shall request a physical inspection from the Ministry of Tourism.
4	Disaster Management Plan of L. Maamendhoo (as a case of island level plan formulated under the Disaster Management Act) Authority in charge: L. Maamendhoo Island Council	<ul style="list-style-type: none"> • Developed by the L. Maamendhoo Council, National Disaster Management Centre and L. Maamendhoo constituents through the 5-day capacity building trainings. • Purpose is to respond to disaster situations that occur at the island level and also to empower the island community to reduce the risk of disasters and potential hazards materializing at the island level. In that respect, it is intended to conduct a situational analysis of the island to undertake capacity and resource mapping to prevent and prepare for disaster situations. • Consists of strategies and measures that can be taken at the island level to reduce the risk of disasters and mitigate its damages upon its occurrence.

Source: JICA Expert Team

The points of laws and regulations that are considered to be a reference during the review of laws and regulations in Table 2.3.8 are described in below by corresponding the numbers of laws and regulations in Table 2.3.9.

- No.1 If a project is likely to cause environmental damage or is discovered during the course of the project, EPA will be notified of the possibility and investigate the problem, take corrective action or issue an order to cease the project. Although the procedures within EPA have not been confirmed during this study period, it is considered that the evaluation of the investigation results of the problem that cause damage to the environment and the evaluation methods of corrective measures can be confirmed in accordance with the examination process of the ICZM Policy and Plan, and these can be considered to state more explicitly during the review of related laws and regulations.
- No.2 Although it is a rule for resort islands, it is considered to be a specific regulation that will be a reference when considering coastal conservation of inhabited islands.
- No.3 Same as above – No.2.
- No.4 Because it is a disaster management plan at the island level, it contains more specific contents than the Disaster Management Act. However, it seems that there is no description of the matters on pre-disaster response such as disaster risk reduction and disaster preparedness. During the consideration of the ICZM Policy and Plan also within the framework of disaster management, it is considered that the sense of level of specific content stipulated at the island level can be referenced.

Regarding the laws and regulations listed in Table 2.3.8 and Table 2.3.9 and the points that need to be deepened into and points that may be helpful, the materials were just shared at the ICZM seminar held on 28 August 2022,

and questions were asked to relevant organizations. In the course of Phase 2 activities, in parallel with the more concrete implementation of the ICZM study, JET plans to discuss measures to implement the ICZM Policy and Plan in the Maldives and compile a draft of legal changes that are considered to be necessary.

2.3.2 Relevant Policy and Plan

The most relevant policies and plans of the Maldives are the National Biodiversity Strategy and Action Plan (2016-2025) and the Strategic Action Plan (2019-2023). The National Biodiversity Strategy and Action Plan seeks to ensure that threats to biodiversity are addressed, biodiversity is conserved, sustainably used and benefits arising from them are shared equitably. The Strategic Action Plan (SAP) was formulated for the use of the government's overarching reference point to steer the national development efforts and raised the 5 priority areas with policy and targets for each area.

In the priority area 4: Jazeera Dhiriulhun (sustainably deriving livelihoods, economies, cultural identity and well-being), there is Sector 3 for environmental protection and preservation. The policies and targets under this sector are shown in Table 2.3.10. The policies closely related to ICZM are Policy 1, 2, 3 and 5.

Table 2.3.10 Policy and Target of the Strategic Action Plan (2019-2023), 4.3 Environmental Protection & Preservation

Policy 1	Strengthen the legislative, regulatory, institutional framework and the human resource capacity to facilitate effective environmental protection and sustainable practices	
	Target 1.1	By 2020, integrate environmental protection and biodiversity conservation with the guidelines, regulations and compliance documents on land use planning, local developments planning, building and all infrastructure development projects
	Target 1.2	By 2020, the independent functioning of EPA is ensured
	Target 1.3	By 2023, a comprehensive legislation on chemicals management is enacted covering the entire lifecycle of chemicals
	Target 1.4	By 2023, standards for fuel quality and vehicle and marine emissions are established
	Target 1.5	By 2023, sustainable production standards are introduced for key industries (tourism, fisheries and construction)
Policy 2	Improve conservation efforts to preserve biodiversity of Maldives and ensure maximum ecosystem benefits	
	Target 2.1	By 2023, a comprehensive and functional protected areas system in the Maldives in accordance with the international standards is established
	Target 2.2	By 2022, a comprehensive reef restoration and protection mechanism under the concept of "Jazeera Island Reef" is introduced and implemented
	Target 2.3	By 2023, at least 10% of coral reef area, 20% of wetlands and mangroves and at least one sand bank and one uninhabited island from each atoll are under some form of protection and management
Policy 3	Strengthen research capacity and evidence-based policy making in environmental protection and conservation	
	Target 3.1	By 2023, establish an evidence-based monitoring system to track the status of key ecosystems, species, and genetic diversity as well as protected areas and species found in the Maldives
	Target 3.2	By 2023, maintain a database on research findings on biodiversity and ecosystems, and enable access to stakeholders
Policy 4	Develop mechanisms to ensure the sound management of chemicals	
	Target 4.1	By 2023, quality control mechanism for labelling imported chemicals are in place and used across the country
	Target 4.2	2023, a national inventory on imported carcinogenic chemicals has been established
Policy 5	Strengthen information management and resource mobilisation	
	Target 5.1	By 2023, an up-to-date database on biodiversity and ecosystems of Maldives is institutionalised and is utilised for conservation, monitoring and enforcement
	Target 5.2	By 2023, user pay principle is mainstreamed and integrated into policies and regulations concerning utilisation of biodiversity resources and ecosystem services
	Target 5.3	By 2022, accurate and regular air pollution data are available to public on a real time basis

Source: Strategic Action Plan 2019-2023

The specific policies of the Government of the Maldives on ICZM are described below, based on the presentations made at the ICZM seminar held on 28 August 2022, on the efforts of MNPHI, MECCT and MMS, the relevant organizations of the Project, the projects currently being implemented, the future plans and the issues recognized at each of the organization.

(1) MNPHI

Coastal erosion is prominent and the coastal protection measures are required. The causes of the coastal erosion are understood as natural cause and anthropogenic cause. The seasonal change of wind and wave patterns, extreme wave and storm surge conditions, changes in long-term wave regimes and sea level rise are seen as the natural cause. Removal of coastal vegetation, sand and coral mining, dredging and land reclamation and coastal modification such as harbours and shore protection structures are regarded as the anthropogenic cause. The impact of the erosion is visible such as loss of vegetation and land, damages to human settlement, damages to critical infrastructure, damages to the other infrastructure and flooding and inundation.

To protect the coastal areas from erosion, two methods of the engineering solution are adopted in Maldives. One is the hard measure, with which armoring structures, such as rock boulder, revetment, breakwater and groynes, are constructed to guarantee no further retreat of existing beach lines and wave overtopping are occurred. It is more commonly used and preferred in the public works, though expensive, it lasts long period. Another method is the soft measure, with which shore stabilization structures, designed to modify coastal processes, are constructed. It is mostly implemented in the resorts, though upfront cost is lower, maintenance cost is higher and the commitment for the maintenance is important. As the other soft engineering measure, beach stabilization with geo-tube or geo-bag is proposed to the islands.

The total cost of the coastal protection projects completed since the year 2019 was MVR 119,496,044.71 (approx. USD 8.9 million), with the total length of 4,678 m was covered in the 13 islands as a whole. The total cost of the coastal protection projects on-going as of August 2022 is MVR 309,854,787.62 (approx. USD 20.7 million), with the total length of 10,297.60 m to be covered in the 11 islands a whole. The total cost of the coastal protection projects that the contracts are concluded (before commencement of the work) as of August 2022 is MVR 595,269,453.35 expected in the 15 islands. Within the budget of FY 2022, MVR 7,000,000 (approx. USD 0.5 million) is planned for the 39 islands. Among them, 13 contracts are at the tender stage.

In 2020, MECCT compiled the emergency response island list, requested budget for the FY 2021 for a part of the list by MECCT and the rest by MNPI (former MNPHI) and almost all were approved. The list prioritized the island for Red: the islands at the risk to public infrastructure, Yellow: the islands face erosion and loss of vegetation and Green: the islands have eroding areas far from public infrastructure. The list compiled in 2020 was composed of 6 islands for Red, 4 islands for Yellow and 8 islands for Green. In 2022, MECCT and MNPHI collaborated to prepare a new list of islands which require coastal protection and prioritized depending on the urgency. Among 31 islands listed, 9 islands were budgeted.

From the past experiences in the planning and implementation process of coastal protection project, 1) budgetary restrictions, 2) increase of project cost, 3) reluctance in adopting soft measure, 4) lack of long-term data and 5) detailed design and implementation of EIA after concluding contract are the major issues raised.

Table 2.3.11 described details of the issues and the current problems.

Table 2.3.11 Issues in Planning and Implementation of the Coastal Protection Project

Issue	Details
1) Budgetary Restrictions	<ul style="list-style-type: none"> • Budget for the coastal protection measures is limited and there is a fixed budget to the specified islands. • There is no budget to cater the emergency islands therefore special permission have to be requested for these islands.
2) Increase of Project Cost	<ul style="list-style-type: none"> • The expenses for structural measures are increased.
3) Reluctancy in Adopting Soft Measure	<ul style="list-style-type: none"> • The effectiveness of the of the soft measure has not been properly demonstrated to the community of islands. • Therefore, the awareness is low in the community and there is no motivation to agree with adopting the soft measure. • They consider the necessity of measurement only when the property is threatened – reactive way of thinking rather than proactive.
4) Lack of Long-term Data	<ul style="list-style-type: none"> • Difficulty in acquiring long-term erosion data.
5) Detailed Design and Implementation of EIA after Concluding Contract	<ul style="list-style-type: none"> • Lack of capacity to prepare detailed designs prior to awarding contracts, resulting in discrepancies in estimated cost and actual price. • EIAs are prepared after awarding the contract, resulting in requiring to bring variations to projects.

Source Presentation material (MNPHI) at ICZM Seminar held on 28 August 2022 edited by JICA Expert Team

Based on the above analysis, the following recommendations are compiled.

As a top priority, it was necessary to allocate funds to the islands that require emergency response, and it was important to identify the most optimal method of protection for the identified islands consider the optimal measures for the protection of the island by evaluating the different options, and to deploy more specialized staff to the site.

Next, it was recommended that it would be necessary to invite financial support from grants and donors, to increase the width of the retreat from the vegetation line to 5 m for tourist islands (actually 10 m) and 20 m for inhabitant islands, and to organize trainings and workshops to raise awareness of coastal protection and various regulations.

For these preparatory items necessary for proceeding the countermeasures, effective use of funds based on proper surveys, ensuring access to data such as erosion, waves and sea level, implementation of surveys to identify the most important islands or locations in coastal protection that consider land use controls and setbacks, retention of coastal vegetation, management of coastal structures on stilts and promoting the exchange of knowledge with other countries, with a focus on raising public awareness of these preparatory measures.

Among the coastal protection projects completed since the year 2019, the major projects are shown in Table 2.3.12.

Table 2.3.12 Major Coastal Protection Projects Completed Since the Year 2019

Island	Project Cost (MVR)	Project Scope	Hard measure	Soft measure
Ha. Dhidhdhoo	10,025,003.00	310 m geo-bag revetment		✓
N. Henbadhoo	5,000,000.00	235 m revetment with backfilling 25 m groyne	✓	✓
N.Fohdhdhoo	7,612,602.00	180 m geo-bag revetment and backfilling	✓	✓
R.Fainu	8,968,065.34	250m geo-bag revetment	✓	
B. Dhonfanu	12,909,684.35	40m groyne 60 m Y groyne 536 m revetment beach nourishment	✓	✓
B.Thulhaadhoo	10,137,775.34	280 m geo-bag revetment		✓
AA.Rasdhoo	14,589,523.50	175 m groyne 39 m revetment beach replenishment	✓	✓
V.Fulidhoo	16,570,324.39	412 m submerged breakwater 162 m groynes 50 m revetment 305 m beach filling, backfilling	✓	✓
V.Rakeedhoo	10,212,941.00	40 m groynes 200m breakwaters swimming area dredging	✓	
M.Mulah	17,665,935.73	411 m geo-bag revetment		✓
S.Meedhoo	5,804,190.06	210 m geo-bag revetment		✓
Total	119,496,044.71	4,678 m	—	—

Source Presentation material (MNPHI) at ICZM Seminar held on 28 August 2022 edited by JICA Expert Team

The coastal protection projects on-going as of August 2022 are shown in Table 2.3.13.

Table 2.3.13 Coastal Protection Projects On-going as of August 2022

Island	Project Cost (MVR)	Project Scope	Hard measure	Soft measure
Ha. Hoarafushi	6,399,518.00	420 m geo-bag revetment 100 m groyne 260 m revetment reprofiled to groyne	✓	✓
Hdh. Nellaidhoo	20,342,491.80	882 m rock revetment	✓	
R. Rasmaadhoo	13,215,945.0	381 m groynes	✓	
Ha.Hoarafushi airport	90,566,804.92	436 m revetment 1,165 m breakwater	✓	

		455 m groyne		
Th.Buruni	28,876,557.10	399 m rock breakwater 220 m rock revetment beach replenishment	✓	✓
B. Kudarikilu	14,749,900.00	836 m revetment 30 m groyne 50 m breakwater	✓	
Lh. Kurendhoo	44,882,495.31	802 m revetment 361m breakwater 142 m groynes	✓	
B. Kendhoo	41,112,650.14	803 m breakwaters 90 m groyne 110 m revetment 20 x 40 m swimming area	✓	
B. Dharavandhoo	22,145,859.20	415m breakwater 144m revetment beach replenishment	✓	✓
M. Kolhufushi	22,961,969.21	518.8 m revetment 202.40 breakwater 30 x 60 m swimming areas (2 nos)	✓	
S. Meedhoo phase 2	4,600,596.94	237 m revetment (geo-bag)	—	✓

Source Presentation material (MNPPI) at ICZM Seminar held on 28 August 2022 edited by JICA Expert Team

The coastal protection projects that the contracts are concluded (before commencement of the work) as of August 2022 are shown in Table 2.3.14

Table 2.3.14 Coastal Protection Projects Contracted as of August 2022

Island	Project Cost (MVR)	Project Scope	Hard measure	Soft measure
Adh. Kunburudhoo	21,753,166.80	430 m revetment, reclamation 185 m geo-tube revetment	✓	✓
Sh.Milandhoo	36,695,523.86	954.43 revetment 44.77 m groynes	✓	
S. Hithadhoo	11,645,907.30	570 m geotube revetment swimming area 100 m breakwater	✓	✓
Hdh.Kulhudhuffushi airport	42,375,467.36	954.43 m revetment 114.56 m groynes	✓	
N. Kudafari	15,011,223.92	718 m geo-bag revetment		✓
L.Gan	11,527,669.60	260 m groyne 30 m revetment beach nourishment	✓	✓
Gdh. Rathafandhoo	27,849,136.20	240 m breakwater 461 m revetment beach replenishment	✓	✓
Gdh.Thinadhoo	17,854,200.00	468 m revetment	✓	
Gn.Fuahmulah	300,343,050.00	2,650 m rock revetment	✓	
Th. Dhiyamigili	23,164,180.00	205 m revetment 392 m breakwater	✓	
Th. Vilufushi	11,192,295.14	184 m revetment 135 m breakwater	✓	
V. Fulidhoo phase 2	8,072,917.00	84 m groyne 180 m breakwaters	✓	

M. Mulah Phase 2	38,968,262.13	343.03 m revetment 539.9 m breakwater beach replenishment	✓	✓
R. Ungoofaaru	11,116,856.00	120 m breakwater 110 m groyne beach nourishment	✓	✓
Th.Gaadhiffushi	17,699,598.04	500 m revetment 15 m groynes	✓	

Source: Presentation material (MNPHI) at ICZM Seminar held on 28 August 2022 edited by JICA Expert Team

(1) MECCT

MECCT is currently formulating the Erosion and Inundation Hazard Maps for the islands and updating the Coastal Vulnerability Index (CVI).

For the hazard maps, the layout of the coastline is drawn by using Google Earth, identifying the land losses and gains over the years by using QGIS based on the information collected from the councils on areas prone to erosion and inundation, and then the information from the Councils are integrated into the hazard map. As of August 2022, 85 islands (45 %) of the total KMZ shoreline layouts are completed and total hazard maps completed are 77 islands (40 %)

With regard to the CVI, desk research on CVIs in other Small Island Developing States (SIDS) was conducted and existing CVI templates were updated. MECCT is currently conducting a reviewing work.

Through these activities, lack of historical data, lack of technical capacity in the islands and necessity to improve inter-agency communications were identified.

(2) MMS

MMS plays a technical key role in collection, archiving and provision of related data, though no direct intervention to ICZM. Currently, MMS focusing on strengthening observation and forecasting capabilities, especially in marine meteorology in addition to expansion and maintenance of land based Automatic Weather Station network on the Strategic Action Plan, and currently has three tide gauges in Hanimaadhoo, Hulhule and Gan. Additionally, MMS is an implementing partner of the water resource management strategies of MECCT and the resilience building and disaster management strategies of NDMA.

Table 2.3.15 shows the excerpt of the Strategic Action Plan that MMS implements.

Table 2.3.15 Strategic Action Plan of MMS

Strategy 7.3	Strengthening Observation Network, data automation and integration [MM 9.2.2]
Action 7.3a	Establish a country-wide lightning network
Action 7.3b	Establish a marine meteorological observatory
Action 7.3c	Develop an ocean weather prediction modelling and forecasting system
Action 7.3d	Improve existing communication networks

Source: Presentation material (MMS) at ICZM Seminar held on 28 August 2022

On marine meteorology, MMS, with the support of the Italian Government, is working to downscale and contextualize wave models to match the Maldives. Wave models can help identify hazardous events related to swell waves and could also be used in the planning process of land use. The data set obtained from the buoy observation network can provide input data to the wave model, which helps to improve the accuracy of the model.

In considering the ICZM Plan, MMS recognizes that data and its analysis are critical to science-backed planning and decision-making. The biggest challenge for MMS is the maintenance and management of equipment installed nationwide and the capacity of human resources within limited funds. The ICZM Plan requires the incorporation of equipment management by each council and the implementation and continuation of human resource development in the specialized fields such as instrumentation and analysis.

2.4 Relevant Organizations of ICZM

2.4.1 C/P Organization

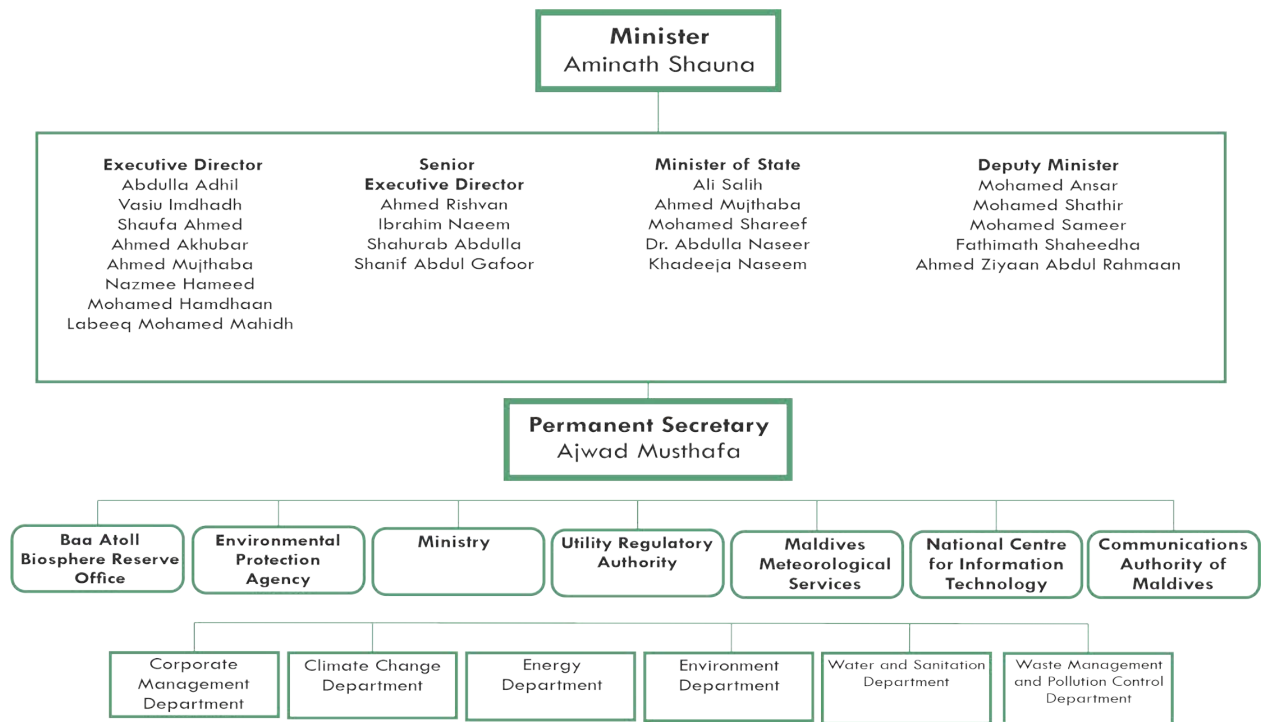
The C/P organization of the Project is MECCT, mainly Environmental Management Department and Climate Change Department, also Environmental Protection Agency (EPA) and Maldives Meteorology Service (MMS), the organizations under MECCT. The mandate of each organization and the organizational structure is described in below.

(1) Ministry of Environment, Climate Change and Technology (MECCT)

Since the mandate of MECCT covers 60 items, it was summarized in the following six points as an outline. The complete set of the mandate is described in Appendix.4.

1. Formulation of strategies, policies, action plans, laws, regulations, guidelines and standards relating to the changes in the climate and environment of the Maldives, areas pertaining to energy, water, waste, sewerage, meteorology, science and communication.
2. Implementation and management of the formulated strategies, policies, action plans, laws, regulations, guidelines and standards as above.
3. Support to the government authorities, island councils, service providers, researchers and the general public to carry out activities related to the above through technical and economic advice, grants and environmental improvements.
4. Advocacy at the regional and international level on other activities related to mitigating the impacts of climate change on the Maldives and other small island developing States.
5. Develop projects to mitigate climate change, and acquire financial assistance from international agencies.
6. Carry out all necessary actions to implement international treaties and agreements signed by the Maldives pertaining to the Ministries' scope of work.

Organization structure of MECCT is shown in Figure 2.4.1.



Source: MECCT Homepage

Figure 2.4.1 Organization Structure of MECCT

The organizations under MECCT are the 6 organizations shown under the “Permanent Secretary” of Figure 2.4.1. In the Project, the C/P organizations under MECCT are EPA and MMS. The departments under MECCT are those shown below the organizations under MECCT. The main C/P departments for the Project are Environment Department and Climate Change Department. The outline and mandates of these departments and organizations are described in below.

(2) Environment Department

Established in 1984, the core duty of the Environment Department is to preserve the Maldives’ unique natural habitat. The department is to advise the government on laws and regulations, adopts policies, and implement environment-related strategies. This department is composed of two sections and four units as in Table 2.4.1.

Table 2.4.1 Organization Structure of Environment Department

Environment Department	
Policy Coordination and Management Division	
	Environment Policy and Multilateral Environmental Agreements Section
	Environmental policy unit
	Multilateral environmental agreements unit
	Maldives Green fund secretariat unit
	Environment Management Section
	Air quality management unit
	National Ozone unit
	Chemicals management unit
	Coastal Zone Management Section
	Knowledge Management, Research and Assessment Section
	Surveying and research unit
	Environment Information System (ENVIS) and State of the Environmental (SOE) unit
	Communication, Education and public awareness (CEPA) unit
Conservation Division	
	Biodiversity Section
	Biodiversity assessment unit
	Biodiversity conservation unit
	Protected Areas Section
	Protected areas designation unit
	Protected areas management unit
	National Parks Section
	S. Hithadhoo unit
	S. Hulhumheedhoo unit
	Fuvahmulah city unit
	South Marine Park (SAMPa) unit

Source: MECCT

The Policy Coordination and Management Division formulates policies related to the environment of Maldives, implement the formulated policies and report the details of policy implementation to relevant parties. Also, develop and implement strategies, action plans, and regulatory programs for protection and conservation of the environment of the Maldives in a sustainable manner. Further, providing expert consultation and assistance in developing concepts of projects related to protection and conservation of the environment.

Under the Policy Coordination and Management Division, the Coastal Zone Management Section plans and formulates strategies, action plans, and programs to develop activities related to coastal zone management, in a sustainable manner. Also, the section implements all projects related to coastal zone management, except those including infrastructure. And it takes initiative in planning and implementing awareness programs at national and international level.

(3) Climate Change Department

The Climate Change Department is in charge of formulating policies and standards to address climate change challenges in line with the legislative framework of the country as well as international practices and conventions. The mandate of this department is as follows.

1. Ensuring and integrating sustainable financing into climate change adaptation opportunities and low emission development measures.
2. Strengthening and developing a low emission system and ensuring energy security
3. Bolstering adaptation actions and opportunities, building climate-resilient infrastructures (including coastal protection) and communities
4. Advocating for a national, regional, and international climate change role in leading international negotiations and awareness in cross-sectorial areas to support the most vulnerable and small island developing states
5. Fostering sustainable development while ensuring security, economic sustainability and sovereignty from the negative consequences of the changing climate
6. Strengthening international cooperation to boost both investment and know-how.

The Climate Change Department is composed of two sections and six units as in Table 2.4.2.

Table 2.4.2 Organization Structure of Climate Change Department

Climate Change Department	
Adaptation and Mitigation section	Monitoring and Evaluation unit
	Greenhouses Gas Rreporting unit
	Clean Development Mechanism unit
Policy and Programs section	Sustainable Development Instruments unit
	Communication and Programs unit
	Policy and Planning unit

Source: MECCT Homepage

(4) Environmental Protection Agency (EPA)

EPA is responsible for regulatory activities for protection, conservation and management of environment and biodiversity, as well as waste management and pollution prevention under the Environment Protection and Preservation Act (4/93). The mandate of EPA is as follows.

1. Plan and organize regulatory activities for protection, conservation and management of environment and biodiversity under the environment Protection and Preservation Act (4/93)
2. Formulate guidelines for EIA data collection, which is a requirement before proceeding with any project that may have a significant impact to the environment.

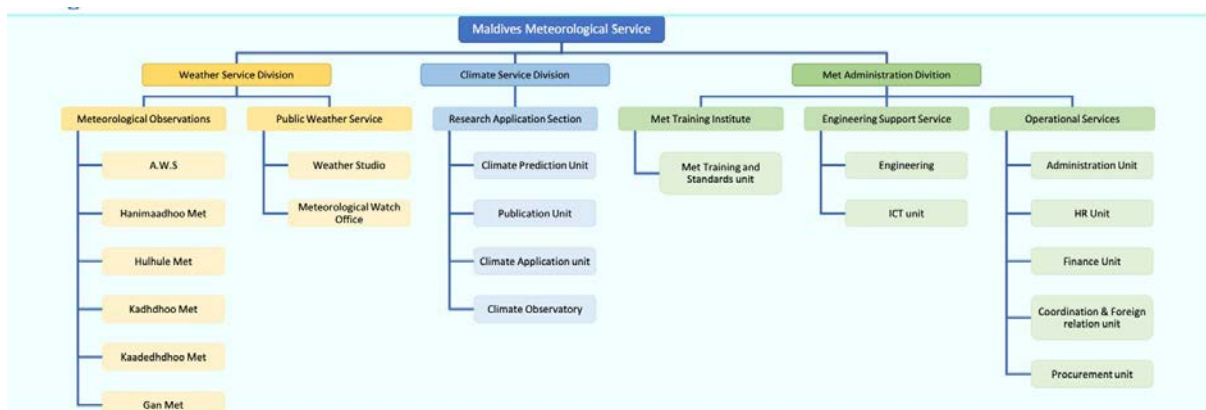
3. Provide expert assistance to relevant authorities pertaining to taking preventative measures based on information related to land erosion, natural and human made environmental problems
4. Valuating the damages sustained by the environment to obtain reimbursement.
5. Implementation of regulations made by the Ministry concerning the environmental protection of Maldivian islands, ensure whether the legislations and regulations are being followed by individuals and governmental authorities, take lawful action where necessary, and provide consultation to government authorities on relevant matters.
6. Carry out scientific research and studies related to Environmental Protection Agency, create and monitor a “Knowledgebase” with the obtained knowledge and arrange dissemination of such information to all relevant persons.
7. Study the changes in coastal regions of Maldivian islands, and the reasons for such occurrences, and give consultation on preventive measures.
8. Collect information pertaining to the formation of islands and any changes that take place in such areas of the Maldives via facilities such as satellite imagery and aerial photography and arrange dissemination of the information required for the Geographic Information System.
9. Carry out research pertaining Land Reclamation, Dredging Reefs, Harbor Construction, and creation of Channel into Harbor in an environmentally friendly manner, and sharing the findings with the relevant parties.
10. Carry out research and studies to understand the pollution in the environment and share the findings and give technical advice to relevant parties.
11. Conduct research pertaining Flora and Fauna and its habitat, and share the experience obtained from the research to relevant parties.
12. Carry out research and studies of Biotechnology and Biosafety related to Maldivian Islands, provide technical consultation of such information.
13. Monitor, record and maintain records regarding the changes in levels of gases, smokes, and particular matter in the atmosphere and arrange dissemination of such information to all relevant persons.
14. Carry out research pertaining water resources available in Maldives, maintain such data and arrange dissemination of this data to relevant persons.
15. Create and publish a knowledge base with environmental related data required to plan the development projects.

(5) Maldives Meteorology Service (MMS)

A meteorological service was established in the early 1940s. After 1974, Met office adapted to the international standard. The sea area forecasts and the route forecasts were prepared by the Colombo Observatory and sent to the Meteorological Centre. Meteorological office became Maldives Meteorological Service (MMS) in 2009. Today, MMS is responsible for the seismological and meteorological services in Maldives. There are 5 Meteorological offices under MMS, the station in Hulhule’ being the main office. Aviation and synoptic observations done in the other four stations are sent to the Hulhule station on their respective time via email or fax. The mandate of MMS is as follows.

1. Plan, administer and develop activities related to meteorology in the Maldives.
2. Maintaining the data on climate, earthquake, and tsunami, required for economically and socially sustainable development.
3. Develop and maintain such a knowledge base and facilitate access to this information to those who require it.
4. Conduct research activities on meteorology and seismology in the Maldives.
5. Provide aeronautical meteorological services to international and domestic aviation requirements as per the required standards of International Civil Aviation Organization and World Meteorological Organization.
6. Monitor weather, earthquake, and tsunami over the region. Issue impact-based forecast and early warning alerts to concerned authorities and general public.

The organization structure of MMS is shown in Figure 2.4.2.



Source: MMS Homepage

Figure 2.4.2 Organization Structure of MMS

2.4.2 Other Relevant Organizations

The relevant organizations participating in the Project are the Ministry of National Planning, Housing and Infrastructure (MNPHI), the National Disaster Management Authority (NDMA) and Local Government Authority (LGA) from the central government, and island and atoll councils from Addu Atoll and Laamu Atoll where the project sites will locate. In this section, the mandate and organization structure of MNPHI, NDMA and LGA from the central government are described.

(1) Ministry of National Planning, Housing and Infrastructure (MNPHI)

Since the mandate of MNPHI covers 54 items, it was summarized in the following 12 points as an outline. The complete set of the mandate is described in Appendix.4.

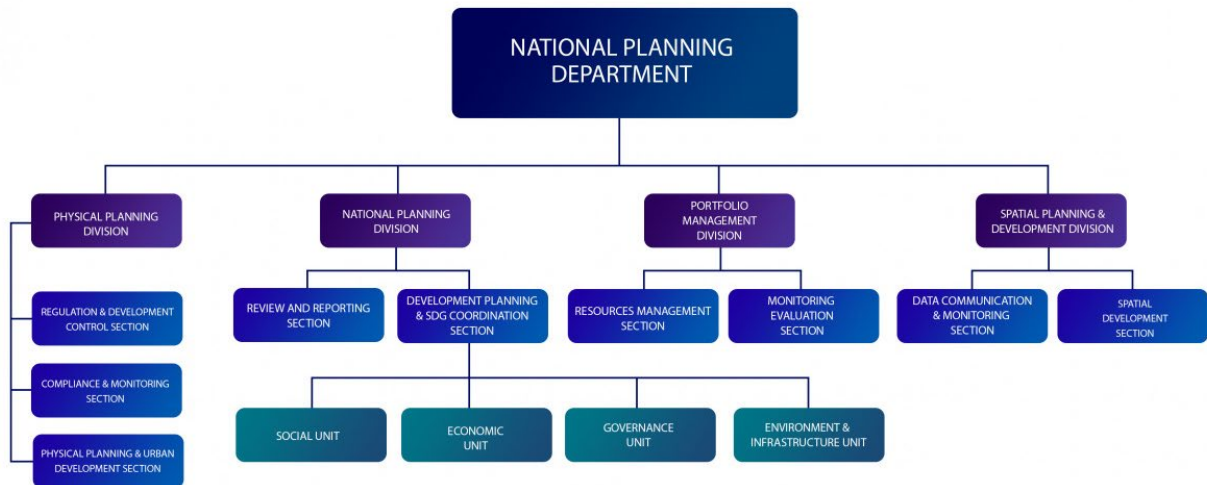
1. Do the necessary research to establish the National Development Plan, make the development plans with the assistance of relevant authorities, work with relevant government authorities to ensure their development plans are consistent with the national development plans, prioritize the development projects, work with the relevant authorities to get the finances to implement the development projects, create

pipelines for the development projects requiring international aid and discuss and provide guidance to use the aid for the relevant authorities and provide technical support and guidance to the relevant government authorities.

2. Evaluate the National Development Plan, Public Sector Investment Program and other development programs and to provide the support to overcome the difficulties faced.
3. Work as the focal point of the government on reaching Sustainable Development Goals, work with the government authorities to reach these goals, oversee these works and to report to the relevant authorities.
4. Prepare the Maldives Regional Spatial Plans, make and revise the master plan of the Urban Area, make the urban redevelopment plan.
5. Prepare the land use plans of islands, approve the land use plans, and make the development controls regarding the plan and to prepare the operational structures
6. Formulate the procedures to maintain the land registries and establish a system to maintain such registers with the relevant authorities, establish the land related policies, rules and regulations that has to be made under the law, make procedures and a system to value the land with the relevant authorities, make housing policies, and plan and carry out ways to implement these policies, plan and manage housing programs under the national housing policies.
7. Provide expertise for drafting bills of the construction industry, establish standards, evaluate the people/workers of the construction industry, register and provide licenses for them, do the necessary research to the construction industry, provide necessary trainings for the people interested to work in the construction industry.
8. Establish the rules and regulations of land reclamation and dredging.
9. Identify and evaluate the disasters, evaluate the damages done to public buildings and other infrastructure and do research to ways to reduce such damages.
10. Manage and monitor projects on public infrastructure (which includes roads, bridge, potable water and sewage service, establishment of energy and communication networks, airports, ports, harbors, land reclamation and coastal protection) and make sure that they are being carried out as per the National Development Plan.
11. Evaluate bids on the development projects by the government offices and give counsel on the tenders, ensure whether the estimated prices provided in the bill of quantities (BOQ) are appropriate.
12. Make necessary arrangements to find a party interested to provide the services and maintain the infrastructure systems.

There are 3 organizations under MNPFI; Maldives Bureau of Statistics, Department of National Registration and Maldives Land and Survey Authority (MLSA), and the one with close relation to the Project is MLSA. MNPFI is composed of Housing Department, Planning Department, Public Works Department, Infrastructure Department, Construction Industry Development Department and Corporate Department

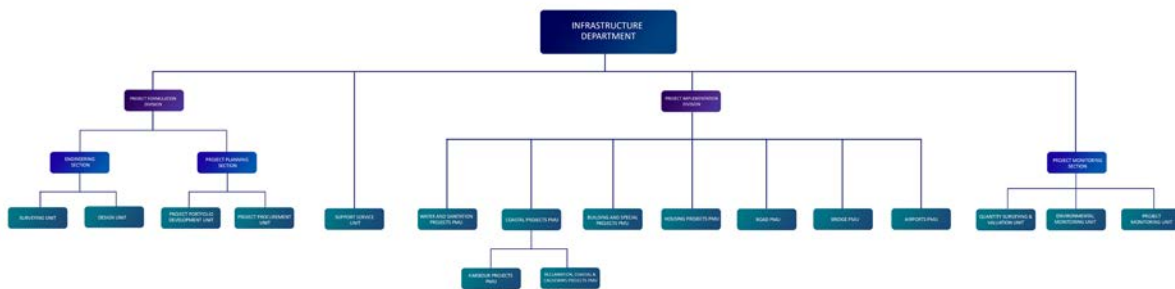
The organization charts and the mandates of Planning Department, Infrastructure Department, Construction Industry Development Department and MLSA, those closely relate to the Project, are shown in below.



Source: MNPHI Homepage

Figure 2.4.3 Organization Structure of Planning Department

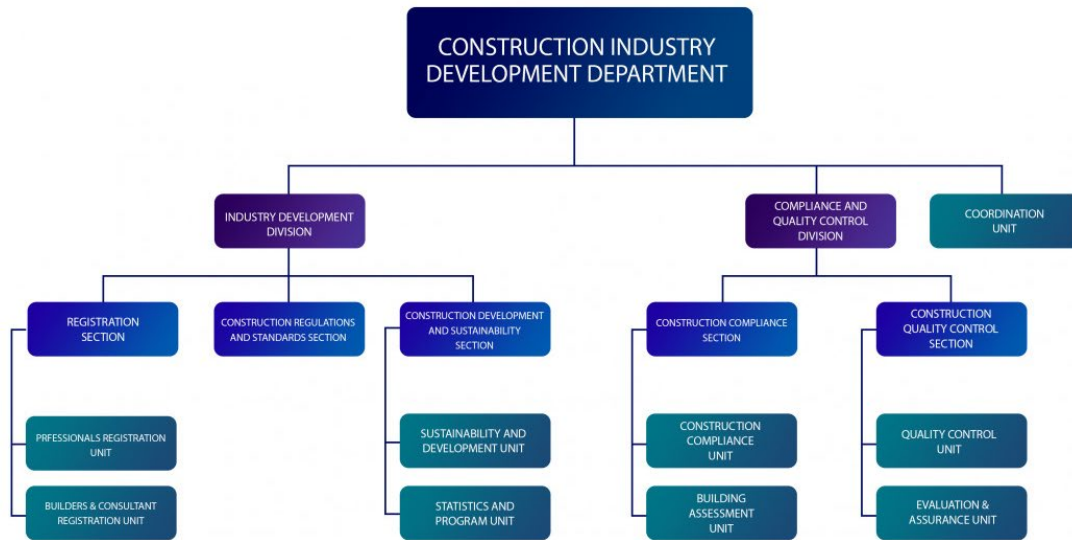
Planning Department makes physical development plan, formulate the procedures to maintain the land registries, prepare the land use plans of islands, make the master plan of the urban area and urban redevelopment plan.



Source: MNPHI Homepage

Figure 2.4.4 Organization Structure of Infrastructure Department

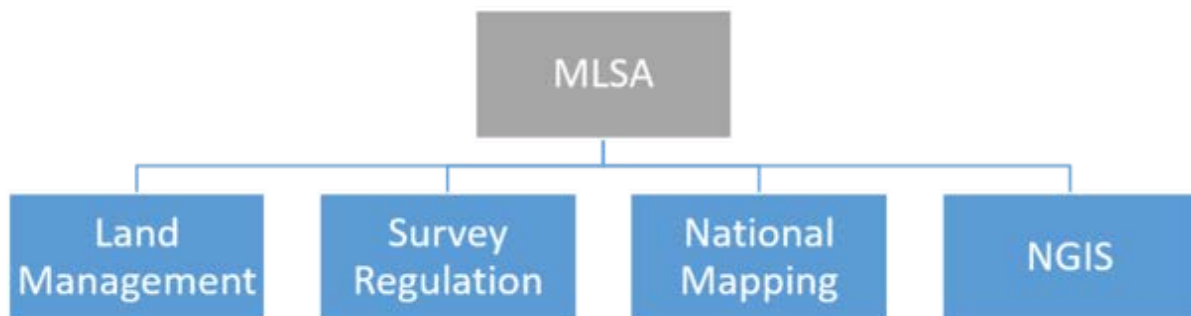
Infrastructure Department plans, develops and manages the designs and projects required to develop the infrastructure, establish a register of the state buildings and other infrastructure, oversee the use of such buildings, provide technical support for the repair works of the buildings and infrastructures by MNPHI. Construction of harbors and all works related to harbor development, harbor repairing, construction of jetties, building flats and houses in islands, providing electricity, water and sewerage for these houses, projects carried out with the help of international aid, road construction in islands, land reclamation and revetment works are the main tasks to be carried out by the infrastructure department.



Source: MNPHI Homepage

Figure 2.4.5 Organization Structure of Construction Industry Development Department

Construction Industry Department plans, guides, manages, oversees and develops the policies and strategies, establishes the regulations, codes, standards of the construction industry and oversees and manages them, establishes standards to ensure that the buildings are made to provide a good health and are safe, evaluates the people/workers of the construction industry, provides necessary training, establishes the rules and regulations of land reclamation and dredging and conducted researches to ensure the easy availability of materials needed for construction.



Source: MNPHI Homepage

Figure 2.4.6 Organization Structure of Maldives Land and Survey Authority

MLSA centralizes management of land Information and consolidate land research that was previously undertaken by different agencies of the government. The authority also has the mandate of regulating cadastral surveys, national mapping as well as establishing and managing the national geographic information system.

(2) National Disaster Management Authority (NDMA)

NDMA was established as per the Disaster Management Act (28/2015) on 30 December 2018. One of the most important objectives of NDMA is to mainstream disaster risk reduction at the national level. This includes planning processes, establishing agreed standards, developing procedures and policies.

Much of the work at NDMA is made possible through its partnership with international technical bodies and donor agencies. Particularly of note are the projects being funded by United Nations Development Programme (UNDP), United Nations Children's Fund (UNICEF), UN International Strategy for Disaster Reduction (UNISDR) and the Asian Disaster Preparedness Center (ADPC). NDMA also received training opportunities from South Asian Association for Regional Cooperation (SAARC), United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), Asian Disaster Reduction Center (ADRC), Malaysian Medical Relief Society (MERCY Malaysia) and several other organizations.

The mandate of NDMA are as follows.

1. Organize and conduct various programs needed to prepare the public in the event of disasters both natural and otherwise and raising government and public awareness of such events.
2. Establish and coordinate the legal and administrative system required to have government ministries, private sector, groups and organizations and individual citizens coordinate for any work that needs to be carried out in a centralized manner due to disasters natural or otherwise.
3. In the event of disasters natural and otherwise, identify immediate response and relief requirement, and organize and coordinate ways to provide relief aid with other authorities concerned.
4. Provide temporary shelter to those whose homes become uninhabitable due to disasters both natural and otherwise.
5. Ensure that the basic necessities are provided for those whose homes become uninhabitable due to disasters both natural and otherwise until temporary shelter can be arranged.
6. Organize and coordinate with concerned government authorities the actions needed to be taken to acquire both local and internal aid in the event of disasters both natural and otherwise.
7. Establish a strong mechanism of working in association with concerned government and non-government authorities to ensure that disaster risk reduction remains a top priority.
8. Conduct research on the devastation caused by natural disasters as well as the impact of epidemic and pandemic in a small country like Maldives, and using the outcomes of the research, compile and publish a set of rules and regulations to be followed for any actions taken.
9. Ensure that any developmental programs or a project conducted by various government ministries conforms to the national disaster risk reduction standards as much as possible.
10. Enhance and increase the capacity of the early warning systems for natural disasters, potential pandemic and epidemic, and other disasters.
11. Establish and implement a system to coordinate facilitate and monitor disaster risk reduction activities in a centralized manner.

12. Establish mechanism in coordination with communities and clubs in the islands to increase the safety of vulnerable groups such as women and people with special needs in the face of disasters.
13. Establish a strong mechanism in which regional and international experience, information and other resources can be utilized, to disaster risk reduction.
14. Conduct awareness programs on disaster risk reduction in all regions of Maldives on a continuous basis.
15. Integrate disaster risk reduction and disaster management into the national education system and school curriculum establish means to deliver it.
16. Facilitate training for government employees of relevant sector of disaster risk reduction to enhance their knowledge on disaster management and disaster risk reduction.
17. Establish a disaster information database and making it accessible to public.

NDMA is composed of 3 units within the organization, such as Early Warning and Emergency Operations, Disaster Preparedness and Risk Reduction and Cooperate Affairs. The Disaster Preparedness and Risk Reduction, which is considered to be closely related to the Project, conducts local and national level programs to prepare and mitigate disaster risks (including handling all matters related to Disaster Risk Reduction Policies, Flood and Fire related issues, Conducting Disaster Awareness Programs).

(3) Local Government Authority (LGA)

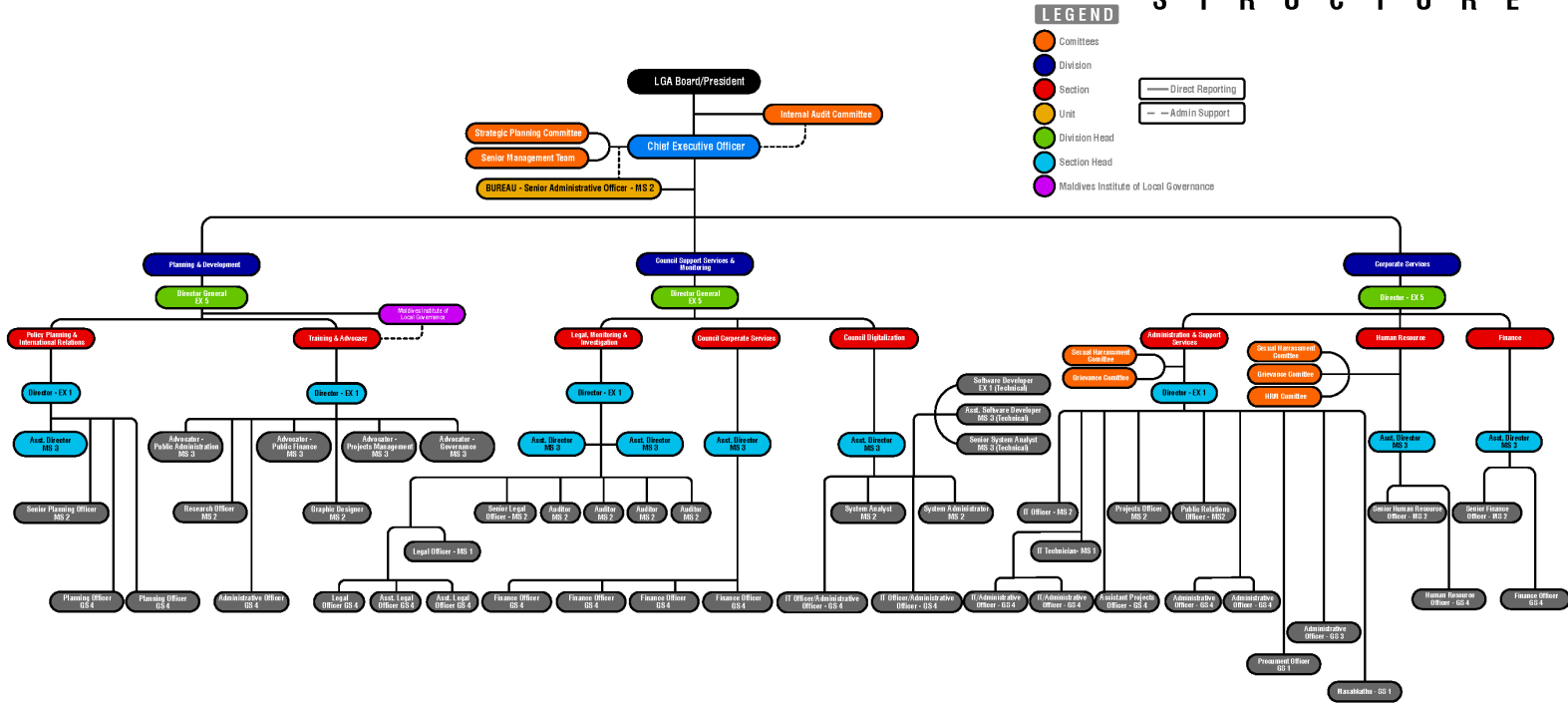
LGA was established under the Decentralization Act to regulate, oversee and develop the local governance system of Maldives as envisioned in the Constitution. The Decentralization Act confers the following mandate on LGA.

1. Money to ensure that the work and activities of councils created under this act function in accordance with the constitution, the decentralization act, and other laws.
2. coordinate the work of the councils at national level.
3. perform all other responsibilities mandated to the LGA under the decentralization act.
4. Monitor and harmonize standards and procedures, work activities, and regulations formulated by different councils.
5. To formulate a mechanism to demark the boundaries of the administrative divisions set forth in the decentralization act.
6. Identify training needs and conduct programs for capacity building of local councils.

Organizational chart of LGA is as in Figure 2.4.7.



ORGANIZATIONAL STRUCTURE

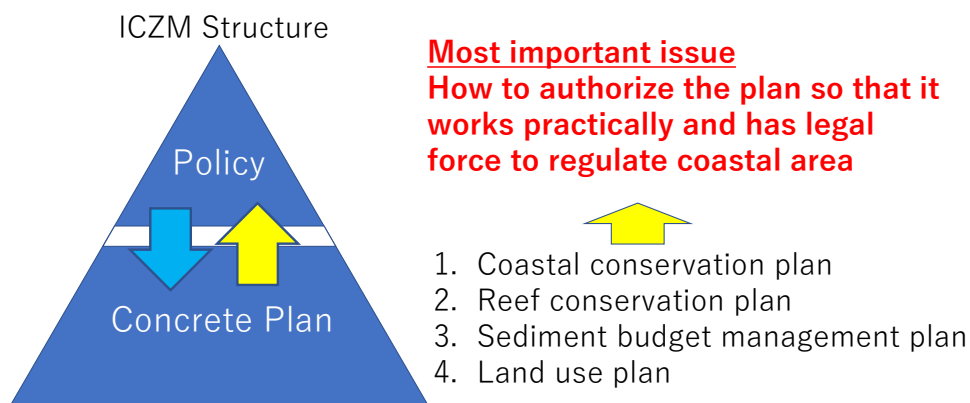


Source: LGA Homepage

Figure 2.4.7 Organization Structure of LGA

2.5 Issues and Image of Concrete Plan for ICZM

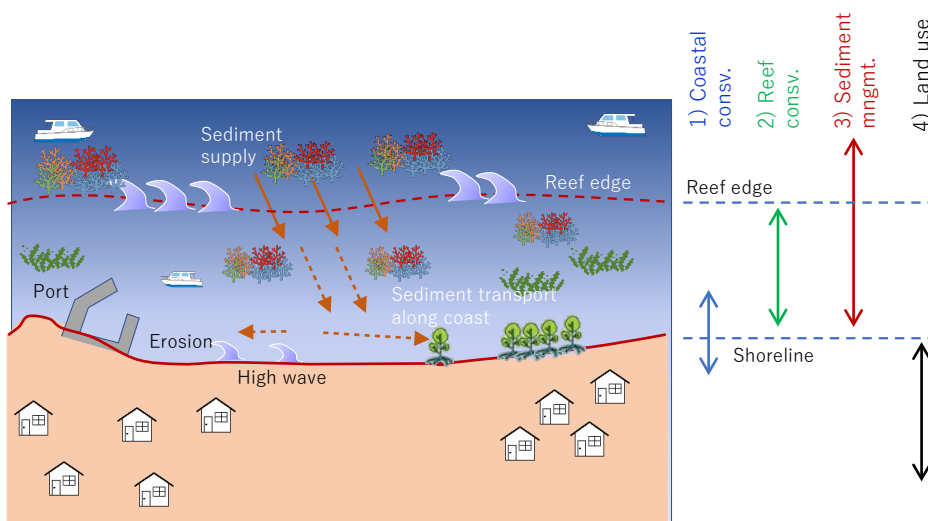
Image of concrete plan of ICZM, which are going to be prepared at Gan and Fonadhoo, is summarized as follows. The concrete plan consists of 1) coastal conservation plan, 2) reef conservation plan, 3) sediment budget management plan and 4) land use plan. In addition, there would be a need to consolidate or modify the legal system, which is described in Sec 2.4, at the policy level (i.e. the central government side) so that these concrete plans can work effectively with legal forth as shown in Figure 2.5.1. This issue is recognized as the most critical issues to be archived in Component 1 in this study.



Source: JICA Expert Team

Figure 2.5.1 Issue and Structure of ICZM

Figure 2.5.2 shows the general area to be covered by each plan. Coastal conservation plan (No.1) covers at nearshore area, which includes physical phenomena such as wave and erosion, coastal structures such as port and revetement, vegetation such as mangrove, and buildings and infrastructures at near shoreline. Reef conservation plan (No.2) mainly covers the reef area between shoreline and reef edge. Sediment budget management plan (No.3) covers from offshore as the source of supply to shore where sediment is supplied. Land use plan (No.4) covers hinterland of coastal area.



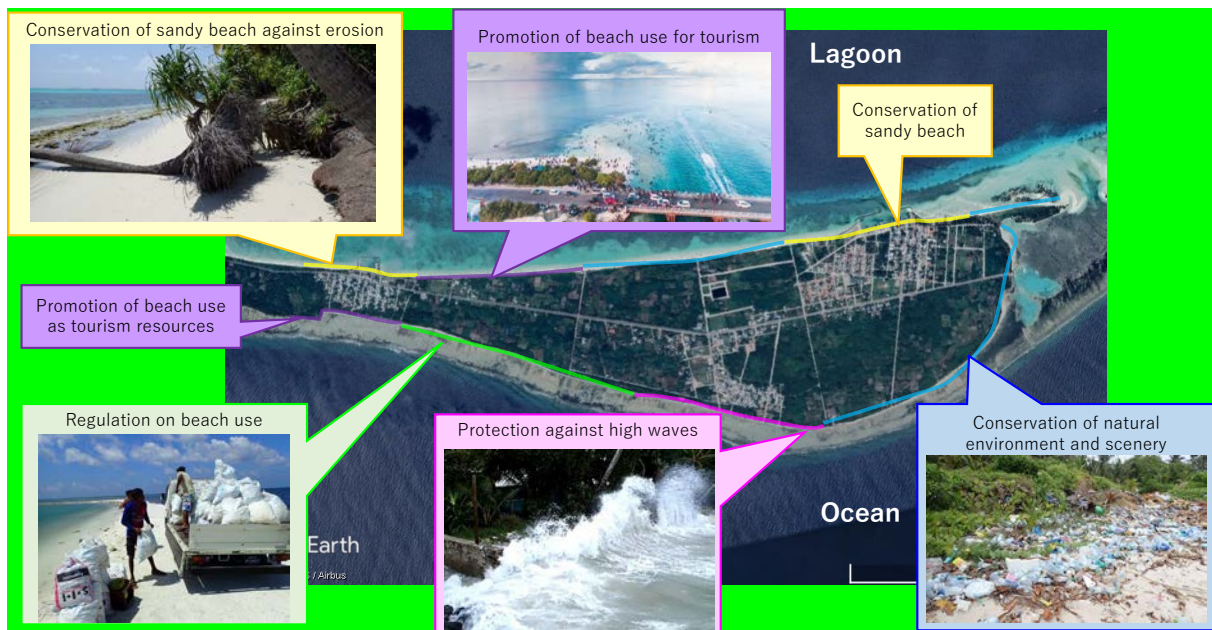
Source: JICA Expert Team

Figure 2.5.2 Coverage Area by Each Plan

2.5.1 Image of Coastal Conservation Plan

Policy for coastal conservation will be firstly prepared to formulate coastal conservation plan. This policy basically covers whole coastal area of target island. Coastal area of island will be separated by zones considering with characteristics of coastal condition, hazard, coastal use, environment, and socio-economic conditions and the policy for coastal conservation will be prepared by each zone. Example of the policies are shown in the followings and Figure 2.5.3.

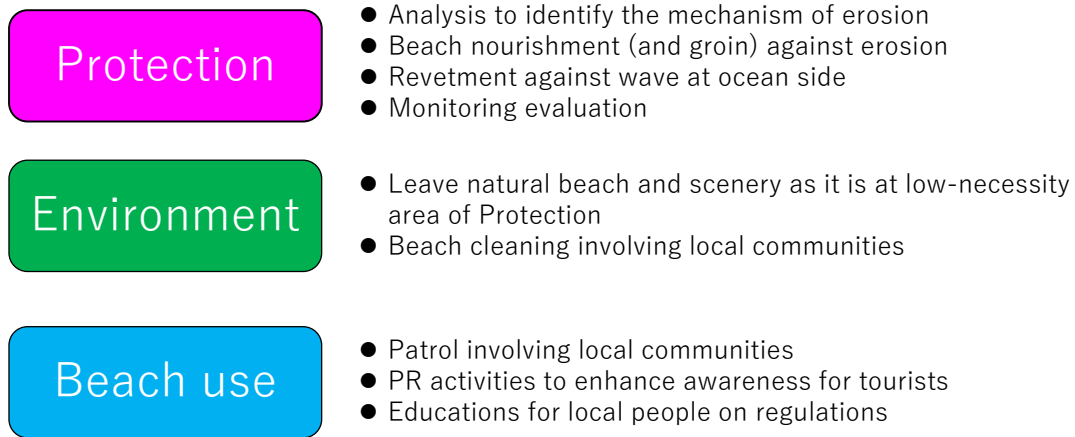
- Policy Example 1: Conservation of natural beach against erosion (yellow highlighted)
- Policy Example 2: Promotion of beach use for tourism (purple highlighted)
- Policy Example 3: Conservation of natural environment and scenery (blue highlighted)
- Policy Example 4: Protection against high waves (pink highlighted)
- Policy Example 5: Regulation on beach use (green highlighted)



Source: JICA Expert Team

Figure 2.5.3 Image of Policy for Coastal Conservation by Zones

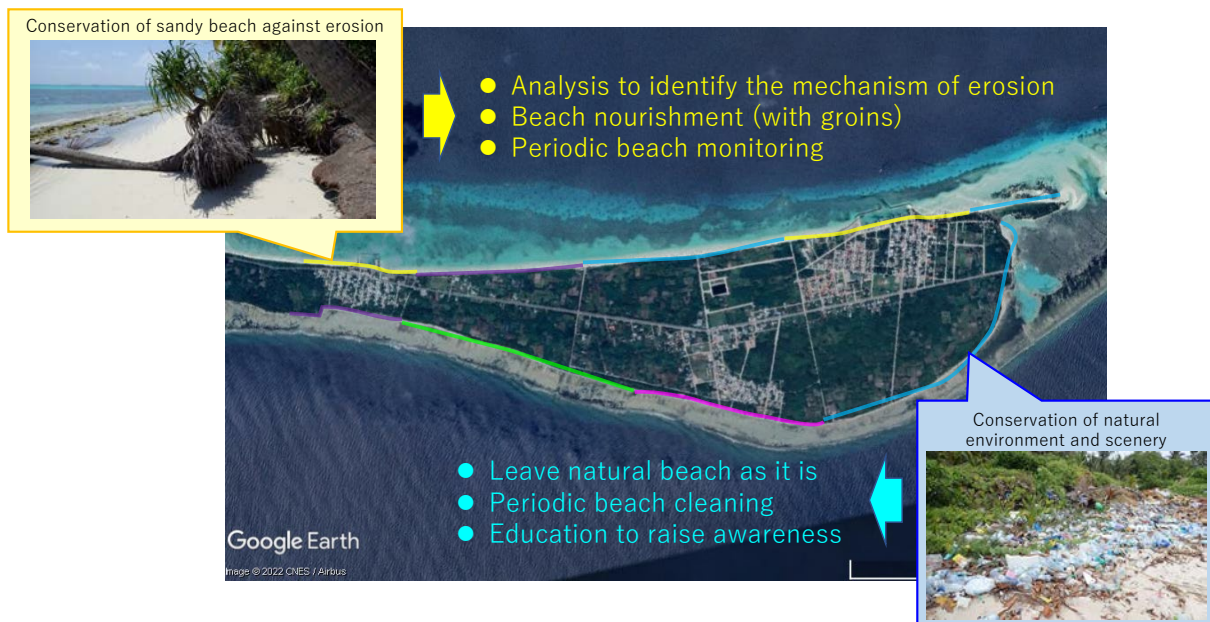
Additionally coastal conservation measures will be prepared in terms of 1) protection, 2) beach use and 3) environment aspects at each zone refereeing to the policy. Figure 2.5.4 shows examples of measures for each aspect.



Source: JICA Expert Team

Figure 2.5.4 Example of Measures in Protection, Environment and Beach Use

Finally, coastal conservation measures will be prepared at each zone as shown in Figure 2.5.5. Regarding with physical measures such as beach nourishment and revetment, detailed images such as layout and cross section will be also prepared for the coastal conservation plan.



Source: JICA Expert Team

Figure 2.5.5 Example of Allocation of Measures based on Policy at Each Zone

2.5.2 Reef Conservation Plan

Items listed in Table 2.5.1 will be included quantitatively in the reef conservation plan. Image of Item (1) and (2) in the table is shown in the Figure 2.5.6. Sediment amount supplied to shore (i.e. item (1)) will be assumed from the satellite image analysis and field investigation survey and potential sand volume at reef flat (i.e. item (2)) will be analyzed by satellite image and sea-bed condition survey.

In additions to above, the coverage ratio of coral reef, water quality and candidate site for coral transplantation will be surveyed and organized in the map as shown in the Figure 2.5.7.

Table 2.5.1 Main Items to be Included in Reef Conservation Plan and Survey Method

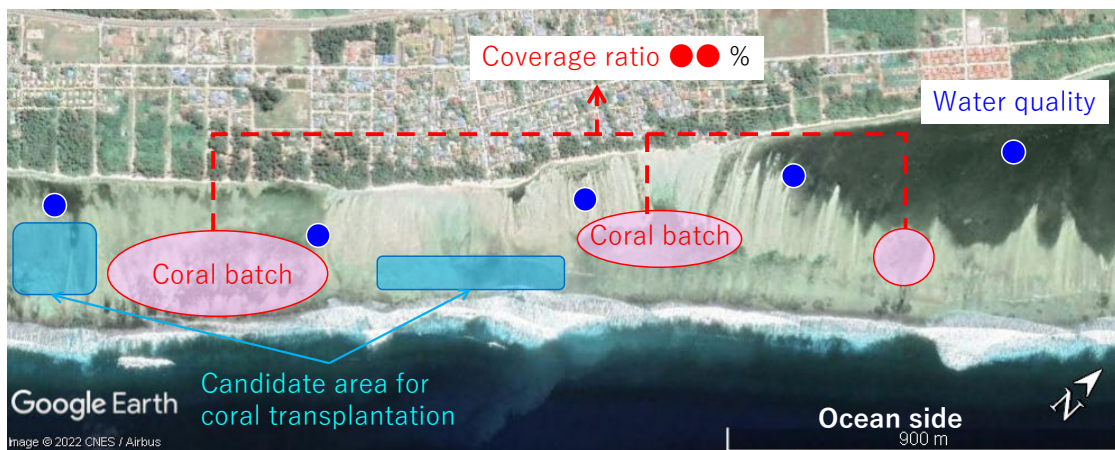
Item	Survey Method
(1) Sand volume supplied from reef to shore (m ³ /y)	Satellite image analysis, beach profile survey
(2) Sand potential volume at reef flat (m ³ /y)	Satellite image analysis, survey on sand distribution, quality, and thickness at reef flat
(3) Coverage ratio of coral reef, water quality, candidate location and method for coral transplantation	Transect survey, dive survey, water quality meter

Source: JICA Expert Team



Source: JICA Expert Team

Figure 2.5.6 Example of Map for Sand Supply Volume and Sand Potential at Reef Flat



Source: JICA Expert Team

Figure 2.5.7 Example of Map for Coverage Ratio and Candidate Area for Coral Transplantation

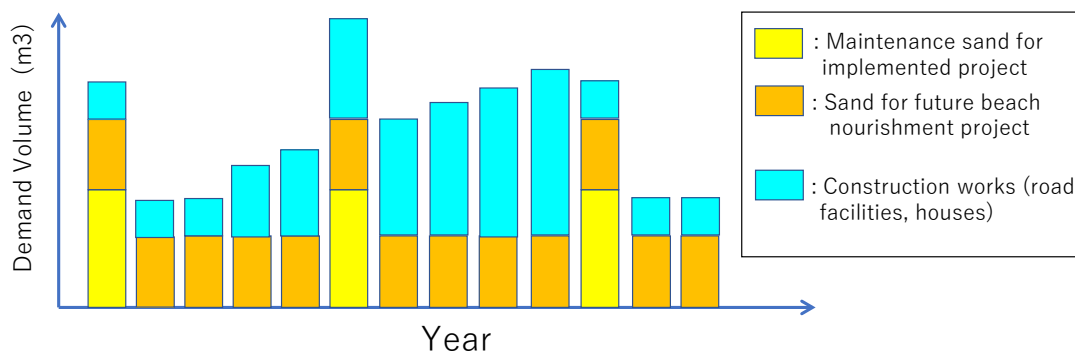
2.5.3 Sediment Budget Management Plan

Quantities of both sand demand and supply will be organized in the sediment budget management plan.

Firstly, sand demand volume by purpose of use will be assumed in time series as shown in Figure 2.5.8. Purpose of use can be, for example, 1) maintenance sand for implemented project, 2) sand required for future coastal projects,

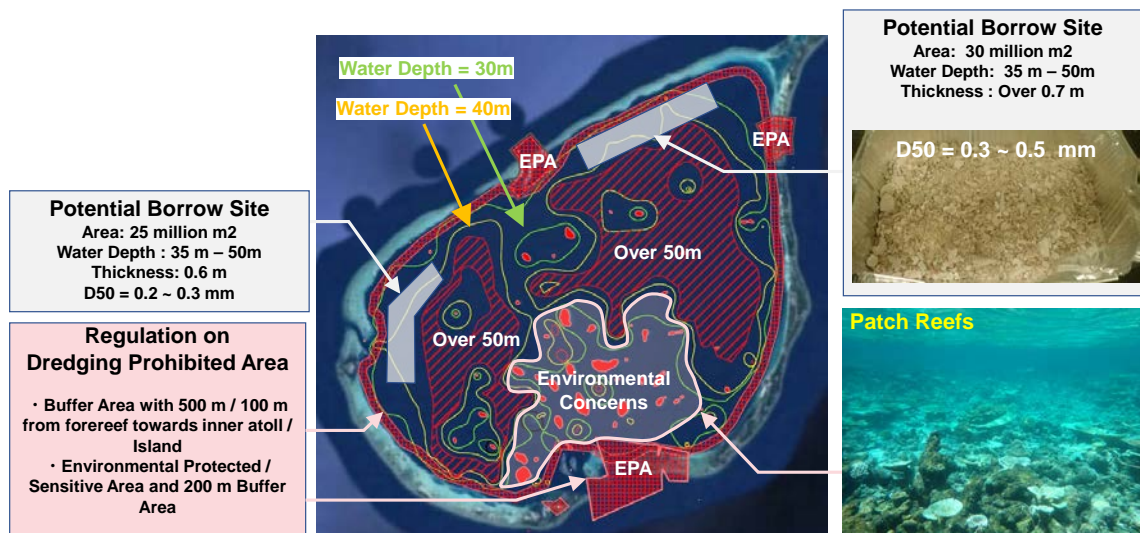
and 3) sand required for construction works such as road, business facilities and houses. It should be noted that requirements for sand will be different by purpose of use, for example, coarse and light-colored sand will be required for beach nourishment project in terms of stability and beach use, while fine sand can be used for the other construction works.

Secondary, in perspective of supply candidate sand borrow site will be identified in this study as shown in Figure 2.5.9. The candidate site is basically studied at lagoon area of the Atoll, to which the target island belongs, considering advantages in wave condition and transportation distance for the works. The restricted area for sand borrow needs to be identified such as deep area in construction works and environmental protected/ sensitive area by EPA and other coral habitat area in environmental aspects. Besides the restricted area, candidate borrow site will be determined by surveys and consideration of workability of construction works. Data for candidate site includes 1) area, 2) water depth, 3) thickness of sand layer, 4) volume, 5) grain size and color, 6) method for dredging, and 7) procurement plan and candidate stockpile site on land.



Source: JICA Expert Team

Figure 2.5.8 Image of Graph for Sand Demand in Long Period



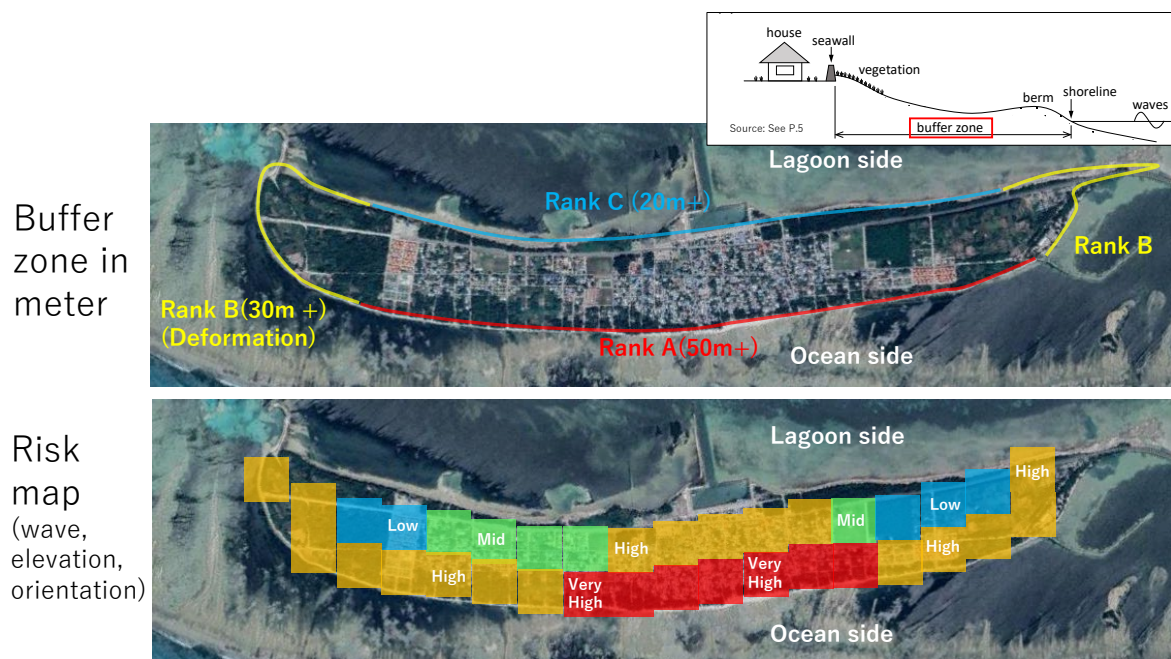
Source: Modified using Google Earth by JICA Expert Team

Figure 2.5.9 Image of Map for Candidate Sand Borrow Site

2.5.4 Land Use Plan

Land use plan will be designed to include buffer zone (or setback, no construction zone) and risk map for future development as shown in the Figure 2.5.10.

Regarding with buffer zone, coastal area will be classified into several zones considering erosion rate, wave height, land use and environment situation and required buffer zone in meter is set at each zone. Satellite image analysis will be applied to figure out the erosion situation at target coast. The land use plan prepared/ to be prepared by Island council will be applied to understand near-future land use at hinterland. Climate change effect such as sea level rise and acceleration of erosion will be evaluated and incorporated into land use plan. Risk map will be prepared considering degree of wave inundation and coastal erosion, land elevation and location.



Source: Modified using Google Earth by JICA Expert Team and Beaches in Okinawa and Recent Changes, Second Edition, June 2021, Takaaki Uda, Public Research Center

Figure 2.5.10 Image of Buffer Zone and Risk Map to be included in Land Use Plan

CHAPTER 3 Related Projects by JICA and Other Donors

3.1 Assistance Projects by JICA in the fields of Environment, Climate Change Countermeasures, and Disaster Prevention

Assistance Projects in Maldives by JICA in the fields of environment, climate change and disaster prevention is shown in Table 3.1.1. Beginning in 1987 with a seawall construction project in Male, the capital city of Maldives, currently Japan still continues to develop a digital terrestrial television broadcasting network through grant aid, and supports the capacity development in the field of climate change through technical cooperation.

Table 3.1.1 Representative Indexes Related to Coastal Vulnerability in Several Atoll Countries

Project Title	Scheme	Period	Note
The project for the Seawall Construction in Male' Island	Grant Aid	1987 - 1999	
Basic Design Study for the Coastal Disaster Prevention Plan for Male' Island, Republic of Maldives	Grant Aid	1993	
Feasibility study for application of photovoltaic power on Male' and Hulhumale' Islands in the Republic of Maldives	Technical Cooperation	2009	
The Project for Clean Energy Promotion in Male	Grant Aid	2010 - 2014	
Japan's Non-Project Grant Aid for Provision of Japanese Disaster Reduction Equipment	Grant Aid	2015	
The Project for the Digital Terrestrial Television Broadcasting Network Development	Grant Aid	2017 – 2024	Ongoing
Building Climate Resilient and Safer Islands in the Maldives	Data Collection Survey	2018 - 2021	
Digital Terrestrial Television Broadcasting Operational Capacity Improvement Project	Technical Cooperation	2019 – 2024	Ongoing
Data collection survey on the possibility of assistance utilizing Okinawa's resources in environment sector in the Maldives	Data Collection Survey	2020	
Data collection survey on climate-related disasters in the Male's region in the Republic of Maldives	Data Collection Survey	2021 - 2022	
Project for Safe and Resilient Islands against Climate Change and Disaster	Technical Cooperation	2021 -2025	Ongoing
Follow Up Cooperation Project for Clean Energy Promotion in Male	Follow Up Cooperation	2021-2022	Ongoing

Source: JICA Expert Team

3.2 Related Projects in Maldives by Other Donors

So far, climate change projects in Maldives have been implemented by various international organizations and other donors. The related projects by other donors and related fields to the project are shown in Table 3.2.1.

Table 3.2.1 Related Projects by Other Donors and Related Fields to the Project

No.	Project	Period	Donor	Related field to the project
1	Integrating Climate Change Risks into Resilient Island Planning in the Maldives	2008-2010	GEF	Enhanced capacity of national, provincial, atoll and island authorities and civil society leaders to integrate climate risk information into policy, planning and investment decisions
2	Present cost-effective, locally appropriate coastal management and drainage management options contributing to climate change resilience of communities in Fares-Maathoda	2010-2015	Government of Denmark	<ul style="list-style-type: none"> Identifying and developing locally appropriate adaptation options on coastal management Implementation of locally appropriate adaptation options
3	UNDP country program on enhancing national capacity for DRRM in Maldives Scaling up the National Capacity for Disaster Risk Reduction and Management in the Maldives Enhance National Capacity for Disaster Risk Reduction and Management in Maldives	2011-2018	UNDP	<ul style="list-style-type: none"> Strengthening the early warning systems Enhancement of community capacity for disaster response
4	IMPACT2C project	2012-2016	IMPACT2C (Research project)	Sea level rise in Maldives for future coastal design
5	Climate Change Adaptation Project (CCAP)	2015	World Bank	<ul style="list-style-type: none"> Coral reef monitoring Building awareness and strengthening local government capacity to address climate change adaptation issues
6	Supporting vulnerable communities in Maldives to manage climate change-induced water shortages, GCF	2016-2021	GCF	Early warning system established on the basis of forecasted meteorological information
7	Coastal protection project of Fuvahmulah City	2017-2018	Netherlands Enterprise Agency, Kuwait Fund	Coastal protection
8	INtegrating SEA-level Projections in climate services for coastal adaptaTION (INSeaPTION)	2017-2020	European Research Area for Climate Services (ERA4CS) (Research project)	Information with extreme wave condition and future climate change scenarios
9	Enhancing National Development through Environmentally Resilient Islands (ENDhERI)	2020-2024	GEF	<ul style="list-style-type: none"> Integrated coastal zone management (ICZM) Marine management area (MMA)
10	USAID Climate Adaptation Project in Maldives	2021-2026	The U.S. Agency International Development (USAID)	Strengthening governance to address climate-related risks

Source: JICA Expert Team

CHAPTER 4 Current Status and Issues of Coastal Conservation on Target Islands

4.1 Background of selection of target islands

Component 2 of the main project targets two islands, Maamendhoo and Fonadhoo in Laamu Atoll, as GCF projects, and Isdhoo and Gan in Laamu Atoll and Meedhoo in Addu Atoll as co-financing projects by the government of Maldives. In the first stage of the project (Data Collection Survey on Building Climate Resilient Safer Cities, 2021, JICA), the project candidate sites were narrowed down to Laamu and Addu atolls in the southern part of the country from the perspective of 1) climate change hazard and vulnerability and 2) project implementation effectiveness. The candidate sites were narrowed down to Laamu and Addu atolls in the southern part of the country. The selection of islands for the GCF project was based on the following criteria as shown in Figure 4.1.1: 1) vulnerability, 2) coastal development and coastal protection requirements, and 3) importance of the islands in terms of economic and development plans. In addition, Isdhoo, Gan, and Meedhoo were selected as sites for co-financing by Maldives government, based on strong demand from the Island Council and the high importance of the islands in the atoll.

Evaluation Category	Evaluation Item	Addu Atoll				Laamu Atoll			
		Hitadhoo	Maradhoo	Feydhoo	Meedhoo	Gan	Fonadhoo	Isdhoo	Maamendhoo
Vulnerability	Topographic characteristics (elevation)	3	3	3	2	1	2	2	4
	Topographic characteristics (area)	3	4	2	1	1	3	1	4
	Exposure of settlements and major infrastructure	3	3	2	1	1	3	1	4
	Other exposure (cultural facilities, archaeological sites, ecosystems, etc.)	2	1	1	3	3	2	3	2
	Severity of beach erosion (amount of retreat)	3	2	0	3	2	3	2	3
	Frequency of storm surge and flood damage	2	1	1	3	2	3	2	4
	Resident awareness, gender issues	2	2	2	3	3	3	3	3
	Island government awareness, initiatives	2	2	2	3	3	3	3	3
Coastal development, coastal protection requirements	Population of beaches and reefs, coastal development (coastal artificialization) plans*)	1	1	1	3	2	2	3	3
	Island demands for beach protection	3	2	1	3	3	3	3	3
Degree of importance of the island based on economic and development plans	Future economic viability	3	3	3	2	3	3	2	3
	Future development plans	3	2	2	3	3	3	2	2
Overall evaluation	Socore	2.5	2.2	1.7	2.5	2.3	2.8	2.3	3.2
	Priorities	3	7	8	3	5	2	5	1

*) Scores are basically assigned as follows: low to 1, medium to 2, high to 3, and very high to 4. However, the reverse is true for the items marked with *).

Based on the above, two high priority islands, Maamendhoo and Fonadhoo, were selected as climate change adaptation projects.

Source: Data Collection Survey on Building Climate Resilient Safer Cities, Final Report, 2021, JICA

Figure 4.1.1 Selection of target islands for GCF project targeting inhabited islands in Addu and Laamu Atolls

4.2 Overview of the target islands and beach conditions

4.2.1 Maamendhoo (GCF project, Laamu Atoll)

Maamendhoo is the smallest inhabited island in Laamu Atoll with an area of 19 ha and having 896 residents. The island has the highest population density in the atoll with 47.9 persons/ha. As Maamendhoo is located at a nearby atoll channel, this island has an important role as the logistic base for traveling from Laamu Atoll to other atolls. Furthermore, this island also has a role of providing the human resources and goods to a world-famous resort island, the Six Senses, which is located next to this island. Since most of the residential areas and important infrastructure facilities are located very close to the coast, the island has extremely high exposure to coastal hazards compared with the other islands. The land elevation of the island is lower (M.S.L+ 0.7~0.8 m in average) than other inhabited islands. Such geographical characteristics together with extremely narrow area and high population density will induce high vulnerability compared with other inhabited islands. Coastal erosion has been a serious problem in the island and retreat of the shoreline at 0.6 m per year from 1999 was reported⁷⁾. Since the land area is very small, the issue of coastal erosion becomes more serious on both impacts of land loss and flooding due to high waves. The island council and residents are very concerned about the coastal erosion and induced coastal disaster. Because of this, they have strongly requested the implementation of coastal protection. Within the limited island areas, as the coastal areas are closely associated with peoples' lives as places for recreation and playing sports, the people's awareness on coastal environment conservation is relatively higher than in the other inhabited islands. Figure 4.2.1 shows the recent beach conditions. P1 is a photograph of the project area on the east coast. The results of the shoreline change analysis shown in Chapter 5 confirm that sand has accumulated a little more than in 2019, but the reefs are exposed over a wide area (toward the back of the photo), and beach cliffs have formed in the backland, indicating that the area is still affected by beach erosion. P2 and P3 are photographs of the project area on the west coast. In P2, which is closer to the convex part of the island, no significant changes are observed between 2019 and 2022. On the other hand, in P3 on the north side, the beach cliff position receded and some reefs were exposed, confirming that erosion is progressing. In addition, as shown in the same figure, sand sampling was observed from the reef in the vicinity of the planned reclamation site on the north side. It is possible that such illegal sand extraction is having a certain impact on the P3 area in its vicinity.



P1



(The foreground side shows sedimentation trend)

P2



(No significant change)

P3



(Progressive erosion)

Sand
Extraction



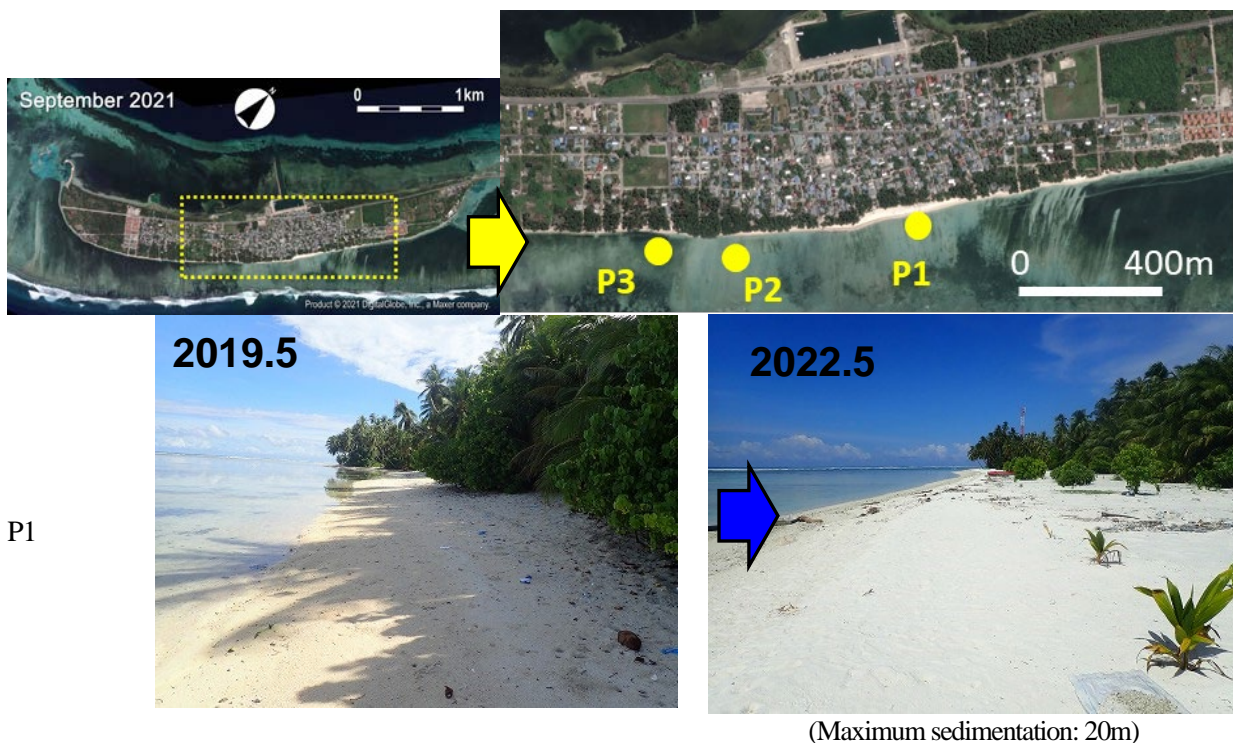
(Illegal sand extraction from the reef around the proposed reclamation site)

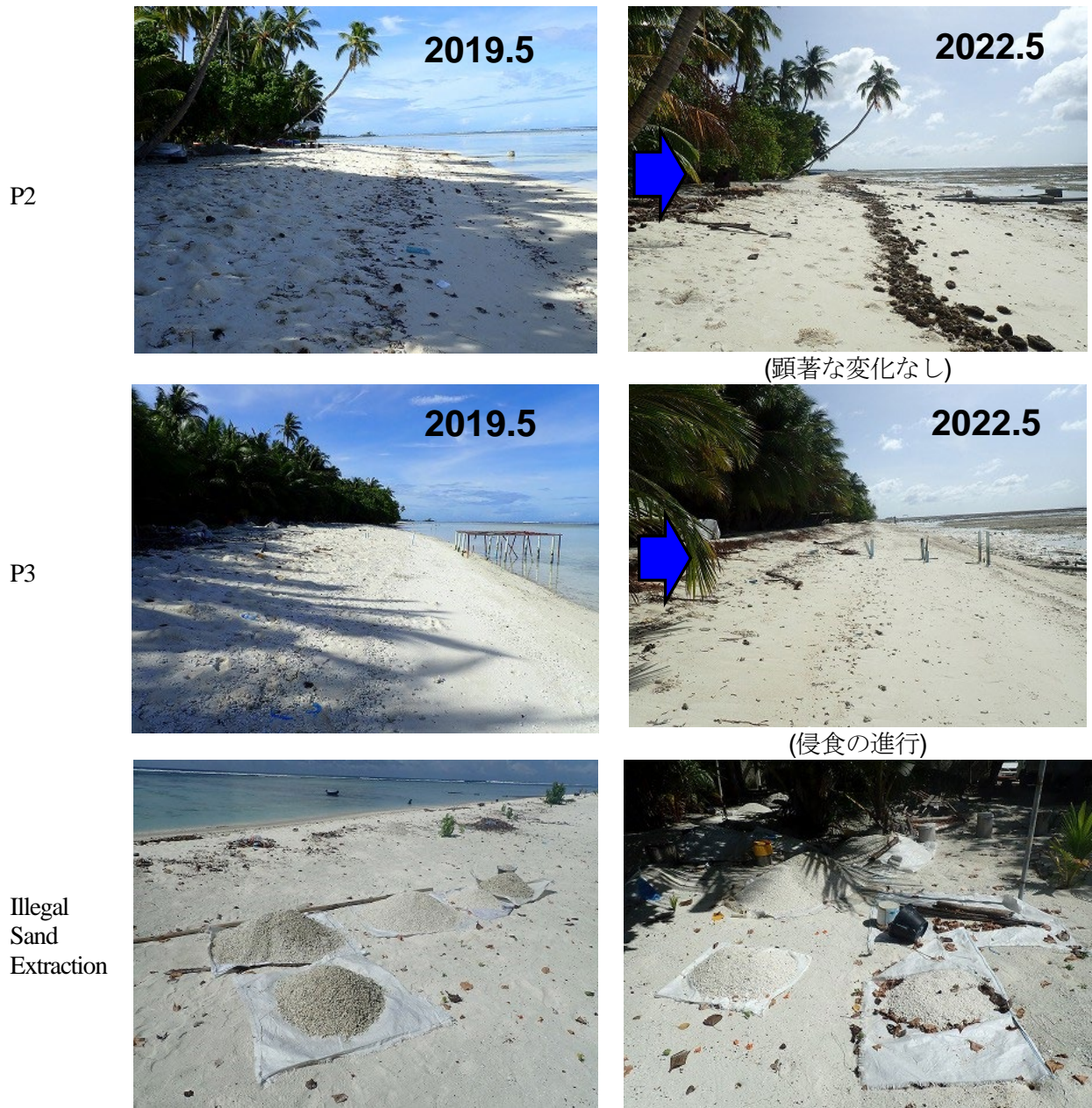
Source: JICA Expert Team

Figure 4.2.1 The Recent Beach Conditions in Maamendhoo

4.2.2 Fonadhoo (GCF project, Laamu Atoll)

Fonadhoo is the second largest inhabited island in Laamu Atoll, next to Gan, with an area of approximately 163 ha and with 2,266 residents. Average elevation is MSL + 0.9 m. As the atoll capital island, the population density is relatively high (13.9 persons/ha) and it is ranked in 3rd place in Laamu Atoll. In addition, the population is increasing due to migration from adjacent inhabited islands, such as Gaadhoo Island, for the purpose of employment opportunities and integration of social infrastructure. Active land use development such as construction of residential areas along the coastal areas are being promoted in the island. Based on the field survey results, the residential areas are extended to the vicinity of the coastal areas and flooding due to intrusion of high waves has occurred frequently at this residential area. The artificial modifications on the coral reef at several points of the lagoon side were observed such as harbor construction and coral mining on the reef to obtain construction material. On the other hand, natural sandy beaches and coral reefs still exist along the ocean-side coastal areas. According to the interview survey to the island council and residents, the coast at the ocean side is suffering from serious coastal erosion; however, coastal protection measures, except the embankment made by coral sand nearby the residential areas, have not been implemented so far. As the coastal areas nearby the residential areas are being used for recreational purposes by the residents, it is assumed that these people have high awareness on coastal environment conservation, so that these residents conduct beach cleaning activities at the regional level from 2019. Since further migration from adjacent islands to the atoll capital island is expected, further development of residential area is planned in Fonadhoo. Figure 4.2.2 shows the recent beach conditions. Among the project areas, the area around P1 showed a sedimentation trend, with a maximum sedimentation of 20m. In P2, approximately 500 m west of P1, no significant beach change can be confirmed. On the other hand, it was confirmed that erosion is progressing in P3 further west. Thus, in recent years, erosion and sedimentation areas tend to be divided even within the project area. In addition, as shown in the same figure, sand extraction from the beach has been confirmed for a long period of time at the beach in question. It is assumed that this extraction has a certain amount of impact on the beach.



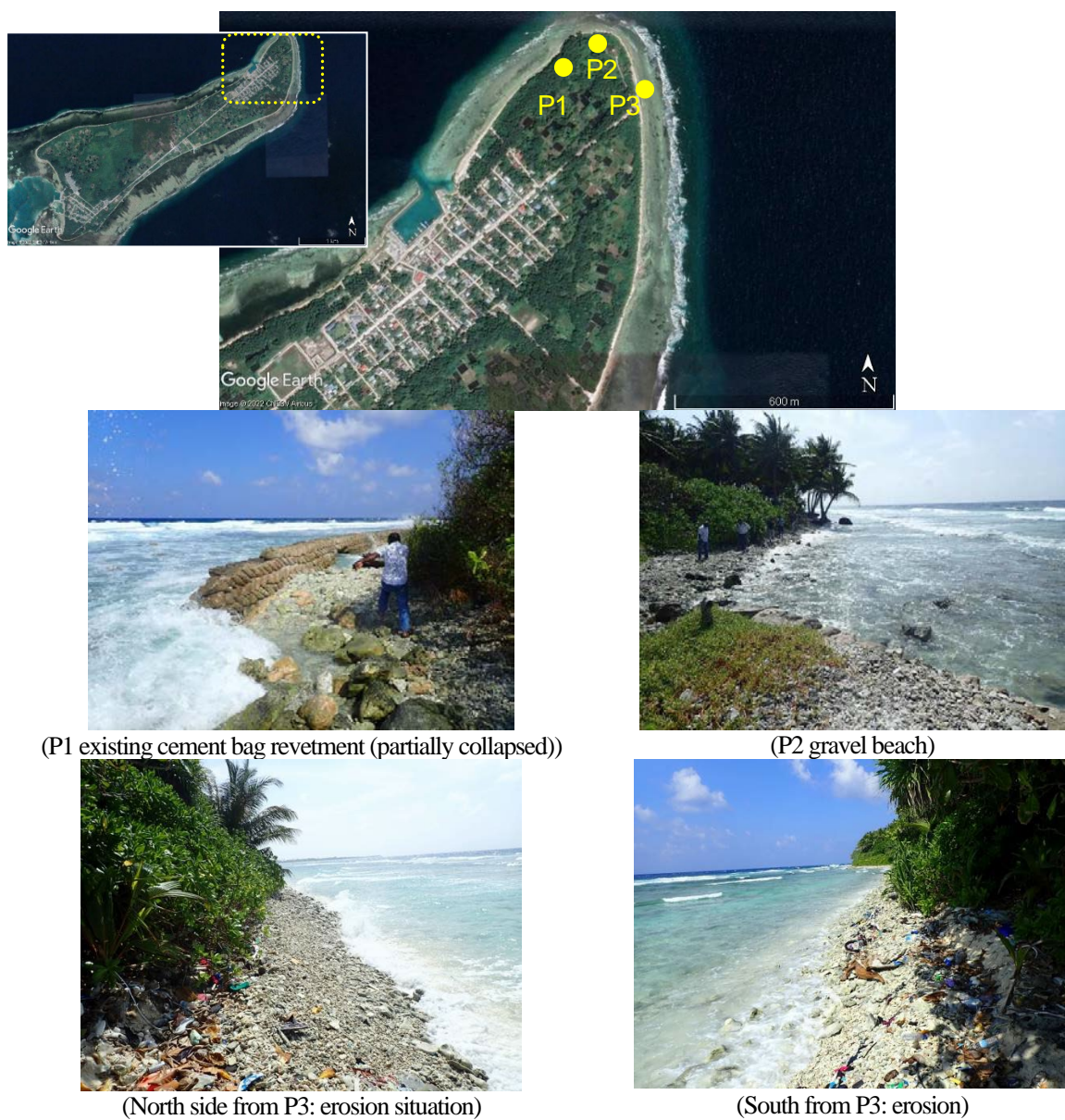


Source: JICA Expert Team

Figure 4.2.2 The Recent Beach Conditions in Fonadhoo

4.2.3 Isdhoo (Co-financing project in Maldives, Laamu Atoll)

Isdhoo has an area of 146 ha and 958 residents, and the population density is the third lowest in the atoll at 6.6 persons/ha. The residential areas are located behind the two main harbors, and as the roads run inland in the island, the exposure to the coastal hazards is not so high compared with other islands. As the island is in the northernmost area in the atoll, the damage due to coastal erosion has been reported especially at the northern part of the island, where the offshore waves directly hit the area. As there exist historical and cultural heritages behind this coast, the island council has raised strong requests to conserve the cultural heritage sites. Figure 4.2.3 shows the recent beach conditions. At site P1, the existing protection measure, the revetment made of cement bags, has partially collapsed. The low top height of the revetment and some collapsed sections did not provide sufficient protection against wave overtopping and were not effective measures. According to the Island Council, the P2 and P3 sites have recently been subjected to beach erosion, and there is no beach at these sites.



Source: JICA Expert Team

Figure 4.2.3 Recent Beach Conditions in Isdhoo

4.2.4 Gan (Co-financing project in Maldives, Laamu Atoll)

Gan in Laamu Atoll is the largest inhabited island in the Maldives with area of approximately 633 ha and with 3,080 residents. Average land elevation is M.S.L.+ 0.9 m. The population density is the lowest in Laamu Atoll with 4.6 persons/ha. Even though the land elevation is lower than the average elevation in the Maldives, the exposure condition to coastal disasters is relatively lower compared with other populated islands as there are still undeveloped areas in the island. At this moment, only limited areas in the island are suffering from the risk of flooding due to high waves. However, coastal erosion, which is caused by artificial modification at the coastal area such as construction of harbor and blockage of inlet between each island by construction of causeway, is increasing. However, since the natural coastlines and coral reefs are still well-maintained compared with other inhabited islands, tourism development will be actively planned in this island. In addition, historical and cultural heritage site exists just behind the ocean side. The revetment was constructed ten years ago but is already damaged by wave action and has collapsed. The island council is highly concerned about coastal erosion and deterioration of the coastal and reef environment so as to be highly conscious of the conservation of the coastal environment for the coastal areas and coral reef. Figure 4.2.4 shows the overall location map of Gan Island. On the lagoon side (west side), the southwest monsoon is thought to be responsible for the predominance of northward coastal drift sand. As a result, beach erosion is occurring on the north side of the fishing port, and the Island Council is currently studying erosion countermeasures. On the ocean side, the northeast monsoon is considered to be responsible for the predominance of southerly coastal drift sand.



Source: JICA Expert Team

Figure 4.2.4 Overall location map of Gan Island



(Erosion on the north side of the fishing port on the lagoon side (central part))



(Erosion on the north side of the fishing port on the lagoon side (north))



(Beach in front of the Heritage site and collapse of the seawall due to cement bags)

Source: JICA Expert Team

Figure 4.2.5 Gan Island Project Sites and Problematic Beach Areas

4.2.5 Meedhoo (Co-financing project in Maldives, Addu Atoll)

Meedhoo/Hulhdhoo are located on the northeastern top of the atoll, far from the abovementioned four connected islands. The land area is 315 ha in total, with a population of 3,113, and a population density of 9.9 persons/ha. The residential areas are mainly located at the lagoon side, and the natural sandy beaches exist along the ocean side coast where the offshore waves occur directly. Several public beach parks are maintained through the support of NGOs, and these parks are used for the recreation of the residents. Tourism development is very active in Meedhoo/Hulhdhoo, and new resort development is currently ongoing at the northwestern area of the island. It has been reported that coastal erosion has become serious along the northern and eastern sides of the coastal areas which face the open ocean. Even though no residential area exists near the northern coast, there exists the oldest graveyards in the Maldives, which is an important historical and cultural heritage site. Furthermore, a plantation land that utilizes freshwater located nearby the coast also exists. Although a seawall has been constructed to prevent shoreline retreat and seawater intrusion caused by coastal erosion, most of the sections have already been damaged. At the eastern side of the island, a rubble-type revetment, with an approximate length of 1.1 km, was newly constructed in 2018. However, this has caused the decrement of the sandy beaches and interference to utilize the coastal areas. Under such situations, the requests from the residents on maintenance of the natural sandy beaches, but not hard-type protection measures, are collected through the hearing survey. Residents in the island have high

awareness and consciousness regarding coastal conservation, and are also keen on coast maintenance activities in collaboration with NGOs. Figure 4.2.6 shows the recent beach conditions. no significant change in the beach is observed in P1 at the western end of the project area from 2019 to 2022. Also, in P3 near the fronted rubble-type revetment in front of the Waste Management Center in the southern part of the project area, there is no significant change in the narrow fronted beach. On the other hand, near P2, where cement bags are installed on the northern beach, concrete shells are exposed, suggesting that beach erosion is progressing. As of September 2022, a sandbag revetment is being constructed around the bend of the project area as an emergency project by MNPFI (see Figure 4.2.7). This revetment also includes reclamation of up to approximately 15 m of the backland. The details of this project need to be confirmed after the completion of the said project. However, since the subject site overlaps with this co-financing project, the handling of the existing sandbag and the beach nourishment width and layout proposed in this project need to be reconsidered during the detailed design.





Figure 4.2.6 Recent Beach Conditions in Meedhoo



Figure 4.2.7 Sandbag Revetment under Construction by MNPFI as an Emergency Project (as of September 2022)

CHAPTER 5 Detailed Survey and Basic Design for Coastal Conservation on the Target Islands

5.1 Climate, Wave, Topographic Characteristics

5.1.1 Climate Condition

(1) Temperature

Maldives has a warm and humid climate throughout the year. The average temperature ranges between 26-33°C. The seasons are divided into two periods: the northeast monsoon season (November-April) and the southwest monsoon season (May-October). The warmest period in a year occurs during March-April, and it continues until the onset of the southwest monsoon in mid of May. Temperature, wind, rainfall and tide levels are monitored at three sites in the Maldives: Haa Dhaalu Atoll Hanimaadhoo in the north, North Male Atoll Male in the center and Laamu Atoll Gan in the south. Average monthly temperatures at each site are shown in the graph below.

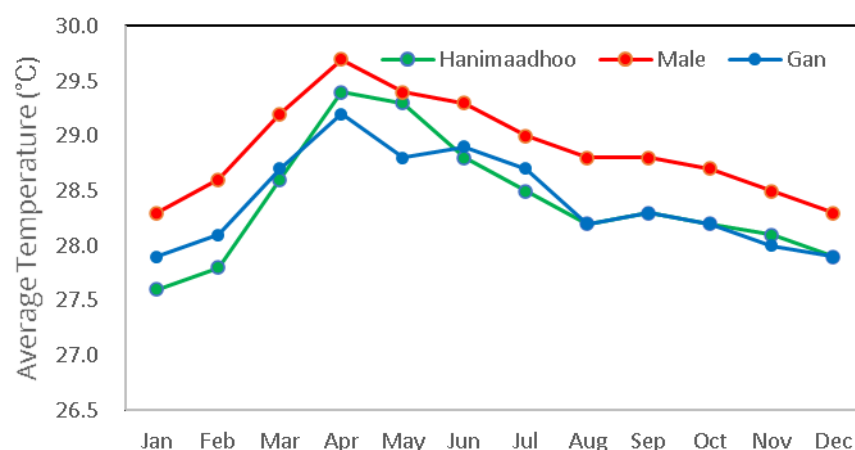
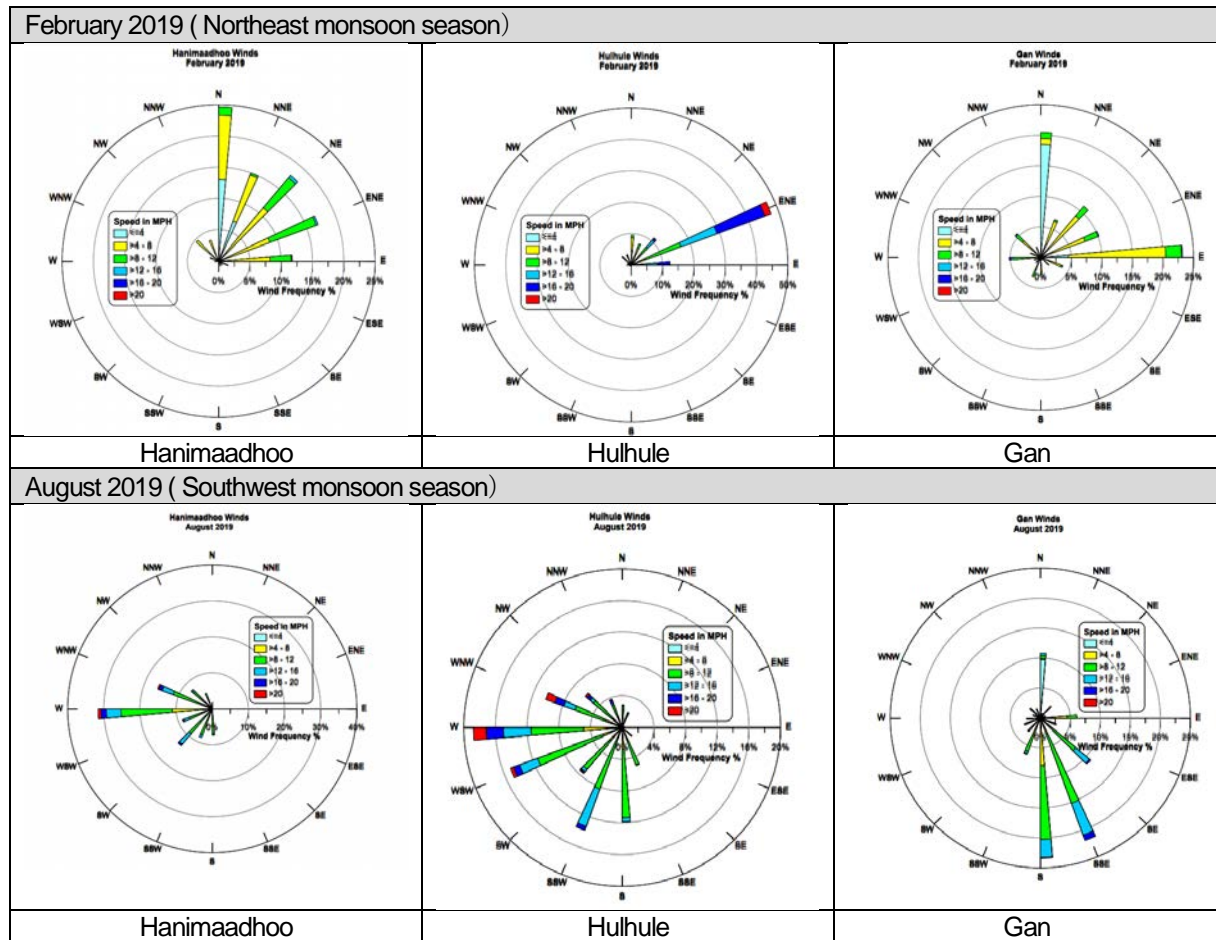


Figure 5.1.1 Average Temperature in Hanimaadhoo, Male, Gan

Source: Champion Traveler¹⁾

(2) Wind Distributing

Figure 5.1.2 shows wind distribution maps for the northeast monsoon season and the southwest monsoon season in 2019 at the three stations, according to the Climate Report¹⁾ published by the MMS. In the Maldives, northeasterly winds prevail during the dry season from December to April, while southwesterly winds prevail during the rainy season from May to November, and this tendency is also observed in the northern, central and southern regions. In all the northern, central and southern monitored points, there are also variations in wind direction within a single month of observation.



Source: Climate Report (2019) published by MMS²⁾

Figure 5.1.2 Wind Distribution in Northeast Monsoon Season and Southwest Monsoon Season in Hanimaadhoo, Hulhule, Gan

(3) Rainfall

Figure 5.1.3 shows annual observations of rainfall in northern Hanimaadhoo, central Hulhule and southern Gan. Rainfall in the Maldives varies according to two seasons. Rainfall increases during the southwest monsoon season from May to October and decreases during the northeast monsoon season from November to April. The graph of rainfall at the three sites shows that monthly rainfall amount tends to increase from north to south.

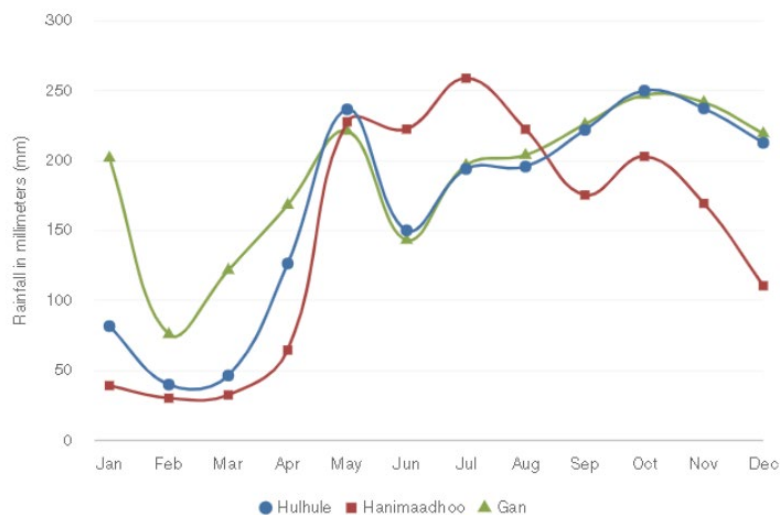


Figure 5.1.3 Monthly Rainfall Record in Hanimaadhoo, Hulehule, Gan

Source: Website of MMS³⁾

5.1.2 Wave Condition

(1) Overview of Wave Observations in Target Atolls

In Maldives, as wave observation data is limited, wave observation have been being conducted under JICA Expert Team to understand wave characteristics at the target atolls, Laamu Atoll and Addu Atoll, and to set the design conditions for design purposes. Wave characteristics of the target atolls is examined from the observation data from 2019 to 2020.

In the wave observation, the equipment called Wave Hunter is used, which is sea mounted type and water pressure type wave observation equipment. The equipment observes water pressure and from water pressure, wave specification such as wave height, wave period can be estimated. Table 5.1.1 summarizes wave observation conditions such as water depths, locations, and observation settings for each location. Figure 5.1.4 - Figure 5.1.5 show the location maps of the observation sites at Laamu Atoll and Addu Atoll.

Table 5.1.1 Wave Observation Conditions

	Laamu Atoll		Addu Atoll	
	Maamenndhoo	Fonadhoo	Hankede	Meedhoo
Station name	St.MA	St.FO	St.HA	St.ME
Coordinate (degree)	LAT: 1.819 N LONG:73.385 E	LAT: 1.830 N LONG:73.508 E	LAT: 0.644 S LONG:73.100 E	LAT: 0.578 S LONG: 73.233 E
Water depth of the installation location	21.4 m	33.5 m	17.3 m	13.5 m
Observation setting	Observation period : 20 min Observation interval : 120 min Sampling interval : 0.5 sec			

Source: JICA Expert Team



Figure 5.1.4 Wave Observation Location (Laamu Atoll)



Figure 5.1.5 Wave Observation Location (Addu Atoll)

(2) Wave Characteristics in Target Atolls

This section describes the results of observations at Hankede in Addu Atoll and Fonadhoo in Laamu Atoll, which was used to establish the design conditions. For the establishment of design conditions, the discussion of the basic design in Section 5.5 is referred.

Figure 5.1.6 shows the time series data for significant wave height (blue line in the figure) and significant wave period (red line in the figure) at the observation site.

1) Laamu Atoll

Fonadhoo: The significant wave heights reaches up to 1.6 m. The significant wave period varies between 12s - 16s. The result indicates clear seasonal variance such as small significant wave heights during the northeast monsoon season, and the wave height of about 0.3 m higher during the southwest monsoon season than the northeast monsoon season.

2) Addu Atoll:

Hankede: The significant wave height has a maximum value of about 2.0m. The significant wave periods vary widely from about 8s to 16 s. There is a seasonal variance with lower wave heights on average during the northeast monsoon season, but it also shows the temporarily high wave heights such as in the latter half of December 2019.

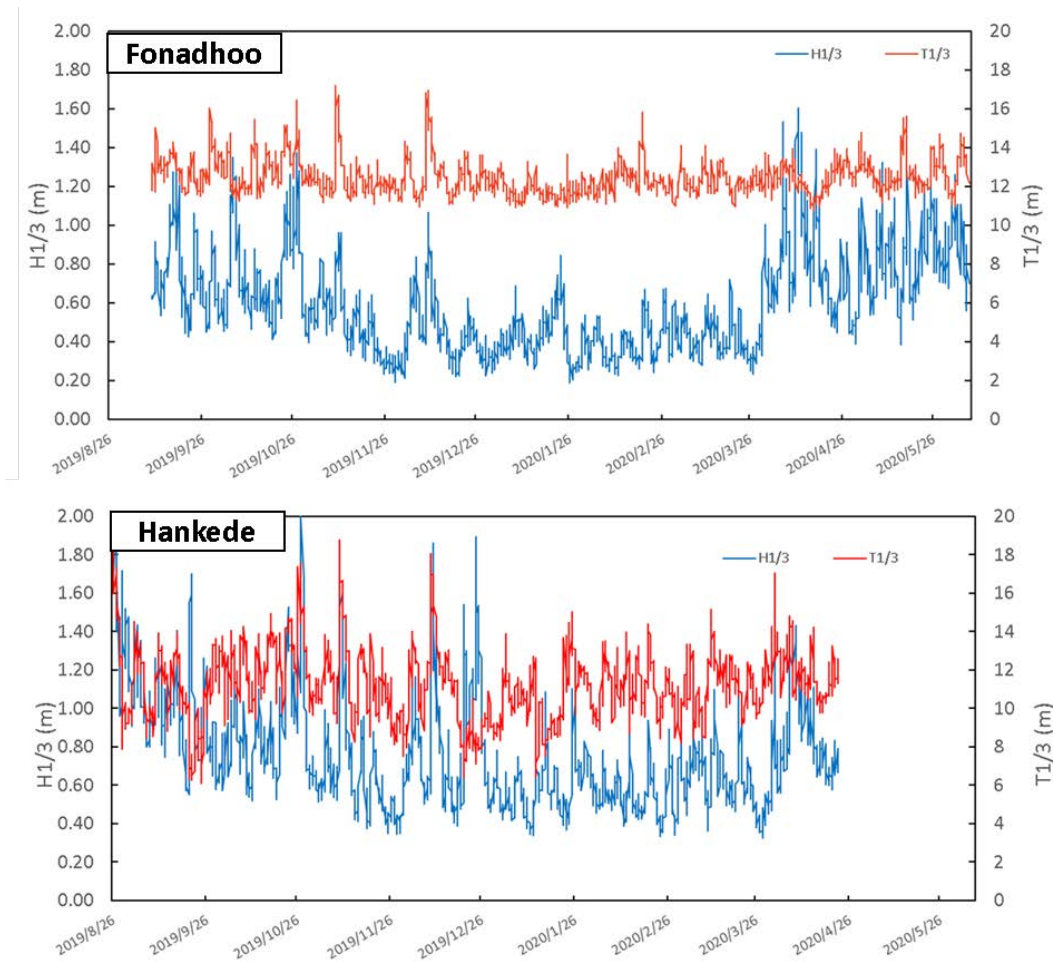


Figure 5.1.6 Wave Observation Result of Time Series for Significant Wave Height and Significant Wave Period in Fonadhoo in Laamu Atoll and Hankede in Addu Atoll

Figure 5.1.7 shows the relationship between wave direction and significant wave height during the southwest monsoon season and northeast monsoon seasons. The results are summarized in seasons since seasonal variations in wind conditions cause seasonal variations in wave condition between the two periods. The following description summarizes wave condition in wave direction and wave height obtained from the results.

3) Laamu Atoll

Fonadhoo: The wave direction of the southeast is dominant regardless of the season as the observation site is located on the southeast ocean side of Fonadhoo Island. Wave heights increase during the southeast monsoon season, with the most frequent values ranging from 0.6 m to 0.9 m.

4) Addu Atoll

Hankede: The dominant wave direction is from the southwest regardless of the season as the observation site is located on the southwest ocean side of Hankede Island. Wave heights tend to be higher during the southwest monsoon season than during the northeast monsoon season.

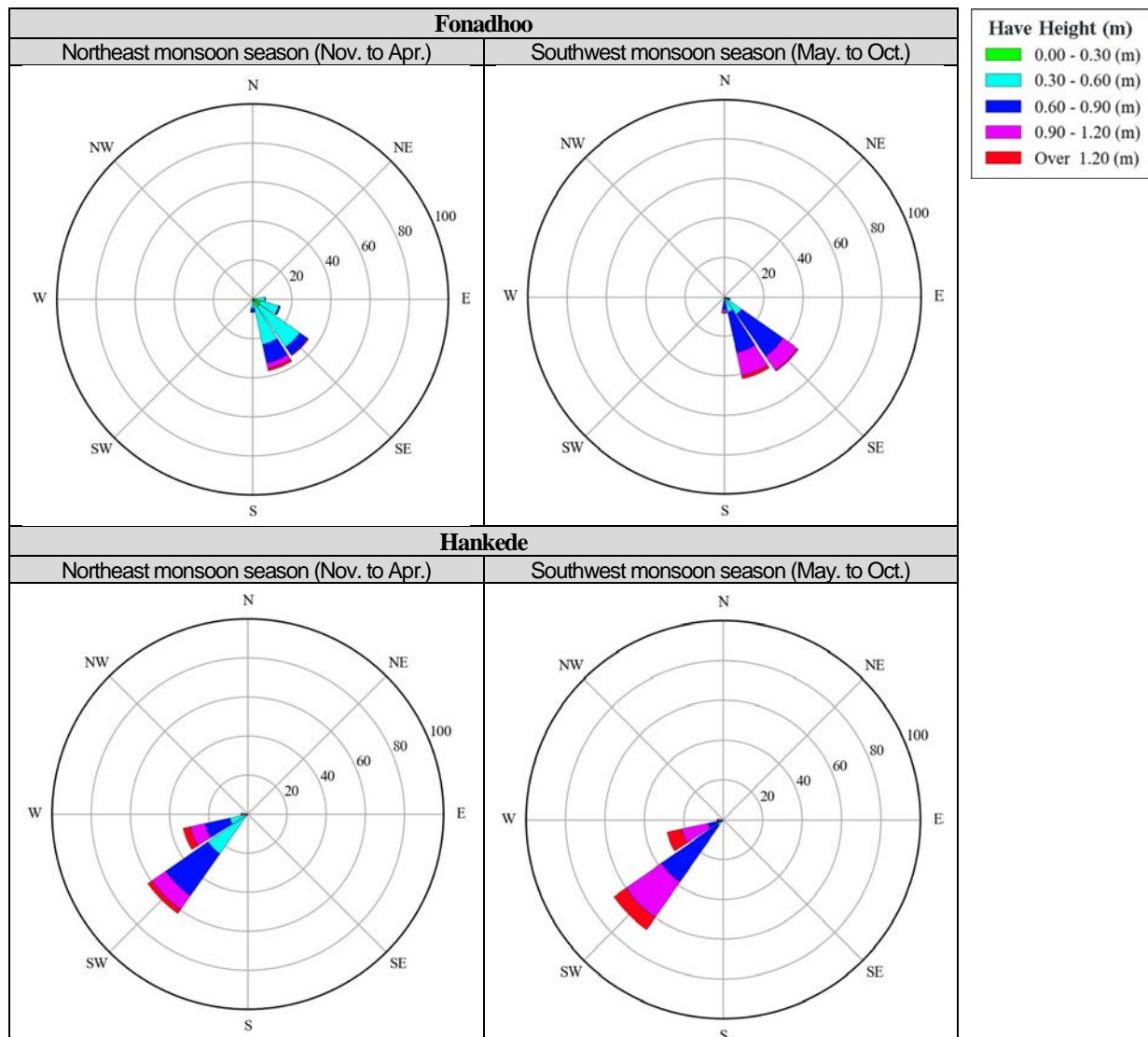


Figure 5.1.7 Wave Observation Result of the Relation Between Wave Direction and Significant Wave Height in the Northeast Monsoon and Southwest Monsoon in Fonadhoo in Laamu Atoll and Hankede in Addu Atoll

5.1.3 Topographic Characteristics

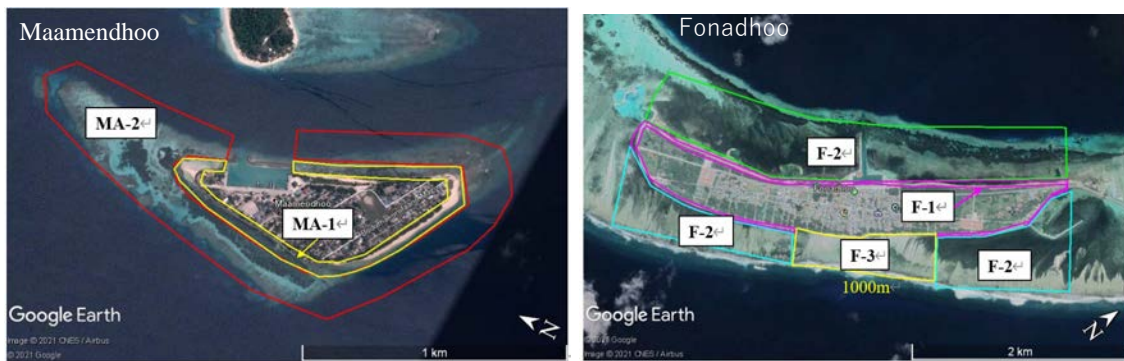
(1) Outline of Topographic and Bathymetric Survey

In January to March and May 2022, monitoring surveys were conducted at Meedhoo, Fonadhoo, and Maamendhoo in order to utilize the survey result to basic design and to understand the current coastal conditions of the Maamenshoo, Fonadhoo, Gan, Isdhoo in Laamu atoll and Meedhoo in Addu atoll. In topographic survey, the survey with total station was carried out from the benchmark installed on each island. In bathymetric survey, the survey with single beam was carried out from the boat. In addition, in order to unify the reference surface of topographic survey and bathymetry survey data, tide gauges were installed on each island during the bathymetry survey, and the elevation of the tide gauge was measured by total station. Length and interval of the survey lines are shown in Table 5.1.2 and survey area in each island was shown in Figure 5.1.8 to Figure 5.1.10.

Table 5.1.2 Details of Survey Area in Each Island

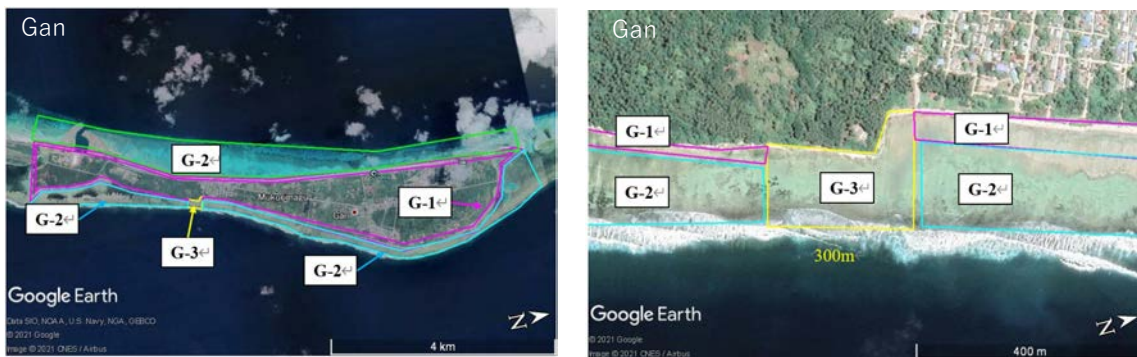
Survey area		Length (m)	Pitch of survey lines (m)	Length of one survey line (m)	Area No.
Laamu Atoll	Maamendhoo(Topo)	2,000	50	30	MA-1
	Maamendhoo(Bathy)			120	MA-2
	Fonadhoo-All-Lagoon (Topo)	7,000	200	30	F-1
	Fonadhoo-All-Ocean (Topo/Bathy)			470	F-2 blue: Topo F-2 green: Bathy
	Fonadhoo-Target(Topo)			400	F-3
	Gan-All-Lagoon (Topo)	1,000	500	30	G-1
	Gan-All-Ocean (Topo/Bathy)	20,000		470	G-2 blue: Topo G-2 green: Bathy
Gan-Target(Topo)	300	100	300	G-3	
Addu Atoll	Isdhoo(Topo)	300	100	50	I-1
	Meedhoo(Topo)	1500	50	30	ME-1
	Meedhoo(Bathy)			90	ME-2

Source: JICA Expert Team



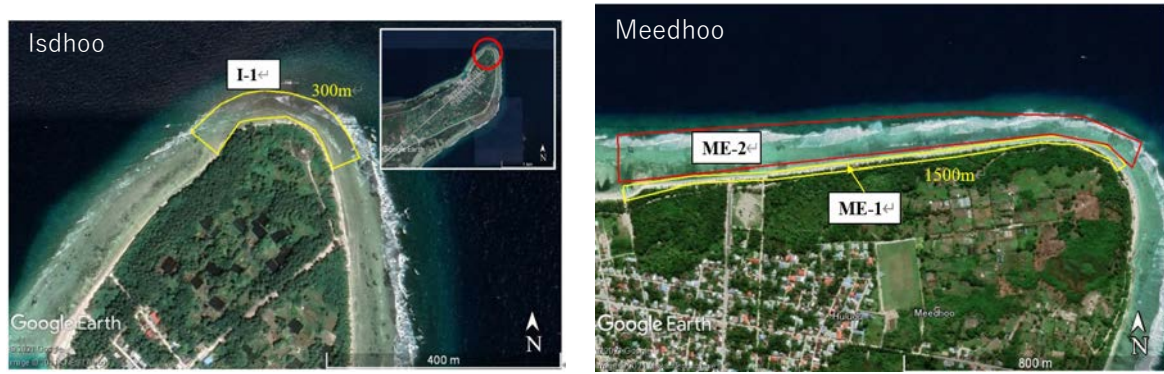
Source: JICA Expert Team

Figure 5.1.8 Survey Area (Left: Maamendhoo, Right: Fonadhoo)



Source: JICA Expert Team

Figure 5.1.9 Survey Area (Left: Overall Map of Gan, Right: Detail Map near G3)



Source: JICA Expert Team

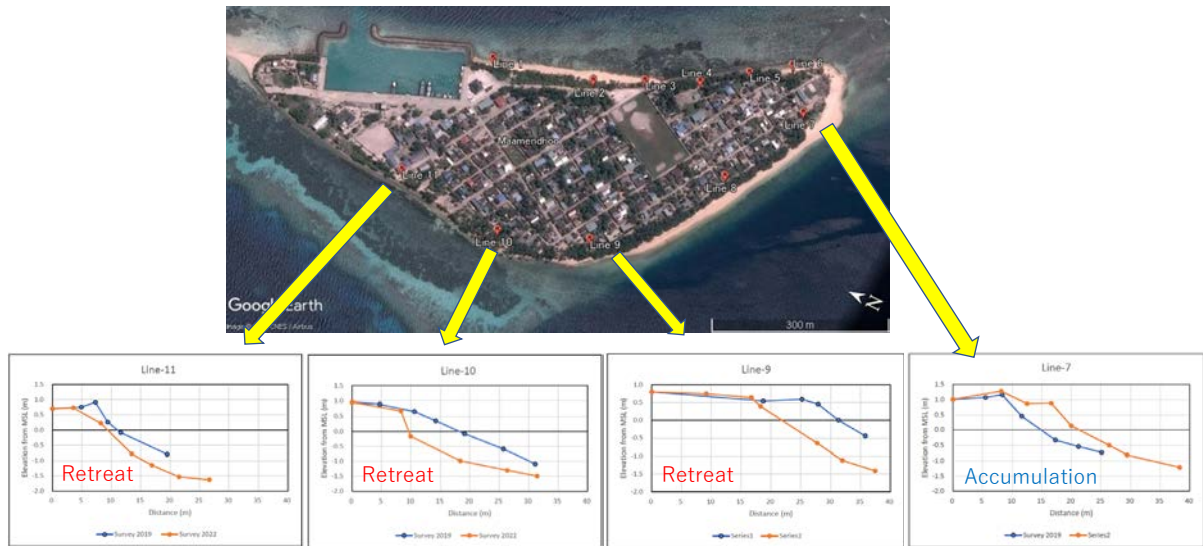
Figure 5.1.10 Survey Area (Left: Isdhoo, Right: Meedhoo)

(2) Survey Results

The topographical cross section for each survey line of each island is summarized in Appendix.5 as a result of survey. In previous survey, topographic survey for monitoring of the target coasts was carried out in Maamendhoo, Fonadhoo, and Meedhoo in December 2019. The comparison between the survey results of Maamendhoo, Fonadhoo, and Meedhoo in December 2019 and the survey in 2022 is shown in Figure 5.1.11, Figure 5.1.12 and Figure 5.1.13 respectively. In addition, in order to make an accurate comparison with the results of surveys conducted in the past, the starting position of the survey was set at a fixed point such as a road edge or a manhole. Figure 5.1.14 shows a photograph of the survey work.

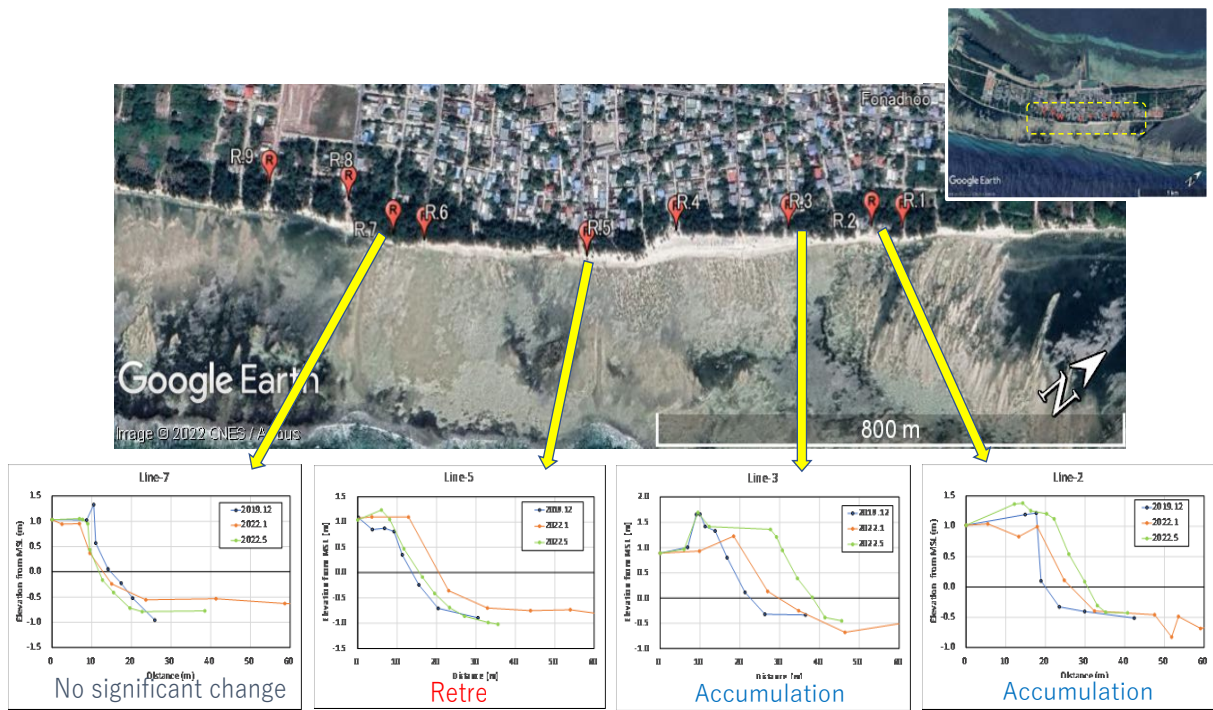
The main results obtained by the comparison with the 2019 survey are described below.

- On Lines 9, 10, and 11 on the west coast of Maamendhoo, the shoreline in 2022 has retreated compared to December 2019. On the other hand, since sand has accumulated on the south coast, the shoreline has advanced about 10m near L7. (Figure 5.1.11)
- On line 3 on the north side of project target sites in Fonadhoo, the shoreline in January 2022 has advanced by about 15m compared to December 2019. On the other hand, shoreline in Line 5 has retreated by about 10m and shoreline in L7 has no remarkable change on the south side. (Figure 5.1.12)
- In Meedhoo, no significant shoreline changes were observed compared to 2019, as shown by Line 1 on the north side of the project target site and Line 4 on the east side. (Figure 5.1.13)



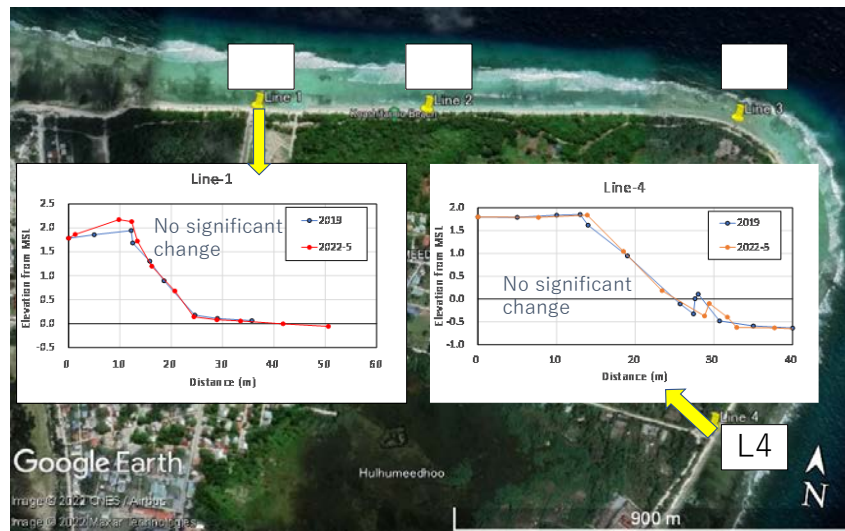
Source: JICA Expert Team

Figure 5.1.11 Monitoring Survey Results in Maamendhoo (Line7, 9, 10, 11)



Source: JICA Expert Team

Figure 5.1.12 Monitoring Survey Results in Fonadhoo (Line2, 3, 5, 7)



Source: JICA Expert Team

Figure 5.1.13 Monitoring Survey Results in Medhoo (Line1, 4)



Source: JICA Expert Team

Figure 5.1.14 Condition of Survey Work

5.2 Coastal mechanism and its evolution

5.2.1 Actual Shoreline Change Analysis based on the Satellite Images

(1) Maamendhoo

The analysis of the actual shoreline change in Maamendhoo based on the satellite images from 1969 to 2021 is as shown in Figure 5.2.1.



Source: JICA Expert Team

Figure 5.2.1 Long-Term Shoreline Change in Maamendhoo

On the west coast, the shoreline retreat were observed at Xw 900 to 1000 m and the accretion at Xw 600 to 750m were found as shown in the Figure 5.2.2

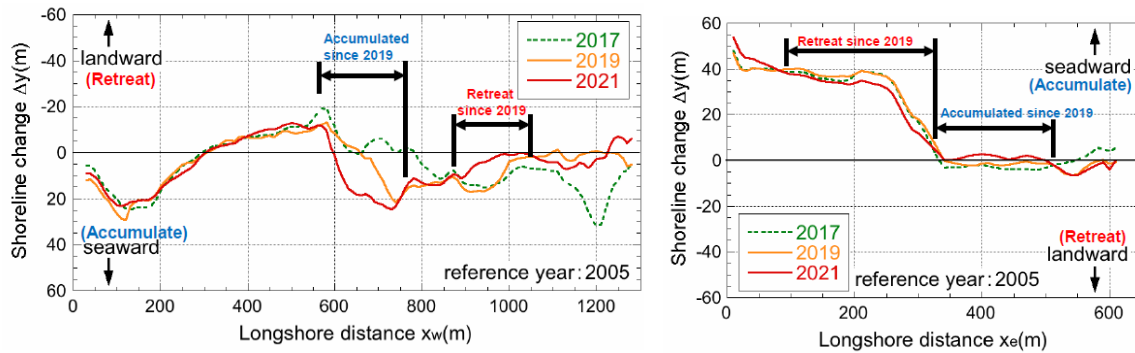
It is assumed that sand from the southwest side of the beach was transported northward and deposited near the bend.

The maximum amount of shoreline advance is 20m at Xw 650m. In contrast, the shoreline change at the north bend is small. The satellite image in 2021 as shown in Figure 5.2.1

shows no sand bar development at the northern end of the island. Sand transport is not considered to have flowed northward beyond the bend.

On the east coast, the shoreline advance up to 7 m were appeared around the southern adjacent area of the port at Xe 0 to 70 m, and the retreat were appeared at Xe 100 to 330 m around the south of the eroded area as shown in the Figure 5.2.2

It is considered that northward sand drift occurred on the east coast as well as on the west coast.



Source: JICA Expert Team

Figure 5.2.2 Shoreline Change at West Side (left) and East Side (right)

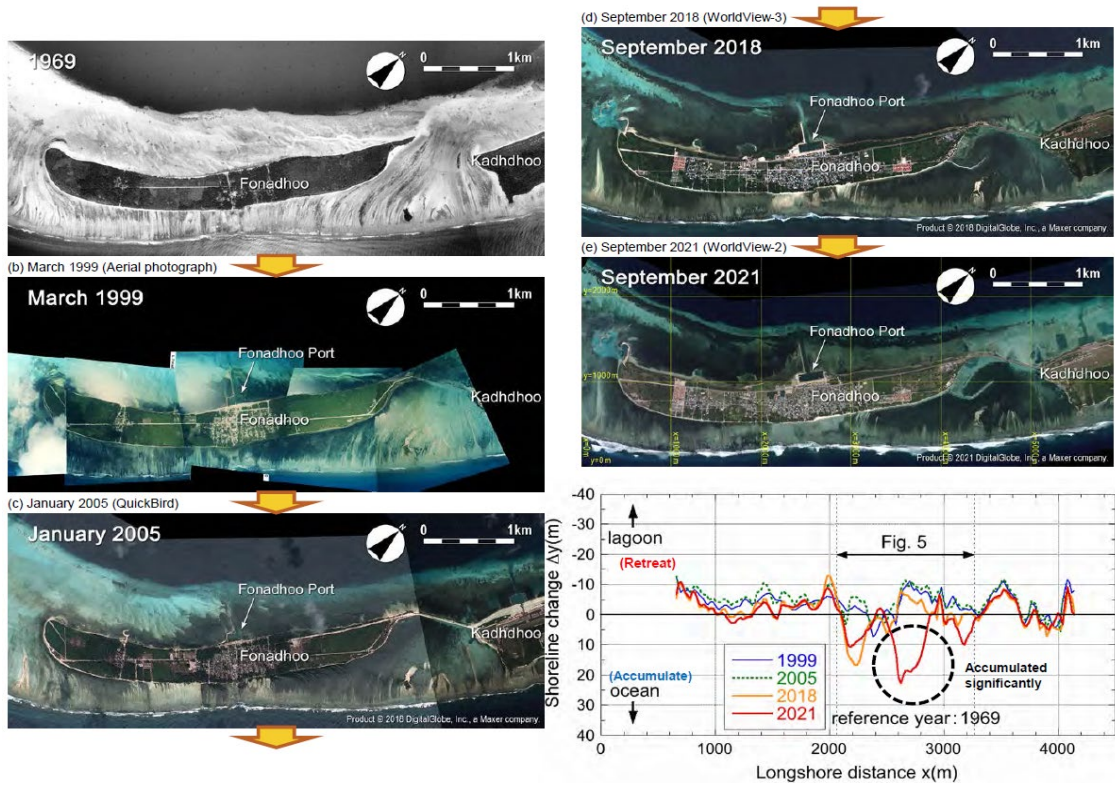
(2) Fonadhoo

On the ocean side, new sand came from the reef around X 2500 to 2900m by 2021. As the result, significant shoreline advance were appeared as shown in the bottom right figure of Figure 5.2.3

. The maximum amount of shoreline advance from 2018 to 2021 was 25 m. At X 3000 to 3200 m, the shoreline also advanced by up to 10 m due to the sand drifting. In contrast, although the shoreline around X 2200m advanced by 2018, the shoreline retreated slightly from 2018. Shoreline change is generally small in areas other than the above.

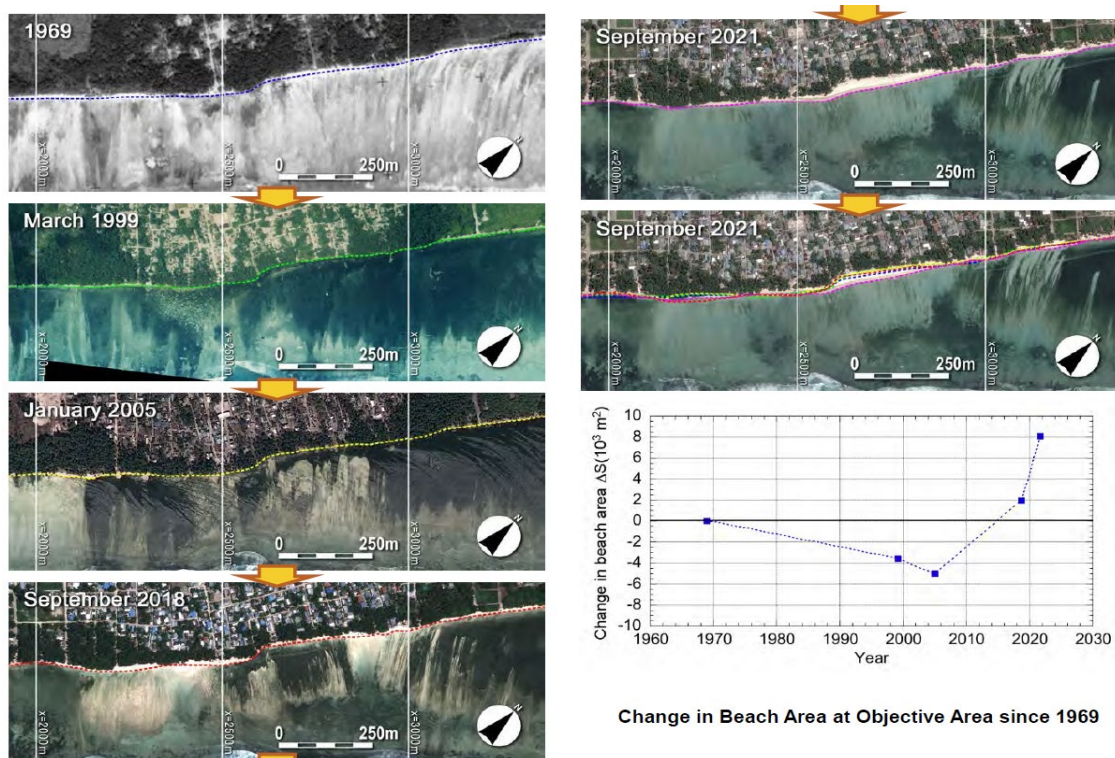
The beach area has been increasing since 2005 until 2021 as shown in the bottom right figure of Figure 5.2.4

. On the ocean side, the area increased by 2.5×10^4 m² from 2005 to 2021. Assuming a closure depth of 1.6 m, the amount of deposition is 4.0×10^4 m³ were estimated and the accretion rate is 2,500 m³/yr. In the X 2060 to 3260m section, where sand drift is significant, the beach area decreased by 5,000 m² until 2005, but increased rapidly by 1.3×10^4 m² by 2021.



Source: JICA Expert Team

Figure 5.2.3 Long-Term Shoreline Change in Fonadhoo



Change in Beach Area at Objective Area since 1969

Source: JICA Expert Team

Figure 5.2.4 Long-Term Shoreline Change in the Adjacent Area of Project Site

(3) Isdhoo

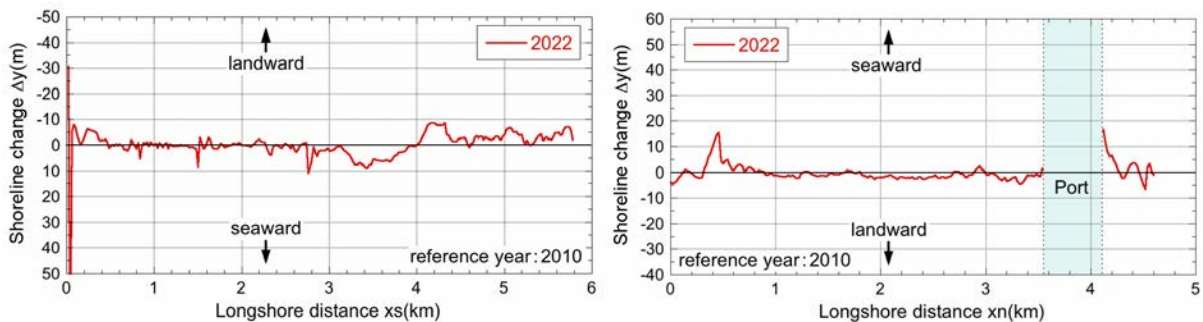


Source: JICA Expert Team

Figure 5.2.5 Long-Term Shoreline Change in Isdhoo

Shoreline change from 2010 to 2022 as shown in Figure 5.2.5 was an advance at Xs 3 to 4 km and a retreat in east of Xs 4 km, but the amount of retreat was less than 10 m and not significant as shown in Figure 5.2.6

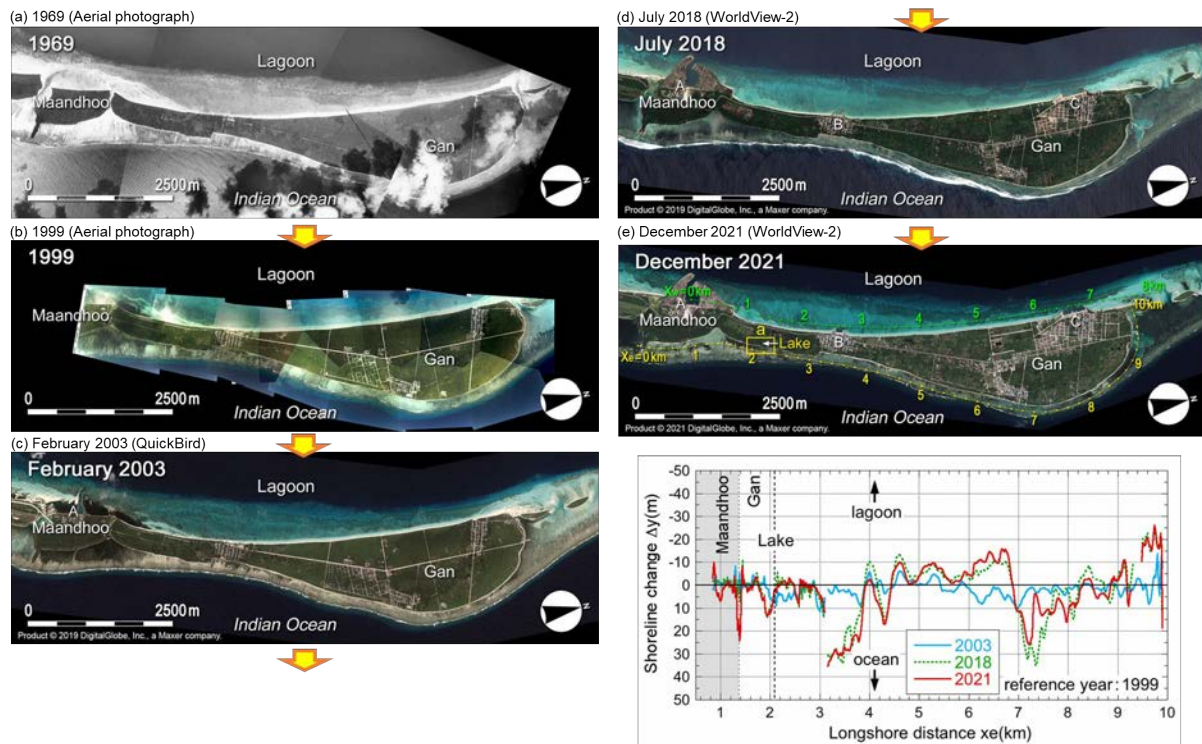
. The shoreline in west of Xs 3 km is stable. In 2010 to 2022, the shoreline retreated slightly in Xn 1 to 3.6 km section, while the shoreline retreated slightly in the Xn 0.6 km section. On the other hand, at Xn 0.4 km, where the shoreline advanced due to the deformation of the spit, and the shoreline advanced by 16m in the area adjacent to the north side of the port.



Source: JICA Expert Team

Figure 5.2.6 Shoreline Change at South Side (left) and North Side (right)

(4) Gan



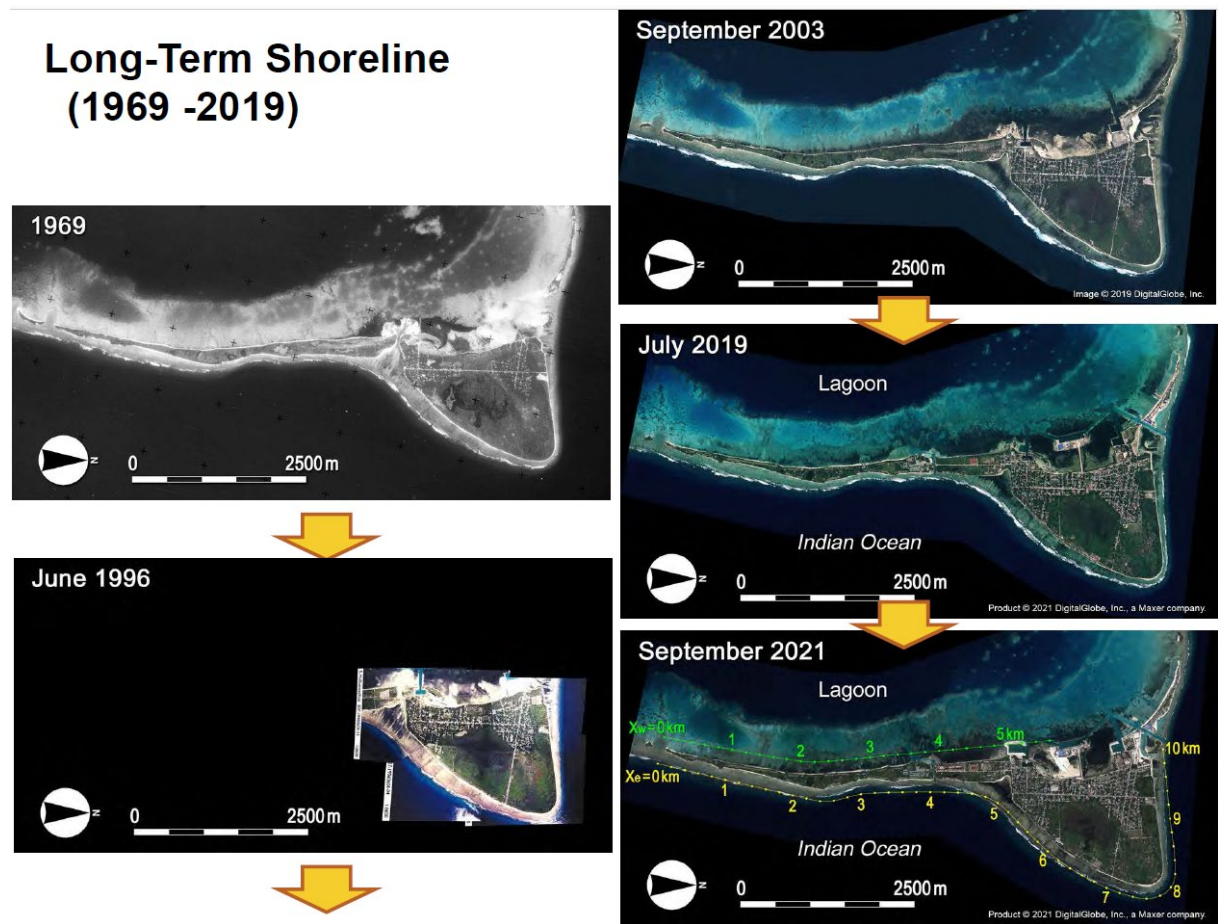
Source: JICA Expert Team

Figure 5.2.7 Long-Term Shoreline Change in Gan

According to the shoreline in 1999 as shown in Figure 5.2.7, the shoreline advanced by a few meters in the Xe 1.9 to 3.9 km and 6.0 to 7.2 km sections by 2003. It is assumed that the shoreline advance was caused by sand drifting from the reef to the foreshore. The shoreline change from 2003 to 2021 shows 30 m shoreline advance in the inner bay between Maandhoo Island. Around near the lake at Xe 2.1 km, the advance occurred on the south side of the lake and a retreat on the north side, and at the Xe 3.1 km berm step, the shoreline on its north adjacent Xe 3.1 to 3.8 km section, the shoreline advanced significantly with a maximum advance of 35 m. The unnatural advance of the shoreline in this section around 2015 indicates the possibility of artificial foreshortening.

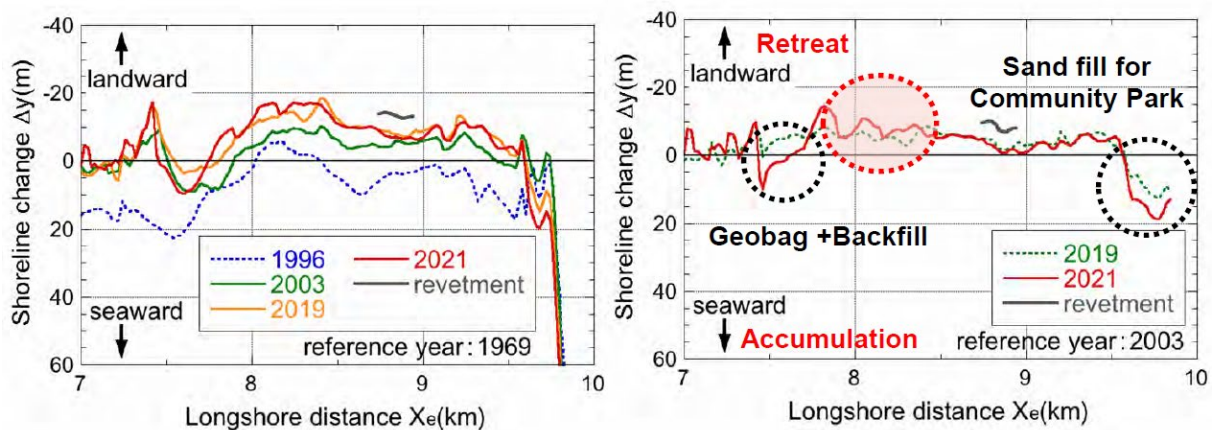
In the northern part of the island, the northern shoreline arcs around the Xe 7 km area, but since 2003, erosion has occurred in the Xe 4.4 to 7.0 km section in the south. In contrast, deposition has occurred in the Xe 7.0 to 8.2 km section in the north. The maximum amount of shoreline retreat and advance is 22 m at Xe 6.7 km and 24 m at Xe 7.2 km, respectively. Sediment from the southern section was probably transported northward through the Xe 7 km point by northward littoral drift. At the northern end of the island, significant erosion occurs on the west side from Xe 9 km, but since the reef surface off the foreshore is widely excavated in a 400 m square area, the erosion is presumed to be due to beach sediment falling into this excavation depression.

(5) Meedhoo



Source: JICA Expert Team

Figure 5.2.8 Long-Term Shoreline Change in Meedhoo



Source: JICA Expert Team

Figure 5.2.9 Shoreline Change at North and East Side based on the Satellite Image in 1969 (left) and 2003 (right)

On the east and north coasts, sedimentation occurred on the south side at Xe 7.5 to 7.8 km and erosion occurred on the north side at Xe 7.8 to 8.3 km of the east-end. On the western edge of the north coast at Xe 9.5 to 9.8 km, the shoreline tended to advance from 2003 to 2021, with a maximum advance of approximately 20 m. Other than the above, changes are generally small, and the foreshore remains almost completely lost in the section where the revetment was installed at Xe 5.0 to 7.7km. On the other hand, on the west coast, the south side of the channel separating the resort area showed a sedimentation trend from 2003 to 2019, and this trend continued until 2021.

5.3 Basic Policy of Coastal Adaptation Measures

5.3.1 Basic Policy

It was common to apply the hard structure measures such as revetment, reclamation, etc. as coastal protection measures in the Maldives. On the other hand, there are issues for hard structure measures as follows.

- The islands in the Maldives were formed by coral sand and gravel which were supplied from coral reef by wave action. Hard structure measures are not to consider such mechanism for sand supply from coral reef and formation of islands.
- Coastal erosion in the Maldives was mainly caused by decrease or disappearing of sand supply to the beach which has been continued in the balance of natural mechanism, by artificial construction and human activities. Even though hard structure measure is applied at the beach where coastal erosion continues, this measure is just “temporary protection”, not “permanent protection” with consideration of fundamental phenomena of coastal erosion that is “to improve the decrease of sand supply to the beach”. This means hard structure measures are not sustainable and permanent solution as measures for coastal erosion under the condition of climate change in long term with uncertainty.
- The proposed sites for physical measures, Fonadhoo and Maamendhoo are faced on serious coastal erosion and flooding due to high wave. On the other hand, natural sandy beach still exists, and beach is utilized as recreation area of the residents. Construction of hard structure measures will induce the disturbance of such beach use forever. Once natural beach is lost by construction of hard structure measures, it is basically difficult to recover the lost natural sandy beach.
- Apart from the above-mentioned coastal measures at two sites founded by GCF, coastal protection measures at three sites are planned, which are coastal protection measures at the ocean aside of Gan Island and the north tip of Isdhoo Island in Laamu Atoll to protect cultural heritage, and coastal conservation measures at the north side of Meedhoo island in Addu Atoll. The objective coastal area at Gan Island mainly consists of rocky beach and no continuous sandy beach exists. The objective area at the north tip of Isdhoo Island mainly consists of gravel beach. On the other hand, the sandy beach consists of coral sand continues at the north side of Meedhoo Island. Furthermore, this coastal area is utilized as recreation area for residents and some public beach park have been maintained by the local community and NGO.

Based on above mentioned issues, the following points shall be considered for proposed coastal adaptation measure as basic policy.

- Proposed adaptation measure shall consider not only to enhance the protection function, but also to maintain the relationship between people’s livelihood and beach (to maintain beach use)

- In order to maintain the beach to next generation, proposed adaptation measure shall consider the natural mechanism on formation of coral beach, maintaining of supply of sand on coral reef and its natural protection function.
- As future scenario for the impact of climate change has uncertainty, proposed adaptation measure is to have a flexibility for actual causing phenomena for climate change.

There is another approach as coastal protection measures, not to use the hard structure measures but to use “beach nourishment” as one of soft protection measures. Table 5.3.1 shows the comparison between revetment as structure measures and beach nourishment as soft measures.

Resident area exists at the hinter area of the beach at proposed sites, Fonadhoo and Maamendhoo, and beach area is highly utilized as recreation area for residents. The beach area at the north side of Meedhoo also highly utilized as recreation area for the residents. Considering such present condition on beach use at these beaches, beach nourishment is basically proposed as coastal protection measures in the Project.

Table 5.3.1 Comparison between Revetment (as Hard Structure Measure) and Beach Nourishment (as Soft Measures)

Measures	Revetment (Hard Structure Measures)	Beach Nourishment (Soft Measures)
Protection Function	Hinter area will be protected as far as revetment is damaged	Hinter area will be protected as far as nourished beach is maintained
Relation for Forming of beach, natural protection function, supply of sand	No relation (Sand supply will be disturbed due to construction)	To enhance such natural mechanism and function
Beach Use	Basically, difficult at every implemented coast	Maintain same function on beach use
Environment and Land Scape	Artificial view image	Maintain natural view image and possibility to enhance habitat of marine biota
Adaptability for uncertain factor for climate change	Basically difficult (as far as to consider improvement of design for future risk such as increase of crown height, enhancement of stability, etc.)	Possible in nourishment area flexibly (as buffer zone)
Sustainability of function	Maintained as far as no damage of revetment. However, some improvement (or maintenance) will be required under progress of coastal erosion (30yrs are applied as life cycle for coastal hard structures)	Maintained as far as beach is well maintained. On the other hand, difficult in case of no maintenance)
Initial cost	Construction cost in the Maldives is about 1,000~2,000 U\$/m (ex.) 2~4 million U\$ (for 2 km)	About 10~15 U\$/m ³ (excluded mobi- and demobi-cost for dredger) (ex.) 2km, 20m 0.6~1 million U\$ (for 2km, 20m wide) (Assuming 2.6 million U\$ for mobi- and demobi-cost for dredger, total 3.2~3.6 million U\$)
Maintenance cost	Basically, it takes same cost after 30yrs If so, 33,000~66,000 U\$/yr	Periodical maintenance is required. If assumed 20 % of initial sand volume in every 3yrs, maintenance cost is 21,000~64,000 U\$/yr

Source: JICA Expert Team

On the other hand, the objective of coastal measures at the ocean side of Gan Island and the north tip of Ishdoo Island is just to protect the cultural heritage at hinterland. Also, continuous sandy beach doesn't exist at these area. Thus, conducting hard-structure measures locally by applying construction of revetment are recommended.

5.3.2 Basic Policy for Target Beaches

(1) Proposed Adaptation Measures at Maamendhoo

Maamendhoo has the highest population density in the Laamu Atoll with about 900 residents in the small island area of 18.7 ha. Most of land area was occupied as resident area and there is no empty space in the island. The land elevation is quite low with MSL +0.6 ~ +0.8 m, and coastal erosion is one of serious issues in the Island (Figure 5.3.1). Flooding sometimes occurred during high wave and high tide conditions (Figure 5.3.2). The impact on the loss of land by decrease of sandy beach due to coastal erosion becomes bigger for small island. The impact of sea level rise and progress of coastal erosion will cause further increase of coastal disaster and acceleration of land loss. Based on such conditions, the basic policy for proposed measures in this island is as follows (Figure 5.3.3).



(1) West Side



(2) East Side

Source: JICA Expert Team

Figure 5.3.1 Beach Condition at Maamendhoo (May 2022)



(1) Around Beach Area



(2) Resident Area at hinterland

Source: Maamendhoo Island Council

Figure 5.3.2 Flooding Due to High Wave



Source: Processed by JICA based on World View in 2019 procured by JICA

Figure 5.3.3 Proposed Area for Adaptation Measures in Maamendhoo

- The purpose to implement the coastal adaptation measures in this island is 1) To protect the land against flooding due to wave run-up during high tide and high waves, and to minimize land loss due to coastal erosion, 2) To secure the evacuation area during the extreme condition (hitting cyclone, Tsunami).
- Based on the result of field investigation, the serious beach area for coastal erosion and flooding is the beach at west side with approximately 600 m and east side with 300 m. The beach at west side has been under coastal erosion as long-term trend. Here, sandy beach still exists even though coastal erosion is in progress, and the beach area is utilized as recreation zone for the residents. Therefore, beach nourishment is proposed as coastal adaptation measures taking into account not only protection function but also beach use and coastal environment. To enhance the stability of sandy beach after the nourishment against wave action, groins are also planned to construct as supplementary coastal facilities.
- The beach at east side is located at following partial reclamation area at north side and the beach consists of beach rock. As the result of satellite image analysis since 2005, no significant retreat was observed at this area. Furthermore, the waves which propagate from outer ocean area directly incident at this area and exiting beach is rocky beach. Considering such conditions, although the possibility to apply beach nourishment will be examined, final recommendation for coastal measures will be as the result of further study.
- It is also proposed to conduct the reclamation to secure the evacuation area against extreme events such as hitting of cyclone and Tsunami. However, it is proposed to minimize the space of reclamation as far as securing enough evacuation area in order to avoid the artificial of natural beach and coral reef. The reclamation area is proposed to set at the north side of existing port considering present land use condition at hinter area (not so utilized as resident area). Furthermore, the land elevation at this reclamation area is planned to increase in order to ensure safety and security as evacuation area. As the planned reclamation area is located on the sand spit at the north tip of island, it will be finally determined after obtaining the consensus with island council and community.

(2) Proposed Adaptation Measures at Fonadhoo

Fonadhoo is the middle size of island in the Laamu Atoll with about 2,200 residents in the area of 163 ha. The main residential and commercial area are located at the hinterland of the Fonadhoo port located at central area of lagoon side. Undeveloped areas still exist except this central area. However, development as residential area is planned at these areas. Flooding has sometimes occurred at the ocean side of central residential area during high wave and high tide condition, and sand embankment was constructed by the island council. Even though the beach erosion is not so significant, the tendency of beach retreat has been identified. However, it was identified that the coastal erosion area is now moved from original planned area to the north (Figure 5.3.4). On the other hand, the original planned area has been getting accumulate since 2018 based on site check (Figure 5.3.5) and further satellite image analysis to compare the shoreline position between 2018 and 2021. This accumulation was caused by sand inflow from offshore side to the shore. However, such phenomena might be just temporary, and not expect to continue. This means there is still facing the coastal disaster for both impact of sea level rise and coastal erosion.

Considering such condition, basic policy for proposed measures are as follows.

- The purpose for proposed measures is to ensure the safety and security at the residential area faced on the ocean side against coastal erosion and intrusion of high wave.
- Sandy beach exists at the proposed area and the beach is utilized as recreation area for the residents. Therefore, beach nourishment is proposed as coastal adaptation measures taking into account not only protection function but also beach use and coastal environment.
- In the previous study, it was proposed to implement the coastal adaptation measures at the central area of ocean side with approximately 850 m as original proposed plan. However, based on further study and site checking, it was found that the eroded and accumulated area are variable depending on on-offshore sand movement as mentioned above. Further, dominant direction of littoral drift was not observed. Even though the littoral drift exists, the magnitude of littoral drift is predicted to be small about several hundred m³/year. Taking into account such conditions, the objective area will be extended from original proposal with 850 m as shown in Figure 5.3.6. Also, the necessity of groin construction will be examined by numerical analysis.



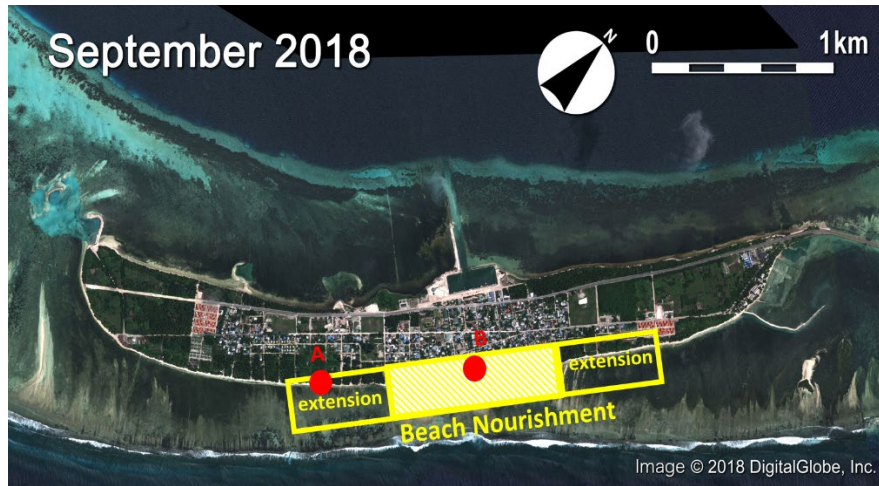
Source: JICA Expert Team

Figure 5.3.4 Erosion at point A (May 2022)



Source: JICA Expert Team

Figure 5.3.5 Sedimentation at point B (May 2022)



Source: Processed by JICA Expert Team based on World View in 2018

Figure 5.3.6 Proposed Area for Adaptation Measures in Fonadhoo (Possibility to Extend)

(3) Proposed Adaptation Measures at Ocean side of Gan and North Tip of Isdhoo

The objective of coastal adaptation measures at both ocean side of Gan (Figure 5.3.7) and north tip of Isdhoo (Figure 5.3.8) is just to protect cultural heritage at hinterland. Taking into account this objective as well as current coastal characteristics, the construction of revetment as coastal protection measures locally is recommended as shown in Figure 5.3.9 and Figure 5.3.10. To minimize expected adverse effect due to construction of hard-structure measures, the alignment of revetment will be maintained almost same as present shoreline position (not to be advanced to offshore side). Further, the rubble type sloped revetment is recommended to reduce the reflection waves and resulting scouring, and not to disturb beach use for the residents. Protected area will be finalized taking into account the necessity for protection, impact to surrounding area and obtaining consensus with Island Council.



Source: JICA Expert Team

Figure 5.3.7 Site Condition at Ocean Side of Gan (May 2022)



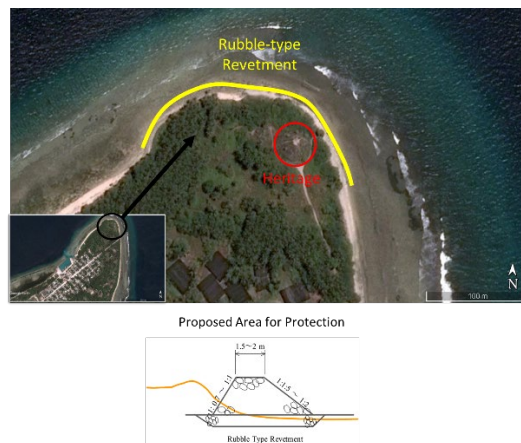
Source: JICA Expert Team

Figure 5.3.8 Site Condition of North Tip of Isdhoo (May 2022)



Source: JICA Expert Team

Figure 5.3.9 Proposed Measure at Gan



Source: JICA Expert Team

Figure 5.3.10 Proposed Measure at Isdhoo

(4) Proposed Adaptation Measures at North side of Meedhoo

Resort development has been on-going at the west area at north side of Meedhoo (Figure 5.3.11). On the other hand, nature condition at hinter area maintained at the east area of north side of meedhoo and the public beach park is well-maintained as recreation area for the residents (Figure 5.3.12). Some area of the east coast of Meedhoo has been protected by construction of revetment with 1.4 km alongshore (Figure 5.3.13) and sandy beach has already disappeared (Figure 5.3.14). On the other hand, natural sandy beach with white colored coral sand is maintaining at the north side (except some part with old seawall), however, the beach has been under progress of coastal erosion. Furthermore, the oldest cemetery in Maldives which was established about 900 years ago exists as cultural heritage at this area however, the risk of coastal disaster due to wave run-up has been increased by progress of coastal erosion. Beach nourishment is proposed to consider the protection with maintaining existing utilization and environment condition. The target area is assumed about 1.4 km from the tourism developed area at west side to the east end (Figure 5.3.15). Even though the necessity of construction of groins will be judged as the result of numerical analysis, it shall be considered to maintain current natural beach as much as possible.



Source: JICA Expert Team

Figure 5.3.11 Tourism Development Area at West Side of North Coast of Meedhoo (May 2022)



Source: JICA Expert Team

Figure 5.3.12 Public Beach Park (May 2022)



Source: JICA Expert Team



Source: JICA Expert Team

Figure 5.3.13 North Coast of Meedhoo (May 2022)

Figure 5.3.14 Coastal Erosion at East Side of North Coast of Meedhoo (May 2022)



Source: Processed by JICA Expert Team based on World View in 2021

Figure 5.3.15 Proposed Area for Adaptation Measures in Meedhoo

5.4 Examination of the draft basic plan

(1) Maamendhoo

The original proposed plan in the Feasibility Study is shown in Figure 5.4.1



Source: JICA Expert Team

Figure 5.4.1 Original Layout Plan in Maamendhoo

According to the Island Council, they strongly requested the plan of reclamation with revetment for the emergency evacuation area as the original proposal. Therefore, the original plan for the evacuation area is applied as it is.

For the protection at east coast and west coast, the beach deformation analysis was used to examine reasonable proposals of nourishment and groins.

At first, the case where only beach nourishment was applied without groins at west coast is examined. The sand that was initially put into the area moves and after 30 years the sand is gone and restored as shown in Figure 5.4.2Figure 5.4.2.

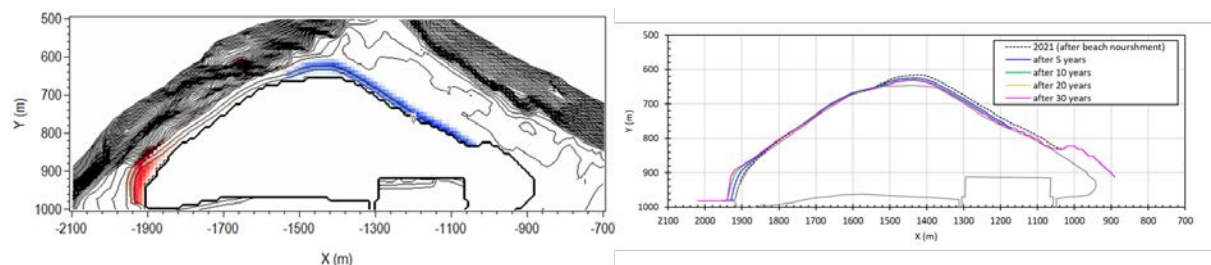
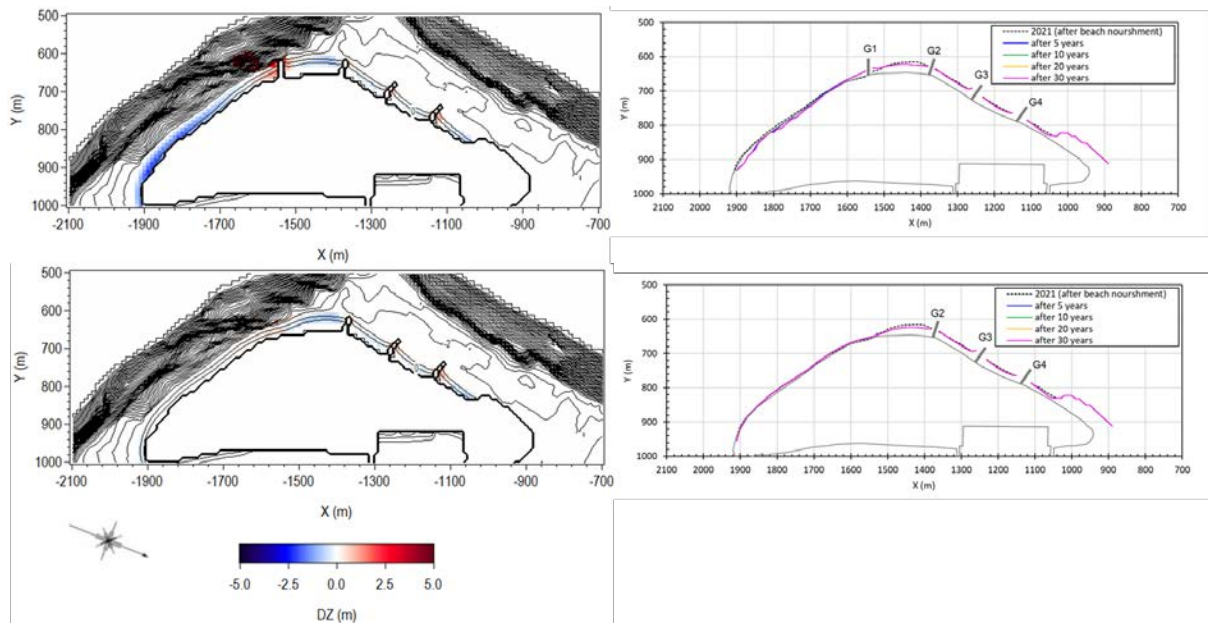


Figure 5.4.2 Results of Shoreline Change in Case: Nourishment without Groin at West Coast

As alternative cases, the nourishment with 4 groins and 3 groins are examined by the beach deformation analysis. The shoreline changes during 30 years in each case are shown in the Figure 5.4.3.

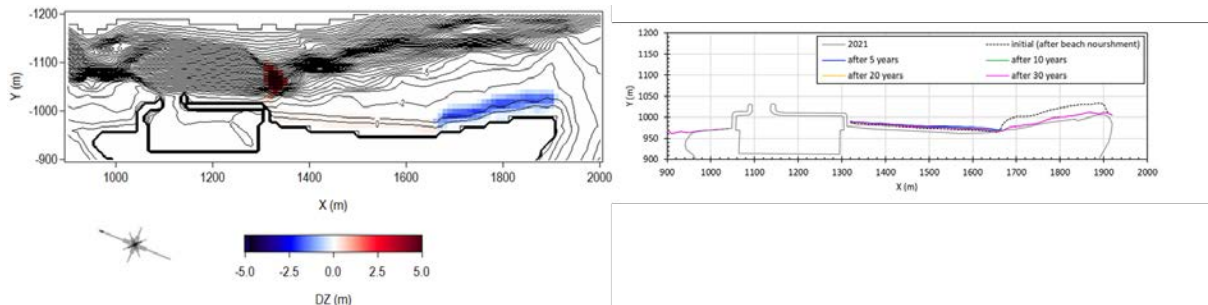
Comparing the two cases, the sand is retained for a long period on the western beach in both cases, while the Case “4 Groins” causes the erosion of the southern beach. Therefore, the Case ‘3 Groins’ are employed in the west coast.



Source: JICA Expert Team

Figure 5.4.3 Results of Shoreline Change in Case: Nourishment with 4 Groins (Upper) / 3 Groins (Bottom)

For the protection at east coast, the case where only beach nourishment was applied without groins is also examined. The sand that was initially put into the area moves and after 30 years the sand is gone and restored as shown in Figure 5.4.4.

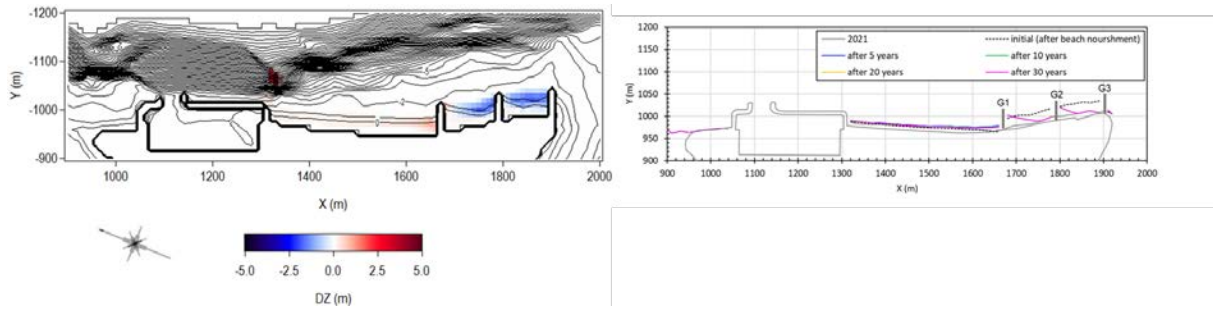


Source: JICA Expert Team

Figure 5.4.4 Results of Shoreline Change in Case: Nourishment without Groin at East Coast

As alternative cases, the nourishment with 3 groins are examined by the beach deformation analysis. The shoreline changes during 30 years in each case are shown in the Figure 5.4.5

Figure 5.4.5. It is difficult to retain sand and layout of beach profile even though the groins are installed. Therefore, beach nourishment is not appropriate and protection by revetment is recommended.



Source: JICA Expert Team

Figure 5.4.5 Results of Shoreline Change in Case: Nourishment with 3 Groins

The alternative layout plan is shown in Figure 5.4.6.

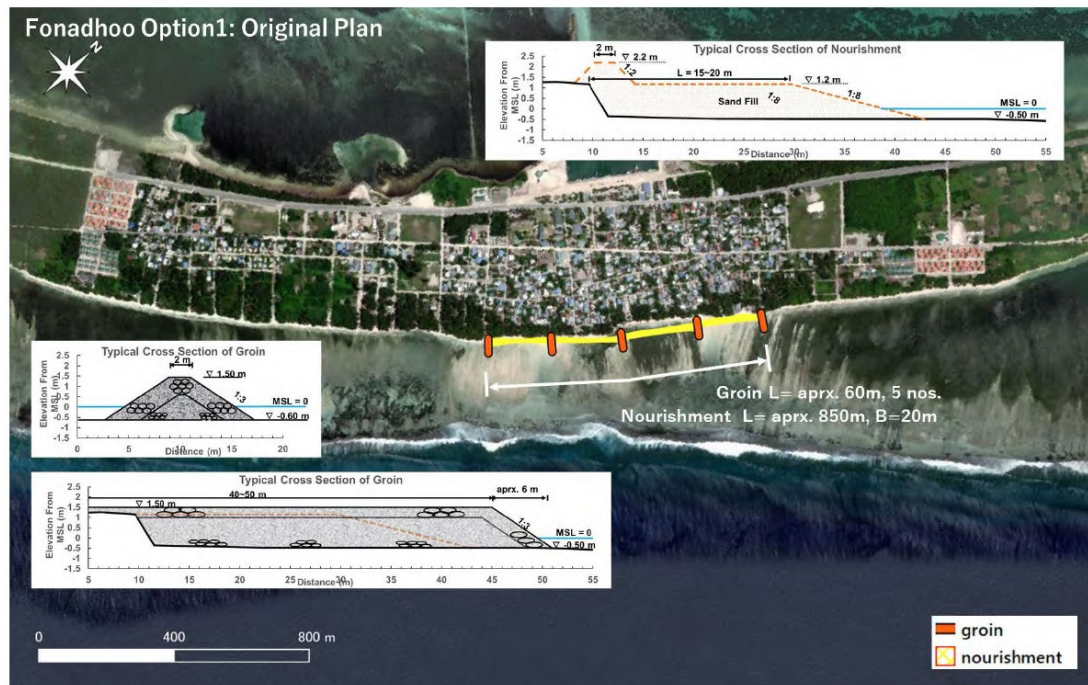


Source: JICA Expert Team

Figure 5.4.6 Alternative Layout Plan in Fonadhoo

(2) Fonadhoo

The original proposed plan in the Feasibility Study is shown in Figure 5.4.7.



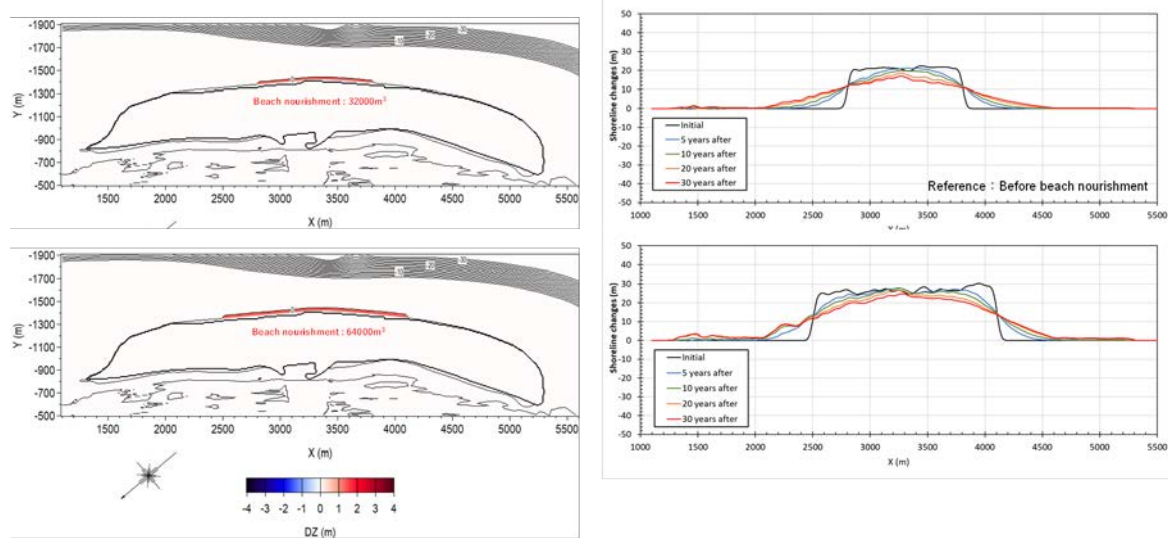
Source: JICA Expert Team

Figure 5.4.7 Original Layout Plan in Fonadhoo

The beach deformation analysis was used to examine reasonable proposals. At first, the case where only beach nourishment was applied without groins is examined, because the magnitude of littoral drift at ocean side seems to be not so significant based on the satellite image analysis and wave direction analysis.

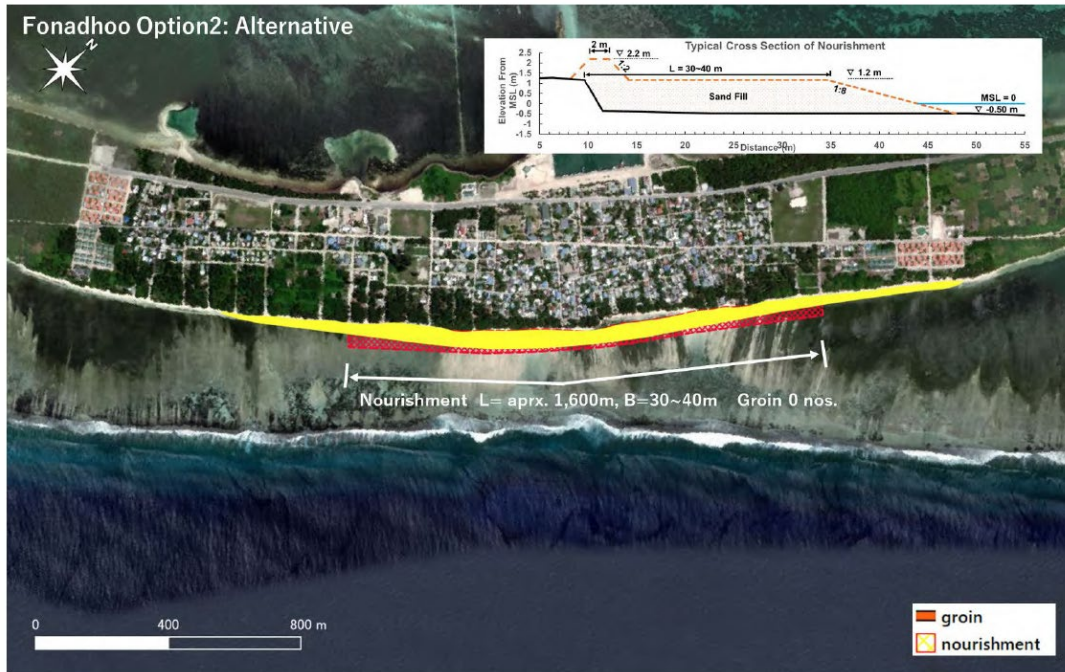
The shoreline changes during 30 years are shown in Figure 5.4.8. The numerical results show that the nourished sand can be maintained for long period in both case, but the case, where 1.6 km and 64,000 m³ of beach nourishment is applied, is more effective than other cases.

The alternative layout plan is shown in Figure 5.4.9.



Source: JICA Expert Team

Figure 5.4.8 Results of Shoreline Change in Case: Nourishment L=1,0km and 32,000m³ (Upper) / L=1.6km and 64,000m³ (Bottom)



Source: JICA Expert Team

Figure 5.4.9 Alternative Layout Plan in Fonadhoo

(3) Isdhoo

The original proposed plan in the Feasibility Study is shown in Figure 5.4.10. In order to protect the heritage area, the current beach use in this area is not a high priority and only the protection function is sufficient. The proposed site is seaward facing, and the coral reef is narrow and limited. Therefore, hard measures using rubble stone revetments are recommended.



Source: JICA Expert Team

Figure 5.4.10 Original Layout Plan in Isdhoo

According to the Island Council, they also wanted to protect an area extending 90 meters south of the proposed area as shown in Figure 5.4.11. Since the expansion area is also an area that is eroding recently and future erosion will affect the heritage area, expansion of the relevant area is considered appropriate.



Source: JICA Expert Team

Figure 5.4.11 Alternative Layout Plan in Isdhoo

(4) Gan

The original proposed plan in the Feasibility Study is shown in Figure 5.4.12. To protect the heritage area, beach use at this area is not high priority and it is sufficient to consider only protective functions. Project site is faced on ocean side and the width of coral reef is narrow, and required area for the protection is limited. Therefore, it is recommended to apply hard structure measure using rubble type revetment as originally proposed.



Source: JICA Expert Team

Figure 5.4.12 Original Layout Plan in Gan

(5) Meedhoo

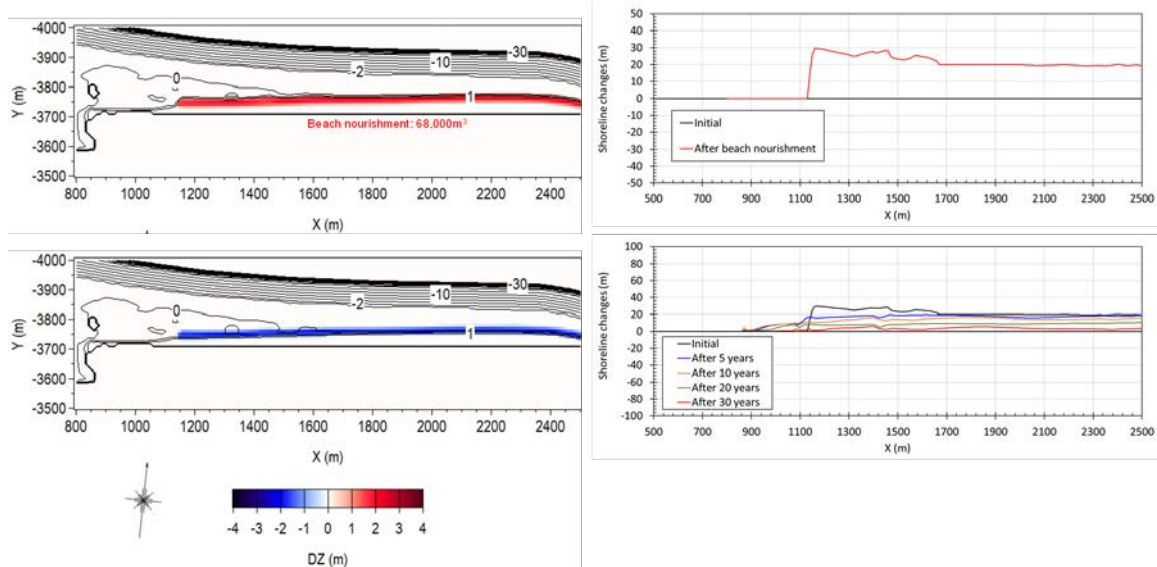
The original proposed plan in the Feasibility Study is shown in Figure 5.4.13.



Source: JICA Expert Team

Figure 5.4.13 Original Layout Plan in Meedhoo

The beach deformation analysis was used to examine reasonable proposals. At first, the case where only beach nourishment was applied without a groin is examined. The shoreline changes during 30 years are shown in the Figure 5.4.14. The sand that was initially put into the area moves from east to west, right to left in the figure, and after 30 years the sand is gone and restored.



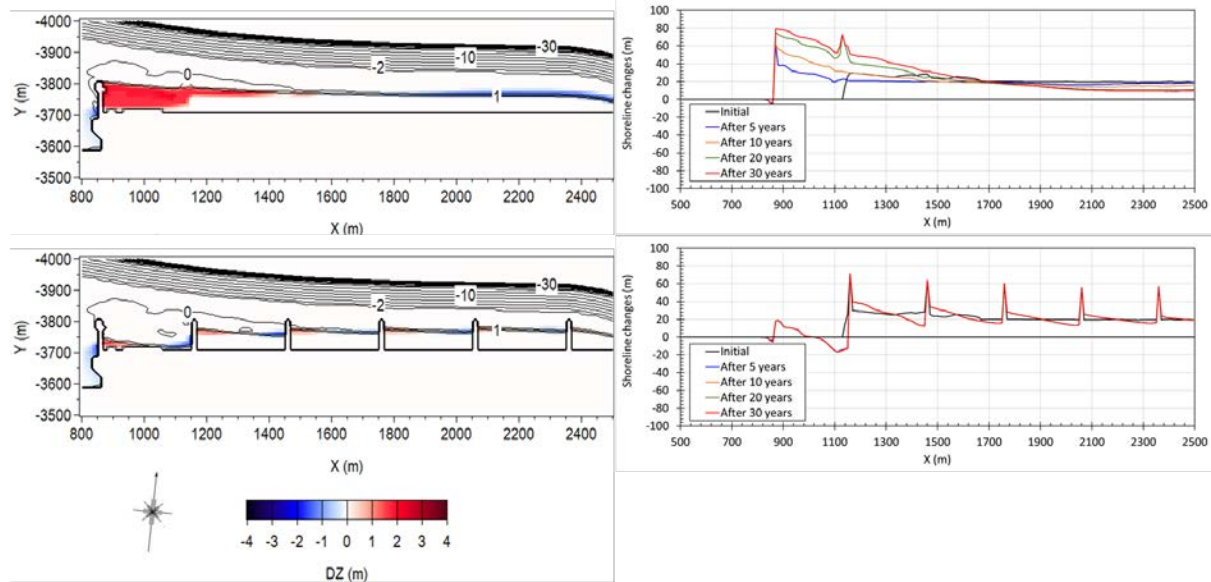
Source: JICA Expert Team

Figure 5.4.14 Results of Shoreline Change in Case: Nourishment without Groin

As alternative cases, the nourishment with a groin and 6 groins are examined by the beach deformation analysis. The shoreline changes during 30 years in each case are shown in Figure 5.4.15.

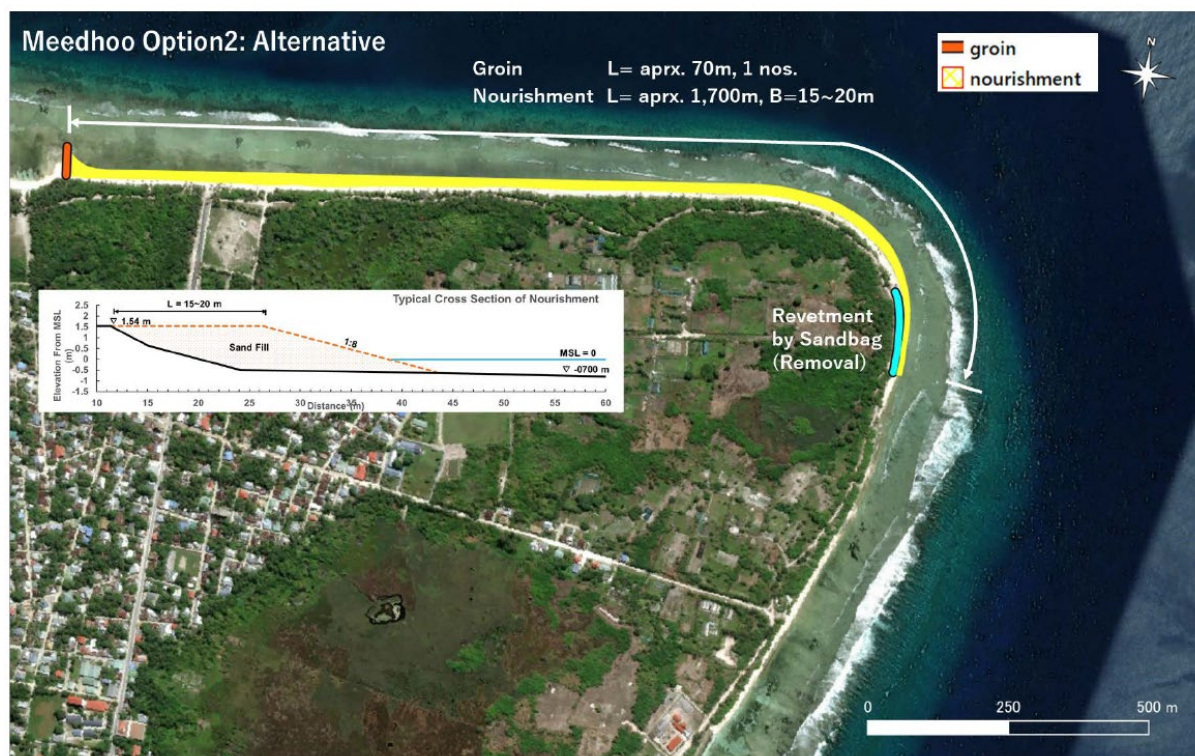
In the Case “6 Groins”, shoreline layout will be deformed and not continuous, while the sand that was put in will remain in place for 30 years. On the other hands, in the Case “A Groin”, although there is an erosion trend on the east side and an accretion trend on the west side, the input sand will continue to remain in place after 30 years, resulting in a continuous beach profile.

Considering beach use and scenery, the Case where beach nourishment and 1 groin is installed are recommended, and alternative layout plan is shown in Figure 5.4.16.



Source: JICA Expert Team

Figure 5.4.15 Results of Shoreline Change in Case: Nourishment with a Groin (Upper) / 6 Groins (Bottom)



Source: JICA Expert Team

Figure 5.4.16 Alternative Layout Plan in Meedhoo

5.5 Examination of basic design

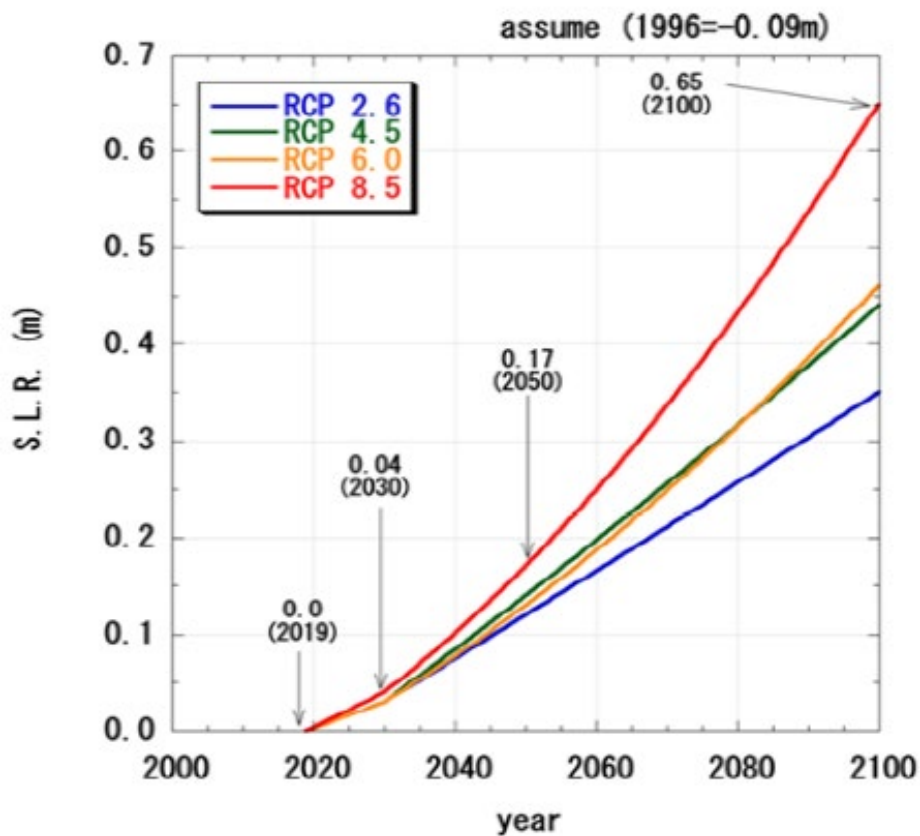
5.5.1 Design water level conditions

The design water level conditions at the Project site in Laamu Atoll and Addu Atoll are determined by taking into account the rising water levels caused by surges due to common climatic and oceanographic effects such as wave setup and storm surge, and sea level rise due to climate change in future.

In the Feasibility Study, the tide level at the Project site was examined by the tidal investigation based on the tidal observation data for 30 years and the harmonic analysis. As the result, the mean High Water Level (HWL) is set as 0.70 m in Laamu Atoll and 0.64 m in Addu Atoll.

Surges are evaluated by the difference between the tidal observation record and the estimated astronomical tide level based on the above-mentioned harmonic analysis. The annual maximum level of the surges are extracted and probabilistic surge level with return period is estimated by the extreme value statistics analysis. As the result, the surges with 50-years return period is 0.18 m. This rise in water level could be due to setup after wave breaking or cyclone, but in this area, setup is considered to be dominant.

To determine the Sea Level Rise (SLR) due to future climate change, the future scenario of SLR is referred to as the scenario presented in the 5th report of IPCC¹⁾. Here, the base year for the future scenario presented in the 5th report was assumed around 1986 to 2005. In order to convert the base year to the present, the value of 9 mm was deducted from the actual observed SLR from 1996. Figure 5.5.1 shows the future scenario of SLR based on 2019. Even though there is a range for each scenario, the median values are employed in this Project.



Source: IPCC Fifth Assessment Report (AR5), 2014

Figure 5.5.1 Future Scenario of SLR based on 2019

The design water level conditions at the Project site in Laamu Atoll and Addu Atoll are summarized as follows.

Table 5.5.1 Design Water Level Conditions in Laamu Atoll

Laamu Atoll	2030	2050	2100
1) High Water Level (HWL)	0.70		
2) Surge (Return Period 50 years)	0.18	0.18	0.18
3) Sea Level Rise due to Climate Change	0.04	0.17	0.65
Design Water Level (= 1)+2)+3)	0.92	1.05	1.53

Source: JICA Expert Team

Table 5.5.2 Design Water Level Conditions in Addu Atoll

Addu Atoll	2030	2050	2100
1) High Water Level (HWL)	0.64		
2) Surge (Return Period 50 years)	0.18	0.18	0.18
3) Sea Level Rise due to Climate Change	0.04	0.17	0.65
Design Water Level (= 1)+2)+3)	0.86	0.99	1.47

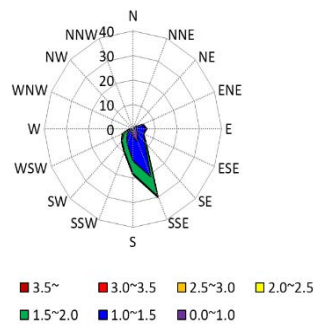
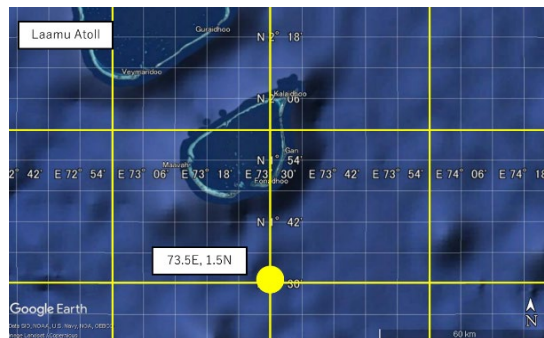
Source: JICA Expert Team

5.5.2 Design wave conditions

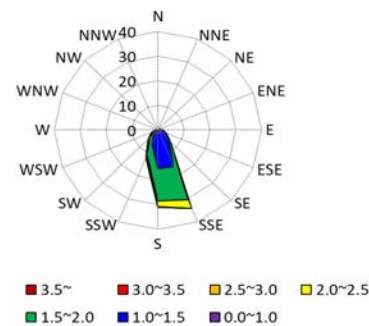
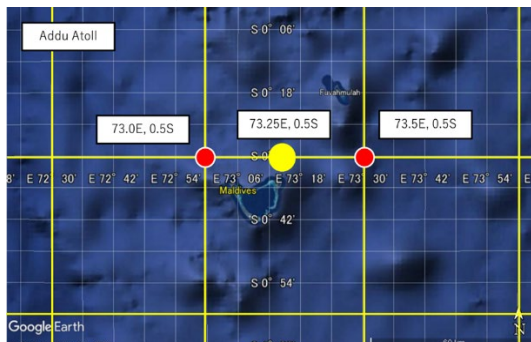
(1) Offshore wave conditions

Characteristics of offshore waves around Laamu Atoll and Addu Atoll are obtained by applying the reanalysis data base (ERA5 produced by EXMWF) for 40 years from 1982 to 2021 as shown in Figure 5.5.2, because no long-term wave observation data can be available in the Maldives. The extracted location and characteristics of the offshore wave around each Atoll are shown below.

Laamu: 73.5E, 1.5N



Addu: 73.25E, 0.5S *

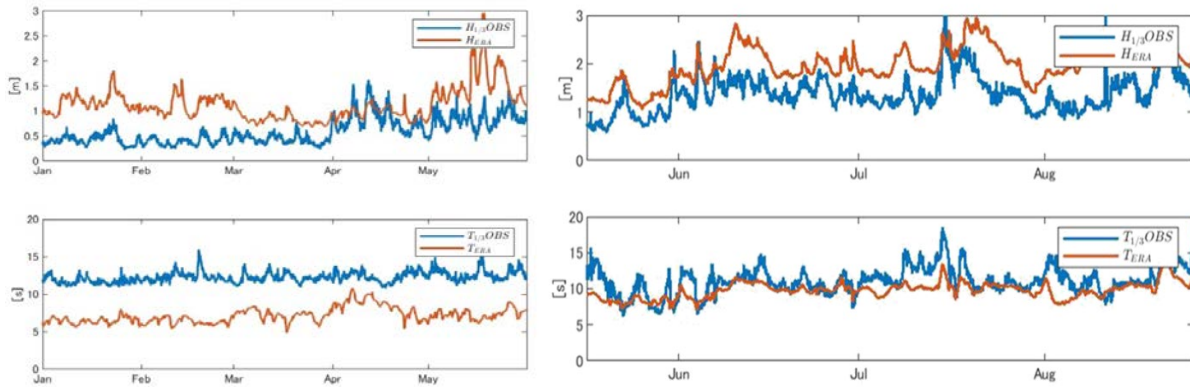


* Note: The characteristics of offshore wave at (73.25E, 0.5S) are estimated by synthesizing both data at (73.0E, 0.5S) and (73.5E, 0.5S).

Source: JICA Expert Team using ERA5

Figure 5.5.2 Characteristics of Offshore Waves around Laamu Atoll and Addu Atoll

Some differences between wave estimation results by ERA5 and actual observation results are found as shown in Source: JICA Expert Team using ERA5 Figure 5.5.3. Therefore, the wave data from ERA5 was corrected so that the wave heights and periods obtained from wave deformation calculations using the wave data from ERA5 as input conditions matched the observed wave heights and periods.



Source: JICA Expert Team using ERA5

Figure 5.5.3 Comparison between the observed waves at Hankede Island from February to August 2019 and ERA5

The correction factors for each atoll and the comparison between the corrected ERA5 and the observed results are shown below. As the result, it was found that the corrected ERA5 corresponds with the results from the observation as shown in Figure 5.5.4.

Correction factor at Laamu Atoll

$$H_{era}(\text{correction}) = H_{era} \cdot (0.0185 \cdot T_{era}^2 - 0.1101 \cdot T_{era} + 0.3596);$$

$$T_{era}(\text{correction}) = T_{era} \cdot (0.0299 \cdot T_{era}^2 - 0.6735 \cdot T_{era} + 5.0041);$$

Correction factor at Addu Atoll

$$H_{era}(\text{correction}) = H_{era} \cdot (0.0172 \cdot T_{era}^2 - 0.3175 \cdot T_{era} + 2.137);$$

$$T_{era}(\text{correction}) = T_{era} \cdot 1.5 \cdot (-0.0372 \cdot T_{era}^2 - 0.2231 \cdot T_{era} + 1.4309);$$

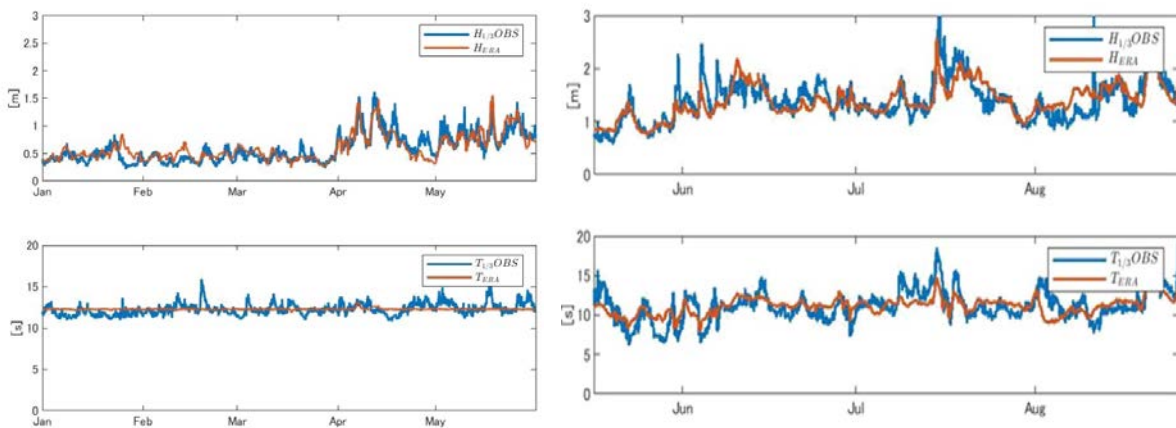


Figure 5.5.4 Comparison between the observed waves at Hankede Island and Corrected ERA5

Source: JICA Expert Team using ERA5

Based on the corrected ERA5 for 40 years, the annual maximum wave heights are extracted and the probabilistic wave height is calculated based on the extreme value statistics analysis proposed by Goda. The probabilistic wave height which indicates the return period of wave height at each Atoll are shown in Table 5.5.3. The wave period is set by the maximum value of 12s when waves equivalent to a 50-year probability were recorded.

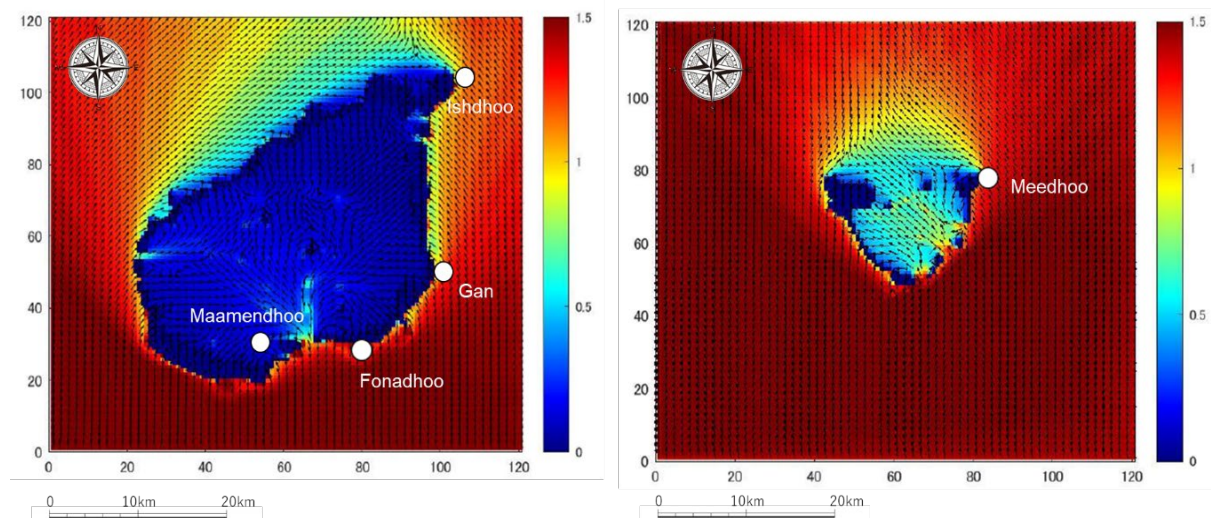
Table 5.5.3 Probabilistic Wave Height at Surrounding Area in Laamu Atoll (Left) and Addu Atoll (Right)

Return Period (Year)	Significant Wave Height (m)	Return Period (Year)	Significant Wave Height (m)
1	2.50	1	2.73
5	3.11	5	3.04
10	3.42	10	3.19
20	3.71	20	3.34
30	3.88	30	3.43
50	4.09	50	3.53

Source: JICA Expert Team using ERA5

The design offshore wave at each project site are estimated by wave deformation analysis from offshore area to the project site considering wave deformation caused by water depth change in shallow water such as refraction, shoaling, breaking wave and diffraction. The SWAN was used to calculate wave deformation as shown in Figure 5.5.5. Details on the calculation method and other details can be found at the following URL. (<https://www.tudelft.nl/>).

The wave height ratio between the boundary wave height which means the corrected ERA5 and the wave height at each project site are summarized in Table 5.5.4. The estimated design offshore wave at each project site are also shown in Table 5.5.4. Since Maamendhoo Island is located inside Laamu Atoll, it is considered to be predominantly affected by wind waves generated by monsoon, etc., rather than by direct wave heights from the ocean side. Therefore, in the Feasibility Study, the SMB method, which can estimate wave heights generated by wind speed and distance from the wind area, was used to set the design waves at Maamendhoo, and these values are also used in this project as well.



Source: JICA Expert Team

Figure 5.5.5 Wave Deformation Calculation around Laamu Atoll (Left) and Addu Atoll (right)

Table 5.5.4 Design Wave Height at each Project Site

Location	Fonadhoo	Maamendhoo (West)	Maamendhoo (East)	Gan	Isdhoo	Meedhoo
Wave Height Ratio (m)	0.93	0.73 *	0.73 *	0.74	0.76	0.82
Design Offshore Wave (m)	3.80	2.99	2.99	3.03	3.11	2.90

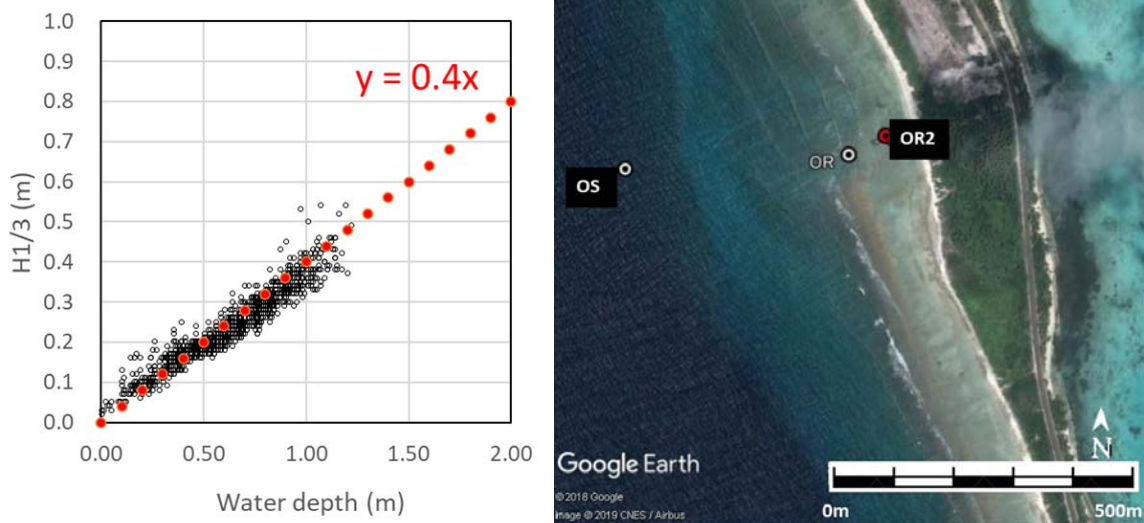
* Based on the result of Feasibility Study

Source: JICA Expert Team

(2) Design wave conditions for the structures

According to the past study results, it was known that the constant value γ was $0.35 \sim 0.4^2$. Here, the value of γ was set to 0.4 based on the relationship between observed waves at outer reef (OS) and inner reef (OR2) in Hankede from February to August 2019.

Based on the characteristic, the design waves at each project site are estimated as shown in Table 5.5.5.



Source: JICA Expert Team

Figure 5.5.6 Characteristics between Wave Height and Water Depth on Reef

Table 5.5.5 Design Waves at each Project Site

Location	Fonadhoo	Maamendhoo (West)	Maamendhoo (East)	Gan	Isdhoo	Meedhoo
Water Depth (m from DWL)	1.55	2.65	2.35	1.70	3.25	1.86
Design Wave Height (m)	0.62	1.06	0.94	0.68	1.30	0.74

Source: JICA Expert Team

5.5.3 Design Concept

(1) Beach Nourishment

- The backshore berm heights which is one of the main specifications are set to the same as the berm height of natural beaches obtained by the field surveys because the berm height of natural beaches is formed by the action of the wave and flow for long period.
- It is known that the foreshore slope depends on the grain size of the sand which constitutes of the beach. The grain size of the sand for beach nourishment is set to the same size as near natural beaches. For these reasons, the foreshore slope is also set to the same as the one of natural beaches obtained by the field survey.
- The berm width is set based on the results of beach deformation analysis as well as considerations of the location of original coastline, the buffer zone for protection of backward, the beach usage for residents, etc.
- The volume of the sand stock is set as the volume to maintain for 30 years considering to the basic service life for the civil structures. Though it is necessary to evaluate the volume and frequency of the additional nourishment quantitatively by the detailed prediction study of future trend of the coast line, the volume of the sand stock is set based on the results of beach deformation analysis.

(2) Groin

- The structure type of the groin adopts the rubble mound groin which was constructed in the Maldives recently considering to the workability and scoring by reflected waves.
- The interval of the groin is set based on the results of beach deformation analysis as well as considerations of the landscape and usability in this study by reference to the similar coastal protection project.
- Though the length of groin depends on the berm width, the interval of groins and stable coastline condition after nourishment, it is basically set to the length with a certain margin (about 10-20 m) from the coastline after nourishment.
- The crown height is set to the berm height + 0.5 m in terms of protection of the discharging the beach sand. The crown width is set to 2 m as the minimum length to ensure the stability of armored stones. The crown slope is set to 1:2.5 as the gently slope enough to climb easily considering the usability.

(3) Revetment and Reclamation

- The elevation of revetment and reclamation is set based on the overtopping waves and allowable volume of water discharge due to the overtopping waves. The detailed study are shown in (4) below.
- The area of reclamation area is set to about 2 ha (about 10 % of the area of Maamendhoo) considering to number of the residents of Maamendhoo (about 900 people), required evacuation facility space and percentage of total island area, etc.
- The structure type of revetment adopts the rubble mound for the same reasons of the groin. The cross section is trapezoidal considering to the reclamation works after constructing the revetment. The slope for the fore side is set to 1:2.5 for the same reasons of the groin, and for the back side is set to 1:1.5 considering to the stability of the rubble mound.

(4) Determination of Required Elevation of Revetment and Reclamation

The crest height was evaluated using the Technical Standard aforementioned and a wave of 50 years return period was used considering the purpose of the measure. The evaluation details are shown as followings.

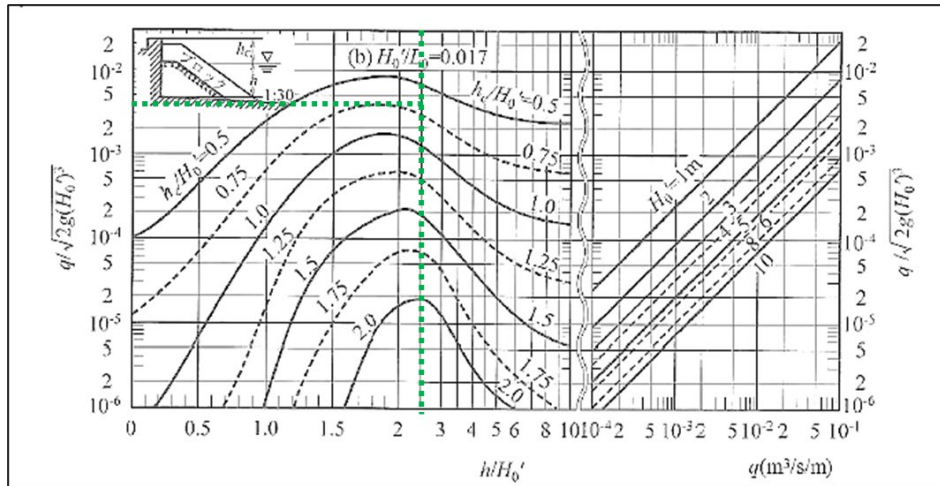
There are some reference values for allowable overtopping rate as shown in Table 5.5.6 and mostly are ranging between 0.01 and 0.05 (m³/s/m). In this study, the value of 0.02 (m³/s/m) for the reclamation in Maamendhoo and 0.05 for other facilities were selected with consideration both of economic efficiency and safety side of design concept.

Table 5.5.6 Reference Values for Allowable Overtopping Rate

Allowable overtopping rate (m ³ /s/m)	Target
0.01	Region where houses and important public facilities are densely located, and severe damage is expected due to wave overtopping and inundation.
0.02	The important region other than above
0.02~0.06	The region other than above

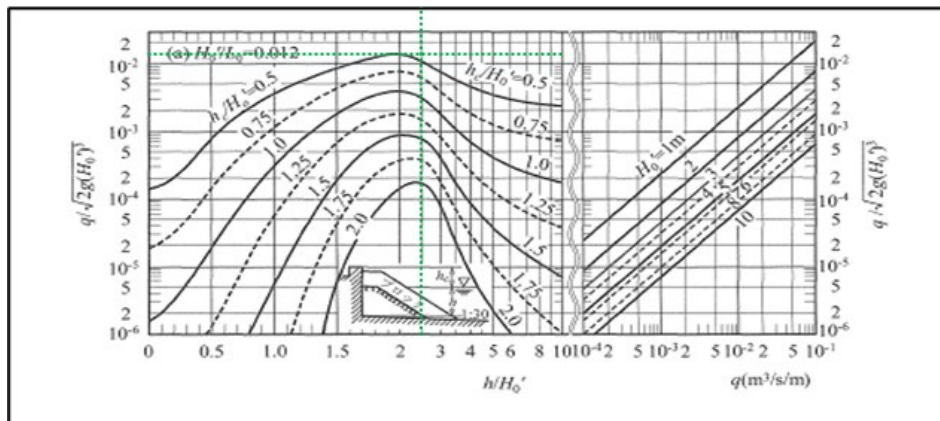
1) Reclamation in Maamendhoo

Crest Height		1.80	m
Design Water Level		1.05	m
Hight from Water Level	hc	0.75	m
Bottom Slope		1/30	
Ground Elevation	z	-1.60	m
Water Depth	h	2.65	m
Equivalent Offshore Wave Height	H0'	1.06	m
Wave Period	T	10	s
Wave Length	L0	156	m
Wave Steepness	H0'/L0	0.019	
	hc/H0'	0.71	
	h/H0'	2.50	
Allowable Overtopping Rate	q0	2.0.E-02	m³/s/m
	$q/\sqrt{2g(H0')^3}$	4.0.E-03	m ³ /s/m
Estimated Overtopping Rate	q	1.7.E-02	m³/s/m



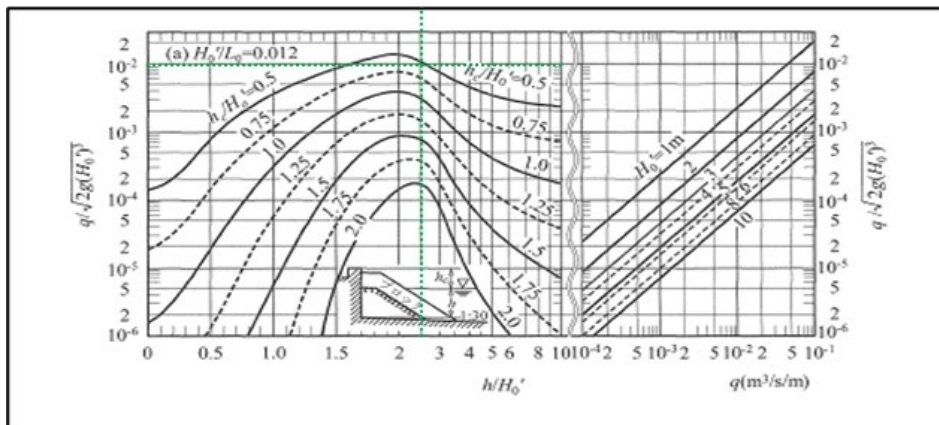
2) Revetment in Maamendhoo

Crest Height		1.50	m
Design Water Level		1.05	m
Height from Water Level	h_c	0.45	m
Bottom Slope		1/30	
Ground Elevation	z	-1.30	m
Water Depth	h	2.35	m
Equivalent Offshore Wave Height	H_0'	0.94	m
Wave Period	T	12	s
Wave Length	L_0	224.64	m
Wave Steepness	H_0'/L_0	0.013	
	h_c/H_0'	0.48	
	h/H_0'	2.50	
Allowable Overtopping Rate	q_0	5.0.E-02	m³/s/m
	$q/\sqrt{2g(H_0')^3}$	1.2.E-02	m ³ /s/m
Estimated Overtopping Rate	q	4.7.E-02	m³/s/m



3) Revetment in Isdhoo

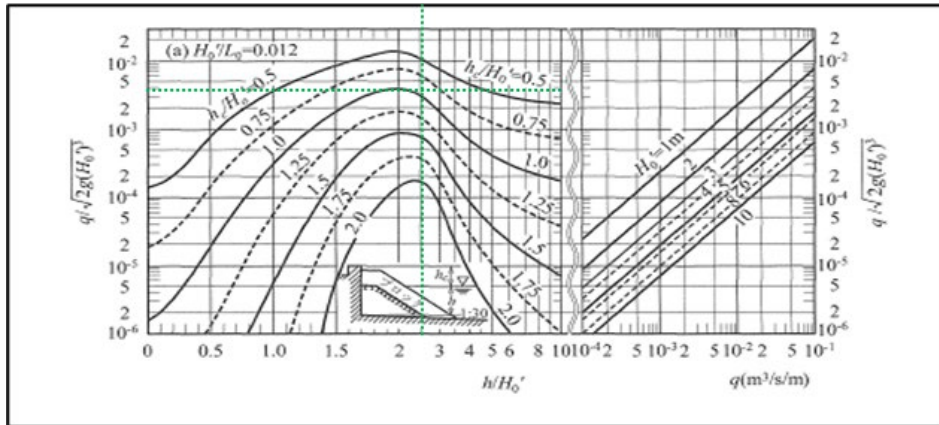
Crest Height		1.70	m
Design Water Level		1.05	m
Hight from Water Level	hc	0.65	m
Bottom Slope		1/30	
Ground Elevation	z	-2.20	m
Water Depth	h	3.25	m
Equivalent Offshore Wave Height	H0'	1.30	m
Wave Period	T	12	s
Wave Length	L0	224.64	m
Wave Steepness	H0'/L0	0.014	
	hc/H0'	0.50	
	h/H0'	2.50	
Allowable Overtopping Rate	q0	5.0.E-02	m3/s/m
	$q/\sqrt{2g(H0')^3}$	1.0.E-02	
Estimated Overtopping Rate	q	4.7.E-02	m3/s/m



4) Revetment in Gan

Crest Height		1.70	m
Design Water Level		1.05	m
Hight from Water Level	hc	0.65	m
Bottom Slope		1/30	
Ground Elevation	z	-0.65	m
Water Depth	h	1.70	m
Equivalent Offshore Wave Height	H0'	0.68	m
Wave Period	T	12	s
Wave Length	L0	224.64	m
Wave Steepness	H0'/L0	0.013	
	hc/H0'	0.96	

	h/H_0'	2.50	
Allowable Overtopping Rate	q_0	5.0.E-02	m ³ /s/m
	$q/\sqrt{2g(H_0')^3}$	4.0.E-03	
Estimated Overtopping Rate	q	1.3.E-02	m ³ /s/m



(5) Determination of Required Weight and Thickness of Armor Rock

1) Weight of Armor for Groin, Revetment and Reclamation

The required weight for armor units (stones) for structure with crest level higher than H.W.L is estimated by Hudson formula as shown follows.

Hudson Formula:

$$W = \frac{\gamma_r H^3}{K_D (S_r - 1)^3 \cot \theta} \dots\dots\dots (Eq.1)$$

- Where, W : Minimum weight in ton of an individual armor unit in the primary cover layer.
- γ_r : Unit weight of armor material in ton/m³.
- Sr : Specific gravity of armor material relatively to seawater = (W / Ww)
- Ww : Unit weight of seawater at the site (1.03 ton/m³)
- θ : Angle in degree of structure slope measured from horizontal
- H : Design wave height in meter at the site of the structure
- KD : Stability coefficient that varies with type of armor units, shape of armor units, roughness of the armor unit surface, number of layers of armor units and magnitude of damage (see Table 5.5.7).

Table 5.5.7 List of KD Value for Determination of Armor Unit Weight

No- Damage Criteria and Minor Overtopping							
Armor Units	n ³	Placement	Structure Trunk		Structure Head		Slope Cot θ
			K _D ²		K _D		
			Breaking Wave	Nonbreaking Wave	Breaking Wave	Nonbreaking Wave	
Quarrystone							
Smooth rounded	2	Random	1.2	2.4	1.1	1.9	1.5 to 3.0
Smooth rounded	>3	Random	1.6	3.2	1.4	2.3	⁵
Rough angular	1	Random 4	⁴	2.9	⁴	2.3	⁵
Rough angular	2	Random	2.0	4.0	1.9	3.2	1.5
					1.6	2.8	2.0
Rough Angular	>3	Random	2.2	4.5	2.1	4.2	⁵
					5.8	7.0	5.3
Rough Angular	2	Special	7.0 -20.0	8.5 -24.0	----	-----	
Parallepiped 7	2	Special					
Tetrapod and Quadripod	2	Random	7.0	8.0	5.0	6.0	1.5
					4.5	5.5	2.0
					3.5	4.0	3.0
Tribar	2	Random	9.0	10.0	8.3	9.0	1.5
					7.8	8.5	2.0
Dolos	2	Random	15.8 ⁸	31.8 ⁸	6.0	6.5	3.0
					8.0	16.0	2.0 ⁹
Modified cube	2	Random	6.5	7.5	7.0	14.0	3.0
Hexapod	2	Random	6.5	7.5	-----	5.0	⁵
Toskane	2	Random	8.0	9.5	5.0	7.0	⁵
Tribar	2	Random	11.0	22.0			⁵
Tribar	1	Unifarm	12.0	15.0	7.5	9.5	⁵
Quarrystone (K _{RR})							
Graded angular		Random	2.2	2.5	----	----	----

- CAUTION: Those K_D values shown in italics are unsupported by test results and are only provided for preliminary design purposes
- Applicable to slopes ranging from 1 on 1.5 to 1 on 5
- n is the number of units comprising the thickness of the armor layer
- The use of singel layer of quarrystone armor units is not recommended for structure subject to breaking waves and
- Until more information is available on the variation of K_D value with slope, the use of K_D should be limited to slopes ranging from 1 on 1.5 to 1 on 3 some armor units tested on a structure head indicated a KD - slope dependence
- Special placement with long axis of stone placed perpendicular to structure face.
- Parallelepiped - shaped stone: long slab - like stone dimension about 3 times the shortest dimension (Mrkle and Davidson, 1979).
- Refers to no - damage criteria (<5 percent displacement, rocking, etc); if no rocking (<2 percent) is desired, reduce K_D 50 percent (Zwamborn and Van Niekern, 1982).
- Stability of dolosse on slopes steeper than 1 and 2 should be substantiated by site-specific model test.

Source: JICA Expert Team

Table 5.5.8 Summary of Required Weight of Armor Rock

Symbol	unit	Maamendhoo (West)	Maamendhoo (East)	Gan	Isdhoo	Meedhoo
M	t	0.216	0.113	0.043	0.450 *	0.056
ρ _b	t/m ³	2.65	2.65	2.65	2.65	2.65
ρ _w	t/m ³	1.03	1.03	1.03	1.03	1.03
Sr=ρ _b /ρ _w	t/m ³	2.57	2.57	2.57	2.57	2.57
H _{1/3}	m	1.17	0.94	0.68	0.68	0.68
K _d		2.0	2.0	2.0	2.0	2.0
Gradient		1:2.5	1:2.5	1:2.5	1:2.5	1:2.5

Source: JICA Expert Team

2) Thickness of Armor Layer

The thickness of the armor layer or any of the subsequent under layers is calculated by the following equation:

$$r = n \cdot K_d \cdot \left(\frac{W}{W_r}\right)^{1/3} \dots\dots\dots (Eq.2)$$

- Where: r = the average thickness of the armor layer, or underlayer (m)
 n = the number of armor units in the layer (minimum n = 2)
 W = mass of individual armor unit in the layer (Ton)
 W_r = mass density of armor unit (Ton/m³)
 K_d : Stability coefficient that varies with type of armor units, shape of armor units, roughness of the armor unit surface, number of layers of armor units and magnitude of damage.

Table 5.5.9 Summary of Required Thickness of Armor Rock

Symbol	unit	Maamendhoo (West)	Maamendhoo (East)	Gan	Isdhoo	Meedhoo
W	t	0.216	0.113	0.043	0.450	0.056
r	m	1.0	0.7	0.7	1.2	0.7

Source: JICA Expert Team

5.5.4 Layout Plan and Typical Cross Section

Based on the above conditions and design concept, the layout plan and typical cross section at each Project site are determined as follows.

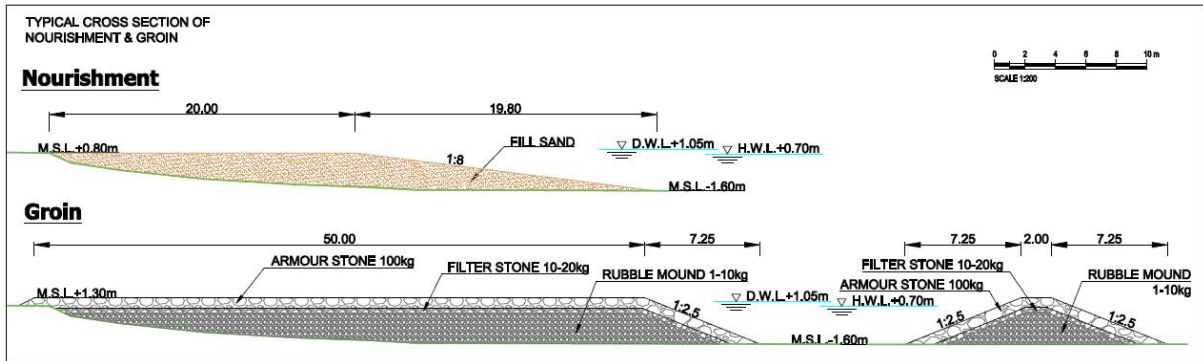
(1) Maamendhoo



Source: JICA Expert Team

Figure 5.5.7 Layout Plan of Maamendhoo

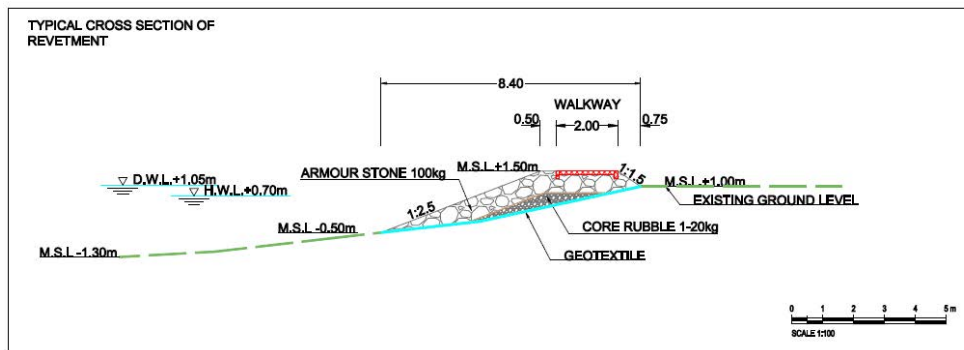
1) West coast



Source: JICA Expert Team

Figure 5.5.8 Typical Cross Section of Nourishment and Groin at Maamendhoo West Coast

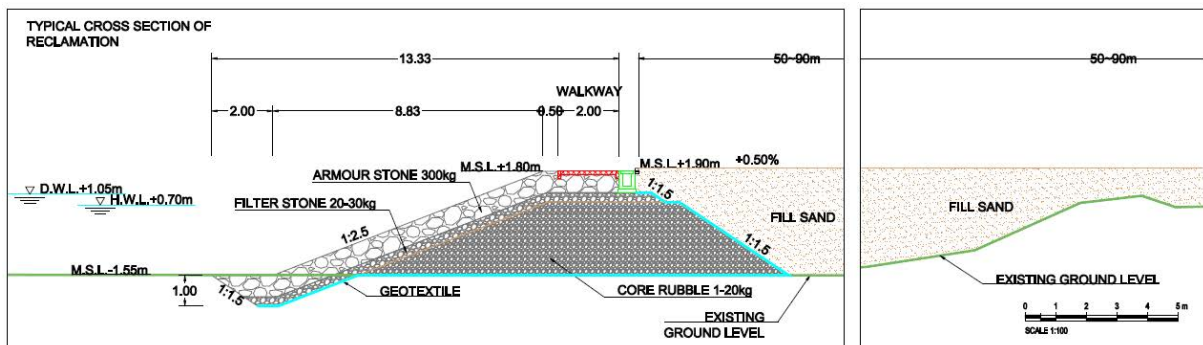
2) East coast



Source: JICA Expert Team

Figure 5.5.9 Typical Cross Section of Revetment at Maamendhoo East Coast

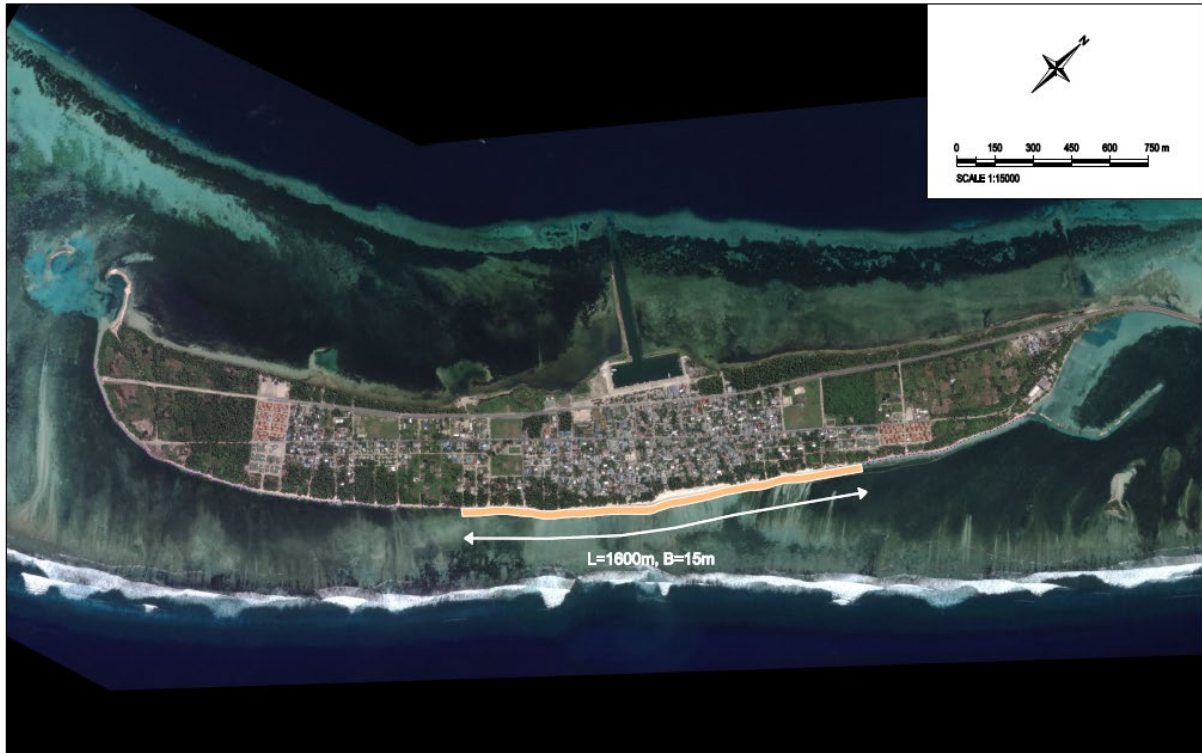
3) North coast



Source: JICA Expert Team

Figure 5.5.10 Typical Cross Section of Reclamation at Maamendhoo North Coast

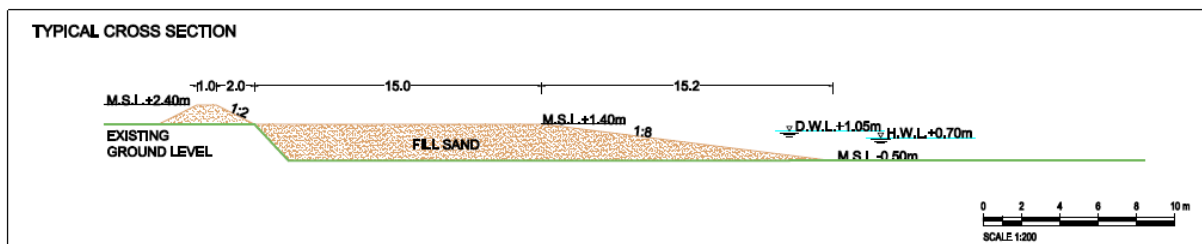
(2) Fonadhoo



Source: JICA Expert Team

Figure 5.5.11 Layout Plan of Fonadhoo

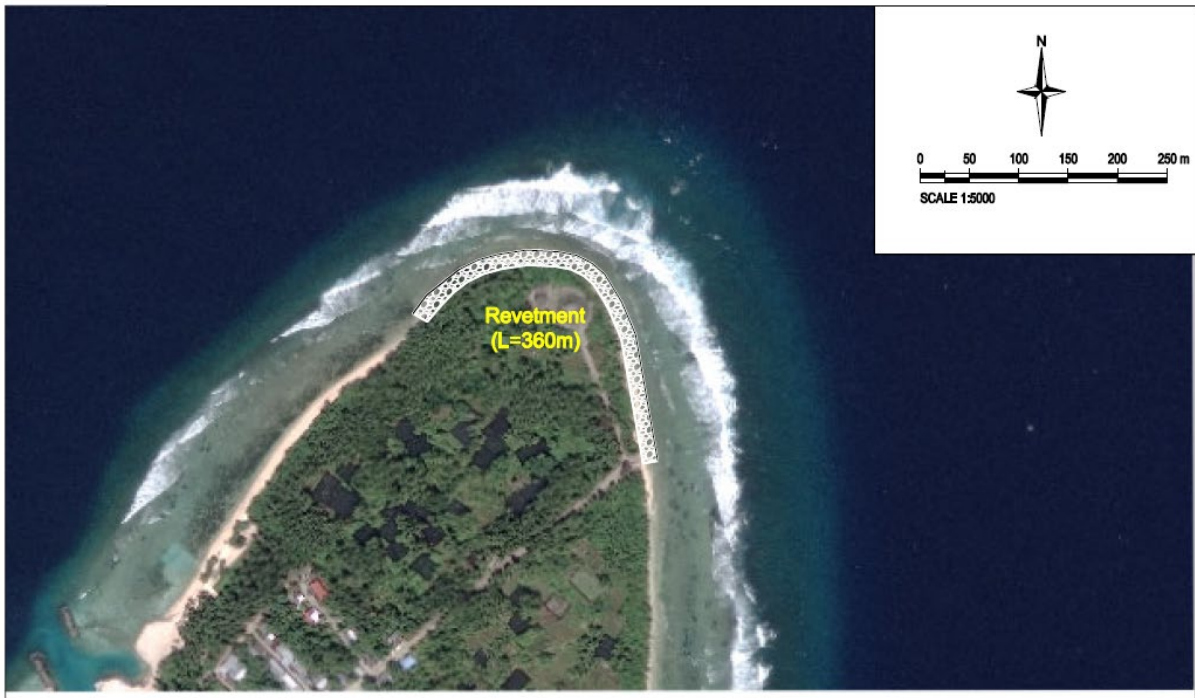
1) Ocean Side



Source: JICA Expert Team

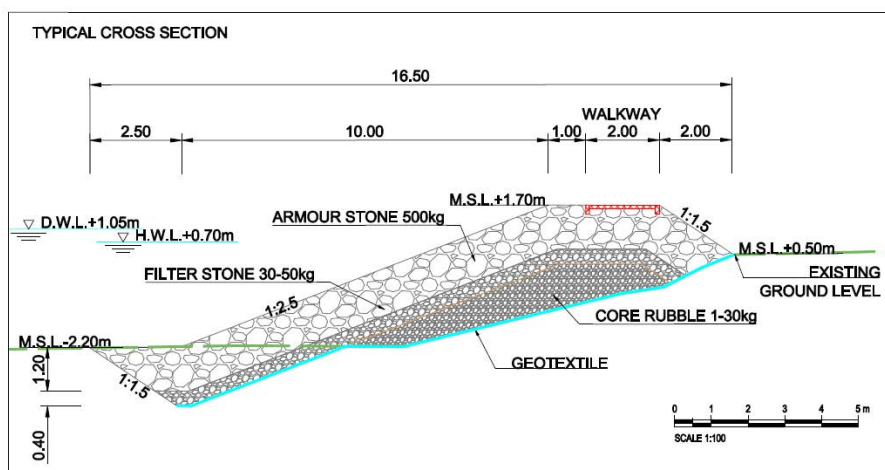
Figure 5.5.12 Typical Cross Section of Nourishment at Fonadhoo

(3) Isdhoo



Source: JICA Expert Team

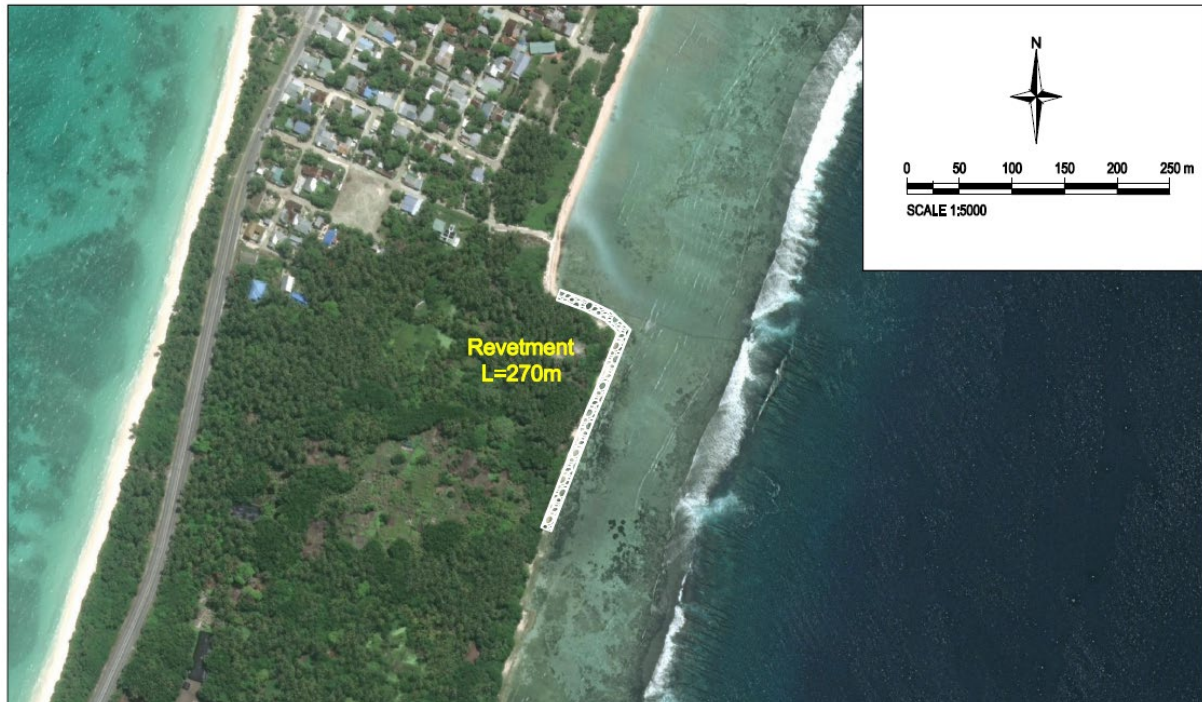
Figure 5.5.13 Layout Plan of Isdhoo



Source: JICA Expert Team

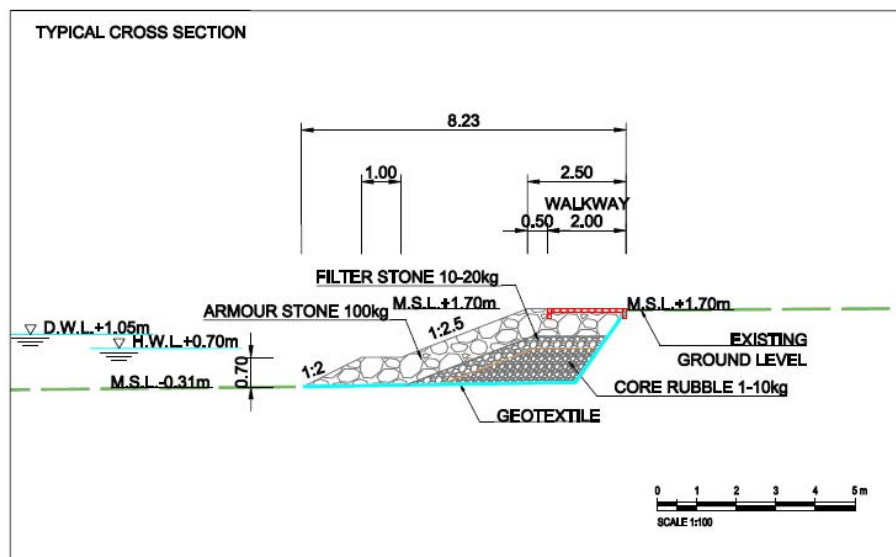
Figure 5.5.14 Typical Cross Section of Revetment at Isdhoo

(4) Gan



Source: JICA Expert Team

Figure 5.5.15 Layout Plan of Gan



Source: JICA Expert Team

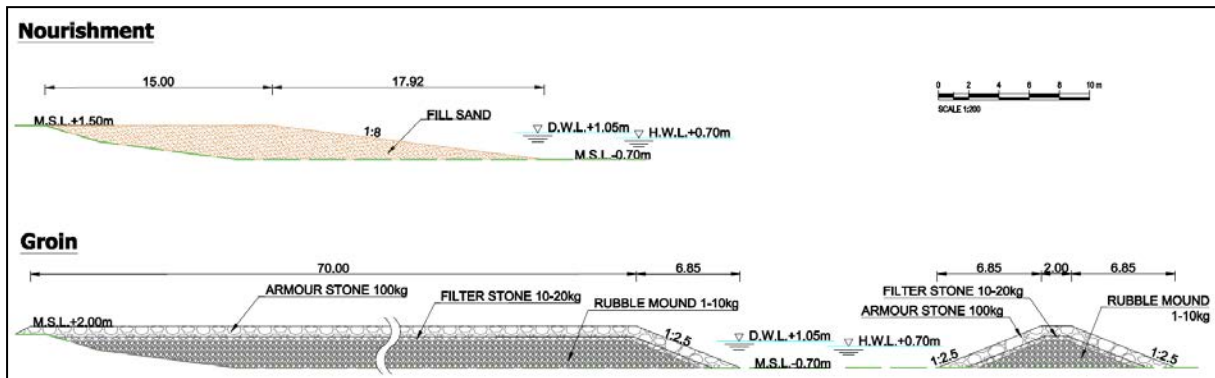
Figure 5.5.16 Typical Cross Section of Revetment at Gan

(5) Meedhoo



Source: JICA Expert Team

Figure 5.5.17 Layout Plan of Meedhoo



Source: JICA Expert Team

Figure 5.5.18 Typical Cross Section of Nourishment and Groin at Meedhoo

5.6 Beach Maintenance

5.6.1 Current Status and Issues of Beach Maintenance and Management

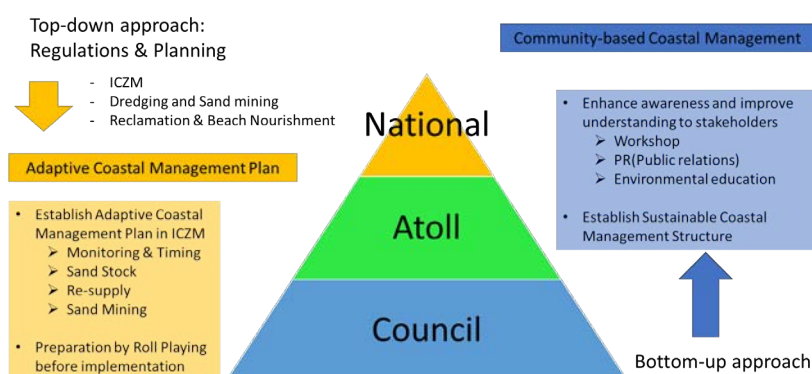
In the Maldives, the current status and issues related to the maintenance and management of sandy beaches are as follows.

- The beach nourishment measures that have been implemented up to the present are related to the maintenance of artificial sandy beaches on resort islands and those that have been nourished for their maintenance, etc. Beach nourishment has not been implemented on resident islands.
- Therefore, the organization necessary for maintenance and management about beach is unclear, and human resources and technology are not developed.
- Activities about beach maintenance involving local residents are only partially implemented, and it is necessary to establish a policy to build a maintenance and management system in beach.
- The legal system that defines the regulations and scope of new excavation and dredging, and the EIA process have been established, but the extraction of sediment for maintenance and management is not envisioned, and a new concept regarding beach maintenance needs to be established in the Maldives.
- Despite the limited sand source areas within each atoll, information sharing and collaboration on sand stocking and exchange has not been implemented in actual projects, such as excavation and dredging projects and reclamation projects.

5.6.2 Basic Direction for this Project

(1) Basic direction

The basic direction for beach maintenance in this project is shown in Figure 5.6.1. As mentioned above, in order to effectively implement maintenance and management for beach nourishment projects on inhabited islands that have not been implemented much in the past, it is necessary to build a community-based beach maintenance and management system with local residents at its core role and with the involvement of government agencies. However, to continue such activities, it is necessary to encourage such activities through regulations and plans by the central government. As for the maintenance and management of sandy beaches in this project, we will study the implementation of maintenance and management on two main approaches: (1) a top-down approach by the central government and (2) a bottom-up approach by local residents.



Source: JICA Expert Team

Figure 5.6.1 Basic Direction on Sandy Beach Maintenance and Management

(2) Top-down approach

A top-down approach from the central government would include the following items. It may be difficult to establish a new system during the project period because it will take time to establish it as a legal system. However, it is very important to provide an opportunity to consider a maintenance and management system for the Maldives as a country. It is also envisioned that this approach will be formulated within the Integrated Coastal Management (ICZM) to accelerate its implementation.

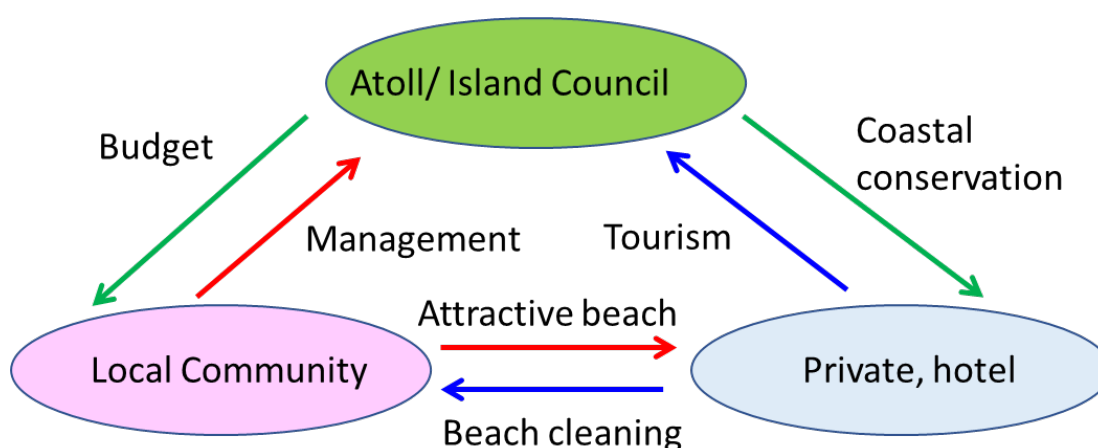
- Discussions among relevant agencies for institutionalization of small-scale, repeated excavation and dredging not covered by the current legal system
- Discussions among relevant agencies to establish a plan and system for long-term management within each atoll of sediment generated by excavation/ dredging projects and sediment used by reclamation projects.

These activities require consultation and consensus building not only by the central government, but also by the atoll councils, island councils, local residents, private companies, and other related organizations. In addition, the intra-atoll sediment management includes ancillary issues such as sand stockyards, its maintenance and management. We assume that the establishment of a system will be promoted by embodying this approach using the actual beach nourishment project on the subject island as a model case, which is explained later.

(3) Bottom-up approach

It is difficult to properly implement the maintenance and management of sandy beaches only through the activities of the central government regulations and plans of a top-down approach, and a bottom-up approach by local residents is essential. The bottom-up approach is assumed to include the following activities. An image of the interaction between the parties involved is shown in Figure 5.6.2.

- Daily cleaning of beaches and daily deformation management based on such cleaning
- Establishment of a regular coastal monitoring system (local residents, councils, private operators, etc.)
- Consensus building and awareness building through workshops, stakeholder meetings, environmental education, etc.



Source: JICA Expert Team

Figure 5.6.2 Image of stakeholder interaction in the bottom-up approach

This approach will be implemented as an on-the-job training activity for the three beaches where the beach nourishment project is actually implemented in this project, targeting local residents, atoll & island councils, private sectors, and others to realize community-based coastal management and its sustainable operation. By involving local residents in the implementation of these activities by government agencies, a sense of unity will be fostered through the establishment of a system and the sharing of successful experiences, and this will be promoted so that active maintenance and management activities will be realized as their own beaches to which they are attached.



Source: JICA Expert Team

Figure 5.6.3 Examples of bottom-up activities

(L: cleanup, M: education for elementary school students, R: stakeholder meeting)

5.6.3 Maintenance Policy for Target Islands

The target islands where beach nourishment measures will be implemented in this project are Meedhoo, Fonadhoo, and Maamendhoo islands. Each of these islands will be stocked with sediment in nearby stockyards in consideration of the amount of sediment that will be required in the future. The policy is to properly maintain and manage these beaches through regular beach monitoring by local residents and additional beach nourishment sand by atoll & island councils and the central government in response to the results of such monitoring. The specific potential stockyard sites on each coast are detailed in Capture 5.8, and the plan is to reserve 30,000 m³ of beach nourishment sand for each target island for maintenance and 15,000 m² (assuming a height of 2 m) for stockyards.

Year	Activities	Sand Volume to be added (m3)		Remaining Sand Volume (m3)
		per times	accumulated	
0	Construction	0	0	30,000
1-4	Monitoring			
5	Maintenance	3,000	3,000	27,000
6-9	Monitoring			
10	Maintenance	3,000	6,000	24,000
11-14	Monitoring			
15	Maintenance	3,000	9,000	21,000
16-19	Monitoring			
20	Maintenance	3,000	12,000	18,000
21-24	Monitoring			
25	Maintenance	3,000	15,000	15,000
26-29	Monitoring			
30	Maintenance	3,000	18,000	12,000
31-34	Monitoring			
35	Maintenance	3,000	21,000	9,000
36-39	Monitoring			
40	Maintenance	3,000	24,000	6,000
41-44	Monitoring			
45	Maintenance	3,000	27,000	3,000
46-49	Monitoring			
50	Maintenance	3,000	30,000	0

Source: JICA Expert Team

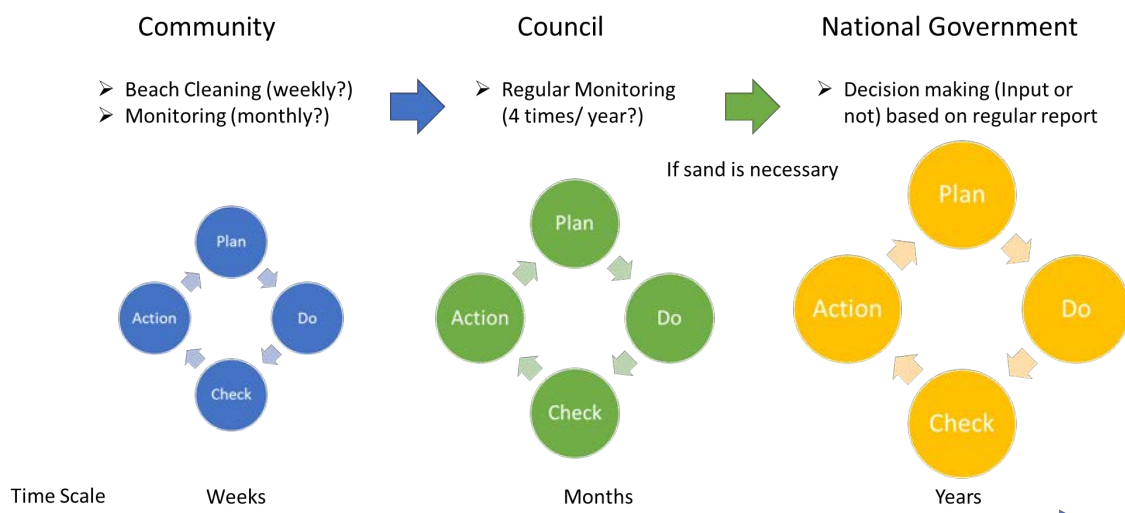
Table 5.6.1 Input image of beach sand for maintenance

Year	Activities	Sand Volume to be added (m3)		Remaining Sand Volume (m3)
		per times	accumulated	
0	Construction	0	0	30,000
1-4	Monitoring			
5	Maintenance	3,000	3,000	27,000
6-9	Monitoring			
10	Maintenance	3,000	6,000	24,000
11-14	Monitoring			
15	Maintenance	3,000	9,000	21,000
16-19	Monitoring			
20	Maintenance	3,000	12,000	18,000
21-24	Monitoring			
25	Maintenance	3,000	15,000	15,000
26-29	Monitoring			
30	Maintenance	3,000	18,000	12,000
31-34	Monitoring			
35	Maintenance	3,000	21,000	9,000
36-39	Monitoring			
40	Maintenance	3,000	24,000	6,000
41-44	Monitoring			
45	Maintenance	3,000	27,000	3,000
46-49	Monitoring			
50	Maintenance	3,000	30,000	0

Source: JICA Expert Team

Table 5.6.1 Input image of beach sand for maintenance

As an example, the image shown in Figure 5.6.1, assuming a maintenance management system in which about 3,000 m³ is added every five years. It is assumed that the monitoring will be carried out periodically for 1-4 years after construction, and about 3,000 m³ will be added in the 5th year; further monitoring will be continued for 6-9 years, and about 3,000 m³ will be added again in the 10th year, and so on, for 50 years. The most important factor in this process will be the timing and location of additional beach nourishment sand application. The roles of the related agencies will be clarified in the course of future activities, and a maintenance and management policy will be agreed upon, taking into consideration the characteristics of each target island. The roles and maintenance approaches at this time are shown in Figure 5.6.4. It is assumed that local residents will be responsible for routine beach cleaning and associated simple monitoring of beach change. In addition, the atoll & island councils will be responsible for regular monitoring, approximately four times a year, to accumulate basic data on beach change. After reviewing such periodic data, the national government is expected to make decisions on whether or not to inject additional beach nourishment sand as needed, and if deemed necessary, to actually implement the beach nourishment project. This system will be discussed among the agencies concerned in this project to clarify the roles of each agency and to organize the details of implementation, frequency, reporting system, etc.



Source: JICA Expert Team

Figure 5.6.4 Image of stakeholder interaction in the bottom-up approach

5.7 Study for Sand Barrow Area

5.7.1 Objective of The Survey

JET propose candidate sand barrow sites for use in beach nourishment and reclamation projects on the project islands. In addition, relevant information on each proposed sand barrow site is organized, and if there are any concerns with each proposed sand barrow site, the items to be considered during future detailed studies are indicated.

5.7.2 Requirements for Potential Sand Barrow Sites

(1) Perspective from Sand Quality

The table below shows the items to be considered for candidate sand barrow sites. In general, beach nourishment projects consider 1) As the quality of the sand, whether the grain size of the sand is coarse as beach nourishment sand, and 2) As the quantity of sand, whether a sufficient quantity of sand can be procured for the project from the selected candidate sites.

1) In terms of sand quality, the grain size of the nourishing sand was checked to ensure that it was not too fine, as grain size affects the anchorage of the sand on the beach and too fine sand tends to run offshore and coastal direction.
2) In terms of sand quantity, the amount of sand that could be procured from each potential site could be estimated by the area of the sand barrow area and the layer thickness. The sand barrow area was considered to be less than 50 m depth in terms of dredging method. The dredging methods and water depths are described in Capture 5.8.

In addition, in the Maldives, 3) Related Legislation for Sand Barrow (described later) has been established, which defines areas within the lagoon where dredging is prohibited, and therefore consideration was given to ensure that the potential site was not included in the dredging prohibited area. In addition, the impact on ecosystems during dredging needs to be fully considered, therefore the impact on other ecosystems, including coral reefs, was examined. During the candidate site review, areas where coral reefs were found on the seabed were excluded from the candidate sites, and the need for detailed studies was described where there was concern about environmental impact on the surrounding area.

Table 5.7.1 Items of Sand Barrow Area Consideration

Item	Contents of Consideration
1) Sand Quality	- Whether the sand at the candidate site have an appropriate grain size for beach nourishment sand
2) Sand Quantity	- Whether the necessary quantity of sand could be procured from candidate site - Whether the area sufficiently extensive within a depth of 50 m
3) Legislation	- Whether candidate site fall within a dredging prohibited area (described later)
4) Environmental Consideration	- Whether the seabed of Candidate site have coral reefs - Whether there are concerns about environmental impacts on nearby coral reefs and other ecosystems

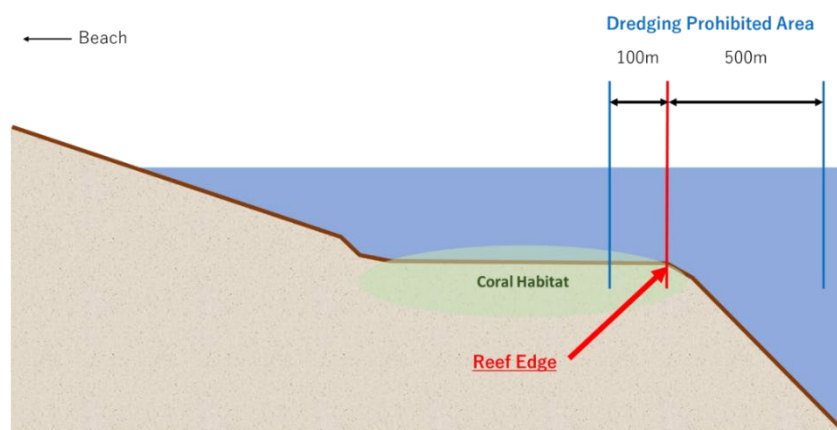
Source: JICA Expert Team

(2) Related Legislation for Sand Barrow

In the Maldives, the "Regulation on Reclamation and Dredging of Islands and Lagoons (No: R-15/2013)" governs dredging within lagoons. The Regulation will therefore also be taken into account when considering the dredging of beach sand in the project. Details of the Regulation are provided in Chapter 2.4 'Relevant Legislation, Policy and Plan of ICZM'.

In considering the dredging area, the following provisions for dredging prohibited area should be noted.

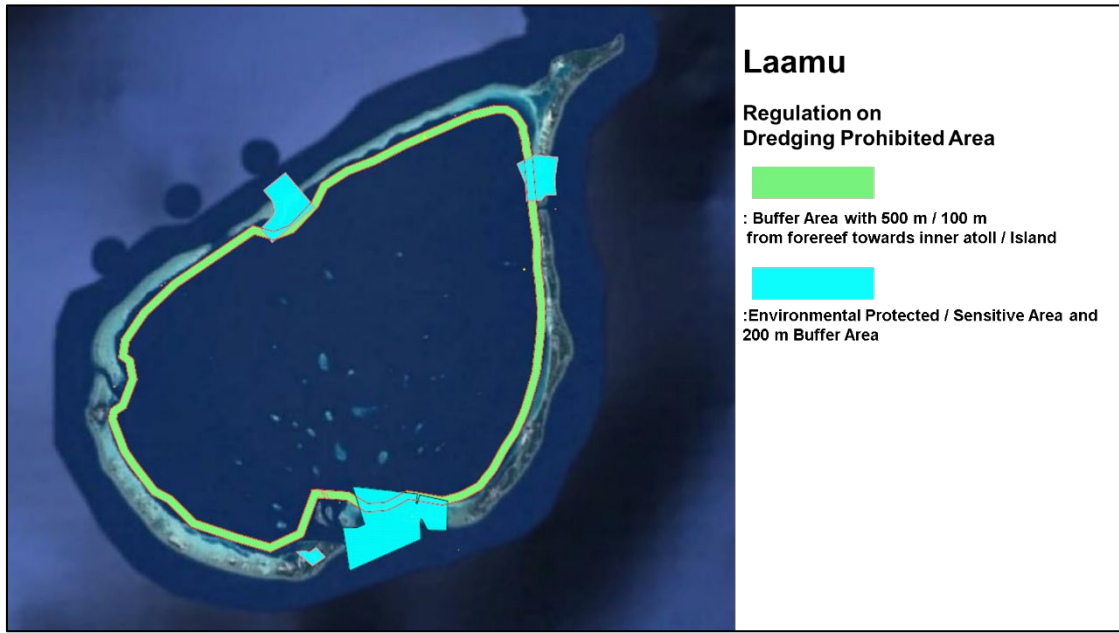
- a) Area 100 m from the reef edge towards the island's shoreline (Refer to Figure 5.7.1)
- b) Area 500 m from the reef edge towards the inside of the atoll (Refer to Figure 5.7.1)
- c) Environmental Protected Area and Environmental Sensitive Area as defined under EPPA 5/93
- d) Buffer zone 200 m from the boundary of the area defined in c)



Source: JICA Expert Team

Figure 5.7.1 Provision of Buffer Zone from Reef Edge

The Figures below show the dredging prohibited areas in Addu and Laamu atolls as a) through d) mentioned above.



Source: JICA Expert Team

Figure 5.7.2 Dredging Prohibited Area in Laamu Atoll



Source: JICA Expert Team

Figure 5.7.3 Dredging Prohibited Area in Addu Atoll

5.7.3 Outline of The Survey

Table 5.7.2 lists the survey items, survey objectives and survey methodology. The survey was conducted to ensure that the above-mentioned items for consideration of the candidate sand barrow site were met. For the seabed condition survey, a remote underwater camera survey was conducted as well as a diving survey in order to efficiently assess the seabed condition over a wide area.

Table 5.7.2 Outline of the Survey

Survey Item	Survey Objective	Survey Methodology
Diving Survey*	Environmental Survey Sand Quality Survey Sand Quantity Survey	Diving surveys were conducted by divers to check seabed conditions and collect sediment samples.
Remote Underwater Camera Survey*	Environmental Survey Sand Quantity Survey	In order to assess the areal sand seabed extent, the seabed was checked by a camera deployed from the vessel.
Bathymetric Survey	Sand Quality Survey	Bathymetry was measured in the offshore direction by a bathymetric instrument to identify the seabed topography.
Sand Layer Thickness Survey	Sand Quantity Survey	Sand layer thickness was measured according to the depth at which the iron piles were inserted into the seabed during the diving survey.
Grain Size Test with Sieves	Sand Quality Survey	Grain size tests were conducted on the sampled sand.

Source: JICA Expert Team

*However, the diving survey was limited to a depth of 40 m. For depths deeper than 40 m, the remote underwater camera survey was conducted.

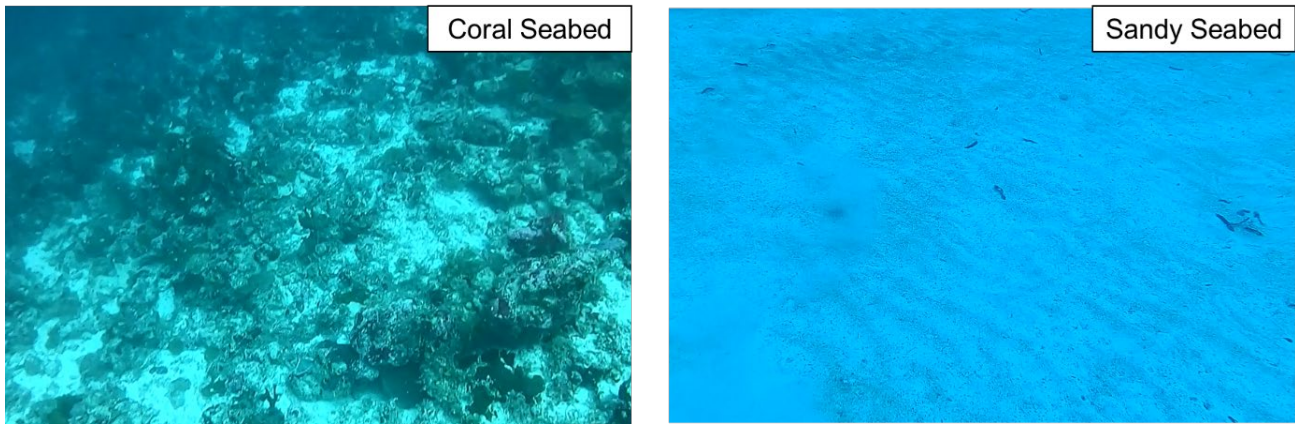
Figure 5.7.4 shows photographs of the diving survey. The left is a photograph of the steel piles used to measure the layer thickness. The steel piles, marked at 0.1 m intervals, were driven into the seabed with a hammer to measure the sand layer thickness. The right figure shows a photograph of diver taking seabed samples.



Source: JICA Expert Team

Figure 5.7.4 Photographs of Diving Survey**(Left: Sand Layer Thickness Survey, right: Sediment Sampling)**

Figure 5.7.5 shows an example of a photograph of the seabed situation taken by remote underwater camera survey. In the case of the coral reef seabed as shown on the left photograph, the area was judged to be unsuitable for sand barrow from construction and environmental aspects. On the other hand, in the case of extensive sandy seabed, as shown on the right photograph, the area was judged as suitable for dredging.



Source: JICA Expert Team

Figure 5.7.5 Seabed Condition Photographs by Remote Underwater Camera Survey

5.7.4 Survey Area

Based on satellite imagery, local topography and local coral reef distribution, the areas considered to satisfy the above consideration items were set as the survey area. The survey was conducted in two phases: phase 1 (February to March 2022) and phase 2 (July to August 2022).

(1) Addu Atoll

In Addu Atoll, 2 surveys were conducted, in 18 points for total.

- Phase 1 Survey: diving survey in 4 points
- Phase 2 Survey: driving survey in 7 points, remote underwater camera survey in 7 points



Source: JICA Expert Team

Figure 5.7.6 Sand Barrow Survey Area in Addu Atoll

(2) Laamu Atoll

In Laamu Atoll, 2 surveys were conducted, in 39 points for total.

- Phase 1 Survey: diving survey in 10 points
- Phase 2 Survey: driving survey in 10 points, remote underwater camera survey in 19 points



Source: JICA Expert Team

Figure 5.7.7 Sand Barrow Survey Area in Laamu Atoll

5.7.5 Survey Results and Candidate Sites

Based on the survey results, the first and second candidate sites for beach nourishment sand barrow are proposed. Mainly, seabed conditions with coral reefs and the areas where the grain size of the sampled sand was too fine were excluded from the candidate sites for sand barrow. Detailed results for each site are described in ANNEX-2.

In selecting candidate sites for beach nourishment sand barrow, the distribution of similar sand within each atoll was estimated based on the wide-area seabed conditions identified by remote underwater camera survey and the bathymetric survey. After comparing the estimated sand distribution with the bathymetric distribution, sites where sufficient high-quality sand could be secured were proposed as candidate sites.

(1) Addu Atoll Option 1

For Option 1, the north-east of Gan Island is proposed. (Refer to Figure 5.7.8)

1) Legislation

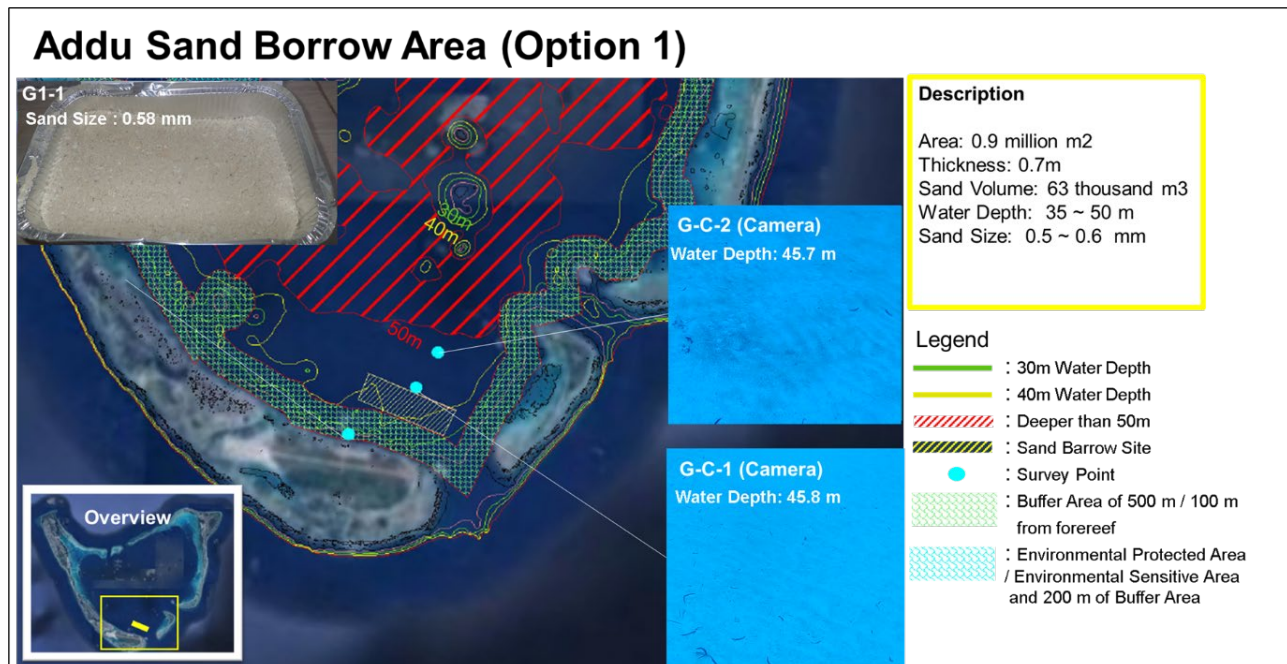
- As it is more than 500m offshore from the reef edge, it is not included in the dredging prohibition area described in (2) Related Legislation for Sand Barrow.

2) Quantity of Sand

- Area of 35 m - 50 m depth is widespread (0.9 million m²).
- The expected volume is 0.63 million m³, as the results of sand layer thickness survey indicate a layer thickness of more than 0.7 m.
- Remote underwater camera survey results show similar sand over an extensive area.

3) Sand Quality

- Good quality sand with a relatively coarse grain size can be obtained.



Source: JICA Expert Team

Figure 5.7.8 Sand Barrow Area Option 1 (Addu Atoll)

(2) Addu Atoll Option 2

For Option 2, the south-east of Hulmeedhoo Island is proposed. (Refer to Figure 5.7.9)

1) Legislation

- As it is more than 500m offshore from the reef edge, it is not included in the dredging prohibition area described in (2) Related Legislation for Sand Barrow.

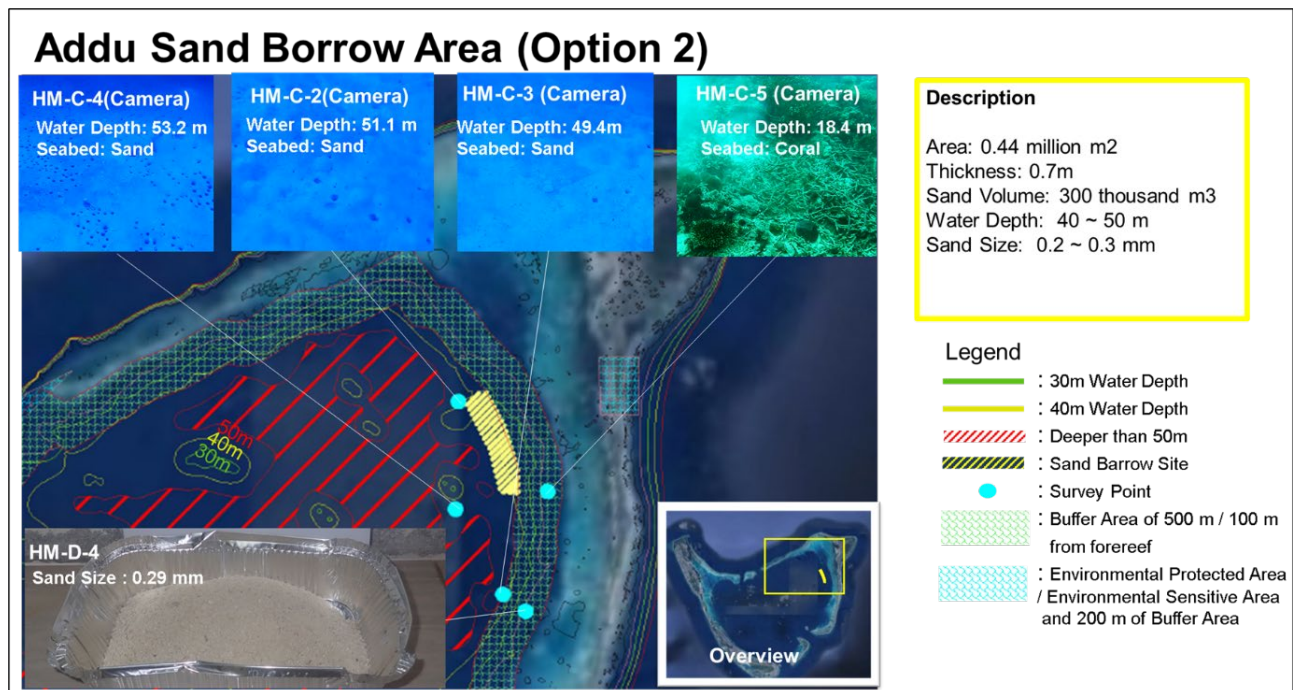
2) Quantity of Sand

- The results of the bathymetric survey confirm that the seabed gradient is steep from the reef edge to offshore, which raises concerns that the expected sand barrow area is small (0.44 million m²). On the other hand, it was confirmed that the area is sufficient for the amount of sand required by the project.
- Sand layer thickness surveys indicate a layer thickness of more than 0.7 m; therefore, the expected sand volume is 0.3 million m³.

- Although there are only a small number of survey sites within the proposed site, it is estimated from remote underwater camera surveys and bathymetry distribution that there is a broad similar sandy seabed, including the surrounding area.

3) Sand Quality

- Although fine sand appears to be deposited in the surface layer, sand of coarse grain size can be obtained by collecting sand from a lower layer of about 0.5 m. It is recommended that the vertical distribution of the sand layer is verified by boring or other means during the detailed study.



Source: JICA Expert Team

Figure 5.7.9 Sand Barrow Area Option 2 (Addu Atoll)

(3) Laamu Atoll Option 1

For Option 1, the south-west of Isdhoo Island is proposed. (Refer to Figure 5.7.10)

1) Legislation

- As it is more than 500m offshore from the reef edge, it is not included in the dredging prohibition area described in (2) Related Legislation for Sand Barrow.

2) Sand Quantity

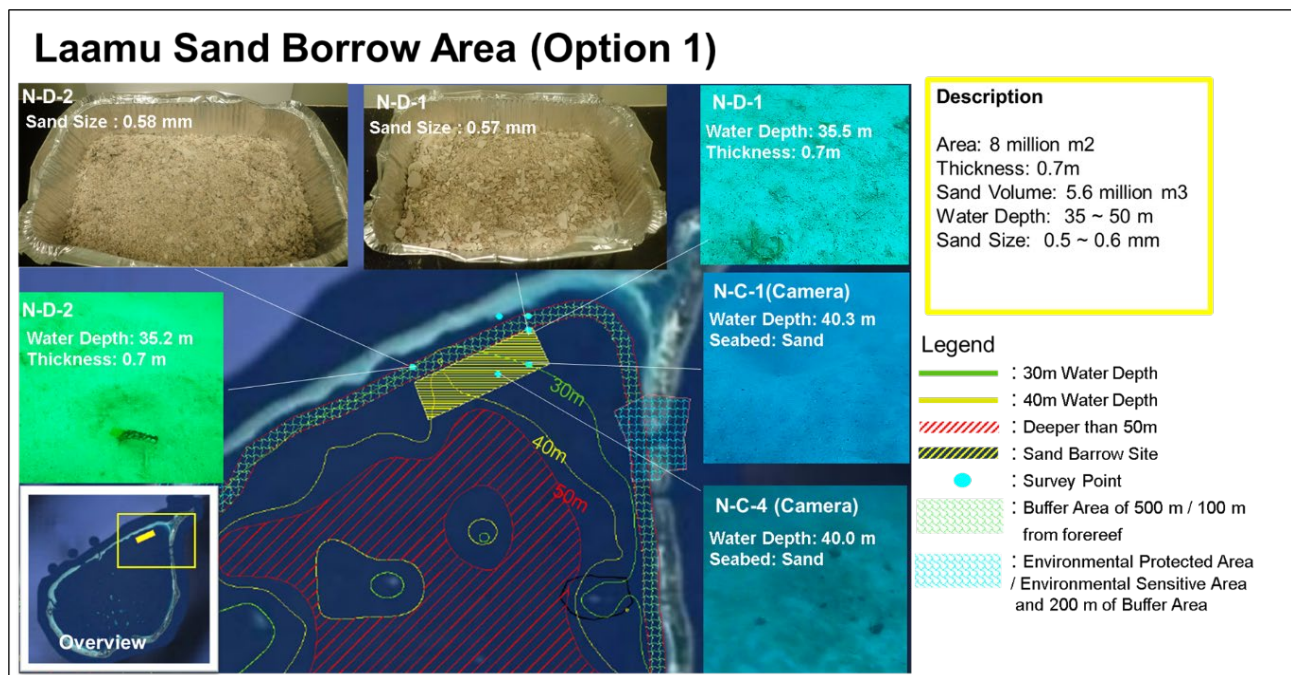
- Area of 35 m - 50 m depth is widespread (8.0 million m²).

- Sand layer thickness surveys indicate a layer thickness of more than 0.7m, therefore the expected sand volume is 5.6 million m³.

- Remote underwater camera survey results show similar sand over an extensive area.

3) Sand Quality

- Good quality sand with a relatively coarse grain size can be obtained.



Source: JICA Expert Team

Figure 5.7.10 Sand Barrow Area Option 1 (Laamu Atoll)

(4) Laamu Atoll Option 2

For Option 2, the west of Maavah Island is proposed. (Refer to Figure 5.7.11)

1) Legislation

- As it is more than 500m offshore from the reef edge, it is not included in the dredging prohibition area described in (2) Related Legislation for Sand Barrow.

2) Sand Quantity

- Area of 40 m - 50 m depth is widespread (2.0 million m²).

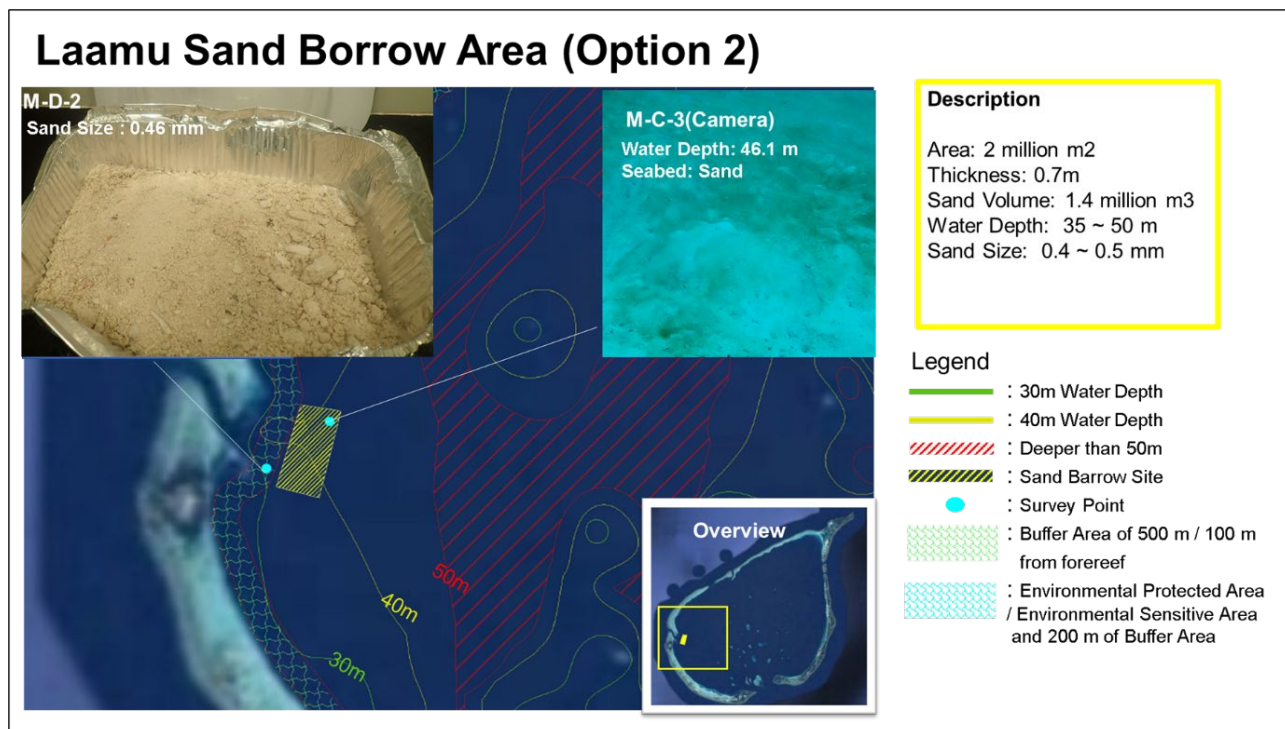
- Sand layer thickness surveys indicate a layer thickness of more than 0.7m, therefore the expected sand volume is 1.4 million m³.

3) Sand Quality

- Sand grain is finer than Laamu atoll Option 1, but sufficient good quality sand can be obtained.

4) Others

- From the perspective of environment, the ocean side of Maavah Island is a dolphin dive spot and there is concern about the impact of turbidity from dredging in the lagoon. In the detail study phase, it is recommended that the site needs to be selected after a thorough study of the environmental impact of turbidity.



Source: JICA Expert Team

Figure 5.7.11 Sand Barrow Area Option 2 (Laamu Atoll)

5.8 Consideration of construction plan and cost estimation

5.8.1 Consideration of construction plan

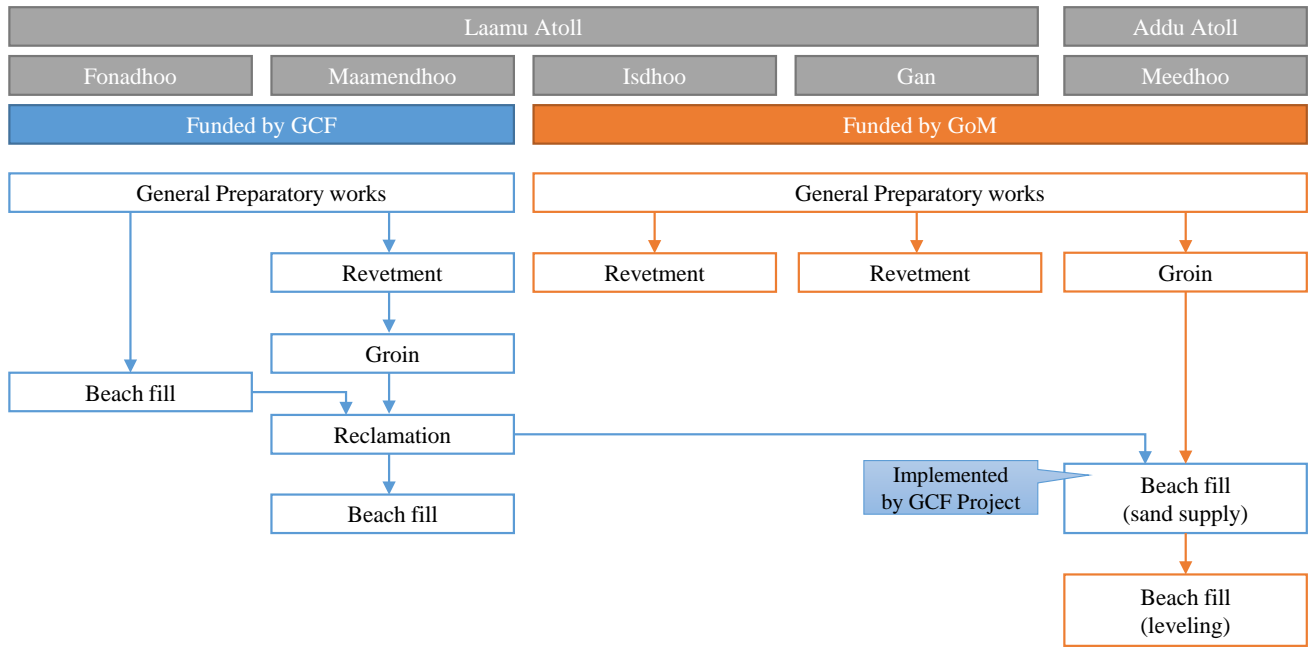
(1) Construction flow

1) Overall construction flow

The following figure shows the construction flowchart of Maamendhoo Island, Fonadhoo Island, Gan Island, Isdhoo Island and Meedhoo Island, which are the targets of the project.

As for the order of construction, revetment works and groin works using rock will be carried out in advance, and beach fill works and reclamation works using sand are planned to be carried out after the rock installation is completed.

It should be noted that the mobilization and demobilization cost of trailing suction hopper dredgers (TSHD) is expensive, and twice as much cost is required when divided by GCF project and the Maldives government co-finance project. For this reason, it was decided that the beach fill work on Meedhoo Island would be carried out with the budget of the GCF project, and after the Laamu Atoll construction, a dredger would be brought to Addu Atoll to carry out the beach fill work on Meedhoo. (It is also calculated in the same way in the Proposal Funding)



Source: JICA Expert Team

Figure 5.8.1 Construction Flow of the Overall Project

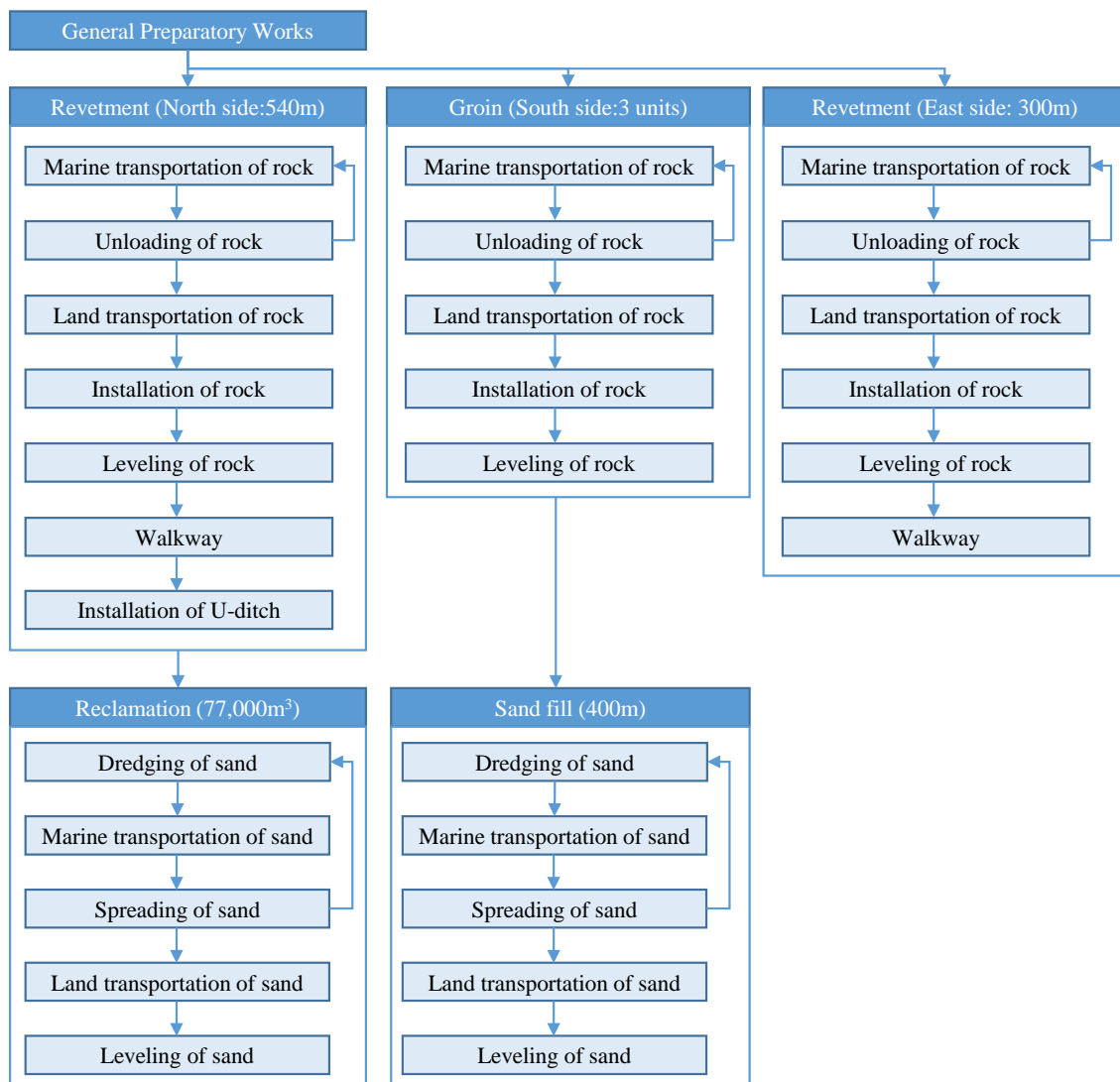
2) Construction flow by target island

a) Construction procedure on Maamendhoo Island

As for the construction procedure on Maamendhoo Island, revetment work and groin work will be carried out first, and then sand using works such as reclamation work and beach fill work will be carried out after rock installation.

The rock used for revetments and groin is imported from India, transported by sea, unloaded, and transported to the installation location by dump truck. After that, the rock is thrown into the installation site, and the rock is leveled to complete the process.

The sand used for reclamation and beach nourishment is procured by dredging from the seabed. The sand dredged by the TSHD is transported by sea to the reef edge near the target site and discharged to the target site by the dredger's pump. The discharged sand is completed by laying it evenly over the landfill site or beach nourishment site.



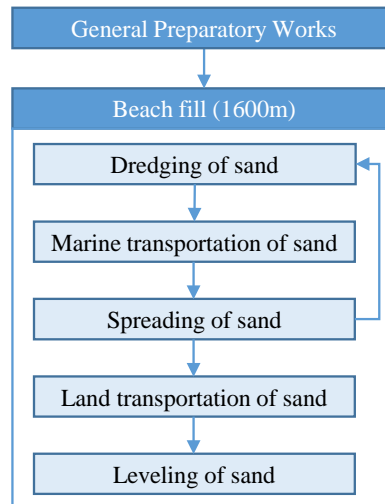
Source: JICA Expert Team

Figure 5.8.2 Construction Flowchart of Maamendhoo Island

b) Construction procedure on Fonadhoo Island

The only type of construction on Fonadhoo Island is a beach nourishment.

The sand used for beach nourishment is procured by dredging from the seabed. The sand dredged by the TSHD is transported by sea to the reef edge near the target site and discharged to the target site by the dredger's pump. The discharged sand is laid evenly on the beach nourishment site to complete the work.



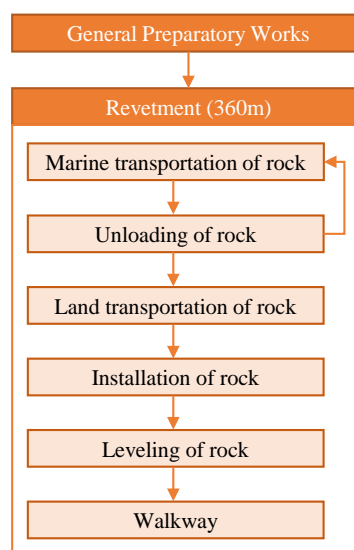
Source: JICA Expert Team

Figure 5.8.3 Construction Flowchart of Fonadhoo Island

c) Construction procedure on Isdhoo Island

The only type of construction on Isdhoo Island is revetment work.

The rock to be used for the revetment will be imported from India, transported by sea, unloaded, and transported to the installation location by dump truck. After that, the rock is thrown into the installation site, and the rock is leveled to complete the process.



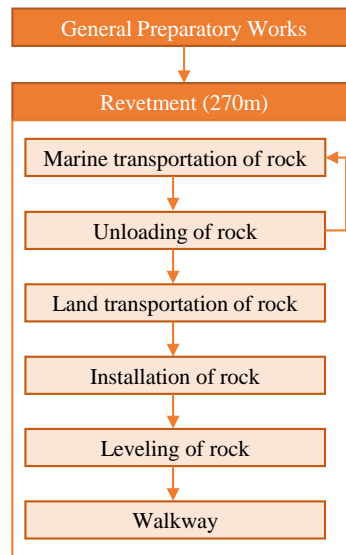
Source: JICA Expert Team

Figure 5.8.4 Construction Flowchart of Isdhoo Island

d) Construction procedure on Gan Island

The only type of construction on Gan Island is revetment work.

The rock to be used for revetment will be imported from India, transported by sea, unloaded, and transported to the installation location by dump truck. After that, the rock is thrown into the installation site, and the rock is leveled to complete the process.



Source: JICA Expert Team

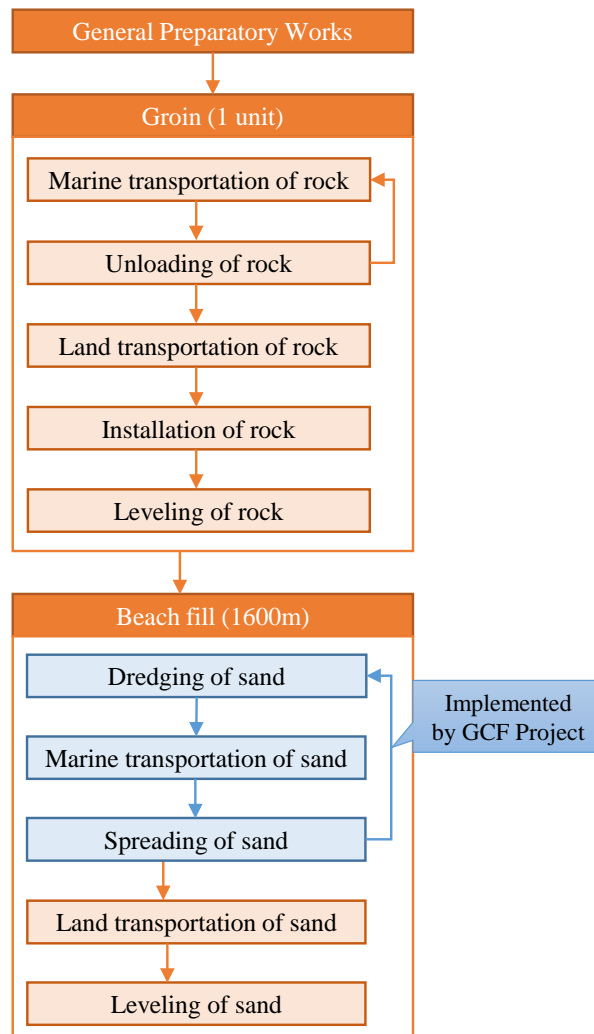
Figure 5.8.5 Construction Flowchart of Gan Island

e) Construction procedure on Meedhoo Island

On Meedhoo Island, groin and beach nourishment measures will be implemented.

The rock used for the groin is imported from India, transported by sea, unloaded, and transported to the installation location by dump truck. After that, the rock is thrown into the installation site, and the rock is leveled to complete the process.

The sand used for beach nourishment is procured by dredging from the seabed. The sand dredged by the TSHD is transported by sea to the reef edge near the target site and discharged to the target site by the dredger's pump. The discharged sand is laid evenly on the beach nourishment site to complete the work.



Source: JICA Expert Team

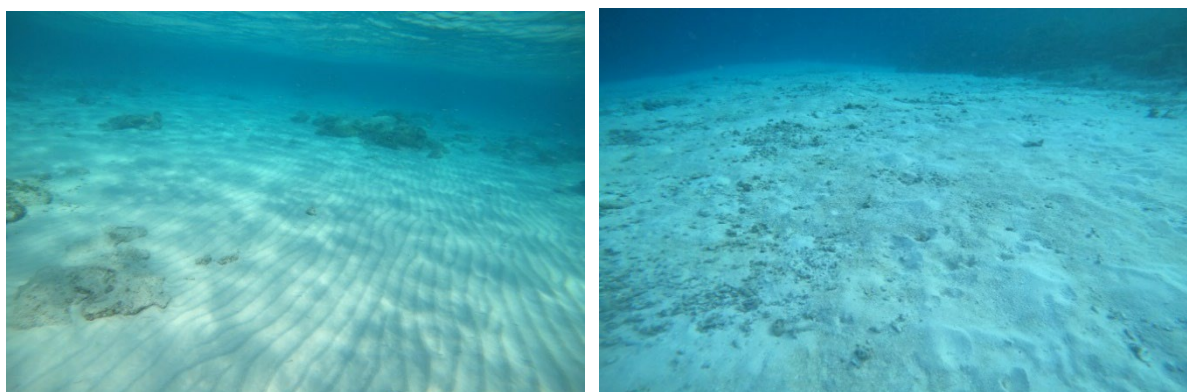
Figure 5.8.6 Construction Flowchart of Meedhoo Island

(2) Construction method by construction items

1) Beach fill work and reclamation work

a) Procurement method of beach fill and reclamation sand

There are sedimented sands on the seabed within the lagoon. The sand used for beach nourishment and reclamation will be secured by dredging sand deposited on the seabed with a dredger.



Source: JICA Expert Team

Figure 5.8.7 Sand Sedimented on the Seabed (Laamu Atoll)

At the time of maintenance, sand dredged for maintenance and management in this project and sand generated periodically during the maintenance dredging of the channel will be used. (Maintenance dredging is performed every 6 to 10 years according to the data from MNPFI.)

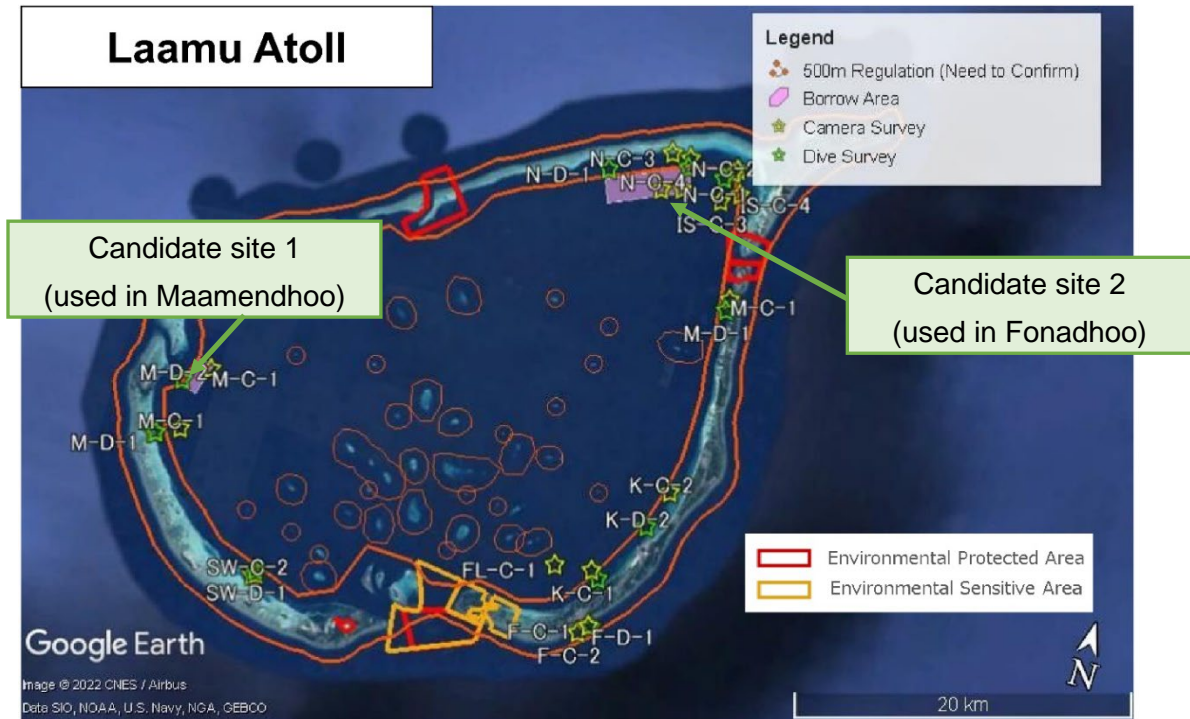


Source: JICA Expert Team

Figure 5.8.8 Statud of Sand Stock (Left: Feydhoo Island, Right: Hulhu-male Island phase 2)

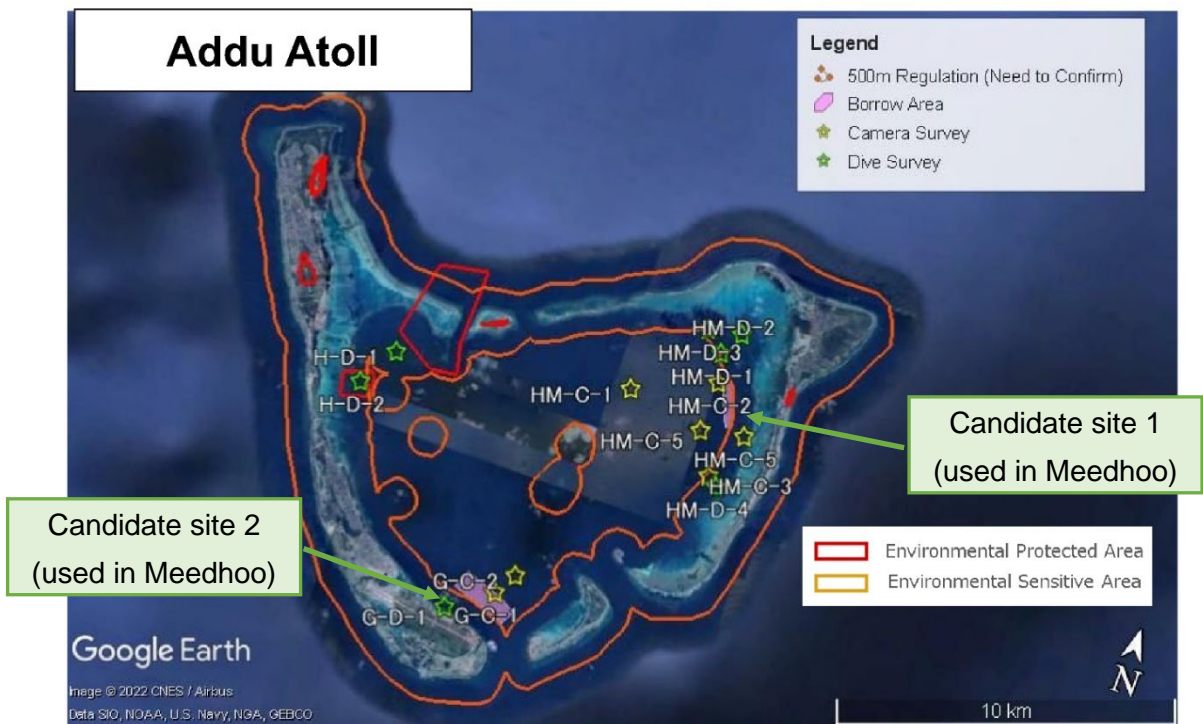
b) Candidate sites for sand borrow

At the basic design stage, candidate sand borrow area shown in the figure below were selected from the perspectives of sand grain size, environmental impact, dredging water depth, and sea transport distance. However, it is necessary to confirm the sand potential in the detailed design.



Source: JICA Expert Team

Figure 5.8.9 Sand Extraction Candidate Sites of Laamu Atoll



Source: JICA Expert Team

Figure 5.8.10 Sand Extraction Candidate Sites of Addu Atoll

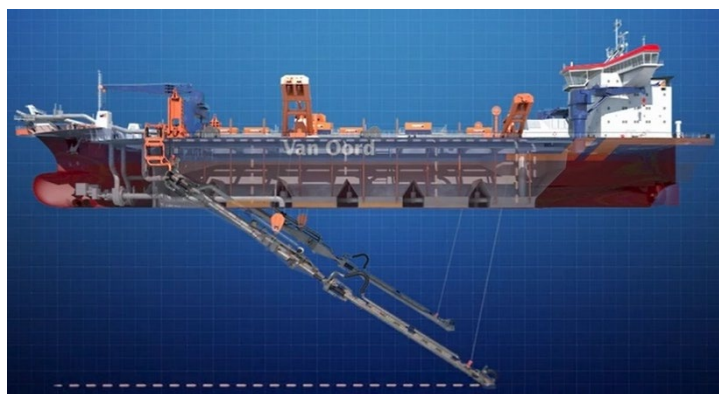
c) Dredging method for beach nourishment and reclamation sand

As for the dredging methods, "trailing suction", "cutter suction", and "excavation dredge" are the mainstream in the construction works in Maldives. There is also a "sand pump", but it is applied only for small-scale beach nourishment such as resort maintenance.

In this project, trailing suction dredging will be adopted as the dredging depth is about - 40m.

[Trailing suction]

Trailing suction is a dredging method that sucks up seabed sediment and sea water while towing a drag head attached to the tip. It can be transported by sea with sand inside the ship and spread to the stop yard.



Source: Van Oord

Figure 5.8.11 Example of a Trailing Suction Dredger

[Cutter suction]

Cutter suction is a dredging method that sucks up seawater with a pump while excavating the seabed with a cutter attached to the tip. Since there is no function to hold the sand inside the ship, it is necessary to discharge it directly into the stockpile or use it together with a ship that has a transport function such as a barge. In the Maldives, actual discharge to barges was not confirmed.



Source: Van Oord

Figure 5.8.12 Example of a Cutter Suction Dredger

[Excavation dredge]

Excavation dredging is a method of excavating the seabed with a excavator bucket using a dredger in which a excavator is mounted on a barge with a sputter. It is necessary to use it in conjunction with vessels with a hauling function such as a barge.



Source: Mikuniya Construction Company

Figure 5.8.13 Example of an Excavation Dredger

Table 5.8.1 Comparison of Dredging Methods

Evaluation items	Trailing suction dredging	Cutter suction dredging	Excavation dredging
Available water depth	Depending on the size of the dredger, can handle up to around -70m.	Depending on the size of the dredger, can handle up to around -18m.	Less than -5m
Subject soil	Sandy soil	Sandy soil, rock	Sandy soil, rock* breaker required
Workability	<ul style="list-style-type: none"> The dredging capacity depends on the capacity of the dredger used, but even a small dredger has a capacity of about 6000 m³/day at 3000 m³ × 2 times/day. One ship has functions of dredging, transport, and discharge, enabling flexible response in stormy weather. 	<ul style="list-style-type: none"> The dredging capacity is typically 1000 m³ to 2000 m³/day, depending on the capacity of the dredger used. When the dredging area and the discharge area are far apart, a platform for transportation and a backhoe for landing, etc. are required. 	<ul style="list-style-type: none"> The dredging capacity is about 300 to 500 m³ per day. Combined use with a barge is mandatory for transport. In addition, it is necessary to take measures such as surrounding the edge of the barge to drain the dredged sediment. For unloading sand, it is necessary to separately use a backhoe, etc..
Economic efficiency	<ul style="list-style-type: none"> Mobilization and demobilization cost and rental fee of the dredger is the most expensive. Since the construction speed is the fastest and all functions can be covered by a single vessel, it will be cheaper depending on the construction conditions. 	<ul style="list-style-type: none"> It is inexpensive compared with the Mobilization and demobilization cost and rental fee of the trailing suction dredger. 	<ul style="list-style-type: none"> It is cheap compared to the rental fee of other dredgers. Since the construction speed is slowest and requires many ships and heavy machinery, it becomes expensive depending on the construction conditions.
Environmental impact	<ul style="list-style-type: none"> The environmental impact is small because it can collect from deep locations. 	<ul style="list-style-type: none"> Since it is necessary to collect from shallow fields, the environmental impact is large. 	<ul style="list-style-type: none"> Since it is necessary to collect from shallow fields, the environmental impact is large.
Companies own dredgers	MTCC, Golf Cobla, Boskalis, Van Oord	MTCC, Golf Cobla, Boskalis, Van Oord	SASe, Heavy Force, Boskalis

e) Dredger standards

The trailing suction dredger to be used cannot be selected at this time, as it depends on the usage situation of the contractor's dredger. However, a relatively small dredger is suitable, considering that the use of sand in this project is less than that of a large-scale landfill project and that the dredged water depth is only -40m.

For this reason, it is assumed that a dredger with a capacity of 10,000m³, which can be used even at a water depth of -40m and is a representative ship type of relatively small dredger will be used. The following table shows the calculation results of the required time per cycle which supposed distance of sand borrow area and stockpile is 20km in oneway.

Table 5.8.2 Setting of the Dredger Cycle Time

1.Calculation of dredging time	Unit	Value	Remarks
①Pump power	kW	3,400	Catalog value
②coefficient of pump power		6	Interview to contractor
③pumping capacity	m ³ /h	20,400	①x②
④soil contain rate	%	10	Interview to contractor
⑤Dredging capacity	m ³ /h	2,040	③x④
⑥Hopper capacity	m ³	11,300	Catalog value
⑦Loading rate	%	80	Interview to contractor
⑧Loading valume	m ³	9,040	⑥x⑦
⑨Dredging time	h	4.4	⑧/⑤
2.Calculation of discharging time	Unit	Value	Remarks
①Pump power	kW	7,500	Catalog value
②coefficient of pump power		6	Interview to contractor
③pumping capacity	m ³ /h	45,000	①x②
④soil contain rate	%	10	Interview to contractor
⑤Discharging capacity	m ³ /h	4,500	③x④
⑥Hopper capacity	m ³	11,300	Catalog value
⑦Loading rate	%	80	Interview to contractor
⑧Loading valume	m ³	9,040	⑥x⑦
⑨Discharging time	h	2.0	⑧/⑤
3.Calculation of transportation time	Unit	Value	Remarks
①Transportation distance	km	40	measured value(round trip)
②Sailing speed	knot	9.18	60% of Catalog value
③Transportation time	h	2.4	①x②
4.Calculation of cycle time	Unit	Value	Remarks
1.Dredging time	h	4.4	1.①
2.Discharging time	h	2.0	2.①
3.Transportation time	h	2.4	3.①
4.Cycle time	h	8.8	1+2+3

Source: JICA Expert Team

f) Stockyard of beach nourishment sand for maintenance

The candidate sites for beach nourishment stockyards are required to meet the requirements shown in the table below from the viewpoint of land use, construction efficiency, and environmental impact. The amount of beach nourishment sand for maintenance is assumed to be about 30,000 m³ on each target island, and assuming that it will be piled up to a height of about 2 m, an area of about 15,000 m² will be required.

Table 5.8.3 Stockyard Requirements

Category	Requirements
Land use	Area under the management of the island, that do not have clear purposes such as residential areas, private property, and public facilities [mandatory]
Construction efficiency	Area where the distance from the reef edge to the stockyard is short (approx. max. 3.0km) Area facing the coastline or easy to land from the target area of the beach
Environmental impact	Area not designated as the Environment Protection Area [mandatory] Area with few trees to be cut (check aerial photographs and on-site)

Source: JICA Expert Team

[Candidate sites on Maamendhoo Island]

The area of the whole island is very small in Maamendhoo Island, and there is no land to secure the stockyard for beach nourishment for maintenance. For this reason, it is planned to make effective use of the reclaimed land that is used as an evacuation area and also to use it as a stockyard for maintenance sand.

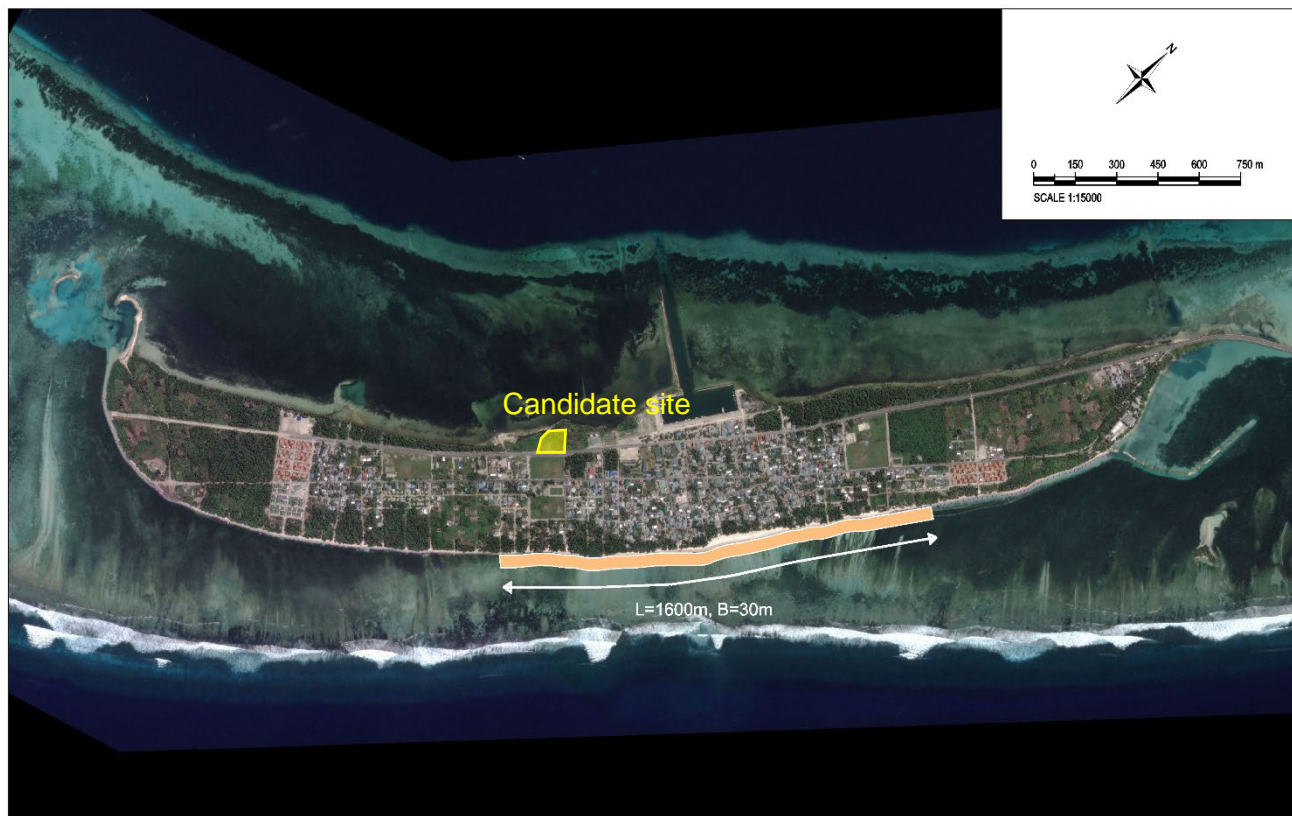


Source: JICA Expert Team

Figure 5.8.14 Stockyard Candidates Sites on Maamendhoo Island

[Candidate sites on Fonadhoo Islands]

In Fonadhoo Island, there is an unused area under the control of the island along the coastline, and it has been informed by the Fonadhoo Council that there is no clear future land use plan for that area. For this reason, the site concerned was selected as a stockyard candidate site on Fonadhoo Island.



Source: JICA Expert Team

Figure 5.8.15 Stockyard Candidate Site 1 on Fonadhoo Island



Figure 5.8.16 Stockyard Candidate Site 2 on Fonadhoo Island

[Candidate sites on Meedhoo Islands]

In Meedhoo Island, stockyards cannot be secured on the land along the coastline because the coastline area is surrounded by an Environment Protection Area. For this reason, unused Green Buffer Areas were selected as candidate sites to provide stockyards on the areas approaching the coast.



Source: JICA Expert Team

Figure 5.8.17 Stockyard Candidate Site 1 on Meedhoo Island

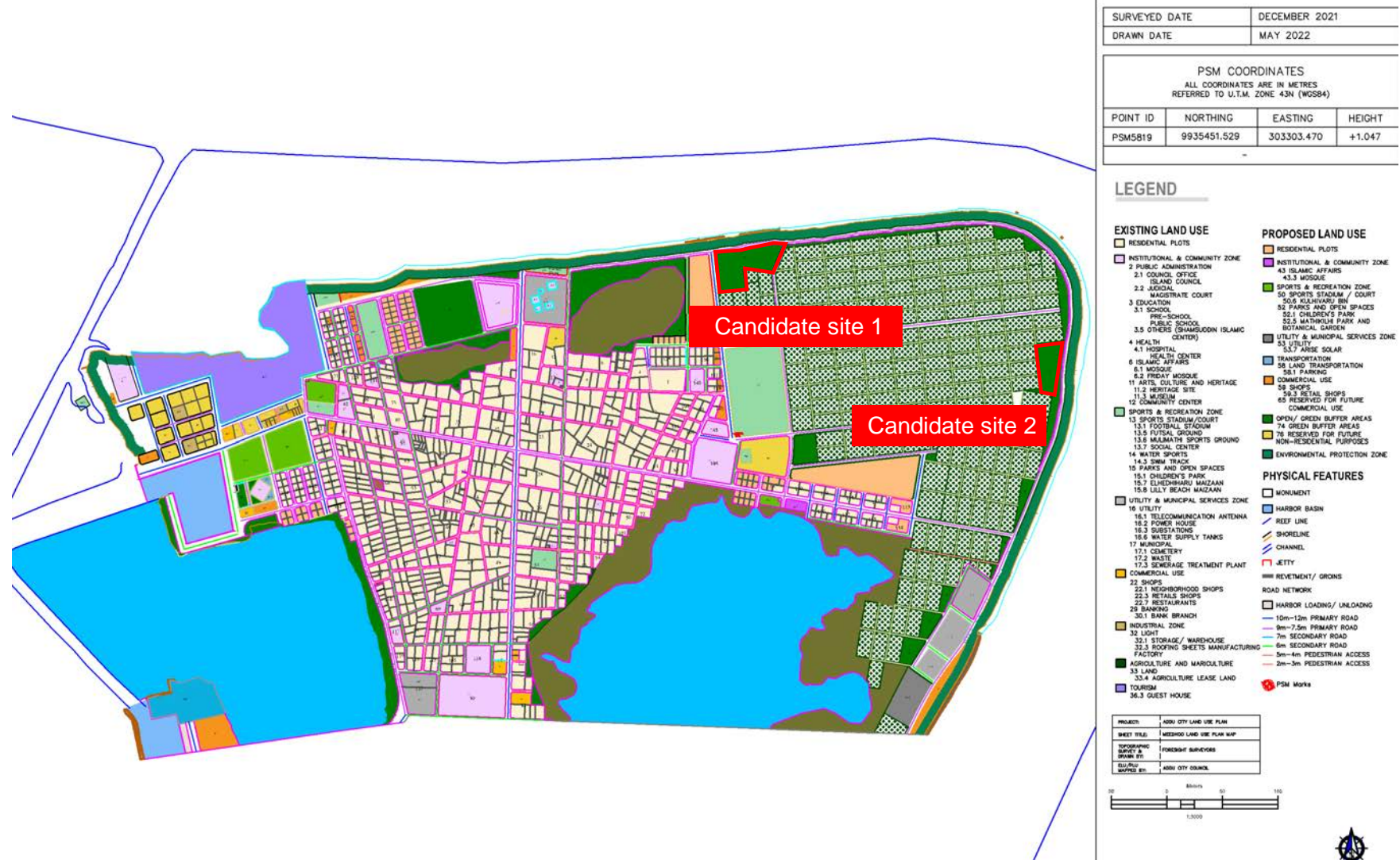


Figure 5.8.18 Stockyard Candidate Site 2 on Meedhoo Island

g) Sand discharge location

[Discharge location on Meedhoo island]

On Maamendhoo Island, a TSHD is berthed offshore around the reef edge offshore of the target area, and sand is discharged to the area through a pipeline. Since it takes time to relocate the offshore berthed position, it is necessary to reduce the number of relocations. Therefore, if the length of the pipeline is less than 1 km, it is necessary to reduce the number of relocations by extending the pipeline on the land side.

In Maamendhoo Island, since the length of the pipeline from the dredger to the discharge point is within 1km on one side, pipeline should be extended without relocating the offshore berthed position.



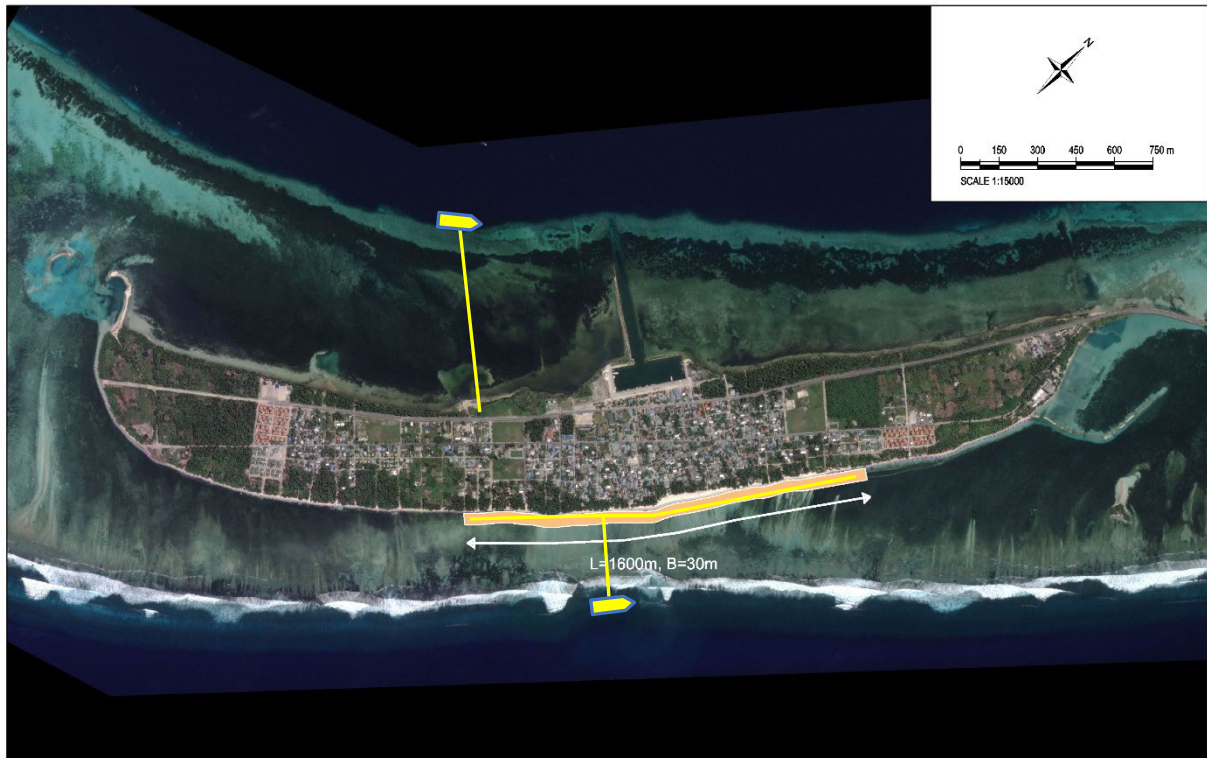
Source: JICA Expert Team

Figure 5.8.19 Sand Discharge Location on Maamendhoo island

[Discharge location on Fonadhoo island]

On Fonadhoo Island, a TSHD is berthed offshore around the reef edge offshore of the target area, and sand is discharged to the area through a pipeline.

Beach nourishment area and stockpile are in Fonadhoo Island, since both pipelines can be corresponded with a pipeline length of about 1.0km, pipeline should be extended without relocating the offshore berthed position.



Source: JICA Expert Team

Figure 5.8.20 Sand Discharge Location on Fonadhoo island

[Sand discharge location on Meedhoo island]

On Meedhoo Island, a trailing suction dredger is berthed offshore around the reef edge offshore of the target area, and sand is exhaled to the area through a pipeline.

In Meedhoo Island, since pipelines can be corresponded with a pipeline length of about 1.0km, pipeline should be extended without relocating the offshore berthed position.



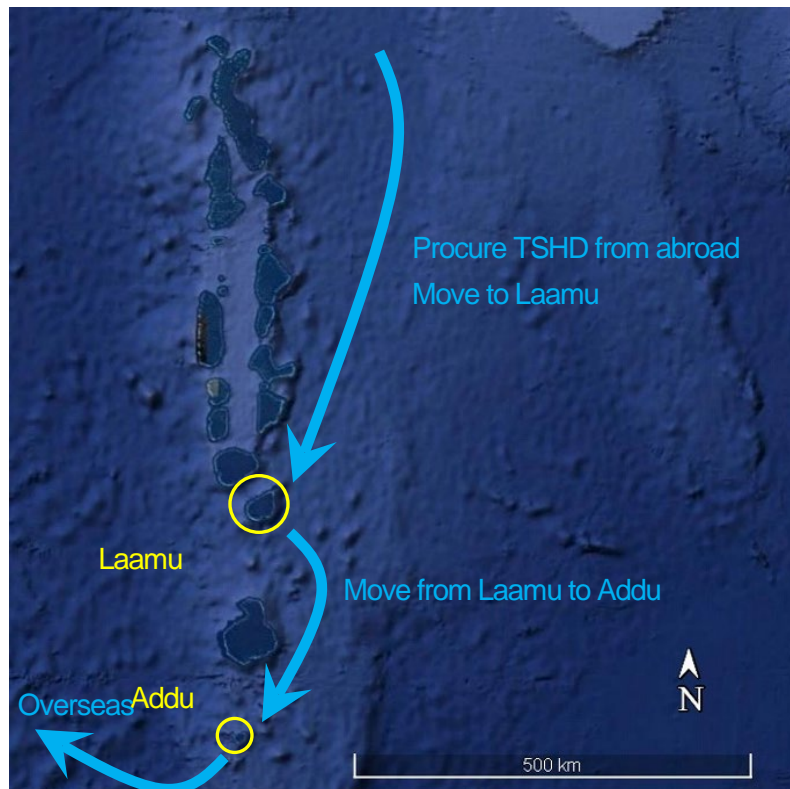
Source: JICA Expert Team

Figure 5.8.21 Sand Discharge Location on Meedhoo Island

h) Navigation route of the dredger

[The navigation route of TSHD for the entire project]

TSHD needs to be procured from outside the Maldives, because there is only one 3000m³ class small dredger in the Maldives. TSHD procured from foreign countries will carry out the work in Maamendhoo island and Fonadhoo island of Laamu Atoll, and then work in Meedhoo island of Addu Atoll.



Source: JICA Expert Team

Figure 5.8.22 Trailing Suction Dredger Navigation Route for the Entire Project

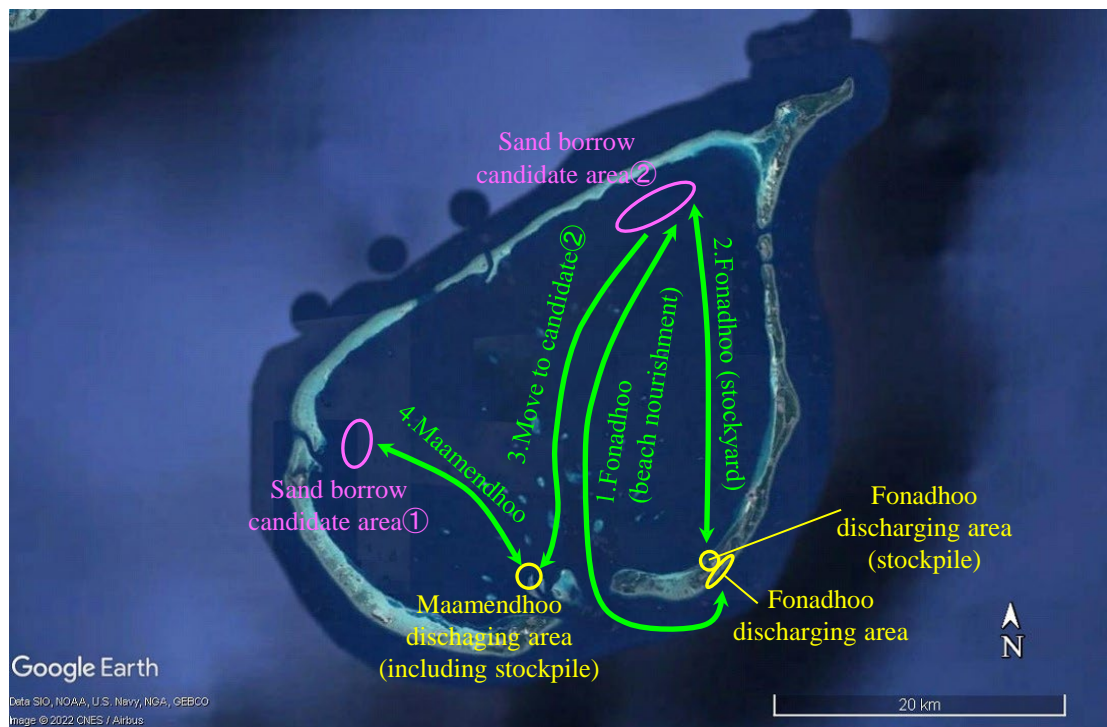
[The navigation route of TSHD in Laamu Atoll]

At Laamu Atoll, it is assumed that sand will be collected from a candidate site within the atoll, and TSHD will travel back and forth from the collection site to the discharge point. As for the order of construction, it is assumed that Maamendhoo Island will be constructed first, followed by the beach nourishment area on Fonadhoo Island, and finally the stockyard on Fonadhoo Island.

Table 5.8.4 Transportation Distances and Volumes by Transportation Route within Laamu Atoll

Transportation route	Method of transportation	Transportation distance (oneway)	Sand transport volume
Sand borrow candidate area 1 ⇔Maamendhoo beach nourishment and reclamation area	Marine transport	Approx. 20km	130,000m ³
Sand borrow candidate area 2 ⇔Fonadhoo beach nourishment area	Marine transport	Approx. 40km	64,000m ³
Sand borrow candidate area 2 ⇔ Fonadhoo stockyard	Marine transport	Approx. 30km	36,000m ³

Source: JICA Expert Team



Source: JICA Expert Team

Figure 5.8.23 Travel Route of TSHD in Laamu Atoll

[The navigation route of TSHD in Addu Atoll]

At Addu Atoll, it is assumed that sand will be collected from a candidate site within the atoll, and the sand will travel back and forth from the collection site to the discharge point. There are two candidate area for sand borrow, it would be decided the priority based on the result of sand potential survey.

Table 5.8.5 Transportation Distances and Volumes by Transportation Route within Addu Atoll

Transportation route	Method of transportation	Transportation distance (Oneway)	Sand transport volume
Sand extraction candidate site 1 ⇔Meedhoo beach nourishment area	Marine transport	Approx. 20km	116,000m ³
Sand extraction candidate site 2 ⇔Meedhoo beach nourishment area	Marine transport	Approx. 20km	



Source: JICA Expert Team

Figure 5.8.24 Travel Route of TSHD in Addu Atoll

i) Setting of sand leveling

The beach nourishment sand unloaded from the dump truck is leveled with a wheel loader (1.5m³ class).



Source: JICA Expert Team

Figure 5.8.25 Wheel Loaders Used in the Maldives

2) Revetment work and groin work

a) Methods of procurement of rock materials

In Maldives, rock materials (granite) imported from India are commonly used, and they are used in seawalls for landfill projects, breakwaters for port development projects, and breakwaters for coastal projects.

Rock materials used in the Maldives are imported from quarries in Tuticorin in southern India. They are generally imported directly from suppliers. They can also be purchased from trading companies, but there are often delays in the supply of materials.



Source: JICA Expert Team

Figure 5.8.26 Rock Materials Used in the Maldives (Hulhumale)

In this project, it is planned to procure rock materials of the following sizes. However, Isdhoo Island suffered damage to breakwaters weighing 400kg~800kg/piece in nearby ports and harbors, so a detailed study is required in the detailed design.

It has been confirmed by local constructors that rock materials of the following sizes can be procured from India.

Table 5.8.6 List of Rock Size for Each Island

Island	Facility	CORE RUBBLE	FILTER STONE	ARMOUR STONE
Maamendhoo	Groin 3 units (West)	1kg~10kg/N	10kg~20kg/N	100kg/N
	Revetment 540m (North)	1kg~20kg/N	20kg~30kg/N	300kg/N
	Revetment 300m (East)	1kg~20kg/N	-	100kg/N
Isdhoo	Revetment 360m	1kg~50kg/N	-	500kg/N
Gan	Revetment 270m	1kg~10kg/N	10kg~20kg/N	100kg/N
Meedhoo	Groin 1 unit	1kg~10kg/N	10kg~20kg/N	100kg/N

b) Method of unloading rock

There are three ways to unload rock materials.





1. Unload at a quay (verification of barge size required)
2. A large barge (3,000 to 10,000 tons) should be anchored around the reef edge and unloaded around the reef edge (a temporary access road (jetty) by sand is required).
3. Transfer from a large barge (3,000t to 10,000t) to a small ferry barge (less than 1,000t) and unloaded near the installation area at HWL

There are no quays that can moor large barges (3,000t to 10,000t) on the target islands, so that relatively small barges should be selected in case of unloading at quays. Therefore, marine transportation will be inefficient.

In case the method of transfer to small ferry barges, it has issues in terms of construction efficiency and safety. For this reason, a method of anchoring a large barge around the reef edge and carrying out landing around the reef edge is selected.

For the reference, candidates for unloading ports on each target island are shown in the table below.

Table 5.8.7 Candidates for Rock Unloading Ports on Each Target Islands

<p style="text-align: center;">Maamendhoo Island</p> 	<p style="text-align: center;">Isdhoo island</p> 
<p style="text-align: center;">Gan Island</p> 	<p style="text-align: center;">Meedhoo island</p> 

Source: JICA Expert Team

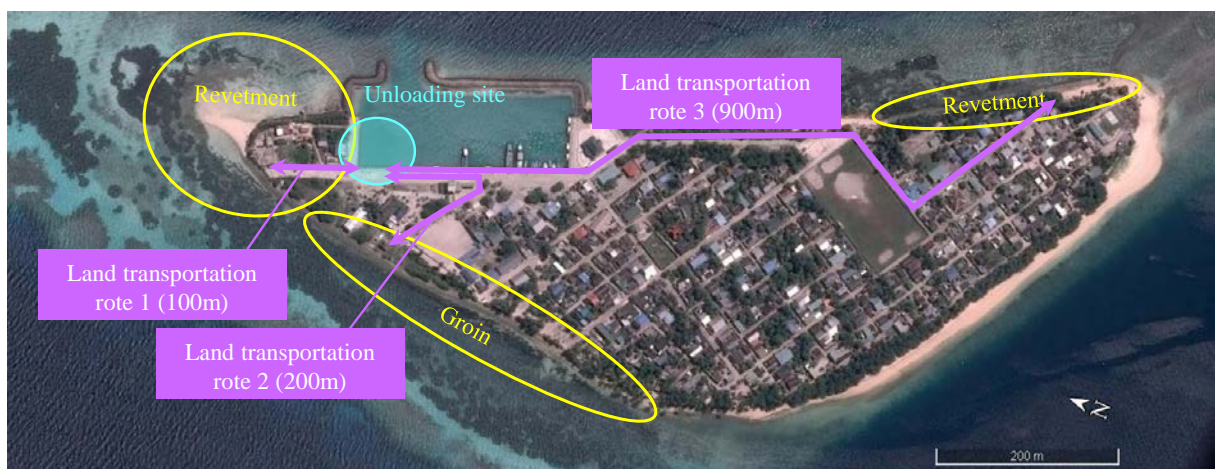
c) Method of land transportation of rock

For reference, the land transportation route for unloading at a port is shown in below.

[Transportation route of rock material in Maamendhoo Island]

A 10-ton class dump truck will be used for land transportation from Maamendhoo Harbor to the area where the revetment and groin are installed. A 10-ton truck, which can turn in a small radius, will be used because it includes narrow roads.

As for the land transportation route for rock materials, existing roads pass through to each target area, so there is no need to develop new access roads.



Source: JICA Expert Team

Figure 5.8.27 Land Transportation Route for Rock Materials on Maamendhoo Island

The table below shows the calculation results of the number of days required for land transportation. When five dump trucks are in operation, transportation of rock materials will take a total of 65 days for three locations.

Table 5.8.8 Calculation of Days Required for Land Transportation of Rock Materials on Maamendhoo Island

Items	Unit	Value			Remarks
		Rote 1	Rote 2	Rote 3	
①Loading time	h/cycle	1.0	1.0	1.0	
②Transportation distance	km	0.1	0.2	0.9	round trip
③Transportation speed	km/h	10.0	10.0	10.0	
④Transportation time	h/cycle	0.0	0.0	0.1	②/③
⑤Unloading time	h/cycle	0.3	0.3	0.3	
⑥Cycle time	h/cycle	1.3	1.3	1.4	①+④+⑤
⑦Transportation volume	m ³	12,474	4,274	2,145	
⑧Loading capacity	m ³ /Num	10	10	10	
⑨Necessity round number	cycle	1,248	428	215	⑦/⑧
⑩Operation hour	h/d	8	8	8	
⑪Daily round number	cycle/d	6	6	6	⑩/⑥
⑫Operation number of truck	Num/d	5	5	5	
⑬Necessity day	d	42	15	8	⑧/⑪/⑫
Necessity day (total)	d	65			

Source: JICA Expert Team

[Transportation route of rock material in Isdhoo Island]

A 10-ton class dump truck will be used for land transportation from Isdhoo Harbor to the revetment installation area. A 10-ton truck, which can turn in a small radius, will be used because it includes narrow roads.

As for the land transport route for rock materials, the existing road runs to the end of the revetment area, so no new access roads need to be constructed.



Source: JICA Expert Team

Figure 5.8.28 Land Transportation Routes for Rock Materials on Isdhoo Island

The table below shows the calculation results of the number of days required for land transportation. When five dump trucks are in operation, it will take 37 days to transport rock.

Table 5.8.9 Calculation of Days Required for Land Transportation of Rock Materials on Isdhoo Island

Items	Unit	Value	Remarks
① Loading time	h/cycle	1.0	
② Transportation distance	km	0.9	round trip
③ Transportation speed	km/h	10.0	
④ Transportation time	h/cycle	0.1	②/③
⑤ Unloading time	h/cycle	0.3	
⑥ Cycle time	h/cycle	1.4	①+④+⑤
⑦ Transportation volume	m ³	11,088	
⑧ Loading capacity	m ³ /Num	10	
⑨ Necessity round number	cycle	1,109	⑦/⑧
⑩ Operation hour	h/d	8	
⑪ Daily round number	cycle/d	6	⑩/⑥
⑫ Operation number of truck	Num/d	5	
⑬ Necessity day	d	37	⑧/⑪/⑫

Source: JICA Expert Team

[Transportation route of rock materials in Gan Island]

A 10-ton class dump truck will be used for land transportation from Thundi Harbor to the revetment installation area. A 10-ton truck, which can turn in a small radius, will be used as there are narrow roads.

As for the land transport route for rock materials, although the existing road runs to the revetment area, there are places where the width is narrow around the revetment area. Therefore, it is necessary to consider whether or not to widen the access road in the detailed design.



Source: JICA Expert Team

Figure 5.8.29 Land Transportation Routes for Rock Materials on Gan Island



Source: JICA Expert Team

Figure 5.8.30 Narrow Area of the Existing Road on Gan Island

The table below shows the calculation results of the number of days required for land transportation. When five dump trucks are in operation, it will take 15 days to transport the rock.

Table 5.8.10 Calculation of Days Required for Land Transportation of Rock Materials on Gan Island

Items	Unit	Value	Remarks
①Loading time	h/cycle	1.0	
②Transportation distance	km	5.2	round trip
③Transportation speed	km/h	10.0	
④Transportation time	h/cycle	0.5	②/③
⑤Unloading time	h/cycle	0.3	
⑥Cycle time	h/cycle	1.8	①+④+⑤
⑦Transportation volume	m ³	2,835	
⑧Loading capacity	m ³ /Num	10	
⑨Necessity round number	cycle	284	⑦/⑧
⑩Operation hour	h/d	8	
⑪Daily round number	cycle/d	4	⑩/⑥
⑫Operation number of truck	Num/d	5	
⑬Necessity day	d	15	⑨/⑪/⑫

Source: JICA Expert Team

[Transportation route of rock material in Meedhoo Island]

From Hulhumeedhoo Harbor to the groin installation area, a 10-ton class dump truck will be used for overland transportation. A 10-ton truck, which can turn in a small radius, will be used as it includes narrow roads.

As for the land transport route for rock materials, the existing road passes through to the jetty area, so no new access roads need to be constructed.



Source: JICA Expert Team

Figure 5.8.31 Land Transportation Routes for Rock Materials on Meedhoo Island

The table below shows the calculation results of the number of days required for land transportation. When five dump trucks are in operation, it will take five days to transport rock.

Table 5.8.11 Calculation of Days Required for Land Transportation of Rock Materials on Meedhoo Island

Items	Unit	Value	Remarks
①Loading time	h/cycle	1.0	
②Transportation distance	km	1.8	round trip
③Transportation speed	km/h	10.0	
④Transportation time	h/cycle	0.2	②/③
⑤Unloading time	h/cycle	0.3	
⑥Cycle time	h/cycle	1.5	①+④+⑤
⑦Transportation volume	m ³	1,042	
⑧Loading capacity	m ³ /Num	10	
⑨Necessity round number	cycle	105	⑦/⑧
⑩Operation hour	h/d	8	
⑪Daily round number	cycle/d	5	⑩/⑥
⑫Operation number of truck	Num/d	5	
⑬Necessity day	d	5	⑧/⑪/⑫

Source: JICA Expert Team

d) Method of throwing and leveling rock materials

The rocks are unloaded from the dump truck near the installation site and thrown in by an excavator. For structures extending offshore like a groin, a temporary access road for dump trucks can be constructed and rock materials can be unloaded from the temporary road, thereby making it possible to load them efficiently.

The rock material that has been put in is completed by leveling the surface with a backhoe while inserting the filling rock.



Source: provided by MTCC

Figure 5.8.32 Installation of the Jetty and Revetment

e) Method of removing the existing revetment

[How to remove the existing revetment (cement bag) of Gan Island and Meedhoo Island]

At the revetment installation position on Gan Island and beach fill position on Meedhoo Island, there is an existing revetment constructed by cement bags. Some existing revetments have already collapsed due to waves, so it is necessary to form a new revetment by breaking it down with an excavator.

There is a possibility that the demolished cement bag can be reused as a new CORE BUBBLE (1 kg to 20 kg). It is necessary to examine whether or not it can be reused in the detailed design.



Source: JICA Expert Team

Figure 5.8.33 Installation Situation of the Cement Bag Revetment (left: Gan Island, right: Meedhoo Island)

[How to remove the existing revetment (sandbag) of Meedhoo Island]

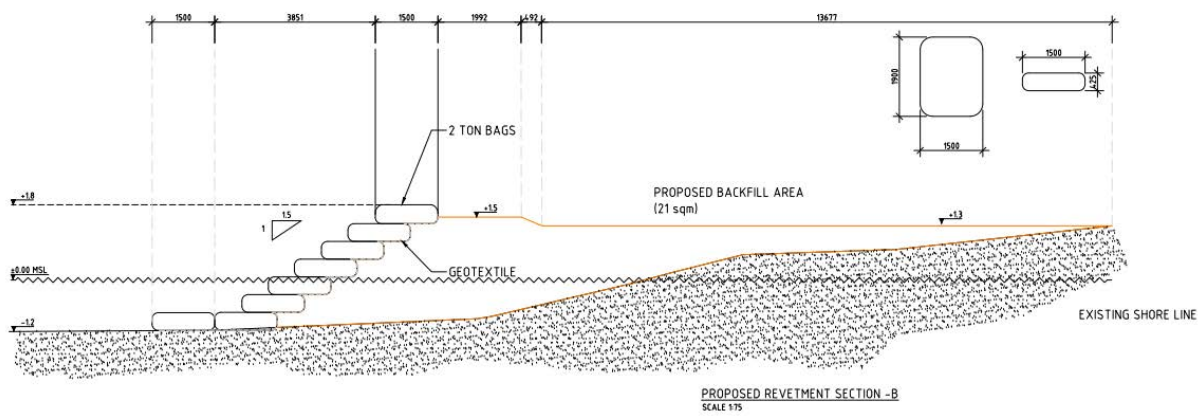
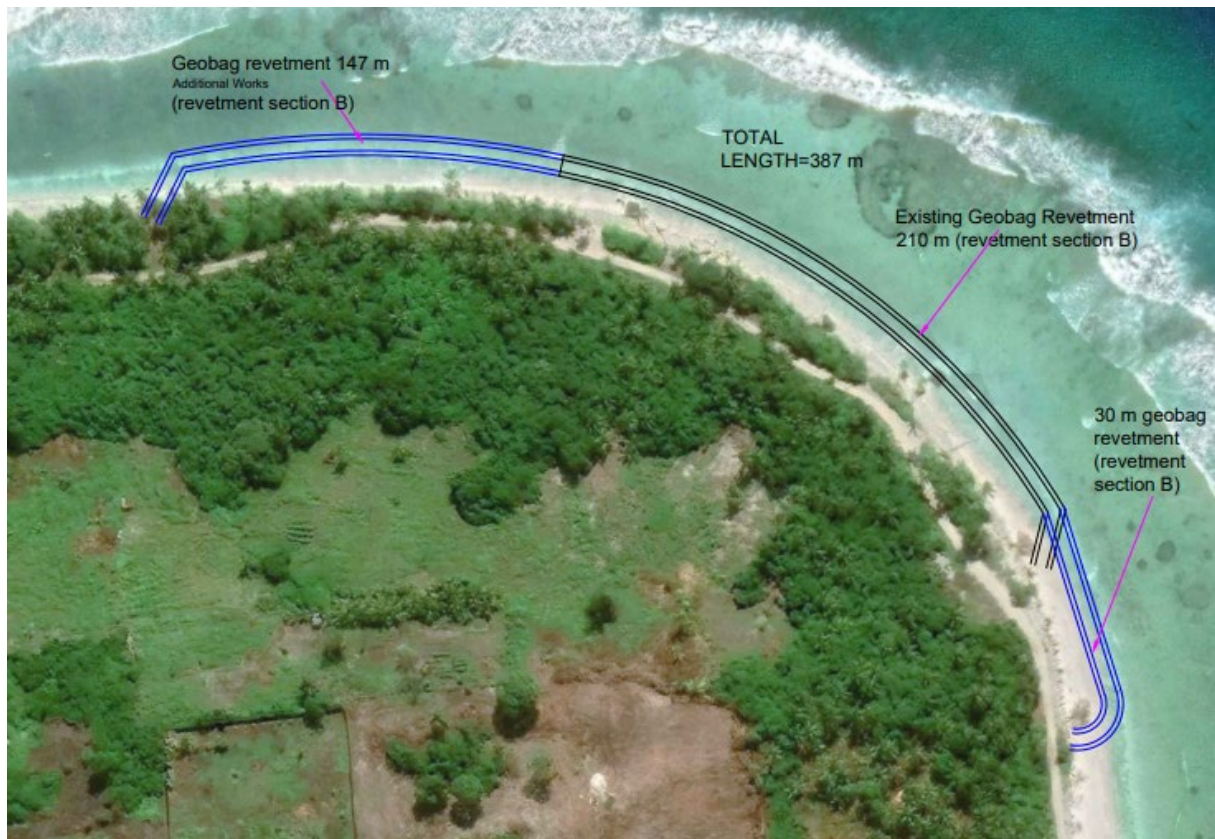
In the beach nourishment area on Meedhoo Island, temporary revetment is planned to be constructed using sandbags as an emergency countermeasure against coastal erosion, and the construction has been completed in some areas. If the temporary revetment is left in place, it may affect the sand supply on the downstream side.

There is a possibility that the sand material for sandbags can be reused as beach nourishment sand. It is necessary to examine whether or not it can be reused in the detailed design.



Source: JICA Expert Team

Figure 5.8.34 Installation Situation of the Existing Revetment on Gan Island



Source: provided by MNPFI

Figure 5.8.35 Temporary Revetment Plan on Meedhoo Island

f) Method of laying the sandproof sheet

A geotextile as shown in the figure below shall be laid between the site ground and CORE BUBBLE.



Source: provided by MTCC

Figure 5.8.36 Installation Situation of Geotextile

(3) Construction schedule

The following pages show the construction schedule for the overall project and for each target island. Construction schedule is considered by 1 package case and 2 packages case. Note that the blue bar indicates GFC projects and the orange bar indicates the Maldives government cofinancing projects.

Table 5.8.12 Construction Schedule for the Overall Project (1 package case)

Island	Construction Items	Unit	Volume	2024												2025												2026																							
				7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12																		
Maamendhoo	1. General and Preparatory Works	Sum	1	Mobilization																								Demobilization																							
	2. Groin (West side: 3 units)	m	150													Walkway, U-ditch																																			
	3. Revetment (North side (Reclamation) :540m)	m	540													Walkway																																			
	4. Revetment (East side :300m)	m	300													Walkway																																			
	5. Beach Fill (West side: 400m)	m	400													Operating TSHD																																			
	6. Reclamation (North side: 22,000m ²)	m ²	22,000													Operating TSHD																																			
Fonadhoo	1. General and Preparatory Works	Sum	1													Mobilization												Demobilization																							
	2. Beach Fill (1600m)	m	1,600													Operating TSHD																																			
Isdhoo	1. General and Preparatory Works	Sum	1																									Mobilization												Demobilization											
	2. Revetment (360m)	m	360																									Walkway																							
Gan	1. General and Preparatory Works	Sum	1																									Mobilization												Demobilization											
	2. Revetment (270m)	m	270																									Walkway																							
Meedhoo	1. General and Preparatory Works	Sum	1	Mobilization												Demobilization												Mobilization												Demobilization											
	2. Groin (1unit)	m	50													Removal of existing revetment																								Operating TSHD											
	3. Beach Fill (1600m)	m	1,600																																																

Table 5.8.13 Construction Schedule for Maamendhoo Island (1 package case)

Construction Items	Operation rate	Unit	Volume	Daily productivity	Necessary days	2024												2025												2026											
						7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12						
1. General and Preparatory Works		sum	1			[Gantt bar spanning from start of 2024 to end of 2025]																																			
1.1 Mobilization	1.0	sum	1			[Gantt bar from start of 2024 to end of 2024]																																			
1.2 Common Temporary Works	1.0	sum	1			[Gantt bar from start of 2024 to end of 2024]																																			
1.3 Survey and Monitoring Works	1.0	sum	1			[Gantt bar from start of 2024 to end of 2025]																																			
1.4 Preparation of Report, Drawings and others	1.0	sum	1			[Gantt bar from start of 2024 to end of 2025]																																			
1.5 Demobilization	1.0	sum	1			[Gantt bar from start of 2026 to end of 2026]																																			
2. Groin (South side: 3 units)		m	150			[Gantt bar from start of 2025 to end of 2025]																																			
2.1 Unloading of rock	0.8	m ³	4,274	500	11	[Gantt bar from start of 2025 to end of 2025]																																			
2.2 Installation and leveling of rock (CORE RUBBLE, FILTETR STONE)	0.8	m ³	3,053	200	20	[Gantt bar from start of 2025 to end of 2025]																																			
2.3 Installation and leveling of rock (ARMOUR STONE)	0.8	m ³	1,221	200	8	[Gantt bar from start of 2025 to end of 2025]																																			
3. Revetment (North side (Reclamation) :540m)		m	540			[Gantt bar from start of 2024 to end of 2025]																																			
3.1 Unloading of rock	0.8	m ³	23,166	500	58	[Gantt bar from start of 2024 to end of 2024]																																			
3.2 Installation of Geotextile	0.8	m ²	14,256	3,000	6	[Gantt bar from start of 2024 to end of 2024]																																			
3.3 Installation and leveling of rock (CORE RUBBLE, FILTETR STONE)	0.8	m ³	14,256	200	90	[Gantt bar from start of 2024 to end of 2024]																																			
3.4 Installation and leveling of rock (ARMOUR STONE)	0.8	m ³	8,910	200	56	[Gantt bar from start of 2024 to end of 2024]																																			
3.5 Walkway	1.0	m ²	1,080	30	36	[Gantt bar from start of 2024 to end of 2024]																																			
3.6 Installation of U-ditch	1.0	m	540	40	14	[Gantt bar from start of 2024 to end of 2024]																																			
4. Revetment (East side :300m)		m	300			[Gantt bar from start of 2025 to end of 2025]																																			
4.1 Unloading of rock	0.8	m ³	2,145	500	6	[Gantt bar from start of 2025 to end of 2025]																																			
4.2 Installation of Geotextile	0.8	m ³	2,805	3,000	2	[Gantt bar from start of 2025 to end of 2025]																																			
4.3 Installation and leveling of rock (CORE RUBBLE)	0.8	m ³	495	200	4	[Gantt bar from start of 2025 to end of 2025]																																			
4.4 Installation and leveling of rock (ARMOUR STONE)	0.8	m ³	1,650	200	11	[Gantt bar from start of 2025 to end of 2025]																																			
4.5 Walkway	1.0	m ²	600	30	20	[Gantt bar from start of 2025 to end of 2025]																																			
5. Beach Fill (West side: 400m)		m	400			[Gantt bar from start of 2025 to end of 2025]																																			
5.1 Dredging and spreading of sand	0.8	m ³	25,920	24,408	2	[Gantt bar from start of 2025 to end of 2025]																																			
5.2 Leveling of sand	1.0	m ³	25,920	1,200	22	[Gantt bar from start of 2025 to end of 2025]																																			
5.3 Dredging and spreading of sand (for maintenance sand)	0.8	m ³	30,000	24,408	2	[Gantt bar from start of 2025 to end of 2025]																																			
5.4 Produce and piling up of sandbag (for maintenance sand, as temporary revetment)	1.0	Num	5,968	288	21	[Gantt bar from start of 2025 to end of 2025]																																			
5.5 Leveling of sand (for maintenance sand, piling up)	1.0	m ³	30,000	1,200	25	[Gantt bar from start of 2025 to end of 2025]																																			
6. Reclamation (North side: 22,000m²)		m ²	22,000			[Gantt bar from start of 2025 to end of 2025]																																			
6.1 Dredging and spreading of sand	0.8	m ³	77,000	24,408	4	[Gantt bar from start of 2025 to end of 2025]																																			
6.2 Leveling of sand	1.0	m ³	77,000	1,200	65	[Gantt bar from start of 2025 to end of 2025]																																			

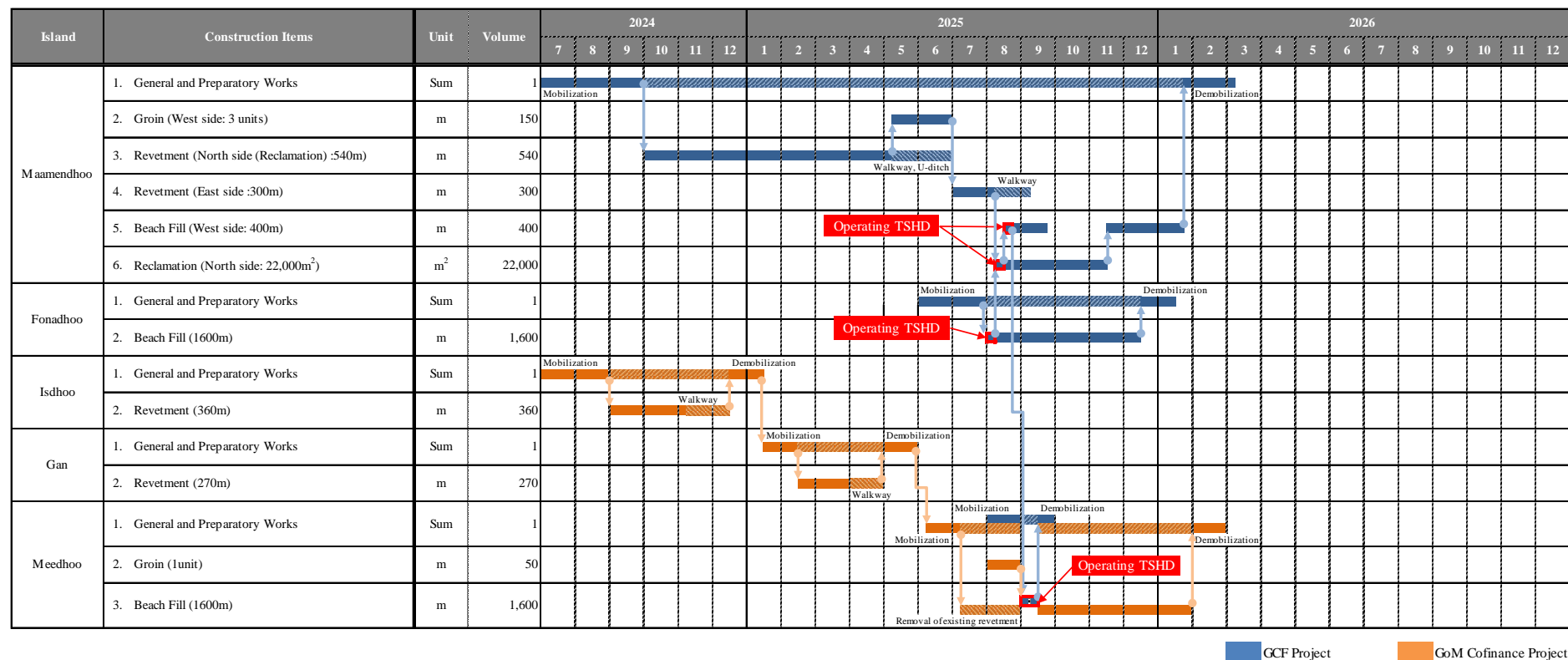
Table 5.8.14 Construction Schedule for Fonadhoo Island (1 package case)

Construction Items	Operation rate	Unit	Volume	Daily productivity	Necessary days	2024												2025												2026											
						7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12						
1. General and Preparatory Works		sum	1																																						
1.1 Mobilization	1.0	sum	1	-	-																																				
1.2 Common Temporary Works	1.0	sum	1	-	-																																				
1.3 Survey and Monitoring Works	1.0	sum	1	-	-																																				
1.4 Preparation of Report, Drawings and others	1.0	sum	1	-	-																																				
1.5 Demobilization	1.0	sum	1	-	-																																				
2. Beach Fill (1600m)		m	1,600																																						
2.1 Dredging and spreading of sand	0.8	m ³	76,800	19,888	4																																				
2.2 Leveling of sand	1.0	m ³	76,800	1,200	64																																				
2.3 Dredging and spreading of sand (for maintenance sand) including sand for Gan	0.8	m ³	36,000	21,696	2																																				
2.4 Produce and piling up of sandbag (for maintenance sand, as temporary revetment)	1.0	Num	1,105	288	4																																				
2.5 Leveling of sand (for maintenance sand, piling up)	1.0	m ³	30,000	1,200	25																																				

Table 5.8.15 Construction Schedule for Isdhoo Island (1 package case)

Construction Items	Operation rate	Unit	Volume	Daily productivity	Necessary days	2024												2025												2026											
						7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12						
1. General and Preparatory Works		sum	1																																						
1.1 Mobilization	1.0	sum	1	-	-																																				
1.2 Common Temporary Works	1.0	sum	1	-	-																																				
1.3 Survey and Monitoring Works	1.0	sum	1	-	-																																				
1.4 Preparation of Report, Drawings and others	1.0	sum	1	-	-																																				
1.5 Demobilization	1.0	sum	1	-	-																																				
2. Revetment (360m)		m	360																																						
2.1 Unloading of rock	0.8	m ³	8,145	500	14																																				
2.2 Installation of Geotextile	0.8	m ³	6,525	3,000	2																																				
2.3 Installation and leveling of rock (CORE RUBBLE, FILTETR STONE)	0.8	m ³	1,800	200	8																																				
2.4 Installation and leveling of rock (ARMOUR STONE)	0.8	m ³	6,345	200	26																																				
2.5 Walkway	1.0	m ²	720	30	24																																				

Table 5.8.18 Construction Schedule for the Overall Project (2 packages case)



■ GCF Project ■ GoM Cofinance Project

Table 5.8.19 Construction Schedule for Maamendhoo Island (2 packages case)

Construction Items	Operation rate	Unit	Volume	Daily productivity	Necessary days	2024												2025												2026											
						7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12						
1. General and Preparatory Works		sum	1			[Gantt bars for 2024-2026]																																			
1.1 Mobilization	1.0	sum	1			[Gantt bars for 2024-2026]																																			
1.2 Common Temporary Works	1.0	sum	1			[Gantt bars for 2024-2026]																																			
1.3 Survey and Monitoring Works	1.0	sum	1			[Gantt bars for 2024-2026]																																			
1.4 Preparation of Report, Drawings and others	1.0	sum	1			[Gantt bars for 2024-2026]																																			
1.5 Demobilization	1.0	sum	1			[Gantt bars for 2024-2026]																																			
2. Groin (South side: 3 units)		m	150			[Gantt bars for 2024-2026]																																			
2.1 Unloading of rock	0.8	m ³	4,274	500	11	[Gantt bars for 2024-2026]																																			
2.2 Installation and leveling of rock (CORE RUBBLE, FILTER STONE)	0.8	m ³	3,053	200	20	[Gantt bars for 2024-2026]																																			
2.3 Installation and leveling of rock (ARMOUR STONE)	0.8	m ³	1,221	200	8	[Gantt bars for 2024-2026]																																			
3. Revetment (North side (Reclamation) :540m)		m	540			[Gantt bars for 2024-2026]																																			
3.1 Unloading of rock	0.8	m ³	23,166	500	58	[Gantt bars for 2024-2026]																																			
3.2 Installation of Geotextile	0.8	m ²	14,256	3,000	6	[Gantt bars for 2024-2026]																																			
3.3 Installation and leveling of rock (CORE RUBBLE, FILTER STONE)	0.8	m ³	14,256	200	90	[Gantt bars for 2024-2026]																																			
3.4 Installation and leveling of rock (ARMOUR STONE)	0.8	m ³	8,910	200	56	[Gantt bars for 2024-2026]																																			
3.5 Walkway	1.0	m ²	1,080	30	36	[Gantt bars for 2024-2026]																																			
3.6 Installation of U-ditch	1.0	m	540	40	14	[Gantt bars for 2024-2026]																																			
4. Revetment (East side :300m)		m	300			[Gantt bars for 2024-2026]																																			
4.1 Unloading of rock	0.8	m ³	2,145	500	6	[Gantt bars for 2024-2026]																																			
4.2 Installation of Geotextile	0.8	m ³	2,805	3,000	2	[Gantt bars for 2024-2026]																																			
4.3 Installation and leveling of rock (CORE RUBBLE)	0.8	m ³	495	200	4	[Gantt bars for 2024-2026]																																			
4.4 Installation and leveling of rock (ARMOUR STONE)	0.8	m ³	1,650	200	11	[Gantt bars for 2024-2026]																																			
4.5 Walkway	1.0	m ²	600	30	20	[Gantt bars for 2024-2026]																																			
5. Beach Fill (West side: 400m)		m	400			[Gantt bars for 2024-2026]																																			
5.1 Dredging and spreading of sand	0.8	m ³	25,920	24,408	2	[Gantt bars for 2024-2026]																																			
5.2 Leveling of sand	1.0	m ³	25,920	1,200	22	[Gantt bars for 2024-2026]																																			
5.3 Dredging and spreading of sand (for maintenance sand)	0.8	m ³	30,000	24,408	2	[Gantt bars for 2024-2026]																																			
5.4 Produce and piling up of sandbag (for maintenance sand, as temporary revetment)	1.0	Num	5,968	288	21	[Gantt bars for 2024-2026]																																			
5.5 Leveling of sand (for maintenance sand, piling up)	1.0	m ³	30,000	1,200	25	[Gantt bars for 2024-2026]																																			
6. Reclamation (North side: 22,000m²)		m ²	22,000			[Gantt bars for 2024-2026]																																			
6.1 Dredging and spreading of sand	0.8	m ³	77,000	24,408	4	[Gantt bars for 2024-2026]																																			
6.2 Leveling of sand	1.0	m ³	77,000	1,200	65	[Gantt bars for 2024-2026]																																			

5.8.2 Calculation of the approximate construction cost

(1) Summary of construction cost

Construction cost for GCF Project is 19,478 thousand USD in total of three islands and total cost is increased 2,834 thousand USD (1.5% increased) compare with funding proposal.

On the other hands, construction cost for Maldivian government cofinancing is 3,884 thousand USD in total of three islands and total cost is decreased 460 thousand USD (10.6% decreased) compare with funding proposal.

The calculated construction cost is temporary result on the basic design phase, and it is necessary to revise on the detail design phase. The total construction cost for funding proposal and final proposal by project fund by target islands is as bellow.

Table 5.8.24 Summary of Construction Cost by Project Fund by Target Islands
(Comparison Funding Proposal and Final Proposal)

unit:USD

Fund	Island	Amount		
		Original Plan	Final Proposal	Difference
GCF	1 Maamendhoo	11,388,500	12,747,725	+1,359,225 (111.9%)
	2 Fonadhoo	6,194,400	4,712,393	-1,482,007 (76.1%)
	3 Meedhoo	1,611,300	2,017,440	+406,140 (125.2%)
	Total	19,194,200	19,477,558	+283,358 (101.5%)
GoM	1 Ishdhoo	886,000	2,126,755	+1,240,755 (240.0%)
	2 Gan	886,000	746,812	-139,188 (84.3%)
	3 Meedhoo	2,572,000	1,010,855	-1,561,145 (39.3%)
	Total	4,344,000	3,884,423	-459,577 (89.4%)

The comparison results of the construction cost for funding proposal and final proposal by target facilities for GCF Project and Maldives government cofinancing project is as follow.

Table 5.8.25 Comparison Result of the Construction Cost for Funding Proposal and Final Proposal by Islands by Facilities (GCF Project)

Fund	Island	Item	Unit	Original Plan		Final Proposal		
				Oty	Amount(USD)	Oty	Amount(USD)	
GCF	1 Maamendhoo	1.General and Preparatory Works	sum	1	3,069,500	1	3,662,159	
		2.1 Groin (W+E) ⇒ (W)	unit	7	1,917,797	3	630,853	
		2.2 Revetment (N)	m	540	1,682,935	540	3,582,306	
		2.3 Revetment (E)	m	-	-	300	366,242	
		3.1 Beach Fill (W+E) ⇒ (W)	m	900	751,200	400	592,804	
		3.2 Reclamation (N)	m ²	22,000	1,120,000	22,000	726,431	
		4.Other Works (10% of Total)	sum	1	949,048	1	1,062,310	
		Total				9,490,479		10,623,104
		Others (20% of direct construction cost)				1,898,096		2,124,621
		Total (including other works)				11,388,500		12,747,725
	2 Fonadhoo	1.General and Preparatory Works	sum	1	2,420,000	1	2,456,859	
		2.1 Groin	unit	5	1,471,671	-	-	
		3.1 Beach Fill	m	850	754,320	1,600	1,077,436	
		4.Other Works (10% of Total)	sum	1	516,000	1	392,699	
		Total				5,161,991		3,926,994
		Others (20% of direct construction cost)				1,032,398		785,399
		Total (including other works)				6,194,400		4,712,393
		3 Meedhoo	1.General and Preparatory Works	sum	1	470,800	1	750,000
	3.1 Beach Fill		m	1,400	872,000	1,600	931,200	
	Total					1,342,800		1,681,200
	Others (20% of direct construction cost)					268,560		336,240
	Total (including other works)					1,611,300		2,017,440
	Total				19,194,200		19,477,558	

Table 5.8.26 Comparison Result of the Construction Cost for Funding Proposal and Final Proposal by Islands by Facilities (Maldives Government Cofinancing Project)

Fund	Island	Item	Unit	Original Plan		Final Proposal		
				Oty	Amount(USD)	Oty	Amount(USD)	
GoM	1 Ishdhoo	1.General and Preparatory Works	sum	1		1	319,013	
		2.1 Revetment	m	270		360	1,276,053	
		4.Other Works (10% of Total)	sum	1		1	177,230	
		Total					738,333	1,772,296
		Others (20% of direct construction cost)					147,667	354,459
		Total (including other works)					886,000	2,126,755
	2 Gan	1.General and Preparatory Works	sum	1		1	112,022	
		2.1 Revetment	m	270		270	448,087	
		4.Other Works (10% of Total)	Sum	1		1	62,234	
		Total					738,333	622,344
		Others (20% of direct construction cost)					147,667	124,469
		Total (including other works)					886,000	746,812
	3 Meedhoo	1.General and Preparatory Works	sum	1		1	151,628	
		2.1 Groin	unit	7		1	433,182	
		3.1 Beach Fill	m	1,400		1,600	173,331	
		4.Other Works (10% of Total)	sum	1		1	84,238	
		Total					2,143,333	842,379
		Others (20% of direct construction cost)					428,667	168,476
		Total (including other works)					2,572,000	1,010,855
	Total					4,343,999	3,884,423	

(2) Construction cost by islands

1) Construction cost for Maamendhoo Island

Construction cost for Maamendhoo Island implemented as GCF Project is 12,748 thousand USD.

Table 5.8.27 Breakdown of Construction Cost for Maamendhoo Island

Bill. No.	Item	Unit	Qty	Unit Price (USD)	Amount (USD)	Remarks
1	General and Preparatory Works					
101	Mobilization and demobilization (TSHD)	Sum	0.5	3,500,000.00	1,750,000	
102	Mobilization and demobilization	Sum	1.0	318,693.13	318,693	3% of Total
103	Common Temporary works	Sum	1.0			
104	Survey and monitoring works before, during and after construction	Sum	1.0		1,593,466	15% of Total
105	Preparation of report, drawing, photo, video and others	Sum	1.0			
	Sub-total				3,662,159	
2.1	Groin (3 unit(W), L=50m/unit)					
201a	Supply and unloading of core rubble and filter stone	cu.m	3,053	123.54	377,168	Overfill factor 10%
201b	Supply and unloading of armour stone	cu.m	1,221	123.54	150,842	Overfill factor 10%
202a	Installation and leveling of core rubble and filter stone	cu.m	3,053	24.06	73,463	
202b	Installation and leveling of armour stone	cu.m	1,221	24.06	29,380	
	Sub-total				630,853	
2.2	Revetment (L=540m(N))					
201a	Supply and unloading of core rubble and filter stone	cu.m	14,256	123.54	1,761,186	Overfill factor 10%
201b	Supply and unloading of armour stone	cu.m	8,910	123.54	1,100,741	Overfill factor 10%
202a	Installation and leveling of core rubble and filter stone	cu.m	14,256	24.06	343,035	
202b	Installation and leveling of armour stone	cu.m	8,910	24.06	214,397	
203	Supply and installation of geotextile	sq.m	14,256	4.52	64,396	
204	Pavement for walkway	sq.m	1,080	61.61	66,535	
205	Supply and installation of U-ditch	ln.m	540	59.29	32,015	
	Sub-total				3,582,306	
2.3	Revetment (L=300m(E))					
201a	Supply and unloading of core rubble and filter stone	cu.m	495	123.54	61,152	Overfill factor 10%
201b	Supply and unloading of armour stone	cu.m	1,650	123.54	203,841	Overfill factor 10%
202a	Installation and leveling of core rubble and filter stone	cu.m	495	24.06	11,911	
202b	Installation and leveling of armour stone	cu.m	1,650	24.06	39,703	
203	Supply and installation of geotextile	sq.m	2,805	4.52	12,670	
204	Pavement for walkway	sq.m	600	61.61	36,964	
	Sub-total				366,242	
3.1	Beach Fill (L=400m(W))					
301a	Supply, transporting and spreading of sand	cu.m	25,920	8.00	207,360	Overfill factor: 20%
301a	Supply, transporting and spreading of sand	cu.m	30,000	8.00	240,000	for stockpile
302a	Forming of beach	cu.m	25,920	1.43	37,174	
302b	Forming of stockpile	cu.m	30,000	1.83	55,035	for stockpile
303	Forming temporary revetment by sand bag	num	5,968	8.92	53,235	for stockpile
	Sub-total				592,804	
3.2	Reclamation (A=22,000m²)					
301a	Supply, transporting and spreading of sand	cu.m	77,000	8.00	616,000	Overfill factor 10%
302c	Leveling	cu.m	77,000	1.43	110,431	
	Sub-total				726,431	
4	Other works (10% of Total)	Sum			1,062,310	
	Total				10,623,104	
	Others (20% of direct construction cost)				2,124,621	
	Total (including other works)				12,747,725	

2) Construction cost for Fonadhoo Island

Construction cost for Fonadhoo Island implemented as GCF Project is 4,712 thousand USD.

Table 5.8.28 Breakdown of Construction Cost for Fonadhoo Island

Bill. No.	Item	Unit	Qty	Unit Price (USD)	Amount (USD)	Remarks
1	General and Preparatory Works					
101	Mobilization and demobilization (TSHD)	Sum	0.5	3,500,000.00	1,750,000	
102	Mobilization and demobilization	Sum	1.0	117,809.82	117,810	3% of Total
103	Common Temporary works	Sum	1.0			
104	Survey and monitoring works before, during and after construction	Sum	1.0		589,049	15% of Total
105	Preparation of report, drawing, photo, video and others	Sum	1.0			
	Sub-total				2,456,859	
3.1	Beach Fill (L=1600m)					
301b	Supply, transporting and spreading of sand	cu.m	76,800	8.00	614,400	Overfill factor: 20%
301c	Supply, transporting and spreading of sand	cu.m	36,000	8.00	288,000	for stockpile
302a	Forming of beach	cu.m	76,800	1.43	110,144	
302b	Forming of stockpile	cu.m	30,000	1.83	55,035	
303	Forming temporary revetment by sand bag	num	1,105	8.92	9,857	
	Sub-total				1,077,436	
4	Other works (10% of Total)	Sum			392,699	
	Total				3,926,994	
	Other works (20% of direct construction cost)				785,399	
	Total (including other works)				4,712,393	

3) Construction cost for Isdhoo Island

Construction cost for Isdhoo Island implemented as Maldives government cofinancing project is 2,127 thousand USD.

Overfill of rock material is increased to 25% because there is possibility to move the normal line to offshore side to protect vegetation which grown by target area on detail design phase.

Table 5.8.29 Breakdown of Construction Cost for Isdhoo Island

Bill. No.	Item	Unit	Qty	Unit Price (USD)	Amount (USD)	Remarks
1	General and Preparatory Works					
102	Mobilization and demobilization	Sum	1.0	53,168.88	53,169	3% of Total
103	Common Temporary works	Sum	1.0			
104	Survey and monitoring works before, during and after construction	Sum	1.0		265,844	15% of Total
105	Preparation of report, drawing, photo, video and others	Sum	1.0			
	Sub-total				319,013	
2.1	Revetment (L=360m)					
201a	Supply and unloading of core rubble and filter stone	cu.m	1,800	123.54	222,372	Overfill factor: 25%
201b	Supply and unloading of armour stone	cu.m	6,345	123.54	783,861	Overfill factor: 25%
202a	Installation and leveling of core rubble and filter stone	cu.m	1,800	24.06	43,313	
202b	Installation and leveling of armour stone	cu.m	6,345	24.06	152,677	
203	Supply and installation of geotextile	sq.m	6,525	4.52	29,474	
204	Pavement for walkway	sq.m	720	61.61	44,357	
	Sub-total				1,276,053	
4	Other works (10% of Total)	Sum			177,230	
	Total				1,772,296	
	Others (20% of direct construction cost)				354,459	
	Total (including other works)				2,126,755	

4) Construction cost for Gan Island

Construction cost for Gan Island implemented as Maldives government cofinancing project is 747 thousand USD.

Table 5.8.30 Breakdown of Construction Cost for Gan Island

Bill. No.	Item	Unit	Qty	Unit Price (USD)	Amount (USD)	Remarks
1	General and Preparatory Works					
102	Mobilization and demobilization	Sum	1.0	18,670.31	18,670	3% of Total
103	Common Temporary works	Sum	1.0			
104	Survey and monitoring works before, during and after construction	Sum	1.0		93,352	15% of Total
105	Preparation of report, drawing, photo, video and others	Sum	1.0			
	Sub-total				112,022	
2.1	Revetment (L=270m(N))					
200b	Removal of existing revetment (cement bag)	cu.m	864	8.72	7,531	
201a	Supply and unloading of core rubble and filter stone	cu.m	1,188	123.54	146,766	Overfill factor:10%
201b	Supply and unloading of armour stone	cu.m	1,485	123.54	183,457	Overfill factor:10%
202a	Installation and leveling of core rubble and filter stone	cu.m	1,188	24.06	28,586	
202b	Installation and leveling of armour stone	cu.m	1,485	24.06	35,733	
203	Supply and installation of geotextile	sq.m	2,822	4.52	12,747	
204	Pavament for walkway	sq.m	540	61.61	33,268	
	Sub-total				448,087	
3	Other works (10% of Total)	Sum			62,234	
	Total				622,344	
	Others (20% of direct construction cost)				124,469	
	Total (including other works)				746,812	

5) Construction cost for Meedhoo Island

Construction cost for Meedhoo Island implemented as GCF Project is 2,017 thousand USD, and Maldives government cofinancing project is 1,011 thousand USD.

Table 5.8.31 Breakdown of Construction Cost for Meedhoo Island (GCF Project)

Bill. No.	Item	Unit	Qty	Unit Price (USD)	Amount (USD)	Remarks
1	General and Preparatory Works					
101	Mobilization and demobilization (TSHD)	Sum	1.0	750,000.00	750,000	
	Sub-total				750,000	
3.1	Beach Fill (L=1600m)					
301d	Supply, transporting and spreading of sand	cu.m	86,400	8.00	691,200	Overfill factor: 20%
301d	Supply, transporting and spreading of sand	cu.m	30,000	8.00	240,000	
	Sub-total				931,200	
	Total				1,681,200	
	Other works (20% of direct construction cost)				336,240	
	Total (including other works)				2,017,440	

Table 5.8.32 Breakdown of Construction Cost for Meedhoo Island (Maldives Government Cofinancing Project)

Bill. No.	Item	Unit	Qty	Unit Price (USD)	Amount (USD)	Remarks
1	General and Preparatory Works					
102	Mobilization and demobilization	Sum	1.0	25,271.37	25,271	3% of Total
103	Common Temporary works	Sum	1.0			
104	Survey and monitoring works before, during and after construction	Sum	1.0		126,357	15% of Total
105	Preparation of report, drawing, photo, video and others	Sum	1.0			
	Sub-total				151,628	
2.1	Groin (1 unit, L=70m/unit)					
201a	Supply and unloading of core rubble and filter stone	cu.m	1,835	123.54	226,696	Overfill factor: 10%
201b	Supply and unloading of armour stone	cu.m	1,314	123.54	162,332	Overfill factor: 10%
202a	Installation and leveling of core rubble and filter stone	cu.m	1,314	24.06	31,618	
202b	Installation and leveling of armour stone	cu.m	521	24.06	12,537	
	Sub-total				433,182	
3.1	Beach Fill (L=1700m)					
200a	Removal of existing revetment (sand bag)	num	2,375	17.29	41,051	
200b	Removal of existing revetment (cement bag)	cu.m	960	8.72	8,368	
302a	Forming of beach	cu.m	86,400	1.43	123,912	Overfill factor: 20%
	Sub-total				173,331	
4	Other works (10% of Total)	Sum			84,238	
	Total				842,379	
	Other works (20% of direct construction cost)				168,476	
	Total (including other works)				1,010,855	

(3) Setting of unit rate of machineries, materials and labor cost

Unit rate of machineries, materials and labor cost is set based on the result of interview to local contractors as follow.

Table 5.8.33 List of Unit Rate of Machineries

Item	Description	Unit	Unit rate
Excavator	D 1.0m ³	USD/d	350
Bulldozer	D6	USD/d	600
Wheel Loader	D 1.5m ³	USD/d	500
Dump Truck	10t	USD/d	250
Baby Roller	1t	USD/d	700
Generator	50KvA	USD/d	150

Table 5.8.34 List of Unit Rate of Materials

Item	Description	Unit	Unit rate
Rock boulder	1kg-30kg	USD/m ³	120
	30kg-50kg	USD/m ³	120
	50kg-100kg	USD/m ³	120
	100kg-300kg	USD/m ³	120
	300kg-500kg	USD/m ³	120
	Over than 500kg	USD/m ³	120
Crushed stones		USD/m ³	30
Base Course		USD/m ³	30
Sand for filling		USD/m ³	10
Natural stone		USD/m ²	20
Mortar		USD/m ³	40
Geotextile		USD/m ²	4
Precast U-ditch		USD/ln	40
Sand bag		USD/n	5
Fuel		USD/L	1.50

Table 5.8.35 List of Unit Rate of Labor

Item	Unit	Unit rate
Supervisor	USD/d	350
Skilled labor	USD/d	600
Common labor	USD/d	500
Operator of Machinery	USD/d	150
Truck driver	USD/d	

CHAPTER 6 Environmental and Social Considerations and Gender Considerations

6.1 Environmental and Social Assessment of the Project

6.1.1 Project Component to be Assessed from Environmental and Social Points of View

(1) Component 1

The Component 1 aims to establish Integrated Coastal Zone Management (ICZM) along with the capacity development of government officials responsible for the enforcement of the ICZM. The proposed adaptation measures do not include the physical development, therefore, there are no adverse impacts for the natural environment. The ICZM plan includes basic plan of coastal and reef conservation, sediment budget control and coastal land use at the national level. Applying the concept of the ICZM at the Island level, the ICZM plans for Gan and Fonadhoo islands in Laamu Atoll are to be formed as a case study. The ICZM at the national level as well as the island level will be examined from the view point of Strategic Environment Assessment (SEA).

(2) Component 2

The component 2 is basic design for physical measures for protecting coastal areas at 5 targeted islands. The project component is presented in Table 6.1.1. (see detail of the project in Chapter 5.4. Examination of the draft basic plan)

Table 6.1.1 Project Component

Location	Project component	
Isdhoo Island, Laamu Atoll	Revetment (Rubble type)	In order to protect the national cultural heritage area from coastal erosion, 360 m of coastal area at the north tip of the island (ocean side) is to be protected with revetment
Gan Island, Laamu Atoll	Revetment (Rubble type)	In order to protect the national cultural heritage area from coastal erosion, 270m of coastal area at the east side (ocean side) of the island is to be protected with revetment
Fonadhoo Island, Laamu Atoll	Beach nourishment	1,600 m of the beach in the east side (ocean side) of island is to be protected by beach nourishment
Maamendhoo Island, Laamu Atoll	Beach nourishment with 3 groins Reclamation Revetment (Rubble type)	400m of the beach in the west side is to be protected by beach nourishment with 3groins 70,000m ³ of the north tip of the island is to be reclaimed for securing an evacuation area 300m of the east costal area is to be protected with revetment
Meedhoo Island, Addu City	Beach nourishment with one groin	1,700m of the north tip of the island is to be protected by beach nourishment with one groin.

Note: Details of each project component will be finalized at D/D phase.

Source: JICA Expert Team

6.1.2 Condition of Survey Area

(1) Natural Environment

Geography

Maldives is formed from 26 atolls and about 1,200 islands of different shapes and sizes in the Indian Ocean. The characteristics of atolls and reefs vary greatly from north to south depending on latitude. The atolls located in the north are not composed of continuous edge of the atolls, but are composed of a large number of ring-shaped coral reefs which is called faro. The atolls located in the south tend to have a series of islands and fewer Faro.

In the north, beach ridges with coral gravel are often formed on the ocean side, and in the south, there are many low and flat islands. The ground levels of the inhabited areas are about 1.0 to 2.0 m above the average sea level on the northern island, and about 0.6 to 1.6 m on the central and southern islands. The water depth of the lagoon is 30 to 40m in the north, 40 to 60m in the middle, and 60 to 80m in the south.

Climate

Maldives has a hot and humid tropical climate with an average temperature of 26 to 33 ° C (average maximum temperature of 30 to 33, ° C and average minimum temperature of 24 to 28 ° C) throughout the year. The seasons are divided into two periods which are the northeast monsoon season (November to April) and the southwest monsoon season (May to October). Temperature, wind conditions, rainfall and tide level are being observed at the three locations of Hanimaadhoo in Haa Dhaalu Atoll, Male in North Male Atoll, and Gan in Laamu Atoll. Figure 6.1.1 and Figure 6.1.2 show monthly average maximum and minimum temperature at each location.

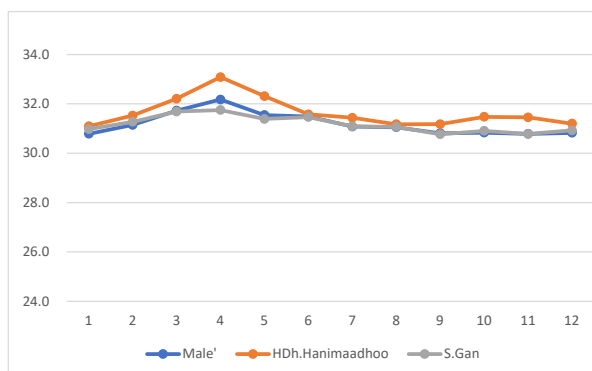


Figure 6.1.1 Average Maximum Temperature at Three Measuring Points

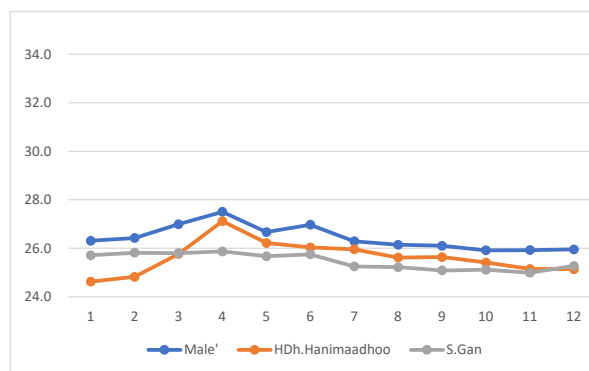


Figure 6.1.2 Average Minimum Temperature at Three Measuring Points

Source: National Bureau of Statics, modified by JICA Expert team

The average monthly rainfall from 2011 to 2020 at three measuring points is shown in Figure 6.1.3. The amount of rainfall in Maldives varies according to the two monsoon seasons. Southwest monsoon season (May to October) has more rainfall than the northeast monsoon season (November to April). As can be seen from the annual average rainfall at the three measuring points shown in Figure 6.1.4, there are no differences in rainfall during the southwest monsoon season (May to October) all over the Maldives, however, rainfall during the northeast monsoon season (November to April) tends to increase from the north to the south in the Maldives.

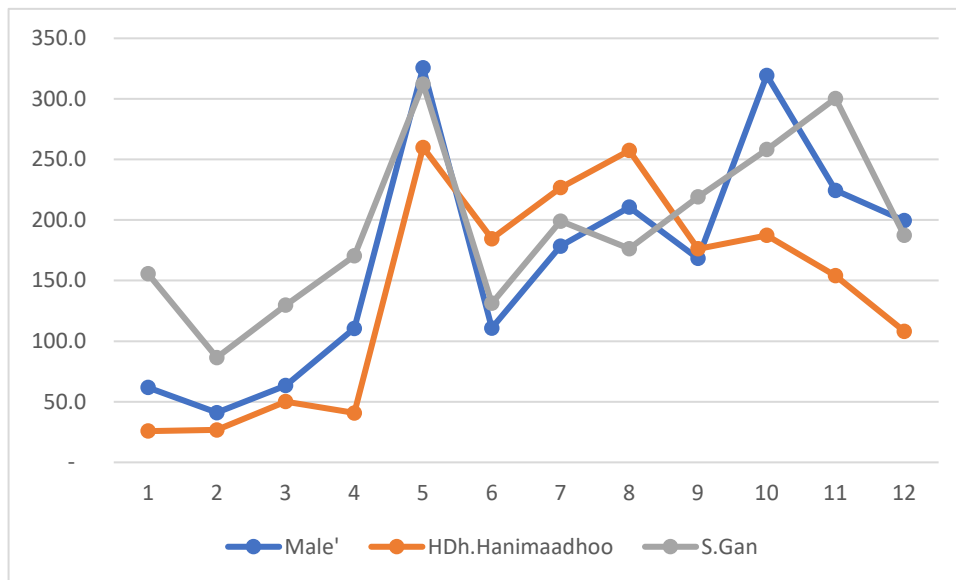


Figure 6.1.3 Average Monthly Rainfall from 2011 to 2020 at Three Measuring Points (2011-2020)

Source: National Bureau of Statics, modified by JICA Expert team

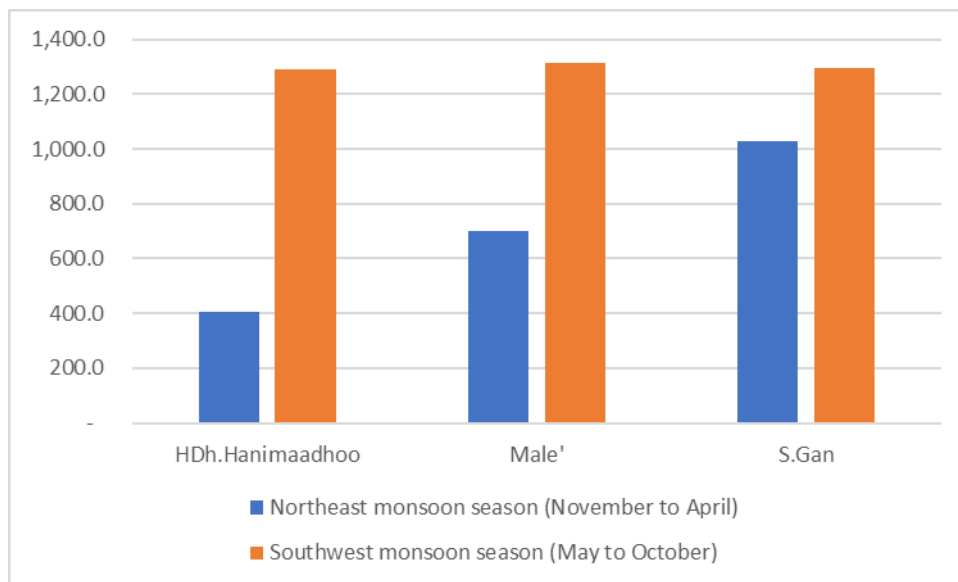


Figure 6.1.4 Annual Average Rainfall at the Three Measuring Points (2011-2020)

Source: National Bureau of Statics, modified by JICA Expert team

Hydrology

Table 6.1.2 shows the tide level conditions at three measuring points in the Maldives obtained from the observation results by Ministry of Environment and Energy (2016). The average tide level difference in Maldives is not so large, and less than 1m in average.

Table 6.1.2 Tide Level Conditions at Three Measuring Points

Water Level from MSL(m)	Hanimaadhoo (2010-2011)	Male (2007-2011)	Gan (1992-1998)
Highest High Water (HHW)	0.62	0.62	0.79
Mean Highest High Water (MHHW)	0.36	0.34	0.39
Mean High Water (MHW)	0.35	0.33	0.38
Mean Low Water (MLW)	-0.41	-0.36	-0.40
Mean Lowest Low Water (MLLW)	-0.42	-0.37	-0.41
Lowest Low Water (LLW)	-0.80	-0.72	-0.78

Source: Second National Communication of Maldives (2016)
University of Hawaii Sea Level Center database.

Source: JICA Expert Team

Protected area

There were no nature reserves, including marine protection areas, established on the target islands of Laamu Atoll, however, in 2021, the seven (7) sites, including coast and coral reef areas around Fairly pond (Boda Fengan' du Area) on Gan Island has been designated as a protected area.

In Addu Atoll, a protected area has been established around Hithadhoo Island and the Kandihera-Maakandu Channel, which is about 7 to 14 km away from the target area in Meedoo island. In 2020, the two (2) sites in Meedhoo (Hulhumeedhoo) island were designated as protected areas: Mathi Kilhi and Maafishi Kilhi, but those two areas are inland wetland, so that there are no adverse impact from the beach nourishment along the northern coast of Meedhoo island.

Protected areas in two atolls are listed as following tables and figures.

Table 6.1.3 Protected Areas in Addu and Laamu Atolls

(1) Laamu Atoll

Name	Islands	Area (ha)	PA Type
L. Gan Boda Fengan' du Area	L. Gan	15.03ha	Wetland/ Terrestrial
L. Maabaidhoo Koaru Area	L. Maabaidhoo	174.46ha	Wetland
L. Fushi Kan' du Area		346.62ha	Marine
L. Bodu Finolhu and Vadinolhu Kandu Olhi Area		706.02ha	Marine
L. Gaadhoo Turtle Nesting Area, Mangrove and Seagrass Area	L. Gaadhoo	614.88ha	Terrestrial/ Marine
L. Gaadhoo Hithadhoo Gan' du Area		777.04ha	Marine
L. Hithadhoo Wetland and Surrounding Marine Area	L. Hithadhoo	43.3ha	Mangrove/ Wetland/ Marine

Source: (IUL)438-ENV/438/2021/371

(2) Addu Atoll

Name	Islands	Area (ha)	PA Type
Eidhigali Kilhi And KoattheyArea	S. Hithadhoo	770.6ha	Mangrove/MPA
Kandihera-Maakandu Channel (Addu MantaPoint)	Kandihera-Maakandu	735.0ha	MPA
British Loyalty Shipwreck		64.7ha	MPA
Kuda Kandu	Kuda Kandu	462.0ha	MPA
Maakilhi and Feheli Kilhi	S. Hithadhoo	25.4ha	Mangrove/ Wetland

Name	Islands	Area (ha)	PA Type
Maafishi Kilhi	S. Hulhumeedhoo	5.8ha	Mangrove/ Wetland
Mathi Kilhi	S. Hulhumeedhoo	54.1ha	Mangrove/ Wetland

Source: (IUL)438-ENV/438/2020/162

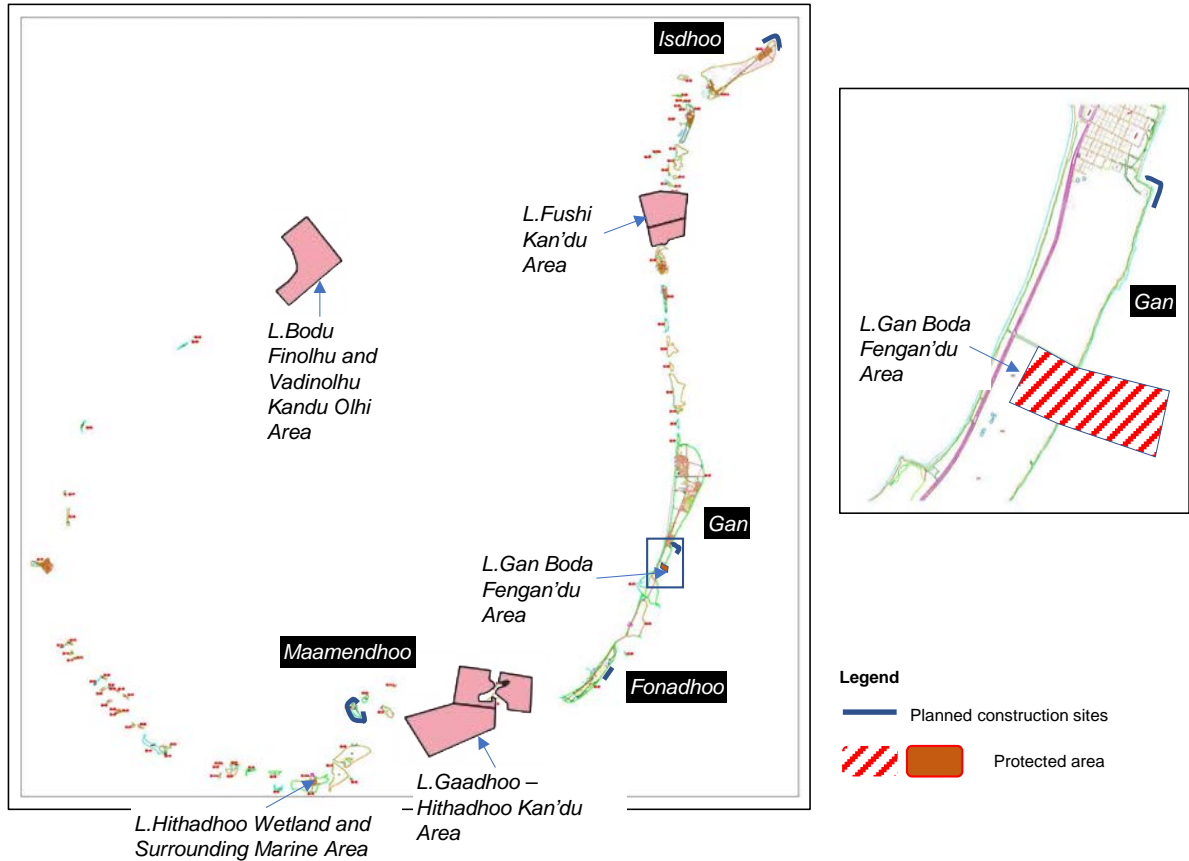


Figure 6.1.5 Location of the Protected Area in Laamu Atoll

Source: EPA (2021), modified by JICA Expert team

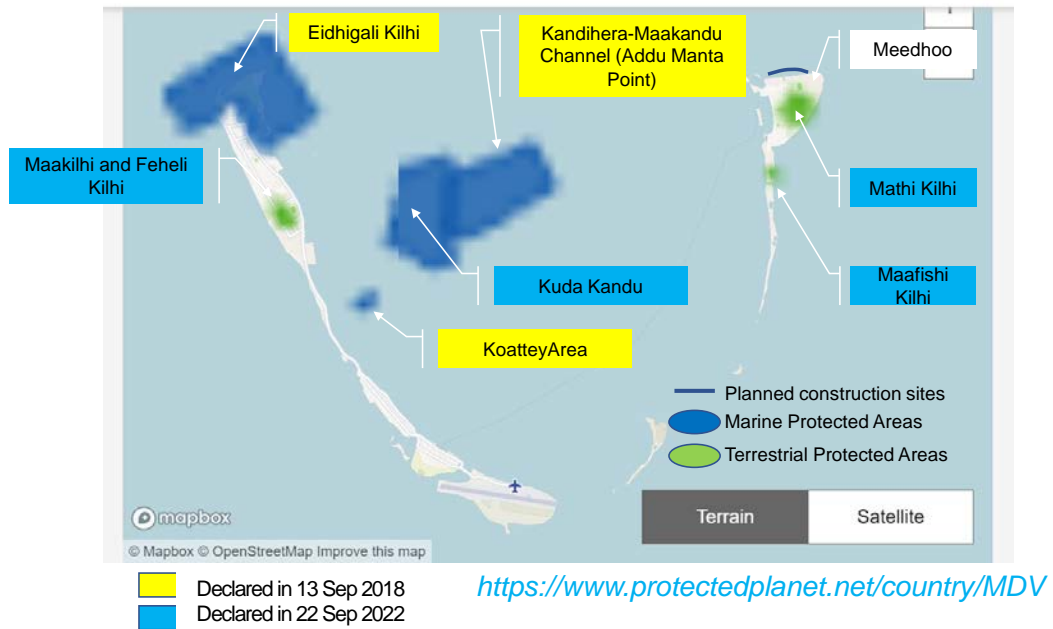


Figure 6.1.6 Location of the Protected Area in Addu Atoll

Source: UNEP-WCMC and IUCN (2022): (<https://www.protectedplanet.net/en/country/MDV>), modified by JICA Expert Team

In Maldives, there is only one Key Biodiversity Area (KBA) site and Important Bird Area (IBA) site in Haa Alifu Atoll, and there is no KBA sites in the project areas.

Also, the whole areas of Addu Atoll were designated as the Addu Atoll Biosphere reserve in October 2020, and all the areas are categorized into three categories: i.e. core zone, buffer zone and transition area. The locations of all of the protected areas are same as the locations of core zones and buffer zones of the Biosphere reserve. The locations of the Addu Atoll Biosphere reserve are shown in the following figure.

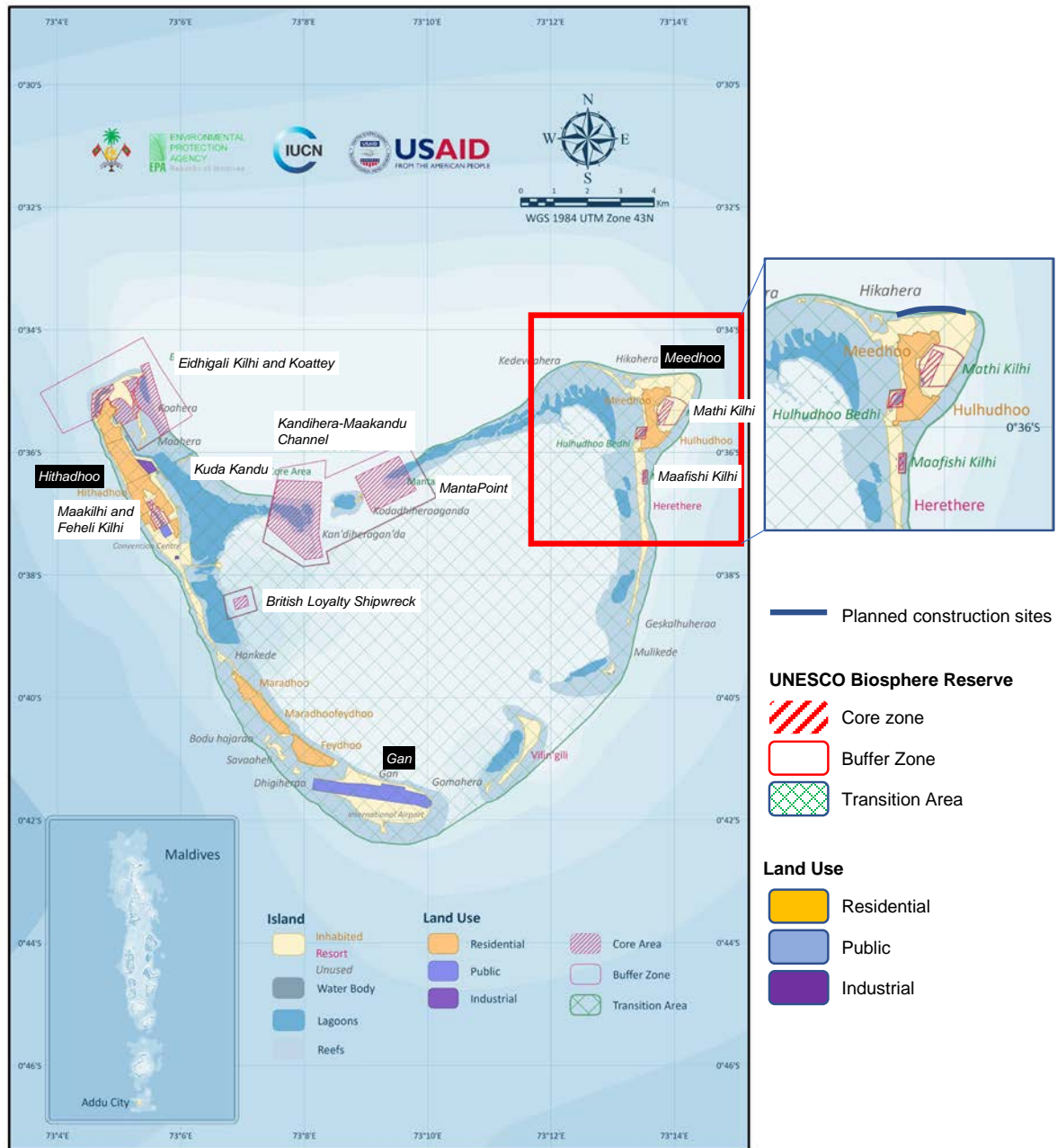


Figure 6.1.7 Location of the Addu Atoll Biosphere reserve

Source: UNESCO (2020) (<https://en.unesco.org/biosphere/aspac/addu-atoll>), modified by JICA Expert Team

(2) Social Environment**Population and Habitat**

Population and population density of 5 targeted islands is shown in Table 6.1.4. The population density in Maamendhoo is prominently high among 5 islands.

Table 6.1.4 Population, Population Density and Number of Households in 5 islands

Island	Population (male/female)	Population Density (person/m)	Households (number)
Fonadhoo	3,010 (1540/1470)	17.79	723
Gan	5,236 (2687/2349)	10.13	710
Isdhoo	1,425 (N/A)	N/A	N/A
Maamendhoo	1,337	68.92	250
Meedhoo	3037 (1549/1488)	16.16	570

Source: JICA Expert Team

Religion

All targeted islands are Suni Muslim.

Employment by Sector

Depend upon the island, employment by sector varies. Government services is the most popular sector in Fonadhoo and Gan. Isdhoo is more agriculture-oriented island. The most of the people is engaged in fishery in Maamendhoo. Private business (trading) is the most popular in Meedhoo. The employment by sector in 5 islands is presented in Table 6.1.5 .

Table 6.1.5 Employment by Sector in 5 islands

Island	Sector	% in total employment
Fonadhoo	1.Government Services	90
	2.Private business (trading)	9
	3.Tourism	1
Gan	1.Government Services	N/A
	2.Fishery	
	3.Agriculture	
	4.Private business	
	5.Tourism	
Isdhoo	1.Agriculture	90
	2.Government Services	N/A
	3.Fisheries	N/A
Maamendhoo	1.Fishery	70
	2.Government Services	15
	3.Tourism	15
Meedhoo	1.Private business (trading)	36
	2. Tourism	35
	3.Government Services	25
	3.Agriculture	2
	4.Fishery	2

Source: JICA Expert Team

Source of Water

Well water and rain water is the most popular water source in 5 islands. Supply water is available in Fonadhoo, Gan and Meedhoo islands. There is a plan to construct water treatment plant in Isdhoo and Maamendhoo. The water source in 5 islands is presented in Table 6.1.6.

Table 6.1.6 Water Source in 5 islands

Island	Water Source	Remarks
Fonadhoo	Well water Rain water Supply water	Ground water is treated at the water treatment plant in the Island and supplied through distribution pipe. 27% of the household is contracted to the supply water system. Rain water is used for cooking, washing, and farming Bottled water for drinking is also popular
Gan	Well water Rain water	Rain water is used for cooking, washing, and farming In case of emergency (draught), water is to be distributed from the desalination plant through water distribution pipe covering all houses in the Island.
Isdhoo	Well water Rain Water	Rain water is used for cooking, washing, and farming
Maamendhoo	Well water Rain water	Rain water is used for cooking, washing, and farming
Meedhoo	Well water Rain water Supply water	Well water is used for washing and cooking Rain water is used for drinking Bottled water is also popular for drinking Most of the household is connected to the desalination plant.

Source: JICA Expert Team

Energy Consumption

All island is electrified by diesel generators. Energy source for cooking is gas (Butane), electricity and firewood in all islands. Electrification rate and energy source for cooking in 5 islands is presented in Table 6.1.7.

Table 6.1.7 Electrification Rate and Energy Source for Cooking

Island	Electrification Rate (%)	Energy Source for Cooking
Fonadhoo	100	Gas (Butane: main source)
Gan	Diesel generator	Electricity
Isdhoo		Firewood (only when cooking large amounts to save gas)
Maamendhoo		
Meedhoo		

Source: JICA Expert Team

Transportation

More than 1 sea port is in operation in 5 islands. Number of seaport and airport in 5 islands is presented in Table 6.1.8.

Table 6.1.8 Number of Seaport and Airport in 5 islands

Island	Seaport	Airport
Fonadhoo	1	0
Gan	2	0
Isdhoo	1	0
Maamendhoo	1	0
Meedhoo	2	0

Source: JICA Expert Team

Education

There is a school covering up to the 12th grade (higher secondary level) in all islands except Isdhoo (up to 7th grade primary level) and Meedhoo (up to 10th grade lower secondary level). Number of schools in 5 islands is presented in Table 6.1.9.

Table 6.1.9 Number of School in 5 islands

Island	Type and number of schools
Fonadhoo	Pre-school 1, School (primary and secondary) 1, Islamic University 1
Gan	Pre-school 1, School 1
Isdhoo	Pre-school 1, School up to 7 th grade 1
Maamendhoo	Pre-school 1, School 1
Meedhoo	Pre-school 2, School up to 10 th grade 1

Source: JICA Expert Team

Waste Management

There is one open dumping site prepared for each island. Starting from the 1st June 2022, waste segregation (organic waste, plastics, others such as papers, cans and glasses) become compulsory¹⁾ at generated points such as household and commercial facilities in the capital city Malé and it will be gradually adapted to other Atolls. In Addu city and Laamu Atoll, the waste segregation has not practiced formally yet. In Meedhoo Island, waste needs to be segregated in 7 items, food residues, paper, plastic bottle, glass, steel, aluminum and hazardous waste and collected once in a week. Number of dumping site and method of collection is shown in Table 6.1.10.

Table 6.1.10 Number of Dumping Site and Method of Collection

Island	Number and location of the dumping site	Method of collection	Collection fee
Fonadhoo	1 End of south east side of the Island	Collected everyday About 70% of houses are registered for the service	150MVR/Month
Gan	1 Middle part along east shoreline	Collected everyday 80% of houses are registered for the service	150MVR/Month
Isdhoo	1 North east of the Island	Collected every day except Friday Isdhoo Island Council is in charge of waste collection service 234 houses and 15 café/shops registered for the service	140MVR/Month
Maamendhoo	1 West tip of the Island	Collected every day except Friday Maamendhoo Island Council is in charge of waste collection service	100MVR/Month from Household 200MVR/Month from Government organizations
Meedhoo	1 North east of the Island	WAMCO (Gov. company) Waste is to be segregated as food residues, plastic bottle, glass, steel, iron, hazardous waste and collected once in a week	100 MVR

Source: JICA Expert Team

Cultural Heritage

Gamu Hath'theli in Gan Island and Isdhoo Bodu Hath'theli in Isdhoo Island are ancient Buddhist heritages declared as National Cultural Heritage in 2019. In Meedhoo Island, the oldest Muslim cemetery in the Maldives called Koagannu Cemetery dating back 900 years is declared as National Cultural Heritage.

6.1.3 Legal and Institutional Framework in Maldives

(1) Legislation relevant to Environmental and Social Considerations

Laws and Regulations

Law and regulations relevant to environmental and social considerations are listed in Table 6.1.11

Table 6.1.11 Law and Regulations Relevant to Environmental and Social Considerations

Regulations
Environmental Protection and Preservation Act (Act No.4/93) First amendment (2014)
Environmental Assessment Regulation (2012) First amendment (2013/ R-18) Second amendment (2015/ R-174) Third amendment (2016/ R-66) Fourth amendment (2017/ R-7) Fifth amendment (2018/ R-131)
Regulation for the Determination of Penalties and Obtaining Compensation for Damages Caused to the Environment (2011/R-9)
Waste Management Regulation (2013/R-58)
Dredging and Reclamation Regulation (Regulation 2013/R15) First amendment (2014)
Cultural and Historical Places and Object Act (Act No.27/79)
Regulation on Cutting Down and Export of Trees and Coconut Palms (Regulation 7-R/2014)
Coral and Sand Mining Regulation (2000)
Regulation on Protected Areas (2018/R-78)
Protect Species Regulation (2021 R-25)

Source: JICA Expert Team

Environmental Protection and Preservation Act (Act No.4/1993)²⁾

The Environmental Protection and Preservation Act of the Maldives (Law No. 4/93), provides the basic framework for environmental management including the Environmental Impact Assessment (EIA) process in the Maldives, which is currently being implemented by the Environmental Protection Agency (EPA) on behalf of Ministry of Planning, Human Resources and Environment. It gives the Government of the Maldives the right to claim compensation for all damages caused by activities that are detrimental to the environment.

1st Amendment to Environmental Protection and Preservation Act (2014)³⁾

The Clause 3 of the Environment Act was amended by the first amendment of the Environmental Protection and Preservation Act in 2014, which defines duties of the state institution mandated with executing the environment policies of the Maldives. It shall formulate policies, regulations and standards with consultation from relevant

authorities to protect biodiversity, access to benefit sharing, to protect freshwater lens of islands and mangroves within, to protect from waste and hazardous gases and protect and conserve the environment.

Environmental Impact Assessment Regulation (2012)⁴⁾

The Ministry of Environment issued the EIA regulation in May 2012, which guides the process of undertaking the Environmental Impact Assessment in the Maldives. This guideline also provides a comprehensive outline of the EIA process, including the roles and responsibilities of the consultants and the proponents. This regulation outlines every step of the EIA process beginning from the application to undertake an EIA, details on the contents, minimum requirements for consultants undertaking the EIA, format of the EIA/IEE report, and many more. The guidance provided in this Regulation was followed in the preparation of this EIA report. The EIA has also been prepared by registered consultants.

First Amendment to the Environmental Impact Assessment Regulation (Regulation 2013/R-18)⁵⁾

This first amendment was gazetted on 9th April 2013. This amendment stipulates that the responsible authority has to check the submitted EIA report for everything mentioned in the Regulation's article (Kaafu) and inform the proponent whether the EIA Report has been accepted or rejected within two working days. The penalty for repetitive offenses has also been updated in this amendment of the regulation.

Second Amendment to Environmental Impact Assessment Regulation (Regulation 2015/R-174)⁶⁾

The second amendment gazetted on 30th August 2015 includes the following important points:

Some procedural changes have been made to the EIA process: e.g., shifting the tourism related developmental project EIAs to the Ministry of Tourism, ii) changes in the process such as finalization of the Terms of Reference during the scoping meeting, and iii) changes in the fees structure for the review process have been made to include three different categories.

Third Amendment to the Environmental Impact Assessment Regulation (Regulation 2016/R-66)⁷⁾

The third amendment gazetted on 11th August 2016 includes the following important points:

- The point system for consultants, categories of the consultants, and amendment of the penalties to consultants and proponents who fail to follow the regulation.

Fourth Amendment to the Environmental Impact Assessment Regulation (Regulation 2017/R-7)⁸⁾

The fourth amendment gazetted on 19th January 2017 includes the following points:

The projects that can be preceded without an Environmental Impact Assessment when the proponent requests to the Ministry of Environment and Energy in writing along with commitments or guarantee that the Proponent will carry out the mitigation measures that may impact the Environment due to such projects. A list of such projects given in the amendment is as follows:

- 1) Removal of deposited sand inside the harbor
- 2) Trees and palms present on lands left for the purpose of building houses need to be taken by the owner of the land.
- 3) If trees/palms present on lands left for building purposes obstruct the roads need to be removed.

(Such cases will be handled by the council of the island).

- 4) Creating boreholes on land for the uptake of water.
- 5) On lands, which are connected to naturally formed islands, projects that are carried out before three years since the reclamation of land.
- 6) On lands, which are newly reclaimed in the middle of a lagoon, projects which are carried out for before five years since the reclamation.

Even on the lands mentioned in numbers 5 and 6 of clause a) of this regulation, the projects listed down below can only be carried out under the EIA regulation (2012) with the approval of the ministry.

- 1) Projects involving hazardous/toxic chemicals
- 2) Projects involving the storage of oil
- 3) Projects involving the usage of incinerators
- 4) Projects which would release any kind of toxic fumes into the atmosphere

Fifth Amendment to Environmental Impact Assessment Regulation (Regulation 2018/R-131)⁹⁾

The fifth amendment gazetted in 2018 includes the following points:

Some procedural changes have been made to the EIA process. The EIA procedure is changed re-including the tourism related developmental project EIAs to the Ministry of Environment from the Ministry of Tourism.

Regulation for the Determination of Penalties and Obtaining Compensation for Damages Caused to the Environment (2011/R-9)¹⁰⁾

The Regulation for the Determination of Penalties and Obtaining Compensation for Damages Caused to the Environment (Regulation No. R-9/2011) was published with the aim of stopping the violations under the Environment Protection and Preservation Act of the Maldives and setting out the procedures and guidelines on how to determine penalties and obtain compensation for damages caused to the environment.

Waste Management Regulation (Regulation 2013 R-58)¹¹⁾

Waste Management Regulation is purposed to implement the national waste policy. It contains five main sections: (i) Waste management standards, ii) Waste management Permits, (iii) Standards and permits required for waste transport on land and sea, including transboundary movements, (iv) Reporting and monitoring requirements and procedures, (v) Procedures to implement waste management regulation and penalties for noncompliance.

It is stipulated that domestic waste produced during the construction and operation phase of the project must be disposed through the existing waste management system in the City/Island Council concerned and, chemical waste or hazardous waste such as used oil or any other chemical used for the project must be transported to Thilafushi Waste Management Centre for disposal.

Dredging and Reclamation Regulation (Regulation 2013/R-15)²⁾

The regulation of Dredging and Land Reclamation was published on 2 April 2013 with the aim of minimizing environmental impacts associated with dredging activities in islands and reefs across the Maldives. It requires that all dredging and reclamation activities must be approved by EPA in writing. The process includes the submission

of project information to EPA along with a scaled before and after map. The regulation defines rationales for reclamation as those absolutely necessary for social, economic, or safety purposes.

Dredging is restricted in the following areas:

- a) 500 m from reef edge to outer reef;
- b) 100 m from reef edge towards island;
- c) 50 m from shoreline;
- d) An environmentally sensitive site;
- e) Land reclamation is restricted within 200 m of a sensitive area; and
- f) Land reclamation cannot exceed 30% of the house reef area.

The regulation requires producing scaled-maps of the island before and after the proposed project. Land use plan and the details of essential requirement should be submitted to EPA as a part of EIA report. Along with these details, a geo-referenced scale map (1:10,000) should be also submitted. Permission of dredging is to be granted by EPA when the submitted EIA report was approved.

Special provisions have been made on protected and sensitive area restricting changes to the environment of the islands.

First Amendment to the Dredging and Reclamation Regulation (2014)¹³⁾

This amendment to the regulation came into force on 9 February 2014 and has brought changes to Clause 13 (d) of the Dredging Regulation. The amendment explains that the developmental projects planned under the cabinet decision or run under government developmental projects can be preceded even after it falls under Clause 13 (d) number 4, which prohibits sand removal for reclamation at environmental sensitive areas, along with the conditions given in the First Amendment. The conditions given in the amendment are as follows:

- a) Carry out a study on the existence of living flora, fauna, and threatened species.
- b) Submit a plan and obtain permission for such plans on how to transfer, shift, and farm the threatened species.
- c) Develop a natural area not smaller than the existing area with the existing characteristics or develop an area with such characteristics that are instructed by the Implementation Agency as per the policy, regulation, and standards and set arrangements to protect, manage, and monitor such areas.
- d) Carry out a study to monitor the impact on the existing aquifer and to take mitigation measures to prevent the occurrence of likely impacts. Additionally, these activities should be monitored by the implementation Agency.
- e) Carry out a study on possible flooding and implement a suitable drainage system as a mitigation measure.

Cultural and Historical Places and Objects Act (Act No.27/79)¹⁴⁾

The Law on Cultural and Historical Places and Objects of the Maldives (27/79) prohibits destroying or damaging any historical and cultural places, sites, objects, and artifacts belonging to the sovereign area of the Maldives.

The cultural sites mentioned in this regulation are things or places used by locals or foreign ancestors who had resided in the Maldives. Monuments or idols, which have been created in honor of certain personalities or idols that people used to worship in the past, are also protected under this regulation. However, with the permission from the relevant authorities of the government, it is stipulated that cultural sites are allowed to be touched and studied in such a way that their original identity is not lost.

Regulation on Cutting Down and Export of Trees and Coconut Palms (Regulation No. 7-R/2014)¹⁵⁾

The Regulation on Cutting Down and Export of Trees and Palms (Regulation No. 7-R/2014) specifies that the cutting down, uprooting, digging out, and export of trees and palms from one island to another can only be done if it is absolutely necessary and if there is no other alternative. It further states that for every tree or palm removed in the Maldives two more should be planted and grown in the island.

The regulation prohibits the removal of the following tree types;

- a) The coastal vegetation growing around the islands extending to about 15 meters into the island;
- b) All the trees and palms growing in mangrove and wetlands spreading to 15 meters of land area;
- c) All the trees that are in a government designated protected areas;
- d) Trees that are being protected by the government in order to protect species of animal/organisms that live in such trees; and
- e) Trees/palms that are abnormal in structure.

Coral and Sand Mining Regulation (2000)¹⁶⁾

The Regulation on Sand and Coral Mining was issued by the Ministry of Fisheries, Agriculture, and Marine Resources (MOFA) on 13 March 2000. Prior to this regulation, coral mining from house reef and atoll rim has been banned through a directive from the President's Office dated 26 September 1990.

This regulation covers sand mining from uninhabited islands that have been leased; sand mining from the coastal zone of other uninhabited islands; and aggregate mining from uninhabited islands that have been leased and from the coastal zone of other uninhabited islands. It stipulated that sand should not be mined from any parts of the existing island, beach, or the newly reclaimed island beach. Sand should also not be mined from within 100 feet of the shoreline.

Regulation on Protected Areas (2018/R-78)¹⁷⁾

The regulation on protected areas categories the protected areas in the Maldives as Category 1) Internationally recognized areas, Category 2) Strict Nature Reserve, Category 3) Wilderness Areas, Category 4) National Park, Category 5) Natural Monument, Category 6) Habitat/Species Management Area and Category 7) Protected Area with Sustainable Use

Regulation on Protect Species (2021 R-25)¹⁸⁾

The regulation on protect species stipulates the protected species in the Maldives. It provides guidelines on designating protected species, permits to handle protected species, procedure to research protected species and fines on capturing and handling protected species or damaging habitats of protected species. In total of 214 species including birds, marine species are listed in this regulation.

Multilateral Agreement

The Maldives is the party of the following multilateral agreement.

- a) United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol¹⁹⁾
- b) United Nations Convention on Biological Diversity (UNCBD)²⁰⁾
- c) United Nations Convention to Combat Desertification (UNCCD)²¹⁾
- d) United Nations Convention on the Law of the Sea (UNCLOS)²²⁾

Environmental Standards

Air Quality

No ambient air quality standards are set in the Maldives. As for the Project, the standards in WHO Global Air Quality Guidelines (2021) are applied as reference standards as shown Table 6.1.12.

Table 6.1.12 Ambient Air Quality Standards

Pollutant	Averaging time	Interim target				AQG level
		1	2	3	4	
PM _{2.5} , µg/m ³	Annual	35	25	15	10	5
	24-hour ^a	75	50	37.5	25	15
PM ₁₀ , µg/m ³	Annual	70	50	30	20	15
	24-hour ^a	150	100	75	50	45
O ₃ , µg/m ³	Peak season ^b	100	70	–	–	60
	8-hour ^a	160	120	–	–	100
NO ₂ , µg/m ³	Annual	40	30	20	–	10
	24-hour ^a	120	50	–	–	25
SO ₂ , µg/m ³	24-hour ^a	125	50	–	–	40
CO, mg/m ³	24-hour ^a	7	–	–	–	4

^a 99th percentile (i.e. 3–4 exceedance days per year).

^b Average of daily maximum 8-hour mean O₃ concentration in the six consecutive months with the highest six-month running-average O₃ concentration.

Source: WHO Global Air Quality Guidelines (2021)

Noise

No ambient noise standard is set in the Maldives. As for the site survey for the Component 2, WHO Noise Environmental Health Criteria 12 (EHC 12, 1980)²³⁾ which recommends noise exposure limits for general outdoor noise levels is 55 dB as well as WHO Environmental Noise Guidelines for EU Region (2018)²⁴⁾ which indicates 53dB as the threshold for desirable road traffic noise levels were applied as reference standards.

Water Quality

Water quality standards for drinking water and marine water quality standards are set by EPA as shown in Table 6.1.13 and Table 6.1.14 respectively. As for the treated waste water, indicative values for treated sanitary sewage discharges in General EHS Guidelines: Environmental, Wastewater and Ambient Water Quality (2007) is applied for the Project as shown in Table 6.1.15.

Table 6.1.13 Drinking Water Quality Parameter Optimum Conditions

Parameter	Optimal Range
Temperature	-
Salinity	-
pH	6.5 – 8.5
Electrical Conductivity	<1000 uS/cm
Total Dissolved Solids	<500 mg/L
Turbidity	<1 NTU
Iron	<0.3 mg/L
Ammonia	<0.02 – 2.5 mg/L
Suspended Solids	5 – 750 mg/L
Total Hardness	<75 mg/L
Hydrogen Sulphide	<0.05 mg/L
Nitrates	<50 mg/L
Chlorides	<200 mg/L
Fecal Coliform	0/100ml CFU
Total Coliform	0/100ml CFU
Free Chlorine	0.04 – 0.2 mg/L

Source: Data collection guideline EPA²⁵⁾**Table 6.1.14 Marine Water Quality Parameter Optimum Conditions**

Parameter	Optimal Range	Reference
Temperature	18°C and 32°C *Changes should not surpass 10C above the average long-term maximum	GBRMPA, 2009
Salinity	3.2% - 4.2% (32‰ - 42‰)	GBRMPA, 2009
pH	8.0-8.3 *Levels below 7.4 pH cause stress	
Turbidity	3-5 NTU >5 NTU causes stress	Cooper <i>et al.</i> 2008
Sedimentation	Maximum mean annual rate 3mg/cm ² /day Daily maximum of 15mg/cm ² /day	GBRMPA, 2009
Nitrates	<5 mg l-1 NO -N	UNESCO/WHO/UNEP, 1996
Ammonia	Max. 2-3 mg l-1 N	UNESCO/WHO/UNEP, 1996
Phosphate	0.005 - 0.020 mg l-1 PO -P	UNESCO/WHO/UNEP, 1996
Sulphate	2 mg l-1 and 80 mg l-1	UNESCO/WHO/UNEP, 1996
BOD	< 2 mg l-1 O ₃	UNESCO/WHO/UNEP, 1996
COD	< 20 mg l-1 O ₂	UNESCO/WHO/UNEP, 1996

Source: Data Collection Guidelines EPA

Table 6.1.15 Waste Water Standards

Pollutants	Units	Guideline Value
pH	pH	6-9
BOD	mg/l	30
COD	mg/l	125
Total Nitrogen	mg/l	10
Total Phosphorus	mg/l	2
Oil and Grease	mg/l	10
Total Suspended Solids	mg/l	50
Total Coliform Bacteria	MPN ^a /100ml	400

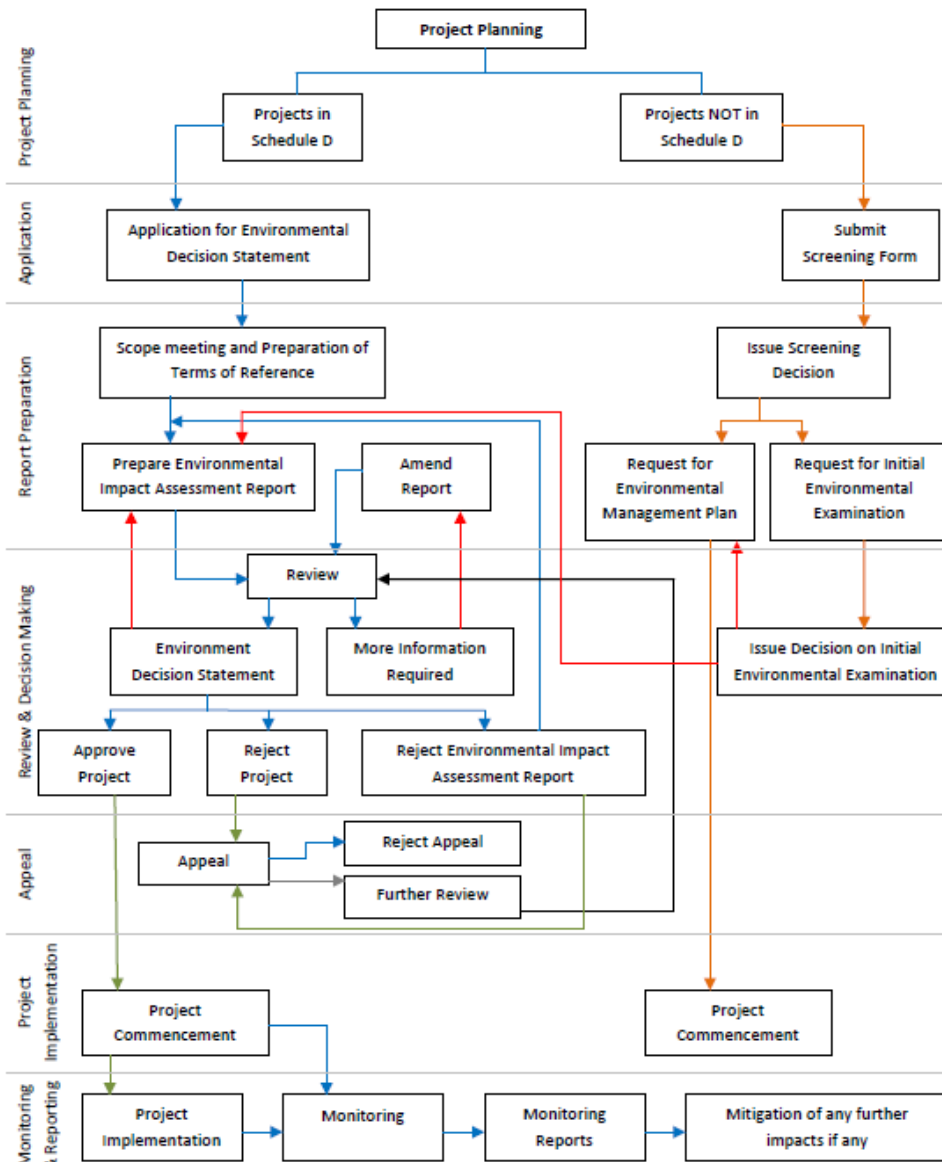
a: Most probable number

Source: IFC General EHS Guidelines: Environmental, Wastewater and Ambient Water Quality

Environment Assessment Process

Under Article 5 (a) of the EPPA, an Environmental Impact Assessment (EIA) has to be submitted by the developer of a project, which may have potential impacts on the environment, to the Environment Protection Agency (EPA) of MECCT for approval before the commencement of the project. The EIA process is coordinated by EPA in consultation with other relevant government agencies and the National Commission for the Protection of the Environment (NCPE).

The EIA process is initiated when the proponent submits a Screening Form to the ministry. This stage identifies if the project requires an Initial Environmental Examination (IEE) or a full Environmental Impact Assessment (EIA). Subsequently, the scope of the EIA will be discussed in a Scoping Meeting attended by representatives from the ministry and the proponent. Once the scope is identified, baseline surveys will be carried out and a report submitted to the ministry according to the guidelines provided in the EIA Regulation. The main components of the report are project description, existing environment, public consultation, impact assessment, alternatives, mitigation, and monitoring. A decision statement is then issued by the ministry stating whether the project is approved, needs further information, or is rejected. The EIA process is schematically shown on Figure 6.1.8. The proposed activities such as land reclamation, sea wall construction projects, beach nourishment projects, and sand mining using machinery are included in the list of activities requiring an EIA of the EIA Regulations.



Source: Environmental Impact Assessment Regulation 2012

Figure 6.1.8 EIA Process in the Maldives

Comparing Government of Maldives and JICA on Environmental Assessment Requirements

The gap analysis between JICA Guidelines and the environmental legislations of the Maldives was conducted. As a result, the following measures are to be applied for bridging the identified gaps.

- There is no specific stipulation on the timing of conducting a stakeholder meeting in the environmental legislations in Maldives. As for the Project, the consultation meeting is to be organized at least twice, at the time of examining the items for environmental assessment and at the time of drafting the environmental assessment in accordance with the JICA Guidelines.
- The required assessment items in the JICA Guidelines are more detailed. Accordingly, all required items in JICA Guidelines are to be assessed.
- There is no specification on the requirement of sharing the result of monitoring among the stakeholders in the Maldivian environmental legislations. In comply with the JICA Guidelines, it is to be incorporated into the

monitoring plan

- There is no specification on the requirement of setting up the grievance redress system in the environmental assessment report of the Maldives. In comply with the JICA Guidelines, the grievance redress system of the Project is to be established.

The results of the gap analysis between the JICA guidelines and the Maldivian environmental legislations and the measures taken for the Project to the gaps are summarized in Table 6.1.16.

Table 6.1.16 The Gap Analysis between the JICA Guidelines and Environmental Legislations in Maldives

No.	JICA Guidelines	Maldivian Legislation	Measures Taken for the Project
1	Environmental impacts that may be caused by projects must be assessed and examined in the earliest possible planning stage.	An impact assessment study shall be submitted to the Ministry of Planning, Human Resources and Environment (at present the task is taken over by the Environmental Protection Agency) before implementing any developing project that may have a potential impact on the environment (Environmental Protection and Preservation Act, Law No.4/93)	No gap.
2	Alternatives or mitigation measures to avoid or minimize adverse impacts must be examined and incorporated into the project plan. (JICA Guideline (Appendix)	The Environmental Impact Assessment report should not comprise statements of general nature but instead shall provide substantive and predictive information on the proposed activity, a realistic review of alternatives, measures proposed to mitigate all adverse impacts, as well as the opportunities for environmental, economic and social enhancement. (Article 12, Regulation on the Preparation of EIA report 2012)	No gap.
3	EIA reports (which may be referred to differently indifferent systems) must be written in the official language or in a language widely used in the country in which the project is to be implemented. When explaining projects to local residents, written materials must be provided in a language and form understandable to them. (JICA Guideline Appendix)	The Environmental Impact Assessment Report may be submitted in Dhivehi (official language) and English. Non-technical summary should be submitted in both Dhivehi and English languages and it should: be concise and use simple, non-technical language; include an outline of the project and its location; and focus primarily upon selection of alternatives, key impacts and mitigation measures (Schedule E ((1)) Regulation on the Preparation of EIA report 2012)	No gap.
4	For projects with a potentially large environmental impact, sufficient consultations with local stakeholders, such as local residents, must be conducted via disclosure of information at an early stage, at which time alternatives for project plans may be examined. The outcome of such consultations must be incorporated into the contents of project plans.	While the Environmental Impact Assessment report as per the format in Schedule E (1) requires the project proponent to conduct public consultation, some projects may be sufficiently controversial or complex to require further public input before an Environmental Decision Statement can be issued; in such instances the proponent will be notified and requested to arrange, and pay for a public meeting or meetings at a location or locations to be determined by the	No gap.

No.	JICA Guidelines	Maldivian Legislation	Measures Taken for the Project
	(JICA Guideline Appendix)	Ministry. (Article 13 (g), Regulation on the Preparation of EIA report 2012)	
5	In preparing EIA reports, consultations with stakeholders, such as local residents, must take place after sufficient information has been disclosed. Records of such consultations must be prepared. (JICA Guideline Appendix)	This (public consultation) is an important part of the Environmental Impact Analysis Report process and should include: -A list of the persons consulted including persons in statutory bodies, province offices and councils, community groups and NGOs, local residents, local fishermen, tourism operators and any others likely to be affected by the proposed development, -Information on how, when and where the consultations were conducted and if the consultations were conducted in group stakeholder meetings, one-on-one meetings or in the form of written questionnaires, -Summary of the outcome of the consultations including the main concerns identified (Schedule E ((1)) Regulation on the Preparation of EIA report 2012)	No gap.
6	Consultations with relevant stakeholders, such as local residents, should take place, if necessary, throughout the preparation and implementation stages of a project. Holding consultations is highly desirable, especially when the items to be considered in the EIA are being selected, and when the draft report is being prepared. (JICA Guideline Appendix)	While the Environmental Impact Assessment report as per the format in Schedule E (1) requires the project proponent to conduct public consultation, some projects may be sufficiently controversial or complex to require further public input before an Environmental Decision Statement can be issued; in such instances the proponent will be notified and requested to arrange, and pay for a public meeting or meetings at a location or locations to be determined by the Ministry. (Article 13 (g), Regulation on the Preparation of EIA report 2012)	As for the Project, the consultation meeting is to be organized at least twice, at the time of examining the items for environmental assessment and at the time of drafting the EIA .
7	The impacts to be assessed with regard to environmental and social considerations include impacts on human health and safety, as well as on the natural environment, that are transmitted through air, water, soil, waste, accidents, water usage, climate change, ecosystems, fauna and flora, including trans-boundary or global scale impacts. These also include social impacts, including migration of population and involuntary resettlement, local economy such as employment and livelihood, utilization of land and local resources, social institutions such as social capital and local decision-making institutions, existing social infrastructures and services, vulnerable social groups such as poor and indigenous peoples,	Description of the natural, economic and human environment should include: -Certified and comprehensive site plans drawn to scale (by a Sworn Land Surveyor) with known landmarks as reference points, and showing Valued Ecosystem Components, water bodies, wetlands, low water mark, high water mark and beach frontage, -Aerial photographs of the site, - Description of site characteristics including soil type, relief, landforms, present land use, drainage systems, -Type of flora and fauna, rare or endangered species, sensitive habitats of ecological importance including wetlands and mangroves, - Marine environment including sand and rocky bottoms, coral reefs, sea grass beds, -Beach systems; composition; stability; current, tide and wave dynamics, -Description of surrounding infrastructure, including utilities, - Socio-economic characteristics including population (numbers, ages, density, distribution),	The items to be assessed is more detailed in the JICA Guidelines than in the Maldivian legislation. As for the assessment of the Project, the items in the JICA Guidelines shall be covered.

No.	JICA Guidelines	Maldivian Legislation	Measures Taken for the Project
	equality of benefits and losses and equality in the development process, gender, children's rights, cultural heritage, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety. (JICA Guideline Appendix)	economic activities, housing and utilities, employment statistics, skill and labour availability and unique cultural characteristics, - Other attributes of the locality e.g. amenities, recreational values (Schedule E ((1)) Regulation on the Preparation of EIA report 2012)	
8	In addition to the direct and immediate impacts of projects, their derivative, secondary, and cumulative impacts as well as the impacts of projects that are indivisible from the project are also to be examined and assessed to a reasonable extent. It is also desirable that the impacts that can occur at any time throughout the project cycle should be considered throughout the life cycle of the project. (JICA Guideline Appendix)	Assessment of the Direct and Indirect Environmental Impacts: Impacts on the biophysical, economic and human environments, including clear details of any impacts on the human wellbeing with special emphasis on the key issues identified during the scoping process. Less important impacts should be mentioned but the amount of space devoted to them should be proportional to their perceived importance. (Schedule E ((1)) Regulation on the Preparation of EIA report 2012)	No gap.
9	Project proponents etc. should make efforts to make the results of the monitoring process available to local project stakeholders. (JICA Guideline Appendix)	Description on sharing monitoring result among stakeholders are not specifically mentioned.	As for the Project, the sharing process on the monitoring result with local stakeholders is to be included in the Project's monitoring plan.
10	When third parties point out, in concrete terms, that environmental and social considerations are not being fully undertaken, forums for discussion and examination of countermeasures are established based on sufficient information disclosure, including stakeholders' participation in relevant projects. Project proponents etc. should make efforts to reach an agreement on procedures to be adopted with a view to resolving problems. (JICA Guideline Appendix)	Description on the grievance redress system is not specifically mentioned.	As for the Project, a provision of the grievance redress system is to be prepared.
11	Projects must not involve significant conversion or significant degradation of critical natural habitats and critical forests. (JICA Guideline Appendix)	If the site/island or surrounding reef or any part of the island or its reef ecosystem included in the areas protected under Act no.4/93 (Maldives Environmental Protection and Preservation Act) or the list of environmental sensitive areas, this site or island should be removed from consideration. (Schedule B, Regulation on the Preparation of EIA report 2012)	No gap.
12	Any adverse impacts that a project may have on indigenous peoples are to be avoided when feasible by exploring	There are no indigenous people involved in the Project.	Not applicable to the Project.

No.	JICA Guidelines	Maldivian Legislation	Measures Taken for the Project
	all viable alternatives. When, after such an examination, avoidance is proved unfeasible, effective measures must be taken to minimize impacts and to compensate indigenous peoples for their losses. (JICA Guideline Appendix)		

Source: JICA Expert Team

Other Permits and Approvals

Prior to any coastal works that required dredging or reclamation, a special permit has to be obtained from EPA. Depend on the jurisdiction of barrow area, permission of dredging needs to be obtained from the Atoll or Island Council. At the time of submitting the EIA report to EPA, the application form of dredging and reclamation including the information of location, area, volume, alternative location shall be attached with the obtained permission from Atoll/Island Council. After examining the application form together with the EIA report, the permission is to be granted as an approval of the EIA report by EPA.

(2) Institutional Framework

Ministry of Environment, Climate Change and Technology (MECCT)

The Ministry of Environment, Climate Change and Technology (MECCT) is the primary environmental institution in the Maldives. MECCT is mandated with formulating policies, strategies, laws, and regulations concerning environmental management, protection, conservation, and sustainable development for the effective implementation of the Environmental Protection Act of the Maldives and has the statutory power over issues related to the environment. MECCT is also responsible for formulating relevant laws and regulations, policies, and strategies concerning energy, water, sanitation, and waste management. It has the central control over environmental protection, management, conservation, and environmental emergencies. The ministry operates mainly at a policy level and the more regulatory and technical assessment activities are mandated to the Environmental Protection Agency (EPA).

Ministry of National Planning, Housing and Infrastructure (MNPHI)

The Ministry of National Planning, housing and Infrastructure (MNPHI) formulates the National Development Plan and the development plans of all islands in the Maldives. It plans infrastructure development projects in the Maldives, prepares land related policies and establish the rules and regulations of land reclamation and dredging. It formulates, manages, and monitors projects on public infrastructure (which includes roads, bridge, potable water and sewage service, establishment of energy and communication networks, airports, ports, harbors, land reclamation and coastal protection) and make sure that they are being carried out as per the National Development Plan.

Environmental Protection Agency (EPA)

The Environment Protection Agency (EPA) of MECCT has responsibilities for the efficient operation of the EIA process. This encompasses a number of tasks, including screening of projects and provision of general procedural advice to the project EIA for any kind of development projects in the Maldives. EPA manages the review of the EIA report and is responsible for any approvals or recommendations associated with the EIA. It is also responsible

for verifying that environmental protection measures are properly implemented by undertaking environmental audits in collaboration with other governments as well as non-government agencies with a role for environmental protection and preservation.

Addu City Council and Laamu Atoll Council

Under the Decentralization Act, the Maldives is grouped into 20 administrative areas under a new local governance system. In line with this, Addu Atoll has an elected City Council located on Hithadhoo Island, while Laamu Atoll has an elected Atoll Council located in Fonadhoo Island. The Council Offices are the main focal point of the Government Ministries and they coordinate and liaises with the Government Ministries and elected island councils on all issues relating to the atoll.

6.1.4 Alternatives

All proposed projects were purposed to protect coastal area from erosion. In case of “Without project”, it meant to be no protection measures applying against on-going erosion at each project site.

Minimizing negative impact on natural and social environment was taken account throughout the process of finalizing basic design in each targeted island. In order to protect coastal area from erosion, a design was selected not to alter natural condition as much as possible and let nature to act as it supposed to be without interruption of man-made structure. The effort was reflected on the basic design from preliminary design as decreasing the number of groins (beach nourishment site at Maamendhoo Island and Meedhoo Island) or not construct groins at all (beach nourishment site in Fonadhoo Island) (see details in Chapter 5.4 Examination of the draft basic design).

Furthermore, the measures such as avoiding protected area, minimizing cutting down trees (consideration on natural environment) and avoiding resettlement or land acquisition (consideration on social environment) were applied for selecting the stock pile sites in terms of storing supplemental sand for the nourished beach in Fonadhoo Island, Maamendhoo, Meedhoo Island and Gan Island (see details in Chapter 5.8 Consideration of construction plan and cost estimation).

Moreover, environmental consideration was also given at the time of selecting borrow sites for collecting sand to nourish beach. Among alternatives, the sites were selected with the conditions as location be at outer reef and deeper seabed in order to minimize any negative impacts on the natural environment at and surrounding areas. (see details in Chapter 5.7 Study for Sand Barrow Area)

6.1.5 Scoping and TOR of an Environmental and Social Survey

(1) Scoping

Component 1

Pilot works will be planned and implemented by applying the knowledge on coastal engineering acquired through the Project. Since the specific countermeasures mentioned in ICZM will be identified and selected during the 2nd stage of the Project implementation, the provisional scoping was carried out based on general structural measures for coastal protection included in ICZM. It is also necessary to consider the alternatives of proposed activity, based on Strategic Environment Assessment, in the process of development of ICZM plan at national level as well as island-level. Table 6.1.17 is the result of the scoping. However, since the contents/details of pilot works are not determined at this stage, it should be updated next phase of the Project.

Table 6.1.17 Scoping Result on Component 1

	Environmental Items	Phase		Scoping Result
		BC/DC	OP	
Pollution Control				
1	Air Pollution	-	-	No adverse effects to the air quality would be occurred, as there are no sources by the activities.
2	Water Pollution	✓	✓	For the implementation of sediment budget control plan, the water quality may be affected to some extent, due to the improper implementation.
3	Soil Contamination	-	-	No adverse effects to the soil contamination would be occurred, as there are no sources by the activities.
4	Noise/Vibration	-	-	No adverse effects to the noise and vibration would be occurred, as there are no sources by the activities.
5	Ground Subsidence	-	-	No adverse effects to the ground subsidence would be occurred, as there are no sources by the activities.
6	Offensive Odors	-	-	No adverse effects to the offensive odors would be occurred, as there are no order sources by the activities.
7	Bottom Sediment	✓	✓	For the implementation of sediment budget control plan, sediment may be affected to some extent, due to the improper implementation.
8	Waste	-	-	No adverse effects to the waste management would be occurred, as there are no sources by the activities.
Natural Environment				
9	Topography and Geographical Features	-	-	No adverse effects to the topography or geographical features would be occurred, as there are no activities which affect to topography and geographical features.
10	Hydrological Situation	-	-	No adverse effects to the hydrological situation would be occurred, as there are no activities which affect to hydrological situation.
11	Groundwater	-	-	No adverse effects to the groundwater would be occurred, as there are no activities which affect to groundwater.
12	Flora, Fauna, and Biodiversity	✓	✓	For the establishment of coastal and reef conservation plan and implementation of sediment budget control plan, the marine system in the coastal areas may be affected to some extent, due to the improper implementation.
13	Protected Area	-	-	There are no protected areas or Marine Protected Areas (MPA) around the proposed project sites.
14	Coastal Zone	✓	✓	For the establishment of coastal and reef conservation plan and implementation of sediment budget control plan, the marine system in the coastal areas may be affected to some extent, due to the improper implementation.
Social Environment				
15	Involuntary Resettlement/Land Acquisition	-	-	No involuntary resettlement or land acquisition will be occurred by implementing the ICZM as there are no activities which cause involuntary resettlement or land acquisition.
16	Poor	✓	✓	If the target areas are used by the local people regularly, there would be possibilities for the local people not to be able to use the areas for their livelihood activities due to the coastal and reef conservation plan.
17	Indigenous, or Ethnic People	-	-	No Indigenous or ethnic people confirmed in the targeted islands. There are no issues related to Indigenous or ethnic people by implementing the ICZM.
18	Local Economies such as Employment, Livelihood, etc.	✓	✓	If the target areas are used by the local people regularly, there would be possibilities for the local people not to be able to use the areas for their livelihood activities due to the coastal and reef conservation plan.

	Environmental Items	Phase		Scoping Result
		BC/DC	OP	
19	Land Use and Utilization of Local Resources	✓	✓	If the target areas are used by the local people regularly, there would be possibilities for the local people not to be able to use the areas due to the coastal and reef conservation plan.
20	Water Usage or Water Rights and Communal Rights	-	-	There would be no construction works or operation activities which will limit water use, or cause impact on water use.
21	Existing Social Infrastructures and Services	-	-	There would be no construction works or operation activities which will cause impact on infrastructures.
22	Social Institutions such as Social Infrastructure and Local Decision-making Institutions	✓	✓	Potential gender discrimination in participating in formulating ICZM.
23	Misdistribution of Benefits and Damages	✓	✓	If the target areas are used by the local people regularly, there would be possibilities for the local people not to be able to use the areas due to the coastal and reef conservation plan.
24	Local Conflicts of Interest	✓	✓	If the target areas are used by the local people regularly, there would be possibilities for the local people not to be able to use the areas due to the coastal and reef conservation plan.
25	Religious Facility	-	-	There would be no construction works or operation activities which will cause impact on religious facility.
26	Cultural Heritage	✓	✓	The future ICZM Plan may raise any impacts to the existing heritage site, if not properly planned.
27	Landscape	-	-	There would be no construction works or operation activities which will cause impact on landscape.
28	Gender	✓	✓	Potential gender discrimination in participating in formulating ICZM and the training related to ICZM.
29	Children's Rights	-	-	There would be no operation activities which will affect right of children.
30	Hazards (risk) Infectious Diseases such as HIV/AIDS	-	-	There would be no construction works or operation activities which will cause infectious diseases.
31	Occupational Safety and Health	-	-	There would be no construction works or operation activities which will affect labour environment.
Others				
32	Accident	-	-	There would be no construction works or operation activities which will raise risk of accident.
33	Climate Change	-	-	There would be no construction works or operation activities which will affect climate change.

Source: JICA Expert Team

Component 2

Environmental Impact resulting from the Component 2 is examined based on the existing documents. The scoping result is represented in Table 6.1.18.

Table 6.1.18 Scoping Result on Component 2

	Environmental Items	Phase		Scoping Result
		BC/DC	OP	
Pollution Control				
1	Air Pollution	✓	✓	BC/DC: Limited air pollution is expected due to heavy machinery operation and construction activities. OP : Unproper management of stocked supplementary sand will cause dust generation.
2	Water Pollution	✓	✓	BC/DC: Dredging for collecting sand for nourishing beach, revetment for the coast and reclamation along the coast will cause water pollution temporarily. OP: Unproper management of stocked supplementary sand will cause water pollution.
3	Soil Contamination	✓	-	BC/DC: Oil leakage from construction vehicles will cause soil contamination. OP: No activities expected to contaminate soil resulting from the Project.
4	Noise/Vibration	✓	-	BC/DC: Noise and vibration will be generated from construction equipment. However, the impact of noise and vibration will be limited because the project sites are coastal area where is not adjacent to the residential area. Land transportation of construction vehicles and machinery may impact on traffic and noise. OP: No activities expected to make noise or vibration by the Project.
5	Ground Subsidence	-	-	BC/DC/OP: No activities are expected to extract groundwater resulting the Project.
6	Offensive Odors	-	-	BC/DC/OP: No activities are expected to emit offensive odors resulting from the Project.
7	Bottom Sediment	✓	✓	BC/DC: Beach nourishment and reclamation will cause soil sedimentation near construction sites. OP: Soil sedimentation will occur near the nourished beach.
8	Waste	✓	-	BC/DC: Construction waste such as removed materials from old revetment will be generated. Hazardous waste such as used engine oil will be generated from construction vehicles. OP: No activities are expected to generate waste resulting from the Project.
Natural Environment				
9	Topography and geographical Features	✓	✓	BC/DC: Reclamation at Maamendhoo island will alter the geographical features. OP: Due to nourishing, revetment or reclamation, geographical features near the Project area may be changed.
10	Hydrological Situation	-	✓	BC/DC: No construction activities are expected to alter hydrological situation. OP: Due to nourishing, revetment or reclamation, hydrological situation around the Project area may be changed.
11	Groundwater	-	-	BC/DC/OP: No activities are expected to effect groundwater resulting from the Project.
12	Flora, Fauna, and Biodiversity	✓	✓	BC/DC: During construction, limited disturbance to terrestrial and marine ecosystem is expected around the project sites and/or sand borrow sites. OP: Due to nourishing, revetment or reclamation, marine ecosystem around the Project area may be disturbed.
13	Protected Area	-	-	BC/DC/OP: There are no protected areas or Marine Protected Areas (MPA) around the proposed project sites. The project site in Meedhoo Island is located near Core Zone/Buffer Zone in Biosphere, however, negative impact is not expected since the Core Zone/Buffer Zone is covered inland area, not coastal area where the Project would be implemented.
14	Coastal Zone	✓	✓	BC/DC: All project sites are located in the coastal zone. Therefore, the construction activities at the project sites will disturb coastal ecosystem. OP: Currents and waves or ecosystem around the Project area will be impacted from the beach nourishment, revetment or reclamation.
Social Environment				
15	Involuntary Resettlement/Land Acquisition (if needed)	✓	-	BC: There will be no involuntary resettlement or land acquisition due to the Project. However, three temporary structures without walls and foundation installed along the coast at the Project site of Maamendhoo Island need to be removed or set backed. It is necessary to discuss about this matter with the owner of these structures. DC/OP: No activities are expected to occur involuntary resettlement or land acquisition.
16	Poor	✓	-	BC/DC: Due to the disruption of access to the coastal area resulting from the construction, vulnerable residents would be affected to their economic activities temporarily. OP: No activities are expected to give negative impact on the poor near the Project sites.
17	Indigenous, or Ethnic People	-	-	BC/DC/OP: The project area does not include the residential area of indigenous or ethnic minorities at present.
18	Local Economies such as Employment, Livelihood, etc.	✓	-	BC/DC: Due to the disruption of access to the coastal area resulting from the construction, local residents would be affected to their economic activities temporarily. OP: No activities are expected to affect local economies.
19		✓	✓	BC/DC: Due to the disruption of access to the coastal area resulting from the construction, local residents would be affected to use local resources temporarily.

	Environmental Items	Phase		Scoping Result
		BC/DC	OP	
	Land Use and Utilization of Local Resources			OP: The beach nourishment and revetment will contribute to stabilize the utilization of local resources in the coastal areas. The reclamation will create evacuation place for the local residents in case of disaster such as hazard of swell and Tsunami.
20	Water Usage or Water Rights and Communal Rights	-	-	BC/DC/OP: There is no activities to affect water usage or water rights and communal rights resulting from the Project.
21	Existing Social Infrastructures and Services	-	-	BC/DC/OP: There is no activities to affect existing social infrastructures and services resulting from the Project.
22	Social Institutions such as Social Infrastructure and Local Decision-making Institutions	-	-	BC/DC/OP: There is no activities to affect social infrastructure and local decision-making institutions resulting from the Project.
23	Misdistribution of Benefits and Damages	✓	-	BC/DC: Due to the disruption of access to the coastal area resulting from the construction, misdistribution of benefits and damages would occur to the users of the Project areas temporarily.
				OP: There is no activities to lead misdistribution of benefits or damages resulting from the Project.
24	Local Conflicts of Interest	✓	-	BC/DC : Due to the disruption of access to the coastal area resulting from the construction, there will be possibility to break out local conflicts of interest among local residents near the Project site temporarily.
				OP : There is no activities to affect local conflict of interest resulting from the Project.
25	Religious Facility	-	-	BC/DC/OP: No religious facilities are identified in the vicinity of the Project sites.
26	Cultural Heritage	-	✓	BC/DC/OP: No cultural heritage is identified in the vicinity of the Project sites except the Project site of Gan and Isdhoo Islands which purposed for protecting the cultural heritage sites against erosion in terms of constructing a revetment.
27	Landscape	-	-	BC/DC/OP: No disturbance of landscape is expected resulting from the Project.
28	Gender	✓	✓	BC/DC: Equal opportunity for employment or equal payment for equal jobs might be distorted by gender discrimination.
				OP: Maintenance and management activities might be distorted by gender discrimination.
29	Children's Rights	✓	-	BC/DC: In case child labor is customarily practiced, it would obstruct schooling opportunities.
				OP : No activities are planned to affect children's right resulting from the Project.
30	Hazards (risk) Infectious Diseases such as HIV/AIDS	✓	-	BC/DC: Inflow of construction workers to local communities would raise risks of communicable diseases.
				OP: No increase in risk of communicable diseases is expected.
31	Occupational Safety and Health	✓	-	BC/DC: Inappropriate management of working environment would raise the risk of accidents and disease.
				OP: No increase in risks in the work environment is expected.
Others				
32	Accident	✓	-	BC/DC: Construction activities along public roads would increase the risk of accidents to the public. Inappropriate management and inappropriate operation of the construction vehicles would increase the risk of accidents.
				OP: No increase in risks of accident would be expected.
33	Climate Change	-	✓	BC/DC: The amount of global warming substances generated by the operation of construction machinery and the driving of construction vehicles is very small and is not expected to have a significant impact on climate change.
				OP: The Project will contribute to decrease the negative affect from climate change.

Source: JICA Expert Team

(2) TOR for Environmental and Social Survey

Based on the scoping result, the TOR for the environmental and social survey is prepared as shown in Table 6.1.19.

Table 6.1.19 TOR for Environmental and Social Survey

No.	Impacts	Items for Study	Methodology
Pollution Control			
1	Air Pollution	1.Present air quality 2.Present condition in the project area 3.Impacts during construction	1.Collect existing information 2.Site investigation and interviews with relevant authorities 3.Confirm content, method, period, location of construction activities and access for construction vehicles
2	Water Pollution	1.Water quality standard in Maldives 2.Present condition in project area 3.Impacts during construction 4.Impacts during operation	1.Collect information on existing standards. 2.Conduct field survey (Sea water quality: temperature, pH, salinity, turbidity, phosphate, nitrate, ammonia, sulphate, BOD at the Project sites, Ground water quality: temperature, pH, salinity) 3.Confirm content, method, period, location of construction activities including dredging area for collecting sand using beach nourishment, site for beach nourishment, revetment and reclamation. 4.Confirm proposed area for storing supplementary sand for beach nourishment
3	Soil Contamination	1.Impacts during construction	1.Confirm content, method, period, location of construction activities.
4	Noise and Vibration	1.Noise standard in Maldives 2.Present condition in the project area 3.Impacts during construction	1.Collect information on existing standards 2.Conduct field survey (Noise measurement at the Project sites) 3.Confirm content, method, period, location of construction activities
7	Bottom Sediment	1.Impacts during construction 2.Impacts during operation	1.Confirm content, method, period, location of construction activities 2.Confirm content of activities during operation.
8	Waste	1.Information on present waste management 2.Impacts during construction	1.Collect existing information on waste management in Maldives 2.Confirm content, method, period, location of construction activities
Natural Environment			
9	Topography and Geographical Features	1.Present condition in the Project area 2.Impact during construction 3.Impact during operation	1.Collect existing information 2.Confirm content, method, period, location of construction activities 3.Confirm content of activities during operation
10	Hydrological Situation	1.Impact during operation	1.Confirm content of activities during operation
12	Flora, Fauna and Biodiversity	1.Present condition in the Project area 2.Impact during construction 3.Impact during operation	1.Conduct field survey (Territorial survey including territorial faunal and flora survey and Marine survey including marine seabed condition survey, reef fish visual census, Line intercept transects survey and photo quadrat analysis) at the Project site 2.Confirm content, method, period, location of construction activities 3.Confirm content of activities during operation
14	Coastal Zone	1.Present condition in the Project area	1.Collect existing information 2.Confirm content, method, period, location of

No.	Impacts	Items for Study	Methodology
		2.Impact during construction 3.Impact during operation	construction activities 3.Confirm content of activities during operation
Social Environment			
15	Involuntary Resettlement/Land Acquisition	1.Information on the owner of three huts at the Project area of Maamendhoo Island	1. Interview with the owner of these huts
16	Poor	1.Present condition in the Project area 2.Impacts during construction	1.Interview with Island councils on the economic and social activities along the coastal area in the Project site 2. Confirm content, method, period, location of construction activities
18	Local Economy such as Employment, Livelihood etc.	1.Present condition in the Project area 2.Impacts during construction	1.Interview with Island councils on the economic and social activities along the coastal area in the Project site 2. Confirm content, method, period, location of construction activities
19	Land Use and Utilization of Local Resources	1.Present condition in the Project area 2.Impacts during construction 3.Impacts during operation	1.Interview with Island councils on the economic and social activities along the coastal area in the Project site 2. Confirm content, method, period, location of construction activities 3.Confirm content of activities during operation
23	Misdistribution of Benefits and Damages	1.Present condition in the Project area 2.Impacts during construction	1.Interview with Island councils on the economic and social activities along the coastal area in the Project site 2. Confirm content, method, period, location of construction activities
24	Local Conflict	1.Present condition in the Project area 2.Impacts during construction	1.Interview with Island councils on the economic and social activities along the coastal area in the Project site 2. Confirm content, method, period, location of construction activities
26	Cultural Heritage	1. Present condition of the Project area at Gan Island and Isdhoo Island	1.Interview with Island councils on the economic and social activities along the coastal area in the Project site
28	Gender	1.Present condition of the employment from gender mainstreaming points of view 2.Impacts during construction 3.Impacts during operation	1.Interview with Island councils and women's development committee (WDC) on the economic and social activities along the coastal area in the Project site 2. Confirm content, method, period, location of construction activities 3.Confirm content of activities during operation
29	Children's Rights	1.Present condition of the children's rights in the Project area	1.Interview with Island councils on the economic and social activities along the coastal area in the Project site
30	Hazardous (Risk) Infectious Diseases such as HIV/AIDS	1.Impacts during construction	1.Confirm content, method, period, location, area of construction activities
31	Occupational Safety and Health	1.Confirm legislations on working environment in Maldives	1.Confirm existing legislations on working environment
Others			
32	Accidents	1.Impacts during construction	1.Confirm content, method, period, location, of construction activities
33	Climate Change	1.Impacts during operation	2.Confirm content of activities during operation

Source: JICA Expert Team

6.1.6 Result of Survey

(1) Field Survey

The field surveys on the baseline for EIA were conducted during February and July 2022 by the sub-contracting works.

1) Terrestrial environmental survey information

Under terrestrial environmental survey information about terrestrial flora, terrestrial fauna and groundwater quality data were collected.

i) Terrestrial flora










Along the coastal lines for the proposed construction sites, terrestrial vegetation surveys were conducted through visual observation. The survey lengths, numbers of observed species and main observed species are described in Table 6.1.20. In the five target islands, 8 to 13 kinds of vegetations are observed, and such species as sea hibiscus, coconut palm, and sea lettuce are dominant. Among them, the observed plants were neither in the protected species under the Maldivian Law or in the IUCN Red List.

Table 6.1.20 Observed Flora at the Five Target Islands

Island	Survey length	Numbers observed	Main observed species (English name/ Divehi name/ Scientific name)
Fonadhoo	2,000m	13 species	Sea Hibiscus (Dhigga/ <i>Hibiscus tiliaceus</i>) Coconut Palm (Ruh/ <i>Cocos nucifera</i>) Indian Tulip tree (Hirudhu/ <i>Thespesia populnea</i>) Sea Lettuce (Magoo/ <i>Scaevola taccada</i>) Tahitian Screw Pine (Boakashikeyo/ <i>Pandanus tectorius</i>)
Gan	1,000m	13 species	Sea Hibiscus (Dhigga/ <i>Hibiscus tiliaceus</i>) Sea Lettuce (Magoo/ <i>Scaevola taccada</i>) Fish Poison Tree (Kinbi/ <i>Barringtonia racemose</i>) Tahitian Screw Pine (Boakashikeyo/ <i>Pandanus tectorius</i>) Grass (Vina/ <i>Poaceae</i>)
Ishdhoo	1,000m	8 species	Sea Lettuce (Magoo/ <i>Scaevola taccada</i>) Tahitian Screw Pine (Boakashikeyo/ <i>Pandanus tectorius</i>) Sea Hibiscus (Dhigga/ <i>Hibiscus tiliaceus</i>) Coconut Palm (Ruh/ <i>Cocos nucifera</i>) Beach Gardenia (Uni/ <i>Guettarda speciosa</i>)
Maamendhoo	1,500m	8 species	Sea Lettuce (Magoo/ <i>Scaevola taccada</i>) Tahitian Screw Pine (Boakashikeyo/ <i>Pandanus tectorius</i>) Sea Hibiscus (Dhigga/ <i>Hibiscus tiliaceus</i>) Coconut Palm (Ruh/ <i>Cocos nucifera</i>) Beach Gardenia (Uni/ <i>Guettarda speciosa</i>)
Meedhoo	3,000m	13 species	Sea Lettuce (Magoo/ <i>Scaevola taccada</i>) Tahitian Screw Pine (Boakashikeyo/ <i>Pandanus tectorius</i>) Coconut Palm (Ruh/ <i>Cocos nucifera</i>) Alexandrian Laurel (Funa/ <i>Calophyllum inophyllum</i>) Sea Hibiscus (Dhigga/ <i>Hibiscus tiliaceus</i>)

Source: JICA Expert Team

Flora species observed during the terrestrial flora survey at Fonadhoo island are shown in Figure 6.1.9.

		
Beach Gardenia (<i>Hernandia nymphaeifolia</i>)	Lantern tree (<i>Scaevola taccada</i>)	Tahitian Screw Pine (<i>Pandanus tectorius</i>)
		
Sea Hibiscus (<i>Hibiscus tiliaceus</i>)	Coconut Palm (<i>Cocos nucifera</i>)	Indian Almond Tree (<i>Terminalia catappa</i>)
		
Octopus Bush (<i>Heliotropium foertherianum</i>)	Cordia (<i>Cordia subcordata</i>)	Headache Tree (<i>Premna serratifolia</i>)

Source: JICA Expert Team

Figure 6.1.9 Flora Species Observed during the Terrestrial Flora Survey at Fonadhoo Island

ii) Terrestrial fauna

At the same locations with the terrestrial flora survey, the terrestrial fauna surveys were conducted through visual observation. The numbers of observed species, main observed species and numbers of observed species listed under the Maldivian laws and IUCN Red List are described in Table 6.1.20. In the five target islands, 5 to 7 kinds of avian species are observed, and such species as Grey Heron, Black Crowned Night Hero are dominant. Among them, 3 to 5 avian species subject to be protected under the Maldivian law are observed, however, observed avian were in the protected species under the IUCN Red List.








Table 6.1.21 Observed Fauna at the Five Target Islands

Island	Numbers observed	Observed species (English name/ Divehi name/ Scientific name)	Protected under Maldivian Law	IUCN Redlist
Fonadhoo	7 species	Grey Heron (Maakanaa/ <i>Ardea cinerea</i>) Black Crowned Night Heron (Raabon'dhi/ <i>Nycticorax nycticorax</i>) Asian Koel (Kaalhu Kovele/ <i>Eudynamis scolopaceus</i>) Maldivian Water Hen (Kan'bili/ <i>Amauornis phoenicurus</i>)	5 species	0 species
Gan	5 species	Grey Heron (Maakanaa/ <i>Ardea cinerea</i>)	3 species	0 species

Island	Numbers observed	Observed species (English name/ Divehi name/ Scientific name)	Protected under Maldivian Law	IUCN Redlist
		Black Crowned Night Heron (Raabon'dhi/ <i>Nycticorax nycticorax</i>) Kentish Plover (Kiru Bondana/ <i>Charadrius alexandrinus</i>)		
Ishdhoo	5 species	Grey Heron (Maakanaa/ <i>Ardea cinerea</i>) Black Crowned Night Heron (Raabon'dhi/ <i>Nycticorax nycticorax</i>) Ruddy Turnstone (Rathafai/ <i>Arenaria interpres</i>)	3 species	0 species
Maamendhoo	6 species	Grey Heron (Maakanaa/ <i>Ardea cinerea</i>) Black Crowned Night Heron (Raabon'dhi/ <i>Nycticorax nycticorax</i>) Maldivian Water Hen (Kan'bili/ <i>Amauornis phoenicurus</i>)	3 species	0 species
Meedhoo	6 species	White Tern (Dhondheeni/ <i>Gygis alba</i>) Crowned Night Heron (Raabon'dhi/ <i>Nycticorax nycticorax</i>) Kentish Plover (Kiru Bondana/ <i>Charadrius alexandrinus</i>) Whimbrel (Bulhithun'bi/ <i>Numenius phaeopus</i>)	4 species	0 species

Source: JICA Expert Team

Fauna species observed during the terrestrial flora survey at Fonadhoo island are shown in Figure 6.1.10.

		
Grey Heron (<i>Ardea cinerea</i>)	Common Sandpiper (<i>Actitis hypoleucos</i>)	Black Crowned Night Heron (<i>Nycticorax nycticorax</i>)
		
Asian Koel (<i>Eudynamis scolopaceus</i>)	White-Tailed Tropicbird (<i>Phaethon lepturus</i>)	Maldivian Water Hen (<i>Amauornis phoenicurus</i>)
		
Common Crow / House Crow (<i>Corvus Splendens Vieillot</i>)		

Source: JICA Expert Team

Figure 6.1.10 Fauna (Avian) Species Observed during the Terrestrial Fauna Survey at Fonadhoo Island

iii) Ground water quality survey

In order to obtain the current conditions before construction, the groundwaters are collected at several points nearby the proposed construction sites at each target island, and the water taken from the sites are analyzed at MWSC Water Quality Assurance Laboratory in Male. Drinking water quality by the Maldives EPA guideline and/or Utility Regulatory Authority of Maldives are used and given as reference standards in Table 6.1.22, and among those parameters, pH and salinity of each sample were analyzed.

Table 6.1.22 Drinking water quality parameters optimum conditions under EPA data collection guideline of Maldives

Parameter	Optimal Range
Temperature	-
Salinity	-
pH	6.5 – 8.5
Electrical Conductivity	<1000 uS/cm
Total Dissolved Solids	<500 mg/L
Turbidity	<1 NTU
Iron	<0.3 mg/L
Ammonia	<0.02 – 2.5 mg/L
Suspended Solids	5 – 750 mg/L
Total Hardness	<75 mg/L
Hydrogen Sulphide	<0.05 mg/L
Nitrates	<50 mg/L
Chlorides	<200 mg/L
Fecal Coliform	0/100ml CFU
Total Coliform	0/100ml CFU
Free Chlorine	0.04 – 0.2 mg/L

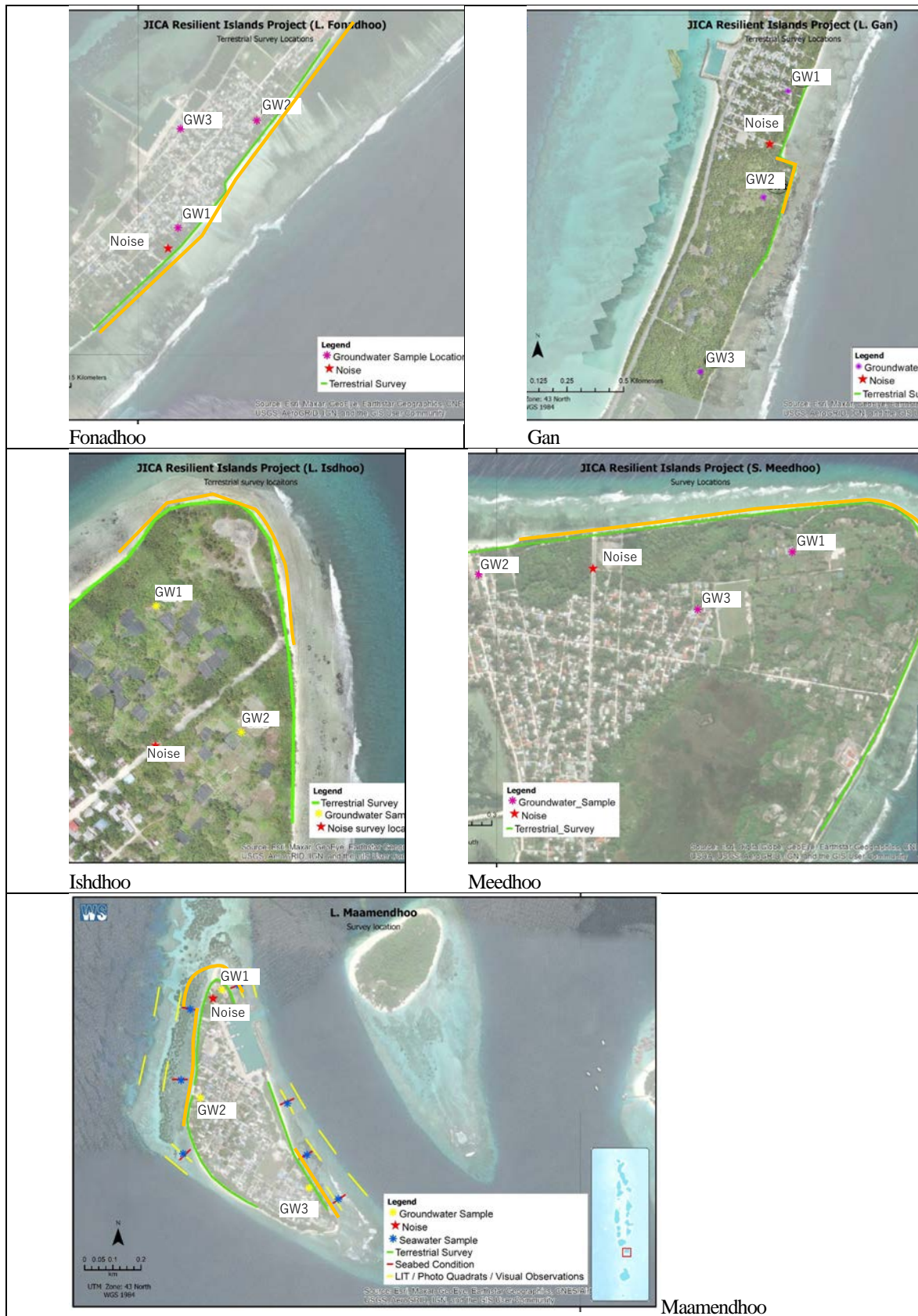
Source: EPA data collection guideline / Utility Regulatory Authority of Maldives

Table 6.1.23 shows the results of the sampled water at each target island. Comparing the pH levels of the tested groundwater, all the readings fall within the optimum range of drinking water.

Table 6.1.23 Groundwater Analysis Results at Five Target Islands

Island		pH	Salinity	Remarks
Fonadhoo	High tide	7.3~7.6	0.51~2.91	
	Low tide	7.2~7.7	0.53~2.88	
Gan	High tide	7.3~7.6	0.30~8.39	The highest is taken from Paree fengandu
	Low tide	7.4~7.6	0.30~8.31	
Ishdhoo	High tide	7.2~7.6	0.18~0.35	
	Low tide	7.0~7.6	0.18~0.34	
Maamendhoo	High tide	7.7~7.8	0.25~1.14	The highest is taken at the western edge of the island.
	Low tide	7.4~7.9	0.25~1.13	
Meedhoo	High tide	7.4~7.5	0.21~0.41	
	Low tide	7.4~7.5	0.20~0.40	

Source: JICA Expert Team



Source: JICA Expert Team

Figure 6.1.11 Locations of the survey points for groundwater quality at Five Target Islands

2) Pollution

i) Noise Survey

In order to obtain the current conditions before construction, the noise survey was conducted and data was taken from near the beach area where there are few residential houses nearby. According to WHO Noise Environmental Health Criteria 12 (EHC 12, 1980) recommended noise exposure limits for general outdoor noise levels is 55 dB and it is a desirable level to prevent significant community annoyance. WHO Environmental Noise Guidelines for EU Region (2018) indicates 53dB as the threshold for desirable road traffic noise levels.

Most of the noise recorded were from people talking and motor vehicles (motorbikes). Noise data was taken from a single location three time period of the day (8-9 am in the morning, 12-1 pm in the noon and 5-6 in the evening). The data's recorded are within the normal range.

Table 6.1.24 Noise Survey Results at Five Target Islands

Island		Average	Maximum	Minimum	Remarks
Fonadhoo	Day 1 (Feb 22, 2022)	47.43	53	49	
	Day 2 (Feb 23, 2022)	50.40	43	37	
	Day 3 (Feb 24, 2022)	47.47	53	48	
Gan	Day 1 (Feb 22, 2022)	50.35	61	45	
	Day 2 (Feb 23, 2022)	51.45	64	48	
	Day 3 (Feb 24, 2022)	48.82	52	46	
Ishdhoo	Day 1 (Mar 01, 2022)	52.48	68	48	
	Day 2 (Mar 02, 2022)	52.50	69	47	
	Day 3 (Mar 03, 2022)	52.08	64	45	
Maamendhoo	Day 1 (Feb 24, 2022)	47.13	59	44	
	Day 2 (Feb 26, 2022)	46.28	48	40	
	Day 3 (Feb 27, 2022)	49.00	62	45	
Meedhoo	Day 1 (Mar 05, 2022)	53.70	66	47	busy road located 160m from the project site.
	Day 2 (Mar 06, 2022)	59.18	68	48	
	Day 3 (Mar 07, 2022)	56.05	65	46	

Source: JICA Expert Team

3) Marine Environment

The marine survey was conducted by using five different methods, which are Line Intercept Transect Survey (LIT), Photo Quadrant Survey, Fish Belt Survey, Seabed Condition Survey and Seawater Sampling.

i) Line Intercept Transect Survey (LIT)

To assess the benthic composition of the survey site, LIT transects of 100 m were undertaken at both inside the reefs (below 1m depth) and outside reefs (at around 10 m depth) as per EPA guidelines.

Table 6.1.25 shows that the benthic compositions at most of site comprised mostly of a hard coral substrate followed by rubble and rock outside reefs, and rock and rubble inside reefs.

Table 6.1.25 Results of the Line Intercept Transect Survey (LIT) at Five Target Islands

Benthic composition		Fonadhoo		Gan	
		Inside Reef	Outside Reef	Inside Reef	Outside Reef
HC	Hard Coral	0-3%	26~55%	1%	26~27%
SC	Soft Coral	0%	0-1%	0%	0%
RKC	Recently Killed Coral	0%	6-16%	0%	16~28%
NIA	Nutrient Indicator Algae	0~16%	0%	3%	0%
SP	Sponge	0%	0-1%	0%	0~1%
RC	Rock	6~33%	7-36%	45~93%	24~27%
RB	Rubble	6~53%	6-29%	5~6%	19~29%
SD	Sand	6~21%	0-1%	0~35%	1~2%
SI	Silt	0%	0%	0%	0%
OT	Others	26~44%	0-1%	1~11%	0%

Benthic composition		Ishdhoo		Maamendhoo	
		Inside Reef	Outside Reef	Inside Reef	Outside Reef
HC	Hard Coral	4~11%	44~65%	0~16%	7~21%
SC	Soft Coral	0%	0%	0%	0~1%
RKC	Recently Killed Coral	0%	15-22%	0%	0~3%
NIA	Nutrient Indicator Algae	14~24%	0%	0~19%	1~54%
SP	Sponge	0%	2-5%	0%	0%
RC	Rock	22~73%	8-26%	0~41%	4~25%
RB	Rubble	0~13%	3%	0~48%	2~61%
SD	Sand	0%	2-4%	0~92%	3~56%
SI	Silt	0%	0%	0%	0~24%
OT	Others	9~31%	0%	0~83%	0~8%

Benthic composition		Meedhoo	
		Inside Reef	Outside Reef
HC	Hard Coral	1~3%	26~34%
SC	Soft Coral	0%	1~2%
RKC	Recently Killed Coral	0%	1-8%
NIA	Nutrient Indicator Algae	0~10%	3~5%
SP	Sponge	0%	0-1%
RC	Rock	0~63%	27-36%
RB	Rubble	13~58%	21~28%
SD	Sand	6~14%	3-7%
SI	Silt	0%	0%
OT	Others	3~28%	0~1%

Source: JICA Expert Team

ii) Detail photo quadrant analysis

At every 20 m along a transect line at each site, a half a metre quadrat is made and a photo was taken and benthic compositions were analyzed. Table 6.1.26 shows that the benthic compositions at most of site of 10m depth comprised mostly of a hard coral outside reefs, and algae (sea weeds) and rock inside reefs.

Table 6.1.26 Results of the Detail photo quadrant analysis at Five Target Islands

Benthic composition		Fonadhoo		Gan	
		Inside Reef	Outside Reef	Inside Reef	Outside Reef
Live reef cover		11~67%	35~84%	2~74%	26~48%
HC	Hard Corals	0%	32~84%	0%	25~46%
SC	Soft Corals	0%	0%	0%	0%
ALG	Algae	0~53%	0~3%	0~74%	0~7%
SP	Sponges	0%	0%	0%	0~1%
OT	Others	0~62%	0%	0~28%	0%
Non-living reef cover		33~89%	16~65%	26~98%	52~74%
DC	Dead Corals	0~1%	0~9%	0%	0~4%
RC	Rock	0~46%	16~62%	24~96%	17~58%
RB	Rubble	0~39%	0~44%	0~2%	4~43%
SD	Sand	9~70%	0~8%	0~6%	0~8%
SI	Silt	0~8%	0~1%	0~1%	0%

Benthic composition		Ishdhoo		Maamendhoo	
		Inside Reef	Outside Reef	Inside Reef	Outside Reef
Live reef cover		23~74%	22~53%	0~100%	6~68%
HC	Hard Corals	0~6%	22~52%	0~8%	3~62%
SC	Soft Corals	0%	0%	0~3%	0~1%
ALG	Algae	17~57%	0~3%	0~26%	0~43%
SP	Sponges	0%	0%	0%	0%
OT	Others	0~17%	0~1%	0~100%	0~4%
Non-living reef cover		26~77%	47~78%	0~100%	32~94%
DC	Dead Corals	0%	1~18%	0~4%	0~5%
RC	Rock	2~65%	28~70%	0~58%	9~74%
RB	Rubble	0~11%	12~10%	0~49%	0~44%
SD	Sand	1~45%	0~2%	0~95%	0~37%
SI	Silt	0%	0~5%	0~1%	0~10%



Benthic composition		Meedhoo	
		Inside Reef	Outside Reef
Live reef cover		0~55%	28~79%
HC	Hard Corals	0~7%	28~79%
SC	Soft Corals	0%	0%
ALG	Algae	0~12%	0%
SP	Sponges	0%	0%
OT	Others	0~55%	0~2%
Non-living reef cover		44~100%	21~72%
DC	Dead Corals	0%	0~5%
RC	Rock	1~20%	10~53%
RB	Rubble	0~60%	2~26%
SD	Sand	18~81%	0~8%
SI	Silt	0%	0~11%

Source: JICA Expert Team

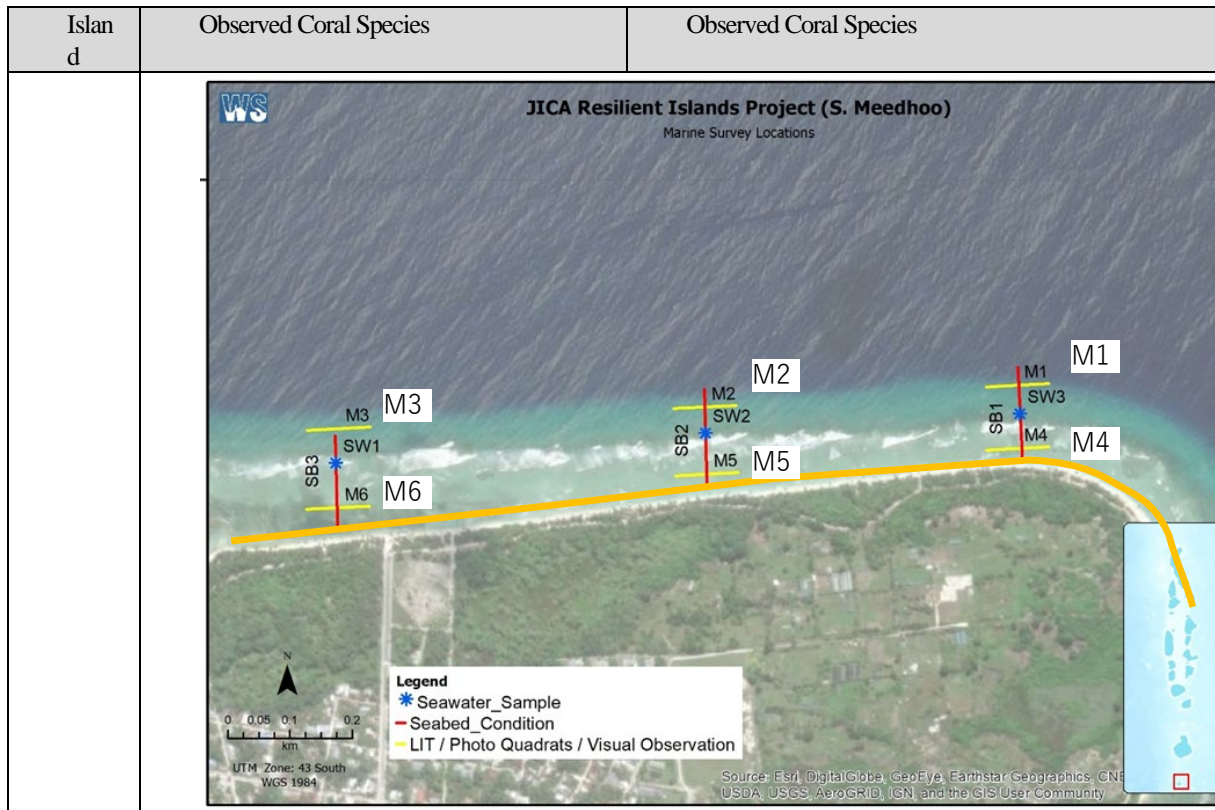
The following coral species that were found at the site, especially outside reefs. And some crown-of-thorns starfish were recorded at some sites in Maamendhoo.

Table 6.1.27 Observed Coral Species at Five Target Islands

Island	Observed Coral Species	Observed Coral Species
Fonadhoo	Inside Reef (M4, M5, M6) <i>None</i>	Outside Reef (M1, M2, M3) <i>Pocillopora verrucosa</i> , <i>Porites lutea</i> , <i>Acropora hyacinthus</i> , <i>Stylophora pistillata</i> , <i>Acropora nasuta</i> , <i>Stylophora pistillata</i> , <i>Pachyseris sp.</i> , <i>Porites cylindrica</i> , <i>Acropora hyacinthus</i> , <i>Platygera synensis</i> , <i>Platygera synensis</i> , <i>Lobophyllia recta</i>
Gan	Inside Reef (M3, M4) <i>Poritidae (M3)</i>	Outside Reef (M1, M2) <i>Stylophora pistillata</i> , <i>Pocillopora verrucosa</i> , <i>Montipora undata</i> , <i>Stylophora pistillata</i> , <i>Acropora latistella</i> , <i>Astreopora myriophthalma</i> , <i>Favites halicora</i> , <i>Platygyra daedalea</i> , <i>Porites lutea</i> , <i>Leptoria Phrygia</i> , <i>Acropora nasuta</i> , <i>Platygera synensis</i> , <i>Porites ru</i>

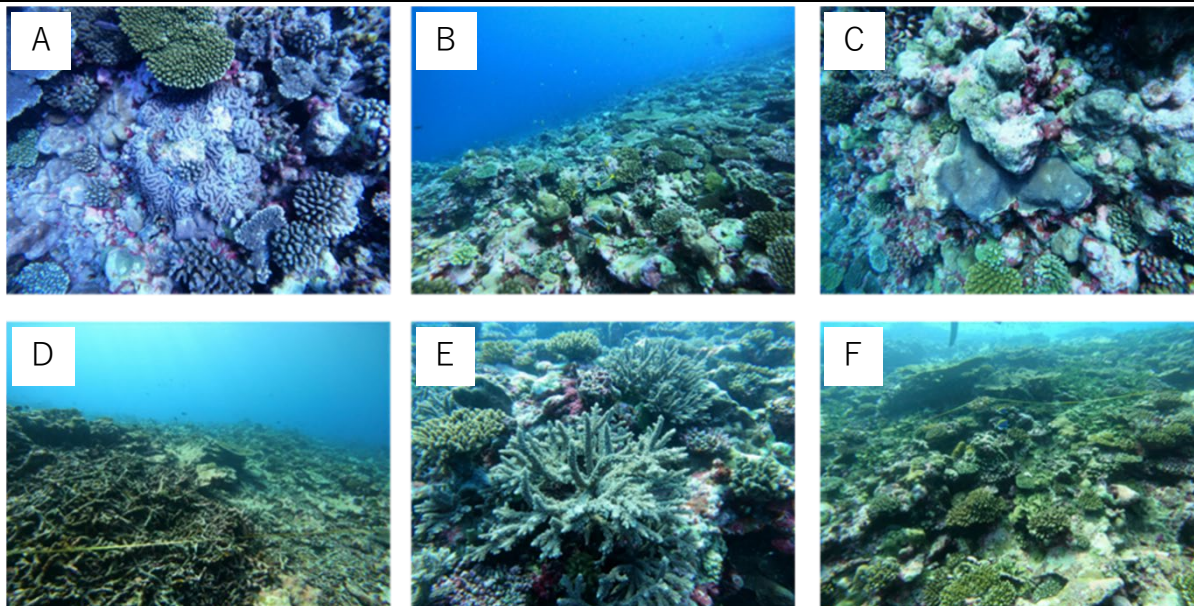
Island	Observed Coral Species	Observed Coral Species
		
Ishdhoo	Inside Reef (M3, M4) <i>Poritidae, Pocilloporidae and Acroporidae</i> <i>Poritidae</i>	Outside Reef (M1, M2) <i>Stylophora pistillata, Pocillopora verrucosa, Porites lutea, Leptoria Phrygia, Pachyseris sp, Acropora nasuta, Plerogyra sinuosa, Platygera synensis, Platygera synensis,</i>
		
Maamdhoo	Inside Reef (M9, m10, M11) <i>Poritidae, Acroporidae</i>	Outside Reef (M1, M2, M3) <i>Acropora hyacinthus, Acropora nasuta, Platygera synensis, Pocillopora verrucosa, Porites lutea, Porites rus, Stylophora pistillata</i>
	Inside Reef (M8, M14)	Outside Reef (M4, M5)

Island	Observed Coral Species	Observed Coral Species
	<i>Poritidae</i>	<i>Acropora nasuta</i> , <i>Annella mollis</i> , <i>Lobophytum sp.</i> , <i>Pocillopora verrucosa</i> , <i>Porites lutea</i> , <i>Porites rus</i> , <i>Sarcophyton sp.</i>
	Inside Reef (M12, M13) <i>None</i>	Outside Reef (M6, M7) <i>Acropora nasuta</i> , <i>Favites halicora</i> , <i>Herpolitha limax</i> , <i>Lobophyllia dimiduta</i> , <i>Pachyseris speciosa</i> , <i>Pocillopora verrucosa</i> , <i>Porites rus</i>
	<p>JICA Resilient Islands Project (L. Maamendhoo) Marine Survey location</p> <p>Legend * Seawater Sample - Seabed Condition - LIT / Photo Quadrats / Visual Observations</p> <p>Scale: 0 0.05 0.1 0.2 km UTM Zone: 43 North WGS 1984</p>	
Meed hoo	Inside Reef (M4, M5, M6) <i>Poritidae</i>	Outside Reef (M1, M2, M3) <i>Acropora tenuis</i> , <i>Stylophora pistillata</i> , <i>Acropora clathrate</i> , <i>Stylophora pistilla</i> , <i>Dipsastrea favus</i> , <i>Platygera synensis</i>



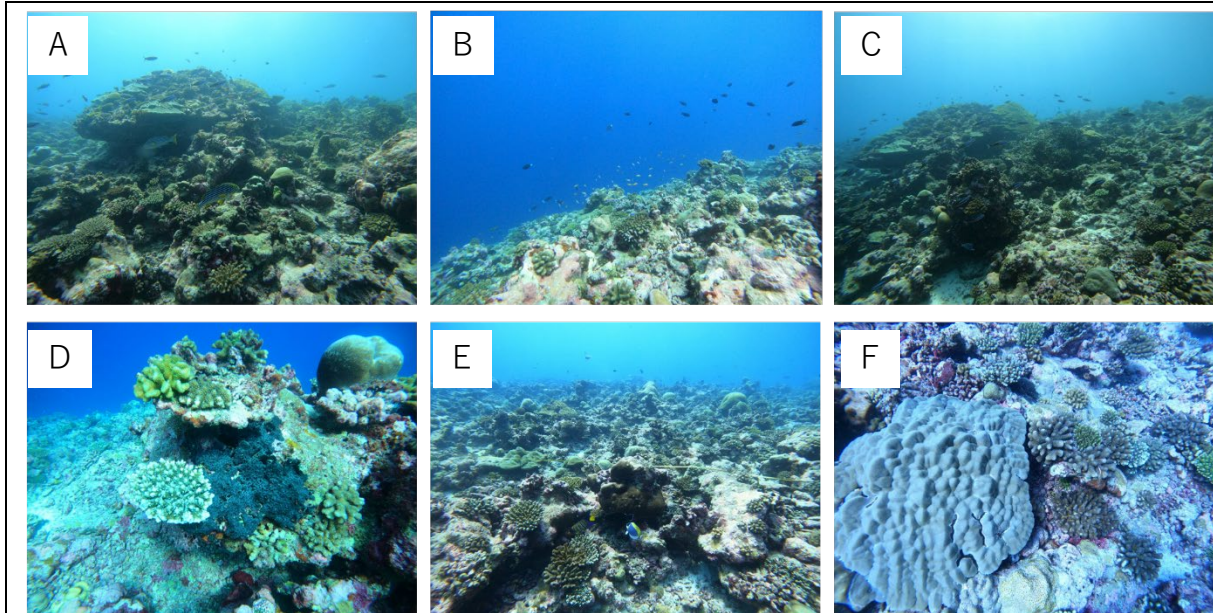
Source: JICA Expert Team

(1) Fonadhoo, Laamu



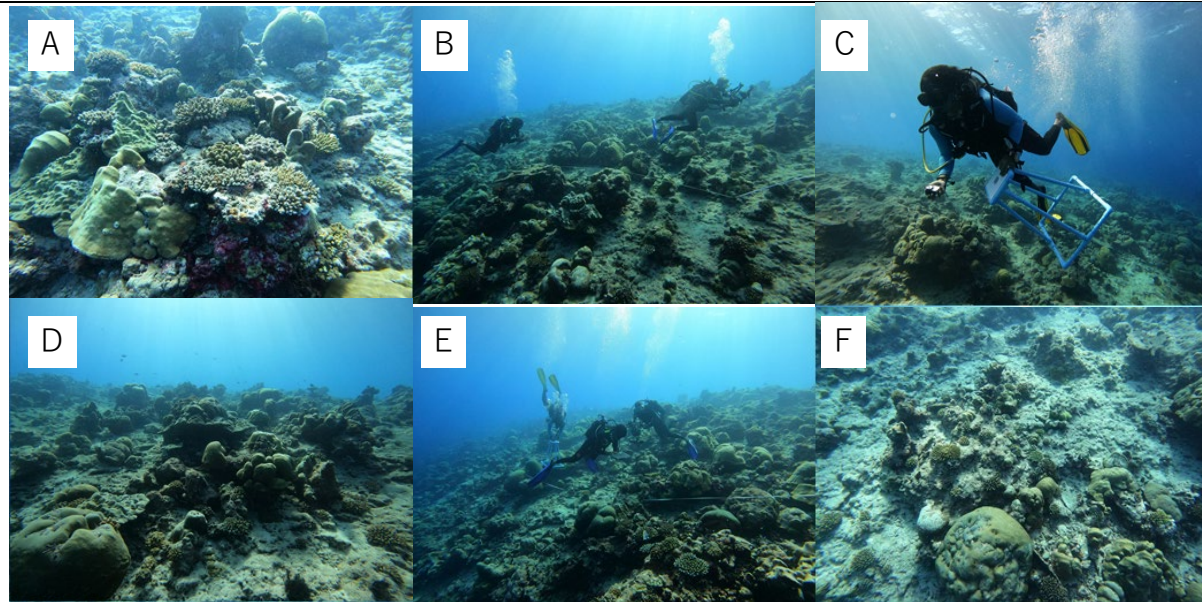
Site M1. A – Species of *Acroporidae* and *Pocilloporidae*. B – Photo of the site showing high live coral cover. C - Photos of corals spotted at site, including species of *Poritidae*. D – RKC found at the site. E, F Different species of hard coral cover at the site.

(2) Gan, Laamu



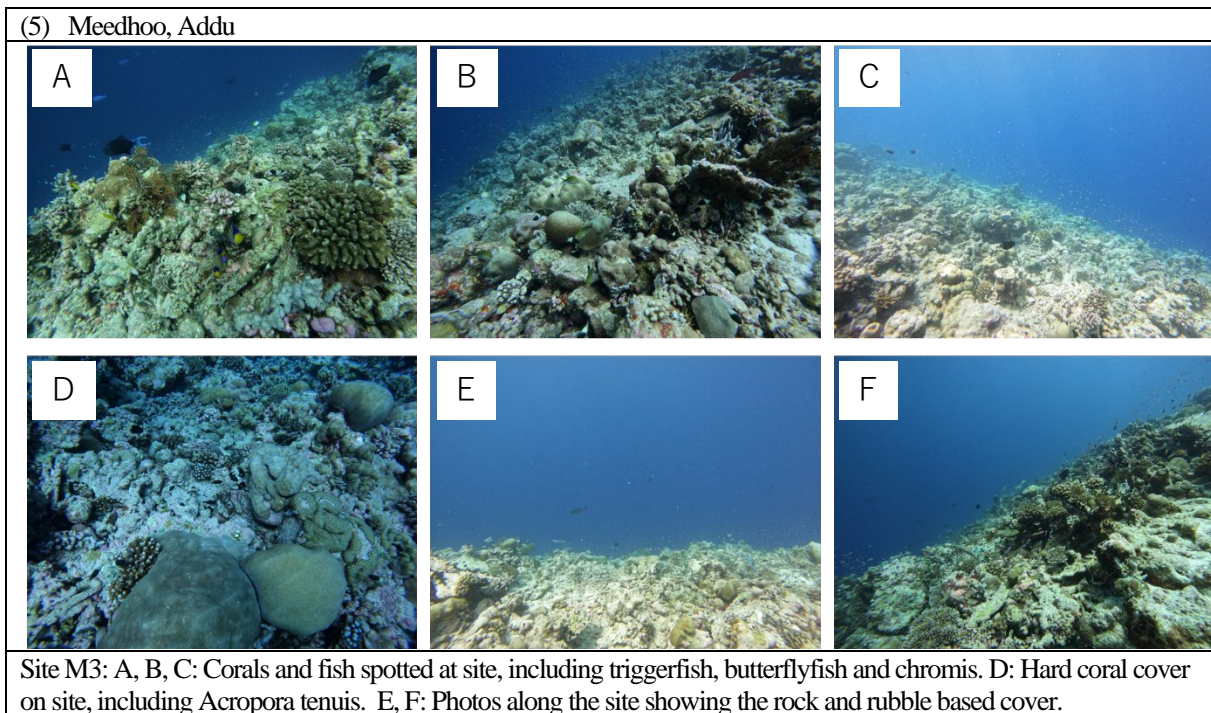
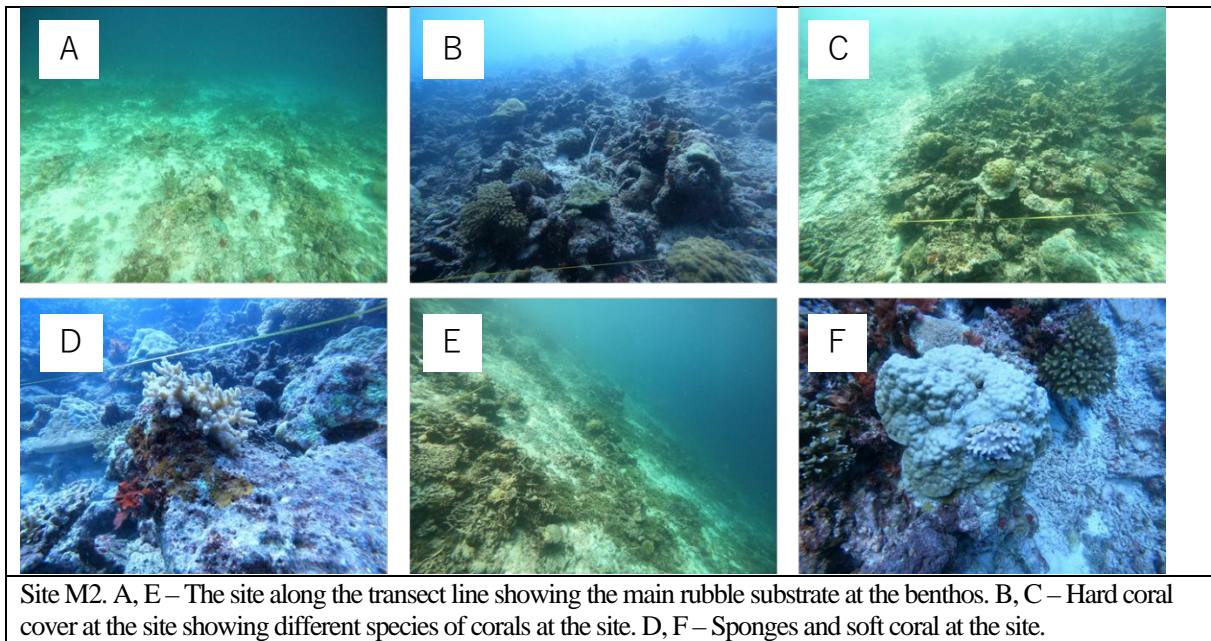
Site M1. A, B, C, E – General condition of the site showing high coral cover with different species of coral. D – *Acroporidae* and *Pocilloporidae* at site. F – *Poritidae* and *Pocilloporidae* at site

(3) Ishdhoo, Laamu



Site M1: A. Photo of the corals taken during the survey; B. LIT survey undertaken; C. Photo quadrat survey undertaken; D. Photo of the survey site; E. LIT and Photo quadrat survey undertaken; F. Photo of the survey site

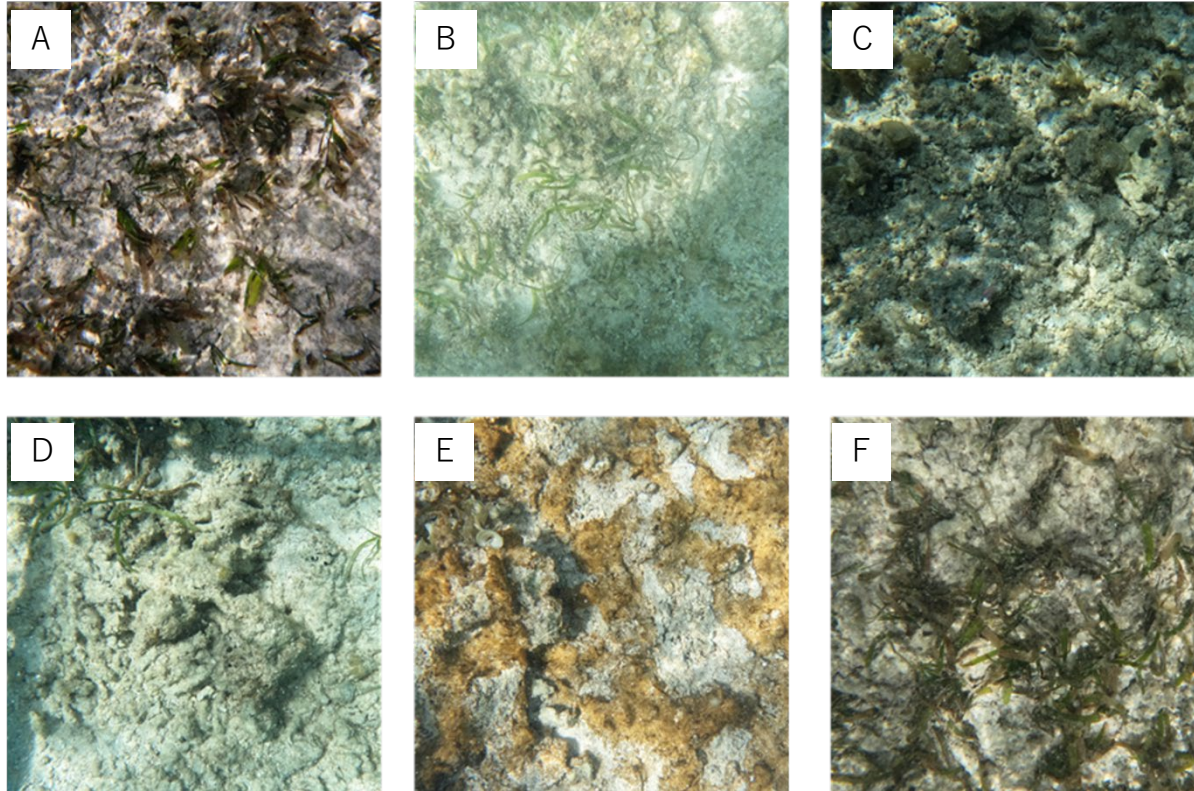
(4) Maamendhoo, Laamu



Source: JICA Expert Team

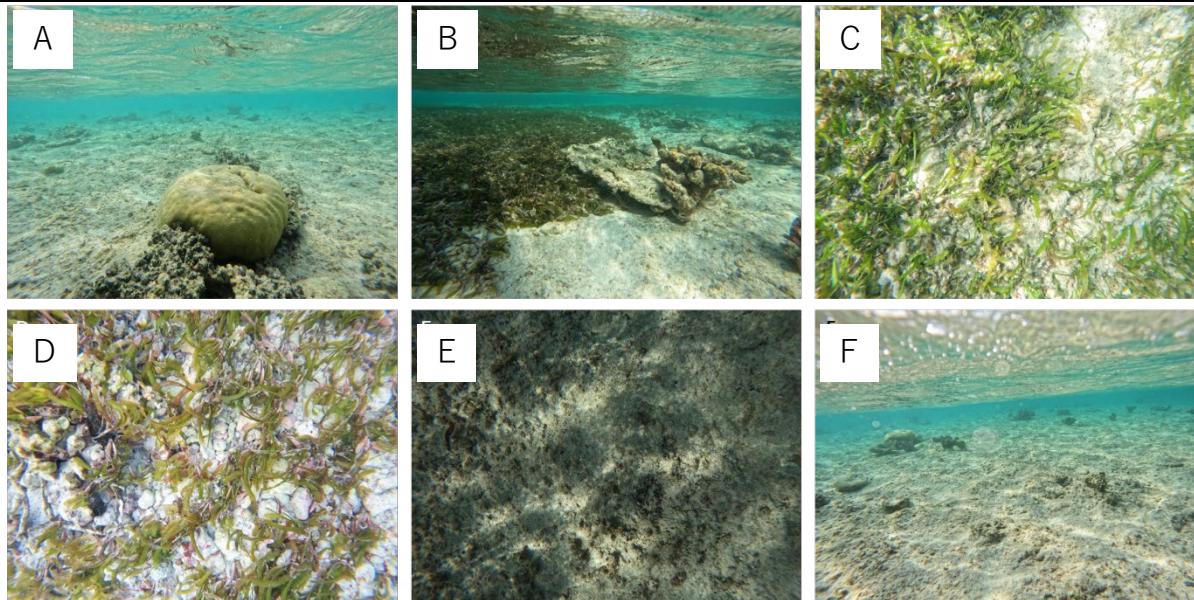
Figure 6.1.12 Sea Bed Situations outside the Reef at Five Target Islands

(1) Fonadhoo, Laamu

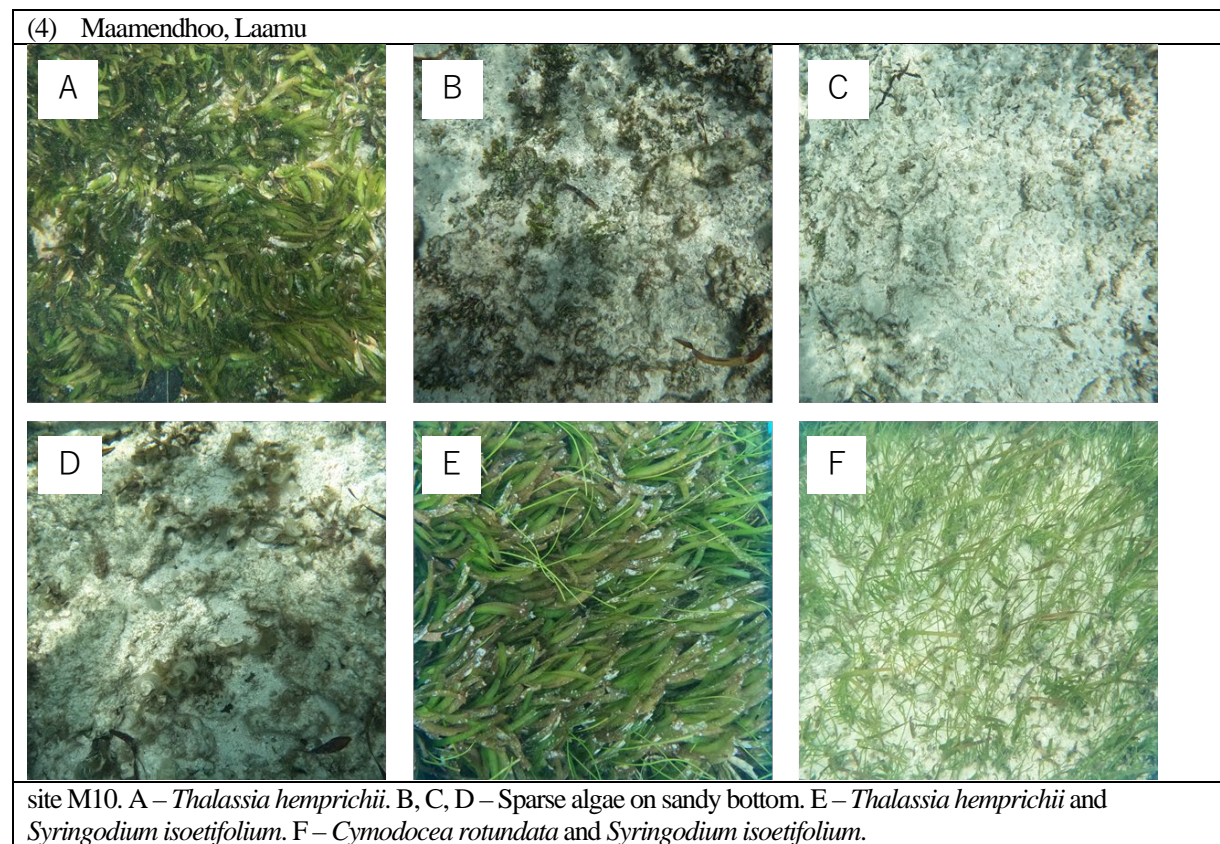
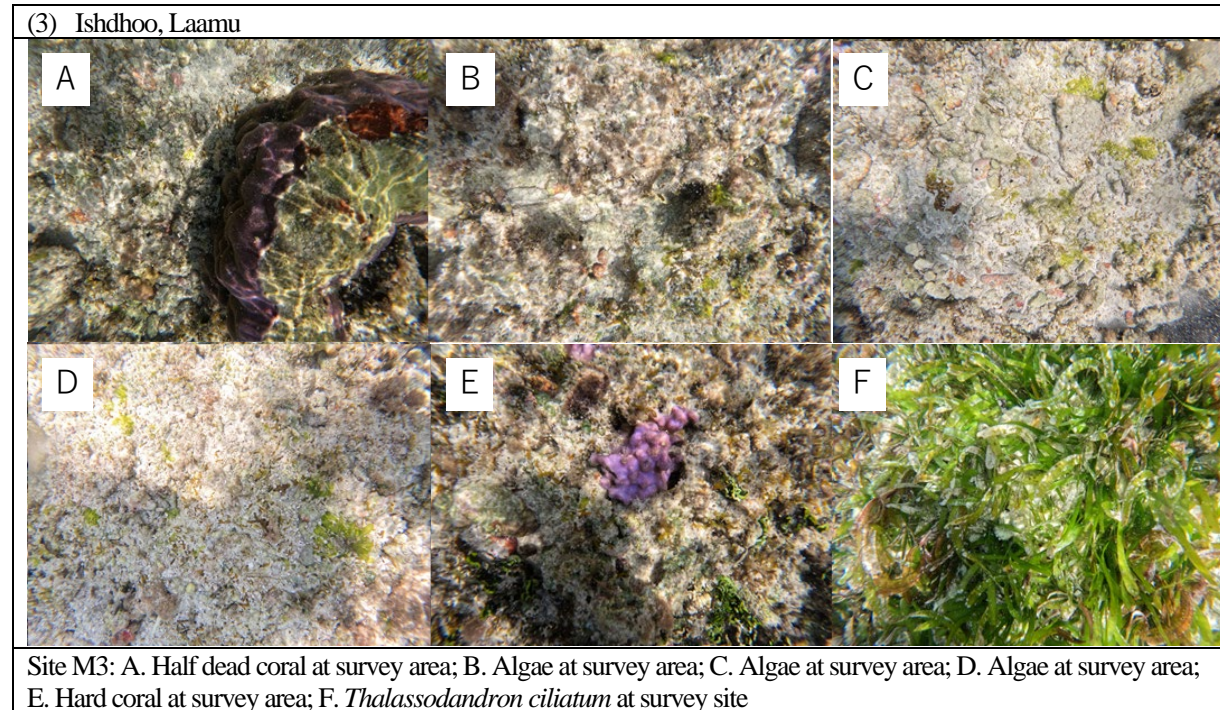


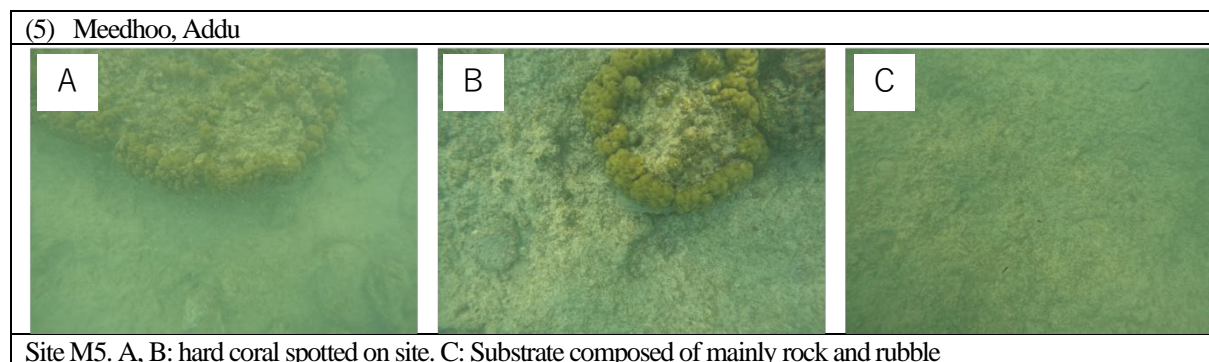
Site M4. A, B, C, D: Shows rubble and sand-based composition of the sediment at the site with sparse seagrass patches. E – Encrusting coral at the site. F: Seagrass at the site.

(2) Gan, Laamu



Site M3. A – Live coral (Poritidae) at site. B – Seagrass at the site showing rock substrate. C, D – Seagrass *Thalassodendron ciliatum* at the site. E, F – Rocky substrate with sparse rubble at the site.





Source: JICA Expert Team

Figure 6.1.13 Sea Bed Situations inside the Reef at Five Target Islands

iii) Threatened coral species in the Red List of International Union for Conservation of Nature (IUCN)

Threatened coral species in the Red List of International Union for Conservation of Nature (IUCN) observed through the Line Intercept Transect Survey and Photo Quadrat Surveys at the target five islands are listed in the following table. All of those threatened species are found along the survey lines outside reef edges, and no species are found inside the reefs, where are nearby the proposed construction sites.

Table 6.1.28 Coral species under “Threatened” category, found at target Five Islands

Scientific Name	Category	Number of survey lines, where endangered coral species are found (upper: outside reef, lower: inside reef)	Fonadhoo	Gan	Maamendhoo	Isdhoo	Meedhoo
<i>Acropora Clathrata</i>	CR	1/17 0/17	0/3 0/3	0/2 0/2	0/7 0/7	0/2 0/2	1/3 0/3
<i>Acropora Hyacinthus</i>	CR	3/17 0/17	2/3 0/3	0/2 0/2	1/7 0/7	0/2 0/2	0/3 0/3
<i>Pachyseris Speciosa</i>	CR	2/17 0/17	0/3 0/3	0/2 0/2	2/7 0/7	0/2 0/2	0/3 0/3
<i>Plerogyra Sinuosa</i>	CR	1/17 0/17	0/3 0/3	0/2 0/2	0/7 0/7	1/2 0/2	0/3 0/3
<i>Pocillopora Verrucosa</i>	VU	13/17 0/17	3/3 0/3	2/2 0/2	6/7 0/7	2/2 0/2	0/3 0/3
<i>Porites Cylindrica</i>	EN	1/17 0/17	1/3 0/3	0/2 0/2	0/7 0/7	0/2 0/2	0/3 0/3
<i>Porites Rus</i>	NT	7/17 0/17	0/3 0/3	1/2 0/2	6/7 0/7	0/2 0/2	0/3 0/3
<i>Stylophora Pistillata</i>	CR	10/17 0/17	3/3 0/3	2/2 0/2	1/7 0/7	2/2 0/2	2/3 0/3

Source: JICA Expert Team

Note: Numbers of survey lines, on which coral species under category “Threatened”: upper is outside reef edge, and lower is inside reef edge.

Category of IUCN Red List: "Endangered Class IA (CR)", "Endangered Class IB (EN)", Vulnerable (VU), and Near Threatened (NT) under "Threatened"

In accordance with Frequent Questions and Answers (FAQs) for JICA's Environmental and Social Consideration Guidelines (July 2011, revised February 2016), among "Important natural habitats or important forests", by referring the definition in the World Bank's Safeguard Policy, etc., "Natural habitats" are defined as (1) terrestrial and water areas (including sea areas) where natural ecosystems are formed mainly by native domestic fauna and flora species, and (2) terrestrial and water areas (including sea areas) where no alterations are added essentially. Furthermore, among the "natural habitats", five (5) criteria are indicated for "important natural habitats", and it was confirmed that all the five criteria are not applicable to the target five islands. The results are summarized in Table 6.1.29. Regarding criteria (5), it is unknown because it cannot be determined based on the information collected at this time.

Table 6.1.29 Current Situations for Five Target Islands to be considered as "Important Natural Habitats" among the Natural Habitats

Standard	Current Situations
(1) Important habitats for species under "Threatened", "Endangered Class IA (CR)", "Endangered Class IB (EN)", Vulnerable (VU), and Near Threatened (NT) species in the Red List of the International Union for Conservation of Nature (IUCN)	Outside the Reef edges, along 16 out of the 17 survey lines on the 5 target islands, 5 species classified as "Critically Endangered (CR)", 1 species under "Endangered Class IB (EN)", 1 species under "Vulnerable II (VU)", and 1 species under "Near Threatened (NT)" on the IUCN Red List were observed. Inside the reef edges, no 'threatened' coral species were found on 17 survey lines on the 5 target islands.
(2) Important habitats for endemic species and/or species with limited distribution	As there are no KBA areas in the target islands, there are no important habitats for the species described in the left.
(3) Habitats that support migratory species and/or globally important assemblages of herd fauna species	As there are no IBA areas in the target islands, there are no habitats for the species described in the left.
(4) Areas where extremely critical ecosystems and/or unique ecosystems are recognized	As there are no KBA/IBA areas, nor protected areas and/or marine protected areas in the target islands, there are no areas described in the left.
(5) Areas associated with important evolutionary processes	N/A

Source: JICA Expert Team

iv) Fish belt survey

Fish belt transects (FBT) surveys were conducted to count (quantify) the abundance and community composition of fish along a transect line for Line Intercept Transect (LIT). The numbers of fish counted by functional groups, such as herbivores (*Acanthuridae*, *Scaridae*), omnivores (selected *Labridae*), corallivores (*Chaetodontidae*) as well as habitat specialists (*Pomacentridae*).


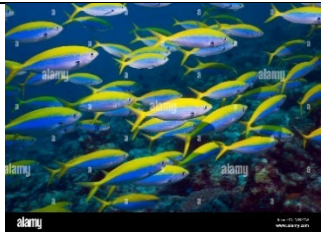










At the sites outside reef, 6 to 25 kinds of fish were observed, and browsers and predators are most abundant groups of fish at the site, and only 1 to 5 kinds of fish were observed inside the reefs.














Table 6.1.30 Numbers of Recorded Fish at Five Target Islands

Island	Site	Total numbers	Functional groups					
			Browser	Grazer	Predator	Planktivore	Coralivore	Omnivore
Fonadhoo	Inside Reef	1~2	1	0	0	0~1	0	0
	Outside Reef	15~18	3~6	2~3	2~5	4~6	1~2	0
Gan	Inside Reef	3	2	0~1	0	0~1	0	0
	Outside Reef	19~25	6~8	5	3~5	5	0~2	0
Ishdhoo	Inside Reef	3~4	2~4	0~1	0	0	0	0
	Outside Reef	22~25	6~8	4~4	6~11	2~4	2~5	0
Maamendhoo	Inside Reef	1~3	1~3	0~1	0~1	0	0	0
	Outside Reef	6~13	3~8	1	0~5	0~3	0~3	0
Meedhoo	Inside Reef	2~5	1~2	0~1	0~1	0	0	1~2
	Outside Reef	22~24	3~4	4~6	9~12	2~4	0~1	0~1

Source: JICA Expert Team

Fish species observed during the terrestrial flora survey at Fonadhoo island are shown in Figure 6.1.14.

		
Trumpetfish (<i>Aulostomidae chiensis</i>)	Yellow-black fusilier (<i>Caesio xanthonota</i>)	Violet soldierfish (<i>Myripristis violacea</i>)
		
Philippine damsel (<i>Pomacentrus philippinus</i>)	Flower grouper (<i>Epinephelus fuscoguttatus</i>)	Blue-striped snapper (<i>Lutjanus kasmira</i>)
		
Indian damsel (<i>Pomacentrus indicus</i>)	Two-tone puller (<i>Chromis dimidiata</i>)	Clown triggerfish (<i>Balistoides conspicillum</i>)
		
Herringbone butterflyfish (<i>Chaetodon Triangulum</i>)	Powder blue tang (<i>Acanthurus leucosternon</i>)	Epaulette surgeonfish (<i>Acanthurus nigricauda</i>)

		
Convict tang (<i>Acanthurus triostegus</i>)	Redtoothed triggerfish (<i>Odonus niger</i>)	Redtail butterflyfish (<i>Chaetodon collare</i>)
		
Forster's Hawkfish (<i>Paracirrhites forsteri</i>)	Humpback snapper (<i>Lutjanus gibbus</i>)	Small-toothed jobfish (<i>Aphareus furca</i>)
		
Steephead parrotfish (<i>Chlorurus strongylocephalus</i>)	Tricolor parrotfish (<i>Scarus tricolor</i>)	Yellow-tail basslet (<i>Pseudanthias evansi</i>)
		
Orange basslet (<i>Pseudanthias squamipinnis</i>)	Moorish idol (<i>Zanclus cornutus</i>)	Thompson's surgeonfish (<i>Acanthurus thompsoni</i>)
		
Indian triggerfish (<i>Melichthys indicus</i>)		

Source: JICA Expert Team

Figure 6.1.14 Fish Species Observed during the Fish-belt Survey at Fonadhoo Island

v) Marine water quality survey

The marine waters are collected at several points mainly inside reefs nearby the proposed construction sites at each target island, and the water taken from the sites are analyzed at MWSC Water Quality Assurance Laboratory in Male. marine water quality parameter optimum conditions set by the Maldives EPA guideline is given as reference standards in the following table.

Table 6.1.31 Marine Water Quality Parameters Optimum Conditions under EPA Data Collection Guideline

Parameter	Optimal Range	Reference
Temperature	18°C and 32°C *Changes should not surpass 10C above the average long-term maximum	GBRMPA, 2009
Salinity	3.2% - 4.2%	GBRMPA, 2009
pH	8.0-8.3 *Levels below 7.4 pH cause stress	
Turbidity	3-5 NTU >5 NTU causes stress	Cooper et al. 2008
Sedimentation	Maximum mean annual rate 3mg/cm ² /day Daily maximum of 15mg/cm ² /day	GBRMPA, 2009
Nitrates	<5 mg l-1 NO -N	UNESCO/WHO/UNEP, 1996
Ammonia	Max. 2-3 mg l-1 N	UNESCO/WHO/UNEP, 1996
Phosphate	0.005 - 0.020 mg l-1 PO -P	UNESCO/WHO/UNEP, 1996
Sulphate ¹	2 mg l-1 and 80 mg l-1	UNESCO/WHO/UNEP, 1996
BOD	< 2 mg l-1 O ₃	UNESCO/WHO/UNEP, 1996
COD	< 20 mg l-1 O ₂	UNESCO/WHO/UNEP, 1996

Source: EPA data collection guideline

Except Sulphate and Phosphate, the results of other parameters comply with the standards set by the EPA.

Table 6.1.32 Marine Water Analysis Results at Five Target Islands

Parameter	Unit	Fonadhoo	Gan	Ishdhoo	Maamendhoo	Meedhoo
		3 samples	2 samples	2 samples	7 samples	3 samples
Physical Appearance		Clear with particles	Clear with particles	Clear with particles	Clear with particles	Clear with particles
Temperature	°C	23.6~24.1	23.8~24.0	24.0~24.2	24.0~24.2	24.3~25.0
Salinity	‰	33.33~33.94	33.55~33.52	33.69~33.80	33.64~34.24	34.05~34.41
pH		8.1~8.1	8.0~8.1	8.0~8.1	8.0~8.2	8.2~8.5
Turbidity	NTU	0.148~0.246	0.148~0.236	0.182~0.280	0.206~0.424	0.207~0.324
Nitrates	mg/L	3.9~4.9	3.5~4.8	4.2~4.6	4.1~6.0	5.6~6.1
Ammonia	mg/L	0.06~0.09	0.04~0.06	0.06~0.23	0.06~0.23	0.08~0.11
Phosphate	mg/L	0.05~0.10	<0.05~0.05	<0.05~0.05	0.03~0.20	0.13~0.16
Sulphate	mg/L	2400~2500	2500~2550	2400~2450	2350~2500	2650~3100
BOD	mg/L	1~1	1~1	1~1	1~3	-

Source: JICA Expert Team

All survey results in each island are attached as Appendix.6.

¹ According to www.britannica.com/science/seawater/Dissolved-inorganic-substances, Sulphate concentration levels in normal seawater are in the range of around 2500 mg/l.

(2) Survey Result of Environmental and Social Considerations

The survey result of environmental and social considerations is shown in Table 6.1.33.

Table 6.1.33 Survey Result of Environmental and Social Considerations

Pollution		
1	Air Pollution	Based on the site reconnaissance as well as hearing from Island Council at each targeted island, it was found that there was no source of air pollution in and around the Project areas because the proposed sites were located along the coast and some distance from residential area and public roads at present. During construction phase, air pollution would be expected due to heavy machinery operation and construction activities, however, it would be limited considering the scale of construction. In the case of beach nourishment project in Maamendhoo Island, Fonadhoo Island, and Meedhoo Island, air quality would be affected near the site for stocked supplementary sand due to unproper management during operation phase.
2	Water Pollution	Ground water as well as sea water at all targeted islands were analyzed and found all parameters satisfying with the national standards. Based on the site reconnaissance and hearing form Island Council at each targeted island, no pollution sources were confirmed in and around the Project area. During construction phase, turbidity shall be constantly checked when operating construction activities at costal area and borrowed area. In an operation phase, supplementary sand for maintaining nourished beach shall be properly stocked in order to avoid any outflow of sand into the sea.
3.	Soil Contamination	Based on the site reconnaissance as well as hearing from Island Council at each targeted island, it was found that there was no source of soil contamination in and around the Project areas. During construction phase, soil contamination would be occurred from construction vehicles due to poor maintenance.
4	Noise and Vibration	Noise survey was conducted at the location along the road to the project site and closer to the residential area in each target island. The results of all islands are around 55dB which is mostly satisfied with the standards set by WHO. Only the result in Meedhoo Island was slightly higher (around 60dB). Main source of the noise is from vehicles and voices of people passing by. During construction phase, noise and vibration would be generated from the construction activities and vehicles transporting construction materials. However, any blasting or drilling works are not planned, so the effects from noise or vibration would be limited. Furthermore, the effects of noise or vibration from the construction activities would be limited since the construction site is not adjacent to residential areas. Effect of noise from vehicles transporting construction materials is to be predicted, but it would be limited considering the scale of construction.
7	Bottom Sediment	Construction activities at the project for beach nourishment and reclamation would cause soil sedimentation during construction phase. Soil sedimentation would be occurred around the nourished beach in the operation phase.
8	Waste	At the project site in Fonadhoo Island, Isdhoo Island, Gan Island and Meedhoo Island, soft measures such as geo-bags installing already for the projection of coast line would be removed and transported from the sites during construction phase. Hazardous waste such as used engine oil would be generated from construction vehicles during construction phase as well.
Natural Environment		
9	Topography and Geographical Features	During construction phase, the location for reclamation at Maamendhoo Island shall be constantly checked in order to avoid any unnecessary reclamation. During the operation phase, the coastal line around the Project area shall be regularly monitored in order to grasp any changes of geographical features.
10	Hydrological Situation	During the operation phase, the waves and current around the Project area shall be regularly monitored in order to grasp any effect on the island's geographical features.
12	Flora and Fauna/ Biodiversity	Based on the field survey and hearing from the island council at each targeted island, there is no designated environmentally protected area near the project site at all targeted islands. Based on the marine survey, no threatened species (rare species) of corals were confirmed and the conditions of

		<p>seabed were dominated rocky bottom with rubble, sand or seagrass and the coverage of corals were low and not concentrated in the project areas. Therefore, it is concluded that the project areas are considered to be not biologically important. According to Appendix 1 “Ecosystem and Biota” in JICA Guidelines for environmental and social considerations, it is stipulated that Projects must not involve significant conversion or significant degradation of critical natural habitats and critical forests. By referring IFC’s standards, it was confirmed that the following conditions were fulfilled by applying mitigation measures.</p> <table border="1"> <thead> <tr> <th>Required considerations</th> <th>Mitigation measures</th> </tr> </thead> <tbody> <tr> <td>(1) Project shall not exert significant adverse impacts on biodiversity values existing in “critical habitat” and key functions of the ecosystems.</td> <td>“Threatened” species in IUCN Red List were confirmed in outer reef area which was several hundred meters away from the project sites, and it was not confirmed any along the coastal area or inside of reef in the project areas. In order to avoid any effect from construction activities or dredging on corals, temporary provisions to reduce turbid water flow to surrounding areas such as installing silt fence.</td> </tr> <tr> <td>(2) Over a reasonable period of time, projects shall not cause net reduction in endangered species population listed below; Species classified into “Critically Endangered (CR)” and “Endangered (EN) out of “Threatened” species listed on the IUCN Red List of Threatened Species, or those that fall under such classifications in accordance with the host country’s rules and regulations</td> <td>“Threatened” species in IUCN Red List were confirmed in outer reef area which was several hundred meters away from the project sites, and it was not confirmed any along the coastal area or inside of reef in the project areas. In order to avoid any effect from construction activities or dredging on corals, temporary provisions to reduce turbid water flow to surrounding areas such as installing silt fence.</td> </tr> <tr> <td>(3) Long-term and effective mitigation measures and monitoring shall be put in place be performed with regard to (1) and (2) above.</td> <td>Due to nourishing, revetment or reclamation, marine ecosystem around the Project area may be disturbed. However, considering the scale of projects, the impacts would be limited and site-specific. The impact needs to be monitored regularly.</td> </tr> </tbody> </table> <p>Terrestrial and marine environment in and around projects sites would be disturbed by the construction activities, however, the impact would be minor considering the scale of the projects. In an operation phase, the state of marine ecosystem around the project sites shall be regularly monitored in order to grasp any changes made by the Project.</p>	Required considerations	Mitigation measures	(1) Project shall not exert significant adverse impacts on biodiversity values existing in “critical habitat” and key functions of the ecosystems.	“Threatened” species in IUCN Red List were confirmed in outer reef area which was several hundred meters away from the project sites, and it was not confirmed any along the coastal area or inside of reef in the project areas. In order to avoid any effect from construction activities or dredging on corals, temporary provisions to reduce turbid water flow to surrounding areas such as installing silt fence.	(2) Over a reasonable period of time, projects shall not cause net reduction in endangered species population listed below; Species classified into “Critically Endangered (CR)” and “Endangered (EN) out of “Threatened” species listed on the IUCN Red List of Threatened Species, or those that fall under such classifications in accordance with the host country’s rules and regulations	“Threatened” species in IUCN Red List were confirmed in outer reef area which was several hundred meters away from the project sites, and it was not confirmed any along the coastal area or inside of reef in the project areas. In order to avoid any effect from construction activities or dredging on corals, temporary provisions to reduce turbid water flow to surrounding areas such as installing silt fence.	(3) Long-term and effective mitigation measures and monitoring shall be put in place be performed with regard to (1) and (2) above.	Due to nourishing, revetment or reclamation, marine ecosystem around the Project area may be disturbed. However, considering the scale of projects, the impacts would be limited and site-specific. The impact needs to be monitored regularly.
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(3) Long-term and effective mitigation measures and monitoring shall be put in place be performed with regard to (1) and (2) above.	Due to nourishing, revetment or reclamation, marine ecosystem around the Project area may be disturbed. However, considering the scale of projects, the impacts would be limited and site-specific. The impact needs to be monitored regularly.									
14	Coastal Zone	Since projects’ purpose is costal protection, all project sites are located along the coastal area. Construction activities would disturb coastal ecosystem, however, considering the scale of construction, the effect would be limited.								
Social Environment										
15	Involuntary Resettlement	Involuntary resettlement or land acquisition is not expected under the Project. There was no illegal occupant found in the Project area. Based on the hearing from the Island Council members in Maamendhoo, there are three temporary structures without walls and foundation installed at the sea adjacent to the proposed reclamation area in which two of them are used for resting area of enjoying sea view by the owner of the structures and his neighbors. These are not used for the purpose of making a living or residence. The rest of the structure is located along the coastline and used for a working space of processing tuna fish. The land adjacent to these structures is belong to the Island and two structures installed at the sea and the extended part of the one located along the coastline								

		<p>are installed illegally without permission of the Island Council. Two structures installed at the sea, where to be reclaimed need to be moved and one temporary structure installed along the coast need to be set back 1m or 2m from existing location. The owner of the three structures is the lessee to the land managed by Island Council. Agreement was made among the owner of the structures, Island Council and MECCT that disassembling and moving the structures with the physical support from the Island Council prior to the commencement of the construction activities would be applied as an alternative compensation measure instead of providing compensation for the loss of structures at a replacement cost.</p> <p>As for the access to the construction sites on land, construction materials will be transported by using existing roads at all targeted islands except the project for protecting cultural heritage site at Gan Island. In the case of revetment project at Gan Island, about 150m of the existing road may need to be expanded 3m width to reach the proposed revetment site for construction vehicle to transport construction materials such as rocks. Details of necessity for the expansion will be examined in the D/D phase. The trees can be cutting down with the consent of Island Council and the owner of the trees (if there is). In addition, tree must be planted in comply with the stipulation in the regulation No.7/2014 that “every tree or palm removed two more should be planted and grown in the island and compensate to the owner of the trees (if there is).</p>
16	Poor	Based on the site reconnaissance and hearings from Island Council members, it was found that there are no residents within the project sites or no commercial activities along the coastal area in all targeted islands.
18	Local Economy such as Employment, and Livelihood etc.,	Based on the site reconnaissance and hearings from Island Council members, it was found that there are no commercial activities along the coastal area in all targeted islands. However, locals are using coastal area for recreational purposes such as walking, swimming, fishing, surfing, snookering, collecting seashells and catching octopus. During construing phase, these activities would be disrupted temporarily.
19	Land use and u Utilization of Local Resources	Based on the site reconnaissance and hearings from Island Council members, it was found that locals are using coastal area for recreational purposes such as walking, swimming, fishing, surfing, snookering, collecting seashells and catching octopus. During construing phase, these activities would be disrupted temporarily.
23	Misdistribution of Benefits and Damages	Based on the site reconnaissance and hearings from Island Council members, it was found that there are no commercial activities along the coastal area in all targeted islands. No activities are expected to lead to misdistribution of benefits and damages due to the Project.
24	Local Conflicts of Interest	Based on the site reconnaissance and hearings from Island Council members, it was found that there are no commercial activities along the coastal area in all targeted islands. No activities are expected to raise to local conflicts of interest due to the Project.
26	Cultural Heritage	There are three national cultural heritages found in the Project area, namely at Gan Island (ancient Buddhist heritage), Isdhoo Island (ancient Buddhist heritage) and Meedhoo Island (oldest Islamic cemetery in the Maldives). As for the two Buddhist heritages, it is the project purpose to protect these sites from costal erosion. The oldest Islamic cemetery is not in the Project site. Therefore, no negative effects are expected from the Project.
28	Gender	Based on the gender assessment meeting implementing at all targeted islands, it was found that there is no gender discrimination on job opportunity or payment by gender at present. However, the decision on the Island is rather made by male than female.
29	Children’s Rights	Based on the hearing from Island Council members, it was found that there is no custom of child labor exist in all targeted islands.
30	Hazardous (Risk) Infectious Diseases such as HIV/AIDS	Some public health impacts are expected due to the influx of construction workers, as well as increased risks related to sexually transmitted diseases (STDs/STIs), HIV/AIDS and COVID-19 between workers and the local population.
31	Occupational Health and Safety	Inappropriate management of working environment would raise the risk of accidents and disease. The contractor shall observe legislations such as Construction Safety Standards (2019) to manage the working environment during construction phase.

Other		
32	Accidents	During construction phase, increase traffic due to transporting construction materials would increase the risk of accidents. Inappropriate management and operation of construction vehicles would increase the risk of accidents during construction phase.
33	Climate Change	During construction phase, generation of greenhouse gases due to the operation of construction equipment and vehicles is minor and is not expected to have a significant impact on climate change. Adopting coastal protection measures will decrease the negative affect from climate change.

Source: JICA Expert Team

6.1.7 Environmental Impact Assessment

Based on the survey, the result of environmental impact assessment on the Component 1 and the Component 2 are shown in Table 6.1.34 and Table 6.1.35 respectively.

Table 6.1.34 Result of Environmental Impact Assessment on the Component 1

	Environmental Items	Phase		Evaluation Based on Survey Results		Reason of Evaluation
		BC/DC	OP	BC/DC	OP	
Pollution Control						
1	Air Pollution	-	-	N/A	N/A	No adverse effects to the air quality at the target sites would be occurred, as there are no sources by the activities.
2	Water Pollution	✓	✓	B-	B-	For the implementation of sediment budget control plan, the water quality may be affected to some extent, due to the improper implementation.
3	Soil Contamination	-	-	N/A	N/A	No adverse effects to the soil contamination at the target sites would be occurred, as there are no sources by the activities.
4	Noise/Vibration	-	-	N/A	N/A	No adverse effects to the noise and vibration at the target sites would be occurred, as there are no sources by the activities.
5	Ground Subsidence	-	-	N/A	N/A	No adverse effects to the ground subsidence at the target sites would be occurred, as there are no sources by the activities.
6	Offensive Odors	-	-	N/A	N/A	No adverse effects to the offensive odors at the target sites would be occurred, as there are no order sources by the activities.
7	Bottom Sediment	✓	✓	B-	B-	For the implementation of sediment budget control plan, sediment may be affected to some extent, due to the improper implementation.
8	Waste	-	-	N/A	N/A	No adverse effects to the waste management at the target sites would be occurred, as there are no sources by the activities.
Natural Environment						
9	Topography and Geographical Features	-	-	N/A	N/A	No adverse effects to the topography or geographical features at the target sites would be occurred, as there are no activities which affect to topography and geographical features.

	Environmental Items	Phase		Evaluation Based on Survey Results		Reason of Evaluation
		BC/DC	OP	BC/DC	OP	
10	Hydrological Situation	-	-	N/A	N/A	No adverse effects to the hydrological situation at the target sites would be occurred, as there are no activities which affect to hydrological situation.
11	Groundwater	-	-	N/A	N/A	No adverse effects to the groundwater at the targeted sites would be occurred, as there is no extraction of a large volume of groundwater by the activities.
12	Flora, Fauna, and Biodiversity	✓	✓	B-	B-	For the establishment of coastal and reef conservation plan and implementation of sediment budget control plan, the marine system in the coastal areas may be affected to some extent, due to the improper implementation.
13	Protected Area	-	-	N/A	N/A	There are no protected areas or Marine Protected Areas (MPA) around the proposed project sites.
14	Coastal Zone	✓	✓	B-	B-	For the establishment of coastal and reef conservation plan and implementation of sediment budget control plan, the marine system in the coastal areas may be affected to some extent, due to the improper implementation.
Social Environment						
15	Involuntary Resettlement/Land Acquisition (if needed)	-	-	N/A	N/A	No involuntary resettlement will be occurred by implementing any proposed projects, as there are no residents and residential areas at all the project sites.
16	Poor	✓	✓	B-	B-	If the target areas area used by the local people regularly, there will be possibilities of misdistribution of benefit and damages by restrictions for the local peoples' livelihood, especially for the low-income group, due to the coastal and reef conservation plan.
17	Indigenous, or Ethnic People	-	-	N/A	N/A	The project area does not include the residential area of indigenous or ethnic minorities at present.
18	Local Economies such as Employment, Livelihood, etc.	✓	✓	N/A	N/A	If the target areas area used by the local people regularly, there will be possibilities for the local people not to be able to use the areas for their livelihood activities due to the coastal and reef conservation plan.
19	Land Use and Utilization of Local Resources	✓	✓	N/A	N/A	If the target areas area used by the local people regularly, there will be possibilities for the local people not to be able to use the areas or local resources due to the coastal and reef conservation plan.
20	Water Usage or Water Rights and Communal Rights	-	-	N/A	N/A	There would be no construction works or operation activities which will limit water use, or cause impact on water use.
21	Existing Social Infrastructures and Services	-	-	N/A	N/A	There would be no construction works or operation activities which will cause impact on infrastructures.
22	Social Institutions such as Social Infrastructure and Local Decision-making Institutions	✓	✓	B-	B-	There would be potential gender discrimination in participating in formulating ICZM.

	Environmental Items	Phase		Evaluation Based on Survey Results		Reason of Evaluation
		BC/DC	OP	BC/DC	OP	
23	Misdistribution of Benefits and Damages	✓	✓	B-	B-	If the target areas area used by the local people regularly, there will be possibilities of misdistribution of benefit and damages by restrictions for the local peoples' livelihood, due to the coastal and reef conservation plan.
24	Local Conflicts of Interest	✓	✓	B-	B-	If the target areas area used by the local people regularly, there will be possibilities of local conflict of interest by restrictions for the local peoples' livelihood, due to the coastal and reef conservation plan.
25	Religious Facility	-	-	N/A	N/A	No religious facilities are identified in the coastal area of the Project sites.
26	Cultural Heritage	✓	✓	B-	B-	There would be a risk that the future ICZM Plan may raise any impacts to the existing heritage site, if not properly planned.
27	Landscape	-	-	N/A	N/A	No adverse effects to the landscapes at the targe sites would be occurred, as all the projects are in small scale.
28	Gender	✓	✓	B-	B-	Potential gender discrimination in participating in formulating ICZM and the training related to ICZM.
29	Children's Rights	-	-	N/A	N/A	There would be no operation activities which will affect right of children.
30	Hazards (risk) Infectious Diseases such as HIV/AIDS	-	-	N/A	N/A	There would be no construction works or operation activities which will cause infectious diseases.
31	Occupational Safety and Health	-	-	N/A	N/A	There would be no construction works or operation activities which will affect labour environment.
Others						
32	Accident	-	-	N/A	N/A	No adverse effects to the accidents at the targeted areas would be occurred, as there are no sources by the activities.
33	Climate Change	-	-	N/A	N/A	No adverse effects to the climate change at the targeted areas would be occurred, as there are no activities which affect to the climate.

A+/-: Significant positive/negative impact is expected.

B+/-: Positive/negative impact is expected to some extent.

C: Extent of impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)

D: No impact is expected.

N/A : Impact assessment isn't conducted because the item was categorized as no impact in scoping phase.

Source: JICA Expert Team

Table 6.1.35 Result of Environmental Impact Assessment on Component 2

	Environmental Items	Phase		Evaluation Based on Survey Results		Reason of Evaluation
		BC/DC	OP	BC/DC	OP	
Pollution Control						
1	Air Pollution	✓	✓	B-	B-	BC/DC: Project sites are located along the coast and some distance from residential area and public roads. Air pollution is expected due to heavy machinery operation and construction activities. However, impacts would be site specific and temporarily. As for the site of reclamation in Maamendhoo, measure to minimize impact of generated dust to the adjacent area shall be applied by installing dust proof sheet etc. OP : Unproper management of stocked supplementary sand will cause dust generation in case of beach nourishment project in Maamendhoo Island, Fonadhoo Island, and Meedhoo Island .
2	Water Pollution	✓	✓	B-	B-	BC/DC: Dredging for collecting sand for nourishing beach (Maamendhoo Island, Fonadhoo Island, Meedhoo Island), revetment for the coast (Gan Island, Isdhoo Island, Maamendhoo Island) and reclamation along the coast (Maamendhoo Island) would cause water pollution near the Project area. However, impacts would be site specific and temporarily. OP: Unproper management of stocked supplementary sand would cause water pollution in case of beach nourishment project in Maamendhoo Island, Fonadhoo Island, and Meedhoo Island.
3	Soil Contamination	✓	-	B-	N/A	BC/DC: Unproper management of construction vehicles would cause soil contamination. OP: No activities expected to contaminate soil resulting from the Project.
4	Noise/Vibration	✓	-	B-	N/A	BC/DC: Since any blasting or drilling works are not planned, impact from vibration or noise would be limited. Furthermore, the effect of noise or vibration from the construction activities would be limited since the construction site is not adjacent to residential areas. Impact of noise from vehicles transporting construction materials would be predicted, but its effect would be site specific and temporarily considering the scale of construction. OP: No activities expected to make noise or vibration by the Project.
5	Ground Subsidence	-	-	N/A	N/A	BC/DC/OP: No activities are expected to extract groundwater resulting the Project.
6	Offensive Odors	-	-	N/A	N/A	BC/DC/OP: No activities are expected to emit offensive odors resulting from the Project.
7	Bottom Sediment	✓	✓	B-	B-	BC/DC: Unproper beach nourishment or reclamation would cause soil sedimentation near construction sites.

	Environmental Items	Phase		Evaluation Based on Survey Results		Reason of Evaluation
		BC/DC	OP	BC/DC	OP	
						OP: Soil sedimentation would be occurred near the nourished beach. The impact needs to be monitored regularly.
8	Waste	✓	-	B-	N/A	BC/DC: Unproper management of construction waste such as removed materials from old revetment or hazardous waste such as used engine oil would cause negative impacts on the project areas. OP: No activities are expected to generate waste resulting from the Project.
Natural Environment						
9	Topography and Geographical Features	✓	✓	B-	B-	BC/DC: Unproper reclamation at Maamendhoo island would alter the geographical features. OP: Due to nourishing, revetment or reclamation, topography and geographical features near the Project area may be changed. However, considering the scale of projects, the impacts would be limited and site-specific. The impact needs to be monitored regularly.
10	Hydrological Situation	-	✓	N/A	B-	BC/DC: No construction activities to alter hydrological situation. OP: Due to nourishing, revetment or reclamation, hydrological situation around the Project area may be changed. However, considering the scale of projects, the impacts would be limited and site-specific. The impact needs to be monitored regularly.
11	Groundwater	-	-	N/A	N/A	BC/DC/OP: No activities are expected to effect groundwater resulting from the Project.
12	Flora, Fauna, and Biodiversity	✓	✓	B-	B-	BC/DC: During construction, terrestrial and marine ecosystem around the project sites and/or sand borrow sites are disturbed. However, considering the scale of projects, the impacts would be limited and site-specific. OP: Due to nourishing, revetment or reclamation, marine ecosystem around the Project area may be disturbed. However, considering the scale of projects, the impacts would be limited and site-specific. The impact needs to be monitored regularly.
13	Protected Area	-	-	N/A	N/A	BC/DC/OP: There are no protected areas, Marine Protected Areas (MPA) or KBA/IBA around the proposed project sites. The project site in Meedhoo Island is located near protected area, however, negative impact is not expected since the protected area is located inland area, not northern coastal area where the Project would be implemented.
14	Coastal Zone	✓	✓	B-	B-	BC/DC: The construction activities at the project sites will disturb coastal ecosystem, however, it is temporarily and site-specific.

	Environmental Items	Phase		Evaluation Based on Survey Results		Reason of Evaluation															
		BC/DC	OP	BC/DC	OP																
						OP: Currents and waves or ecosystem around the Project area would be impacted from the beach nourishment, revetment or reclamation. However, considering the scale of projects, the impacts would be limited and site-specific. The impact needs to be monitored regularly.															
Social Environment																					
15	Involuntary Resettlement/Land Acquisition (if needed)	✓	-	B-	N/A	<p>BC: There will be no involuntary resettlement or land acquisition due to the Project. However, three temporary structures (without wall and foundation) installed illegally at the sea need to be moved because these structures are located at the reclamation area by the Project in Maamendhoo. No economic loss would occur from the moving of two structures because these structures are not used for commercial purpose of making a living. There is no cost for resettlement since these structures are not used for residential purpose. The remaining structure is used for working space of tuna fish processing, however, alternative space can be secured in the same area. Thus, economic loss would be avoided. Agreement was made among the owner of the structures, Island Council and MECCT that disassembling and moving the structures with the physical support from the Island Council prior to the commencement of the construction activities. This would be applied instead of providing compensation for the loss of structures at a replacement cost. The entitlement policy for the affected temporary structures are as follows;</p> <table border="1"> <thead> <tr> <th>Type of Loss</th> <th>Entitled Persons</th> <th>Entitlement</th> <th>Implementation Issues/Guidelines</th> <th>Responsible Organization</th> </tr> </thead> <tbody> <tr> <td colspan="5">Temporary Loss Assistance</td> </tr> <tr> <td>1 Relocation Assistance</td> <td>Owner of temporary structures</td> <td>- Physical support for disassembling and moving the temporary structures by Island Council of Maamendhoo</td> <td>Prior to the commencement of construction, Island Council will notify and provide support to the owner of temporary structures for disassembling and moving</td> <td>MECCT</td> </tr> </tbody> </table> <p>In case the trees need cutting down for expanding existing road near proposed site for protecting cultural heritage at Gan Island, permission shall be obtained from Gan Island Council (and the owner of the trees, if there is). In addition, doubled number of cutting down trees shall be planted in the Island and compensation of loss of the tree shall be provided to the owner of the tree (if there is).</p> <p>DC/OP: No activities are expected to occur involuntary resettlement or land acquisition.</p>	Type of Loss	Entitled Persons	Entitlement	Implementation Issues/Guidelines	Responsible Organization	Temporary Loss Assistance					1 Relocation Assistance	Owner of temporary structures	- Physical support for disassembling and moving the temporary structures by Island Council of Maamendhoo	Prior to the commencement of construction, Island Council will notify and provide support to the owner of temporary structures for disassembling and moving	MECCT
Type of Loss	Entitled Persons	Entitlement	Implementation Issues/Guidelines	Responsible Organization																	
Temporary Loss Assistance																					
1 Relocation Assistance	Owner of temporary structures	- Physical support for disassembling and moving the temporary structures by Island Council of Maamendhoo	Prior to the commencement of construction, Island Council will notify and provide support to the owner of temporary structures for disassembling and moving	MECCT																	
16	Poor	✓	-	D	N/A	<p>BC/DC: No residents or commercial activities are found in the project areas.</p> <p>OP: No activities are expected to give negative impact on poor near the Project sites.</p>															

	Environmental Items	Phase		Evaluation Based on Survey Results		Reason of Evaluation
		BC/DC	OP	BC/DC	OP	
17	Indigenous, or Ethnic People	-	-	N/A	N/A	BC/DC/OP: The project area does not include the residential area of indigenous or ethnic minorities at present.
18	Local Economies such as Employment, Livelihood, etc.	✓	-	D	N/A	BC/DC: No commercial activities found in the project areas. OP: No activities are expected to affect local economies.
19	Land Use and Utilization of Local Resources	✓	✓	B-	B+	BC/DC: Coastal area in project sites is used for recreation purposes such as walking, swimming, fishing, surfing, snookering, collecting seashells and catching octopus. Due to the disruption of access to the coastal area resulting from the construction, local residents would be disturbed to do these activities. However, the impacts will be site-specific and temporarily. OP: The beach nourishment and revetment will contribute to stabilize the utilization of local resources in the coastal areas. The reclamation will create evacuation place for the local residents in case of disaster such as hazard of swell and Tsunami.
20	Water Usage or Water Rights and Communal Rights	-	-	N/A	N/A	BC/DC/OP: There is no activities to affect water usage or water rights and communal rights resulting from the Project.
21	Existing Social Infrastructures and Services	-	-	N/A	N/A	BC/DC/OP: There is no activities to affect existing social infrastructures and services resulting from the Project.
22	Social Institutions such as Social Infrastructure and Local Decision-making Institutions	-	-	N/A	N/A	BC/DC/OP: There is no activities to affect social infrastructure and local decision-making institutions resulting from the Project.
23	Misdistribution of Benefits and Damages	✓	-	D	N/A	BC/DC: No commercial activities found along the coastal area in project sites. OP: There is no activities to lead misdistribution of benefits or damages resulting from the Project.
24	Local Conflicts of Interest	✓	-	D	N/A	BC/DC : No commercial activities found along the coastal area in project sites. OP : There is no activities to affect local conflict of interest resulting from the Project.
25	Religious Facility	-	-	N/A	N/A	BC/DC/OP: No religious facilities are identified in the vicinity of the Project sites.
26	Cultural Heritage	-	✓	N/A	B+	BC/DC/OP: No cultural heritage is identified in the vicinity of the Project sites except the Project site of Gan and Isdhoo Islands which purposed for protecting the cultural heritage sites against erosion in terms of constructing a revetment.
27	Landscape	-	-	N/A	N/A	BC/DC/OP: No disturbance of landscape is expected resulting from the Project.

	Environmental Items	Phase		Evaluation Based on Survey Results		Reason of Evaluation
		BC/DC	OP	BC/DC	OP	
28	Gender	✓	✓	D	B-	BC/DC: No gender discrimination on job opportunity or payment by gender found in the targeted Islands for the Project. OP: The decision related to the Island policy are tended to be made by male than female.
29	Children's Rights	✓	-	D	N/A	BC/DC: No custom of child labor found in all targeted island for the Project. OP : No activities are planned to affect children's right resulting from the Project.
30	Hazards (risk) Infectious Diseases such as HIV/AIDS	✓	-	B-	N/A	BC/DC: Inflow of construction workers to local communities would raise risks of communicable diseases. OP: No increase in risk of communicable diseases is expected.
31	Occupational Safety and Health	✓	-	B-	N/A	BC/DC: Inappropriate management of working environment would raise the risk of accidents and disease. OP: No increase in risks in the work environment is expected.
Others						
32	Accident	✓	-	B-	N/A	BC/DC: Construction activities along public roads would increase the risk of accidents to the public. Inappropriate management and inappropriate operation of the construction vehicles would increase the risk of accidents. OP: No increase in risks of accident would be expected.
33	Climate Change	-	✓	N/A	B+	BC/DC: The amount of global warming substances generated by the operation of construction machinery and the driving of construction vehicles is very small and is not expected to have a significant impact on climate change. OP: The Project will contribute to decrease the negative affect from climate change.

A+/-: Significant positive/negative impact is expected.

B+/-: Positive/negative impact is expected to some extent.

C: Extent of impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)

D: No impact is expected.

N/A : Impact assessment isn't conducted because the item was categorized as no impact in scoping phase.

Source: JICA Expert Team

6.1.8 Environmental Management Plan and Mitigation Measures

Component 1

In the process of formulating the ICZM including coastal and reef conservation plan and implementation of sediment budget control plan, particular attention shall be paid for avoiding or minimizing negative impact on water quality, bottom sediment and marine environment in the coastal areas.

In addition, consideration on local economies, land use/utilization of local resources, social institutions, misdistribution of benefit/damages and local conflicts of interest, protection of cultural heritage and gender discrimination shall be made both at the formulation and implementation phases of the ICZM.

Mitigation measures for each identified impact with implementing organization, which is to carry out formulated coastal and reef conservation plan and sediment budget control plan and responsible organization, which is to support for implementing organization to carry out those plans are shown in Table 6.1.36. Since the ICZM including coastal and reef conservation plan and implementation of sediment budget control plan will be discussed and developed among stakeholders in the next phase, these mitigation measures shall be updated time to time.

Table 6.1.36 Environmental Mitigation Measures on Component 1

No.	Item (Impacts)	Proposed Mitigation Measures	Implementing Organization	Responsible Organization
2	Water Pollution	- Water pollution prevention plan shall be included in the sediment budget control plan to avoid water pollution at the time of dredging sand, stock the sand and renourishing beach	Island Council	MECCT
7	Bottom Sediment	- Soil sedimentation prevention plan shall be included in the sediment budget control plan to avoid soil sedimentation at the time of dredging sand, stock the sand and renourishing beach	Island Council	MECCT
12	Flora/Fauna/Biodiversity	- Flora/Fauna/Biodiversity protection plan shall be included in the sediment budget control plan to avoid any damage from dredging sand, stock the sand and renourishing beach	Island Council	MECCT
14	Coastal Zone	- Marine system protection plan shall be included in the sediment budget control plan as well as coastal and reef conservation plan to avoid any damage from dredging sand, stock the sand and renourishing beach to marine system	Island Council	MECCT
16	Poor	The coastal and reef conservation plan shall include the provision of social considerations to avoid any negative effects on low-income group in the target area.	Island Council	MECCT
22	Social Institutions such as Social Infrastructure and Local Decision-making Institutions	All segments of population including women, youth, the elderly and the disabled are equitably represented in the decision-making process as planned Stakeholder Engagement Plan (SEP) and Gender Action Plan (GAP).	Island Council	MECCT
23	Misdistribution of Benefits and Damages	The coastal and reef conservation plan shall include the provision of social considerations to avoid any misdistribution of benefits and damages in the target area.	Island Council	MECCT
24	Local Conflict of Benefit	The coastal and reef conservation plan shall include the provision of social considerations to avoid any local conflict of benefit in the target area.	Island Council	MECCT
26	Cultural Heritage	At the time of planning ICZM, it shall be avoided any physical impact to cultural	Island Council	MECCT

No.	Item (Impacts)	Proposed Mitigation Measures	Implementing Organization	Responsible Organization
		heritage in case it locates in the target area.		
28	Gender	All segments of population including women, youth, the elderly and the disabled are equitably represented in the decision-making process as planned Stakeholder Engagement Plan (SEP) and Gender Action Plan (GAP).	Island Council	MECCT

Source: JICA Expert Team

Component 2

Mitigation measures for each identified impact are proposed together with implementing organization, responsible organization and cost in Table 6.1.37.

In the construction phase, the Contractor is to carry out mitigation measures and PMU is to supervise the effectiveness of the Contractor's applied measures. During the operation phase, measures to mitigate negative impacts such as dust generation, water pollution from location of stocked supplementary sand for the maintenance of nourished beach shall be applied. Moreover, shorelines and marine environment in and around the project sites shall be regularly monitored to grasp any changes and apply appropriate restoration measures if necessary. The environmental management during the operation phase is to be implemented by the Island Council with the support of MECCT and MNPHI. The details of the mitigation measure and its institutional arrangement will be finalized at the further phase.

Table 6.1.37 Environmental Mitigation Measures on Component 2

No.	Item (Impacts)	Proposed Mitigation Measures	Implementing Organization	Responsible Organization	Cost
Pre-Construction/Construction Phase					
1	Air Pollution				
	-Emission from construction vehicles	- Maintain vehicles in good condition to minimize exhaust emissions - Use fuels and lubricants of good quality in compliance with national standards	Contractor	PMU	Included in the contract document
	-Dust especially when the weather is dry	- Cover load-carrying platforms properly when carrying earth/sand - Spray water at construction sites - Install dust proof sheet at the adjacent area to reclamation as appropriate	Contractor	PMU	Included in the contract document
2	Water Pollution				
	- Dredging for collecting sand, revetment and reclamation	- Conduct baseline survey to record state of water quality prior to the commencement of any construction activities	Contractor	PMU	Included in the contract document

No.	Item (Impacts)	Proposed Mitigation Measures	Implementing Organization	Responsible Organization	Cost
		<ul style="list-style-type: none"> - Conduct water/sediment quality monitoring - Provide and maintain temporary provisions adequately such as setting ponds, sediment trap, geotextile at installed spillway for reclamation site in order to reduce turbid water flow to surrounding areas - Select dredging/dumping equipment taking account for minimizing turbidity - Install silt fence as required - Minimize dredging time 			
3	Soil Contamination				
	- Oil leakage from construction vehicles	- Maintain vehicles in good condition	Contractor	PMU	Included in the contract document
4	Noise/Vibration				
	- Generating from vehicles transporting construction materials	<ul style="list-style-type: none"> - Conduct baseline survey to record state of noise level prior to the commencement of any construction activities - Avoid construction works at night 	Contractor	PMU	Included in the contract document
7	Bottom Sediment				
	- Soil sedimentation resulting from improper management of construction sites for beach nourishment and reclamation	<ul style="list-style-type: none"> - Implement nourishing sand or reclamation at precise location - Install silt fence as appropriate 	Contractor	PMU	Included in the contract document
8	Waste				
	- Generating construction waste	- Disposed of generated waste such as removed materials from old revetment, engine oil at dumping places designated by local authority	Contractor	PMU	Included in the contract document
9	Topography and Geographical Features				
	- Altering geographical features	- Implement reclamation at precise location	Contractor	PMU	Included in the contract document
12	Flora/Fauna/Biodiversity				
	- Disturbance on terrestrial and marine ecosystem	- Conduct baseline survey to record state of terrestrial and marine ecosystem prior to the commencement of any construction activities	Contractor	PMU	Included in the contract document

No.	Item (Impacts)	Proposed Mitigation Measures	Implementing Organization	Responsible Organization	Cost
		<ul style="list-style-type: none"> - Carry out construction activities at precise location - Provide and maintain temporary provisions adequately such as setting ponds, sediment trap, geotextile at installed spillway for reclamation site in order to reduce turbid water flow to surrounding areas - Install silt fence as required 			
14	Coastal Area				
	- Disturbance on terrestrial and marine ecosystem	<ul style="list-style-type: none"> - Conduct baseline survey to record state of terrestrial and marine ecosystem prior to the commencement of any construction activities - Carry out construction activities at precise location 	Contractor	PMU	Included in the contract document
15	Involuntary Resettlement				
	- Improper handling of structure removal from the project site	<ul style="list-style-type: none"> - Inform construction schedule prior to the commencement of construction activities - Support removal and set back of three temporary structures 	Island Council	PMU	-
19	Land Use and Utilization of Local Resources				
	- Disruption of access to the coastal area	<ul style="list-style-type: none"> - Establish a grievance desk in PMU and the Contractor's office for mediating construction related complain by local people - Inform the construction schedule prior to the commencement of construction activities - Distribute information on the construction project by signboards and circular 	Contractor/PMU	PMU	Included in the contract document
30	Hazardous (Risk) Infectious Diseases such as HIV/AIDS				
	- Increase the risk of infectious diseases resulting from influx of workers to the project area	<ul style="list-style-type: none"> - Conduct awareness/training program on HIV/AIDS and STDs 	Contractor	PMU	Included in the contract document
31	Occupational Health and Safety				
	- Inappropriate management of working environment would raise the risk of accidents and	<ul style="list-style-type: none"> - Prioritize employment opportunities for local people as much as possible - Maintain hygienic accommodation in work camps - Carry out measures against 	Contractor	PMU	Included in the contract document

No.	Item (Impacts)	Proposed Mitigation Measures	Implementing Organization	Responsible Organization	Cost
	disease	COVID-19			
32	Accidents				
	- Inappropriate management and operation of the construction vehicles would increase the risk of accidents	- Announce a safety notice regarding the dredging and reclamation operation works to the public - Provide the dredger operating route and the schedule to the public, coast guard and marine police - Install barricades in the project site as appropriate	Contractor	PMU	Included in the contract document

Source: JICA Expert Team

6.1.9 Environmental Monitoring Plan

Environmental monitoring plan for the Component 2 is shown in Table 6.1.38

During the construction phase, monitoring result is to be submitted to GCF/MNPFI from the construction contractor via PMU together with the report of construction progress. MNPFI shall submit the summary of monitoring result to EPA at every three months throughout the construction phase. The monitoring result will be also shared with the Island Council as appropriate. The monitoring implementing during the construction phase will be continued till the end of defect period of the construction, which is one year after the completion of the construction. After the defect period, the monitoring will be carried out by the Island Council where the Project locates with the support of MECCT and MNPFI. Similar to the environmental management plan, the details of the monitoring plan and its institutional arrangement will be finalized at the further phase.

Table 6.1.38 Environmental Monitoring Plan

Item (Impacts)	Monitoring Item	Monitoring Site	Method of Monitoring	Frequency	Implementing Organization	Responsible Organization	Cost (USD)
Construction Phase							
Air Pollution	Maintain vehicles in good condition to minimize exhaust emissions	Project Sites in Isdhoo Island Maamendhoo Island Gan Island Fonadhoo Island Meedhoo Island	Visual inspection on site	Monthly	Contractor	PMU	Included in the contract document
	Spray water at the construction sites, on unpaved roads, and adjacent to restaurant/shops during dry conditions	Along the Project Sites in Isdhoo Island Maamendhoo Island Gan Island Fonadhoo Island Meedhoo Island	Visual inspection on site	Monthly	Contractor	PMU	Included in the contract document
Marine Environment (Water)	Percent of live coral cover and fish species	Along the Project Sites in Isdhoo Island Maamendhoo Island	LIT, Fish census and visual observation	Once prior to commencement of construction activities	Contractor	PMU	13,175/time

Item (Impacts)	Monitoring Item	Monitoring Site	Method of Monitoring	Frequency	Implementing Organization	Responsible Organization	Cost (USD)
Pollution, Bottom Sediment, Flora/Fauna/Biodiversity)	abundance and composition	Gan Island Fonadhoo Island Meedhoo Island		and after completion of construction activities			
	pH, Salinity, Temperature, Turbidity, Ammonia, Nitrate, Phosphate, Sulphate, BOD	Along the Project Sites in Isdhoo Island Maamendhoo Island Gan Island Fonadhoo Island Meedhoo Island	On-site and Lab testing	Once prior to commencement of construction activities and after completion of construction activities	Contractor	PMU	
	Turbidity/Location (GPS logs)	Dredging sites (2)	On-site testing	Every day during dredging operation	Contractor	PMU	7,000/site
Coastal Area (Topography and Geographical Features, Flora/Fauna/Biodiversity)	Shoreline, vegetation line, reef line	Along the Project Sites in Isdhoo Island Maamendhoo Island Gan Island Fonadhoo Island Meedhoo Island	High resolution aerial imagery and surveying	Once prior to commencement of construction activities and after completion of construction activities	Contractor	PMU	12,250/time
Soil Contamination	Maintain vehicles in good condition	Project Sites in Isdhoo Island Maamendhoo Island Gan Island Fonadhoo Island Meedhoo Island	Visual inspection on site	Monthly	Contractor	PMU	Included in the contract document
Noise	Noise from vehicles transporting construction materials	Along the Project Sites in Isdhoo Island Maamendhoo Island Gan Island Fonadhoo Island Meedhoo Island	Noise measurement	Once/ Quarter	Contractor	PMU	15,000/time
Waste	Disposed of generated waste such as removed materials from old revetment, engine oil at dumping places designated by local authority	Project Sites in Isdhoo Island Maamendhoo Island Gan Island Fonadhoo Island Meedhoo Island	Visual inspection on site	Monthly	Contractor	PMU	Included in the contract document
Involuntary Resettlement	Inform construction schedule prior to the commencement of construction activities	Project site in Maamendhoo Island	Record of announcement	Prior to commencement of construction	Island Council	PMU	-
	Support move and set back of three temporary structures	Project Site in Maamendhoo Island	Record of move/set back	Prior to commencement of construction	Island Council in Maamendhoo	PMU	-

Item (Impacts)	Monitoring Item	Monitoring Site	Method of Monitoring	Frequency	Implementing Organization	Responsible Organization	Cost (USD)
Land Use and Utilization of Local Resources	Establish a grievance desk in PMU and the Contractor's office for mediating construction related complain by local people	Contractor's Office in the Project Sites and PMU	Record of establishment	Prior to commencement of construction	Contractor/ PMU	PMU	-
	Inform the construction schedule prior to the commencement of construction activities	Along the Project Sites in Isdhoo Island Maamendhoo Island Gan Island Fonadhoo Island Meedhoo Island	Record of announcement	Prior to commencement of construction	Contractor	PMU	Included in the contract document
	Distribute information on the construction project by signboards and circular	Along the Project Sites in Isdhoo Island Maamendhoo Island Gan Island Fonadhoo Island Meedhoo Island	Record of announcement	Prior to commencement of construction	Contractor	PMU	Included in the contract document
Hazardous (Risk) Infectious Diseases such as HIV/AIDS	Conduct awareness/training program on HIV/AIDS and STDs	Project Sites in Isdhoo Island Maamendhoo Island Gan Island Fonadhoo Island Meedhoo Island	Record of training/program	Monthly	Contractor	PMU	Included in the contract document
Occupational Health and Safety	Prioritize employment opportunities for local people as much as possible	Project Sites in Isdhoo Island Maamendhoo Island Gan Island Fonadhoo Island Meedhoo Island	Record of employment	Monthly	Contractor	PMU	Included in the contract document
	Maintain hygienic accommodation in work camps	Project Sites in Isdhoo Island Maamendhoo Island Gan Island Fonadhoo Island Meedhoo Island	Visual inspection on site	Monthly	Contractor	PMU	Included in the contract document
	Carry out measures against COVID-19	Project Sites in Isdhoo Island Maamendhoo Island Gan Island Fonadhoo Island Meedhoo Island	Visual inspection on site	Monthly	Contractor	PMU	Included in the contract document
Accidents	Announce a safety notice regarding the dredging and reclamation	Project Sites in Maamendhoo Island Fonadhoo Island Meedhoo Island	Record of announcement	Prior to the commencement of construction activities	Contractor	PMU	Included in the contract document

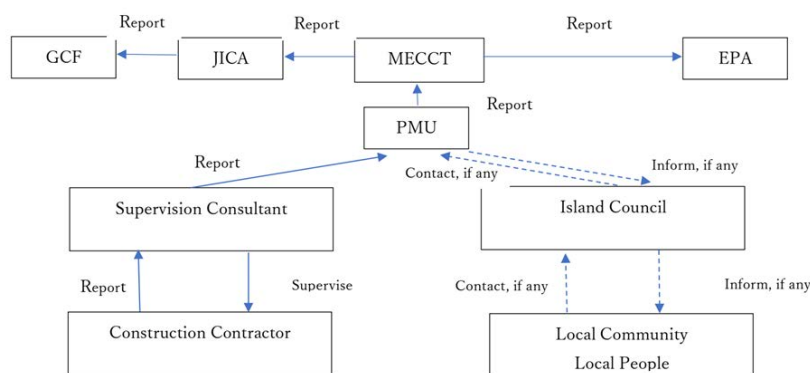
Item (Impacts)	Monitoring Item	Monitoring Site	Method of Monitoring	Frequency	Implementing Organization	Responsible Organization	Cost (USD)
	operation works to the public						
	Provide the dredger operating route and the schedule to the public, coast guard and marine police	Project Sies in Maamendhoo Island Fonadhoo Island Meedhoo Island	Record of announcement	Prior to the commencement of construction activities	Contractor	PMU	Included in the contract document
	Install barricades in the project site as appropriate	Project Sies in Isdhoo Island Maamendhoo Island Gan Island Fonadhoo Island Meedhoo Island	Visual inspection on site	Prior to the commencement of construction activities/ Monthly throughout construction period	Contractor	PMU	Included in the contract document

Source : JICA Expert Team

6.1.10 Institutional Arrangement

(1) Institutional Arrangement on Environmental Management

Institutional arrangement for the environmental management during construction phase is shown Figure 6.1.15. During the construction phase of the Component 2, PMU is to supervise construction activities and receive the report by the Contractor on the progress of construction through the supervision consultant. The progress of the construction is to be informed to GCF via JICA by MECCT. Also, the progress is to be reported to EPA by MECCT. During the operation phase, the Island Council at the Project site will carry out environmental management with the support of MECCT and MNPHI. The details task and responsibility of each party will be formulated at the further phase.



Source: JICA Expert Team

Figure 6.1.15 Institutional Arrangement during the Construction Phase

(2) Grievance Redress Mechanism

Grievance redress mechanism process for the Project is divided into three tiers. In the Tier 1, grievance is informed to the community leaders and/or Atoll/Island Council. The grievance is discussed at the Community Advisory

Board through Atoll/Island Council in order to find solution. The decision made at the Advisory Board is to be informed to the complainant through Atoll/Island Council. In case not satisfied with the decision, the complainant is to submit the complaint to the Tier 2 (MECCT). MECCT is to collect information through PMU and inform the decision to the complainant through PMU. In case not satisfied with the decision, the complainant is to inform his/her dissatisfaction and to go to the established judiciary system of the country. The grievance redress mechanism is shown in Table 6.1.39. As for the Project, the grievance redress mechanism will be started activating after the establishment of PMU.

Table 6.1.39 Grievance Redress Mechanism

Tiers of Grievance Mechanism	Nodal Person for Contact	Communication and Other Facilitation by the Project	Timeframe to Address Grievance
First Tier (Tier 1): (Atoll/City Council/ Island Council/ Community Advisory board)	Atoll Councils/ City Council will be the first point of contact for any grievances. Once the community advisory board is formed, complaints received by the Atoll/City council will be sent to the community advisory board for advice	<ul style="list-style-type: none"> - In the Council Offices and at the project locations, there will be an Information Board listing the names and contact telephones/emails. - Grievances can be addressed informally by contacting the Councils. - If the grievance cannot be resolved informally, an aggrieved party must submit a complaint on the Tier 1 Complaint Form. A copy of the form should be provided to the aggrieved party as evidence of receipt. The complaint form should be available from the website of MECCT and from the Atoll/ City Councils. - For those who cannot write, a council staff will assist them to fill the form. - The council may pass the grievance to the Community Advisory Board for comments and input. - A meeting (if required, a public meeting) must be held by the Community Advisory Board to discuss a complaint submitted on a Complaint Form. - If the complaint is resolved within 15 days, the Atoll/ City Council must communicate the decision to the aggrieved party in writing. - The aggrieved party must acknowledge the receipt of decision and submit their agreement or disagreement with the decision within 10 days. - If no acknowledgement is submitted from the aggrieved party, then the decision will be considered as accepted. - If a complaint requires more time to address, this requirement must be communicated to the aggrieved party in writing and the aggrieved party must consent and sign-off the request for the extension to take effect. An extension can be made to an additional 15 days. 	15 days
Second Tier (Tier 2): (MECCT)	MECCT, Social Environmental and Gender Officer (SEGO) at the Project Management Unit (PMU) will be the focal point.	<ul style="list-style-type: none"> - MECCT will forward the grievance to PMU. - PMU will screen the grievance to determine if it is related to GCF project. If it is unrelated, the aggrieved party must be notified in writing and the way forwarded must be outlined to them including the necessary government institutions to follow up, like the Police. - Social Environmental and Gender Officer at PMU will be the contact person in processing a grievance through the Tier 2. - If required, MECCT must arrange a public meeting to address the Tier 2 grievance and notify the nature of the grievance and the meeting venue to the aggrieved party. - ME may also visit the site and hold onsite discussions and meetings. - PMU will be responsible to ensure that there is no cost imposed on the 	15 days

Tiers of Grievance Mechanism	Nodal Person for Contact	Communication and Other Facilitation by the Project	Timeframe to Address Grievance
		<p>aggrieved person, due to the grievance mechanism at the second tier.</p> <ul style="list-style-type: none"> - If the complaint is resolved within 15 working days, PMU must communicate the decision to the aggrieved party in writing. - The aggrieved party must acknowledge the receipt of decision and submit their agreement or disagreement with the decision within 10 days. - If no acknowledgement is submitted from the aggrieved party, then the decision will be considered as accepted. - If the grievance is not resolved to the satisfaction of the aggrieved party within 15 working days of submission of the grievance to Tier 2 then the aggrieved party may notify MECCT, in writing, of the intention to move to Tier 3. 	
Third Tier (Tier 3): Judiciary Power /Assistance to Vulnerable Persons beyond the Project's Grievance Redress Mechanism	An individual has the option of going to established judiciary system of the country	<ul style="list-style-type: none"> - The legal system is accessible to all aggrieved persons. - Assistance from GCF project is available only for vulnerable person(s) as per this grievance mechanism. - In cases where vulnerable person(s) are unable to access the legal system, the Attorney General's office will provide legal support to the vulnerable person(s). PMU must assist the vulnerable person(s) in getting this support from Attorney General's Office. PMU must also ensure that there is no cost imposed on the aggrieved person if the person belongs to the vulnerable groups. The list of vulnerable groups is as defined in the footnote but may be further defined by MECCT. - The verdict of the Courts will be final 	As per the judicial procedure of the Maldives.

Source: JICA Expert Team

6.1.11 Stakeholder Meeting

(1) First Stakeholder Meeting

The first stakeholder meeting (SHM) was organized at each targeted island from 22 May to 29 May, 2022. The purpose of the meeting was 1) to share the results of the environmental surveys, 2) to explain the latest project basic design of the component 2 by the coastal engineer (JET) and 3) to collect opinions/suggestions on the Project from the stakeholders. Throughout the discussion among stakeholders, the concept of the Project as well as the basic design of the Component 2 were shared. Collected opinions were helped to finalize the basic design. The summary of the SHM is presented in Table 6.1.40 and photos taken at the SHM is shown in Figure 6.1.16. Details of the SHM in each island is included as Minute of Meeting in Appendix.6.

Table 6.1.40 Summary of the 1st SHM

Date and Location	May 22 Isdhoo Island
Time	12:30-14:00
Venue	Isdhoo Island Council

Participants	15 (Males 8/Females 7) including Island Council, Atoll Council, officials representing government organizations and Women Development Committee of Isdhoo Island.
Main subjects raised at the question and answer session	<p>Location of the revetment</p> <p><i>Q: Concern on impact to the littoral movement due to constructing the revetment</i></p> <p>A: (JET) The revetment will be constructed along with the existing shoreline, therefore, disruption to the littoral movement will be to a minimum.</p> <p><i>Q: Request to extend the area for revetment</i></p> <p>A:(JET) After confirming the proposed site with the Island President, critical erosion area in the west side was already included in the original design and the extension of 70m in the east side of proposed revetment would cover the concerned area where the Island council has been requested to add to the original design.</p> <p>A:(METT) The request of the extension of the project area will be discussed internally since the project will be funded by the Maldivian Government.</p> <p>Revetment design</p> <p><i>Q: Request for easy accessibility from the revetment to the beach</i></p> <p>A: (JET) The request of easy accessibility from the revetment to the beach will be taken account for the revetment design such as constructing gentle slope to reach the beach.</p>
Date and Location	May 23 Maamendhoo Island
Time	12:30-14:00
Venue	Maamendhoo School
Participants	17 (Males 11/Females 6) including Island Council, Atoll Council, officials representing government organizations and Women Development Committee of Maamendhoo Island.
Main subjects raised at the question and answer session	<p>Project Design</p> <p><i>Q: (Island Council) Request to do reclamation for expanding Island area at the west side of coastal area, instead of beach nourishment</i></p> <p>A: (JET) The project purpose is not the expansion of the Island's residential area by the reclamation but the protection of coastal area by nourishing the beach. The idea of reclamation at the west side of coastal area is contradict to the project purpose.</p> <p><i>Q: (JET) Preference to reclamation or evacuation tower for evacuation area</i></p> <p>A: (Island Council) Creating evacuation area by reclamation is preferable to constructing the evacuation tower at the north corner of the island.</p>
Date and Location	May 24 Gan Island
Time	12:30-14:00
Venue	Island Council
Participants	10 (Males 5/ Females 5) including Island Council, officials representing government organizations and Women Development Committee of Gan Island.
Main subjects raised at the question and answer session	<p>Project location</p> <p><i>Q: Request to include "Paree Fengandu" mangrove area in this project</i></p> <p>A: (JET) It shall be discussed with GCF, the Government of Maldives and JICA.</p> <p><i>Q: Request to include the west side of Thundi beach area in this project</i></p> <p>A: (JET) Using Y shaped groynes to protect the west side of Thundi beach area, near the Reveries guest house would not stop the erosion in this area but might lead to erosion in other areas of the island.</p> <p>A: (MECCT) To add this area in the project needs further discussion with GCF, the Government of Maldives and JICA.</p> <p><i>Q: Request to include the Mukurimagu harbor area in this project</i></p> <p>A: (JET) The port construction was the main reason for the erosion and stated that introducing the sand bypassing method to this area would be good case study for applying the ICZM to actual coastal protection. It is worth considering to realize this project since the Gan Island is selected one of the pilot sites for preparing ICZM.</p>
Date and Location	May 25 Fonadhoo Island
Time	12:30-14:00
Venue	Fonadhoo Island Council

Participants	11 (Males 3/Females 8) including Island Council, officials representing government organizations and Women Development Committee of Fonadhoo Island
Main subjects raised at the question and answer session	<p>Project Design</p> <p><i>Q: Concerns on removal of groyne from original design</i></p> <p>A: (JET) Numerical modelling using 30 years of data shows that sand can be retained without any hard structures in this area. However, the sand will be retained in the area only if there are no other major detrimental projects to the environment within the project vicinity.</p> <p>Borrow area for beach nourishment</p> <p><i>Q: Place for borrow area</i></p> <p>A: (JET) It will be decided at a later stage in the project. However, it will be proposed far from the shoreline as possible as it could worsen the erosion otherwise.</p>
Date and Location	May 29 Meedhoo Island
Time	9:30-11:30
Venue	Meedhoo Island Council
Participants	6 (Males 3/ Females 3) stakeholders including Meedhoo Town Office, officials representing government organizations and ‘Nalafehi’ NGOs Meedhoo island.
Main subjects raised at the question and answer session	<p>Project Design</p> <p><i>Q: (NGOs) Concerns on removal of groyne from original design</i></p> <p>A: (JET) After conducting the survey, it was found that there has not been a drastic change of wave condition in the past few years. The numerical analysis shows that the nourished sand will remain in the project area unless there is severe erosion due to a storm. However, enough sand will be stockpiled in the island which can be used for emergency nourishment as well as regular nourishment.</p> <p>Maintenance of the nourished beach</p> <p><i>Q: (NGOs) Institutional arrangement for maintaining the nourished beach</i></p> <p>A: (JET) After the completion of construction, the city council with the help of the community will be responsible to maintenance of nourished beach by using the stockpiled sand. The vehicles and other necessary equipment for the maintenance of the beach will be necessary to consider in the Project’s budget. Also, the capacity building of city council as well as community in the project area for the maintaining the nourishment is included in this project.</p>

Source: JICA Expert Team



SHM at Gan Island Council

SHM at Isdhoo Island Council

Source: JICA Expert Team

Figure 6.1.16 The 1st SHM at the Targeted Islands

(2) Second Stakeholder Meeting

After building a consent on the basic design for the Component 2 at the central government level (the 1st ICZM seminar on 28 August, 2022), the series of second stakeholder meeting (SHM) was organized at each targeted island

from 3 September to 11 September, 2022. The purpose of the meeting was 1) to share the results of the environmental impact assessment based on the findings of environmental surveys and information collection at each targeted island (JET), 2) to explain the latest project basic design of the component 2 by the coastal engineer (JET) and 3) to collect opinions/suggestions on the Project from the stakeholders and build consensus for the latest basic design of the component 2 among the stakeholders. The summary of the SHM is presented in Table 6.1.41 and the photos taken at the SHM is shown in Figure 6.1.17. Details is shown in Appendix.7.

Table 6.1.41 Summary of the 2nd SHM

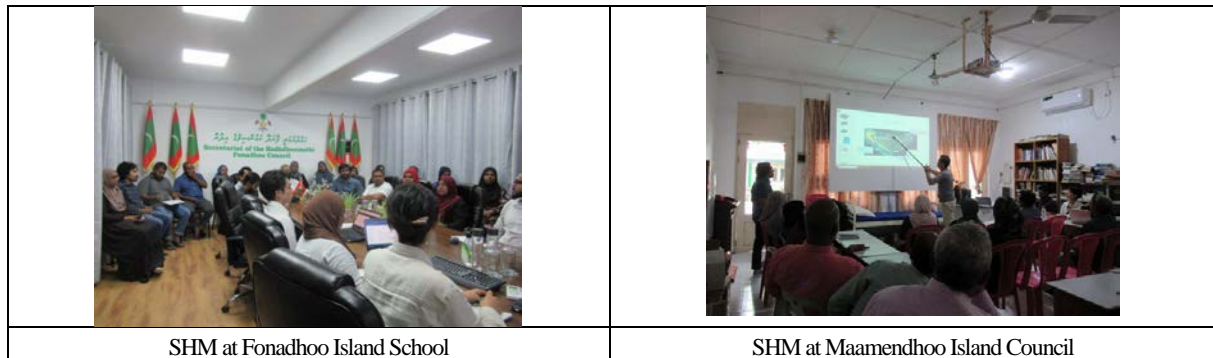
Date and Location	September 3 Fonadhoo Island
Time	20:30-22:25
Venue	Fonadhoo Island Council
Participants	22 (Males 9/Females 13) including Island Council, Atoll Council, officials representing government organizations and Women Development Committee of Fonadhoo Island.
Main subjects raised on the meeting	<p>Impact from beach nourishment</p> <p><i>Q: Concern on impact to the adjacent area to the Project site</i></p> <p>A: (JET) There will be not much impact to the adjacent beach. Based on the numerical analysis, the sand in the beach nourishment area will be eventually spreading both adjacent sides.</p> <p>Due to the less incline of wave in the project area, it will only allow the sediment to spread along the island. Based on the numerical analysis it estimated that the spread of the sand from the nourished beach will be about 500m- 1000m in both sides.</p> <p>At the west side of the project site, there is a jetty for the sea cucumber bed which will act as a groynes., which would stop the sand going beyond and falling into the hole made from past dredging activities. At the west side of the project site, the distance between the hole made from past dredging activities and the project site is far. Therefore, the sand will not reach to the dredged area.</p> <p>Borrow area</p> <p><i>Q: Location of borrow area</i></p> <p>A: (JET) There are several candidate areas selected but not yet finalized. Sand would be dredged deeper sea about 40 to 45m depth.</p> <p>Implementation schedule</p> <p><i>Q: Construction schedule</i></p> <p>A: (JET) Construction is scheduled to start from mid of 2024. Before the commencement of construction, the condition of the project area will be checked again at the detailed design stage and any changes would be reflected on the design.</p> <p>Maintenance for the nourished beach</p> <p><i>Q: Method and frequency of the maintenance</i></p> <p>A: (JET) In the scope of the project there is a plan to stock pile sand for future maintenance. The frequency of the maintenance is difficult to determine but usually it is typically within every 5 years.</p> <p>Stocked Sand</p> <p><i>Q: Concern on keeping the sand only for the maintenance of the project because there are a lot of demand for the sand for Island's public works such as road construction</i></p> <p>A: (JET) Fonadhoo island is one of the target islands for ICZM. Sediment management is the one of the ICZM plan, which purposes to manage demand and supply of the sand based on the Island's (infrastructure) development plan.</p>
Date and Location	September 5 Gan Island
Time	12:30-14:15
Venue	Gan Council
Participants	7 (Males 4/Females 3) including Island Council, Atoll Council, officials representing

	government organizations and Women Development Committee of Isdhoo Island.
Main subjects raised on the meeting	<p>Sand bypassing at west side of the Island</p> <p><i>Comment: (Island council) It is not preferable to implement the sand bypassing plan because it would transfer rubble in the accumulated sand to the sandy beach and it would degrade the touristic value of the beach. There is a plan for the reclamation in order to widen the buffer area between seashore and the link road.</i></p> <p>A: (JET) The sand bypassing is the one of the suggestions. If you have already submitted a proposal (reclamation), we can incorporate it in ICZM.</p> <p>Impact of Revetment</p> <p><i>Q: Concern impact from revetment to adjacent area</i></p> <p>A: (JET) In the lagoon side the dominant wave direction is from south to north. If there is any hard structure the impact will only occur at the downstream. The residential area of the adjacent side is located at the upstream side of the revetment. Therefore, the residential area will not have much negative impact due to construction of this revetment.</p> <p>Beach nourishment at “Paree fenganda”</p> <p><i>Q: Concern on the beach nourishment without groynes</i></p> <p>A: (JET) The erosion of the ‘Paree Fenganda ‘area has suffered about 10M in the last 20 years based on the analysis of the satellite images from past years. The erosion rate is not so significant here.</p>
Date and Location	September 6 Maamendhoo Island
Time	12:30-14:45
Venue	Maamendhoo School
Participants	18 (Males 10/ Females 8) including Island Council, officials representing government organizations and Women Development Committee of Gan Island.
Main subjects raised on the meeting	<p>Overlapping project locations</p> <p><i>Q: Request to provide update on the reclamation project which overlapped the location of reclamation and beach nourishment of the GCF project</i></p> <p>A: (MECCT) MHPHI mentioned that there is no allocated budget for Maamendhoo at present. So, we decided to go on with the current plan.</p> <p>A: (Council President) From the council a letter was sent to the president’s office requesting for the possibility of the land reclamation in Maamendhoo. President’s office has shared the concern with MNPHI to see the possibility of reclamation. MNPHI has not responded yet.</p> <p><i>Q: (JET) Request to the Island Council for choosing either reclamation project or beach nourishment project</i></p> <p>A: (Attendee) As a citizen of the island, I want the island to be protected.</p> <p>A: (Attendee) We want both reclamation and coastal protection. So, we don’t want to stop the coastal protection project.</p> <p>Basic design</p> <p><i>Q: Request to construct stairways for easy access to the beach from the proposed reclamation and revetment site.</i></p> <p>A: (JET) It is possible to include a walkway for the east coast. The strength of the structure can be weakened if stairs were included but can be taken into consideration after carrying out more survey. But for the north coast it might be difficult as it is the evacuation area and the structure should be persistent.</p> <p>Impact from groynes</p> <p><i>Q: Concerns on the groynes in the beach nourishment to give negative impact to other areas.</i></p> <p>A: (JET) Based on the numerical analysis, some negative impact is expected in the north side. However, the south side has no significant impact because the area would be protected by the reclamation area.</p> <p>Sand Borrow area</p> <p><i>Q: Location of sand borrow site</i></p> <p>A: (JET) It is not finalized yet. It is planned to borrow from deeper point (water depth 40m) outside the lagoon in order to minimize the impact on the natural environment.</p>

	<p>Impact from revetment <i>Q: Concerns on the impact from the revetment to on-going eroded area next to the harbor</i> A: (JET) The revetment area is rocky shoreline without sand at present. Therefore, the revetment would not affect to the area next to the harbor since there is no sand movement.</p> <p>Construction waste <i>Q: Handling of generated construction waste</i> A: (JET) the detail will be finalized at the detailed design phase. However, this project is not expected to generate a lot of construction waste since there is no concrete work or demolition.</p> <p>Maintenance for the nourished beach <i>Q: Concern on the maintenance for the nourished beach</i> A: (JET) Sand will be stocked at places such as the proposed excavation area to supply to the beach.</p>
Date and Location	September 7 Isdhoo Island
Time	10:30-12:00
Venue	Isdhoo Council
Participants	10 (Males 8/Females 2) including Island Council and officials representing government organizations
Main subjects raised on the meeting	<p>Project Design <i>Q: Concerns on the size of armor stones for the revetment</i> A:(JET) The size of the armor stones will be taken into considerations based on further surveys. The armor stone size will be decided after analyzing the size of stone needed for the foot part of the revetment as this would be the most crucial area. If we installed bigger stone at the foot part, we would apply the same size of stone to all revetment area.</p> <p><i>Q: Length of buffer area between vegetation line and revetment</i> A: (JET) If location of revetment would move to ocean side, it would affect to the other part of the beach adjacent to the project site The exact line is not yet fixed but it will be decided after careful analysis to minimize the risks to affect existing geography. The ideal distance would be less than 5M.</p> <p><i>Q: Shape at the end of the revetment</i> A: (JET) It will be smoothly cut to reach the ground. The walkway on the revetment will be also reach to the ground with gentle slope.</p>
Date and Location	September 11 Meedhoo Island
Time	12:45-14:09
Venue	Meedhoo Island Council
Participants	8 (Males 6/ Females 2) stakeholders including Meedhoo Town Office, officials representing government organizations and ‘Nalafehi’ NGOs Meedhoo island.
Main subjects raised on the meeting	<p>Project Design <i>Q: Concerns on the present design and the number of the groynes’ effectivity against strong wave energy around the north tip of the island</i> A: (JET) Sand movement is from south to west. We assume that if a hard structure is constructed at the upstream side (north tip of the island), it would have less sand supply for the downstream side and it would cause erosion. We assume that the constructed rock revetment for protecting the waste management center has been blocked sand supply and caused erosion in the west side of the island. Based on our field survey at site and the results from numerical analysis, we believe that beach nourishment with one groyne is the best solution for this site. However, the natural condition can change from what is expected. Hence, our suggestion is after implementation, monitoring will be continued in corporation with the government and island council. Based on the changes, if necessary, we will propose adaptive measures.</p> <p><i>Q: Proposing offshore breakwater as a second option</i> A: (JET) The natural sandy beach has the function of reducing the wave energy. We expect</p>

	<p>some nourished area would lose sand however for the most part we expect to have a wide beach for 20-30 years. In our plan, sand at eroded part would be supplied regularly with maintenance work.</p> <p>Impact from climate change</p> <p><i>Q: Concerns if the impact from the climate change was taken accounts for the basic design</i></p> <p>A: (JET) Sea level rise in the future is considered. It depends on the scenario but by 2100 the predicted level of sea level rise is about 30-40M after considering high and low tide.</p> <p>Beach Nourishment</p> <p><i>Q: Type of sand for beach nourishment</i></p> <p>A: (JET) Only sand is used, not with the mixture of sand and corals/rocks</p> <p><i>Q: Maintenance Works</i></p> <p>A: (JET) If sand would be accumulated around the groynes, we would transfer the accumulated sand to the eroded area. We propose sand bypassing combine with beach nourishment. Maintenance work will be not difficult by using excavator and track. Moreover, the frequency of the maintenance will not be every year.</p>
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Source: JICA Expert Team



Source: JICA Expert Team

Figure 6.1.17 The 2nd SHM at the Targeted Islands

6.2 State of Obtaining Approval for EIA and Other Environmental Permits

As described in 6.1.3 (1) Environmental Assessment Process, the Projects of the Component 2 need to be reviewed and approved by EPA since the Projects contains physical development. MNPFI need to appoint registered environmental consultant for conducting EIA, preparing EIA reports and then submit to EPA for obtaining approval during the D/D phase. When submitting the EIA reports, permission of dredging obtained from the Atoll or Island Council concerned with the information of location, area, volume, alternative locations (at least two locations) shall be attached.

6.3 Feedback for Other Projects on Environmental and Social Considerations

Following information on environmental monitoring was obtained in the course of implementing environmental and social considerations for the Project.

Environmental monitoring

Supervising side: Environment compliance and assessment section in EPA is in charge of environmental monitoring. In this section, there are 5 officers handling the works related to the environmental monitoring such as reviewing monitoring reports submitted by project proponents both public and private sector from all over Maldives and conducting inspection for evaluating environmental mitigation activities at project sites. In order to ensure the fairness, cost incurred from the works related to environmental monitoring such as site inspection was budgeted by EPA itself. At present, about 15% in the total ongoing construction sites are inspected at randomly by EPA. Environmental monitoring is carried out throughout the construction phase and during the 5 years of the operation phase including 1 year of defect period. According to the interviewee, at least 5 more officers with sufficient budgetary measures would be necessary to increase the effectiveness of supervising the state of environmental mitigation works at on-going construction sites considering the present situation. In addition, technical assistance on the strategic environmental assessment (SEA) is helpful to improve the capacity for environmental management since only EIA is practiced at present. (Hearing from EPA on 15 Sep, 2022)

Implementing side: MNPFI is in charge of all development projects in public sector. Therefore, these projects shall be implemented environmental monitoring by MNPFI. Environmental monitoring is carried out by the section concerned in MNPFI depends on the project's feature. As for the environmental monitoring on the coastal protection project, the coastal protection and reclamation unit in the infrastructure department is in charge. Task of environmental monitoring is included in the contract between the construction contractor and MNPFI during the construction phase. The contracted contractors monitor the construction sites regularly and report the result to the section concerned in MNPFI till the end of defect period of the construction in comply with EPA approved environmental management and monitoring plan in the EIA report. However, due to lack of human resources (i.e.2 officer is handling 26 projects at the same time in the coastal protection and reclamation unit) and budgetary constraints, environmental monitoring for the most of the public sector development projects are not able to practice except the project with external funding. (Hearing from MNPFI on 15 Sep, 2022)

6.4 Gender Mainstreaming

6.4.1 Women Development Committee at the Targeted Islands

While collecting information on gender mainstreaming in the targeted islands, the Women's Development Committee (WDC) were found as a key player for enhancing women's empowerment. At the time of the site reconnaissance of 4 islands, namely Fonadhoo, Gan, Isdhoo and Maamendhoo, a hearing from members of the WDC was conducted at each island in February, 2022. In total of 13 members (2 from Fonadhoo island, 5 from Isdhoo island, 5 from Gan Island and 1 from Maamendhoo island) were kindly cooperated for the interview. It was found that the WDC is an organization under the island council and its status as well as responsibility is high in the island society. The members are elected by the vote of all islanders aged older than 18 years in every 5 years. Some of the members are also the member of the island council. Its mandate is set by the Local Government Authority as betterment of community and play an important role in each island's public services. The WDC's activities varies such as providing vocational training for women, organizing awareness program on health consciousness, etc. It is considered that the involvement of the WDCs through the process of project planning is vital.

The photos at the hearing are shown in Figure 6.4.1, the summary of the hearing at each island are shown in Table 6.4.1.



Source: JICA Expert Team

Figure 6.4.1 Hearing with WDC members

Table 6.4.1 Summary of the Hearing

No.	Date	Organization
1	Feb 2, 2022	Fonadhoo Women's Development Committee
	Participants	
	Ms.Rishma (President) Ms.Shakeela	
	Minutes	
	General information about the Fonadhoo WDC <ul style="list-style-type: none"> • It is comprised of 5 members elected by islanders over 18 years old and their terms is 5 years. The last election was held in May, 2021. Number of the members were set depending on island's population • It is under the Local Government Authority (LGA). • 5% of the island budget is allocated to the WDC yearly and it includes the salary of the WDC members. • In case the budget is not enough to cover the activities, the WDC seek funding from private sectors. • The WDC act as an implementor for awareness program financed by the public sector such as health center 	
	Activities <ul style="list-style-type: none"> • On-going Vocational training for women (short course program for entrepreneurship i.e. Pastry making, Sewing, Farming etc.) Awareness Program (raising health consciousness, support for disability etc.) Organize conference together with other members of the WDC in the Laamu Atoll for betterment of community in the filed of security, education, health Provide scholarship to be a lecturer for the vocational training for women 	
2	Feb 3, 2022	Isdhoo WDC
	Participants	
	Ms.Mariyam Shaira (President) Ms.Mariyam Shameema (Vice president) Ms.Fathmath Asiga Ms.Aminath Zumra Ms.Aminath Rasheedha	
	Minutes	
	General information about the Isdhoo WDC <ul style="list-style-type: none"> • The same as the Fonadhoo WDC • Salary of the WDC (president 6,000/month, vice president 5,000/month, member 4,000/month) 	
	Activities <ul style="list-style-type: none"> • Cleaning at public area in the island (paid) 80-84 women are employed for the cleaning work once a week from 16:00-18:00 with 20,000-30,000MVR/month divided by the number of employed women • Cleaning at beach area and children park (unpaid volunteer work due to lack of budget) • Due to the pandemic, the activities are limited at present • Following activities are planned after the pandemic; Awareness event for raising health consciousness (check-up on diabetics, blood testing for retired people) Organizing event for Children's Day and Women's Day Provide vocational training (Pastry making, Sewing) Donate TV to Secondary School in the island 	
3	Feb 4, 2022	Gan WDC (woman's development committee L-Gan (face book))
	Participants	
	Ms.Fathimath Ali (President) Ms.Ihusana Saeed (Vice president) Thahumeena Ali Fathimath Raziyya	
	Minutes	
	General information about the Gan WDC	

	<ul style="list-style-type: none"> • The same as the Fonadhoo WDC <p>Activities</p> <ul style="list-style-type: none"> • Awareness program on DV, • Vocational training (agriculture: hydroponic cultivation using solar energy and rain water) <p>The hydroponic cultivation was selected because it fit for female farmer (requires less physical strength and unsoiled). 20 HHs will be selected for this agriculture after training. Land and the system will provide by the WDC and the selected HHs will pay for utility only.</p>	
4	Feb 5, 2022	Maamendhoo WDC
	Participants	
	Ms.Aishath Neesha	
	Minutes	
	<p>General information about the Maamendhoo WDC</p> <ul style="list-style-type: none"> • The same as the Fonadhoo WDC <p>Activities</p> <ul style="list-style-type: none"> • Vocational training for financial independence of woman WDC assign trainers for providing short courses such as cooking, sewing, pastry making, electrician Except the course for electrician, applicants pay course fee • Awareness program for raising health consciousness Organize fitness program for women (1,000 MVR/month) • Create business opportunity for women (many projects were implemented or under preparation) Organize a group to weave cloth using fiber taken from Coconut and sell to the Six Senses Resort Hotel (it was not success because the quality of the cloth was not meet the requirement of the Hotel) Make a reusable bag (eco-bag) for shopping and sell to the islanders in order to reduce the use of plastic bag Establish a shop for selling traditional food, traditional goods for tourists • Cleaning guest house owned by the island council and public park (the island council outsourced the work to members of the WDC) • Donate water dispenser to public school in order to reduce the use of disposable plastic bottle for drinking water <p>Beach Cleaning</p> <ul style="list-style-type: none"> • The island council outsources the task for beach cleaning to two organizations (MU and MG) in the island. The beach in the island is cleaned by the people assigned by these organizations 3 times in a week. 	

Source: JICA Expert Team

6.4.2 Stakeholder Meeting

Effort was made for enhancing participation of women in the stakeholder meetings. With the participation from the WDC and women's officer from the governmental institutions, the women's participants in total number of the participants were quite high. The women's participants in the total number of the participants at the SHM is shown in Table 6.4.2. The participation of women in total participants exceed 35% in all targeted islands except Ishdhoo (20% at 2nd SHM) and Meedhoo (25% at 2nd SHM).

Table 6.4.2 SHM Participants by Gender

	Location	Total number of Participants (Number)	Male (Number)	Female (Number)	Female in Total Number (%)
1 st SHM	Isdhoo Island	15	8	7	47
	Gan Island	17	11	6	35
	Maamendhoo Island	10	5	5	50
	Fonadhoo Island	11	3	8	73

	Location	Total number of Participants (Number)	Male (Number)	Female (Number)	Female in Total Number (%)
	Meedhoo Island	6	8	3	50
2 nd SHM	Isdhoo Island	10	8	2	20
	Gan Island	7	3	4	57
	Maamendhoo Island	17	11	6	35
	Fonadhoo Island	22	9	13	59
	Meedhoo Island	8	6	2	25

Source: JICA Expert Team

6.4.3 Gender Assessment Meeting

Gender assessment meeting was organized followed by the first stakeholder meeting at each targeted island. It purposed for finding out female role in family as well as society and collecting opinions and suggestions on the project from gender points of view. In order to make easier to speak up, the number of participants was limited around 10 and the meeting was separated by gender.

It was found that the traditional role for women as a manager of family budget and taken domestic tasks and men as a bread earner for the family have been changing, particularly in younger generation with various reasons such as change of working environment during pandemic, increase contribution to family income by women etc. At the female session as well as male session, it was agreed that there is no job discrimination by gender, though some jobs are in particularly taken up by a specific gender based on interest.

As for decision-making, when it comes larger community related projects such as harbor development, it is mainly men who take decision-making roles. On the other hand, women are to be as the main decision makers in the household level.

The summary of the gender assessment meeting at each island is as shown in Table 6.4.3 and photos taken at the meetings are shown in Figure 6.4.2 Minute of meeting at each island is included in Appendix.6.

Table 6.4.3 Summary of the Gender Assessment Meeting

Date and Location	May 22 Isdhoo Island
Time	14:30-15:30 (Female session) 16:00-17:00 (Male session)
Venue	Isdhoo Island Council
Participants	20 Females (Famer, Housewives, Teachers, WDCs, Council Members)
	10 Males (Engineer, Business owner, Teachers, Fishermen, Famers, Religious Leader)
Subjects discussed on the meeting	<p>Gender roles:</p> <p>Majority of people in the Island are engaging in farming which made a married couple to work cooperatively and to commonly recognize earning income together. It used to be wife's role to manage family budget, however, after popularization of E-bank, generated income is saved in their shared account and managed jointly.</p> <p>In terms of job opportunities, both genders have equal opportunities for jobs. However, some jobs are in particularly taken up by a specific gender based on interest. For example, teachers are mainly women and staff at the powerhouse are mainly men.</p> <p>As for larger community related projects such as harbor development, it is mainly men who take decision-making roles. Women is to be as the main decision makers in the household level. As recently women Council have been elected, it is a tendency that Women, especially WDC are involved in community development activities.</p>

	<p>Use of project area: Fishing (In order to catch frying fishes migrating during north west monsoon season, many locals go fishing at the project area. Some of the locals use the caught frying fish for catching bigger fish such as giant trevally), Surfing (youngster), Collecting Sea sells (women), Snorkeling (Foreigners visiting by a tour boat), Lobster fishing at outerleef area</p> <p>Coastal protection activities in the project area: Locals constructed the revetment by cement bags financed by the central government in 1993-1994.</p> <p>Activities against coastal protection: After prohibition, activities such as sand collection and waste dumping into the sea were stopped. Sand generated during construction under the management of the Island Council can be provided to locals after the registration at the Island Council.</p> <p>Management at the Heritage area: It is taken care by the Island Council.</p> <p>Opinions (expectation/concern) on the project: - Support this project because it protects coastal area from erosion. (Female session) - Request to employ women for cleaning and cooking during construction phase (Female session) - Request for good arrangement of maintenance after construction (Female session) - Revetment area need to be extended to east side and to cover the west side where the coastal line is curved (Male session)</p> <p>Others: Request JICA to provide training for appropriate use of agricultural chemicals and testing pesticides residues of our produce (Female session)</p>
Date and Location	May 23 Maamendhoo Island
Time	14:30-15:30 (Female session) 16:00-17:00 (Male session)
Venue	Maamendhoo School
Participants	10 Females (Teachers, Civil Servants) 6 Males (Construction Contractor, Teachers, Civil Servants)
Subjects discussed on the meeting	<p>Gender roles: Ratio of generated income by male and female in family budget varies depending on families, however, the ratio of female income in the family budget tends to be increased in younger generation. Women is the manager of family budget in most married couples and most of the domestic tasks are taken by women (wives). In terms of job opportunities, both genders have equal opportunities for jobs. However, some jobs are in particularly taken up by a specific gender based on interest. As for larger community related projects such as harbor development, it is mainly men who take decision-making roles. Women is to be as the main decision makers in the household level. However, women are slowly showing interest in stakeholder meetings and are attending when they are invited. The introduction of new rule that half of the council members need to be women in every island also encourages this mind set.</p> <p>Use of project area: <i>Reclamation area</i> Bathing, Fishing <i>Beach for nourishment (west)</i> Fishing, Catching octopus <i>Beach for nourishment (east)</i> Bathing, Caching octopus</p> <p>Activities against coastal protection: After prohibition of collecting sand at the beach, the Island Council provide alternative area for the sand collection at uninhibited island near the Maamendhoo Island.</p> <p>Opinions (expectation/concern) on the project: - Prefer to create evacuation area by reclamation (Female and Male sessions) - Intend to use the evacuation area for outdoor activities since there is no public park in the island (Female session)</p>
Date and Location	May 24 Gan Island
Time	14:30-15:30 (Female session) 16:00-17:00 (Male session)
Venue	Gan Island Council

Participants	4 Females (Teacher, Civil Servant, Farmer, Housewife) 6 Males (Teacher, Private Business Owners, Fisherman, Council Member)
Subjects discussed on the meeting	<p>Gender roles: Ratio of generated income by male and female in family budget varies depending on families. The family budget is managed jointly. Women (wives) used to take most of the domestic tasks, however, men also take some tasks at present. As the case of both parents to earn money, domestic tasks are outsourced such as hiring housekeeper sometimes. In terms of job opportunities, both genders have equal opportunities for jobs. However, some jobs are in particularly taken up by a specific gender based on interest. As for larger community related projects such as harbor development, it is mainly men who take decision-making roles. Women is to be as the main decision makers in the household level.</p> <p>Use of project area: Surfing (youngster), Snorkeling, Reel fishing, Net fishing (illegal), Collecting Sea sells, Catching octopus</p> <p>Coastal protection activities in the project area: There are no regular coastal protection activities carrying out in the project area. Occasionally, students or community clean the beach. The revetment work was done by cement bags in the past.</p> <p>Activities against coastal protection: To date, the sand collection activities at the beach is still on-going for domestic as well as commercial purposes although it has been prohibited. The main cause of not disappearing the illegal activity is lack of officer to monitor long coastline (Gan Island is the biggest island in Maldives) and lack of alternative place for the sand collection.</p> <p>Opinions (expectation/concern) on the project: Concern on the acceleration of coastal erosion at west side of the island due to constructing new port (Male session)</p>
Date and Location	May 25 Fonadhoo Island
Time	14:30-15:30 (Female session) 16:00-17:00 (Male session)
Venue	Fonadhoo Island Council
Participants	9 Females (Housewives, Private Business Owner, Scholl Staff) 6 Males (Private Business Owners, Council Members)
Subjects discussed on the meeting	<p>Gender roles: Under the COVID-19 pandemic, e-commerce via Viber become popular particularly among housewives. Those housewives started business to sell the items such as flower seedlings grown in their home garden and food for delivery. As a result, the ratio of generated income by female in family budget increased. In general, woman is the manager of the family budget. In terms of job opportunities, both genders have equal opportunities for jobs. However, some jobs are in particularly taken up by a specific gender based on interest. Women is to be as the main decision makers in the household level.</p> <p>Use of project area: Recreation (wedding, party etc.), Catching octopus, Collecting Sea sells</p> <p>Coastal protection activities in the project area: Beach cleaning is traditionally carried out by women in community near-by. No regular cleaning is done at the beach locating far from residential area.</p> <p>Activities against coastal protection: Sand collection is prohibited, however, it is still on-going at many places in the coastal area. Although the Island Council designated the sand collection area, it is not popular since the type of the sand from the designated area does not fit the preference of locals.</p> <p>Opinions (expectation/concern) on the project: Request to construct swimming pool including in the Project Concern on the beach nourishment without constructing groyenes (Female session) Request to do reclamation at the project site for expanding Island's area and cover the area</p>

	<p>by robust revetment, instead of just nourishing the beach. (Male session)</p> <p>Others Request JICA to consider forming a project focusing on “Food Security” in Maldives introducing latest technology. (Male session)</p>
Date and Location	May 29 Meedhoo Island
Time	14:30-15:30 (Female session) 16:00-17:00 (Male session)
Venue	Meedhoo Island Council
Participants	<p>7 Females (Civil Servants, NGO members)</p> <p>5 Males (Civil Servants, Construction Contractor, Owner of Trading Company)</p>
Subjects discussed on the meeting	<p>Gender roles: Ratio of generated income by male and female in family budget as well as method of managing family budget varies depending on families. Most of domestic tasks used to be taken by women (wives). Similar to other islands, however, men tended to take more part in domestic tasks in younger generation. In terms of job opportunities, both genders have equal opportunities for jobs. However, some jobs are in particularly taken up by a specific gender based on interest. As for larger community related projects such as harbor development, it is mainly men who take decision-making roles. Women is to be as the main decision makers in the household level. However, women are slowly showing interest in stakeholder meetings and are attending when they are invited. Because one of the highest positions such as the president of the Island Council and the headmaster of the school are taken by women, there is an environment where it is easy for women to speak out. In addition to this, there are few female-led NGO’s focusing on betterment of community in the island such as WDC, ‘Cheynu’ and ‘Raafalhaa’</p> <p>Community activities: Community activities are very brisk in Meedhoo Island. There are 4 registered NGOs including organizations for youth activities, women’s empowerment, environmental protection activities. In addition, there is a group actively working for community development focusing on health care for elderly, beach clearing, education for children by creating open-air library on the beach in the project area.</p> <p>Use of project area: Bathing, Collecting Sea shells, Catching octopus, Recreation (barbecue, walking etc), fishing, Diving at outerleef</p> <p>Coastal protection activities in the project area: Install geo bags at the north corner of the Island Install concrete mass generated from demolishing old harbor at the north corner (it was washed away by waves already)</p> <p>Activities against coastal protection: The Island Council provides sand collection area in uninhabited island near-by. However, because it is costly to reach the island by boats and still profitable after paying the fine for trading illegally collected sand, the illegal sand collection at the beach is still on-going.</p> <p>Opinions (expectation/concern) on the project: Concern on the beach nourishment only constructing one groynes at the end of project area (Female and Male sessions) Concern on the project’s sustainability at the following points; finding borrow area and collecting the sand for maintaining the beach sustainably (Female and Male sessions) management and maintenance after completion of the project construction period securing budget for management and maintenance after completion of the project construction period capability for implementing management and maintenance by the Island Council and community</p>

Source: JICA Expert Team



Women's session at Fonadhoo Island

Men's session at Meedhoo Island

Source: JICA Expert Team

Figure 6.4.2 Haring with WDC members

CHAPTER 7 Human Resource Development Plan

7.1 Current Status / Issues

Maldives is a small island nation consisting of approximately 1,200 islands, which are vulnerable to the effects of climate change and natural disasters, and many islands are at risk of submergence due to sea level rise and coastal erosion caused by global warming. The country faces many development challenges to achieve sustainable growth, and there is an urgent need to improve the administrative capacity and human resource development of government officials and other relevant organizations that are responsible for overcoming these challenges.

There is no human resource development plan related to promote understanding of coastal erosion mechanisms in the Maldives, and that human resources in this field are limited, with a particular need for technology transfer of basic knowledge and training in effective data application methods. The current status and issues for each organization (EPA, MECCT, MMS, LGA, MNPHI, and NDMA) are as follows.

Table 7.1.1 Current Status and Issues of Each Organization

organization name	Current Status and Issues
EPA	The number of staff is insufficient for the volume of work. The number of staff is expected to be increased in the future. Although some staff members have basic knowledge of the coast, it is not enough.
MECCT	Limited human resources with the capacity to properly and effectively collect, process, and manage data in field surveys, etc. Lack of equipment to conduct the survey.
MMS	There is no active wave observation network. Currently, tidal forecast maps are obtained from the University of Hawaii based on information from three tide stations. In addition, Italy funded for wave model predictions. MMS has difficulty in obtaining sustainable data and lacks knowledge on how to analyze and utilize the data.
LGA	The technical capacity and knowledge on coastal protection and environmental management to cope with the impacts of climate change is lacking.
MNPHI	There is a lack of human resources capable of collecting, analyzing, and disseminating data, conducting research, and proposing new standards. Lack of facilities and human resources to conduct field surveys. Few coastal engineers are available.
NDMA	Coastal management is an important area that we believe is not being addressed very well. Chronic shortages of human resources and budgets have become an issue. There is a need for more efficient business practices and enhanced staff capacity.

Source: JICA Expert Team

7.2 Human Resource Development Plan (Draft)

In formulating this human resource development plan, JET organized the roles and responsibilities for related organizations and identified items for capacity building. Then, through interviews and questionnaires to the relevant organizations and persons in charge of the capacity enhancement items, the current status and needs were identified, and human resource development plan (draft) and implementation schedule (draft) were formulated as follows.

Table 7.2.1 Draft Human Resource Development Plan

Item	Details	
Capacity Development Items	Basic knowledge on coasts	1. Formation and source of sandy beach
		2. Climate change impacts, coastal erosion mechanisms
		3. Coastal conservation and protection
		4. Environmental and social impact (including reef environment)
		5. Coastal maintenance and management
	Coastal planning for priority areas	6. National and regional planning
		7. Socio-economic conditions
		8. Land use of hinterland
	Benefits expected from the Project	9. Coastal erosion
		10. Benefit type to be considered
	Wave Observation System	11. Financial and economic evaluation methods
		12. Equipment Installation
		13. Data Acquisition
		14. Data Analysis
		15. Data Utilization
	Others	16. Maintenance
Environmental Monitoring		
Shoreline analysis using Remote sensing and Geographical information system data		
Project Feasibility / Risk Analysis and Risk Management		
Management and Maintenance of structures		
Coastal Adaptation measures		
Numerical Modelling and Physical Testing		
Performance Monitoring and Design Optimization		
Target Group	MECCT、MNPHI、Local Stakeholders	
Objectives	Strengthen the capacity of relevant agency staff to implement coastal protection	
Indicators	• Evaluation of the training by the participants' organization	
	• Changes in Attitudes and Behaviors of Training Participants at their organization	
	• Examples of practical application of training content by trainees	
Baseline	Questionnaires, Interview, etc...	
Means of Implementation	• OJT (To C/P such as MECCT、MNPI)	
	• Off-JT (Lecture by JICA expert)	
	• JCC (8 times)	
	• Seminar (4 times)	
	• Training in Japan (3 times)	
	• Training in Indonesia (1 time)	

Source: JICA Expert Team

Table 7.2.2 Draft Implementation Schedule

Activity	2nd Year (2022)				3rd Year (2023)				4th Year (2024)				5th Year (2025)								
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III						
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9
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in Japan																					
entry Training																					
/ Phasing																					

Source: JICA Expert Team

7.3 Goals for each organization

Targets and capacity building items were developed through hearings and consultations with relevant agencies (EPA, MECCT, MMS, LGA, MNPHI, and NDMA).

Table 7.3.1 Current status, issues, and goals at the end of the project for each organization

organization name	Goals at the end of the project	Means of Implementation to Achieve Goals
EPA	Develop an understanding of sand movement around the island and monitoring methods related to climate change and the impact of development projects on the island.	OJT/Off-JT Seminar
MECCT	Establish a data collection, processing, and sharing system that links related institutions.	OJT/Off-JT Seminar JCC Training in Japan Third Country Training
MMS	Issue appropriate wave warnings and messages Provide accurate and reliable wave height and current forecasts Use data to improve reliability and parameterization of wave models Provide data to researchers and development projects	OJT/Off-JT Seminar
LGA	Strengthen the technical capacity of local councils to take effective environmental measures to ensure the sustainable protection of the coast and its resilience to climate change.	OJT/Off-JT Seminar
MNPHI	Obtain the knowledge and ability to conduct surveys, numerical modeling, analyze field data, and propose viable and efficient solutions. Propose solutions for coastal protection and management.	OJT/Off-JT Seminar Training in Japan
NDMA	Integrate coastal management and DRR to minimize storm surges, which are considered the main risk on islands.	OJT/Off-JT Seminar

Source: JICA Expert Team

Table 7.3.2 Items to strengthen the capacity of each organization

Category	Item	Check					
		EPA	MECCT	MMS	LGA	MNPHI	NDMA
Basic knowledge on coasts	Formation and source of sandy beach	✓	✓			✓	✓
	Climate change impacts, coastal erosion mechanisms	✓	✓		✓	✓	✓
	Coastal conservation and protection	✓	✓			✓	✓
	Environmental and social impact (including reef environment)	✓	✓		✓	✓	✓
	Coastal maintenance and management	✓	✓			✓	✓
Coastal planning for priority areas	National and regional planning			✓	✓	✓	✓
	Socio-economic conditions				✓	✓	✓
	Land use of hinterland					✓	✓
	Coastal erosion		✓			✓	✓
Benefits expected from the Project	Benefit type to be considered		✓			✓	✓
	Financial and economic evaluation methods		✓		✓	✓	✓
Wave Observation System	Equipment Installation			✓			
	Data Acquisition		✓	✓			
	Data Analysis		✓	✓		✓	
	Data Utilization		✓	✓		✓	✓
	Maintenance			✓			
Others	Environmental Monitoring	✓					
	Shoreline analysis using Remote sensing and Geographical information system data	✓				✓	
	Project Feasibility / Risk Analysis and Risk Management					✓	
	Management and Maintenance of structures					✓	
	Coastal Adapatation measures					✓	
	Numerical Modelling and Physical Testing					✓	
	Performance Monitoring and Design Optimization					✓	

Source: JICA Expert Team

CHAPTER 8 Cooperation with GCF Projects

8.1 Progress of PSC and PMU Establishment

In the implementation of the entire GCF project, various government agencies are involved, such as MECCT, including EPA and MMS under MECCT, as the Executing Entity (EE) and MNPHI, NDMA, LGA, Laamu Atoll Council and Addu Atoll Council (including target project islands within the atolls) as relevant organizations. To effectively implement the 4 components of the GCF project and facilitate nationwide rollout of the project outcome, Project Steering Committee (PSC) will be established.

The chair of PSC is a senior official from MECCT, and the secretary of PSC will be from the Environmental Department of MECCT. In addition to the 8 organizations mentioned above, the Ministry of Finance and JICA as EE of JICA financing Component 1, 3 and 4 will be participating in the PSC as the member.

The Project Management Unit (PMU) will be established for MECCT executing Component 2 and JICA expert teams will be established for JICA financing Component 1, 3 and 4 for the efficient implementation of these activities and reporting to each EE. At the application of GCF project, it was agreed with MECCT that the PMU members will be procured as individual consultants, Technical Adviser and Senior Procurement Advisor will be procured by JICA as Accredited Entity (AE) and the other members will be procured by MECCT (Refer to Annex 10 of GCF Funding Proposal). Also, it was agreed that the consultant may be entirely of national consultants when the procurement value is less than USD 16,667 or equivalent in accordance with the GCF's interest in encouraging the development and use of national consultants from partner countries of operation.

The establishment of PSC and PMU shall be started by appointing PSC members within the Government of Maldives and procurement of PMU members after the conclusion of the Subsidiary Agreement (SA) which will be agreed between JICA as AE and MECCT as EE. Since the SA is not yet concluded as of September 2022, PSC and PMU are not yet established. The description in 8.2 TOR of PMU Members and 8.3 Reporting Documents to GCF are from the Data Collection Survey on Building Climate Resilient Safer Cities Final Report by JICA in 2021.

8.2 TOR of PMU members

The PMU, established on behalf of the EE for Component 2, are responsible for the procurement of consultant for detail design/construction supervision and contractors and the day-to-day project management including design, construction, monitoring of defect liability period and commencement of beach monitoring and management activities. The members of PMU are composed of various experts such as project manager, technical adviser, social environmental and gender officer, knowledge management officer, procurement/contract manager, senior procurement adviser, and supporting staffs, such as office administrator, accountant, document controller and secretary; all of them are employed from external sources outside of MECCT. The function of PMU will end when the final performance report of the Project is submitted, and the final administration of the Project expenses is settled. The draft TOR of the PMU members are shown in Table 8.2.1.

Table 8.2.1 Draft TOR of PMU Members

Position	Draft TOR
Project Manager	<p>Overall supervision, technical supervision and daily activity management, report preparation</p> <p>As a leader of PMU, responsible for daily management of the activities based on the plan, ensure the activities to be completed within the period and expenses as planned and fulfill the required quality.</p> <p>In case unexpected situation arises, consult with PSC for policy guidance and advice so that the activities will continue to achieve the objectives.</p> <p>When necessary, attend the PSC meeting together with the representative of MECCT.</p>
Technical Adviser	<p>Providing technical advice, quality assurance (reviewing bidding documents, evaluation, checking consultant report, etc.), safety management of construction</p> <p>Support PMU work by providing technical expertise on coastal protection/conservation in reviewing and evaluating bidding documents, scrutinizing reports of detailed design/construction supervision consultant regarding civil work and maintenance work and other matters from the technical engineering aspect.</p> <p>Since it works most closely with the activities implementation and assures quality of the activities, the procurement and contract of the technical adviser are carried out by JICA using the GCF fund. The reporting lines of the technical adviser are JICA as employer and the Project Manager as the leader of PMU.</p>
Social Environmental and Gender Officer	<p>Environmental and social and gender consideration (necessary administration, coordination with concerned agencies, monitoring)</p> <p>Responsible for the administration necessary for confirming the approval of the Environmental Social Impact Assessment and coordination with concerned agencies for smooth implementation of the activities according to the plan, stakeholder engagement plan and gender action plan.</p> <p>Review the consultant's environmental, social and gender monitoring report and confirm necessary measures are taken.</p> <p>In case unexpected situation is foreseen, report to the project manager with possible countermeasures and implement the measures.</p> <p>When necessary, attend the PSC meeting together with the project manager.</p>
Knowledge Management Officer	<p>Communication of the activities, promotion of the activities among stakeholders including preparation of awareness materials, media engagement, and writing update reports etc.</p> <p>Collecting and organizing knowledge and lessons learned from the project activities to improve the activities and reflect to activities to other projects in Maldives and other countries.</p>
Procurement/Contract Manager	<p>Procurement administration (reviewing and preparing draft bidding documents, announcement, evaluation, contract negotiation, management of procurement and contract related documents)</p> <p>Lead the procurement of the consultant for detailed design and construction supervision, and the contractors for civil work according to the procurement policy of JICA as AE.</p> <p>Review the draft bidding documents prepared by the MECCT for the selection of the consultant, review the documents prepared by the consultant for the selection of the contractor, finalize and announce bidding documents, evaluate bidders, request PSC approval for evaluation report, discuss contract conditions during contract negotiation and conclude contract with successful bidder, and file documents regarding procurement and contracts.</p>
Senior Procurement Advisor	<p>Procurement supervision</p> <p>Confirm that the activities led by the procurement/contract manager comply with procurement policy of AE, by providing technical expertise on AE's procurement system.</p> <p>Since it works as a double check function within PMU, the procurement and contract of the technical adviser are carried out by JICA using the GCF fund.</p> <p>The reporting lines of the senior procurement adviser are JICA as employer and the project manager as the leader of PMU.</p>
Office Administrator	Logistics arrangement
Accountant	<p>Management of project budget and project management budget, disbursement request, management of accounting documents</p> <p>Manage project budget and Maldives co-financed activity budget including project management</p>

	budget, preparing the disbursement request, file accounting records and documents throughout the project period under the supervision of the project manager
Document Controller	Support day-to-day documentation work of Procurement/Contract Manager in preparation of bidding documents, reports, and contract related documents
Secretary	Administration work other than above

Source: JICA (2021) Data Collection Survey on Building Climate Resilient Safer Cities Final Report

8.3 Reporting Documents to GCF

For the implementation of the Project, reporting to the GCF Secretariat through certain documents is required. The outline of the documents, the organizations in charge of preparing the documents, and the approvers are shown in Table 8.3.1.

Table 8.3.1 Documents of the GCF Project Submitted to the GCF Secretariat

Type of Documents	Outline	Organizations in Charge of Preparation	Approvers
Annual Performance Report	Project information, Project cost, progress, performance against GCF investment criteria, progress updates of the indicators of logical framework, changes, issues and lessons learned after commencement of the Project, environmental, social and gender impact, compliance status with the rules and regulations, implementation status of environmental and social management plans, monitoring and gender action plans and planned activities, updated project schedule, financial information and evaluation report.	PMU, JICA Expert Team, EE (MECCT/ JICA-1&4/ JICA-3)	Chairman of PSC, JICA (AE)
Evaluation Reports	Evaluation of the Project (mid-term and final)	Evaluator	JICA
Financial Information	Financial information of each component	PMU, JICA Expert Team, EE (MECCT/ JICA-1&4/ JICA-3)	Chairman of PSC, JICA (AE)
External Audit Report	Audit of financial information	Independent auditor selected by JICA	JICA (AE)

Source: JICA (2021) Data Collection Survey on Building Climate Resilient Safer Cities Final Report

8.4 Progress of Component 3 (JICA)

In the Component 3: Development of Disaster Warning and Information Dissemination, a system for disaster warning and information dissemination that widely covers the residents for protecting their lives will be developed and operated. In addition to the development of a hard system, the component includes a soft system such as capacity development of relevant organization on system operation, public education and awareness raising activities. These activities are under implementation through The Project for the Digital Terrestrial Television Broadcasting Network Development (Grant Aid Project) and the Digital Terrestrial Television Broadcasting Operational Capacity Improvement Project (Technical Assistance Project) as a sub-set of activity financed by JICA. Table 8.4.1 shows the outline of the activities and the relevant grant aid project and technical assistance project of JICA.

Table 8.4.1 Outline of Component 3 Activities and Sub-set of Activity Financed by JICA

Activity 3.1: Installment of terrestrial digital broadcasting system ISDB-T television network will be installed to allow broadcasting digital television broadcasts throughout the Maldives.	Sub-activity 3.1.1: Standardization of Disaster Warning and Information Dissemination System	Grant Aid
	Sub-activity 3.1.2: Awareness Raising on Disaster Warning and Information Dissemination	Technical Assistance (Output 3)
Activity 3.2: Establishment of Disaster Early Warning and Information Broadcasting System In the Maldives, including Laamu Atoll, the access to weather/disaster information through a digital terrestrial television broadcasting system will be improved by implementing digital broadcasting that takes advantage of its features and is suited to the situation of the Maldives. The activity will be carried out while keeping it in line with the progress of the grant aid project of Sub-activity 3.1.1.	Sub-activity 3.2.1: Examination of Operational System for Disaster Warning and Information Dissemination	Technical Assistance (Output 4)
	Sub-activity 3.2.2: Establishment of the Structure to Operate Disaster Warning and Information Dissemination through the Terrestrial Digital Broadcasting System	Technical Assistance (Output 1,2,3)

Source: JICA Expert Team

According to the persons in charge of both projects, the schedules are delaying due to the Covid-19. Regarding the grant aid project, the construction work is on-going with expected hand-over to be in August 2023 (as of September 2022) and the progress rate as of July 2022 at 63.5%. For the technical assistance project, progress rate is 55.2% and expected to be completed in January 2025.

8.4.1 Sub-activity 3.1.1: Standardization of Disaster Warning and Information Dissemination System (Grant Aid)

In this sub-activity, the facilities equipment listed in the Table 8.4.2 and Table 8.4.3 are under constructed/installed nationwide, including Gan island of Laamu Atoll, for obtaining and disseminating necessary information related to coastal and ocean disaster for the central- and atoll-level concerned authorities.

Table 8.4.2 Construction Facilities and Quantity of Target Atoll in the Grant Aid Project

Facility	Quantity	Remarks
Network operation center	1 atoll	Villingili (Male) (K)
Microwave relay stations	3 atolls	Maafushi (K), Feeali (F), Fiyoari (GDh)
Digital transmitting stations	18 atolls	Dhidhdhoo (Ha), Kulhudhuffushi (HDH), Funadhoo (Sh)*1, Manadhoo (N), Ungoofaaru (R), Eydhafushi (B), Naifaru (Lh)*2, Villingili (Male) (K), Felidhoo (V), Dhangethi (ADh), Nilandhoo (F), Gan (L), Guraidhoo (Th), Gadhadhoo (GDh), Thinadhoo (GDh)*3, Villigili (Ga), Fovammulah (Gn), Hithadhoo (S)
		Note: *1: Funadhoo (Sh) was replaced with Maaungdhoo (Sh), *2: Naifaru (Lh) was replaced with Hinnavaru (Lh), *3: Thinadhoo (GDh) was cancelled.

Source: JICA (2021) Data Collection Survey on Building Climate Resilient Safer Cities Final Report

Table 8.4.3 Facilities and Equipment to be Introduced in the Grant Aid Project

Item	Detail
Facility	Antenna tower, transmission center building, etc.
Equipment	Digital transmission system, equipment for network operation center, PSM equipment, etc.

Source: JICA (2021) Data Collection Survey on Building Climate Resilient Safer Cities Final Report

8.4.2 Sub-activity 3.1.2: Awareness Raising on Disaster Warning and Information Dissemination (Technical Assistance Project Output 3)

In this sub-activity, pilot evacuation drills with test transmission of EWBS will be organized in selected towns, with participation of communities for practical disaster information transmission. Through this activity, familiarize, as well as raise awareness of, municipalities and local residents with the categories and contents of warning/information and appropriate responsive actions. Lesson learned from the pilot evacuation drills will be reviewed for further improvement of EWBS. The progress of this sub-activity is as shown in Table 8.4.4.

Table 8.4.4 Progress of Sub-activity 3.1.2

Activities	Progress
Raise the awareness of the broadcasters on data broadcasting service	Completed.
Conduct training on handling Broadcast Markup Language (BML)	Temporarily halted. TO be resumed after the installation of GAP's equipment.
Operate programmes for region-specific data broadcasting which are not linked to TV programmes	To be conducted later.
Prepare a scheduling plan for data broadcasting programmes	To be conducted later.
Conduct OJT on transmission of data broadcasting programmes	To be conducted later.
Prepare a manual for operation of data broadcasting programme	To be conducted later.
Hold workshops on operation of data broadcasting programmes	To be conducted later.

Source: Digital Terrestrial Television Broadcasting Operational Capacity Improvement Project JICA Expert Team

The achievement of the technical assistance project output for this sub-activity is as shown in Table 8.4.5.

Table 8.4.5 Achievement of Technical Assistance Project Output for Sub-activity 3.1.2

Output	Objectively Verifiable Indicator	Status of Achievement
Capability is upgraded in operating data broadcasting programmes.	Sections that handle data broadcasting are established in PSM.	IT, News and Graphic Design Sections are currently operational with five members of staff.
	At least 4 templates / contents for data broadcasting are available.	None of the templates have been produced yet, and required specifications of the templates have not been finalized in the GAP yet either. Thirteen members of Data Broadcasting team were briefed about the fundamentals of BML programming via OJTs conducted online.
	Manual for operation of data broadcasting program is prepared.	Preparation has been suspended until installation of equipment by GAP is completed. Therefore, no progress to this indicator is recognized.

Source: Digital Terrestrial Television Broadcasting Operational Capacity Improvement Project JICA Expert Team

8.4.3 Sub-activity 3.2.1: Examination of Operational System for Disaster Warning and Information Dissemination (Technical Assistance Output 4)

In this sub-activity, appropriate disaster alert information dissemination system will be developed and its appropriate operation will be assisted in order to transmit the necessary information properly in the event of a disaster. Real-time warnings can be provided through the Early Warning Broadcasting System (EWBS) and can be received even for vessels under sea navigation which is expected to result to prompt and appropriate evacuation behavior. At the same time, the equipment such as digital signages, etc., will be procured for EWBS, as well as necessary equipment for production of appropriate data broadcasting programs.

At the same time, necessary equipment such as 3 units of Data Broadcasting Operation Equipment with necessary licenses, EWBS receivers with monitors and antennas, and digital signages, etc. will be procured.

For the assistance of proper operation of the EWBS, the mechanism of the disaster broadcast should be clarified at first, and then the operation of EWBS will be assisted as a part of the disaster broadcast. The operating organizations of EWBS are PSM, MMS and NDMA. The expected roles for each organization are as in Table 8.4.6.

Table 8.4.6 Roles Expected for EWBS Operating Organization (PSM, MMS, NDMA)

Operating Organization	Expected Role
MMS	Announce weather warnings/advisories and send the information to PSM
PSM	Announce the alarm through the EWBS
NDMA	Announce evacuation information/disaster information in response to an alarm

Source: JICA (2021) Data Collection Survey on Building Climate Resilient Safer Cities Final Report

When issuing an alarm through EWBS, real-time wave information obtained from the wave observation system proposed in Component 4 of GCF Project will be utilized.

The progress of this sub-activity is as shown in Table 8.4.7. The working group for EWBS operation were established and the EWBS operation guidelines were developed. The table of contents for the EWBS operation manual is under preparation at present. Also, the plan of evacuation drill is at the planning stage. Regarding the procurement of necessary equipment for EWBS, procurement of the Data Broadcasting Operation Equipment was completed, and the training is under implementation. The digital signage will be expected to be procured within the year 2022. Further, the software of EWBS receivers was updated to appropriately show in Divehi language. EWBS receivers are to be procured by PSM.

Table 8.4.7 Progress of Sub-activity 3.2.1

Activities	Progress
Establish a working group for operation of EWBS	Completed.
Develop guidelines for EWBS operation	Completed.
Prepare a manual for EWBS operation	The members of WG are working on developing the Table of Contents for the EWBS Operation Manual.
Conduct training on activating alerts / warning through EWBS	This activity will be conducted later amongst parties, such as: NDMA, MMS and PSM – after the equipment installation by GAP.
Conduct OJT on operation of EWBS-related equipment	This activity will be conducted later on by PSM and MMS – after equipment installation by GAP.
Implement pilot evacuation drill(s) with test	The members of the Working Group and JET traveled to H. Dh

transmission of EWBS and participation of those who are concerned such as NDMA and MMS	<p>Kulhudhuffushi and S. Hithadhoo to survey the islands and meet the council members in August. The purpose of these trips was to plan for the Evacuation Drills in the future.</p> <p>Also, NDMA has proposed an alternative Island, K. Dhiffushi for the evacuation drill, the one which was confirmed in the Working Group (WG). However, WG would like to still keep V. Keyodhoo as a backup since a community-based disaster management plan in Dhiffushi is not finalized yet.</p> <p>Meanwhile, WG has recognized providing information on execution of the drill – before the drill – to be of high importance; especially for Dhiffushi. Since the radio waves in Dhiffushi will be propagated from the Male’ transmitting station, and it would be necessary to take preemptive measure to avoid any confusions during the drill.</p>
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Source: Digital Terrestrial Television Broadcasting Operational Capacity Improvement Project JICA Expert Team

The achievement of the technical assistance project output for this sub-activity is as shown in Table 8.4.8.

Table 8.4.8 Achievement of Technical Assistance Project Output for Sub-activity 3.2.1

Output	Objectively Verifiable Indicator	Status of Achievement
Emergency Warning Broadcasting System (EWBS) is properly established and operated.	Necessary documents, i.e., guidelines and manual, are developed.	EWBS guidelines were prepared. The EWBS operation manual is currently under development. Alert messages and voice message of EWBS have been confirmed.
	At least 12 DBNO staff possess the capability to operate EWBS-related equipment on their own.	Due to the delay in GAP, no achievement to this indicator is recognized.
	At least 3 time(s) of evacuation drill(s) are carried out in collaboration with the concerned organizations. Besides evacuation drills, operational drills should be conducted at least once a month between PSM and MMS.	The initial meetings for the evacuation drills were held at two shortlisted Islands, Kulhudhuffushi and Hithadhoo. Also, K. Dhiffushi has been confirmed as the third candidate whilst V. Keyodhoo remains as a backup.

Source: Digital Terrestrial Television Broadcasting Operational Capacity Improvement Project JICA Expert Team

8.4.4 Sub-activity 3.2.2: Establishment of the Structure to Operate Disaster Warning and Information Dissemination through the Terrestrial Digital Broadcasting System (Technical Assistance Project Output 1, 2, 3)

The terrestrial digital broadcasting technology is a completely new technology that will be introduced to the Maldives. As a first step to implement the terrestrial digital broadcasting system in the Maldives, a system for promoting and spreading terrestrial digital broadcasting system will be established. Technical transfer to improve the capacity to operate and maintain the equipment and facilities to the staff and engineers on broadcasting should be done in order to operate the equipment and facilities properly. The assistance for the production of data broadcasting program in consideration of regional characteristics and the program-unlinked data broadcasting program, the creation of the program scheduling plan, and the preparation of program production manuals will be conducted. The progress of this sub-activity is as shown in Table 8.4.9.

Table 8.4.9 Progress of Sub-activity 3.2.2

Activities	Progress
Develop Public Relations Plan for Digital Migration	The contents of draft Public Relations Plan (PR Plan) are 85% completed, with the exception of budget section. A few details regarding PR activities such as logo, slogan and their guidelines were confirmed. Digital Broadcasting Experts Group (DiBEG) has handed the 'Test Stream items for transfer to a JET member who is currently active in Male'. In the meantime DiBEG is drafting the terms of use contract for prospective tenderers. Furthermore, PSM is currently preparing the procurement of STBs for the bid. The estimated duration of the tender process was aligned with four phases.
Conduct public relations activities in accordance with the Public Relations Plan	Due to prioritization of Digital Signage and STB Procurement, the budget allocation for PR Plan is under consideration and no PR activities have commenced as of yet. Currently, PSM members are developing spot contents for the TV and radio broadcasts for the launch of PR activities. So far, PSM has only managed to confirm the usage guidelines of the logo and slogan in respect to PR activities.
Establish a call centre for viewers support	The current call centre, PSM Connect, will be integrated with DTTB services once launched.
Prepare a manual for call centre operation	There is no progress in this activity due to the prioritization of Digital Signage and STB Procurement. JET has confirmed the revised draft Call Center Training Participation Plan which was provided from PSM on August, 2021.
Disseminate outputs of the Project, nationally and internationally, which fully utilizes the advantage of digital terrestrial broadcasting (ISDB-T), i.e. EWBS, to mitigate information gap on natural disasters.	This activity will be conducted later.
Conduct On-the-Job Training (OJT) on periodical inspection and spare parts replacement upon equipment failure of transmitter systems	No OJTs were conducted related to this item during this monitoring period.
Prepare a manual for operation and maintenance of transmitter systems	From 15th to 28th May, 2022, JET managed to conduct 5 in-person OJTs to study the GAP approved drawings. Drawings were studied and several questions were drafted accordingly with the help of PSM's technical team. Subsequently, the questions were emailed to GAP contractors for further clarification. Also, some of the concerns related to the smooth operation of EWBS was discussed in the GAP drawing analysis sessions; and questions regarding the concerns that were raised was included in the questionnaire to GAP. By 21st July, GAP contractors had provided answers to all the queries which were presented to them. Currently, WG2 members are working on preparing follow up questions to GAP replies.
Conduct OJT on radio wave measurement	There was no online OJTs for radio wave measurement in this monitoring period, and further OJTs will be provided after GAP is completed.
Prepare a manual for management of DTTB coverage area	This activity will be conducted later.
Prepare a plan for constructing additional transmitting stations	Upon amending their request with the correct specifications, PSM were able to negotiate a permit with CAA to build a 55m Tower in M. Muli – which does not interfere with the obstacle limited surface. For the time being PSM is estimating the budget for constructing additional stations and working on attaining permits from relevant authorities. JET and PSM have also been discussing with each other to produce ideas to come up with solutions on existing concerns regarding the expansion plans. During this monitoring period, the topics discussed were the predicted receiving levels in remote islands, and the viability of existing analog stations as potential DTTB stations in selected islands.
Conduct OJT on operation and	PSM with the support of JET has finished analyzing the consultant approved

maintenance of NOC equipment	documents of GAP, and the results will be utilized for considering operation and maintenance methods. However, the drafting work has not begun as of yet.
Conduct training on taking emergency measures upon failure of NOC equipment as well as transmitter systems	Same as activity 11 mentioned above.
Conduct OJT on production of electronic programme guides (EPG) and Superimpose	Same as activity 11 and 12 mentioned above.
Prepare a manual for operation and maintenance of NOC equipment	As mentioned in activity 9, JET has completed the analysis of the construction documents provided by GAP.

Source: Digital Terrestrial Television Broadcasting Operational Capacity Improvement Project JICA Expert Team

The achievement of the technical assistance project output for this sub-activity is as shown in Table 8.4.10.

Table 8.4.10 Achievement of Technical Assistance Project Output for Sub-activity 3.2.2

Output	Objectively Verifiable Indicator	Status of Achievement
A system for facilitating viewers' digital migration is established.	Public Relation Plan is developed.	The contents of the plan are 85 % completed.
	Call centre is established and properly functioning.	OJTs are being planned, although not executed as of yet.
	Operation manual for the call centre is prepared.	Due to having prioritized other activities, the preparation of the manual is halted.
Technical capability is upgraded in the field of the operation and maintenance of the equipment for digital terrestrial broadcasting.	At least 27 DBNO staff possess capability to properly operate and maintain the equipment for digital terrestrial broadcasting on their own.	A total of 42 staff members participated for each of the OJTs: "operation and maintenance of transmitters" and "conducting radio wave measurement." Further OJTs will be planned when the equipment provided by GAP is installed. The Director of DBNO has already been officially appointed.
	Necessary documents, i.e., manuals and plans, are prepared.	The table of contents for the manuals have been drafted. Members of PSM have been analyzing the documents of GAP comprehensively, and the results of analysis will be incorporated into the manuals. Currently PSM has been communicating with GAP querying on several points especially the things related to the establishment of the additional transmitting stations – to be installed by PSM.
Capability is upgraded in operating data broadcasting programmed.	Sections that handle data broadcasting are established in PSM.	IT, News and Graphic Design Sections are currently operational with five members of staff.
	At least 4 templates / contents for data broadcasting are available.	None of the templates have been produced yet, and required specifications of the templates have not been finalized in the GAP yet either. Thirteen members of Data Broadcasting team were briefed about the fundamentals of BML programming via OJTs conducted online.
	Manual for operation of data broadcasting program is prepared.	Preparation has been suspended until installation of equipment by GAP is completed. Therefore, no progress to this indicator is recognized.

Source: Digital Terrestrial Television Broadcasting Operational Capacity Improvement Project JICA Expert Team

CHAPTER 9 Outline of Cooperation

9.1 Basic Plan of Cooperation

9.1.1 Name of the Project

The Project for Building Climate Resilient Safer Islands in the Maldives

9.1.2 Period of Cooperation

October 2021 to October 2025 (48 months)

9.1.3 Overall Goal

Overall Goal	Objectively Verifiable Indicators
National resiliency and safety against climate change is promoted due to the implementation of coastal protection measures considering climate change in the Maldives	<ul style="list-style-type: none"> ICZM plans based on the information on monitoring of wave, coast, reef and land use are formulated in more than 3 inhabited islands except target islands of the Project
	<ul style="list-style-type: none"> Countermeasures are implemented in target islands in accordance with formulated ICZM plans

(Supplementary explanation on indicators)

The indicator for project purpose is that coastal protection measures will be incorporated into the annual plans of the concerned organizations. The overall goal envisages that, as a mid- to long-term development effect, coastal protection measures will be implemented based on the ICZM plan, in accordance with the annual plans of the relevant ministries and agencies. It is also envisioned that ICZM plans will be developed for the three inhabited islands other than the target islands in the mid- to long-term as a result of strengthening the capacity of the officers of the concerned organizations.

9.1.4 Project Purpose

Project Purpose	Objectively Verifiable Indicators
Capacity of related organizations to implement coastal protection measures considering climate change is strengthened.	Coastal protection measures considering climate change and countermeasures to implement ICZM plans in the targeted inhabited islands are applied to annual plans of related ministries

(Supplementary explanation on indicators)

Possible measures for ICZM are related to coastal protection, land use, sediment management, and reef environment protection. It is envisioned that the division of responsibilities among relevant ministries and agencies for these measures will be clarified, and that the measures will be incorporated into the annual plans of each relevant ministry and agency and budgeted for in their budgets.

9.1.5 Outputs and Activities

Output 1	Objectively Verifiable Indicators
Cooperation among related organizations to prepare basic policy of ICZM at national level and countermeasures in targeted inhabited islands are strengthened.	a. Basic policy of ICZM is agreed among related organizations b. Basic policy of ICZM is applied to ICZM plans including climate change adaptation measures such as coastal protection/adaptation measures in the targeted inhabited islands c. Basic design of coastal protection is developed in targeted inhabited islands d. Level 2 of ICZM integration: Governments use knowledge about ICZM plan in development plans in 2 islands ¹
Activities	
1-1	Conduct inventory study on coastal conditions in inhabited islands
1-2	Prepare basic policy of ICZM at national level
1-3	Prepare ICZM plan at targeted inhabited islands (Gan, Fohadhoo in Laamu Atoll)
1-4	Conduct basic design and survey on environmental impact assessment in targeted inhabited islands (Gan, Fonadhoo, Maamendhoo, Ishdhoo in Laamu Atoll and Meedhoo in Addu Atoll) in accordance with the basic policy of ICZM
1-5	Implement seminars for capacity development on ICZM and its dissemination

Note: *1: ICZM integration level indicators: Level 0 = No knowledge about ICZM implementation and no plans where ICZM has been integrated, Level 1 = Governments get knowledge about ICZM plan but no plans where ICZM has been integrated, Level 2: Governments use knowledge about ICZM plan in development plans in 2 islands, Level 3: Governments use knowledge about ICZM plan in development plans in 3 islands. (ICZM plan is the one to build resilient and safer islands by harmonizing human lives with nature along coast including coastal conservation, reef conservation, sediment budget management, and land use; development plans are the regional development plans to harmonize between coastal development such as port plans and reclamation plans and natural environment.)

(Supplementary explanation on indicators and activities)

Since ICZM straddles the jurisdiction of not only the main counterpart organization, MECCT, but also multiple concerned organizations such as MNPHI and NDMA, agreement among the concerned organizations is essential for the implementation of ICZM, as indicated in a. of the indicator. It is necessary to consider the basic policy for ICZM at the national level in Activity 1-2 based on specific cases, so it is envisioned that there will also be a process to feed back the results of the ICZM planning in the target islands between Activity 1-3 and Activity 1-2.

Output 2	Objectively Verifiable Indicators
Structure to implement community-based beach maintenance is established in targeted inhabited islands in accordance with ICZM plan	Countermeasures of community-based beach maintenance is implemented in the targeted inhabited islands
Activities	
2-1	Prepare concrete method, structure and operation for adaptive management and promote agreement among related actors in the targeted inhabited islands (Gan, Fonadhoo, Maamendhoo, Ishdhoo in Laamu Atoll and Meedhoo in Addu Atoll)
2-2	Prepare concrete method, structure and operation for community-based beach maintenance and promote agreement among related actors in the targeted inhabited islands
2-3	Implement public education and public relations on beach maintenance and management in the targeted inhabited islands

(Supplementary explanation on indicators and activities)

The timing of each activity in Output 2 comes before the construction of beach nourishment and revetment, so role-playing and other activities will be incorporated so that community-level stakeholders in the target island can visualize the construction and subsequent maintenance.

Output 3	Objectively Verifiable Indicators
Wave, beach, coral reef and land use monitoring system is developed and operation capacity of related organizations is promoted in the targeted inhabited islands	a. Monitoring system is installed, managed and operated by related organizations b. Level 2 of Proficiency in Monitoring: Stakeholders will be able to implement monitoring works by themselves ²
Activities	
3-1	Develop wave monitoring system and establish structure for technical transfer, management and monitoring on analysis and data processing
3-2	Develop coast, reef and land use monitoring system utilizing satellite images and the UAV technology, and establish structure for technical transfer, management and monitoring on analysis and data processing

Note: *2: Proficiency of monitoring indicators: Level 0 = Stakeholders (MEE, MMS, atoll and Island councils and communities in 5 islands) have no/ insufficient knowledge on monitoring. Level 1= Stakeholders will acquire sufficient knowledge on monitoring methods. Level 2 = Stakeholders will be able to implement monitoring works by themselves, Level 3 = Stakeholders will be able to accumulate monitoring data in proper manner so that the data can be directly applied for coastal planning.

(Supplementary explanation on indicators and activities)

For Activity 3-1, it is assumed that the Wave Observation System will be installed in the northern, central, and southern parts of the Maldives. The concerned organization to be targeted for capacity development is MMS.

9.1.6 Input**(1) Japanese Side****a. Dispatch of Experts**

Team Leader / Regional Planning

Deputy Team Leader / Coastal Conservation Plan/ Integrated Coastal Zone Management (ICZM) 2

Coastal Conservation Plan/ Integrated Coastal Zone Management (ICZM) 1

Coastal Engineering/Shoreline Change Analysis 1

Coastal Management/Coastal Monitoring

Oceanographic Investigation/ Survey 1

Facility Design and Construction Plan/Cost Estimate

Wave Observation System

Reef Environment Planning

Regulatory System/Organizational Cooperation/ GCF Scheme

Capacity Development/Training Plan

Environmental and Social Consideration/ Consensus Building/ Gender 1

Environmental and Social Consideration/ Consensus Building/ Gender 2

Satellite Image Analysis / GIS

Coastal Engineering/Shoreline Change Analysis 2/ Coordinator 2

Oceanographic Investigation/ Survey / Coordinator 1

b. Training of Counterpart Personnel in Japan and third country

c. Equipment: Wave hunters, drones, analysis software

(2) Maldivian Side

a. Allocation of Counterpart Personnel

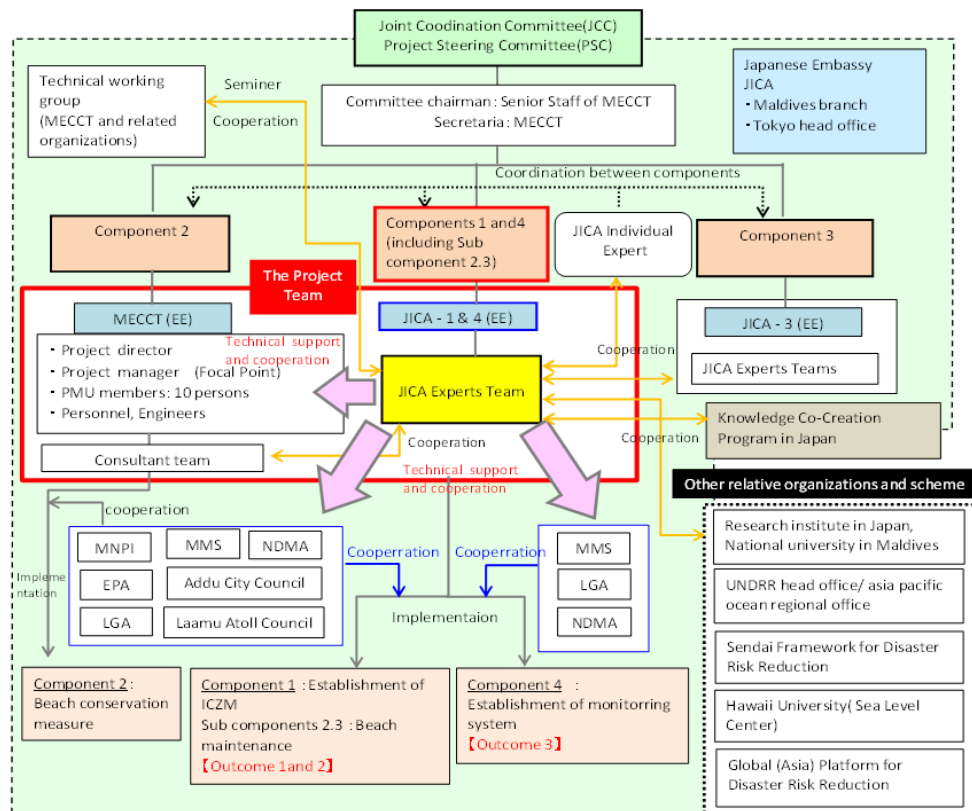
b. Local cost (domestic travel expenses, office utilities, etc.) other than covered by GCF fund

9.1.7 Important Assumption

No change in Maldives' policy/legislation on coastal protection measures

9.2 Implementation Structure

The implementation structure of this project is shown in the figure below. Since this work is part of the GCF project (Components 1, 4, and Sub-Components 2.3), the structure will be established for close collaboration with the implementing agencies and relevant parties of other components.



Source: JICA Expert Team

Figure 9.2.1 Implementation Structure of the Project

9.3 Plan of Monitoring and Evaluation

(1) Main Indicators to be used in the Evaluation

The indicators were shown in 9.1.

(2) Plan of Evaluation

Post evaluation will be conducted three year after the project completion.

(3) Plan of Monitoring during the Project

Monitoring sheet is prepared every 6 months after starting the project

Confirmation of progress and annual work plan once half year at JCC meetings

Preparation of project completion report at the project completion

CHAPTER 10 Six Evaluation Items

10.1 Relevance

The project is highly appropriate because of its consistency with the relevant policies of the Maldives, the needs of counterpart institutions and the target society, and the appropriateness of its approach.

10.1.1 Consistency with Coastal Conservation Policy in the Maldives

The Constitution of the Republic of Maldives is the basic statement of the principles of the Republic of the Maldives. Article 22 of the Constitution states that "The State has a fundamental duty to protect and preserve the natural environment, biodiversity, resources and beauty of the country for the benefit of present and future generations." and Article 23(d) states that "Every citizen the rights to a healthy and ecologically balanced environment pursuant to this Constitution, and the State undertakes to achieve the progressive realization of these rights by reasonable measures within its ability and resources." Article 67 (h) states that " The exercise and enjoyment of fundamental rights and freedoms is inseparable from the performance of responsibilities and duties, and it is the responsibility: to preserve and protect the natural environment, biodiversity, resources and beauty of the country and to abstain from all forms of pollution and ecological degradation" and Article 232(c) states that "The responsibilities of councils elected to provide for decentralized administration shall include: to establish a safe, healthy and ecologically."

In addition, the Maldives Updated Nationally Determined Contribution (NDC) in 2020 describes the promotion of an eco-based approach in the field of coastal conservation, the promotion of coastal conservation projects, and the acquisition of funds, including from foreign donors. In addition, the Strategic Action Plan 2019-2023 specifies the implementation of eco-based adaptation measures in coastal conservation.

The project intends to strengthen the capacity of five inhabited islands in Addu and Laamu atolls for coastal conservation measures in consideration of climate change, and to promote measures that take advantage of the natural protection functions of sandy beaches and reefs. Therefore, the project approach is appropriate as it is consistent with the policy of the Maldives on coastal conservation projects.

10.1.2 Needs from Society

State of the Environment 2016 reported that coastal erosion has been remarkable in the Maldives since the 1980s, and 116 inhabited islands out of 189 inhabited islands were experiencing coastal erosion, of which 38% were in a severely eroded condition as of 2014. Among 76 inhabited islands that responded to the inventory survey for this detailed planning study conducted in 2022, about half answered that coastal erosion was identified as a problem occurring on the coast, and about 80% of these islands reported that coastal erosion conditions were serious. About 60% of the islands also indicated that they would like to take measures to minimize the impact on the environment. Thus, coastal erosion is recognized as the most typical coastal problem in many inhabited islands in the Maldives, and there is a high social need for coastal protection to prevent and mitigate coastal erosion while also taking less environmental impacts into consideration.

10.1.3 Relevance of Counterpart Agencies

MECCT is responsible for policy development and implementation related to climate change measures both mitigation and adaptation and serves as a focal point for international organizations such as the GCF in the area of climate change. MECCT's mandate includes strengthening activities and opportunities related to climate change adaptation, building infrastructure and communities resilient to the impacts of climate change, including

management in coastal protection. MNPFI is responsible for the implementation of coastal protection and works closely with MECCT to implement coastal protection.

Since this project is to build climate resilient safer islands and also requires coordination with the GCF, it is highly appropriate to have MECCT as the main counterpart agency.

10.1.4 Appropriateness of approach

The project will strengthen coordination among relevant organizations to formulate a national level policy for ICZM and specific measures for the target inhabited islands, and prepare ICZM plans for the target islands in Output 1. Output 2 will establish a community-based beach maintenance and management system on the target islands based on the ICZM plan. A long-term monitoring system for waves, beaches, coral reefs, and land use will be established, and the operational capacity of relevant institutions will be improved in Output 3. Long-term observation and monitoring under Output 3 will capture the effects of climate change and will contribute to ICZM planning and coastal maintenance management on other inhabited islands after the project is completed. The achievement of the three outputs will also strengthen the capacity of officers of the concerned organizations to implement coastal protection measures in which climate change impacts are taken account. It will contribute improving the resilience and safety of the Maldives against climate change. Thus, the logic of the approach is appropriate, as it will improve the resilience and safety of the Maldives against climate change by enhancing the capacity of the officials of the concerned organizations to implement coastal protection measures while taking into climate change impacts.

10.2 Coherence

Japan's "Country Assistance Policy (formulated in April 2020)" for the Maldives sets "support for sustainable economic growth with due consideration for vulnerability" as a major goal, and states that assistance will be provided to achieve sustainable economic growth from a medium- to long-term perspective, while taking into account vulnerability to climate change and natural disasters, etc. The program also includes "Support for sustainable economic growth (including climate change and natural disasters)" in which higher priority will be given. The program also identifies "(2) Environment, Climate Change, and Disaster Management" as one of the priority areas of assistance, with emphasis on support for environmental and climate change countermeasures and disaster risk management, such as addressing climate change and promoting the use of renewable energy, and for disaster risk management, particularly disaster risk management in rural areas.

In this context, the "Data Collection Survey on Building Climate Resilient Safer Cities", which has been implemented by JICA since 2018, investigated climate change and coastal conditions in the Maldives to prevent and mitigate land loss on inhabited islands. Technical support to the project formulation considering utilization of the Green Climate Fund was also carried out in the study. "The Project for the Digital Terrestrial Television Broadcasting Network Development" (grant aid scheme) and the " Digital Terrestrial Television Broadcasting Operational Capacity Improvement Project" (technical assistance scheme) have also been implemented to support filling information gaps and improve the efficiency of disseminating disaster risk related information. This project is part of a collaborative project with the GCF, which was formulated on the basis of the data collection survey, and the two projects related to the digital terrestrial TV broadcasting network are also part of the collaborative project with the GCF. The project purpose of this project is to strengthen the capacity of related organizations to implement coastal protection measures considering climate change, with the supports provided to date and in coordination with ongoing projects. This is consistent with Japan's assistance policy for the Maldives.

10.3 Effectiveness

The effectiveness of this project is expected to be enhanced, as the achievement of each output is expected to enable the achievement of the project goals. The project will strengthen the linkages between the national level policy of Integrated Coastal Zone Management (ICZM) and the relevant agencies for the planning of target islands in Output 1. Community-based coastal maintenance management system will be established on the target islands in Output 1, based on the ICZM plan to be developed in Output 1. A long-term monitoring system for waves, beaches, coral reefs, and land use will be established on the target islands, and the operational capacity of relevant institutions will be improved in Output 3. By achieving these outputs, it is highly likely that the project will achieve its project purpose of "Capacity of related organizations to implement coastal protection measures considering climate change is strengthened."

On the other hand, as for the achievement of outputs within the set input and period, the establishment of the PMU is essential for the implementation of GCF projects and Maldivian government co-financed projects, and activities in Output 1 also need to be coordinated with the PMU, so the early establishment of the PMU is awaited.

10.4 Efficiency

The project is expected to be generally efficient in terms of efforts to take efficient activities through selection and concentration of project components, a smooth implementation structure, appropriate project duration and inputs, and synergies with previous cooperation achievements and related projects in the field concerned. In this project, three working groups will be formed for each output, and discussions will be held between JET members and officers from the concerned organizations on themes related to each output. The efficient and effective development of activities are considered through the establishment of the working groups.

On the other hand, since the COVID-19 infection situation also affects project efficiency, it will be necessary to continue monitoring the situation in order to ensure project efficiency.

Although there is no overlap between this project and the supports provided by other international partners during this detailed planning survey, it is necessary to keep a close eye on the activities by the other international partners.

10.5 Impact

While the project's target area is centered on Laamu and Addu atolls, it is expected to disseminate the project outputs throughout the Maldives. Since the project has activities with a view to nationwide expansion, it is expected to have a high impact on the entire country through the solid implementation of the planned activities.

Furthermore, this project will contribute to the achievement of SDGs Goal 11 "Make cities and human settlements inclusive, safe, resilient and sustainable" and Goal 13 "Take urgent action to combat climate change and its impacts" and to the realization of the Sendai Framework for Disaster Risk Reduction 2015-2030 (Priority Action 1: Understanding disaster risk, Priority Action 2: Strengthening disaster risk governance to manage disaster risk, Priority Action 3: Investing in disaster reduction for resilience, and achieve global targets (a)-(d)).

No negative impacts are envisaged at the time of the detailed planning survey.

10.6 Sustainability

The institutional sustainability is generally high, as coastal conservation is stated as an important issue in various laws and plans of the Maldives. If the importance of the national ICZM policy to be developed in this project is recognized by relevant organizations and leads to policy implementation, the policy institutional sustainability can be further enhanced.

As far as organizational sustainability, the interest and awareness of the main C/P, MECCT, toward the project is high, and other related agencies such as MNPHI are actively participating in the project. There have been few dismissals or transfers at the director level of MECCT, and few dismissals or transfers of staff at the working level. It is also envisioned that members to be employed through the establishment of the PMU will work on the project, and that these individuals will be hired by MECCT after the project. If this plan is realized, organizational sustainability will be further enhanced.

Since there have been no budget cuts in MECCT and MNPHI so far, there should be no major problems with financial sustainability after the end of the cooperation. However, budget reductions are one concern that could hinder the possibility of self-sustaining development. It is necessary to continue closely monitoring situations of the budget.

It is highly likely that the technology will be maintained, as various manuals are planned to be prepared jointly by Japanese experts and C/P staff, and the transfer technology is to be executed and maintained through various training programs to be implemented in the project. On the other hand, the examination of ICZM and the implementation and maintenance of beach nourishment projects on inhabited islands will be a new challenge for the Maldives stakeholders, adequate trainings and the joint preparation of user-friendly manuals in line with C/P needs will be particularly important to ensure technical sustainability.

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