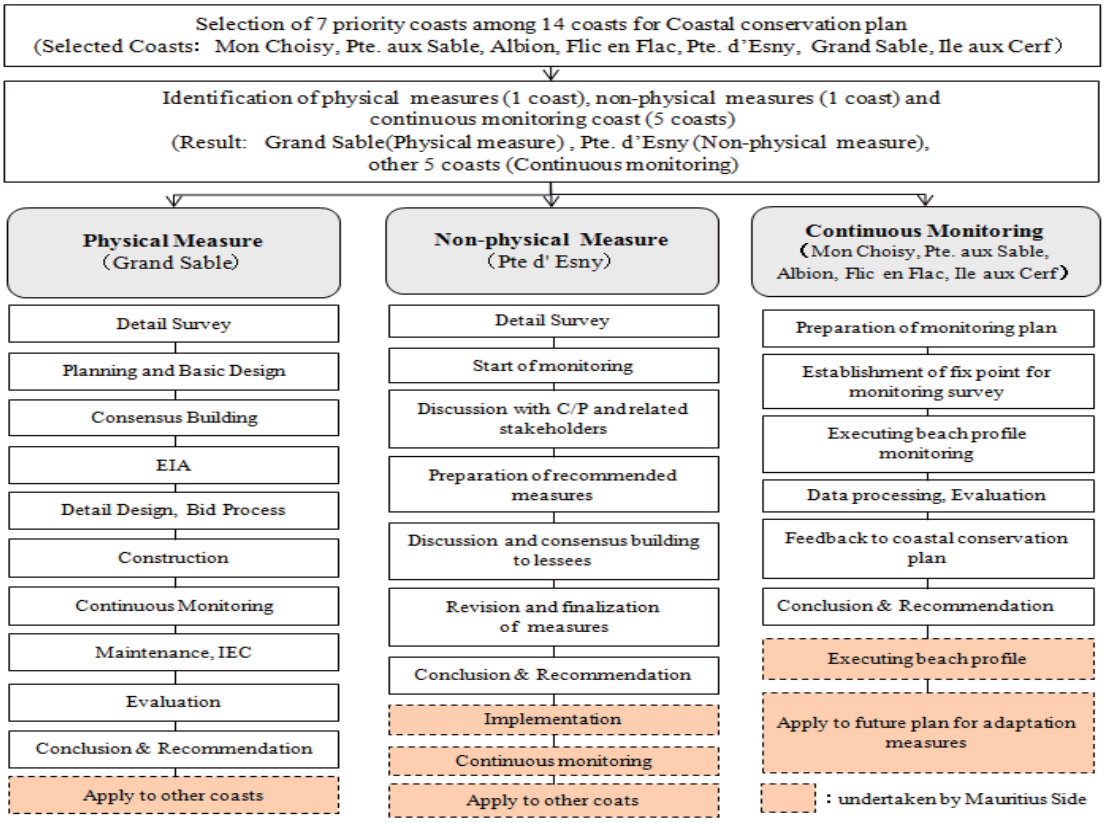
Chapter 8

Implementation of Demonstration Project

8 Implementation of Demonstration Project

8.1 Outline

Figure 8.1.1 shows the outline for implementation of the demonstration project.



Source: JICA Study Team

Figure 8.1.1 Study Flow for Implementation of the Demonstration Project

The main purpose of the demonstration project was to conduct the capacity development for the C/P and related stakeholders through each step with actual experience on planning, design, implementation, monitoring, and evaluation in order to obtain sufficient capability for planning and management on coastal conservation in Mauritius. Considering these principles, it is necessary to proceed with each activity and work together with the C/P and related stakeholders.

The consensus building with third parties such as residents, hotels, NGOs, etc. is also required for the implementation of coastal conservation. Furthermore, it might be effective to utilize the local knowledge from these parties for the coastal conservation planning and required maintenance and management work. Thus, the demonstration project is one of the tools to achieve this.

8.2 Technical Transfer and Capacity Development Through the Demonstration Project

The purpose of the demonstration project was to conduct technical transfer and capacity development for the C/P and related stakeholders to enhance coastal conservation planning and management skills. The purpose, concrete actions for physical / non-physical measures,

and continuous monitoring are summarized in Table 8.2.1. Figure 8.2.1shows the example for its progress. Temporary events such as seminars, workshops, etc. are not sufficient on their own for technical transfer and capacity development. The most effective approach for technical transfer and capacity development is continuous on-the-job training through the implementation of each activity for the demonstration project.

Table 8.2.1 Technical Transfer and Capacity Development through the Demonstration Project

Category	Purpose	Action
Physical Measure	- Technical transfer for the knowledge of relevant coastal protection measures in Mauritius trough implementation and continuous monitoring - Technical transfer and capacity development for skills on planning and design methods (hard part technique) for coastal protection measures - Technical transfer and capacity development for monitoring the method, data processing and analysis through the monitoring works on beach profile and wave-current observation - Enhancement the public`s understanding for the necessity of coastal conservation and the coastal environment through public participation events such as beach cleaning, monitoring, etc.	➢ Joint site investigation with C/P and related stakeholders (several times), and joint beach profile survey (see Figure 8.2.1(1)) ➢ Conduct Technical Committee Meeting (TC) and working session to transfer the design method and procedure (design wave, wave run-up, etc.) ➢ Technical guidance of the instruction of equipment, field work and data processing on wave and current observation (Figure 8.2.1 (2)) ➢ Joint field work for installation and removal of equipment (Figure 8.2.1 (3)) ➢ Conduct the socialization and public participation programs (beach cleaning, beach monitoring) with MOESDDBM (several times)
Nonphysical Measure	- Capacity development for the beach conservation planning taking into account the integrated characteristics of littoral movement (enhancing software skills) - To share the issues on coastal conservation and management at leased areas together with the C/P and related stakeholders and to examine the solution - Consensus building for integrated coastal conservation with relevant partners (lessees),. Also improvement of skills for the C/P and related stakeholders on consensus building based on a technical background.	➢ Conduct the Technical Committee Meeting (TC) and individual working session to discuss issues, possible measures on coastal conservation. ➢ Joint field observation to check the current condition (several times) ➢ Joint survey (establishment of fixed points, beach profile survey) ➢ Individual discussion with related lessees ➢ Guideline preparation on coastal conservation
Continuous Monitoring	- Data accumulation for beach and reef monitoring to be utilized for coastal conservation planning and management hereafter. - Enhance the knowledge on coastal engineering to know the short and long term beach change though monitoring. - Technical transfer and capacity development for beach monitoring, data processing and data archive method.	➢ Joint site investigation (several times) ➢ Joint survey (establishment of fixed points, beach profile survey) (Figure 8.2.1 (4)) ➢ Technical guidance for data processing and evaluation ➢ Joint monitoring for water quality and coral reef in cooperation with MoF and MOI ➢ Technical guidance and training for survey equipment (auto level, total station)

Source: JICA Expert Team

(1) Joint site investigation (Grand Sable)

(2) Technical guidance for wave-current recorder

(3) Joint field work for installation of wave-current recorder

(4) Joint beach profile survey

Source: JICA Expert Team

Figure 8.2.1 Example for Progress of Technical Transfer

8.3 Physical Measures in the Demonstration Project

8.3.1 Validity for Selection

a. Validity of Adopted Coastal Problems

Based on the discussion with C/P and related stakeholders, the coastal problems which were to be adopted as physical measures in the demonstration project were deemed to have to fulfill the following requirements. “The selected coastal problem were to be those identified as problems exposed at the public residential areas (uncommitted areas), and problems with the potential of increased risk due to future climate change expectations.”

The coastal problems in Mauritius are mainly divided into two issues, which are 1) wave overtopping and flooding due to high wave strikes at the low elevation hinter area, 2) beach erosion and resulting retreat at sandy coasts. The former is identified mainly at public residential areas (uncommitted areas), and the latter is identified mainly at beach resort areas, consisting of lease areas for hotels, private villas, etc., and public beach areas. Figure 8.3.1 shows the coasts at public areas which have the coastal problems of wave overtopping and flooding. Figure 8.3.2 shows the elevation of the coastal road at each coast. As shown in these figures, such problems can be identified at several coasts in Mauritius. Based on these results, wave overtopping and flooding due to high wave strikes were regarded as the coastal problems for the physical measures, and the same opinion from the Mauritian side was also confirmed.

① Le Morne

② Baie du Cap

③Pointe Citronniers

④Bois des Amourettes

⑤ Pointe des Bambous

⑥ Quatre Soeures

Source: Location Map: Arranged by JICA Expert Team based on Google Map, Photos: JICA Expert Team

Figure 8.3.1 Coasts which have Wave Overtopping and Flooding Problems

No	Coast	Elevation (MSL)	Planning / Construction of Coatsal Protection Measures by MoESD
1	Quatre Soeures	2.1	Under construction
2	Grand Sable	1.59	Implemented at some area
3	Pte. Des Bawbous	2.45	
4	Bois des Amourettes	1.73	
5	Pomponnette	1.95	
6	Riviere des Galets	2.6	
7	Baie du Cap	1.27	Implemented at some part
8	La Prairie	1.43	
9	Le Morne	2.93	Under planning

Source: Location Map: Arranged by JICA Expert Team based on the map received by MOESDDBM, Table: JICA Expert Team

Figure 8.3.2 Elevation of Coastal Road at Several Coasts

b. Validity of Selected Candidate Coasts

Grand Sable is the only coastline amongst the seven selected priority coasts that fulfills all of the above mentioned requirements, namely it is facing all of the above coastal problems. For the selection of a candidate coast regarding physical measures, it is required to fulfill not only measures from a technical point of view, but also from economical and social points of view.

The necessity and validity to select Grand Sable for the physical measures were examined based on four aspects, such as 1) necessity from geographical and coastal conditions, 2) demand and awareness of residents on coastal disasters due to waves, 3) necessity from socioeconomic conditions, and 4) possibility of other countermeasures except coastal protection measures

b.1 Necessity from geographical and coastal conditions

Figure 8.3.3 shows the coastal geography at Grand Sable. The coral reef exists at approximately 3 km in width at an offshore area, and a natural trench of more than 20 m deep exists at an inner side of the offshore reef. Figure 8.3.4 shows the long term shoreline change for 45 years from 1967 to 2012 at Area A, as indicated in Figure 8.3.4. No significant beach retreat was observed over these 45 years and slight accretion of the beach was observed at the vicinity of the southern cape, where the small river inflows. From the numerical analysis for the wave distribution which is described in the latter section, the transmitted waves near the coast become too small relative to the offshore waves. As a result, the predicted wave height near the coast is almost the same level as the wave height for wind waves generated inside the lagoon. Figure 8.3.5 and Figure 8.3.6 show the current conditions of the coast at Area A, and the ground elevation at the seaside edge along the coastal road. There was not sufficient space between the coastal road and the coast observed, and the ground elevation at the lowest position is about MSL+1.6m. Here, the datum line (D.L.) in Mauritius for the bench mark on land, which was established by MoHL (Ministry of Housing and Lands), took the Mean Sea Level (MSL). According to this definition, the mean high water spring tide (HWL) is MSL+0.5m, and the mean low water spring tide (LWL) is MSL-0.3m. From the results of an interview survey to the residents, storms have caused wave overtopping on the coastal road at

some locations in the past. The calculated wave run-up under the design wave conditions with a 30-year return period was also described in Figure 8.3.6. The run-up height at some parts of south area are higher than the ground elevation of the coastal road, and the risk for coastal disaster will increase in accordance with the increase of seawater levels and wave energy due to climate change.

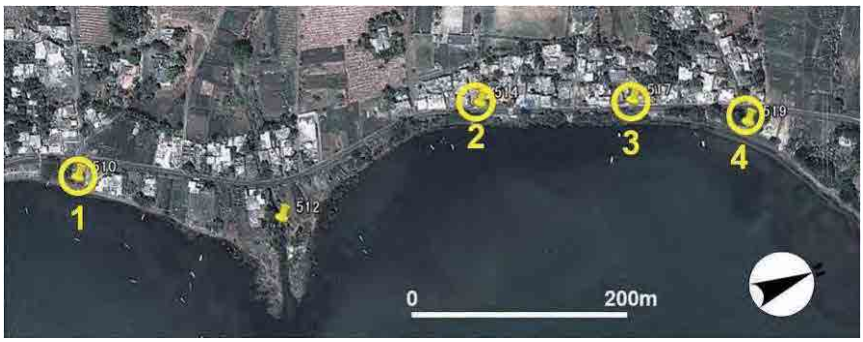
As a result, the necessity to undertake coastal measures at Grand Sable was shown from the expected natural conditions and current coastal conditions.

Source: Arranged by JICA Expert Team based on Google Map

Figure 8.3.3 Coastal Geographical Condition at Grand Sable

Source: JICA Expert Team based on Google Map

Figure 8.3.4 Long Term Shoreline Change at Area A between 1967 (left) and 2012 (right)



Point1: MSL+2.0m

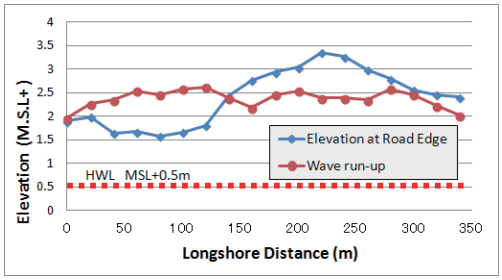
Point 2: MSL+1.6m

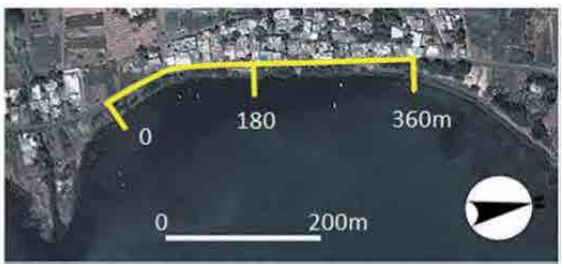
Point 3: MSL+3.0m

Point 4: MSL+2.4m

Source: Upper: Arranged by JICA Expert Team based on Google Map, Lower: JICA Study Team

Figure 8.3.5 Current Condition at Area A



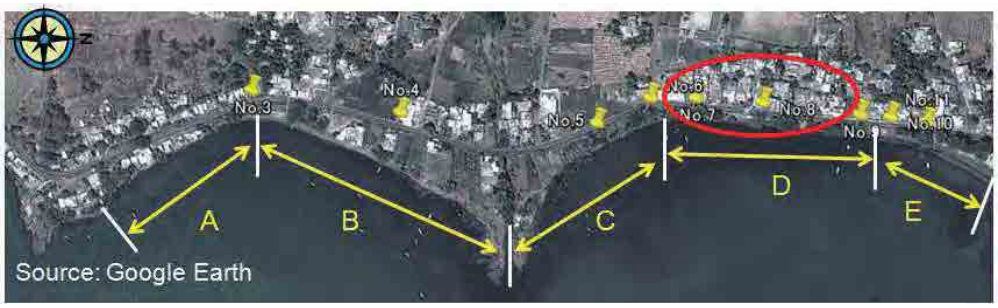


Source: JICA Expert Team

Figure 8.3.6 Ground Elevation and Calculated Wave Run-up at Area A

b.2 Necessity from awareness of residents for coastal disasters

The interview survey was carried out by the C/P and JICA Expert Team together at Grand Sable to grasp the awareness of coastal disasters, information of previous coastal events such as wave overtopping, flooding, etc. and requests for coastal protection from the residents. The results show in Figure 8.3.7. A lot of people who answered that wave overtopping occurred in the past were identified at Area D in Figure 8.3.7. This result well meets with the geographical condition of Area D, where the ground elevation is the lowest in this area. The high demand from the residents for coastal protection was also identified from the results of



Question	Area A	Area B	Area C	Area D	Area E
Wave overtopping occurred in the past	17/50 (34%)	15/50 (30%)	21/50 (42%)	27/50 (54%)	24/50 (48%)

Question	Absolutely	Necessary	Ordinary	Not necessary	No need
Necessity for coastal protection	43/50 (86%)	5/50 (10%)	0/50 (0%)	1/50 (2%)	1/50 (2%)

Source: JICA Study Team

Figure 8.3.7 Summary for the Result of Interview Survey

the interviews.

b.3 Necessity from economical point of view

The necessity from an economical point of view was examined from the following two aspects, ①function of the coastal road, and ②conservation of asset in the hinter areas. Figure 8.3.8 shows the relation of the location between Grand Sable and representative resort areas in Mauritius. The high class resort areas which are Ile Cerfs and Belle Mare exist at the northeast area. The coastal road at Grand Sable is being utilized as an access road from the airport to these areas. The coastal road has also been highly utilized for transportation of sugarcane products as well as providing residents access to public transportation.

As shown in Figure 8.3.7, a residential area is concentrated just behind the coastal road, and the elevation at some parts of the residential area is almost the same as that for the coastal road. Based on this information, the necessity for coastal protection from an economical point of view was validated.

b.4 Other possibility of measures besides coastal protection measures

Other possible measures for the prevention of wave overtopping besides coastal protection measures were examined. Different measures include 1) raising the coastal road and 2)

resettlement. Here, no future development plans for the coastal road or residential area was planned in this area.

1) Possibility of raising the coastal road

Up to now, the basis of the coastal protection projects, the elevation of the existing coastal road, has already been carried out by MOESDDBM at some areas in Grand Sable. Furthermore, the elevation at the hinter residential area at some areas is almost the same as that of the coastal road as shown in Figure 8.3.9. Thus, the idea of raising the coastal road is not realistic considering these conditions.

2) Possibility for Resettlement

Figure 8.3.10 shows the geographical condition at the hinter area. As shown in this figure, the back area from the residential area to the mountain side mostly belongs to the steep slope area, and it might be difficult to look for a suitable area for resettlement.

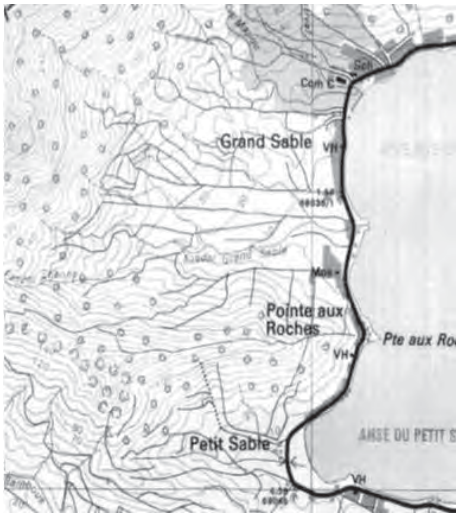
As a result, we concluded that the possibility to employ other measures besides coastal protection measures is unrealistic.

Source: JICA Expert Team

Figure 8.3.8 Relation of the Location between Grand Sable and Beach Resort Area

Source: JICA Expert Team

Figure 8.3.9 Coastal Road and Hinter Area



Source: Purchased from MoHL

Figure 8.3.10 Geographical Condition

8.3.2 Principle for Selection of Construction Method

The following principles were established for the selection of construction methods of coastal protection measures on the projected site.

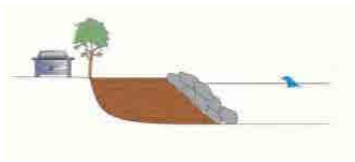
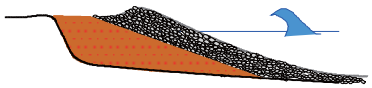
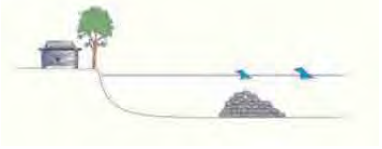
- It needs to have flexibility for modification regarding uncertain factors related to climate change.

- The method needs to adhere to the concept of eco-friendly as well being functional for coastal use as one of the general ideas of coastal protection in Mauritius. However, revetment construction as a coastal protection measure against high waves and wave over-topping is common in Mauritius.

- The idea of regenerative design needs to be sustained with a focus on future project implementation by Mauritius. Therefore the proposed method should be implemented with available materials in Mauritius and it should be economically efficient. Additionally, no specialized and difficult methods should be proposed

Table 8.3.1 illustrates the comparison of three imaginable construction methods. Based on the comparison table, the flexible revetment with gravel is the appropriate construction method in accordance with the principles mentioned above and it is proposed as a coastal protection measure against high wave and wave over-topping in the target site.

Table 8.3.1 Comparison of Imaginable Construction Methods

	Rock Revetment		Flexible Revetment		Breakwater（Submerged）	
Image						
General	A common method applied in Mauritius. The Structure is composed of rocks installed along the coast.		A mass of gravels creates gentle slope with flexible modification of its shape on coast.		A submerged structure off-shore to reduce wave energy.	
Disaster Prevention	Effectiveness for disaster prevention is ensured.	○	Effectiveness for disaster prevention is ensured.	○	Effectiveness for disaster prevention is ensured.	○
Environment Landscape	Steep slopes have some impact on environment and landscape.	△	Gentle slopes ensure accessibility to the beach for people as well as fishermen's' boats.	○	It could have some negative impact on the reef environment and landscape, whereas the landscape on the landside would not have any dynamic changes.	△
Usage	Coastal usage will decrease due to the steep slope and slipway functions will not be ensured.	△	Accessibility to the sea as well as from the sea for fishing boats is ensured due to the gentle slope.	○	No change for coastal usage will be expected. This will not help with regard to the required slipway functions.	△
Applicability to Mauritius	It is difficult to apply mitigation measures for climate change. Additionally the design of the current facility seems inappropriate as it is over specification.	△	It envisions low construction cost and high applicability to climate change as well as to other coasts.	○	No projected construction plan has been conducted in Mauritius. Construction cost is high due to the working environment of offshore sites.	△
Total Evaluation	Low priority because of poor usage, environment and landscape evaluations.	△	It is superior for usage, economic and applicability reasons. It is appropriate for the demonstration project.	○	At the current technical level in Mauritius it would be difficult to construct projects and apply it to other sites. It is not appropriate for the demonstration project.	△

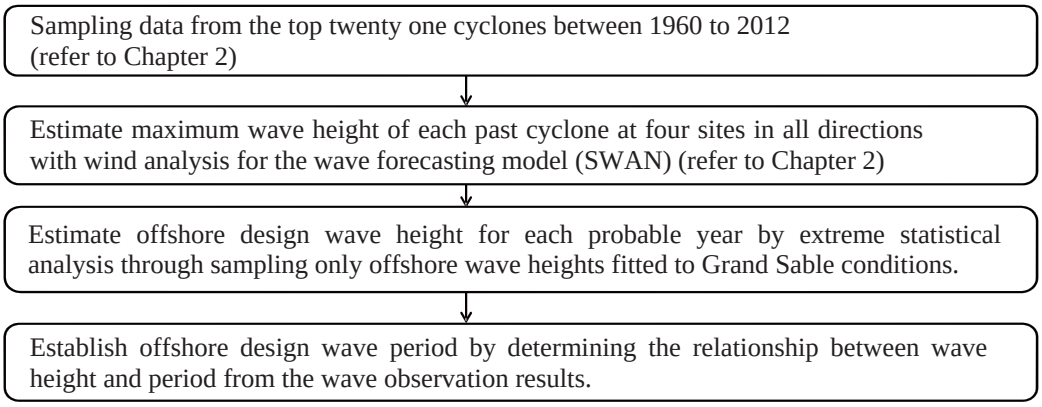
Source：JICA Expert Team

8.3.3 Design Condition on External Forces

Three categories of the design condition on external forces are established as 1) Offshore design waves, 2) Design tide level and 3) Design waves for coastal facilities.

a. Calculation of offshore design waves by wave forecasting model

As described in Chapter 2, the offshore design waves and design waves for coastal facilities have not been determined in Mauritius. The JICA Expert Team conducted the wave forecasting by numerical approach using the numerical atmospheric pressure and past cyclone routes and the extreme statistics analysis for the offshore design waves at Grand Sable. The flow chart for the determination of design offshore waves is shown in Figure 8.3.11.



Source：JICA Expert Team

Figure 8.3.11 Procedure of Offshore Design Wave Height with Wave Forecasting Model

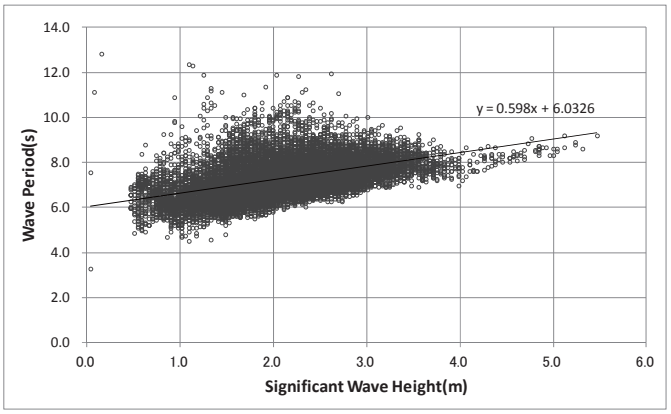
Table 8.3.2 shows the calculated wave height with each return period by extreme statistics analysis, using the sampled twenty-one offshore wave height data through estimation of offshore wave directions at Grand Sable.

Table 8.3.2 Estimated Offshore Wave Height with Each Return Period for Each Offshore Wave Direction

Offshore Wave Direction	**S**		**SSE**		**SE**		**ESE**		**E**	
Return Period	**H_0(m)**	**T_0(s)**	**H_0(m)**	**T_0(s)**	**H_0(m)**	**T_0(s)**	**H_0(m)**	**T_0(s)**	**H_0(m)**	**T_0(s)**
5years	4.3	8.6	4.8	8.9	4.9	9.0	4.8	8.9	4.2	8.5
10years	7.2	10.4	7.3	10.5	7.3	10.5	7.3	10.4	6.9	10.1
20years	9.3	11.6	9.4	11.6	9.2	11.5	9.2	11.5	9.1	11.5
30years	10.3	12.2	10.3	12.2	10.1	12.1	10.1	12.1	**10.3**	**12.2**
50years	11.4	12.9	11.4	12.9	11.2	12.7	11.2	12.7	11.7	13.0
100years	12.8	13.8	12.7	13.7	12.5	13.5	12.5	13.5	13.5	14.1

Offshore Wave Direction	**ENE**		**NE**		**NNE**		**N**	
Return Period	**H_0(m)**	**T_0(s)**	**H_0(m)**	**T_0(s)**	**H_0(m)**	**T_0(s)**	**H_0(m)**	**T_0(s)**
5years	3.3	8.0	2.8	7.7	2.9	7.8	2.3	7.3
10years	5.9	9.6	5.4	9.2	4.8	8.9	4.7	8.9
20years	8.5	11.1	8.0	10.8	7.1	10.3	7.2	10.3
30years	10.1	12.1	9.5	11.7	8.6	11.2	8.7	11.2
50years	12.0	13.2	11.5	12.9	10.7	12.4	10.5	12.3
100years	14.7	14.8	14.1	14.4	13.7	14.3	12.9	13.8

Source: JICA Expert Team

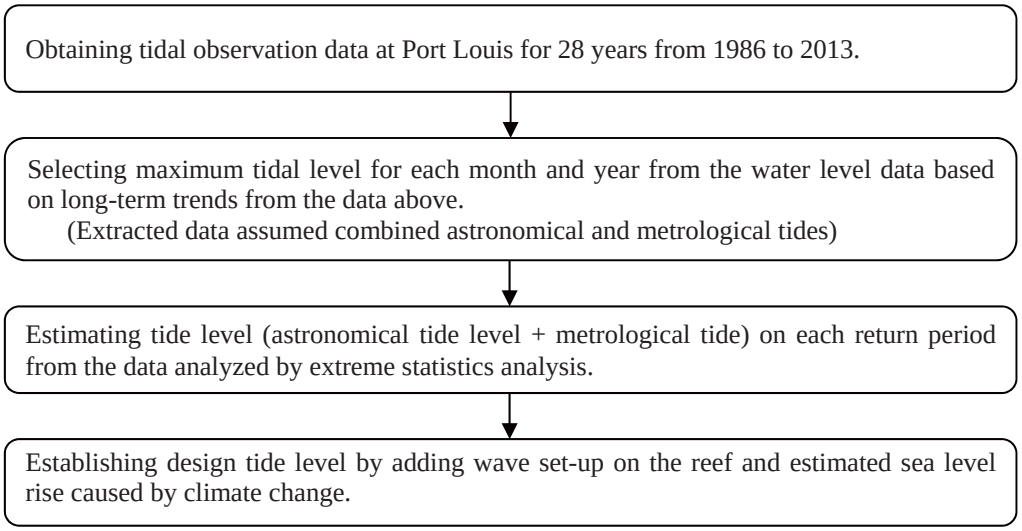


Source：Data from MOI modified by JICA Expert Team

Figure 8.3.12 Relationship of Wave Height and Period from Observation Results Offshore of Blue Bay

b. Design Tide Level

Design tide level is established under the procedure as shown below.



Source: JICA Expert Team

Figure 8.3.13 Procedure of Establishment of Design Tide Level

As described in Chapter 2, the sea level rise of 3.9mm/year has been determined from the tidal observation for the past 28 years at Port Louis. After omitting the values through the long term trend, the results of extreme statistical analysis are shown in Table 8.3.3. The tide level with a return period of 30 years was taken as a design tide condition for wave calculation.

The long-term tide observation data could be obtained only at Port Louis. However, there is another tide observation at Blue Bay. Some differences on tide fluctuation were identified between the two stations. It is recommended to add the tide station in Mauritius to clarify the difference of tide conditions for planning and designing of coastal measures.

Table 8.3.3 Design Tide Level of Each Return Period

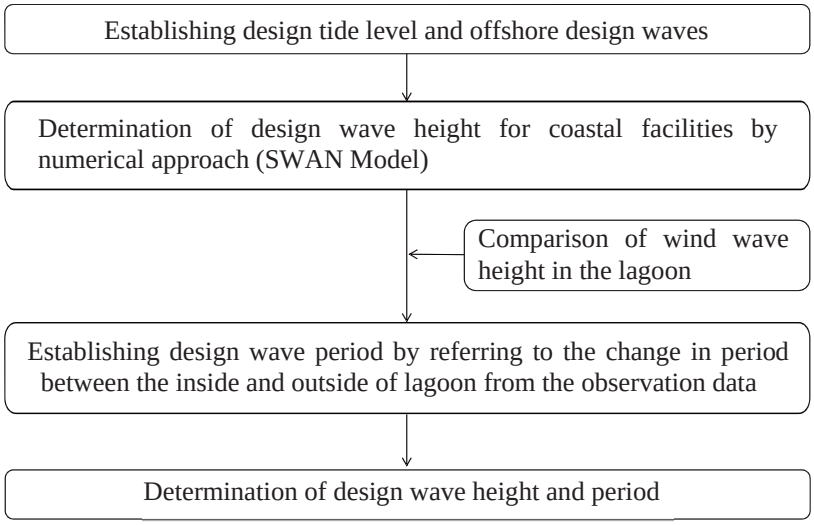
Return Period (year)	Astronomical and Metrological Tide Level		Sea Level Rise (3.9mm/year)	Wave set-up (estimated based on numerical result)	Design Tide Level	
	(ACD)	(MSL)			(ACD)	(MSL)
5	0.94	0.57	0.02	0.30	1.26	0.89
10	0.98	0.61	0.04	0.42	1.44	1.07
20	1.02	0.65	0.08	0.50	1.60	1.23
30	1.04	0.67	0.12	0.55	1.71	1.34
50	1.06	0.69	0.20	0.61	1.87	1.50
100	1.09	0.72	0.39	0.68	2.16	1.79

Source: JICA Expert Team

c. Design Wave Height for Coastal Facilities

Design waves for coastal facilities are established by the following the procedure. Table 8.3.4 shows the design condition for numerical wave calculation (SWAN). Figure 8.3.15 illustrates

the distributions of calculated wave height and direction, and wave set-up.



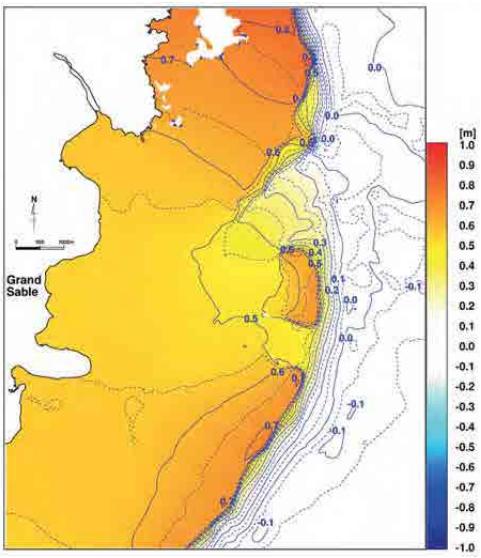
Source: JICA Expert Team

Figure 8.3.14 Procedure of Design Waves for Coastal Facilities

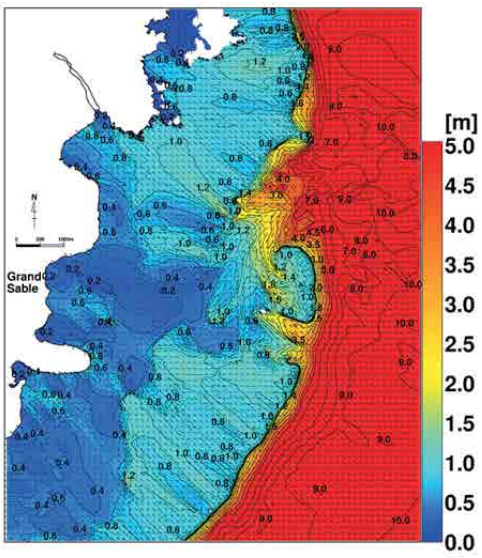
Table 8.3.4 Calculation Condition for Wave Calculation using SWAN

Design Condition	Set-up Value or Description about Consideration	Remarks
Offshore wave height, period, wave direction	16 directions in 30 probable years shown on Table 8.3.2	Applied6 directions from NE to SSE
Tide Level	CD+1.04m (MSL +0.67)	Tide level with return period of 30 years
Wave Attenuation by Seabed Friction	Not taken into account	Design safety side
Wave Set-up	Taken into account	
Growth of wind waves in the lagoon	Not taken into account	Compare additional wind wave analysis

Source: JICA Expert Team



Distribution of wave-setup
(ESE：30 years return period)



Distribution of wave height and direction
(ESE：30 years return period)

Source: JICA Expert Team

Figure 8.3.15 Calculated Wave Height and Wave Set-up

- The wave height for coastal facilities will dramatically decrease to approximately 0.4m (4% of offshore wave) due to the impact of refraction and breaking waves from the existing reef. In the meantime, the study found that the wave height for coastal facilities can be set to 0.4 m since the estimated wind wave height that occurred in the reef was almost the same height.

- The wave period inside the reef commonly decreases due to wave breaking at the reef edge. According to wave observation data conducted offshore in Blue Bay by MOI as well as research from a reef at Pte. d'Esny, it was confirmed that the offshore wave period in the reef area is from 0.4 to 0.6 times. Based on this result, the design wave period was set at eight seconds.

8.3.4 Basic Design

a. Layout Arrangement

a.1 Scope of Projected Site

The scope of the projected site covers an area of high risk from wave overtopping and flooding at Grand Sable under the conditions described below.

1) Area where dense residential housing is located on the land side of the coastal area

2) Area with low elevated roads

3) Area which has a limited buffer area between the coast and residential areas

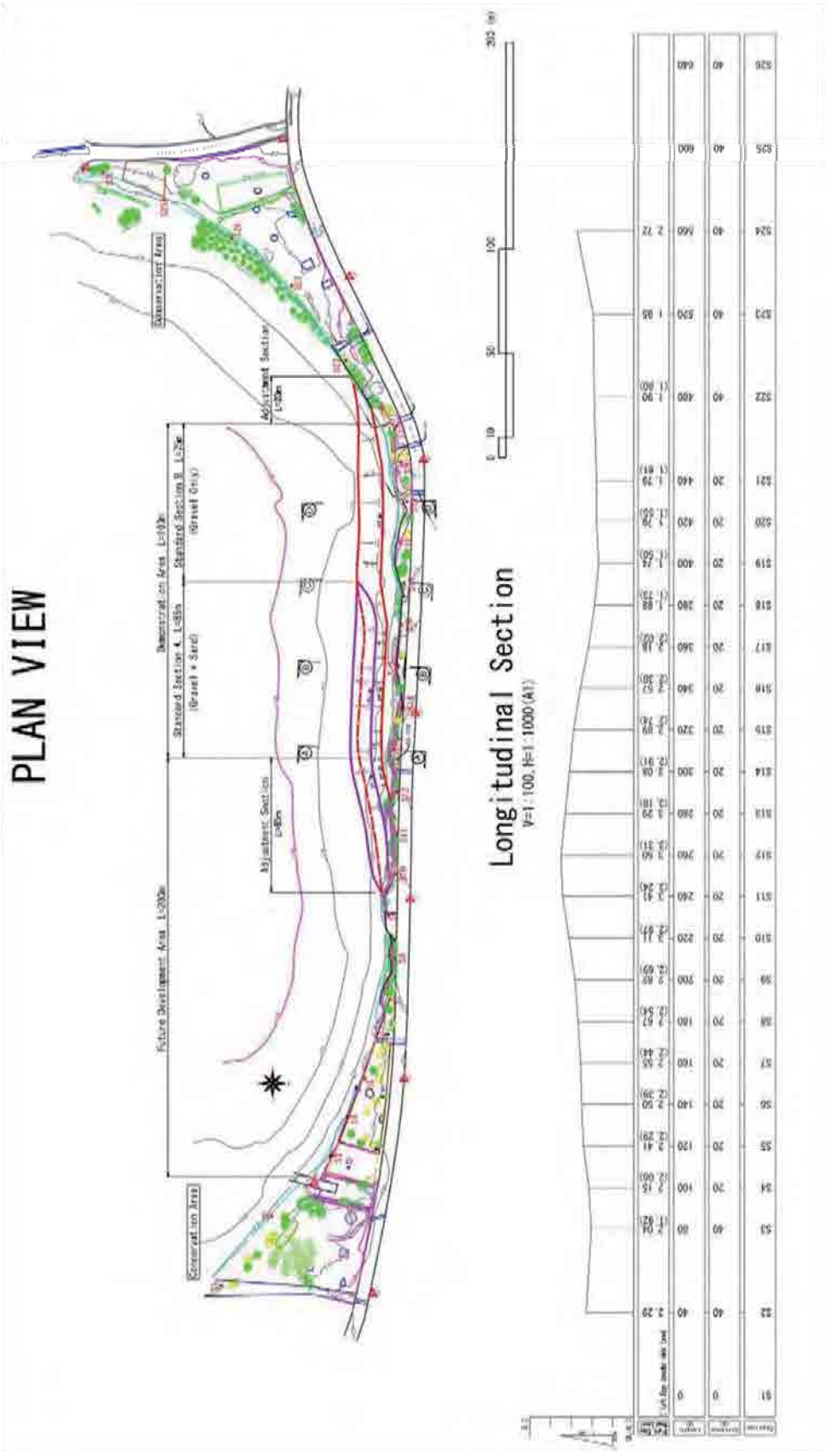
a.2 Graduated Slopes on Both Ends of the Revetment

Considering wave characteristics and the possibility of future extensions by the Mauritian Government, there was initially a general policy of not building any slope structures (namely slopes to blend in with the surrounding coastline) on the ends of physical structures (revetments). However, in order to minimize the movement of nourished materials to the surrounding area due to sudden topographical changes, gentle slope gradients and smooth alignment of coastal lines for flexible revetments are facilitated. Moreover, considering the existing coastal geographic conditions, gently sloping ends of 40 m at the northern and 10 m at the southern ends of the revetment are considered to be constructed.

a.3 Alignment of the New Coastline

The current topography of the coastal lines in the projected site is not uniform and uneven in shape. Therefore it is necessary to consider aligning the new coastlines to make them uniform with the natural (stable) state of the coastline in question. The purpose of which is to minimize partial deformation caused by concentration of wave energy due to local alignment changes.

In terms of the scope of the projected site, it has been designated through discussion with the C/P and other related stakeholders of Mauritius through consensus building with the residents. As a result, the projected site has been identified and chosen. The section is approximately 190 m from the existing bus stop from the south to north as shown in Figure 8.3.16. (when sloped ends are included, it is approximately 240 m)



Source: JICA Expert Team

Figure 8.3.16 Plan View

b. Consideration Points for Sectional Design

Based on the results of the interview survey with the residents and the discussion results with the C/P and related stakeholders, it was necessary to consider the items below for the sectional design of the flexible revetment.

b.1 Establishment of appropriate crest height to ensure the drainage function in heavy rain

Since the hinterland is relatively steep, a large amount of rain water is discharged to the sea side in the heavy rain. Along with the problem of wave overtopping from the sea side, the residents raised concerns about the side effects of storm water runoff from heavy rain. Therefore, the section and crest height of the revetment need to be appropriately designed so as not to interfere with the current drainage system. In other words, it is necessary to minimize the raise the elevation of the crest height so as not to decrease the existing drainage function.

b.2 Use of materials and the section considered in harmony with the natural environment and landscape

Based on one of the basic policies, a friendly construction method in harmony with nature that utilizes materials available from adjacent regions to the projected area is the basic idea of the construction. Also an appropriate width and gradients are designed with close consideration for existing coastal conditions and refer to the section of similar shaped coasts. In addition, for the gravel and rock sand, the revetment is comprised of low cost and easily procured inland materials, as opposed to high cost and valuable materials such as those that originate from coral.

b.3 Consideration of current beach use, especially fishing boat landing

Fishery activities currently exist in this area. The beach area is utilized as mooring spaces and fishing boats landings. So as not to hinder the coastal use of this area, a section with appropriate gradient slopes is proposed. For this reason, this project mixture of gravel and rock sand is used for the main body of revetment. Additionally, two types of sections, gravel and gravel and rock sand, are applied to the revetment to compare the differences between these two types sections.

c. Design Condition and Required Function

The crest height and width for the flexible revetment is set to ensure that the predicted wave run-up doesn’t exceed the existing elevation of the coastal road. The calculation of wave run-up is conducted using a virtual gradient method proposed by Nakamura (1972). The design condition for wave run-up is shown on Table 8.3.5. As a required function, the design height (H=0.4m) at the place where the road elevation is MSL +1.6m doesn’t run-up under the design tide condition of MSL+1.34m.

Table 8.3.5 Design Condition

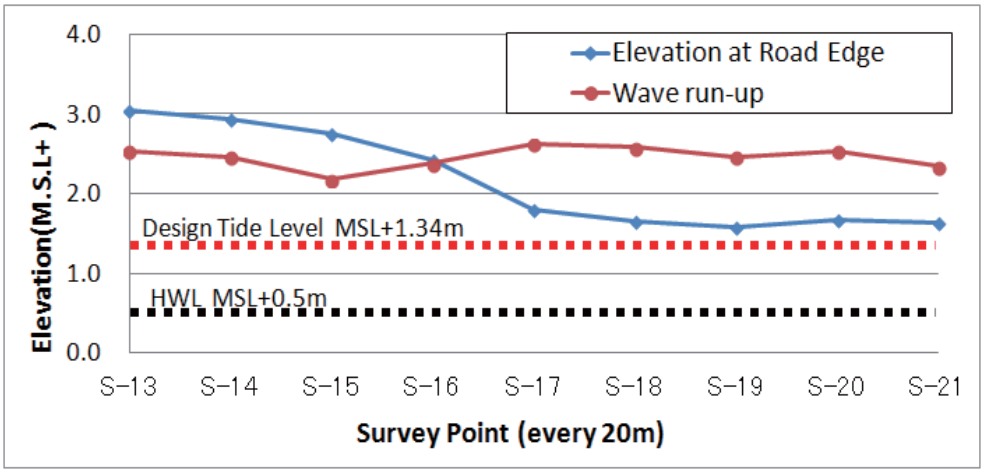
Profile	Design Condition	Remarks
Tide level with return period of 30 years (a)	MSL+0.67m (CD+1.04m)	From extreme statistics analysis using tidal data for 30 years (refer to chapter 2, 2.2.3)
Wave set-up (b)	0.55m	From calculation result for design wave height with return period of 30 years
Predicted Sea level rise (c)	0.12m	0.39mm/year×30years
Design tide level	MSL+1.34m (CD+1.71m)	= (a) + (b) + (c)
Design wave height $(H_{1/3})_{30yrs}$	0.4m	Wave height with return period of 30 years
Design wave period$(T_{1/3})_{30yrs}$	8.0 s	
Topography		Survey results on August 2013

Source：JICA Expert Team

d. Sectional Design

d.1 Crest height

Figure 8.3.17 illustrates the relationship between estimated wave run-up under the conditions of Table 8.3.5 and elevation at the edge of the coastal road in the demonstration project area. It is inferred from the calculation of the wave run-up that it will be raised about +2.5 m MSL from the current state. Basically the higher the elevation of the crest and the wider the crest width is, the more the wave run-up decreases. However, it is important to consider not only the functional point of view, but also beach utilization for the determination of crest height. Moreover, from the results of the interview survey from the residents, floods from running water from the hinterland due to heavy rain has been reported. Therefore, the crest height is set as MSL+2.0m at the seaside edge of the crest so as not to interfere with the existing drainage systems.



Source：JICA Expert Team

Figure 8.3.17 Elevation at Edge of Coastal Road and Calculated Wave Run-up

d.2 Crest Width

The crest width was examined to ensure the wave run-up was kept lower than the set crest height (MSL+2.0m) using a virtual gradient method described above. Based on the analysis,

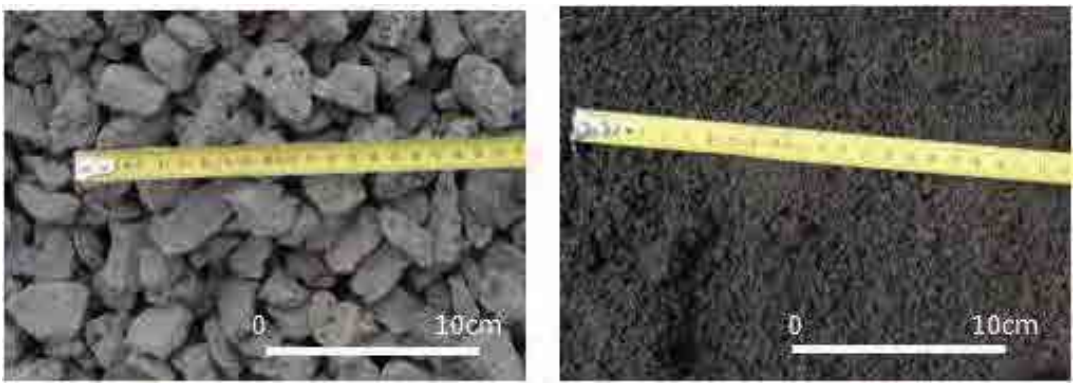
in order to satisfy its predetermined function, it is found that the crest width needs to be more than 7.6 m. Taking into account the deformation of the section due to wave action, the crest width is set to be more than 10 m from the road edge.

d.3 Slope Gradient

Based on other examples and research works of flexible revetments, it is generally known that the gradient of gravel beaches reach levels from 1:3 to 1:5. In this project, the gradient of the flexible revetment is set out about 1:5.After referring to other similar gravel coasts in Mauritius, this was seen as a stable gradient level. Additionally the gradient of the section which used mixed materials of gravel and rock sand in the comparison study was set to about 1:8 by referring to other similar coastal conditions in Mauritius.

d.4 Specification of Gravel and Sands

Considering the applicability of construction in Mauritius, it is recommended that a large amount of the materials, gravel and rock sand be prepared easily at a low cost. Different from white sand originated from coral which can be seen at other resort areas, the projected coast is comprised of dark colored sand. Therefore, there is no restriction against protection of the existing landscape in terms of material colors. For the flexible revetment material, crushed basaltic rock is applied as an easily provided, low cost gravel. The size of gravel is set out as 10 to 30 mm, and 2 to 4 mm for rocksand based on the available side of existing stonecrushing plants. Figure 8.3.18 illustrates photos of materials, gravel and rock sand for the Project.



Source：JICA Expert Team

Figure 8.3.18 Gravel and Rocksand for the Construction

Source：JICA Expert Team

Figure 8.3.19 Existing Drainage (left: near Section S19, right: near Section S20)

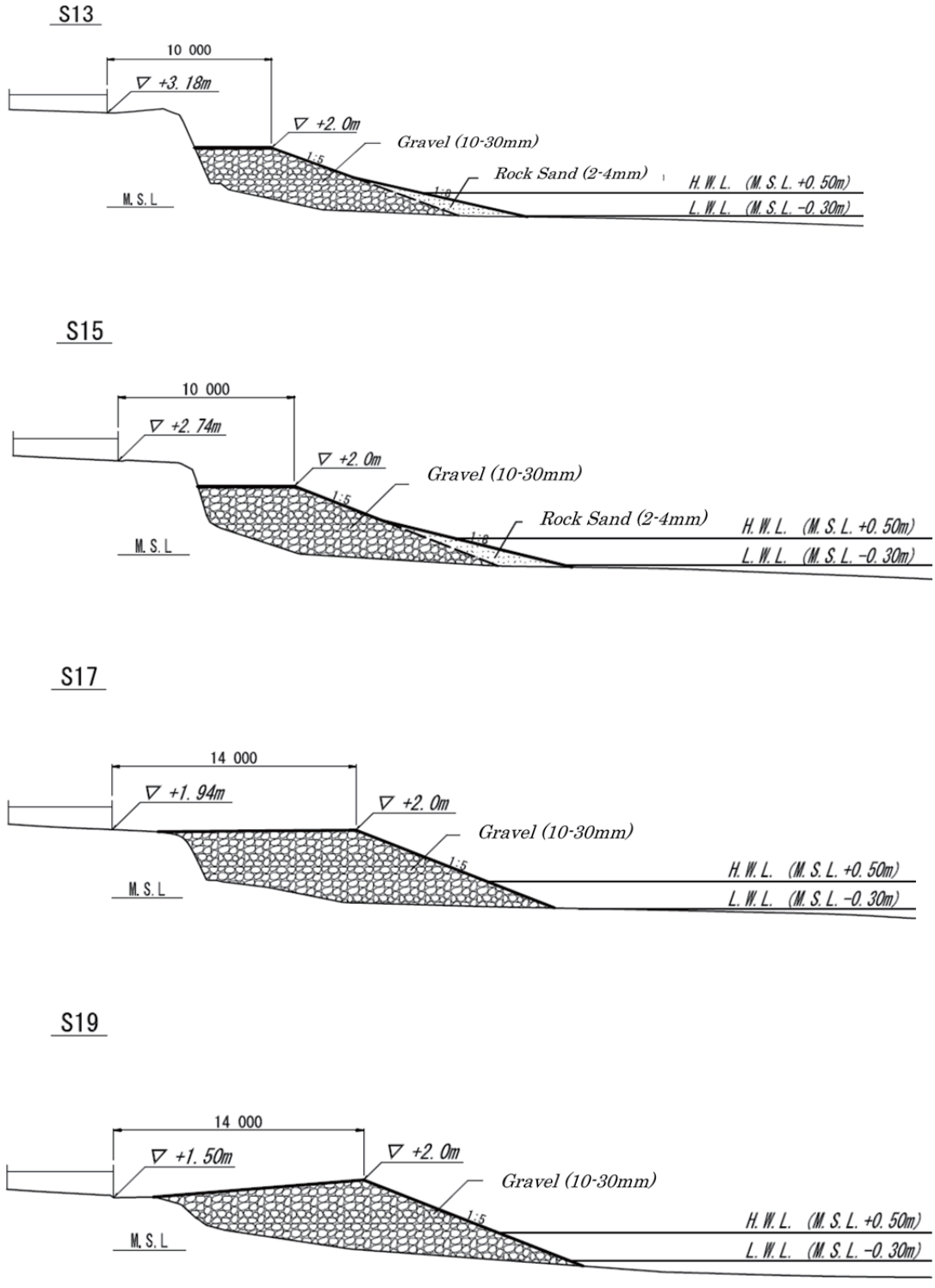
d.5 Extension of Existing Drainage

With the waterfront line stretching in the direction off the coast, existing drainage as shown in Figure 8.3.19 is set to be extended in length (eight in total for Grand Sable, four locations in the demonstration project section). The extension work is conducted by connecting new Hume concrete pipes to the existing drainage and installing the pipes in the section of the flexible revetment. The inside diameter of the pipe is the same or larger than a real section of existing drainage and can be selected from the size of a pre-cast concrete pipe. Three of the extended pipes sized at 533 mm of inside diameter for two locations and 685 mm for one location in the demonstration project area.

Figure 8.3.20 illustrates a single material section of gravel only as well as a mixed material section of gravel and rock sand. Other sections of detailed drawings can be referred to Appendix 6.4.1. Estimated required volume of both materials is shown below.

Gravel : 4600m^3

Rock sand : 340m^3



Source：JICA Expert Team

Figure 8.3.20 Typical Cross Sections

8.3.5 Consensus Building

a. Overview

Table 8.3.6 shows a summary of activities conducted to obtain residents' consensus on the basic plan of the Demonstration Project at Grand Sable.

Table 8.3.6 Summary of Activities for Consensus Building at Grand Sable

Activity	1. Interview survey for basic planning	2. First stakeholder meeting with residents' representatives	3. Second stakeholder meeting with whole residents
Date and Time	2013/6/26 (10:00～15:00)	2013/8/21 (15:00～16:20)	2013/9/16 (16:30～18:00)
Venue	Grand Sable	Grand Sable Community Centre	Grand Sable Community Centre
Participants from the Government and JET	ICZM Div. (4 members), JET(5 members)	MOESDDBM (4 members including Deputy Director) JET(1 member)	Ministers of Ministry of Foreign Affairs and MOESDDBM (20 members), JICA(1 member), JET(5 members), MBC
Participants from Grand Sable	Residents (50 households)	Residents' representatives (8 members including District Council and Village Council)	Residents (about 60 members)
Method of Implementation	Interview survey by ICZM Div. officers in Creole, supported by JET	Presentation by ICZM officer in Creole	To improve understanding for each other, presentation was conducted by JET in English then translated in Creole by ICZM officer to residents.
Objective	(1) Obtain basic information such as past coastal disasters and usage of coastal area to utilize it for basic planning (2) Improve residents' awareness of coastal conservation (3) Capacity development in interview survey for ICZM officer	(1) Grasp residents' opinion about the Project (2) Obtain basic consensus from representatives on the Project's objective (3) Identify the issues to be reviewed to obtain consensus from residents	(1) Obtain adequate understanding of Project's objective (2) Obtain consensus from residents on the Project's basic plan (3) Encourage residents to participate in coastal management
Materials	Questionnaire (Appendix 6.4.2)	Presentation materials (Appendix 6.4.2)	Presentation materials (Appendix 6.4.2)

Source: JICA Expert Team

b. Results of Activities

b.1 Interview Survey for Basic Planning

<Results and policy >

- Since more than 90% of residents answered that they strongly needed coastal conservation its high needs were confirmed at Grand Sable.
- "Damage by wave overtopping" accounts for a higher percentage among types of coastal disasters at Grand Sable. This verified the objective of the Demonstration Project, namely that there is a need for protection from wave overtopping.
- The Proposed Project area (i.e. lowest elevation area at Grand Sable) corresponded to the area that accounts for the highest percentage of residents who answered that damage by wave overtopping occurred. This showed the adequacy of the selected Project area.
- As for coastal functions, residents put high value on coastal environment and beach utilization as well as coastal protection. Therefore, it is confirmed that the proposed countermeasure (i.e. flexible revetment) would satisfy residents' requirement.
- Residents have a high awareness of waste problems at the coastal area and showed a willingness to participate in the coastal management activities.
- The basic Project plan will be finalized taking into account the results above and then it will proceed to the stakeholders meeting with residents.

Source: JICA Expert Team

Figure 8.3.21 Photos of Interview Survey

b.2 1st Stakeholder Meeting with Residents' Representatives

<Results and policy to next step>

- Residents' representatives basically agreed with the Project's plan. However, the following issues were raised; 1) maintenance of the bus stop area where the foundation had eroded and 2) plantation and car parking space at the Project area.
- According to the demands above, it seemed that their understanding of the Project's objective (i.e. examine the effectiveness of countermeasures) was not satisfactory. Therefore, to build consensus with residents, clarification of the Project's objective would be mostly focused on in the next meeting (i.e. 2nd stakeholder meeting).
- Participants of 2nd stakeholder meeting will invite all the residents at Grand Sable to obtain final consensus with them.


Source: JICA Expert Team

Figure 8.3.22 Photos of 1st Stakeholder Meeting

b.3 2nd Stakeholder Meeting with whole Residents

<Results>
The residents fully agreed to the Project's objective and basic plan (i.e. countermeasures, cross section, materials, and Project area). In addition, residents showed a willingness to participate in coastal management activities at Grand Sable cooperating with MOESDDBM and JET.


Source: JICA Expert Team

Figure 8.3.23 Photos of 2nd Stakeholder Meeting

<Important questions and answers related to consensus building>

Q1. There is limited land space at Grand Sable. So, is it possible to include supplementary facilities at the Project area; kiosks, benches, car parking space and vegetation?

A1. The Demonstration Project is an experimental project to propose new nature-friendly conservation methods in Mauritius and to examine the effectiveness of the countermeasures. Therefore, building such facilities is not planned considering the Project's objective. If the effectiveness is confirmed, however, those facilities can be accompanied with the flexible revetment.

Q2. Can the Project's area cover the whole coastal area at Grand Sable?

A1. The Project's area is designed to protect wave overtopping that is mostly anticipated at Grand Sable with consideration of future climate change. The north end of the area is set around the bus stop area. This proposed area fully covers vulnerable areas against wave overtopping and the other areas with higher elevation have less chance of wave overtopping. If the effectiveness is confirmed, however, the Project's area can be extended to the whole coastal area at Grand Sable.

Q3. Considering the projected layout of Project area, we anticipate waste accumulation and concentration of waves at the edge of the Project's area.

A3. One of the most important concepts of the Project is "restoring nature". For example, rock revetment that is common in Mauritius can make wave conditions worse by reflection. On the other hand, the flexible revetment can absorb wave energy like a natural beach does and minimize wave reflection as well. Therefore, we don't expect any major negative impact caused by construction at this moment. Even though we must admit there is some room of uncertainty because this is a matter of nature. Thus, we plan to conduct continuous monitoring after construction to check if any negative impact occurs and to evaluate it with residents and MOESDDBM.

8.3.6 Environmental and Social Consideration (EIA Study)

a. Role of EIA in Demonstration Project

MOESDDBM informed the JICA Expert Team that scales of the projects were used as the criteria for the decision on whether their implementation requires an EIA or PER (preliminary environmental report) study.

Implementation of a MOESDDBM project requires either a PER or an EIA study. However, since such a project is assessed and implemented by the same body, no permit will be issued. Since the JICA Expert Team was to implement the physical demonstration project, the team decided to implement an EIA in accordance with the JICA guidelines, in principle. The team designed the EIA study in such a way that it also satisfied the requirements of the EIA study of Mauritius.

It generally takes three to four months to complete the EIA procedures. However, implementation of public projects is approved in a shorter period of time (approx. one to two months). The EIA study for the demonstration project began in early August. A public consultation was held in early September. The EIA report was prepared and approved after the TC meeting in mid-September. The following is the outline of the report. The EIA report on the demonstration project is shown in Appendix 6.4.3.

b. Outline of EIA Study

b.1 Outline of the Project

b.1.1 Environment around the Project Site

The site for the demonstration project is located in Grand Sable. Grand Sable is located on the southeastern coast of Mauritius. Its population as of July 2011 was 2,215. Most of the houses in Grand Sable stand along the coastal road on the inland side. Beach cliffs with a height of 2 m or more are found along the shoreline. Most of the disasters along the coastal road are caused by wave overtopping from high waves caused by cyclones.

b.1.2 Outline of the Project

The JICA Expert Team prepared a plan for the demonstration project after having studied various alternative structural measures with the assessment of those measures not only on economic and technological grounds but also on environmental and social effects and impact.

The team decided to implement the structural measure mentioned below in the demonstration project.

A flexible seawall (the total length assumed at the time of the EIA study was approx. 160m, of which a 75 m part has a gravel cross-section. The remaining 85 m part has a sand/gravel cross-section.)

b.2 Baseline Survey for EIA

Since the scale of the structural measure taken in the demonstration project is relatively small, it is unlikely to have any impact on the environment. However, since there is a possibility that it may have an impact on part of the marine environment, a baseline survey was conducted on the following subjects.

Table 8.3.7 Subjects of Baseline Survey for EIA

Survey Subject		Survey Method
Physical Environment	Meteorological phenomenon	Analysis based on the collection of existing materials
	Hydrographic phenomenon	Analysis based on the collection of existing materials
Natural Environment	Coastal bottom material（grain size）	Field survey
	Coastal topography	Field survey
	Bottom topography（bathymetry）	Analysis based on the collection of existing materials
	Water quality	Field survey
	Marine ecosystem（sea grass, coral reef, benthos, etc.）	Field survey
	Coastal vegetation	Field survey

Source: JICA Expert Team

b.3 Scoping

This section describes the main environmental and social impact items expected for the implementation of the demonstration project, degrees of these impacts, and proposals of mitigation measures, which are summarized in the table below.

Table 8.3.8 Expected Environmental Impact Items

During Construction	Assessment	After Construction	Assessment
Air Quality	B	Topography and Geology	C
Noise and Vibration/Traffic	B	-	-
Water Quality	B	-	-
Fauna and Flora /Biodiversity	B	Fauna and Flora /Biodiversity	D

Source: JICA Expert Team

Note: A: Serious impact is expected.
B: Some impact is expected.
C: Unknown (must be examined.)
D: Little impact is expected. (Not covered by FA/EIA)

b.4 Main socio-environmental impacts and measures to alleviate the impacts

The following are the measures to be taken when it becomes necessary to alleviate the above-mentioned socio-environmental impacts.

Air Quality

Generation of dust is expected from deposition of gravel and sand on the seashore during the construction period. Therefore, stockpiled gravel and sand shall be watered regularly to suppress generation of dust. Frequent traffic of heavy machinery and a consequent increase in the amount of exhaust gas is expected to deteriorate air quality. Therefore, heavy machinery in good condition shall be used with an appropriately prepared work schedule (to minimise any unnecessary vehicle/machinery movements).

Noise and Vibration /Traffic

Because of the frequent operation and heavy traffic of heavy machinery, the levels of noise and vibration and traffic volume are expected to increase in the area around the project site during the construction period. In order to reduce adverse effects, low-noise-types of heavy machinery shall be used as stipulated by law and the work shall be executed with an appropriately prepared schedule (a schedule in which construction works are to be executed only during the daytime).

Water Quality

The sediment on the bottom of the sea near the planned construction site has a large proportion of fine silt. Suspension of the silt in the water caused by deposition of gravel and sand on the seashore is expected to increase turbidity in the sea around the site during the construction period. Therefore, silt protectors shall be installed around the construction area in order to prevent diffusion of turbidity caused by the construction work.

Fauna and flora / Biodiversity

There is thick growth of several species of trees on the shoreline in the construction area. Part of this may become an obstacle to the construction work. However, instead of felling those trees, branches shall be lopped off in such a way not to compromise their growth for the execution of the construction work.

Topography and Geology

The ends of the flexible seawall to be constructed in the demonstration project shall be contiguous with the existing topography of the seashore so that reflection of waves at the ends is suppressed and the reflected waves do not have any impact on the seashore nearby.

b.5 Monitoring

Monitoring is carried out in two stages. One was carried out during the construction work and the other is to be continuously carried out after the completion of the project. Routine visual observation of the above-mentioned environment affecting factors shall be carried out in the area around the project site during the construction. After construction is completed, assessment of the effects and impacts of the flexible seawall will be the main aim of the monitoring. See 8.3.8 for the post-construction monitoring plan.

b.6 Public consultation

The public consultation meeting was held on September 16th, 2013. The purposes of the meeting were to inform the local residents of the plan for this project and its impact on the environment, listen to their opinions on the project and incorporate the opinions in the plan and design of this project. As the residents requested an expansion of the project area and construction of recreational facilities in the meeting, the JICA Expert Team explained the objectives and purposes of the project to them for the second time. The residents fully understood the second explanation and, in the end, expressed their support for the implementation of this project and their willingness to participate in the project activities.

8.3.7 Implementation

a. Major Construction Types

The construction types of the demonstration project were divided into preparatory works, safety measures and management, environment measures and monitoring during the construction, survey works, flexible revetment construction and drainage works. Details of each type of construction are described below.

a.1 Preparatory Work

Preparation work aims to have smooth construction progress, ensuring stock yard of construction equipment or materials, cleaning up the construction site, pruning tree branches which affect construction work, installing information board, setting up temporary construction fence and holding of public consultations for the residents were conducted.

a.2 Safety Measures and Management

Safety measures include making sure all workers wear helmets, conducting traffic control to avoid traffic congestion, practicing equipment maintenance, preventing material robbery and holding meetings for anticipated problems. These safety and management measures were not only for the workers but also for the regions of the demonstration project during the construction period.

a.3 Environment Measures and Monitoring during the Construction Work

Prior to the implementation of the construction project, as part of environment and social considerations, the Environment Impact Assessment (EIA) was developed in accordance with the JICA guidelines. Approved by MOESDDBM and other relevant authorities, it compiled expected environmental and social impacts and mitigation measures during the construction works. Construction work was required to follow EIA guidelines by facilitating a silt fence for protection from soil diffusion, establishing a working hour management for noise pollution and watering for prevention of dust pollution as well as monitoring these measures during the construction period.

a.4 Flexible Revetment Construction

Construction work for the flexible revetment was conducted based on the basic policy described in the previous chapter. The delivery of materials, land form works and finalizing slope were ensured for the construction works entrance and maintenance road. Materials of the revetment consisted of crushed basalt rock and rock sand and the size of gravel was

designed at 10-14 mm, 14-20 mm, 20-31.5 mm in the mixed ratio of 2:5:3 whereas the size of rock sand was 2-4 mm. Both materials were required to be washed. For the construction works, a backhoe loader was equipped for land form and an excavator was equipped for finalization of the slope gradient.

a.5 Drainage Works

For the four existing drainages affected by the demonstration project, extension of the three drainages and installation of rock layers at the mouth of the four existing drains were conducted. Taking into account applicability and operability, a round shaped pre-cast concrete pipe was applied. The size was decided depending on the section area of existing drainage so as not to affect drainage functions. A rock layer in front of the mouth was installed for protection against erosion caused by water flow from the drain. For the installation of the pipe, a backhoe loader was equipped for land form and an excavator was equipped for the installation.

a.6 Survey Works

Before the construction works of revetment and drainage, survey work was conducted to follow the exact measurement and traverse the layout respective to the original design. Additionally after the construction survey work was conducted and built as planned the section drawing was prepared.

b. Procurement of Construction

The JICA Expert Team conducted procurement and tender activities based on an estimation analysis of the construction cost for preparation works of the construction project for coastal facility. The methodology of the tender activity of the construction works for the physical measures of the demonstration project basically followed the “Guidelines of contract agreement with locals for consultancy or other works, April 2012” issued by JICA.

A designated competitive bidding system was applied for the tender activity since the project specialized in construction of coastal facilities and the contractor was required to have adequate knowledge about coastal area works. Furthermore, since it was critical to avoid the cyclone period between December to March, the construction works were required to be completed within 2013. In terms of the bidding system for this type of construction work in Mauritius, contactors were limited due to the specific requirements of construction work capacity, therefore selective bidding system was applied. Therefore the procedure of procurement and tender activities for the demonstration project is matched to the systems in Mauritius

b.1 Selection of Bidding Company

The JICA Expert Team selected three designated construction companies based on the evaluation listed below.

i) The company was required to have construction experience related to coastal work

ii) The company had to be on the list of registered construction companies issued by the Mauritius government that are eligible for projects graded “E” or higher which are estimated to have construction costs of more than 10 million Rupees.

iii) The company was required to own adequate heavy machinery to be considered. This was determined by questionnaire to the designated companies.

iv) The company was required to be able to provide required workers and equipment during the construction period and to manage the planned schedule of the construction. This was determined by questionnaire to the designated companies.

b.2 Selection of Contractor

The JICA Expert Team conducted bidding and opening tenders with all the designated competitive companies and selected the preliminary contractor based on lowest bidder. For a smooth progression of confirming the contents of the contract before reaching an agreement, the JICA Expert Team requested the company submit a proposal for construction schedule management.

c. Implementation of Construction

c.1 Implementation Period

The construction period was planned for one and half months from the end of October to the middle of December. The preparation activities were deployed without any problem and the whole construction schedule was soundly kept as it had been planned. The construction schedule, actual works and photos taken during the construction are shown below.

Table 8.3.9 Construction Schedule

No.	Contents	Oct. 2013	November	December	Remarks
1	Preparation				Building detail schedule, procurement materials
2	Safety Measures				Construction sign, safety fence, public consensus
3	EIA & Monitoring				Silt fencing, environment monitoring
4	Flexible Revetment				Installation of gravels and sand, slope finalization
5	Drainage				
6	As built survey				

Work Schedule

Actual Works

Source: JICA Expert Team

(1) Nourishment gravel (November 2013)

(2) Grading gravels (November 2013)

(3) Finalizing slope (November 2013)

(4) Installation of drainage (November 2013)

(5) Placing sand (December 2013)

(6) Grading sand (December 2013)

Source: JICA Expert Team

Figure 8.3.24 Progress of Construction

c.2 Construction Supervision

During the construction period, the JICA Expert Team supervised construction works such as checking work progress and management of overall construction works. Additionally, on-sight training and lectures about the significance of the construction supervision was undertaken as one part of the technical transfer for the officers of MOESDDBM. Supervision activities conducted by the JICA Expert Team are shown below.

c.2.1 Supervision Activity and Organization

Supervision activities were organized by one expert from the JICA expert team and one local consultant as an assistant to activities. The supervision staff was established with as few people as possible since the size of the construction is small-scale and the period of construction is limited. The main activities of the supervision are summarized below.

- Reconfirming the detail design and sharing information about construction works such as construction procedures, schedule and methodology
- Paying attention to safety management and environmental monitoring to avoid unexpected accidents
- Checking quality and quantity of construction materials such as gravel, sand, drainage pipes and concrete.
- Checking the finished height of the revetment through survey and guiding the workers and conveying to them the revetment height.
- Checking the construction schedule, managing the time table for construction works as well as developing weekly reports.

c.2.2 Lecture of Construction Management

As one of the technical transfers for the officers of MOESDDBM, an on-site lecture was carried out with the aim of developing construction supervision abilities. Supervision experts explained general instructions for construction supervision in terms of priority items and management for activities on the construction site. The overall contents of the lecture are shown below.

- It is critical to know the characteristics of the construction site since all the working activities to be supervised would be different depending on the content and locational conditions of construction.
- It is critical to understand a point of critical path for the working flow in order to complete all the work procedures in the shortest period of time within the construction schedule.
- It is critical to determine the type and frequency of heavy machinery trouble during construction and prepare to deal with further troubles. Especially for crawler types of heavy machine, it is important to watch closely since it will take a long time to carry and substitute to others.
- It is important to sensitize and communicate with the residents regarding the construction site and the supervisor has to pay attention to any conflicts the residents may have and try to avoid them.

c.2.3 Issues of Construction Management

Regarding the construction of coastal structures in the demonstration project, sensitization programs about the contents of the project and construction works to the residents was carried out and public consensus and agreement was established prior to the construction. This resulted in establishing cooperative relationships with the resident and gave the construction workers and supervisor positive motivation towards the construction works. As a result, this construction environment led to a smooth progression and completion of the construction works. On the other hand, it was clear there some trouble with the construction schedule management. These were more or less indirect, such as suspension of material supply due to plant trouble and delivery delays of concrete drainage pipes. The construction was completed within the planned construction period. However, it would be better to have a longer construction period in case of any unexpected contingencies during construction. Additionally, regarding the progress of construction supervision abilities of the MOESDDBM officers, implementation of an all-day on-site training would have proved effective and led to achievable results. This is recommended in the future.

d. Site after construction

The beach conditions after construction is compared with before implementation as follows.

Source: JICA Expert Team

Figure 8.3.25 Before and After the Construction (Left: Sep. 2013, Right: Mar. 2014)

8.3.8 Progress and Result of Coastal Monitoring

a. Objective

Gravel beach nourishment (flexible revetment) implemented as a physical measure of the demonstration project allows a profile change due to incident wave action in order to be able to adjust to uncertain factors caused by future climate change and finally provides a stable profile. Also, this type of measure is aimed at fulfilling the required function to protect the hinter residential area against wave overtopping as well as to maintain the environment along with desirable beach uses. Taking into account these types of purposes and measures, the following viewpoints were considered in the monitoring items:

- To check the stability of the beach profile, that is to monitor the profile change, segregation and movement of nourishment materials (gravel, sand)
- To check the influence on neighboring areas including the movement of materials alongshore
- To check the change in condition on beach use and environment
- To monitor the action taken on maintenance and self-management of the beach under residential ownership, and raise the awareness for coastal environment conservation

b. Monitoring Items and Method

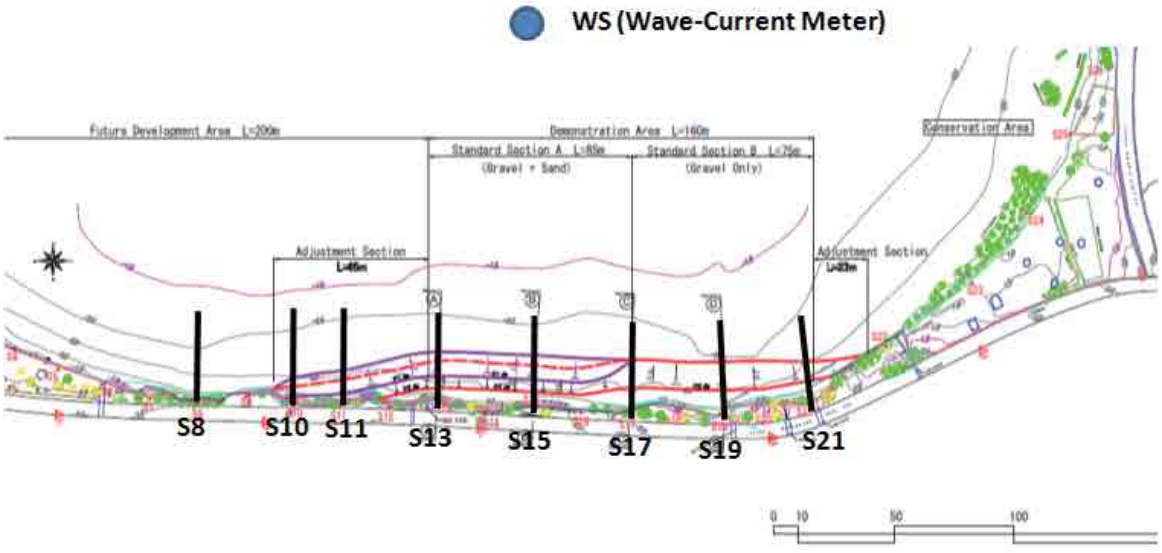
Table 8.3.10 shows the monitoring item, purpose and its method. Monitoring point and its coordinates are shown in Figure 8.3.26 and Table 8.3.11 as well.

Table 8.3.10 Monitoring Item, purpose and Method

Item	Purpose	Method
Incident Wave, Seawater Level Observation	To examine the relation between external forces (wave, current, sea level) and change in profile.	Setting wave-current meter (WAVE HUNTER) at sea side (inside of reef) of target area around 3.0m deep, and observe incident wave (wave height, cycle, direction), current and water level. Continuous observation is carried out during monitoring period since commencement of construction (October, 2013). Also, MOI is observing the waves at neighboring areas (out of reef). To know the wave decrement effect by reef, the above two data should be compared.
Beach Profile Survey	For quantitative evaluation of the change in profile and influence on the surrounding coast.	The profile survey with auto level, level staff, and measure tape should be conducted periodically every three months every 40m (total 10 lines) in the target area and surroundings. In case of particular events occurring such as storm, heavy rain, etc., the irregular profile survey is also carried out.
Taking Photograph from Fixed Point	For quantitative evaluation of the change in profile and influence on the surrounding coast, To enhance awareness of coastal conservation by resident participation.	Photos are taken by MOESDDBM and JET from the fixed points on the same line of the profile survey periodically every three months and irregularly in case of particular events. Photos are also taken frequently by representatives of residents to cover intermediate information (once per week) and to enhance people's awareness of coastal conservation.

Item	Purpose	Method
Change in Condition of the Coastal Environment	To check improvement effects of water quality and growth of natural vegetation after the Project	<Water quality improvement> Check water quality improvement at the gravel beach by the two methods below. For comparison, have two lines for check points, one is inside of the project and another one is outside of the project. Measurements should be done at two points for each line, shoreline and off shore. (1) Sampling the seawater in a cylinder and compare the cloudiness, (2) Measure the item of EIA by a Multi-purpose water quality analyzer (it will be done later) <Growth of natural vegetation> Check the growth of natural vegetation and take photos periodically. Confirm growth condition of vegetation.
Change in Condition of Beach Use	To check improvement effects of beach use after the Project	Conduct periodical field survey and confirm the improvement of beach utilization by photograph and field hearing.
Sampling of Bottom material	To check separation of materials (gravel and sand) due to wave action, To check abrasion of gravels due to wave action	Take bottom material sample from 3 points on the same monitoring line. A photo is taken to monitor the condition for separation and abrasion of gravel.

Source: JICA Expert Team



Source: JICA Expert Team

Figure 8.3.26 Monitoring Point

Table 8.3.11 Coordinates for Each Monitoring Line

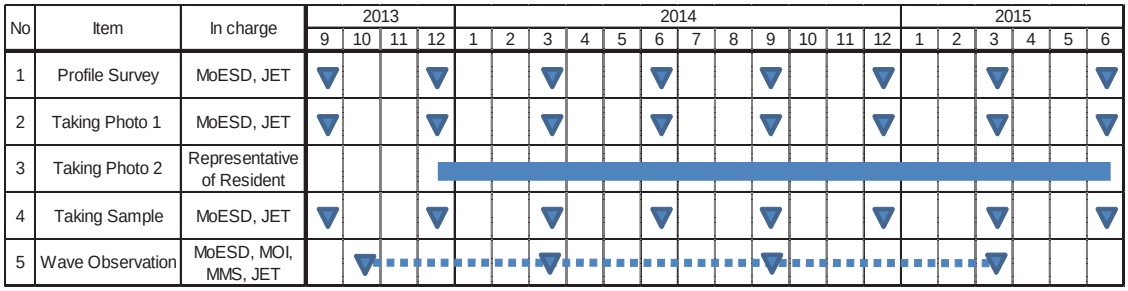
Line No	Position		Remark
	Latitude	Longitude	
S8	20°19'11.80"S	57°46'12.10"E	Out of project area
S10	20°19'13.00"S	57°46'12.00"E	North transition area
S11	20°19'13.70"S	57°46'11.90"E	North transition area
S13	20°19'14.90"S	57°46'11.90"E	Section A (gravel with sand)
S15	20°19'16.20"S	57°46'11.90"E	Section A (gravel with sand)
S17	20°19'17.60"S	57°46'11.80"E	Boundary between Section A and B
S19	20°19'18.80"S	57°46'11.90"E	Section B (only gravel)
S21	20°19'20.10"S	57°46'11.90"E	Section B (only gravel)
WS	20°19'17.50"S	57°46'27.10"E	Wave Current Meter (depth: 2m)

Source: JICA Expert Team

c. Monitoring Schedule

Table 8.3.12 shows Monitoring Schedule, and actual monitoring activity is shown in Table 8.3.13 as of June 2014.

Table 8.3.12 Monitoring Schedule



Source: JICA Expert Team

Table 8.3.13 Actual Monitoring Activities (as of June 2014)

No	Date	Remark
1st	2013.Dec.17	Just after completion of construction
2nd	2014.Jan.10	After Cyclone Bejisa passed (Jan. 2-3, 2014)
3rd	2014.Feb.14	After Cyclone Edilson passed (Feb. 5-7, 2014)
4th	2014.Mar.28	Regular Monitoring every 3 months
5th	2014.Jun.13	Regular Monitoring every 3 months
6th	2014.Sep.14	Regular Monitoring every 3 months
7th	2014.Dec.12	Regular Monitoring every 3 months
8th	2015.Feb.27	Regular Monitoring every 3 months

Source: JICA Expert Team

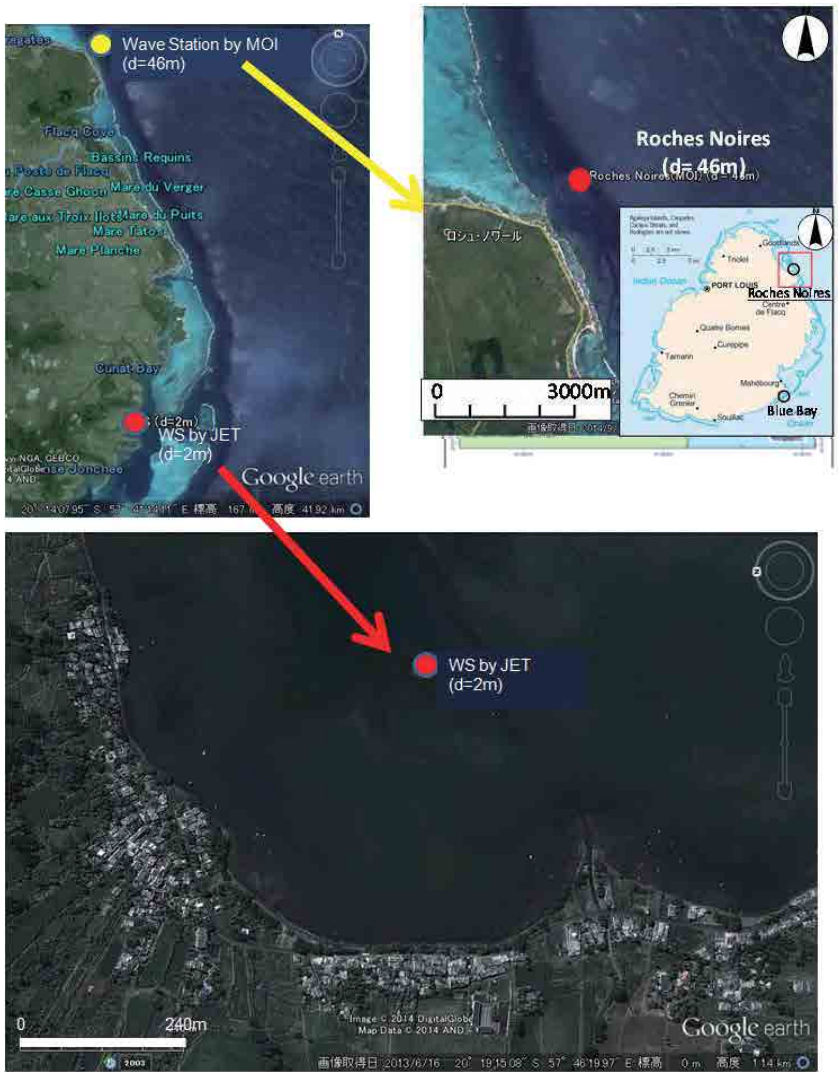
d. Monitoring Result

d.1 Result of Incident Wave, Seawater Level Observation

The wave conditions during this monitoring period were presented based on two points of wave observation data. One is the offshore wave data which was measured by MOI at the offshore area nearby Roches Noires located at the northeast area of Mauritius. The other is the incident wave data using a bottom mounted wave-current meter (Wave Hunter) set by JET at the project site, which is located inside of the lagoon at Grand Sable (see

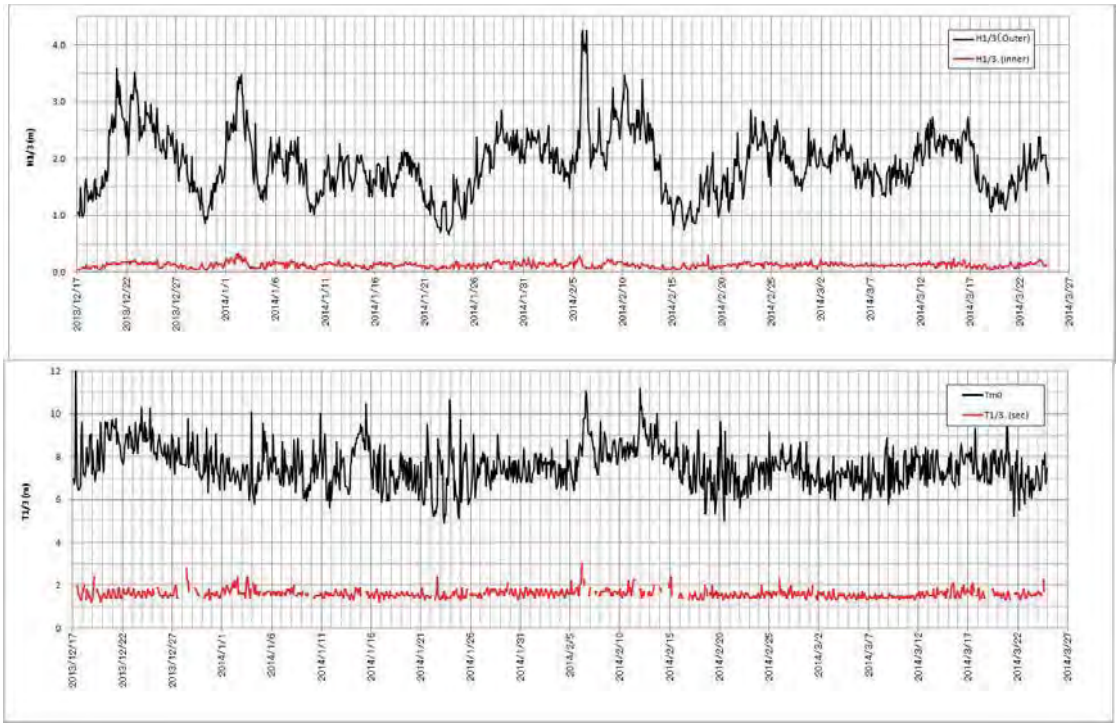
Figure 8.3.27). The wave observation was carried out for 1 year from 9th October 2013 to 7th October 2014.

The obtained wave statistic data from two cyclones that approached Mauritius from December 2013 to March 2014 is shown in Figure 8.3.28.



Source: JICA Expert Team

Figure 8.3.27 Location of WAVE HUNTER (inside lagoon) and wave observation point by MOI (outside lagoon)



Source: JICA Expert Team

Figure 8.3.28 Time Series of Wave Height and Period during Monitoring Period

Two cyclones approached Mauritius during this monitoring period. One is Cyclone Bejisa (2nd to 3rd Jan.), the other is Cyclone Edilson (5th to 7th Feb.). The track of each cyclone is shown in Figure 8.3.29. Cyclone Bejisa passed at the west side coast, and Cyclone Edilson passed at the east side coast in Mauritius. Based on the above situation, findings for the incident wave, seawater level observation result are described hereafter.

(1) Cyclone Bejisa (2) Cyclone Edilson

Source: JICA Expert Team

Figure 8.3.29 Track of Each Cyclone

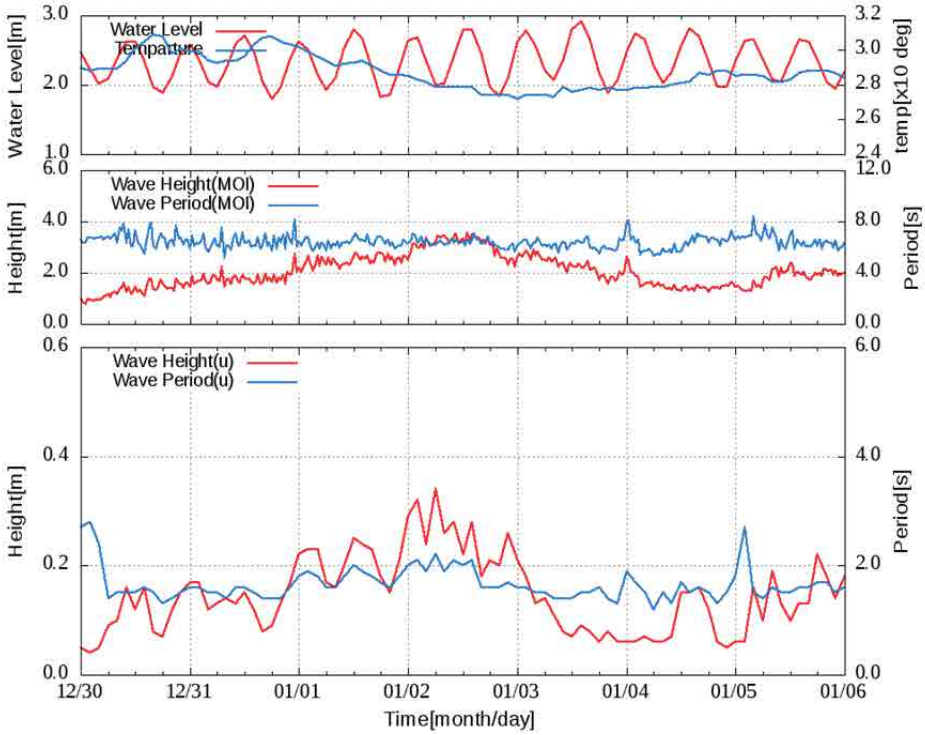
<Findings for the incident wave, seawater level observation result>

- The maximum offshore significant wave height ($H_{1/3}$) when the two cyclones approached Mauritius was 3.5m and 4.3m, respectively. On the other hand, no significant increase of wave height was observed at the inner reef area, and the wave height was about 0.2m more or less.

- Figure 8.3.30 and Figure 8.3.31 show the offshore and inner wave height and change in seawater level during the duration of each cyclone. At the peak time of high offshore waves, the wave height at the inner reef also increased compared to other periods, but not significantly. The water level was quite normal even when the offshore wave height increased. This means wave induced wave set-up was not significant at least for this level of offshore wave height.

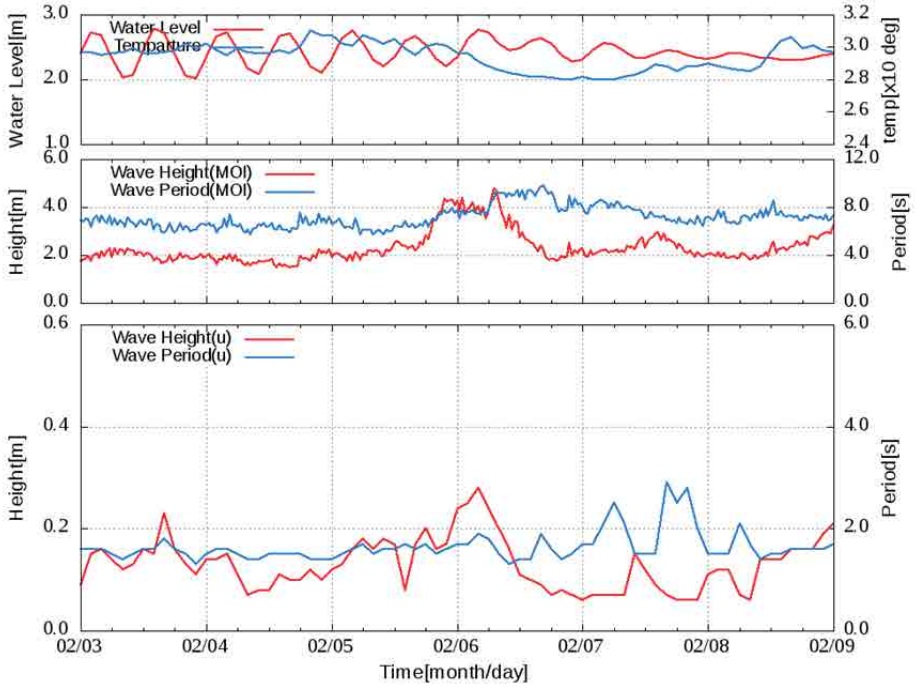
- The change in wave height at the inner reef area was not closely related to the tidal change at Grand Sable. This tendency is quite different from the results obtained at Pte. d'Esny.

- It is still necessary to continue wave and sea level observation to know the incident wave set-up for extreme storm (cyclone) conditions, which might impact the coast.



Source: JICA Expert Team

Figure 8.3.30 Time Series of Wave Height and Period during Cyclone Bejisa



Source: JICA Expert Team

Figure 8.3.31 Time Series of Wave Height and Period during Cyclone Edilson

d.2 Result of Beach Profile Survey and Fixed Point Photograph

The findings for the result of beach profile survey and fixed point photograph are described below.

- As of present, one year after completing the demonstration project, no significant change in profile has been observed. Also, as described later, although seasonal changes are recognized, sand and gravel have been observed moving from south to north throughout the year. Survey results of March 2014, after the two cyclones Bejisa and Edilson approached the sites, a significant change in profile was not observed,

- The line S17 is just positioned at the boundary between two different types of profiles, which are the profile formed by gravel and sand and that by only gravel. Just after the completion of the project (17 Dec. 2014), no sand existed from line S19 to the south. However, since the second monitoring, the sand contents were identified at the swash zone in the profile from line S19 to the south. It thought that a part of sand which formed the bank part at north part seems to be expanding southward because of wave effects (refer to Figure 8.3.34, Figure 8.3.35),

- From the result of the fixed point photos, it seems that nourished sand was moving to the south until March 2014. However, after June 2014, the opposite tendency was observed. During this period, a part of sand and gravel was moving to the north. Also from survey results, the beach profile at the northern monitoring lines (from Line No.S8 to No.S11) seems to have slightly increased. In contrast, the beach profile at the southern monitoring lines (from Line No.S13 to No.S21) seems to have slightly decreased (refer to Figure 8.3.36),

- The period from March to June is the transition period changing from the summer to the winter season. The wind direction also changes between the summer and winter seasons. In the summer season, the wave direction is usually scattered from S to N, and the wind speed is usually not so strong. On the other hand in the winter season, the wind direction is almost constantly SE and the wind is stronger than the summer season. The tendency for moving sand and gravel is quite similar to the seasonal change of wind characteristics.

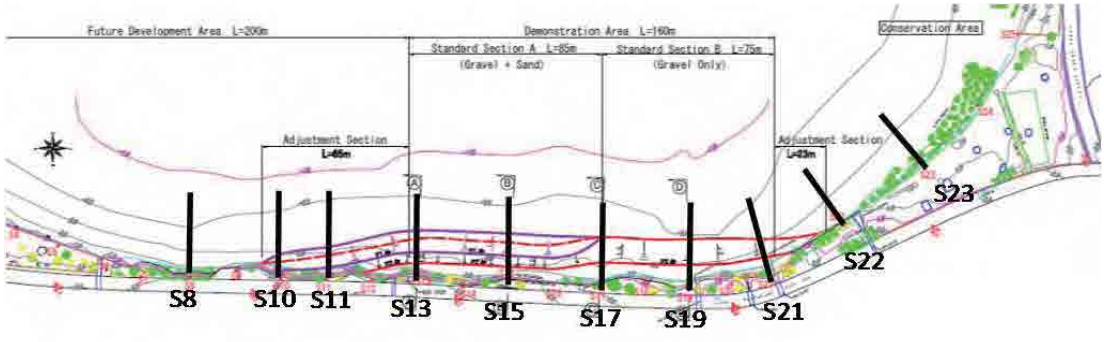
- After June 2014 (Sep. 2014 and Dec.2014), change of the profile shape became small compared to previous times and it shows a tendency to be stable. From this situation, even under influence of waves throughout a year, the possibility can be considered that the shape of the profile has become gradually stable.

- Three possibilities can be considered for the decrease of sand on the beach profile. 1) It moved along the shore direction, 2) flowed out to sea, 3) settled into (ran into) spaces within gravel. Among them, for 1), moving in a northward direction was observed as a net result throughout a year according to the profile survey results and site reconnaissance. On the other hand, even though it is difficult to confirm from monitoring results, it can be guessed that a certain amount of sand flowed out to sea. When comparing yearly changes of the beach profile of gravel parts only (S19, S20) to those formed by both gravel and sand (S13, S15, S17), the change of the beach profile is smaller (more stable) in the latter one. For this reason, the possibility for a stable profile can be considered the result of sand settling into (running into) spaces between gravel due to wave effects.

- (According to the above mentioned discussion), if a stable profile shape occurs by settling of sand (mix of sand and gravel), the nourishment sand from the initial state of the project will decrease from the initial profile during this stable process. Upon considering the importance of beach utilization in this area, it is recommended to nourish sand again at certain periods (at least more than once a year) after the project is implemented.

- After one year of the project, garbage such as PET bottles is found in many places of the beach line (Figure 8.3.34, Figure 8.3.35). This is not human-induced dumping of garbage from the landward side but those are washed ashore from the sea side. For disposal of the garbage, it is difficult from the resident level given the large amount of garbage. So a pro-active response from the government sector would be favorable.

- Also, inflow of seagrass and gravel at the mouth of the drainage pipe was confirmed (Figure 8.3.33). As for countermeasures, regular flushing of inflow garbage and materials, and extension of drainage pipes are taken into consideration. However, for any countermeasures, it is difficult to carry out on a resident level and so implementation by the government is preferable.



Source: JICA Expert Team

Figure 8.3.32 Location Map for Monitoring Line

Source: JICA Expert Team

Figure 8.3.33 Condition of Outlet of Drainage Pipe

Record period	S15 (left side facing the sea)	S15 (right side facing the sea)
Before project		
1st Monitoring (Dec. 2013, after implmen-tation)		
7th Monitoring (Dec.2014)		

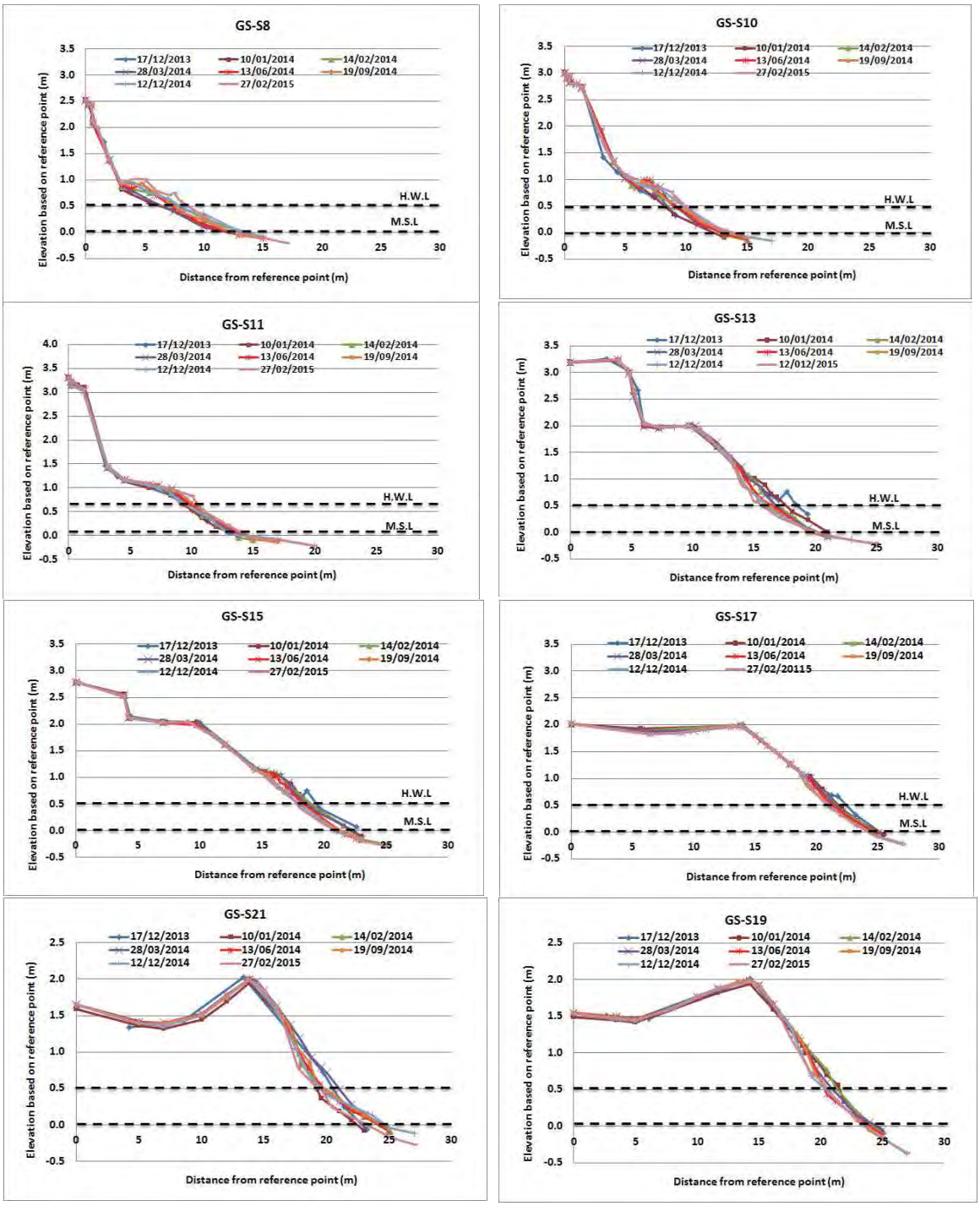
Source: JICA Expert Team

Figure 8.3.34 Change in Profile of Shoreline at Representative Monitoring Lines
(S15 line, profile of gravel and sand mix)

Record period	S19 (left side facing the sea)	S19 (right side facing the sea)
Before project		
1st Monitoring (Dec.2013, after implmen-tation)		
7th Monitoring (Dec.2014)		

Source: JICA Expert Team

Figure 8.3.35 Change in Profile of Shoreline at Representative Monitoring Lines
(S19 line, profile of gravel and sand mix)



Source: JICA Expert Team

Figure 8.3.36 Time Series Variation of Profile at Representative Monitoring Lines

d.3 Improvement of Coastal Environment

It was identified that the coastal environment has also improved after the project. The improvements are as follows:

<Purification of water quality >

Before the Project, the seawater on the shore was always turbid due to the disturbance of silty sand. To check the difference of water conditions at the project area and the outer area, the water samples were collected and the water transparency was visually compared. Sampling points are shown in Figure 8.3.37.

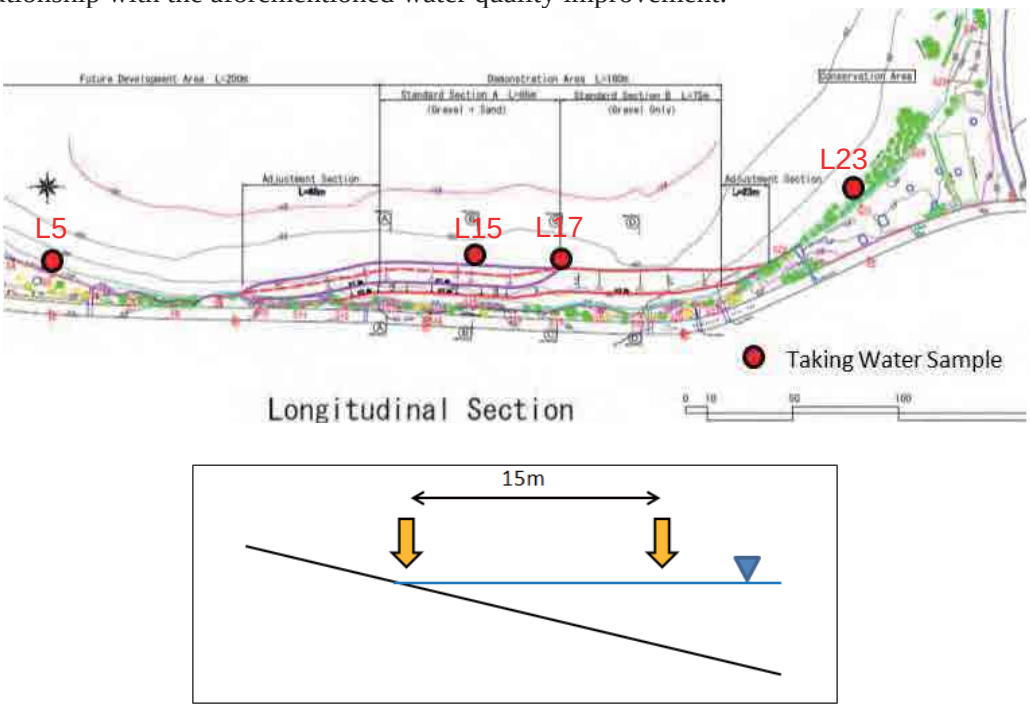
Figure 8.3.38 shows the comparison of water transparency which was observed on 13th June 2014 at four positions. Here, Line No. S5 and S23 are outside of the project area, and Line No. S15 and S17 are within the project area. After the project was implemented, the seawater drastically changed, becoming transparent. A significant difference of this water transparency was observed between inside and outside of the project area. It might be caused by suppression and filter effects due to the nourishment of gravel and sand.

<Growth of vegetation naturally>

It was identified that some of vegetation was growing naturally where the crushed sand was placed. This condition of growing vegetation shall also be monitored from now (refer to Figure 8.3.39).

<Smell reduction>

There was an unpleasant smell on the beach before the Project. According to information from residents, this smell was reduced drastically. It seems that there might be some relationship with the aforementioned water quality improvement.



Source: JICA Expert Team

Figure 8.3.37 Water Quality Sampling Points

(1) Line S5 (In front of North Public Beach, Outside of Project Area)

(2) Line S15 (within Project Area)

(3) Line S17 (within Project Area)

(4) Line S23 (Outside of Project Area)

Source: JICA Expert Team

Figure 8.3.38 Water Transparency (Left: directly in front of shore, Right: 15 m from shore)

(Line No. S12)

(Line No. S16)

Source: JICA Expert Team

Figure 8.3.39 Natural Vegetation on the Nourished Crushed Sand

d.4 Enhancement of Beach Use

Before the Project, the use of the coastal area at the project site was not so active. The reason is that before the Project, there was no beach space to utilize as beach recreation areas for residents. After the Project, several kinds of beach use were identified because of foreshore space formations and appropriate beach slopes (refer to Figure 8.3.40).

(1) Boat Landing

(2) Play Fishing

(3) Recreation and Relaxation

Source: JICA Expert Team

Figure 8.3.40 Beach Use by Residents after the Project

e. Conclusion

The conclusion is described below based on one year monitoring results from December 2013 to February 2015 after the completion of the project (8 times of monitoring).

- The beach profile formed by gravel and sand is quite stable even though two cyclones (Bejisa and Edilson) approached Mauritius in January and February 2014. However, the wave conditions at the outer reef during the cyclones were not so high, and no significant wave increase at inner reef of project area was observed. It is necessary to continue the profile monitoring for justification of the stability of the projected gravel beach.

- Since the completion of the project from Dec 2013 to March 2014, a part of materials seem to have moved southward. On the other hand after March 2014, a part of materials moved northward. This change of alongshore movement might be due to seasonal changes of wind induced wave direction.

- If we compare the six months right after the completion of the project with the following six months after that we see the latter six months shows small changes of the profile. From this fact, it can be reasoned that there is a possibility for the profile to gradually stabilize due to the wave effect. Also, the change of profile is smaller in places formed by gravel and sand than gravel parts and so the possibility for a stable of profile can be assumed possible because of the settling of sand (run into) into gravel spaces. However, this may cause a decrease of nourishment sand of the initial profile and so upon considering the importance of beach utilization in this area, it is recommended sand be nourished again at certain periods (at least more than once per year) after the project is implemented.

- It is difficult on a resident level to tackle the garbage that is washed ashore from the sea, and inflow of seagrass and gravel at the mouth of drainage pipes. Therefore, implementation by the government is preferable.

- Desirable enhancements for beach use and the coastal environment were identified. These effects are one of the strong advantages for this type of coastal conservation measure that is nature and environmentally friendly, which isn’t the case in the common physical type of structural measures.

- The beach profile monitoring was carried out in cooperation with the ICZM division and JET during the Project, and is being continued by the ICZM Division. These results will contributed to the planning and design of future flexible revetments (gravel beach) as one of the coastal conservation measures in Mauritius. The extension plan at Grand Sable (Phase-2) is referred to in the Coastal Conservation Plan in Volume 2.

8.3.9 Residents' Participation and IEC Activities

a. IEC Activities

IEC activities related to residents' participation at Grand Sable are aiming to (1) build a smooth consensus for physical measures and (2) establish the participatory coastal management organization after implementation of those countermeasures through enhancing residents' awareness and understanding of coastal conservation. Activities regarding aforementioned (1) have been completed in 2013 (Phase-I), and continuous activities targeting (2) are on-going now in Phase-II. The table below shows a summary of IEC activities as of Dec 2014.

Table 8.3.14 Summary of IEC Activities (at Grand Sable)

Date	Activity/objective	Participants/scale	Category*			
			I	E	C	PR
2013/ 6/26	Confirmation of residents' knowledge, awareness, demands of coastal conservation through questionnaire survey (interview).	50 households	○	○	-	-
2013/ 8/21	Stakeholder meeting with Residents' representatives to improve their understanding of project's objective and build consensus	Residents' representatives (7 members including Village Council, District council)	-	○	○	-
2013/ 9/16	- Whole residents' meeting to build consensus for project implementation, - Preparation and distribution of project's pamphlet to PR of the project.	Residents (60 people), Village Council, District council, TV station (MBC)	-	○	○	○
2013/ 10/14	Meeting to set up residents' monitoring team and to improve their awareness of coastal conservation.	Residents' representatives (12 members including Village Council, District council)	-	○	-	-
2013/ 10/20	1st beach cleaning event to improve residents' awareness of coastal conservation and to enhance their participation in coastal management.	Residents (150 people), Village council, District council, Coast guard, NGO TV Station (MBC)	-	○	-	○
2014/ 4/1	- Presentation meeting regarding importance of coastal management and practical illegal activities (including introduction of participatory coastal management activities), - Explanation of latest monitoring result	Residents, Village council, District council, Coast guard	○	○	-	-
2014/ 5/23	Residents' representative meeting to build up participatory coastal management organization.	Residents, Village council, District council	-	-	○	-
2014/ 6/5, 6/6	Introduction of physical countermeasures implemented at Grand Sable, as a good practice of "Eco-friendly coastal protection method of construction" (Panel presentation on World Environment Day in Mauritius University).*This activity will be introduced in Residents' meeting at Grand Sable in future.	Junior and high school students、general public、UNDP、IOC、NGO	-	○	-	○
2014/ 10/07	・Confirmation and dissemination of the situation of beach cleaning by the residents. ・Questionnaire about the effects of gravel beach	Resident Village council	-	○	○	-

Source: JICA Expert Team

* Details of Category refers to IEC Plan

(1) Meeting to set up Residents' Monitoring Team

(2) 1st Beach Cleaning Event

(3) Residents' Meeting to build up the Coastal Management at Their Own Initiative

(4) Panel Presentation on Coastal Conservation for World Environment Day

Regular beach cleaning event at the initiative of residents
(July 2014)

Source: JICA Expert Team

Figure 8.3.41 IEC Activities at Grand Sable

b. Implementation of Coastal Management at the Initiative of Residents

At the Residents' representative meeting (May 23, 2014) which discussed the beach cleaning and beach control at the residents' initiative, the following opinions and demands were confirmed:.

- Many families use the project beach for picnics on holidays. It functions as a place of recreation and relaxation for neighboring residents and is used for fishing and the mooring of fishing boats. A good environmental situation is observed because of an improvement of seawater transparency near the beach line and growth of natural vegetation at the gravel beach.

- After completion of the Project, gravel was stolen once by a resident. At that time, the person who saw this illegal act informed the representative of the Village Council and this representative reported the situation to MOESDDBM. Since then, more careful observation (patrols) at gravel beach have been undertaken with residents and relevant government agencies (i.e. police) and no such incident has occurred since.

- So far, there has been no illegal waste dumping or noticeable garbage on the beach and the shore has been kept in good condition.

- The Village Council and District Council have established the beach cleaning organization. This organization plans to do beach cleaning every three months. Additional public trash bins were required to dispose the collected garbage. (To respond to this request, trash bins were placed at the beach by MOESDDBM)

Source: JICA Expert Team

Figure 8.3.42 Residents' Meeting to build up the Coastal Management under Their Own Initiative

Important factors to implement the coastal management under the residents' initiative are "Understanding the importance of self-management" and "Improving awareness of coastal conservation for action". IEC activities at Grand Sable have been conducted in order to enhance their understanding and awareness as of today. As a result, it was confirmed that they had a high level awareness for coastal management and they took part in voluntary activities for coastal conservation in accordance with reporting from the residents mentioned above. Considering the situation above, JET decided to continue monitoring coastal management activities for the time being in respect for the self-initiative of the residents. However, if it is judged necessary during monitoring, JET plans to advise and instruct the residents' organization. Also, JET plans to request the relevant government agencies to place additional public trash bins, to reinforce monitoring patrols and so on.

8.4 Non-physical Measure in the Demonstration Project

8.4.1 Adequacy of Selection

The objective of non-physical project as a pilot project is shown as below.

Preparing comprehensive and concrete coastal conservation plans in consideration of not only technical points of view but also non-technical points such as law/regulation, organization, operation and management, consensus building and so on against beaches where various problems such as protection, utilization, landscaping, environment, etc. are due to coastal erosion and countermeasures which have been conducted up until now. To realize such comprehensive and concrete coastal conservation plans, the plans should be realistic and based on a full understanding of each other through discussions between relevant peoples and stakeholders. This will enable the plans to be applicable to other beaches which have similar problems.

The adequacy of selection is evaluated from the following four points based on the above-mentioned objective.

a. Physical perspectives

Pte. d'Esny was selected as one of the priority beaches for the beach conservation plan among the 12 priority beaches from four physical aspects (natural/geography, environment, shoreline change and utilization) regarding physical perspectives in accordance with the result of the basic survey. The sediment budget at this beach has had a tendency to increase in recent years. However, at some areas of the beach, erosion is continuing due to an imbalance of the entire sediment transport by beach protection facilities which were constructed by each leaseholder individually. Moreover, existing groynes and seawalls have influenced the disappearance of the beach, beach utilization and landscaping. In order to promote sustainable coastal conservation at this beach, countermeasures from a comprehensive view based on sediment transport mechanism at the entire beach are required because continuous sediment transport cell is formed northward.

b. Beach Management perspectives

As described above (preceding chapter), beach management has been transferred to each leaseholder because this beach is a leasehold area. The government side only conducts evaluation of each proposed measure through the EIA which requires submission of necessary documents when leaseholders have a plan to construct coastal protection facilities. The main cause of erosion at this beach is considered to be due to the fact that countermeasures and conservation planning has not be undertaken from an overall perspective that takes into account the continuous sediment transport of the coastline. Observance of the regulations about setback line of 30 m and public domain at coastal area were clarified in 2004. However, it is difficult to enforce these regulations to leaseholders considering the long land lease periods. In other words, there are problems and inconsistencies in beach management, especially land use which can't be solved from technical points at this beach. Both the government and resident sides had not been aware of these problems and inconsistencies. It was necessary to study suitable solutions after a common recognition of problems between the government and the private sector. In order to observe the regulations for land use, review of management and organizational structure is also required after understanding the reality of the situation.

c. Consensus Building perspectives

In total, 114 leaseholds exist along this beach and various and individual coastal protection measures have been conducted at this beach in order to protect land, building and property for each lease holder. However, it is difficult to conserve whole areas of this beach as long as beach protection measures are considered individually like before. Therefore, in order to conserve all areas of this beach, consensus building subject to common understanding is required.

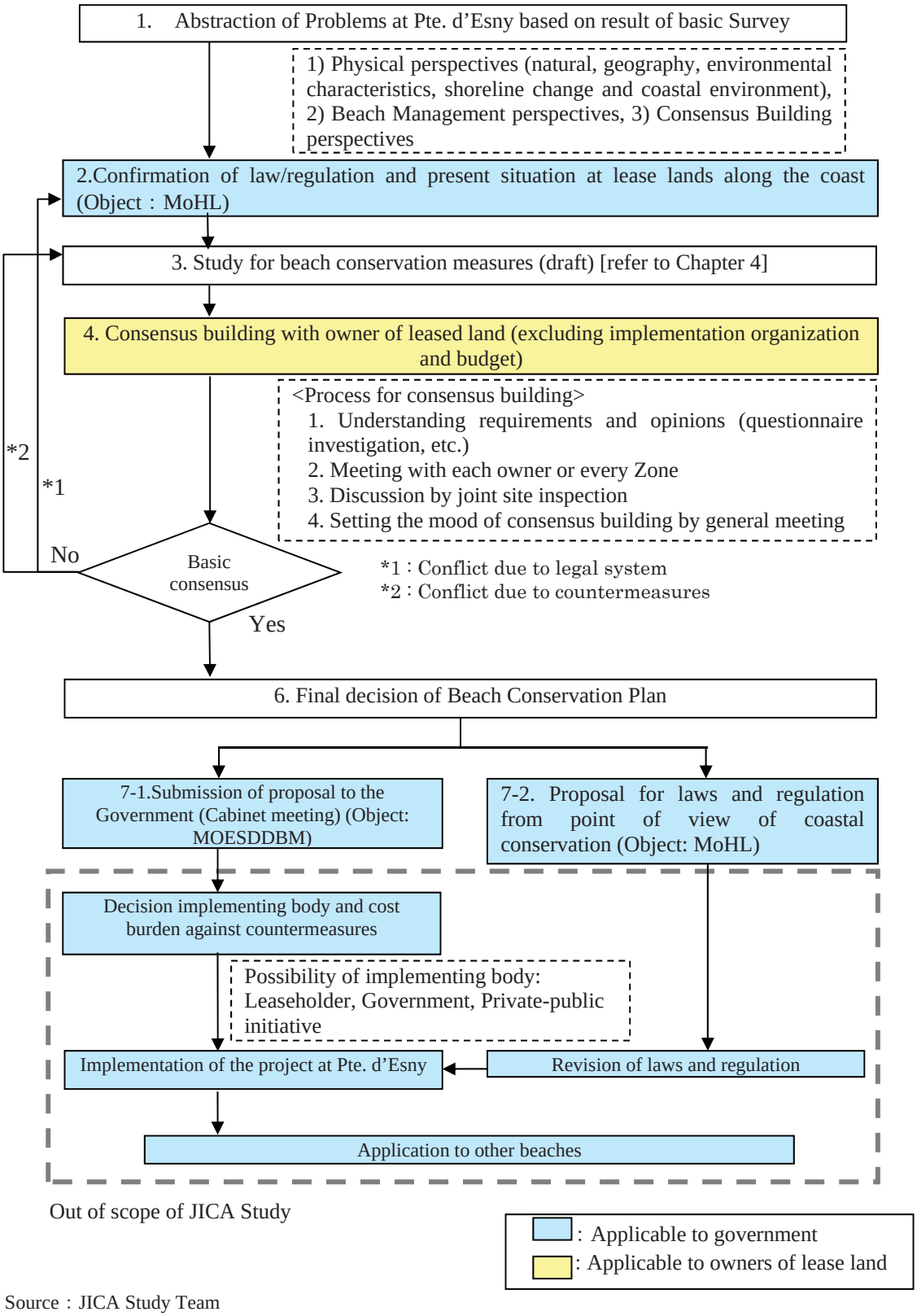
d. Application to other beaches

Many coastal areas in Mauritius that are used as resorts have problems with beach management because beach management is entrusted to each leaseholder. This is seen in Pte. d'Esny (e.g, Pte. aux Cannoniers, Pte. aux Sables, Albion, etc.). Accordingly, it is thought that a concrete approach at Pte. d'Esny can be applied to leased lands at other beaches that have similar problems.

Pte. d'Esny was identified as a site that was adequate for the non-physical demonstration project of the coastal conservation plan.

8.4.2 Study Process

The study process for the non-physical project at Pte. d'Esny is shown as follows:



Source : JICA Study Team

Figure 8.4.1 Process of Study for Non-Physical Demonstration Project at Pte. d'Esny

8.4.3 Extraction of Problems and Future Principles for Implementation (Government Side)

a. Confirmation of legal system/regulation and present state at leased land along the coast

The discussion with MoHL was carried out in order to confirm legal system/regulations at leased lands along the coast because some problems were pointed out through data collection and meetings with leaseholders at Pte. d'Esny in preparation for the coastal conservation plan (October 2013 and June 2014). Some points confirmed through discussions are as follows:

1st meeting：October, 2013

2nd meeting：June, 2014

Source：JICA Study Team

Figure 8.4.2 Discussion for legal system/regulation and present state at leased land along the coast with MoHL

a.1 Land lease/licensing organization

- Licensing organization of land lease : MoHL
- Licensing organization of buildings/facilities (house, seawall, groyne, outside wall) : District Council (MoLG)

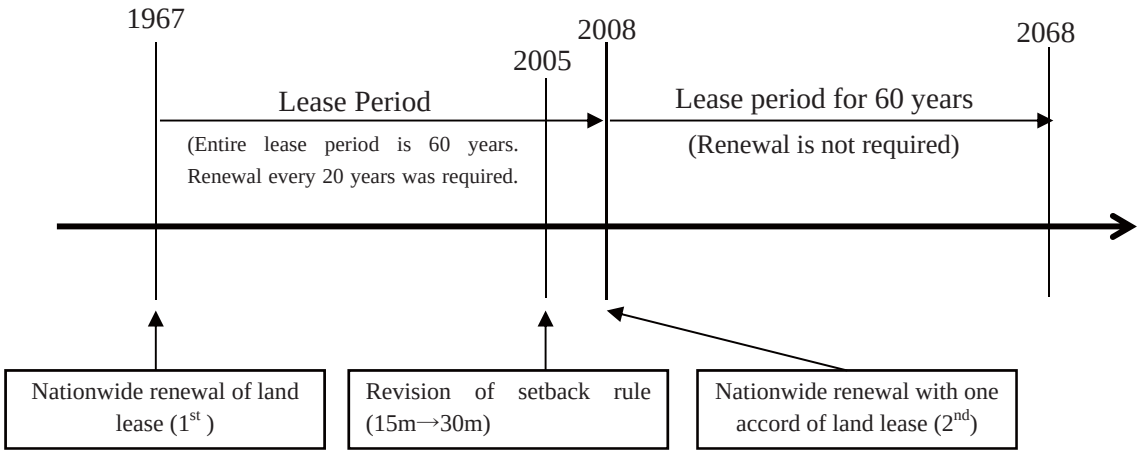
a.2 Transition of land lease

The nationwide renewal of land lease along the coast was conducted in 1968 and 2008. Three points listed below were renewed in 2008. In addition, the rules for setback (prohibited area of fixed construction) were modified from [15 m from H.W.L] to [30 m from H.W.L] in 2005.

① Boundary on the ocean side of leased land (only if leaseholder desires)

② Lease period: 60 years for contract period, obligation of renewal every 20 years before 2008. This obligation of renewal was abolished after 2008.

③ Lease rate: Steep rate rise since 2008. 60Rs/m^2 of annual usage fee and 1,200Rs/m^2 of additional fee (contract unit) are imposed at best grade zone (including Pte. d'Esny) (Pas Geometriques, 1987 (revised edition)).



Source : JICA Study Team

Figure 8.4.3 Transition for land lease

a.3 Rules and present state for boundary on the ocean side of leased land

- Principle (rules from a legal standpoint): The boundary on the ocean side at leased land is fixed as far as the H.W.M at time of contract. The boundary is also defined by distance from a random fixed point on land such as road, etc. The countermeasures depending on beach conditions are shown as follows.

  - Case-1 (Erosion): The area of leased land can be reduced if the land has been eroded compared with the time of entering the contract（only if leaseholders desire）.

  - Case-2 (Accumulation): The area of leased land cannot be expanded to the sea side if the land has accumulated compared with the time of entering the contract.

- Present state (Refer to Figure 8.4.4):

  - Case-1 (Erosion): There are almost no cases of people applying to reduce their area of leased land if the land has been eroded. In this case, the, land below the water surface is owned by the leaseholder from a legal standpoint.

  - Case-2 (Accumulation): There is some evidence of expansion of leased land at accumulated areas. The permission for expansion of lease of additional land cannot be overturned until the next contract in 2068 if one of the licensing organizations (MoHL or District Council) permitted it due to lack of verification.

a.4 Setback rule

Setback rules define the prohibited area of fixed construction by distance from the H.W.L. (above-mentioned fixed point). Although that distance was 15 m before 2005, it was changed to 30 m in 2005 (Beach Authority Act 2004).

- Principle (rule from a legal standpoint): The new setback rule is applicable only to new buildings built in or after 2005. Advice for existing buildings and advice at the time of being repaired are possible by this rule, but this rule is unenforceable.

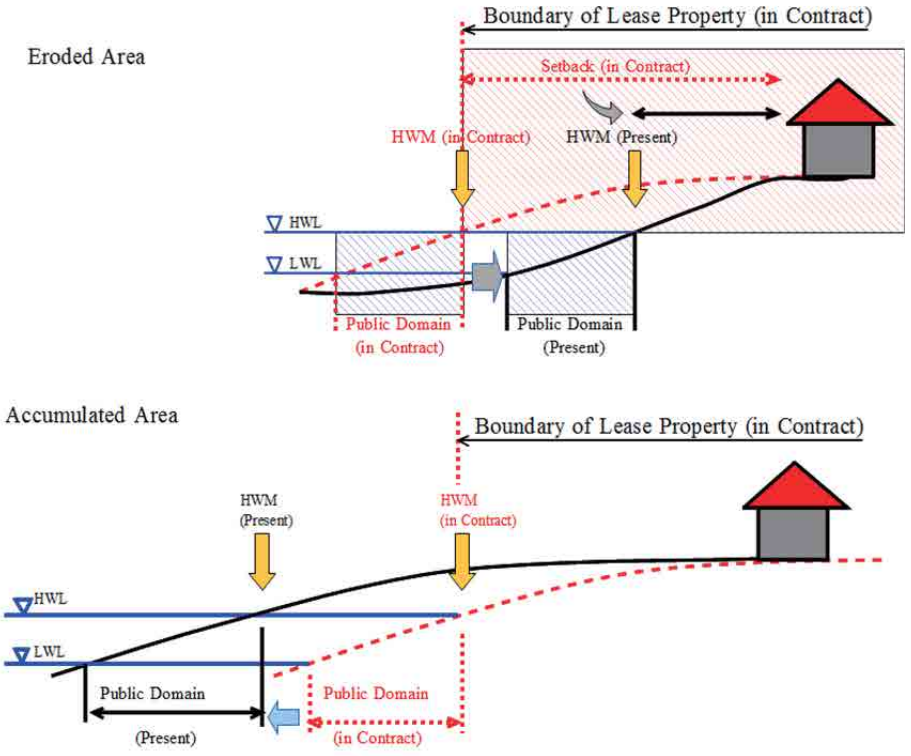
- Present state: As for the buildings of the coast in Pte.d'Ensy, most of them were built

before revision of the setback rule (2005). Therefore, there are few buildings which are the target of this regulation in fact. Moreover, there are cases when the 30 m setback has not been observed regardless of new buildings that are the target of this regulation. It is thought that the cause of this is insufficient confirmation of the District Council in the field. Once the District Council grants a license, the District Council can't enforce owners of the lease land to follow the setback rule until the time of the next contract renewal in 2068. This means that this rule has become a rule in name only.

a.5 Securement of public access

- Principle (rule from a legal standpoint): In order to secure public access, the land between H.W.L. and L.W.L. is uniformly regarded as Public Domain (public land that anyone can use). In addition, the H.W.L. here is not a "fixed H.W.L." in the land lease contract but "a varying H.W.L." decided by daily sea level and the position of the sandy shore.

- Present state: As mentioned above, since the definition of the H.W.L varies,, the boundary of public domain and the leased land areas overlap. In this case, preference is given to the lease contract. As a result, public access is not secured.



Source: JICA Study Team

Figure 8.4.4 Diagram of Sea Side Boundary of the Leased Land and Public Access (Upper: Eroded Area, Lower Accumulated Area)

b. Problems heading towards implementation and principles for future action (the government side)

The problems heading towards implementation and future principle of coastal protection and management which became apparent from discussions with MoHL are shown in the following table. In addition, it is thought that as most of the problems are concerned with the

content of the statute and its management system, a short-term solution is difficult. On the other hand, from the MoHL side, the position which recognized the importance of these problems and also examined future legal changes was shown in the discussion process. Therefore, as for the future policy of the JET side, making a proposal concerning legal reform from the viewpoint of coastal protection and management was decided.

Problems of the proposal heading towards implementation and future endeavors are described as below. Also, the proposed structure and procedure will be described in Section 7.3.

Table 8.4.1 Problems Heading Towards Implementation and Principles for Future Action (the Government Side)

Problems	Principles for future action
Sufficient check by MoHL and District Council as licensing organization of leased land and facilities was not carried out. For new construction, especially a lot of cases in which the outside wall of residential buildings do not observe the regulation of setback line.	As the licensing organization of facilities, it is incumbent on MoLG to perform the site confirmation as part of the approval procedure. During the site confirmation, the map of the boundary location of the structures (prepared by MoHL) must be brought and confirmation should be based on that map.
Problems related to boundary of leased land area **1. Leased land boundary at accumulation area** In review of the leased land area at accumulated areas, in some cases the ocean side boundary (H.W.M. position) of the original agreement is expanded to the ocean side. **2. Leased land boundary at the erosion area** When erosion advances, cases have occurred where the land under the water surface is included in the individual leased land area. This causes troubles in regard to continuous seashore management.	The review of the lease land area boundary is disseminated to MoHL which is the licensing organization of the following rules. **1. Leased land boundary at accumulation area** The ocean side boundary must be until H.W.M. in original agreement, and it cannot expand to the ocean side. **2. Leased land boundary at erosion area** The lands which are lost by erosion must be excluded from the agreement in the review.
Considering the seashore change, since the lease contract period is too long (60 years) and setback rule cannot be adapted during the time, this setback rule has become a rule in name only.	In consideration of seashore changes, the review of leased land areas should be conducted every 10 years from the view of coastal protection. From the view point of coastal management, a proposal about how to review the lease land boundary according to erosion degree is made.

In the overlapping region of the public domain and leased land area, the land lease has priority and public domain is not secured.	The government or the land owner should prepare walkway, etc. in the area where Public Domain cannot be arranged.

Source: JICA Study Team

8.4.4 Development Process of Coast Conservation Plan and Final Proposed Plan (Lease Land Owner Side)

a. Discussion concerning countermeasures of coastal protection (proposal)

About the outline of countermeasures of coastal protection (proposal), overall discussions (4 times) and joint site reconnaissance and discussions (5 times) with the target owners of lease land were carried out, and their opinions and request of those involved were confirmed. Moreover, in order to contribute to the formulation of the detailed plan, the collection of the land specific information such as the situation and actual damage of sandy beaches, and the construction period of the physical structures (groyne or seawall, etc.) were carried out.

Meeting with owners of lease land (2014/5)

Joint site reconnaissance (Zone1, 2014/6)

Joint site reconnaissance (Zone2, 2014/6)

Joint site reconnaissance (Zone3, 2014/6)

General meeting with owners of leased land

Individual exchange of opinions with owners

Source: JICA Study Team

Figure 8.4.5 Check and Discussion with MoHL about the Legal System, Rules and Actual Conditions Related to Leased Land of Coastal Area

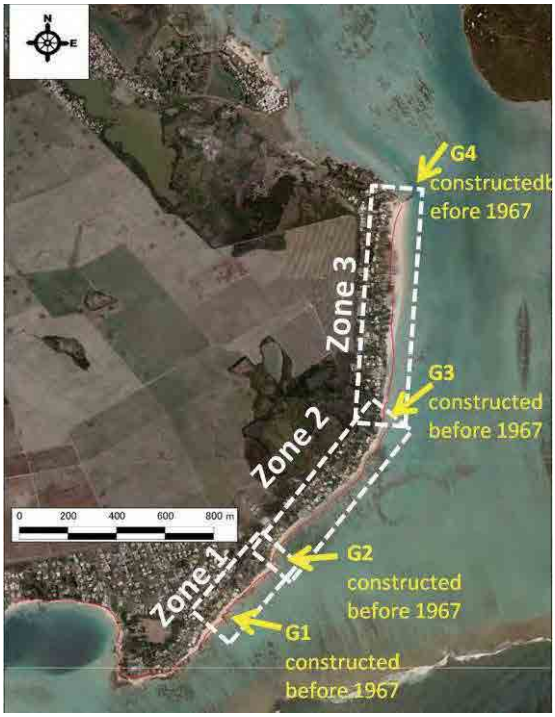
Some of the opinions and requests from owners of lease land are shown in the following table. The shoreline change analysis of this division in the basic study is based on the aerial photos after 1967, and since many of the owners of lease land have been living in this local area from before 1967, they are the precious witnesses to knowing changes of the past seashore (see No.1, 2). Since their dwellings and leased lands face the seashore, it was confirmed that their awareness of the coastal changes or coastal protection is very high (see No.3, 4. This is a greatly different point from the original situation of the residents of Grand Sable where physical measures have already been undertaken in the Project). However, the owners were divided in their opinions of the extent to which coastal protection measures should be taken. Some owners understand that the seashores are linked together and think that conservation of the entire coastal area is required (see No, 5). In contrast to those owners, the other owners are focused solely on the limited area in front of their houses (see No.6). Moreover, there are also those who have a misunderstanding of the influence of the seashore in case of installing coastal facilities such as jetties (see No.6), and in the deposition area (Zone3), there are those who have declared the deposited front beach as individual leased land without any governmental permission (see No.7).

Table 8.4.2 Some Opinions and Requests from Owners of Lease Land (extract)

No.	Outline of opinions and requests
1	(Zone1, Zone2) Although it was the rocky coast where sand hardly existed before construction (before 1950) of the main jetties (G1, G2), sand began to deposit after construction of these jetties.
2	(Zone3) Although the main groyne (G4) was constructed in the 1940s, this area prior to this construction was a rocky coast with little sandy beach. Significant deposition of sand was confirmed after the construction, and around Pte. d'Esny, amount of sand sediment is largest now.
3	(Zone2) Foreshore has already disappeared and it is absolutely necessary to implement urgent measures of some sort.
4	(Zone2) In order to recover sandy beach, experiments on bamboo float type detached breakwater had been conducted until last year (although certain wave absorbing effect of this breakwater was confirmed, however it was removed subsequently since long term installation was difficult structurally).
5	(Zone1, Zone2) It is thought that as size of the groynes is large (width, height, and

	length), trouble occurs in case of access to the sandy beach. Moreover, it seems that sand trapping effect is too strong.
6	(Zone2) The groyne in front of our house is preventing sand from being washed away and it is not causing any negative impacts on surrounding beaches (down drift side).
7	(Zone3) The foreshore has a tendency of accretion, and since H.W.L. has advanced significantly compared to before, owners of lease land want to apply to the government to expand the leased land area (see following figure).

Source: JICA Study Team



Zoning by main groynes (G1-G4)

Large scale groyne (Zone2)

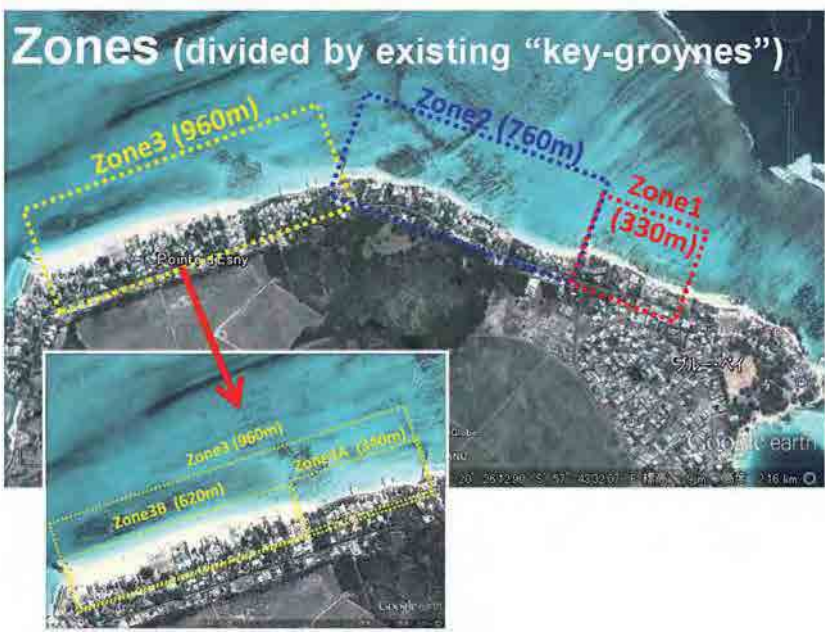
Expansion of private leased land area of deposition (Zone3, owner of lease land declare the boundary without permission)

Source: JICA Study Team

Figure 8.4.6 Zoning of Coastal Areas and Present Condition Photograph

b. Planning of coastal protection reflecting to opinions of residents

Coastal area of Pte. d'Esny was divided into three parts based on the existing large-sized groynes (the places where there is discontinuity of longshore drift) and coastal protection plans were developed for each zone. Below follow explanations of each zone, namely: 1) the initial plan, 2) the opinions of the residents regarding the plan, 3) planning of coastal protection reflecting to the opinions of residents for each zone will be described. For further details of the plans please refer to Volume 2 (Planning of coastal protection).



Source: JICA Study Team base on Google Map

Figure 8.4.7 Zoning of Coastal Area in the Planning

b.1 Zone 1

b.1.1 Initial Plan

Summary of the initial plan is described in the following figure. This plan is to remove the ineffective concrete enclosures and small groynes in this zone from point of view of beach utilization and landscape conservation.

Source: right) JICA Study Team base on Google Map, left) JICA study team

Figure 8.4.8 Summary of Initial Plan in Zone 1

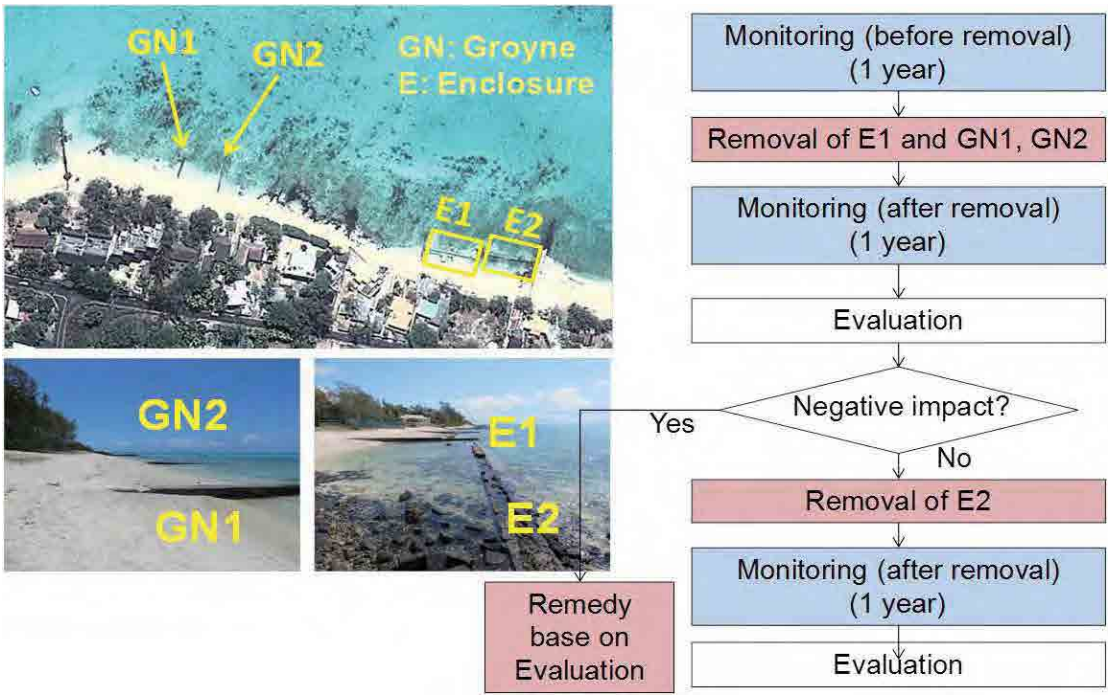
b.1.2 Opinions of the residents regarding the plan

The following opinions and demands were described from the results of resident meeting for the initial plan.

- Concern about the possibility of the occurrence of serious erosion due to the removal of all of the structures at once.

b.1.3 Planning of coastal protection reflecting to the opinions of residents

From the results of prediction of beach line changes using 1-Line model for case of removing all structures, there were predicted to be no significant changes after removal. However, upon consideration of all unexpected changes of natural conditions, the initial plan was revised from removal of all structures at once to the method to remove these structures in a step-by-step manner while monitoring the impacts of the removal. The summary of the revised plan is as shown in the following figure.



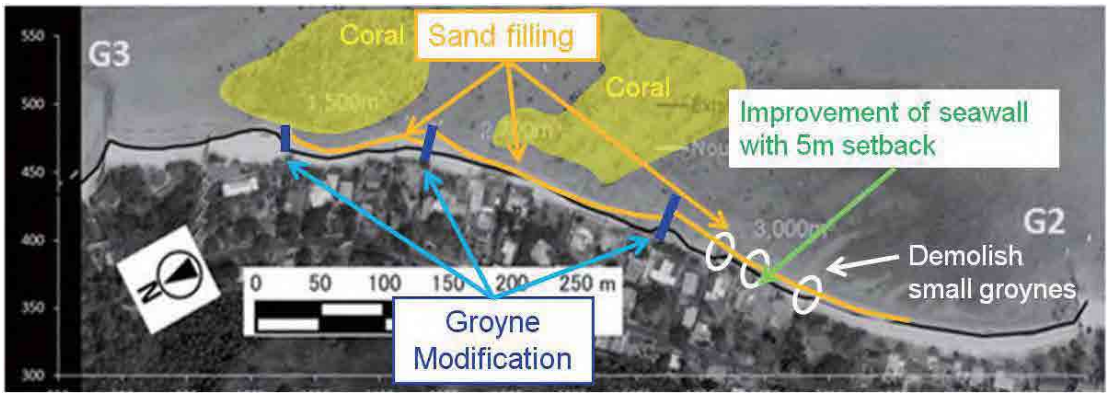
Source: Aerial photo) JICA study team base on Google Map, Others) JICA study team

Figure 8.4.9 Revised Plan of Coastal Protection in Zone 1

b.2 Zone 2

b.2.1 Initial Plan

Summary of the initial plan is described in the following figure. In this plan, sand nourishment at central area where sandy beaches currently hardly exist, and groyne modification to control the flow-out rate of nourishment sand are included. Additional, the removal of small groynes which are ineffective and wall setbacks of the residential buildings which are blocking longshore drift are also included in the plan.



Source: JICA Study Team

Figure 8.4.10 Initial Plan in Zone 2

b.2.2 Opinions of the residents regarding the plan

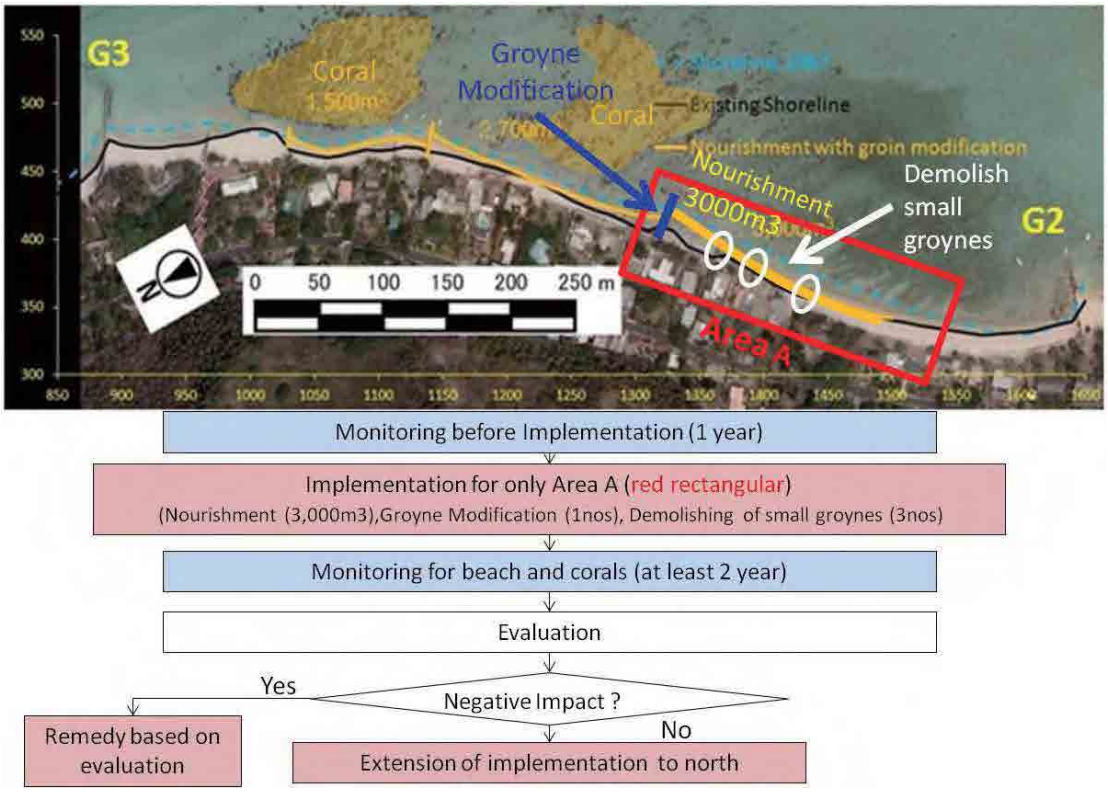
The following are opinions and demands voiced in the resident meeting regarding the initial plan.

- Regarding the setback of the walls of residential buildings, the opinion was expressed that it is impossible to implement in reality because of a lack of setback space in the hinterland (behind the H.W.M).

- Since there are coral reefs growing clusters in this zone just offshore of the shoreline, implementation of measures that will have a minimal impact on the coral reefs were requested.

b.2.3 Revised plan reflecting residents' opinions

Summary of the revised protection plan that reflects the opinions of residents is described in the following figure. As for measure to protect the coral reefs, the implementation will start step-by-step from the area within the red boundary in the figure. After implementation of the countermeasures, monitoring will be carried out to understand the effect on the surrounding environment. Then, the implementation area will be expanded to the northward if no effect to the environment is confirmed. Then, the confirmation of the effect to environment will be carried out by monitoring. For setback of the wall of residential buildings, it was judged, based on opinions of the residents, to be unpractical because of a lack of space in the hinterland. Even in the narrowest place, the width of sand nourishment will be secured over 2 or 3 m.



Source: JICA Study Team

Figure 8.4.11 Revised Plan of Coastal Protection in Zone 2

b.3 Zone 3

b.3.1 Initial Plan

Summary of the initial plan is described in the following Figure. Zone3 is divided into two parts, Zone 3A and Zone3B. There is almost no sandy beach left due to beach erosion in Zone 3A, on the other hand, a huge amount of sedimentation is recognized in Zone3B. In the initial plan, as a first step, it was proposed to conduct sand-bypassing from the accumulated area (Zone 3B) to the eroded area (Zone 3A). As a second step, improvement of the existing groyne was proposed to reduce sand outflows at the downstream side of the groyne. In addition, planting of vegetation and setback of house walls, if possible, were additionally proposed to reduce sand outflow. And finally, as a third step, development of artificial coral reefs and plantation of seagrass was proposed in front of the eroded area to reduce wave energy and currents. In this regard, however, feasibility of these measures has to be examined before their full- scale implementation can get underway.

Source: JICA Expert Team

Figure 8.4.12 Initial Plan in Zone 3

b.3.2 Opinions of the residents regarding the plan

The following are opinions and demands voiced in the resident meeting regarding the initial plan.

- The erosion situation in Zone 3A is so serious that urgent countermeasure is definitely needed.

- Strong objection was raised against sand-bypassing from Zone 3B to Zone 3A. Main reasons for this were: 1) Part of accumulated area had been already permitted as leased area in Zone 3B. 2) Accumulated area in Zone 3B in now frequently used for beach activities especially for kite surfing.

- Large amount of accumulated sand is recognized in northern lagoon area of project site, which can be alternative source of sand for Zone 3A.

b.3.3 Revised plan reflecting residents' opinion for Step-1

With residents' opinion on the land use situation of Zone 3B, sand-bypassing from Zone3B to 3A is considered to not be feasible. Therefore, sand-bypassing from Zone 3B is not proposed. Therefore an alternative sand borrow site is required to implement beach nourishment in Zone 3A. Extraction of sand from lagoon is absolutely prohibited by the Cabinet's decision (CAB (2001) 12th Meeting-No.574). Thus, alternative source of coral sand is limited only from the quarry sites from land. However upon considering the periodic maintenance cost of sand nourishment, this alternative does not seem to be feasible because the procurement cost from quarry sites is rather expensive. Surplus of sand in lagoon is highly expected in Mauritius, such as northern area of Pte. d'Esny, offshore of Grand Sable, channel of Ile aux Cerfs, and outside of reef edges. It is expected that further study on the possibility of the procurement shall be conducted from the perspectives of both technical and institutional aspects.

8.5 Implementation of Continuous Monitoring

8.5.1 Principle

a. Beach Monitoring

The objective of continuous monitoring is to conduct the technical transfer and capacity development thorough the actual monitoring work both for physical and non-physical measures. The short term and discontinuous monitoring data is not effective for coastal conservation planning, maintenance and management. Thus, it is important to know how to obtain and accumulate continuous data over the long term. To achieve this, it is necessary to propose and take action through simple and easy monitoring methods as much as possible in order to carry out sustainable long term monitoring by C/P and related stakeholders.

Continuous beach monitoring will be conducted based on the following principles:

- The field work for continuous beach monitoring basically involves regular beach profile surveys and taking photos from fixed points. It is preferable to do the beach profile survey using general survey equipment, such as auto level, staff, measuring tape, digital cameras, etc., which can be utilized by everybody without technical knowledge of survey work.

  Continuous beach monitoring is basically planned to be carried out every 3 months, at least during the period of this project. However, in case unforeseen events occur, such as large storms, heavy rain, etc., additional beach monitoring will be carried out on an irregular basis (when needed) to trace the changes in the beach profile due to such exceptional events.

- Basically, detailed information for beach change can be obtained in proportion to the increase in the number of survey lines. On the other hand, the increase of survey lines will cause complications and increase the necessary manpower and working time for survey work on site as well as data processing and compilation of the database. From this point of view, the number of survey lines shall be determined appropriately, taking into account both required information for beach monitoring and required manpower and time. As a guide, the number of monitoring lines is planned to be roughly 10 lines.

- The obtained monitoring data will be accumulated gradually, and become a vast amount of data in the long term. Also, if uncommon software is employed for data processing and for compiling the obtained monitoring data into the database, it will cause a lack of versatility and difficulty for sustainable beach monitoring. Based on this concern, Microsoft Excel will be used as the common/standard software for data processing and compilation of the database.

b. Monitoring for Coral Reef Environment

It is also important to perform monitoring for the coral reef environment together with beach monitoring to carry out the beach conservation plan, especially from the viewpoints of the middle and long term beach conservation plan. In seven selected priority beaches of the demonstration project, Mon Choisy, Pte. aux Sables and Albion were identified as beaches where the coral reef conditions (corals and water quality) had worsened. In contrast, Pte. d'Esny, which was selected as the site for non-physical measures, has maintained satisfactory

coral reef environmental conditions, and it is required to further maintain such satisfactory conditions to achieve the long term beach conservation goals.

Coral monitoring and water quality monitoring are pointed out as items of coral reef monitoring. Such monitoring has already been carried out continuously over several years by MoF and MoI. Considering the tasks for MOESDDBM, MoF and MOI, it is recommended to undertake monitoring for the coral reef environment by MoF and MOI in cooperation with MOESDDBM. If there is insufficient data on the purpose of coastal conservation planning and management, which will be mainly examined by MOESDDBM, it is recommended for MOESDDBM to request that MoF and MOI consider adjusting their monitoring method.

8.5.2 Items and Purpose of the Continuous Monitoring

Five coasts of continuous monitoring were selected and presented in section 6.2. Continuous beach monitoring is also required for the beaches of physical and non-physical measures. The outline of the monitoring method for physical measures at Grand Sable was presented in section 8.3.8. Thus, the items and purposes of continuous monitoring at six coasts excluding Grand Sable are shown in Table 8.5.1.

Table 8.5.1 Items and Purpose of the Continuous Monitoring

No.	Coast	Category	Monitoring Item	Purpose of Monitoring
1	Mon Choisy	Continuous Monitoring	Beach Monitoring Reef Environment Monitoring (carried out by MoF, MOI)	- To obtain the base data to make a beach conservation plan and continuous beach maintenance plan at southern public beach - To obtain the base data for water quality and corals to make middle and long term beach and reef conservation and management plan
2	Pte. aux Sable	Continuous Monitoring	Beach Monitoring Reef Environment Monitoring (carried out by MoF, MOI)	- To obtain the base data to examine the influence of new revetment at public beach to surrounding area, and to make maintenance plan. - To obtain the base data for water quality and corals to make middle and long term beach and reef conservation and management plan
3	Albion	Continuous Monitoring	Beach Monitoring Reef Environment Monitoring (carried out by MoF, MOI)	- To examine the condition of seasonal beach change and forming of beach scarp especially in front of AFRC - To monitor the influence to the change in beach and reef environment change of coral reef due to flushing of fresh water at southern area.
4	Flic en Flac	Continuous Monitoring	Beach Monitoring	- To obtain the base data to make a beach conservation plan and continuous beach maintenance plan at the public beach located at central area. including sand recycle from northern acculturated area
5	Pte. d'Esny	Non-physical Measure	Beach Monitoring Wave-current observation Reef Environment Monitoring (carried out by MoF, MOI)	-To obtain the data (evidence) to be utilized for the socialization with lessees to discuss the suitable beach conservation measures which will be carried out by lessees.
6	Ile aux Cerf	Continuous Monitoring	Beach Monitoring	- To monitor the change of open channel part due to sedimentation, and beach change at surrounding area to make a suitable maintenance plan to maintain good beach condition as highest tourism area in Mauritius.

Source: JICA Expert Team

8.5.3 Implementation Plan of Continuous Monitoring

a. Establishment of Fixed Monitoring Lines

It is necessary to establish fixed monitoring lines for continuous and long term beach monitoring. The fixed monitoring lines were established together with the C/P taking into account the purpose of monitoring for each beach as presented in the previous section.

For the establishment of fixed monitoring lines, it is necessary to set the fixed starting point for each line. For fixed starting points, permanent facilities such as street lamps or the roots of a large tree were adopted since they can be expected to be permanently fixed objects. The position and coordinates of each fixed object was measured by GPS and photos. This information shall be well recorded and arranged to enable clear understanding of all the information of fixed points even if the person in charge of the survey work changes in the future, as shown in Table 8.5.2.

Table 8.5.2 Example for the Record of Fixed Monitoring Lines

	FEF-1	FEF-2	FEF-3
Fixed starting points			
	20° 18'50.00"S 57° 22'01.60"E	20° 18'38.00"S 57° 21'59.90"E	20° 18'34.90"S 57° 21'59.50"E
Photos taken at fixed points	 	 	 
	Taken at HWM	Taken at HWM	Taken at HWM

Source: JICA Expert Team

Technical background for determination of fixed monitoring lines is shown in Table 8.5.3. The location map for establishment of fixed monitoring lines is presented in Appendix 7.5.1.

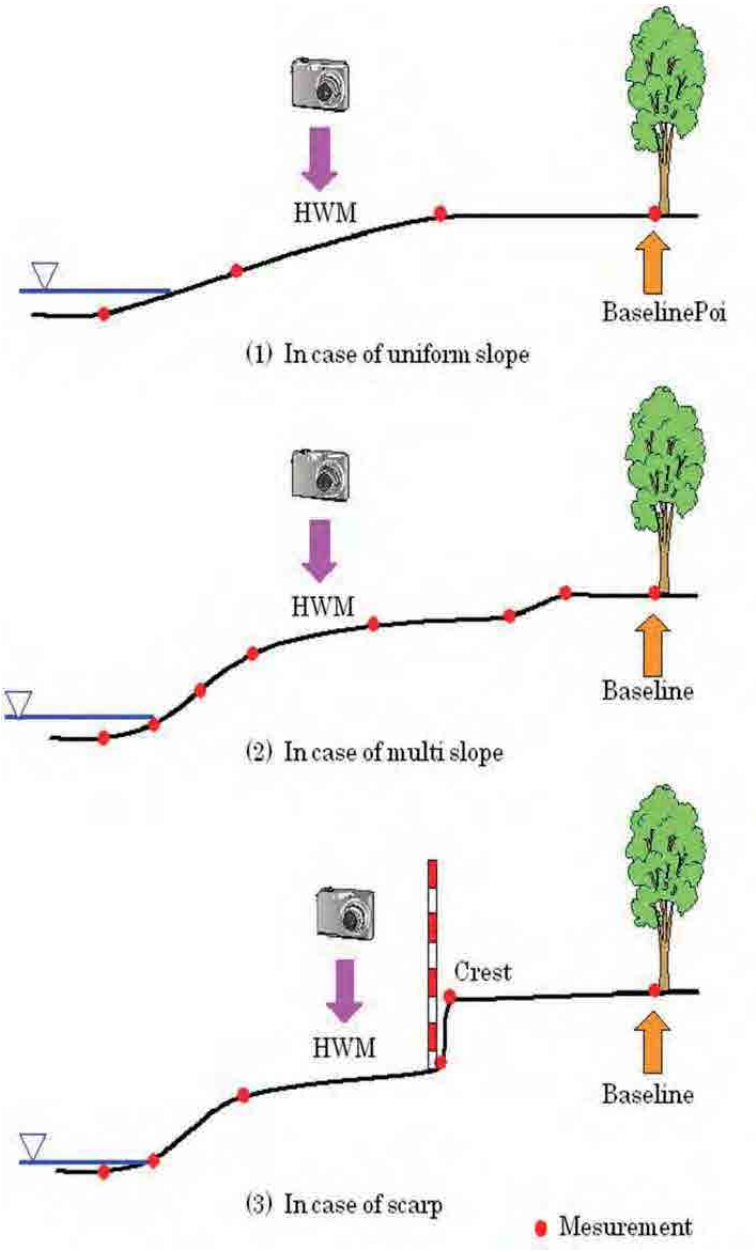
Table 8.5.3 Technical Reason for Establishment of Fixed Monitoring Lines

No	Coast	Technical Background
1	Mon Choisy	The monitoring area was set mainly to cover the southern public beach area and part of the north area taking into account the northward littoral drift.
2	Pte. aux Sables	The monitoring area was set to cover both areas of new revetments at the public beach, where beach scarp was formed.
3	Albion	This beach was identified as being totally eroded. Also beach change due to freshwater flushing is expected at the southern area. Taking this fact into account, the monitoring line was set to cover the whole area including such phenomena.
4	Flic en Flac	The monitoring area was set mainly to cover the public beach area located at the central area of the beach, and the northern accumulation area due to northward littoral drift.
5	Pte. d'Esny	The monitoring line was basically established to check the beach change on both sides of the existing groynes at the central retreat area. The northern accumulation area was also covered in the monitoring area.
6	Ile aux Cerfs	The monitoring area was set-up to cover the central open channel area, and surrounding retreat areas.

Source: JICA Expert Team

b. Monitoring Method

The monitoring method for beach profile surveys and taking photos from fixed points are presented in Figure 8.5.1. The technical transfer by means of OJT (on-the-job training) and by technical guidance will be continuously conducted through the activities of continuous monitoring at each beach.

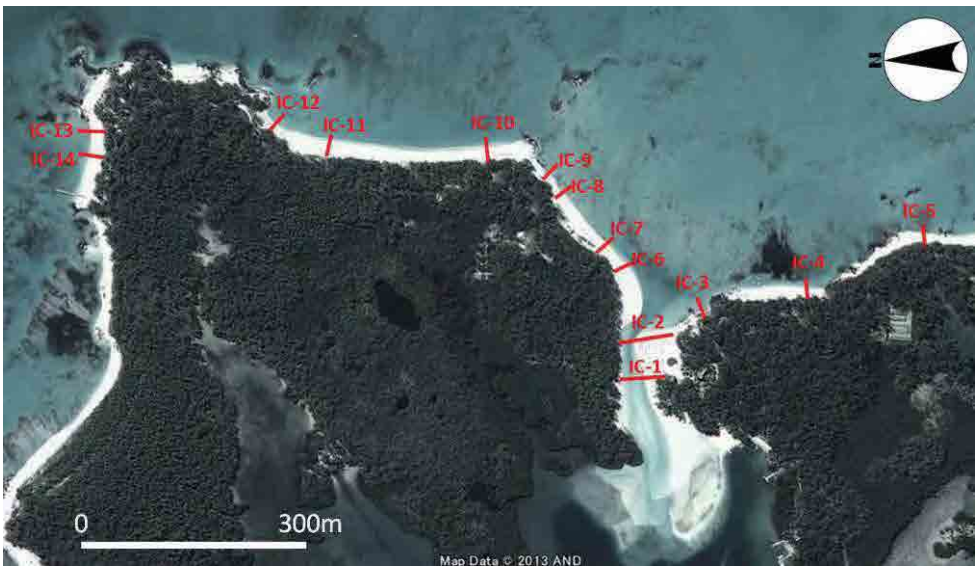


Source: JICA Expert Team

Figure 8.5.1 Method of Beach Profile Survey and Taking Photo from Fixed Point

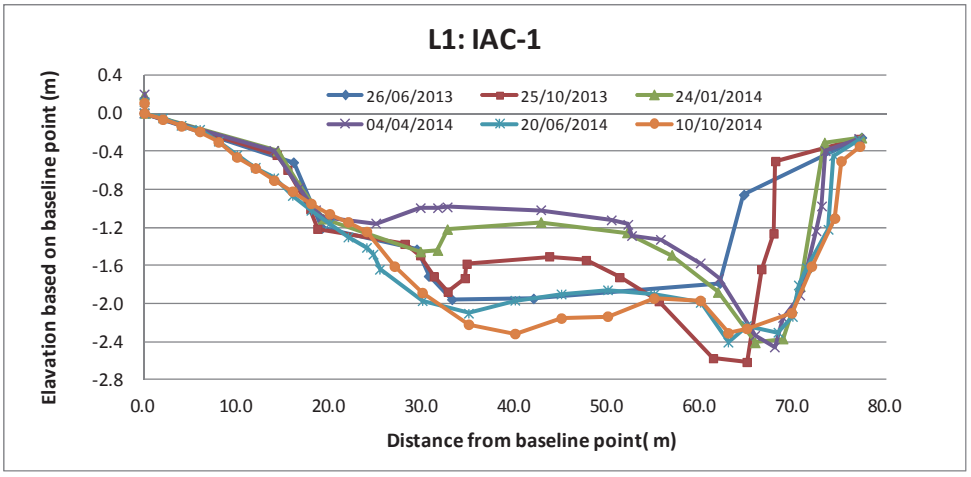
c. Example of Monitoring Results

Continuous monitoring has already commenced at several beaches. Among five monitoring beaches, the continuous monitoring at Ile aux Cerfs has been carried out five times (from June 2013 to up to present). Figure 8.5.2 shows the established fixed monitoring lines at Ile aux Cerfs, and Figure 8.5.3 and Figure 8.5.4 show the example of survey results, which were processed by C/P under the guidance of the JICA Expert Team. The accumulation tendency is clearly observed from the results until April 2014. Then the channel was dredged by the management body (i.e. hotel), and the channel had an appropriate water depth in June 2014.



Source: Arranged by JICA Expert Team based on Google Map

Figure 8.5.2 Location Map showing the Fixed Monitoring Lines (Ile aux Cerfs)



Source: JICA Expert Team

Figure 8.5.3 Change in Profile at the Fixed Monitoring Line in the Channel (IC-1)

Source: JICA Expert Team

26th June 2013 6th October 2013

Figure 8.5.4 Taking Photos from Fixed Point in the Channel

d. Recommended Execution Structure

Technical transfer for continuous monitoring will be carried out mainly by MOESDDBM under the guidance of the JICA Expert Team in the beginning. However, based on the opinion of MOESDDBM, the survey work on the field will be carried out by the Living Environment Unit which is one of the divisions under MOESDDBM, and/or by the Survey team in MoHL. And the ICZM Division will be mainly in charge of the planning of beach conservation and management using obtained monitoring results.

e. Progress and Monitoring Schedule Hereafter

Table 8.5.4 shows the progress of technical transfer on the continuous monitoring which was carried out until now Table 8.5.5 shows the monitoring plan hereafter.

Table 8.5.4 Progress of Technical Transfer for Continuous Monitoring

Date	Contents of Technical Transfer	Attendants
2013/1/25	Technical guidance for wave current observation using wave-current recorder	MoESD、MOI, MMS、Beach Authority, Coast Guard
2013/6/6 2013/6/14	Guidance for installation and removal work of wave-current recorder through the field work	MoESD, Coast Guard, Beach Authority, MOI
2013/6/20	Workshop (1st) for setting and data processing of wave-current recorder	MoESD、MOI, MMS、Beach Authority, Coast Guard
2013/6/26	Setting of fixed monitoring line and 1st monitoring survey at Ile aux Cerf	MoESD
2013/10/4	Confirmation of fixed monitoring line and 2nd monitoring survey at Ile aux Cerf	MoESD
2013/10/7	Workshop (2nd) for setting and data processing of wave-current recorder	MoESD、MOI, MMS、Beach Authority, Coast Guard
2013/10/8 2013/10/10	Guidance for installation and removal work of wave-current recorder through the field work	MoESD, Coast Guard, Beach Authority, MOI
2013/10/10	Setting of fixed monitoring line at Pte. d' Esny	MoESD
2013/10/11	Setting of fixed monitoring line（at Monchisy, Pte. Sable, Albion)	MoESD, Coast Guard
2013/10/18	Setting of fixed monitoring line and 1st monitoring survey at Flic en Flac	MoESD, Coast Guard
2013/10/25	1st monitoring survey at Pte. d' Esny	MoESD, Coast Guard

Source: JICA Expert Team

Table 8.5.5 Implementation of Continuous Monitoring (as of June 2014)

No.	Coast	No. of survey lines	2013			2014											
			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Mon Choisy	8			○	○				○			○		○		
2	Pte. Aux Sable	8	○	○		○			○			○			○		
3	Albion	7	○	○		○			○			○		○			
4	Flic en Flac	11	○			○			○		○				○		
5	Pte. d'Esny	13	○		○	○		○				○			○		
6	Grand Sable	10			○	○	○	○			○			○			○
7	Ile aux Cerf	15	○			○			○		○				○		

Source: JICA Expert Team

The data obtained by continuous monitoring will be utilized as fundamental information to implement beach conservation planning, maintenance and management by the Mauritian side.

We would like to emphasize that it is vitally important to establish a certain method and sustainable system for obtaining long term and continuous monitoring data as well securing a certain level of accuracy. There is a possibility that human error could intrude in the process of monitoring work through the field survey work and data processing, and as a result, such obtained data may be void.

Continuous monitoring will proceed based on the initially proposed method. However, it might be necessary to review and improve the monitoring method in order to achieve monitoring with sufficient efficiency and practicability.

8.6 Economic Impact by Preliminary Cost Benefit Analysis

8.6.1 General

a. Cases for Preliminary Cost Benefit Analysis

Three areas have been targeted for beach conservation; physical measures (at Grand Sable), non-physical measure (at Pte. d'Esny) and tourism spot (at Le Morne) have been carried out for preliminary cost benefit analysis. The effects of beach conservation projects in general include defending assets behind the beach and enhancing the promotion of beach utilization and environment. Countable and un-countable effects for cost benefit analysis for the three cases have been assessed in Table 8.6.1. The un-countable effects mean they are not considered for the preliminary cost benefit analysis even though they indirectly have some effects. Specific beach conservation plans for the three cases are presented in Volume 2.

It should be noted that the cost benefit analyses presented herein have not been carried out with the aim of evaluating project viability, but rather they have been assessed for the purposes of preliminary evaluation on the limited conditions given.

Table 8.6.1 Economic Impact by Beach Conservation Projects

Category	Sub-Category	Grand Sable	Pte. d'Esny	Le Morne
Coastal Defense	Prevention of flooding (Reduction of damage to flooded area)	△	-	-
	Prevention of coastal erosion (Preservation of land and property)	△	○	△
	Impact in case of natural disasters (effect on transport infrastructure)	○	-	-
Environ-ment	Preservation of Natural Scenery	△	△	△
	Protection of Eco-System	△	△	-
	Purification of Sea Water	△	-	-
Utilization	Recreational Utilization	△	△	△
	Fishery Activities	△	-	-
	Revitalization of regional industry (including enhancement of beach activity)	-	-	○

○ : Countable benefits considered for cost benefit analysis
△ : Un-countable benefits considered for cost benefit analysis

Source: Cost Benefit Analysis Guideline of Projects in Coastal Areas in Japan (Revised Edition) (Ministry of Land, Infrastructure, Transport and Tourism)

b. Method and Procedure of Cost Benefit Analysis

Cost benefit analysis is carried out by comparing the costs required to implement the project and benefits to be generated during the project period, confirming the viability of the

proposed project. The project benefits are assessed by comparing the difference between the "With" (the project) case and "Without" case.

The project costs and benefits are to be estimated on a yearly basis. The project life for coastal projects is 30 years (or 50 years) applied in general. Costs and benefits during the project life are discounted from the base year and as a result, present values for costs and benefits are to be compared and evaluated.

c. Evaluation Method of Cost Benefit Analysis

The following three figures are generally used for cost benefit analysis.

c.1 Net Present Value (NPV)

The net present value (NPV) is calculated by the difference between the benefits and costs. The benefits are to be generated by the implementation of a coastal project. The higher net present value means higher benefits caused by the project and the NPV should be more than zero.

c.2 Cost Benefit Ratio (CBR)

The cost benefit ratio (CBR) is calculated by dividing benefits by costs. The higher cost benefit ratio means higher benefits are brought on by the project and the CBR should be more than zero.

c.3 Economic Internal Rate of Return (EIRR)

The economic internal rate of return (EIRR) is the discount rate which makes the costs and benefits for a coastal project during the project life equal. The calculated EIRR should be higher than social discount rates if the project is to be regarded viable. The EIRR is calculated by the following formula.

$$\sum_{i=1}^{n} \frac{(Bi - Ci)}{(1+r)^{i-1}} = 0$$

Where,

n	:	Period of economic calculation
i	:	Year
Bi	:	Benefits in i-th year
Ci	:	Costs in i-th year
r	:	Discount rate

d. Assumptions of Cost Benefit Analysis

d.1 Discount Rate

The long term discount rate of national debts can be used for social discount rates for the project. The average discount rate at the Bank of Mauritius for the last eight years (6%) has been used for the analysis. In the European nations, discount rates between three to eight percent are generally used for evaluation.

d.2 Project Life and Base Year

The project life in general is determined by considering the life period of the facilities. Commonly, 50 years is used as a project life for concrete structures while 30 years is applied for others. Thus, 30 years has been applied for the project life in this analysis. The base year has been set to the year 2014.

8.6.2 Cost Benefit Analysis for Physical Measures at Grand Sable

a. General

Gravel nourishment was conducted at Grand Sable as a physical measure in order to protect the property and coastal road from overtopping waves and flooding (See section 8.3 for details). The benefits for this case include preventing disruptions to transport infrastructure.

b. Benefits (Prevention of transport infrastructure)

The coastal road at Grand Sable is the sole route from the international airport to resort areas such as Ile Cerfs and Belle Mare. The coastal road plays an important role for commuting by bus and transporting sugarcane to factories by truck. If the coastal road is closed due to flooding or waves, an alternative route must be used. As a result, the distance between the origin and destination via the alternative route becomes longer, consuming more fuel for transportation. Thus, with the project implementation, such costs can be saved and such costs can be regarded as the benefits applied herein. In order to grasp the present traffic conditions at Grand Sable, a traffic count survey was conducted as outlined below.

Table 8.6.2 Traffic Count Survey (Grand Sable)

Date	7th October 2014 from 09:00 to 17:00 (Weather: Sunny)
Place	Coastal road A28 at Grand Sable
Traffic	Number of cars heading in northbound (to Ile aux Cerfs) and southbound (to airport) directions were counted separately.
Vehicles	Tour buses, public buses. taxis, ordinary cars, trucks (carrying sugarcane), trucks (carrying non-sugarcane goods), motorcycles

Source: JICA Expert Team

According to the results of the traffic count survey, 500 vehicles passed the coastal road in each direction during the survey period. Accordingly, it can be assumed that roughly 2,000 vehicles in total use the coastal road per day (24 hours)

In cases where the coastal road at Grand Sable is eroded and closed as a result, vehicles must take a detour during the rehabilitation period of the coastal road and thus the users will incur more fuel costs which could otherwise be spent on other activities. The additional costs for fuel can be calculated based on the additionally required distance and the number of days required for rehabilitating the coastal road. Figure 8.6.1 shows the comparison between the original coastal road route and the detour route for the route between Sir Seewoosagur Ramgoolam International Airport and Hotel Le Touessrok.

Original Route in case Road A28 is used

Detour Route in case Road A28 is closed

Source: JICA Expert Team

Figure 8.6.1 Comparison between Original Route and Detour Route (Sample)

The following assumptions have been used for estimating the benefits of this case and as a result, a benefit of 780,000 Mauritian rupees has been calculated per annum.

<Calculation Method>

Annual benefits = (Number of vehicles passing the coastal road per day) x (Additional distance in case of using the detour route) / (Fuel consumption efficiency (kilometers per liter)) x (Number of days for rehabilitating the coastal road)

<Assumptions>

- Number of vehicles passing the coastal road per day：2,000 vehicles
- Additional distance (per vehicle) in case of using the detour route：45km
- Fuel consumption efficiency：7km per liter
- Fuel cost per liter：Rs.50
- Number of days for rehabilitating the coastal road：1 day
- Frequency of occurrence：Once or twice per year (1.5 times per year)

c. Costs

c.1 Construction Costs of Gravel Nourishment

The construction costs for gravel nourishment at Grand Sable have been estimated at 10 million Mauritius Rupees.

c.2 Maintenance Costs

The maintenance costs including rehabilitation and running costs have been simply estimated at 0.5 percent of the initial construction costs.

d. Cost Benefit Analysis

The results of the cost benefit analysis are presented below. All the figures such as NPV, CBR, EIRR satisfy the requirements. Among several possible benefits, the benefits to be generated by the prevention of disruptions to traffic flow have been used for this analysis. It can be said that more benefits can be anticipated in the actual case.

Table 8.6.3 Cost Benefit Analysis (Grand Sable)

Net Present Value (NPV)	Cost Benefit Ratio (CBR)	Economic Internal Rate of Return (EIRR)
2,600(×1,000Rs)	1.2	8.3%

Source: JICA Expert Team

8.6.3 Cost Benefit Analysis for Non-Physical Measure at Pte. d'Esny

a. General

Non-physical measures have been planned in three zones taking into account the sediment transport in Pte. d'Esny (See Section 8.4 and Volume 2 for details). Cost benefit analysis has been focused on Zone 2 where more erosion damage is seen than other zones.

b. Benefits (Prevention of Erosion)

The shoreline change at the target area (Zone 2) is shown below. The blue line shows the shoreline in 1967 while the red line indicates the shoreline in 2008. Comparing those shorelines, the eroded area was calculated to be about 10,000 m^2 over the 41 years (2008-1967). This indicates roughly 300 m^2 eroded annually in that period. Without the project, erosion will continue at the aforementioned rate of erosion.

Source: JICA Expert Team

Figure 8.6.2 Shoreline Change at Zone 2 (Blue line: Year 1967, Red line: Year 2008)

The land in Pte. d'Esny is a leased area and there are five categories in Mauritius for leased areas. The land in Pte. d'Esny is the highest ranked called Zone A and the lease fees are shown in Table 8.6.4.

Table 8.6.4 Lease Fee for Pte. d'Esny (Zone A)

	Lease Fee
(1) Land lease fixed fee for 60 years	5,000,000 (Rs/Arpent)
(2) Annual rental fee	250,000 (Rs/Arpent・year)

Source: Pasgeometriques Act 1874 (Revised)

The land price at the eroded area is supposed to be equal to the leased land price. Considering that the land is priced in the 60 years terms, the following calculation can be made using the figures in Table 8.6.4.

<Calculation> [(1)+(2)×60(years)]/4,221(m^2/arpent)=<u>4,800 Rs/m^2</u>

The above calculation shows a benefit of (preventing erosion) 1,440,000 Mauritian Rupees [=300m^2/year × 4,800Rs/m^2] annually compared with the "Without" project case.

c. Costs

c.1 Initial Costs

Beach nourishment (about 7,500 m^3) and rehabilitation of the existing groynes (30 m x 3 numbers) will be required as an initial measure. Sand to be used for beach nourishment can be obtained from a quarry site with a unit price of 1,500 Rs/ m^3. However, if the recycled sand can be used, a unit price of 550 Rs/m^3 can be applied although sand recycling is prohibited in Mauritius. The rehabilitation of the existing groynes has been estimated at 26,000Rs/m. Thus, the initial costs can be estimated as below.

- Nourishment (sand from quarry site) : 7,500m^3 × 1,500Rs/m^3=11,250,000 Rs
- Nourishment (recycled sand) : 7,500m^3 × 550Rs/m^3=4,125,000 Rs
- Rehabilitation of existing groynes : 30m × 3Nos × 26,000Rs=2,340,000 Rs

c.2 Maintenance Cost

The frequency of maintenance is estimated to be once every two years and a volume of 1,000m^3 of sand should be used for maintenance.

d. Cost Benefit Analysis

The results of the cost benefit analysis are presented below. Except for Case 1 (where all sand for initial nourishment and maintenance will be purchased from a quarry site), the figures for Cases 2 and 3 satisfy the aforementioned requirements. Among the possible several benefits, the benefits to be generated by erosion prevention have been used for this analysis. It can be said that more benefits can be anticipated in the actual case.

Table 8.6.5 Cost Benefit Analysis (Pte. d'Esny, Zone2)

Cases	Sand Nourishment		Net Present Value (NPV)	Cost Benefit Ratio (CBR)	Economic Internal Rate of Return (EIRR)
	Initial	Maintenance			
Case 1	Purchase	Purchase	-4,000(×1,000Rs)	0.9	4.5%
Case 2	Purchase	Recycle	4,600(×1,000Rs)	1.1	7.6%
Case 3	Recycle	Recycle	9,000(×1,000Rs)	2.0	18.0%

Source: JICA Expert Team

8.6.4 Impact on Tourism (Case Study at Le Morne)

a. General

There are a lot of tourist destinations in Mauritius characterized by beautiful beaches and therefore tourism plays an important role in attracting foreign tourists and gaining foreign currencies. How coastal preservation projects contribute to gaining revenue by the tourism industry has been examined choosing the Le Morne case. This case study has been made for projecting benefits only.

b. Benefits (Impact on Revenue by Tourism)

An interview survey was carried out at the Le Paradis Hotel in the Le Morne area with an aim at grasping the importance and attractiveness of the beach conditions for the hotel guests (tourists). The outline of the interview survey is presented below.

Table 8.6.6 Outline of Interview Survey (Le Morne, at Le Paradis Hotel)

Date	8th October 2014 from 09:30 to 12:00 Sunny
Place	Le Paradis Hotel
Interviewees	100 hotel guests
Questions	Q1: What was your main reason for selecting this hotel ? a)Beach Activity, b)Non Beach Activity, c) Scenery
	Q2: Would you like to stay at this hotel again?
	Q3: Suppose this beach is eroded, would you still wish to stay at this hotel again?
	Q4: Where do you come from?
	Q5: How many times have you visited Mauritius?
	Q6: Which hotel did you stay at when you visited Mauritius last time?
	Q7: How many days are you staying at this hotel this time?
	Q8: What is your budget for this trip including airfares per person? a) Euro0-2,000, b) 2,001-4,000, c) 4,001-6000, d) 6,001-8,000, e) 8,001-10,000, f) More than 10,000

Source: JICA Expert Team

The following results were gained by the interview survey.

1) The main reason to choose the hotel: beach activity for 56 guests, non-beach activity for 23 guests and scenery for 23 guests.
2) 97 guests answered that they would like to stay at the same hotel again.
3) 86 guests said they would not like to stay at the same hotel if the beach is eroded.
4) 41 hotel guests were from South Africa, 18 from Germany, 17 from Switzerland, 10 from France, 4 from the United Kingdom, 4 from Belgium, 4 from the Netherland and 3 from Italy.
5) 40 hotel guests came to Mauritius for the first time and the average tourist had visited Mauritius 3.61 times.
6) 27 hotel guests among 60 who have come to Mauritius before stayed at the same hotel as last time and it shows a repeating ratio of 45 percent.
7) The number of stays on average is 9.97.
8) Almost half of the guests replied that their budget for this trip is between 2,001 and 4,000 Euros including their airfare.

According to the results of the interview survey, the following facts can be found.

1) 56 percent of the hotel guests aimed at beach activity at first and 80 percent of them replied that if the beach were eroded they would not feel any special appeal of the hotel. Thus, beach conditions play an important role for tourists in Mauritius.

2) Supposing the beach was eroded 86 hotel guests indicated they would not like to stay at the same hotel anymore. This fact underscores the importance of beach activities for tourists.
3) 97 percent of the hotel guests answered that they would like to stay at this hotel next time. It implies that they are essentially satisfied with the hotel activities.
4) The number of stays is 10 days and it is almost same as the average figure for all tourists in Mauritius.

<Calculation of Benefits>

The interview survey has revealed the importance of coastal conditions for the hotel guests. The hotel guests would not like to use the hotel if erosion continues at the hotel's private beach. Thus, in the case without implementation of the project, erosion of the beach at the hotel will have a detrimental impact on the hotel since the number of the guests may decrease knowing such beach conditions. On the contrary, with the project, such damage may be avoided.

The tourists in Mauritius in general have the same ideas as this study. According to the results of the interview survey, about 30 percent of the hotel guests would not stay at the same hotel if erosion of the private beach continues.

- The primary objective of the trip (staying at the hotel) is beach activity for the hotel guests. (From Q.1)
- Some hotel guests have stayed at the same hotel more than twice and they are so called repeaters of the hotel. (From Q.2)
- Supposing erosion continues at the hotel's private beach, most hotel guest would not like to stay the same hotel. (From Q.3)

Considering the above information, the benefits can be calculated by the following formula and the annual benefit is equal to about 2.3 million Mauritian Rupees.

Calculation of Benefits

Annual benefits＝(Number of guests to stay at the hotel)×(Annual expenditure on average (Rupees/person) × (Percentage of guests who would not stay at the hotel if the private beach is eroded according to the interview survey)

- Number of guests to stay at the hotel: about 19,000 guests (according to the data the hotel provided)
- Annual expenditure on average: about Rs 41,000 per person (according to the Digest of International Travel and Tourism Statistics 2013)
- Percentage of guests who would not stay at the hotel if the private beach is eroded (according to the interview survey results) : 33%

8.7 Outcome of Demonstration Projects

In this Project, three kinds of Demonstration Projects were implemented; 1) Physical measures at Grand Sable, 2) Non-physical measures at Pte. d'Esny, and 3) Continuous monitoring at seven beaches including Grand Sable and Pte. d'Esny. In continuous monitoring, beach profile monitoring was conducted at seven beaches and wave and current measurements were conducted at Grand Sable and Pte. d'Esny.

Since one of the main objectives of the Project is the capacity development, the process to achieve the outcome was considered to be important as well as the outcome itself. The outcome and future subjects are summarized for each Demonstration Project as follows.

8.7.1 Physical Measure at Grand Sable

a. Outcome in the implementation process

- The Demonstration Project as a physical measure was implemented at Grand Sable to protect the hinterland against wave overtopping and high waves. The process required for the implementation (i.e. survey, planning, design, consensus building, preparation of tender documents, EIA, construction management, monitoring after implementation) was conducted together with relative stakeholders and knowledge, understanding and experience has been improved and accumulated throughout this process.
- Stakeholders understood how to determine dimensions of gravel beach profile (i.e. backshore height, backshore width, beach slope and gravel size)
- Residents' awareness and willingness to participate on coastal management were improved through IEC activities, several meetings with residents and beach cleaning events.
- Participatory coastal management by residents has been developed and they have already started to conduct beach cleaning at regular intervals (see Figure 8.7.1 (1) for details).
- MOESDDBM showed a positive attitude to participate in the coastal management cooperating with residents and the beach is going to be declared a Public each.

b. The outcome

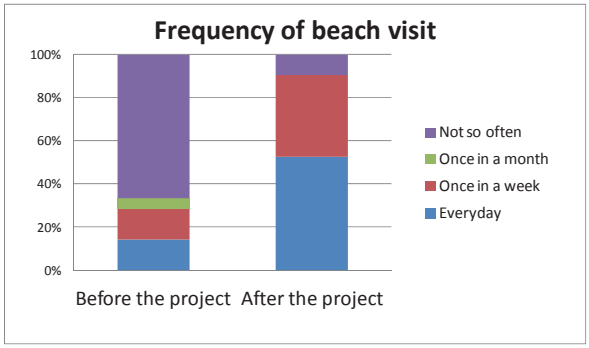
- The effectiveness of the gravel beach against wave overtopping and high waves is confirmed based on the monitoring results. In addition, effectiveness of the measures in terms of environment and beach use is presented based on the questionnaire results by residents (see Figure 8.7.1 (2) to (5)).
- The applicability of the gravel beach is presented as a desirable coastal conservation measure that MOESDDBM would apply for future projects.

c. Future subject

- Through the project, the self-control (beach cleaning) by the residents is now effectively maintaining the beach. However, a lot of garbage drifts in from the sea, and it might be difficult for the residents alone to clean up such a large amount of garbage. Thus, the government's support and participation in periodic beach cleaning is also seen as favorable.
- There are still some cases where the monitoring data had been updated without confirming its accuracy. Important issues to be checked for monitoring are going to be clearly described in the monitoring guideline prepared in this Project. It is recommended for C/P to use this guideline for monitoring to obtain proper data.

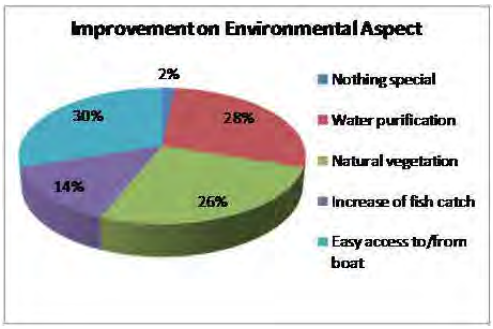
- The pilot Project at Grand Sable applying the gravel beach (flexible revetment) seems to have provided a desirable outcome. However, the applicability of the gravel beach method as one of coastal protection measures depends on each site condition. Thus, taking into account each site condition, careful evaluation when applying this method is strongly required for the future planning and design of coastal protection measures.

(1) Number of participation of beach cleaning
[Majority participated more than once]

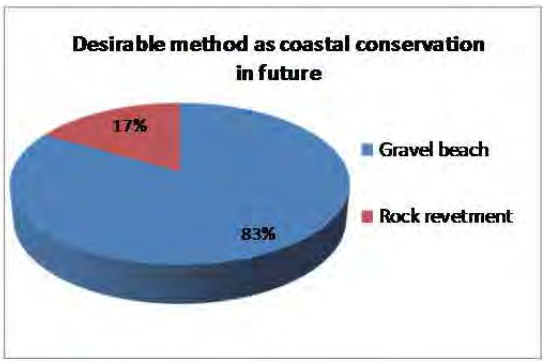


(2) Changes of frequency of beach visit
[Frequency substantially increased after project]

(3) Main purpose of beach visit
[Gravel beach can be used for a variety of purposes]



(4) Improvement of environmental aspects
[Variety of improvements are recognized]



(5) Desirable method as coastal conservation in future
[Majority preferred gravel beach to rock revetment]

Source: JICA Study team

Figure 8.7.1 Questionnaire Results by Residents on the Effectiveness of Gravel Beach

8.7.2 Non-physical Measure at Pte. d'Esny

a. Outcome in the implementation process

- The demonstration project as non-physical measure was implemented at Pte. d'Esny to prepare the coastal conservation plan against beach erosion and interruption of sediment transport by artificial structures at the leased coastal area. The process required for implementation (i.e. survey, planning, conceptual design, and consensus building with residents) was conducted together with relative stakeholders. Their knowledge, understanding and experience had been improved and accumulated through this process.
- Through participation in the process, MOESDDBM accumulated know-how and experience on building consensus with stakeholders to prepare the coastal conservation plan.
- Through several meetings, residents have learned characteristics of sediment transport and the importance of integrated coastal management for beach conservation. In addition, they have learned the adverse effects of groynes along sandy beaches.
- In the planning process, the difference between legislative acts and actual conditions for coastal land use and the lease contract had been realized, especially by MoHL. Residents' understanding on the regulation of lease contracts and land use also improved through the process.
- Effectiveness of the coastal conservation plan was improved by reflecting their local knowledge and opinions from discussions with residents.

b. The outcome

- The coastal conservation plan is finalized by reflecting the resident's opinions into the plan.
- In the coastal conservation plan, residents agreed on beach nourishment and improvement of existing groynes with monitoring.
- Issues required for proper coastal management were clarified and ideas for improvement on the system of coastal management were proposed including lease contracts and land use (see Ch.7.3 for details).

c. Future subject

- In the coastal conservation plan, the removal of existing groynes has not yet obtained consensus from residents. Residents did understand the importance of coastal continuity through several meetings. However, they assign the highest priority to protect their own land and properties. Further detailed discussions on the plan would be needed to obtain consensus, and in some cases, a compromise might need to be reached in order for an agreement.
- Most of the coastal problems are exposed at the leased area, similar to Pte. d'Esny. The coastal management, including planning, design and construction has been basically the responsibility of each lessee individually until now. And this is one of the main reasons for the acceleration of coastal problems, because it causes the littoral movement to become unbalanced. It is necessary to re-discuss such current coastal management systems at lease areas in Mauritius.

8.7.3 Continuous Monitoring at 7 Beaches

a. Outcome in the implementation process

- Relevant stakeholders understood points to be checked for the beach profile monitoring including beach slope, location of the H.W.M. and the L.W.M., grain size, and vegetation area.
- Relevant stakeholders have learned procedures of beach profile monitoring and the survey method using the auto-level, tape measure, GPS, staff, and survey poles.
- Relevant stakeholders understood survey items of wave and current measurements and the procedures of the analysis including primary data processing.
- Relevant stakeholders have learned the measurement sequence of wave and current meters, setup of data acquisition, installation and removal of instruments, and data acquisition.

b. The outcome

- For beach profile monitoring, the implementation system was organized jointly between MOESDDBM and LEU. They have learned how to conduct the profile survey and how to organize and evaluate those results.
- For WAVEHUNTER and current meters, MOESDDBM, MMS and MOI have learned how to conduct the measurements and how to organize and evaluate those results.
- The effectiveness of the coastal conservation plan was improved by applying the data obtained from the beach profile as well as wave and current conditions.

c. Future issues

- There is some room for improvement on the validation capacity of the obtained data (i.e. capacity to pinpoint human errors in the obtained data). It is important to accumulate experience on monitoring to reduce these errors through practice, using the monitoring guidelines prepared in the Project.
- The final goal for continuous monitoring is to obtain the skills for understanding the beach processes and its changes, characteristics of littoral drift, which are required for the planning and design of coastal conservation measures in Mauritius. From this point of view, skills are insufficient and continuous technical transfer based on the OJT method is still required.

Chapter 9

Technical Transfer

9 Technical Transfer

9.1 General

9.1.1 Purpose and Policy

Technology transfer has been carried out to build the capacity for the development of coastal conservation plan and to disseminate necessary engineering knowledge in practice for coastal protection measures, mainly by on–the-job training (OJT) in the course of field investigation, monitoring, data analysis, problem analysis, formulation of plan and conducting demonstration project. The technical transfer also involved development of guidelines, holding of a workshop and seminars in Mauritius, and training in Japan and technical exchange. The technical level corresponded to those in Mauritius.

9.1.2 Items of Technical Transfer

Specific items, purposes and inputs for the technical transfer are shown in Table 9.1.1

Table 9.1.1 Items, Purposes and Inputs for Technical Transfer

Item	Purpose	Input
1. Formulation of technical guidelines	The necessary technical guidelines for the implementation of coastal protection projects are formulated to maintain a suitable technical level.	・Survey on technical items and levels for the coastal protection in Mauritius. ・Acquirement of the method for utilization of the guidelines by OJT
2. Formulation of monitoring guidelines	The guidelines to monitor the changes in beach form and the coral reef environments are formulated. The guidelines are utilized to manage the coastal protection.	・Formulation of the guideline to monitor changes in natural and artificial (nourished) beach form ・Formulation of the guideline to monitor the condition on the health and rehabilitation of coral reefs ・Monitoring using the guideline by OJT
3. Formulation of EIA (Technical Guideline for Environment Impact Assessment) guideline	The guideline is formulated to implement the suitable development with consideration to mitigate coastal erosion because the developments in coastal areas have the potential to cause issues such as coastal erosion.	・Review of existing EIA reports and environmental impacts by coastal projects ・Selection of necessary evaluation items and formulation of the guideline ・Training by ex-post assessment of EIA
4. Workshop and seminars in Mauritius, training in Japan, and technology exchange	Promoting the capacity building for each participant as well as raising the awareness of the importance of coastal conservation by conveying the outcomes of the Project to the government officials, municipal organizations, local companies, residents, and NGOs.	・Holding of a workshop ・Holding of seminars ・Implementation of training in Japan ・Implementation of technology exchange with Seychelles

Source: JICA Expert Team

9.1.3 Method of Technical Transfer

a. Confirmation of Technical Capacity

Regarding the technical transfer, capacity assessments were conducted for three aspects (C/P, C/P organization, and society) at the stage of the beginning, middle, and end of the Project.

The capacity assessments helped the Project to achieve its goals.

b. Stages of Technical Transfer

The technical transfer in the Project was conducted under a four-stage capacity development methodology (Table 9.1.2). The capacity development was performed going through these four stages for each countermeasure activity, and this four-stage capacity development process was repeated numerous times for various countermeasures during the Project period. This repetition helped to improve the C/P's ability effectively.

Table 9.1.2 Stages of Capacity Development

Development Stage
① Acquirement of knowledge for basic management of coastal protection area
② Acquirement of planning and management technology for coastal management
③ Training of planning and works management through the demonstration project
④ Independently implementing, planning and managing surveys

Source: JICA Expert Team

9.1.4 Structure of Technical Transfer

For the effective and smooth technical transfer, the idea was to form groups based on the respective expertise of both the JET and C/P. The groups were basically comprised as follows in the Table 9.1.3. The concept of the technical transfer was to transfer a basic understanding and technology method for the coastal protection to all the members of the C/P.

Table 9.1.3 The JICA Expert Team Member Groups by Expertise

	Group	JET	C/P
1	**Management/Conservation Plan** （Chief Adviser, Vice Chief Adviser/ Coastal Conservation Plan, Countermeasure to Coastal Erosion/Monitoring, Coastal Space Management）	K. ICHIKAWA H. HASHIMOTO S. ONAKA S. ENDO	R Beedassy MOESDDBM R Seenauth MOESDDBM N Soogun MOESDDBM
2	**Survey/Analysis** （Natural Condition Survey/ Analysis, Coastal Transformation Analysis, Coral Reef Conservation, GIS/Topographic Survey ）	M. SAKURABA M. ITSUI S. NOJIMA M. SUGITA	N Soogun MOESDDBM A Jheengut MOESDDBM. AK Dhoomun MOESDDBM
3	**Design/Construction** （Design/ Cost Estimation /Supervision）	M. WASHIDA T. FUJITA M. SHIRATORI	N Soogun MOESDDBM A Jheengut MOESDDBM.
4	**"Soft" countermeasure** （Economic, Financial Analysis, Participatory Coastal Management/IEC Plan, Institution/system analysis/capacity development. Water quality management/environmental and social consideration）	H. TAKAKAZE S. ICHIKAWA K. SAITO T. KURATA	H Ramdour MOESDDBM N Soogun MOESDDBM

Source: JICA Expert Team

9.2 Acquirement of Engineering Knowledge

9.2.1 Coastal Survey of Existing Conditions

The coastal survey of existing conditions in order to grasp the situation of coastal erosion and beach space management was carried out for four days from 26 November to 20 December, 2012 together with the OJT. Four counterparts from the integrated coastal zone management (ICZM) section and two staff from Beach Authority participated in the survey. The survey was carried out using the survey sheet at every coast.

Main items are the height and area of scarp, foreshore slope, bed materials, existing structures, the condition of beach management (distance from shoreline to existing facilities, damage due to wave overtopping, garbage and seaweed on the beach, boundary of setback line, and use situation of the beach).

Counterparts and staff from Beach Authority could master the confirmation method of beach erosion, simplified survey, the difference of slope and bed material of the coast, and beach management problems through the survey.

9.2.2 Coral Reef Survey

Technology transfer was carried out to the C/P during the surveys on coral reefs in June and October 2012. The survey method was the spot-check method shown in the guideline, and the training of the spot-check method was done.

9.2.3 Water Quality Survey

The OJT (on-the-job) training with the aim of transferring technical skills on the water quality surveying to the concerned persons from the analysis organizations was conducted over four days in December 2012. Four persons from NEL in MOESDDBM and five persons from AFRC of the finance ministry participated in the water quality survey of the lagoons and rivers.

9.3 Development of Guidelines

As the final stage of this project, the guidelines listed below were developed in collaboration with the stakeholders. Each guideline is intended to be useful so that the administrator for coastal zone can fully utilize them for the coastal management. The guidelines are explained separately to this main report, namely in Volume 3, to enable the counterparts to easily use them in their daily work. Please refer to Volume 3 for more details.

1. Technical Guideline for Coastal Conservation

2. Technical Guideline for Beach Monitoring

3. Reef Environment Conservaiton Guideline

4. Technical Guideline for Environment Impact Assessment (EIA) on Coastal Conservation Project

For worldwide known guidelines related to coastal protection, there are several guidelines

such as Coastal Engineering Manual (ASCE: 2008), Rock Manual (CIRIA: 2007) and Beach Management Manual (CIRIA: 2010). However, these guidelines are developed for the administrative officers of coastal management and for the consultants who will be engaged with coastal design and planning.

The objective of the development of the guidelines in this project is to establish useful contents for the coastal management works conducted by coastal managers (MOESDDBM). Therefore, it is critical to have the contents of evaluation methodology for feasibility of the plan and selection of construction method for adequate coastal protection considering protection, use and the environment of the coastal zone.

9.4 Workshop and Seminars in Mauritius, Training in Japan and Technology Exchange

9.4.1 Workshop and Seminars

a. Workshop

The workshop on coastal conservation planning was held on June 28th 2013 at Domaine Les Pailles and was attended by over 50 persons. The purpose was to discuss the coastal conservation plan and to inform the results of the Project. The program of workshop is shown in Table 9.4.1. The coastal characteristics of 12 coasts selected as targets for formulation of coastal conservation plans were presented by JET in the workshop. The problems of coastal management of each coast were explained and enhanced common understanding with related organizations from the small meeting results of each coast before the workshop.

The main results were;

- Understanding of coastal characteristics and problems of each coast between stakeholders was achieved.

- It was explained, that when proposing a seatback as a coastal countermeasure, there is a need to check the current status of each facility position and shoreline position (HWM), and to set an appropriate setback line for each area considering the sea level rise in future due to the long-term climate change.

- The need for the environment management based on regulations and active measures such as coral planting for the improvement of the environment was also explained.

- The workshop also explained the need for further studies on the extraction of sand outside of the reef to ensure a long-term and stable sand supply for a beach reprofiling.

Table 9.4.1 Workshop Program for Coastal Conservation

Activity	Time	Speaker
Registration	09: 00 – 09: 15	
Welcome speech	09:15 – 09: 30	Deputy Director Mr. P Kallee Ministry of Environment and SD
Overview of coastal conservation plan	09:30 – 10:00	JET/ Dr. Hiroshi Hashimoto
Coastal conservation plan for Mon Choisy and Pointe aux Cannoniers	10:00 – 10:20	JET/ Mr. Susumu Onaka
Discussions/inputs from stakeholders	10:20 – 10:40	

Tea break	10:40 – 11:00	
Coastal conservation plan for Trou d'Eau Douce, Ile aux Cerfs and Bras d'Eau	11:00 – 11:30	JET/ Dr. Hiroshi Hashimoto
Discussions/inputs from stakeholders	11:30 – 11:40	
Coastal conservation plan for Grand Sable and Pte. d'Esny	11:40 – 12:10	JET/ Mr. Susumu Onaka
Discussions/inputs from stakeholders	12: 10 – 12: 20	
Lunch	12:20 – 13:20	
Coastal conservation plan for Bel Ombre and Le Morne	13:20 – 13:50	JET/ Dr. Hiroshi Hashimoto
Discussions/inputs from stakeholders	13:50 – 14:00	
Coastal conservation plan for Flic en Flac and Albion (beach)	14:00 – 14:20	JET/ Mr. Susumu Onaka
Discussions/inputs from stakeholders	14:20 – 14:30	
Coastal conservation plan for Albion (cliff), Pointe aux Sables and Baie du Tombeau	14:30 – 15:00	JET/Dr. Hiroshi Hashimoto
Discussions/inputs from stakeholders	15:00 – 15:10	
Closing speech	15:10 – 15:30	Dr. Hiroshi Hashimoto
Tea break	15:30 –	

Source: JICA Expert Team

b. 1st Seminar

The 1st seminar was held on June 17th 2013 at the Meridian Hotel for the presentation of the Project and the attendance was over 60 persons including the minister and permanent secretary of MOESDDBM. The program of the seminar is shown in Table 9.4.2. The results of the Project basic study were presented by each member. Also the coastal conservation and space management plan, and capacity development were explained.

The main results were;

- Understanding of the natural characteristics of Mauritius coasts such as the change of waves and tide, water quality and reef environment was achieved by the explanation and discussion of the basic study results obtained newly in the Project.
- Understanding of the present condition and problems of the coast and the direction of conservation plan was achieved.
- The active program for capacity development which is the main purpose of the Project was presented.

Table 9.4.2 Program for 1st Seminar

Activity	Time	Speaker
Registration	09:15 – 09:30	
Welcome speech	09:30 – 09:35	Mrs. D. L. NG., Director of Ministry of Environment and Sustainable Development
Welcome speech/Overview of the study	09:35 – 09:55	Dr. Hiroshi Hashimoto
Opening speech	09:55 – 10:05	Minister of Environment & Sustainable Development
Tea break	10:05 – 10:20	

Wave observation and conditions	10:20 – 10:50	JET/ Mr. Masaaki Sakuraba
Water quality in coral reef	10:50 – 11:20	JET/ Mr. Takayoshi Kurata
Present condition of coastal structures	11:20 – 11:50	JET/ Dr. Hiroshi Hashimoto
Coastal erosion and conservation measures	11:50 – 12:35	JET/ Mr. Susumu Onaka
Lunch	12:35 – 14:00	
Outline of coastal conservation plan	14:00 – 14:30	JET/ Dr. Hiroshi Hashimoto
Coastal space management	14:30 – 15:00	JET/ Mr. Shubun Endo
Public awareness and capacity development	15:00 – 15:30	JET/ Mr. Shingo Ichikawa
Closing speech	15:30 – 15:40	Dr. Hiroshi Hashimoto
Tea break	15:40 –	

Source: JICA Expert Team

c. Regional Seminar (Technical Exchange with the Southwest Indian Ocean Islands)

c.1 Background

In line with the work plan of this Project, the regional seminar on the landslide and coastal zone management in the southwest Indian Ocean islands was organized in order to share the outcomes of the project with the neighboring islands. JET sought to cooperate with the other organizations such as the IOC and the UNDP which both have actively implemented the natural disaster risk measures for the southwest Indian Ocean islands. The IOC was supposed to be responsible for funding and logistics for the seminar, however the IOC could not provide the support for organizing the seminar as the IOC has suspended its main project of natural disaster risk management due to lack of funding. Hence JET initiated to organize the regional seminar.

c.2 Effects of the Seminar on Climate Change Measures and Disaster Risk Reduction Measures

The effects, as judged by the Project, of the regional seminar on climate change and disaster risk reduction measures were:

1) Sharing the outcomes of JICA's activities in Mauritius to the other southwest Indian Ocean islands which could be an example of JICA's technical exchange on disaster risk reduction for the small island developing states (SIDS) at the Third United Nations World Conference on Disaster Risk Reduction in Sendai in 2015;

2) Highlighting JICA's presence in the southwest Indian Ocean islands as well as the measures on climate change and natural disasters implemented by the Government of Japan as linking the regional seminar to the International Year of Small Island Developing States in 2014 and the Third International Conference on SIDS held in Samoa in September 2014;

3) Emphasizing aid coordination and cooperation of the regional seminar by linking the seminar with the Third International Conference on SIDS held in 2014;

4) Following JICA's south-south cooperation as the regional seminar provides an opportunity for Mauritius and the neighboring islands for technical exchange;

5) Extending the outcomes of JICA's project on coastal rehabilitation and protection and landslide management in Mauritius to the neighboring islands through the

presentation and field visits; and

6) Sharing the issues in the southwest Indian Ocean islands with a consideration of the regional centre such as CCIC in Mauritius.

c.3 Seminar Outline

1) Schedule: 5 March 2015 to 6 March 2015 (Day 1: presentation, and Day 2: field visits)

2) Participating islands: Mauritius (including Rodrigues), Madagascar, Seychelles, Comoros and Reunion

3) Participants: one management officer and two technical officers from Madagascar, the islands of Seychelles, Comoros and Reunion, and concerned officers of JICA project from Mauritius (including Rodrigues)

c.4 Purposes of the Seminar

1) Extending the outcomes of JICA's project on landslide management and coastal protection in Mauritius to the neighboring islands;

2) Organizing the seminar in collaboration with the international organizations in order to initiate disaster risk reduction including landslide management and coastal protection; and

3) Promoting technical exchange between Mauritius and its neighboring islands.

c.5 Regional Seminar (Day 1)

Ninty-two participants including the minister for MOESDDBM, the permanent secretary for the MPI, the Japanese ambassador to Mauritius, delegations from the southwest Indian Ocean islands, stakeholders of the project and international organizations participated in the first day of the seminar. Following the speeches by the minister for MOESDDBM and other delegations, the counterparts of the Project and the delegations from Madagascar, Seychelles, Comoros and Reunion gave presentations. The summary of the presentations is as follows.

Photo 9.4.1 Participants of the Seminar (5th March 2015)

Photo 9.4.2 Presentation by a Participant from a Neighbouring Island (5th March 2015)

Source: JICA Expert Team

Table 9.4.3 Presentation Details

Presenter	Presentation details
Mauritius MPI (landslide C/P)	• Landslide management in Mauritius • Classified landslide sites and main related organizations • Landslide monitoring • Countermeasure works in Chitrakoot
Mauritius MOESDDBM (coastal C/P）	• Coastal zone issues in Mauritius (i.e. coastal erosion, coral reef destruction, siltation of lagoons, sea level rise, natural calamities, overfishing, uncontrolled development on the coast, and marine litter) • Coastal zone management (i.e. legal framework, and implementing organizations project details) • JICA's coastal protection and rehabilitation project
Mauritius MESDDBM (climate change C/P）	• Impacts of climate change in Mauritius • Visions and initiatives on climate change and natural disasters
Madagascar	• Natural and human made disasters in Madagascar (i.e. cyclones, landslides, ocean pollution, and oil spills) • Responses for the disasters (i.e. human development, and organizational reinforcement) • Issues of landslide (i.e. .soil, environmental degradation, and lack of data)
Seychelles	• Hazard profile in Seychelles (i.e. storm surges, landslides, coastal erosion, heavy rainfall, and flash floods) • Responses for disasters (i.e. organisational set up, and project implementation) • JICA's project on coastal erosion and flooding
Comoros	• Natural disasters in Comoros (i.e. landslides, coastal erosion, and flooding) • Impacts caused by the disasters • Responses for the disasters
Reunion	• Natural disasters in Reunion (i.e. landslides, coastal erosion, flooding, and sea level rise) • Projects implemented for the natural disasters

Source: JICA Expert Team

c.6 Regional Seminar (Day 2)

Approximately 60 participants from the southwest Indian Ocean islands, counterparts of the Project and stakeholders in Mauritius joined the field visits for the second day of the regional seminar. Participants visited Chitrakoot, where the landslide countermeasure works were implemented under the landslide management project, and Grand Sables, where the flexible revetment (gravel nourishment) was implemented under the coastal protection and rehabilitation project.

Photo 9.4.3 Explaining the Monitoring System and Countermeasure Works in Chitrakoot (6th March 2015)

Photo 9.4.4 Group Photo taken at Grand Sable (6th March 2015)

Source: JICA Expert Team

Engineers of the MPI who are the counterpart of the landslide management project explained the countermeasure works, early warning system and monitoring devices in Chitrakoot. At Grand Sables, environmental officers of the MOESDDBM explained flexible revetment (gravel nourishment). Additionally, local villagers explained the positive effects of the demonstration project.

c.7 Discussion

Followed by the presentations by each participant from southwest Indian Ocean islands, participants discussed the ways of cooperation such as technical exchange on climate change adaptation and mitigation measures, and information sharing for disaster risk reduction and management. The three following points; 1) possible areas of cooperation, 2) systems to be introduced and 3) establishment of regional centre were mainly discussed. Discussion details are shown in the Table 9.4.4.

Table 9.4.4 Discussion Details

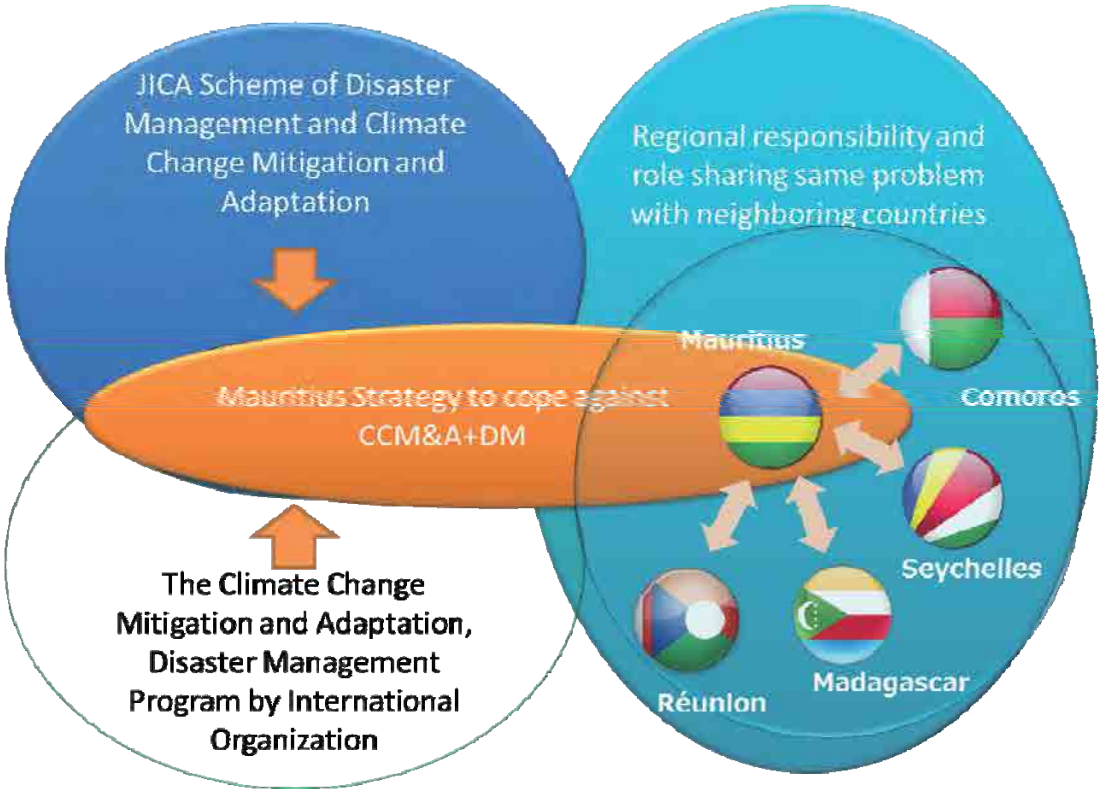
Answered by countries/ organizations	Discussion details
1. What kind of disaster risk reduction measures are taken in each island?	
Comoros	• Mangrove plantation
Madagascar	• Enhancement of the research activities • Introduction of early warning system at the community level • Mangrove plantation
Reunion	• Enhancement of sensitization activities • Establishment of effective and efficient disaster risk reduction measures in the limited budget • Enhancement of soft countermeasures (i.e. information sharing with local residents)
Seychelles	• Enhancement of multi-agency cooperation before and after the disaster in order to prevent duplication of the activities • Establishment of the early warning system • Mangrove plantation • Enhancement of awareness raising activities
2. What are required for disaster risk reduction in future?	
Mauritius	• Enhancement of vulnerability analysis

	• Establishment of a platform where officers at technical and management level are able to share the information in the region • Capacity building in terms of data collection and monitoring
Comoros	• Enhancement of academic knowledge on coastal zone management • Establishment of a platform to share information and experience in the region • Organizational reinforcement in terms of human resources and equipment
Reunion	• Establishment of a platform to share information beyond Reunion
Seychelles	• Collection of data and experience • Accessing funds
IOC	• Cooperation beyond the different level of development and organizational capacity in the islands • Understanding the issue of accessing data rather than lack of data. Firstly data sharing among the different ministries in the same country needs to be strengthened and the data sharing system at the national level is required. • Establishment of database for information and data sharing in the region • Promoting the technical exchange beyond individual countries
3. What are the ways of cooperation among the southwest Indian Ocean islands?	
Mauritius	• Utilization of the Climate Change Information Centre (CCIC) established by JICA's support • Sharing the data and materials collected at the CCIC
IOC	• Development of the training programme for island technical officers in order to deal with the island specific issues
4. Landslide early warning system	
MPI Mauritius	• Three stages of warning, evacuation and termination • The device has a yellow light for warning stage and a red light with alarm for evacuation stage.
5. Landslide monitoring	
MPI Mauritius	• Consulting the monitoring works to the Mauritian private company • Conducting monitoring at three sites
6. Climate change adaptation measures for coastal zone	
MOESDDBM Mauritius	• Shifting from hard countermeasures to soft countermeasures
7. Examples of information sharing in the region	
IOC	• Sharing the information such as waves and water quality on the website of Mauritius Oceanography Institute (MOI)
8. Any actions taken at the community level for demonstration project	
MOESDDBM Mauritius	• Awareness raising of the local residents through beach beautification organized once a month at Grand Sable • Organized stakeholder meeting for more than five times before the demonstration project

Source: JICA Expert Team

Participants including the IOC pointed out that the information sharing system at the regional level is necessary. Caribbean Disaster Emergency Management Centre (CDEMA) in Caribbean Community (CARICOM) in Central and South America could be an example of cooperation, however the southwest Indian Ocean islands have several issues to establish the cooperation system as the islands have different development levels, economies and issues on climate change and disaster risk management. The regional seminar could be a first step to establish an information sharing system.

The following diagram (Figure 9.4.1) proposed by JET was generally accepted as common concepts among countries participating in the seminar.



Source: JICA Expert Team

Figure 9.4.1 Concept Diagram of Cooperation on Climate Change and Disaster Risk Management among JICA, International Organizations, Mauritius and the Southwest Indian Ocean Islands

c.8 Outcomes of the Regional Seminar

The outcomes of the JICA'S Project on coastal protection and rehabilitation, and landslide management in Mauritius were shared through the presentation in the first day and field visits in the second day. Technical knowledge and experience of the other islands were also shared. Moreover, cooperation on climate change and disaster risk management were emphasized, and participants had a fruitful discussion for continuous cooperation in future.

c.9 Participant List for the Day 1

Table 9.4.5 Participant List for the Day 1

	Name	Designation
Ministry of Public Infrastructure and Land Transport		
1	Mr. V. LUTCHMEEPARSAD	PERMANENT SECRETARY
2	Mr. LALLCHAND	SENIOR ADVISOR TO MINISTER MPI
3	Mr. R. JEWON	DIRECTOR, CIVIL ENGINEERING
4	Mr. T. PARBHUNATH	DEPUTY DIRECTOR, CIVIL ENGINEERING
5	Mr. D. CHINASAMY	CHIEF ENGINEER, LMU/RRU
6	Mr. N. EARALLY	CHIEF ENGINEER
7	Mr. S.P. ANADACHEE	ENGINEER/ SENIOR ENGINEER

8	Mr. M. K. MOSAHEB	ENGINEER/ SENIOR ENGINEER
9	Mr. L. BISSESSUR	ENGINEER/ SENIOR ENGINEER
10	Mr. V. RAMDHAN	ENGINEER/ SENIOR ENGINEER
11	Mr. B. DABYCHARUN	ENGINEER/ SENIOR ENGINEER
12	Mr. VISHAN	TECHNICAL OFFICER
13	Mr. V. RAMCHURN	TECHNICAL OFFICER
MINISTRY OF ENVIRONMENT, SUSTAINABLE DEVELOPMENT, DISASTER AND BEACH MANAGEMENT		
14	Hon. JAYESHWUR RAJ DAYAL	MINISTER
15	Mrs. S.L. NG YUN WING	DIRECTOR
16	Mr. S. MOOLOO	DEPUTY DIRECTOR
17	Mr. R. SEENAUTH	DIVISIONAL ENVIRONMENT OFFICER (ICZM)
18	Mr. J. SEEWOOBADUTH	DIVISIONAL ENVIRONMENT OFFICER (CCD)
19	Mrs. S. R. N. B. SOOGUN	ENVIRONMENT OFFICER (ICZM)
20	Mr. A. JHEENGUT	ENVIRONMENT OFFICER (ICZM)
21	Mr. J.R. OH-SENG	ENVIRONMENT OFFICER (CCD)
22	Mrs. T. GUJADHUR	ENVIRONMENT OFFICER (CCD)
23	Mr. H. BHOLAH	CHIEF PROJECT MANAGER
UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP)		
24	Mr. S. SPRINGETT	UN RESIDENT COORDINATOR & UNDP RESIDENT REPRESENTATIVE
25	Mr. S. RAMCHURN	ENVIRONMENT PROGRAMME OFFICER
AFRICAN FUND PROGRAMME (AFP)/UNDP		
26	Mr. M N. KHEDAH	PROJECT MANAGER
27	Ms. M. CLARKE	HEAD OF CLIMATE CHANGE CONSULTING
INDIAN OCEAN COMMISSION (IOC)		
28	Ms. G. BONNE	CHARGEE DE MISSION
29	Mr. S. AHAMADA	EXPERT IN MARINE AND COASTAL BIODIVERSITY
30	Mr. J. B. ROUTIER	TECHNICAL ASSISTANT
EUROPEAN UNION (EU)		
31	Mr. H. GRANDJEAN	PROJECT MANAGER
AGENCE FRANÇAISE DEVELOPMENT (AFD)		
32	Ms. S. AMMEARALLY- NISTAR	CHARGEE DE PROJETS
BUREAU NATIONAL DES GESTIONS DES RISQUES ET CATASTROPHES (BNGRC) MADAGASCAR		
33	MR. C. RAMBOLARSON	ADJ. DU SÉCRETAIRE EXÉCUTIF
34	Mr. J. J. RAZAFIARISON	DIRECTEUR DES RÉPONSE AUX URGENCES
MINISTRY OF ENVIRONMENT AND ENERGY, SEYCHELLES		
35	Mr. N. SENARATNE	DIRECTOR, COASTAL ADAPTATION AND MANAGEMENT SECTION
36	Mr. L. PAYET	LOCAL PROJECT MANAGER
37	Mr. H. FIGARO	SENIOR INSPECTOR (CAMS)
DIRECTION GÉNÉRAL DE LA SÉCURITÉ CIVILE, UNION DES COMORES		
38	Mr. COLONEL I. MOGNE DAHO	DIRECTEUR GÉNÉRAL DE LA SÉCURITÉ CIVILE UNION DES COMORES
39	Mr. A. AHMED	CHEF DU CENTRE DES DONNÉES OCÉANIQUE
40	Mr. N. B. ALI MOEGNI	TECHNICIEN AU SERVICE DES ÉTUDES ET PRÉVENTION
DIRECTION DE L'ENVIRONNEMENT, DE L'AMENAGEMENT ET DU LOGEMENT REUNION		
41	Mr. O. BIELIN	CHEF DE L'UNITÉ PRÉVENTION DES RISQUES NATURELS
RODRIGUES REGIONAL ASSEMBLY		
42	Mr. J. L. AZIE	AG. ENVIRONMENT OFFICER
MINISTRY OF HOUSING AND LANDS		
43	Mr. S. GUNNOO	SENIOR TOWN & COUNTRY PLANNING

		OFFICER
44	Mr. R. SOBORUN	SENIOR PLANNER
MINISTRY OF TOURISM AND EXTERNAL COMMUNICATIONS		
45	Mrs. L. SANSPEUR	PRINCIPAL TOURISM PLANNER
46	Mr. J. GOPAUL	TOURISM PLANNER
MINISTRY OF LOCAL GOVERNMENT		
47	Mr. M.B. RAJABALEE	ASSISTANT PERMANENT SECRETARY
MINISTRY OF OCEAN ECONOMY, MARINE RESOURCES, FISHERIES, SHIPPING AND OUTER ISLANDS		
48	Ms. N. ROOMALDAWOO	TECHNICAL OFFICER
49	Mr. V. MUNBODHE	SCIENTIFIC OFFICER
NATIONAL DISASTER RISK REDUCTION AND MANAGEMENT CENTRE (NDRRMC)		
50	Mr. R. LUXIMON	ENVIRONMENT OFFICER
MAURITIUS METEOROLOGICAL SERVICES (MMS)		
51	Mrs. S. RAMESSUR	AG. DIVISIONAL METEOROLOGIST
WATER RESROUCES UNIT		
52	Mr. S.A. ZEADALLY	SENIOR HYDROLOGICAL OFFICER
FORESTRY SERVICES		
53	MR. N. NAWJEE	DIVISIONAL FOREST OFFICER
54	Mr. Z. JHUMKA	ASSISTANT CONSERVATOR OF FORESTS
SPECIAL MOBILE FORCE/ POLICE DEPARTMENT		
55	Mr. D. RAMGUTEEA	SERGEANT
56	Mr. S. BEEDASY	LIEUTENANT
MAURITIUS OCEANOGRAPHY INSTITUTE (MOI)		
57	Mr. O. PASNIN	ASSOCIATE RESEARCH SCIENTIST
58	Dr. D. BISSESSUR	ASSOCIATE RESEARCH SCIENTIST
ROAD DEVELOPMENT AUTHORITY (RDA)		
59	Mr. V. MULTRA	MANAGER
TRAFFIC MANAGEMENT AND ROAD SAFETY UNIT		
60	Mr. D.P. GOOLJAR	ENGINEER/SENIOR ENGINEER
61	Mr. I. MUSTALLY	TRAINEE ENGINEER
WASTEWATER MANAGEMENT AUTHORITY (WMA)		
62	Mr. N. BANHARALLY	CIVIL ENGINEER
63	Mr. R. JHURRY	WORK MANAGER
UNIVERSITY OF MAURITIUS (UOM)		
64	ASSOC. PROF Dr. NOWBUTH	DEAN OF FACULTY AND OCEAN STUDIES
65	Mrs. Y. BAGUANT	SENIOR LECTURER
BEACH AUTHORITY		
66	Mr. V. TOOFANY	TECHNICAL OFFICER
NATIONAL COAST GUARD		
67	Mr. H. CAULEECHURN	INSPECTOR OF POLICE
NATIONAL PARKS AND CONSERVATION SERVICES		
68	Mr. P. MOOLEE	SENIOR PARK RANGER
69	Mr. S. PANDOO	TECHNICAL OFFICER
CITY COUNCIL OF PORT LOUIS		
70	Mr. R. MADHUB	AG. PRINCIPAL HEALTH INSPECTOR
71	Mr. O.C.G. DOMAH	HEAD, PUBLIC INFRASTRUCTURE DEPARTMENT
MUNICIPAL COUNCIL OF CUREPIPE		
72	Mr. J. JAUNKY	SENIOR HEALTH INSPECTOR
MUNICIPAL COUNCIL OF QUATRE BORNES		
73	Mr. A. REESAUL	HEAD, PUBLIC INFRASTRUCTURE DEPARTMENT
MUNICIPAL COUNCIL OF BEAU BASSIN		
74	Mr. R. OODALLY	HEAD, PUBLIC INFRASTRUCTURE
MUNICIPAL COUNCIL OF VACOAS PHOENIX		
75	Mr. S. LALOO	CIVIL ENGINEER
DISTRICT COUNCIL OF GRAND PORT		

76	Mr. S. SAIRALLY	HEAD, PUBLIC INFRASTRUCTURE DEPARTMENT
DISTRICT COUNCIL OF SAVANNE		
77	Mr. D. KOONJUL	HEAD LAND USE PLANNER
78	MR. A. RUNGASSAMY	CHIEF HEALTH INSPECTOR
DISTRICT COUNCIL OF PAMPLEMOUSSES		
79	Mr. R. RADHA	HEAD, PUBLIC INFRASTRUCTURE DEPARTMENT
DISTRICT COUNCIL OF BLACK RIVER		
80	Mr. P. BALLOO	HEAD, PUBLIC INFRASTRUCTURE DEPARTMENT
DISTRICT COUNCIL OF MOKA		
81	Mr. M. RAGAVEN	CIVIL ENGINEER
EMBASSY OF JAPAN IN MADAGASCAR/MAURITIUS		
82	H.E. Mr. HOSOYA	AMBASSADOR OF JAPAN TO MAURITIUS
83	Ms. TAMOTO	THIRD SECRETARY
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		
84	Ms. K. TAKAHASHI	PROJECT FORMULATION ADVISOR
85	Mr. CHIBA	INTERN
86	Mr. TSUDA	INTERN
JICA EXPERT TEAM		
87	Mr. K. ICHIKAWA	CHIEF ADVISOR
88	Ms. H. YOSHIDA	PROJECT COORDINATOR
89	Ms. J. BHANDARI	LOCAL CONSULTANT WITH JICA
90	Ms. S.B. MUNGROO	PROJECT ASSISTANT
OTHER		
91	Mr. BEEHUSPUTEE	AG D.C.E D.C.P
92	Mrs. BHENDANEE	

Source: JICA Expert Team

d. 2nd Seminar

The 2nd seminar was held on April 8th 2015 at Westin Hotel for the presentation of Project outcomes and the attendance was over 60 persons including the minister and permanent secretary of MOESDDBM. The program of the seminar is shown in Table 9.4.6. The main outcomes were presented in the seminar; coastal conservation plan, beach management plan, reef conservation plan and capacity development plan.

The main results were;

- Understanding on beach erosion issues in Mauritius and its mechanism and countermeasures was improved.
- Understanding on importance of coastal management and monitoring for future adaptive management was improved.
- Understanding that cooperation by different stakeholders (i.e. Ministries) necessary for successful integrated coastal management was improved.

Table 9.4.6 Program for 2nd Seminar

Activity	Time	Speaker
Registration	09:15 – 09:30	
Welcome speech	09:30 – 09:40	Mrs. D. L. NG., Director of Ministry of Environment and Sustainable Development
Welcome speech	09:40 – 09:50	Mr. Kensuke Ichikawa/ JET Chief Adviser
Opening speech	09:50 – 10:10	Hon. J. R. Dayal, Minister of MESDDBM
Tea break	10:10 – 10:20	
Overview of the Project	10:20 – 10:50	JET/ Dr. Hiroshi Hashimoto
Coastal Conservation Plan	10:50 – 11:20	JET/ Mr. Susumu Onaka
Beach Management Plan	11:20 – 11:50	JET/ Mr. Shubun Endo
Coral Reef Conservation Plan	11:50 – 12:20	JET/ Dr. Satoshi Nojima
Information, Education & Communication Plan	12:20 – 12:40	JET/ Mr. Shingo Ichikawa
Closing speech	12:40 – 12:50	Mr. S. Mooloo
Lunch	13:00 –	

Source: JICA Expert Team

9.4.2 Training in Japan

The objective of the training in Japan is to enhance the understanding of coastal conservation and management system from Japanese practices, and to enable the C/P trainees to apply this knowledge in the activities in Mauritius. In the training the characteristics of the coastal conservation management in Japan were taught through the field observations and lectures. The applicability to the coastal problems in Mauritius was also discussed. Table 9.4.7 shows the training items and contents of the training. The aim of the training was for the C/P trainees to acquire knowledge from planning to management of coastal conservation through hard and soft measures.

Table 9.4.7 Training Items and Contents

Training Items	Contents
1) Measures and effects of coastal structures and beach nourishment against coastal erosion and waves and storm surges 2) Maintenance of structures.	Purposes: In Japan structural measures have been taken for coastal conservation. Those examples are the coasts of Kanagawa, Ibaragi and Chiba Prefecture where the participants visited and received lectures of management and planning methods of beach nourishment. The knowledge is obtained for the idea, technology, effect and maintenance of coastal conservation. The applicability is also considered to the coast of Mauritius. The effects and impacts of structures are obtained from the training. Visiting site and coastal works: Sand and gravel nourishment, sand bypassing, head land, detached breakwater and outlet improvement at the coasts of Kanagawa, Ibaragi and Chiba Prefecture Site visit and lecture: Dr. Takaaki Uda of the Public Works Research Center gave lectures on the site. He is one of the authorities of coastal engineering field and has many experiences for coastal planning and structures.
3) Beach conservation with nature friendly measures 4) Beach management with the collaboration between governments and local people	Purpose: The knowledge of coastal zone management in Japan is obtained through site visits, lectures and discussions at Shiraho in Ishigaki Island of Okinawa Prefecture where the similar conditions as in Mauritius has like coral reef. The applicability is also considered to the coast of Mauritius. Site and activities: Shiraho, Ishigaki Island of Okinawa Prefecture In Shiraho area, stakeholders of the local government, researchers and local people have been conducted for the integrated coastal zone management such as tourism development, nature conservation, eco-tourism, environmental education, treatment of washing ashore of debris, conservation of traditional cultures, rules of lagoon use, prevention of outflow of red soil. Those activities are discussed with governmental and non- governmental people. Site visit and lectures: Dr. Seino (Associate Professor in Kyushu University) who has many experience for the practice of soft measures and public consultation for beach management, conducted a lecture on soft measures methods. Dr. Nojima of the JET gave a lecture on the conservation of coral reef in Ishigaki Island.

Source: JICA Expert Team

9.4.3 Technology Exchange

The technology exchange was held between Mauritius and Seychelles where the similar project as “Coastal Erosion and Flood Control Management in the Republic of Seychelles” was in progress. Six members of MOESDDBM and one member of MPI attended to the seminar and site visits of pilot projects at Seychelles.

The objective of the technology exchange is to enhance spread effect in south west Indian Ocean because they have common issue such as shortfall in human resources and lack of ability. The schedule is shown in Table 9.4.8.

Table 9.4.8 Program of Technology Exchange

Date	Items	Activities
July 8th (Mon)	Transfer	Mauritius to Seychelles
July 9th (Thu)	Attending seminar	Members presented the coastal management and flood problems in Mauritius and discussed the pilot projects in Seychelles at the seminar
July 10th (Wen)	Site visit at Mahe	Pilot projects of beach nourishment at North East point, outlet improvement at Au Cap
July 11th (Thu)	Site Visit at La Digue	Pilot projects of groyne and beach nourishment at La Passe
July 12th (Fri)	Lecture of GIS, Transfer	Explanation of GIS application in Seychelles and discussion Seychelles to Mauritius

Source: JICA Expert Team

9.4.4 Steering Committee

The Steering Committee (hereinafter SC) is held with relevant organizations in Mauritius, in order to establish smooth cooperative system, to have common understanding about the progress and issues on the Project, and to facilitate decision making and problem solving. The establishment and operation of the SC should be handled by C/P, and JET helps the C/P to precede the meetings.

Table 9.4.9 Plan of SC

Item	Coastal Protection
Contents	● Approval of activity plan ● Confirmation of progress ● Discussion of issues ● Discussion of necessary matter on the Project
Members	Chairman: MOESDDBM PS Member: MOESDDBM, ICZM Division Director, MoLG, MoFR, MoHL, MoTL, MoAFS, MoEPU, MPI, BA, MOI, NCG, Other related organizations, Japan Embassy of Madagascar, JICA Madagascar Office, JET
Schedule	Each period based on report submission
Participants	Around 20

Source: JICA Expert Team

The initial SC was held on 28th May, 2012 to explain the role of the SC followed by the explanation of countermeasures needed to prevent coastal erosion and the role of stakeholders to the project.

Table 9.4.10 The Contents of the 1st SC

Item	Overview
Date/Time	28 May, 2012 09:30-11:00
Venue	Conference room, MOESDDBM Headquarters.
Contents	● Role of SC ● Countermeasures to coastal erosion ● Role of stakeholders
Participants	MOESDDBM: D L Ng, P Kallee, J Peeroo, S Seewoobaduth, R Beedassy, R Seenauth, BMD Kurreemun, L Magho, N Soogun, S Buskalawa, A Jheengut, R Luximon,

Item	Overview
	H Ramdour, AK Dhoomun Other Ministries/Organizations: M Hurbungs, D Jhuboo, N Mungroo, N Khedah, R Bhagooli, S Zeadally, C P Aubeeluck, D Bissessur, J Mosaheb, H B Naujeer, H Cauleechurn, G Rosunee JICA: Tsukizoe, Kawase, Razafimahefa JET: Ichikawa, Hashimoto, M. Citon

Source: JICA Expert Team

The second SC was held on 4th July, 2013 to explain the Progress Report and after its approval was obtained. The coastal conservation plan is formulated for 12 coasts, the demonstration project for two coasts and the monitoring for five coasts.

Table 9.4.11 The Contents of the 2nd SC

Item	Overview
Date/Time	4 July, 2013 13:00-14:15
Venue	Conference room, MOESDDBM Headquarters.
Contents	● Acceptance of PR ● Coastal conservation plan of 12 coast ● Demonstration project of 2 coast ● Monitoring project of 5 coast
Participants	MOESDDBM: D L Ng, P Kallee, J Peeroo, S Mooloo, R Seenauth, D Rajkoomar, M Jeelall, BMD Kurreemun, L Magho, N Soogun, S Buskalawa, A Jheengut, R Luximon, H Ramdour, AK Dhoomun Other Ministries/Organizations: B Ramcharun, M Hurbungs, D Jhuboo, C Green Jokhoo, S Permala, P Balloo, S K Seechurn, H Gopaul, B M Heetun, R Ramessur, G Servansingh, H Cauleechurn, S Zeadally, J Mosaheb, J Mosaheb, P Juddoo JET: Hashimoto, Onaka, Ichikawa(Shingo), Kurata, Yoshida

Source: JICA Expert Team

The third SC was held on 12th December, 2013 to explain the Interim Report and after its approval was obtained. Also the progress of demonstration projects was explained.

Table 9.4.12 Contents of the 3rd SC

Item	Overview
Date/time	12 December, 2013 13:00-15:30
Venue	Conference room, MOESDDBM Headquarters.
Contents	● Acceptance of Interim Report ● Progress and output for Demonstration Project (Physical, Non-physical, Beach Monitoring)
Participants	MOESDDBM : D L Ng, P Kallee, J Peeroo, R Seenauth, D Rajkoomar, M Jeelall, N Soogun, H Ramdour, B M D Kurreemuh Other Ministries/Organizations :

Item	Overview
	C Green-Jokhoo, C N Pauplah, HT Parsad, O Gooroochurn, H Caulleechurn, P Balloo, A Reesaul, I Auladin, N Langur JET： K. Ichikawa, Onaka, S B Mungroo (Assistant)

Source: JICA Expert Team

The fourth SC was held on 20th October, 2014 to explain the Progress Report 2 and after its approval was obtained. Also the progress and results of demonstration projects was explained.

Table 9.4.13 Contents of the 4th SC

Item	Overview
Date/time	20 October, 2014　14:00-15:30
Venue	Conference room, MOESDDBM Headquarters.
Contents	● Acceptance of Progress Report 2 ● Progress and output for Demonstration Project (Physical, Non-physical, Beach Monitoring)
Participants	MOESDDBM： D L Ng, P Kallee, S. Mooloo, J Peeroo, D Prithipaul, N Soogun, H Ramdour , I Auliar, VKanhye, B M D Kurreemuh , A K Dhoomun, S Sannassy, Other Ministries/Organizations: C Green-Jokhoo, R Juggoo, S Zeadally, N Bheemul, S Ramessur, J Mosaheb, H Caulleechurn, H Kinoo, S Pandoo, G Servansing, A Makkhankhan, R Ramessur, P Balloo, K K Sowaruth JICA: K. Takahashi JET： Hashimoto, Onaka, S. Ichikawa, Nojima, Endo, S B Mungroo (Assistant)

Source: JICA Expert Team

The fifth SC was held on 2nd April, 2015 to explain the Draft Final Report and after the Report was accepted by stakeholders.

Table 9.4.14 Contents of the 5th SC

Item	Overview
Date/time	2 April, 2015　9:30-10:35
Venue	Conference room, MOESDDBM Headquarters.
Contents	● Explanation and Acceptance of Draft Final Report
Participants	MOESDDBM： O Jadoo, D L Ng, R S Snea, R Seenauth, A Jheengut, N Khedah, S Salamut, S Sannassy Pilly, N Soogun Other Ministries/Organizations: C Green-Jokhoo, R SOborum, N Roomaldawo, V Bahraz, Z Jhmka, R Virasami, R Hemoo, D Cyparsade, S Zeadally, H Kinoo, M K Bhoyrag, K Domah, M Chadee JET： K. Ichikawa, Hashimoto, Onaka, S. Ichikawa, Nojima, Yoshida, S B Mungroo (Assistant)

Source: JICA Expert Team

9.4.5 Technical Committee

The Technical Committee (hereinafter TC) is held as a support of SC in order to share the gradual accomplishments and corresponding problems with relative organizations during the assignments. The technical committees have been conducted fourteen times and the overview of each committee is listed in the following tables.

Table 9.4.15 The Contents of the 1st TC

Item	Overview
Date/Time	24 July, 2012　13:30-15:00
Venue	Conference room, MOESDDBM Headquarters.
Contents	● Overview of the accomplishments and schedule ● Request for the data needed for following study ● Schedule of technical transfer ● Explanation about the instruments used in this study
Participants	MOESDDBM: R Beedassy, N Soogun, S Buskalawa, A Jheengut, H Ramdour, AK Dhoomun, P. Samy Other Ministries/Organizations: N Khedah, S Zeadally, Mosaheb, L. Appadu, M Hurbungs, V. Bachraz, H Cauleechurn JET: Hashimoto, Sugita, Sakuraba, Washida, Itsui, M. Citon

Source: JICA Expert Team

Table 9.4.16 The Contents of the 2nd TC

Item	Overview
Date/Time	17 Aug, 2012　13:30-15:00
Venue	Conference room, MOESDDBM Headquarters.
Contents	● The characteristics of erosion by field survey (By Mr. Uda) ● Case examples of erosions in Japan and the countermeasures (By Mr. Uda) ● Overview of the accomplishments and schedule
Participants	MOESDDBM: R Beedassy, D Prithipaul, D Boodhun, D S Chamilall, N Soogun, Bhaguirutty, A Jheengut, H Ramdour, R Mookool, Y Poinen, AK Dhoomun, N Sunathee Other Ministries/Organizations: N Nawjee, J Jokhoo, D Bissessur, Y Gungah, M Hurbungs, S Pandoo, H Cauleechurn, R Ramessur, C Pothunah- Aubeeluck JET: Uda, Onaka, Kurata, Washida, Sakuraba, Itsui, Ichikawa, S. Bundhun

Source: JICA Expert Team

Table 9.4.17 The Contents of the 3rd TC

Item	Overview
Date/Time	25 September, 2012　13:30-15:00
Venue	Conference room, MOESDDBM Headquarters.
Contents	● Present coral condition based on field survey
Participants	MOESDDBM：R Beedassy, D Prithipaul, D Boodhun, D S Chamilall, N Soogun, Bhaguirutty, A Jheengut, H Ramdour, R Mookool, Y Poinen, AK Dhoomun, N

Item	Overview
	Sunathee Other Ministries/Organizations：N Nawjee, J Jokhoo, D Bissessur, Y Gungah, M Hurbungs, S Pandoo, H Cauleechurn, R Ramessur, C Pothunah-Aubeeluck JET： Nojima, S. Bundhun

Source: JICA Expert Team

Table 9.4.18 The Contents of the 4th TC

Item	Overview
Date/Time	7 December, 2012　10:00-11:40
Venue	Conference room, MOESDDBM Headquarters.
Contents	● Beach erosion based on the analysis from aerial photos ● Schedule of hearing survey for coastal disaster ● Schedule of water quality survey ● Confirmation of organization/Institution
Participants	MOESDDBM：S Meeheelaul, D Rajkumar, L Magho, P Samy, N Soogun, T Abdool, R Ohseng, V Ponin Other Ministries/Organizations：H B Naujeer, H B Naujeer, Dass Bissessur, J Mosaheb, G Servansingh, P Gujadhur, H Caullechurn, N Nawjee JET： Hashimoto, Endo, Takakaze, Sugita, Saito, Kawanishi, S. Bundhun

Source: JICA Expert Team

Table 9.4.19 The Contents of the 5th TC

Item	Overview
Date/Time	29 January, 2013　10:00-11:30
Venue	Conference room, MOESDDBM Headquarters.
Contents	● Explanation of DFR ● Explanation of 12 selected beaches for coastal conservation plan and 20 selected beaches for basic survey
Participants	MOESDDBM：D. Lan Ng , K. Heeramun , J. Seewoobaduth ,S Meeheelaul, D. Prithipaul, R. Beedassy, R. Seenauth, M. Jeelall, B.M.D Kurreemun, N. Soogun, S. Buskalawa, A. Jheengut, H. Ramdour, Y. Poinen, Y. Fanny Other Ministries/Organizations：H. Cauleechurn, P. Jhuboo, J. Mosaheb, R. Ramessur, H B Naujeer, N Nawjee, Y. B. Moonshiram, C. P. Aubeeluck, G. Servansing, R. Soborun, M. Marie JICA: Takahashi (Madagascar office) JET： Ichikawa, Onaka, Sakuraba, Itui, Kawanishi, Saito, M Citon, S. Bundhun

Source: JICA Expert Team

Table 9.4.20 The Contents of the 6th TC

Item	Overview
Date/Time	31 May, 2013 10:00-12:00
Venue	Conference room, MOESDDBM Headquarters.
Contents	● Explanation of PR ● Proposal for 20 beaches for basic survey, 12 beaches for coastal conservation plan, 7 beaches for demonstration project and monitoring
Participants	MOESDDBM：P. Kallee, R. Seenauth, D. Rajkoomar, B.M.D Kurreemun,

Item	Overview
	M.L.Magho, N. Soogun, H. Ramdour, N. Khedah, A.K.Dhoomun, P. Juddoo, A. Jheengut Other Ministries/Organizations：B. Ramcharrun, C.P.Aubeeluck, M. Marie, B.M.Heetun, H. Cauleechurn, G. Servansing, K. Cuniah, Y. Ibrahim, J. Mosaheb, S. Zeadally, R. Ramessur, P. Balloo, D. Siburuth, S. K. Seechurn JET： Hashimoto, Onaka, Kurata, S. Ichikawa, Yoshida, M. Citon, N. Marie

Source: JICA Expert Team

Table 9.4.21 The Contents of the 7th TC

Item	Overview
Date/Time	30 August, 2013 10:30-12:00
Venue	Conference room, MOESDDBM Headquarters.
Contents	● Explanation on preliminary design for physical measure ● Conservation plan for 12 beaches ● Work plan for demonstration project
Participants	MOESDDBM：P. Kallee, R. Beedassy, D. Prithipaul,R. Seenauth, S. Buskalawa, B.M.D Kurreemun, N. Soogun, A. Jheengut, H. Ramdour, M. Sardoo, . P. Juddoo, D. Dumur, J. Sannassy Pilly , A.K.Dhoomun Other Ministries/Organizations：B. Ramcharrun, H Naujeer, D. Bholee, S. Ramracheya, Y. Baguant-Moonshiram, J. Mosaheb, S. Zeadally, S. Ramkaun, H. Cauleechurn, G. Servansing JET： Hashimoto, Kurata, Fujita, S. Ichikawa, M. Cition, N. Marie

Source: JICA Expert Team

Table 9.4.22 The Contents of the 8th TC

Item	Overview
Date/Time	19 September, 2013 1400-16:00
Venue	Conference room, MOESDDBM Headquarters.
Contents	● Construction plan and EIA for physical measure at Grand Sable ● Plan for non-physical measure at Pte. d'Esny
Participants	MOESDDBM：P. Kallee, R. Beedassy, D. Prithipaul,R. Seenauth, S. Buskalawa, B.M.D Kurreemun, N. Soogun, A. Jheengut, H. Ramdour, M. Sardoo, . P. Juddoo, D. Dumur, J. Sannassy Pilly , A.K.Dhoomun Other Ministries/Organizations：B. Ramcharrun, H Naujeer, D. Bholee, S. Ramracheya, Y. Baguant-Moonshiram, J. Mosaheb, S. Zeadally, S. Ramkaun, H. Cauleechurn, G. Servansing JET： Hashimoto, Onaka, M. Citon, N. Marie

Source: JICA Expert Team

Table 9.4.23 The Contents of the 9th TC

Item	Overview
Date/Time	5 December, 2013 14:00-16:10
Venue	Conference room, MOESDDBM Headquarters.
Contents	● Progress of demonstration projects (Physical and non-physical measures, continuous monitoring)

Item	Overview
	● Plan for the schedule of 2nd stage
Participants	MOESDDBM：S Mooloo, R Seenauth, N Soogun, J Sanassy Pilly Other Ministries/Organizations：D. Rajkoomar, C G Jokhoo, B Dwarka, C N Pauplah, S Ramah, G Servansing, O Gooroochurn, B M Heetun, H T Parsad, H Gopaul, H Caulleechurn, W S Gopal, M S Sairally, N Langur, P Balloo, A Reesal, S K Seechurn JICA：K. Takahashi JET：K. Ichikawa, Onaka, Yoshida, N. Sumoodhee, S.B. Mungroo (Assistant)

Source: JICA Expert Team

Table 9.4.24 The Contents of the 10th TC

Item	Overview
Date/Time	7 April, 2014 13:00-15:10
Venue	Conference room, MOESDDBM Headquarters.
Contents	● Progress of coastal conservation plan and future plan ● Progress of demonstration projects (Physical and non-physical measures, continuous monitoring)
Participants	MOESDDBM：S Mooloo, R Seenauth, H Pathel, K Heeramun, D Prithipaul, B M D Kurreemun, A Jheengut, H Ramdour, S Salamat Other Ministries/Organizations：R Ramessur, C G Jokhoo, C N Pauplah, T Abdool, D Vithilingum, R Soborun, G Servansing, J Mosaheb, R Virasami, H Gopaul, R Dookbhunjun, W S Gopal, N Roopun, J F M Enouf, P Balloo, S K Seechurn JET： Hashimoto, Ichikawa, S.B. Mungroo (Assistant)

Source: JICA Expert Team

Table 9.4.25 The Contents of the 11th TC

Item	Overview
Date/Time	9 June, 2014 14:00-15:40
Venue	Conference room, MOESDDBM Headquarters.
Contents	● Progress of coastal conservation plan and demonstration projects ● Contents of guidelines
Participants	MOESDDBM：S Mooloo, R Seenauth, H Pathel, K Heeramun, D Prithipaul, R K Foolman, D C Chamilall, N Khedah, V Clair, N Soogun, A Jheengut, H Ramdour, S D Jowahir, I Auliar, D Tatur Ramasamy, S Salamat, A K Dhoomun Other Ministries/Organizations：R Ramessur, R Soborun, N Roomaldawo, G Servansing, J Mosaheb, R Virasami, H B Naujeer, H Gopaul, S Zeadally, R Dookbhunjun, W S Gopal, J F M Enouf, M F Joomratty, N Roopun JET： Onaka, Ichikawa, Sakuraba, Itsui, Sugita, S.B. Mungroo (Assistant)

Source: JICA Expert Team

Table 9.4.26 The Contents of the 12th TC

Item	Overview
Date/Time	31 July, 2014 10:00-12:00
Venue	Conference room, MOESDDBM Headquarters.
Contents	● Explanation of progress report 2 ● Progress of coastal conservation plan and EIA guideline
Participants	MOESDDBM：S Mooloo, R Seenauth, K Heeramun, Y. Pathel, R.Beedassy, D. Boodhun, N Soogun, V. Kanhye, M. L. Magho, R. Sadayen, S. Buskalawa, Sannassy Pilly S, J Sanassy Pilly, A. Jheengut Other Ministries/Organizations： J. Mosaheb, S. Gunnoo, J Ramen, N Roomaldawo, S Zeadally, S Salamut, R Gowreea, R Virasami, D Cyparsade, H Gopaul, H Cauleechurn, D Koonjul, W S Gopal, J F M Enouf, M F Soowratty JET： Hashimoto, Nojima, Kurata

Source: JICA Expert Team

Table 9.4.27 The Contents of the 13th TC

Item	Overview
Date/Time	15 October, 2014 10:00-12:00
Venue	Conference room, MOESDDBM Headquarters.
Contents	● Response to comments for the Progress Report 2 ● Principle for the coastal conservation plan ● Progress of demonstration projects at Grand Sable and Pte d'Esny ● Contents of guidelines
Participants	MOESDDBM：Y Pathel, A Ghoorah, N Soogun, H Ramdour, I Auliar, S D Jowahir, Sannasy Pilly S, A Jheengut Other Ministries/Organizations：J Mosaheb, R Juggoo, N Ramaldawo, D Cyparsade, C Cyparsade, S Sauba, H Cauleechurn, R Virasami, R Ramessur, R Bhagooli, R Zeadally JET： Onaka, Nojima, Endou, Ichikawa, S.B. Mungroo (Assistant)

Source: JICA Expert Team

Table 9.4.28 The Contents of the 14th TC

Item	Overview
Date/Time	26 March, 2015 10:00-12:00
Venue	Conference room, MOESDDBM Headquarters.
Contents	● Discussion on Draft Final Report including Coastal Conservation Plan for Priority Coasts ● Confirmation on Ministries that Wave Hunters and Current Meters to be Provided ● Announcement of 2nd Seminar
Participants	MOESDDBM： S Mooloo, R Beedassy, D Boodhun, R Seenauth, S Soobron, L Magho, N Soogun, H Ramdour, S Salamut, N Khedah, Sannasy Pilly S, A Jheengut Other Ministries/ Organizations; J Mosaheb, R Sogorun, M J Lau Yuk Poon, L Bissesur, H Ninoo, N Ramaldawo, Z Jhumka, K Ruhomaun, H Cauleechurn, R Virasami, R Ramessur, R Bhagooli, R

Item	Overview
	Zeadally, S Dhunnoo, N Rpun, D Cyparsade, K Domah, P Baloo, V Mnebhurrun JET: K. Ichikawa, Onaka, Nojima, Endo, S. Ichikawa, S B Mungroo(Assistant)

Source: JICA Expert Team

9.5 Summary

Technology transfer has been carried out to build the capacity for the coastal conservation and to learn the necessary engineering knowledge in practice, mainly by the OJT in the course of field investigation, monitoring, data analysis, problem analysis, formulation of plan and conducting demonstration project. The guidelines are also planned together with the workshop, seminar, training in Japan and technical exchange. The technical level should correspond to those in Mauritius. The result of capacity development which includes the technology transfer is explained in Chapter.7 of Capacity Development and ICE Plan.

9.5.1 Basic Technology

Basic technologies for coastal conservation are the beach monitoring, understanding of shoreline changes, coral reef and water quality monitoring, wave observation, application of coastal environment data base, sand nourishment and reprofiling, and the designing and planning of coastal facilities. Among these the beach monitoring, understanding of shoreline changes, sand nourishment and reprofiling, and the designing and planning of coastal facilities were not carried out in the past and have been newly introduced in Mauritius. The coral reefs and water quality monitoring have been carried out in Mauritius already, however the spot-check method of coral which is considered necessary from the point of view of coastal conservation and Chlorophyll *a* method for the water quality measurement were introduced as technology transfer. The Offshore waves have been measured in Mauritius, however, the monitoring of water level, waves height and current in the lagoon were not implemented, therefore the measuring technology in a lagoon was transferred. The application method of the existing database of coastal environment was introduced for the coastal erosion management.

In the past the importance of beach monitoring was pointed out, however the beaches were not monitored. During the basic study of the Project, the technology transfer was implemented by conducting the monitoring of the beaches in cooperation with C/P. Also ICZM put it to practical the technology transfer by conducting monitoring of the priority coasts of the coastal conservation plan and coastlines where it had implemented projects in the past. This monitoring was conducted at 3-monthly intervals from November 2013. This data will contribute to understanding of long term coastal changes in Mauritius.

The beach reprofiling is an effective countermeasure for beach scarps caused by cyclones but it had not been implemented before the Project. MOESDDBM organized LEU (Living Environment Unit) and trained its technicians in cooperation with JET by lectures and field training. As a result, reprofiling has been used as beach maintenance works from 2014.

The technology transfer for the observation of waves, currents and tides has been carried out to the members of MMS and MOI at the time of the Project basic study and with a workshop because they did not have experience. These organizations are planning to continue the

observation after the transfer of the equipment. The results will contribute to the accumulation of wave data around Mauritius in future.

9.5.2 Technology of Planning and Management for Coastal Conservation

The technologies of planning and management for coastal conservation were mainly transferred to the MOESDDBM, related government organizations and academic institutions through Technical Committee. In Mauritius those technologies were limited and not applied to coastal erosion measures before the Project.

Technical Committee was held 14 times from the beginning of the Project on July 2012 to March 2015 and supported the technology transfer and the capacity development of stakeholders in the course of discussions on the coastal conditions, their problems, coastal conservation plans and the implementation and evaluation of the demonstration projects as the progress of the Project.

In Mauritius there was no experience for the formulation of coastal conservation plan for individual coasts. Then for the plan of priority coasts, working session was held three times to each coast and the contents were discussed. Also the plan was checked at the site. The planning technology has been transferred to stakeholders for the understanding of site specific issues and the selection of measures with their capacity development.

Before the Project, the coastal management was not considered fully the coastal erosion problems. It is believed that each organization obtained the knowledge and method for the management of coastal disasters such as the integrate coastal zone management by MOESDDBM, the setback management by MHL, the management of public beach by BA, and the reef conservation by MoOEMRFSO (Ministry of Ocean Economy, Marine Resources, Fisheries, Shipping and Outer Island).

9.5.3 Technical Guidelines

The technology related to the basic study and the formulation of conservation plan were summarized as guidelines because there is no guideline for the coastal erosion measures corresponding to the specific conditions in Mauritius. These guidelines consist of the natural and design conditions for the coastal conservation measures, the planning, designing, construction and maintenance for the conservation facilities, beach and coral monitoring, water quality analysis, coral plantation and EIA.

The guidelines were summarized upon considering the characteristics of Mauritius for the MOESDDBM and related organizations in the course of coastal conservation practice. In the future, together with the utilization of the guidelines by MOESDDBM for coastal conservation, the Project proposes to continue to improve the guidelines based on experience it gains from implementing coastal conservation in Mauritius.

9.5.4 Seminar and Training

Workshop was held to dissimulate the information of coastal conservation which was not common in Mauritius. In the workshop for the coastal conservation plan, the contents were discussed with the stakeholders which include residents, and confirmed at the site. In the seminar, the Project's overall description was explained and at the end of the project the results were explained. As technical exchange the C/P attended the seminar held in

Seychelles where similar project was held and discussed with the related people. The results will contribute to the development of technical capacity of both countries.

The training in Japan was held in December 2013 with seven participants of Mauritius because of the lack of sufficient knowledge and experiences of the engineers in Mauritius. The participants attended lectures and field observation on the coast of Ibaragi, Chiba and Kanagawa Prefectures and learned the present conditions of coastal conservation in Japan. Also they observed the examples of coastal conservation of coral coast in Okinawa Prefecture similar to Mauritius and exchanged opinions on measures for environment and landscape conservation with the persons concerned. In addition, the participants studied the applicability of these examples to Mauritius. The engineers obtained new perspective and the application is expected in the future.

9.5.5 Demonstration Projects

Flexible revetment was proposed as applicable measures in Mauritius for the physical demonstration project because the nature friendly measures were not investigated. The technology were transferred to C/P through its planning, designing and construction. The flexible revetments of gravel were constructed by ICZM at Riviere des Creoles and Bois Des Amourettes by the application of the demonstration project.

In the past a consensus was formed for the demolish of individual structures but not for the coastal conservation plan for a coast. For the consensus building as non-physical measures of demonstration project, the meetings were held with the stakeholders and residents and tried to make a plan for the coastal conservation at Pte d'Esny. The experiences can be applied to similar cases in the future though the consensus was not formed.

9.5.6 Recommendations

The capacity development is a kind of a continuous activity. It has to be continued according to the capabilities improvement and IEC plan as explained in Chapter7. Especially recommended is the selection and development of the capacity which is required in Mauritius because the human resources and budget is limited in Mauritius. This Project will become the start of the development for technical capacities.

Chapter 10

Environment, Climate Change and Disaster Management

10 Environment, Climate Change Adaptation and Disaster Management

10.1 General

In the Hyogo Framework for Action (hereinafter referred to as HFA) adopted by the World Conference on Disaster Risk Reduction (hereinafter WCDRR), signatory countries agreed on a disaster prevention action plan for 10 years setting more effective integration of disaster risk considerations with a special emphasis on disaster prevention as a strategic goal. Based on this framework, the Japanese Government announced the Initiative for Disaster Reduction through Official Development Assistance (hereinafter ODA), and the Yokohama Action Plan compiled at the Fourth Tokyo International Conference on African Development (hereinafter referred to as TICAD IV), which both address environmental/climate change issues as an urgent challenge. In the Summary by the Chair of TICAD IV, Japan mentioned special considerations to small island states. Meanwhile, various climate change adaptation programs are underway in Mauritius, mainly by the Japanese Government, the United Nations Development Programme (hereinafter referred to as UNDP) and the Indian Ocean Commission (hereinafter referred to as IOC).

Under such global circumstances, in Mauritius which is vulnerable to climate change, landslide issues in particular are becoming more serious due to the recent natural disasters resulting from environmental changes and the increased number of structures on steep slopes because of tourism and land development. Mauritius has been taking disaster prevention measures. The country has come up with plans and measures based on scientific and technical grounds through consultancy services from international firms as the local counterparts did not have all the necessary skills or experience to conduct the work independently. So far, Mauritius has been undertaking disaster prevention measures since the 1990's. In this context, the Government of Japan has agreed to provide Technical Assistance on coastal protection and rehabilitation upon the request of the Government of Mauritius.

After the commencement of the Project, the United Nations Conference on Sustainable Development 2012 (RIO +20) and the Fifth Tokyo International Conference on African Development 2013 (TICAD V) were held. The vulnerability of Small Island Developing States (SIDS) to climate change was emphasized and acknowledged as an important issue at RIO +20, and the Yokohama Declaration 2013 and the Yokohama Action Plan 2013 – 2017 came into effect in the TICAD V. The following points are noted in relation with the Project.

1. Yokohama Declaration 2013

   Africa is still one of the most vulnerable regions to natural disasters and climate change impacts, thus, the TICAD process will aim to build a resilient society to climate change to facilitate sustainable development.

2. Yokohama Action Plan

   (1) Environmental and Climate Change

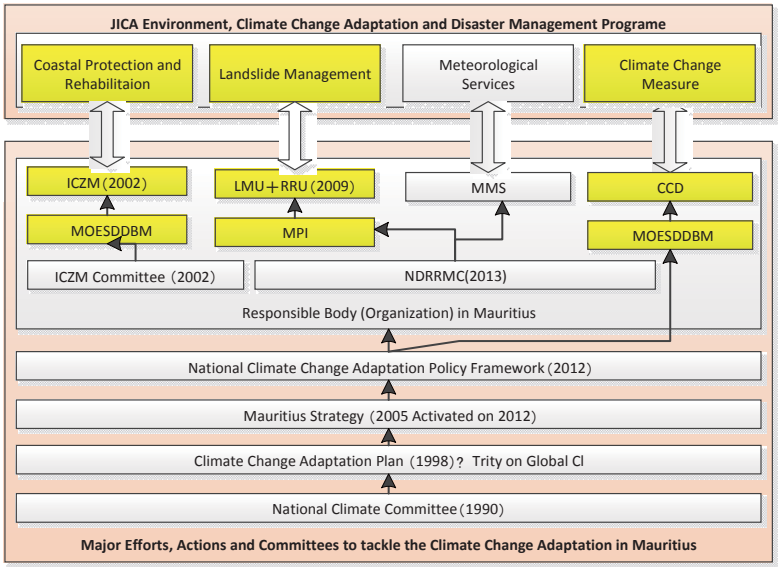
   Climate change is compounding existing development challenges as Africa's major economic sectors such as agriculture and fisheries are vulnerable to climate sensitivity and are projected to be increasingly severely impacted by climate variability and change. Special attention must be paid to the building of climate change resilient societies that are

capable of anticipating and facing environmental disasters as well as to conservation and sustainable use of biodiversity, prevention of desertification and land degradation. Measures to address environment and climate change are articulated across various sectors in this Action Plan, such as in infrastructure, agriculture and water.

(2) Disaster Prevention

Out of all natural disasters, droughts occur most frequently and cause the highest number of victims in Africa, while storms and floods due to cyclones cause serious damage to island and coastal countries. As Africa's natural disasters are mostly climate-related such as drought and floods, adaptation to climate change must be directly linked to efforts toward disaster risk reduction. It is critical to mainstream disaster risk reduction into development agendas with special consideration for vulnerable groups such as the elderly, women and disadvantaged persons

In July 2014, Prime Minister Shinzo Abe visited the Caribbean Community (hereinafter referred to as CARICOM) member states, and presented Japan's CARICOM policies consisting of three pillars (1. Cooperation towards sustainable development, including overcoming the vulnerabilities particular to small island states, 2. Deeping and expanding fraternal bonds of cooperation and friendship and 3. Cooperation in addressing challenges of the international community). Following that, in November 2014, the Ministerial Joint Statement between Japan and CARICOM, Japan's Foreign Minister Kishida reaffirmed Japan will give utmost consideration to the fields of disaster risk reduction, countermeasures and to actively engage in international discussions concerning vulnerabilities particular to Small Island Developing States (herein after referred to as SIDS). Over the past decade, Japan focused on the Environment, Climate Change Adaptation and Disaster Management issues as important diplomatic roles. Japanese technology and expertise is nurtured through its similar experience in the fields of disaster risk reduction, countermeasures against environmental degradation and climate change.



Source: JICA Expert Team

Figure 10.1.1 JICA Environment, Climate Change Adaptation and Disaster Management Program and Related Mauritius Agencies

Following the aforementioned global action, the Coastal Protection and Rehabilitation Project was launched as a component of the Program of the Japan International Cooperation Agency (hereinafter referred to as JICA) Environment, Climate Change Adaptation and Disaster Management Scheme. The Project should also share the view of the Climate Change Adaptation, Environment and Disaster Management in Mauritius to produce a synergistic effect with other components (or projects). The effective technical transfer shall first consider the relation with political and administrative capability of Mauritius together with the collaboration of other relevant Projects by other Development Partners. Figure 10.1.1 shows the relation of JICA Project components and respective Mauritius organizations.

10.2 Environment, Climate Change Adaptation and Coastal Protection and Rehabilitation

There is a possibility that climate change—and associated oceanographic and weather changes—may increase the risks posed to the natural environment such as changes to ecosystems and coastal erosion as a result of rising sea levels and seawater temperatures and higher frequency of cyclones and subsequent tidal waves and storm surges.

Sea level rise is expected to affect low-lying coastal regions (approximately 0.5% of Mauritius), mainly along the southwestern shore of Mauritius Island and all of the Agalega islands which are all low-lying. Concern has been raised about coastal erosion, however, construction of seawalls and breakwaters, depending on the design, may increase the rate of erosion. Seawalls that induced coastal erosion are a matter of concern because such cases have been reported in Mauritius. Sea level rise is likely to cause flooding in houses and major roads along the coast.

One effect of rising ocean temperatures on ecosystems is likely to be increased coral bleaching. The ecosystem of mangrove forests may also be affected by sea level and seawater temperature rises. Tourism is a major industry in Mauritius and it mostly depends on coastal ecosystems and scenery. Consequently, the impact on tourism as a result of ecosystem degradation is of great concern.

The Government of Mauritius (GOM) responded by establishing the National Climate Change Committee in 1990 to mitigate the impacts of climate change; then in 1998 it established a Climate Change Action Plan in accordance with the United Nations Framework Convention on Climate Change. The Plan made the climate change adaptation measures—coastal protection measures such as seawalls and coral protection—a strategy of national importance. In 2000, the ICZM division was established and provision was made EPA 2002 for the ICZM Committee.

Emergency protocols concerning coastal disasters were compiled into the Cyclones and Other Natural Disasters Scheme (CONDS). This includes protocols for evacuation during cyclones, storm surges and tidal waves. Changes in policies on disaster management were observed after the flood in Port Louis in April 2014. A disaster management advisor was appointed for the formulation and introduction of new policies on disaster management in May 2013. The bill of the new policy on disaster management has been prepared and is being considered by the Government. A National Disaster Risk Reduction and Management Centre (NDRRMC) has been set up in 2014. The disaster management policies will be formulated under the National Disaster Risk Reduction and Management Committee, which includes introduction of the cross sectorial plan for disaster reduction, measures and management as well as the transition from the former scheme to the new NDRRMC.

10.3 The Project and Related Organizations

The Climate Change Division in the Ministry of Environment and Sustainable Development, Disaster, Beach Management (hereinafter referred to as MOESDDBM) is in charge of all projects related to climate change adaptation such as the Africa Adaptation Programme (hereinafter referred to as AAP). The coastal management projects (Adaptation Fund Programme (hereinafter referred to as AFB) funded by UNDP) are coordinated by the MOESDDBM. The Indian Ocean Commission (IOC) is also one of the stakeholders in the field of disaster risk reduction. The mandate of IOC is to coordinate development objectives, including disaster risk reduction, amongst its five Indian Ocean nations; Mauritius, Comoros, Madagascar, Reunion (France), Madagascar and the Seychelles. The IOC has a unique approach compared to other development partners.

The JICA Expert Team (hereinafter referred to as JET) suggested launching a committee called CADMaC (Climate Change Adaptation and Disaster Management Committee) for collaboration and exchange to avoid overlapping or similar activities which may overburden the related sectors of Mauritius government organizations. However, this function already existed in the MOESDDBM. Therefore, the JET decided with the recommendation of the counterpart organizations to reduce the tasks of CADMaC into "Climate Change Adaptation and Disaster Management Group" which consists of a Chief Advisor and a Co Chief Advisor of Coastal and Landslide management components. The Group shall grasp the progress of other related projects and share information to reflect their outcome on the Project.

10.3.1 Government Agencies and Organizations of Mauritius

Disaster management in Mauritius basically comes under the "Cyclone and Other Natural Disasters Scheme" as the national strategy against the expected natural hazards in the country. The Scheme has been updated and modified at the Prime Minister's Office (PMO). The natural disasters considered are landslides, cyclones, torrential rainfall and tsunami, and describes actual action plans for evacuation procedures. The monitoring protocol, emergency warning for the residents, command structure, methodology of evacuation and specific plan with the responsible body are mentioned in this paper.

Maurice Ile Durable (MID) under the Prime Minister's Office was inaugurated in 2013. In the MID, the MOESDDBM has the important role of acting on environmental issues. The result of AAP is projected to the action plan. It`s called the "National Climate Change Adaptation Framework for the Republic of Mauritius" (12 December 2012). This framework is currently conducted by the Climate Change Division (CCD) of MOESDDBM. The Climate Change Information Center was established in August 2012 under the CCD.

There are changes in policies after the devastating flood in Port Louis in April 2013. The disaster management advisers were called to the Prime Minister's Office at the direction of the Prime Minister, and new policies have been formulated since May 2013. Anew disaster policy has been announced by the cabinet. It was announced that the government policies on disaster measures will be decided by the National Disaster Risk Reduction and Management Committee, and it is focused on a cross sectorial approach with government agencies, private sectors and other academic sectors. The new centre will not only be responsible for disaster schemes that deal with the aftermath of disasters but will research integrated disaster countermeasures (disaster risk reduction and prevention, and emergency relief and recovery efforts) by coordinating with public, private and academic stakeholders. It was also announced that the past disaster manual of "Cyclone and Other Natural Disasters" will be taken over by

the NDRRMC's new disaster scheme.

10.3.2 Development Partners

In relation with the Environment, Climate Change Adaptation and Disaster Management Scheme, there are 4 active development partners existing including JICA. In those programs, the following three components are related to the Coastal Protection and Rehabilitation.

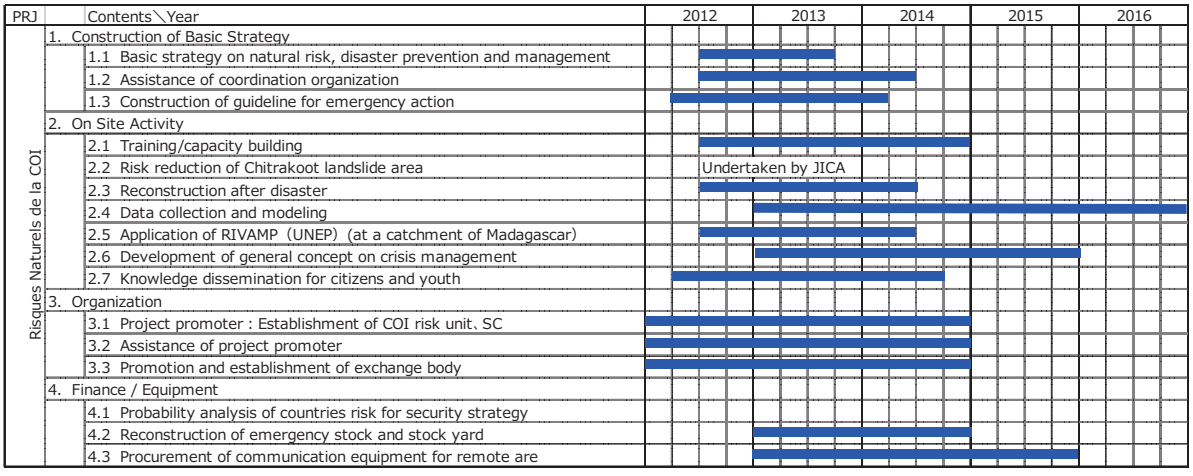
Table 10.3.1 Relevant Programs of Major Development Partners

Organization	Fund	Program	Major Components
UNDP (Japan)		Africa Adaptation Program（AAP）	・Integrated risk management of disaster ・Climate change adaptation on multi sectors
UNDP + GOM		Climate Change Adaption Program in the Coastal Zone（AFB）	・Design and execution of coastal erosion measures ・Emergency warning, evacuation, capacity building, Knowledge dissemination of coastal management
IOC	AFD, EU, etc.	Risques Naturels de la COI	・Risk management of natural hazard risks and disaster prevention in IOC 5 countries ・Knowledge dissemination

Source: JICA Expert Team

a. IOC (Indian Ocean Commission)

Almost half of the funding comes from AFD (Agence Française de Développement) and EU. IOC is conducting a project on disaster risk reduction and management (Risques Naturels de la COI) in the five island counties of Madagascar, Seychelles, Reunion, Mauritius and Comoros from 2011 until 2016. There are altogether 16 components including the Chitrakoot Landslide Monitoring Program which is currently undertaken by JICA. The project components and schedule after 2012 are shown in the figure below.



Source: JICA Expert Team compiled based on project brochure of COI-RN

Figure 10.3.1 Major Components of IOC Program

Other than JICA's project component of Chitrakoot Landslide Monitoring Program, the similar or duplicated components are as follows;

2.1 Training/capacity building

2.3 Reconstruction after the disaster

2.6 Development of general concept against risk management

2.7 Education activities for citizens and youth

Information on these areas of duplication is to be shared with the IOC, and adjustment of the respective actions will be discussed. The Stakeholder meeting was held on 22 June 2012. The current status and the future direction of the Project were discussed. Following the meeting, the site excursion to Chitrakoot was conducted. The explanation of the landslide and the future activities were made by the JICA study team to the stakeholders of the IOC on 23 June 2012.

The final workshop was held in October 2014. The major outputs of the projects are 1) identification on needs and requirements with regard to natural disasters, 2) description of mission and 3) framework formulation on general management and reduction of natural disasters.

b. Climate Change Adaptation Programme in the Coastal Zone of Mauritius (AFB)

This Project was announced to be started before the commencement of the JICA Project. However, TOR and the implementation organization structure of the Project became effective at the inception workshop which was held in August 2012. The AFB has five components described as follows;

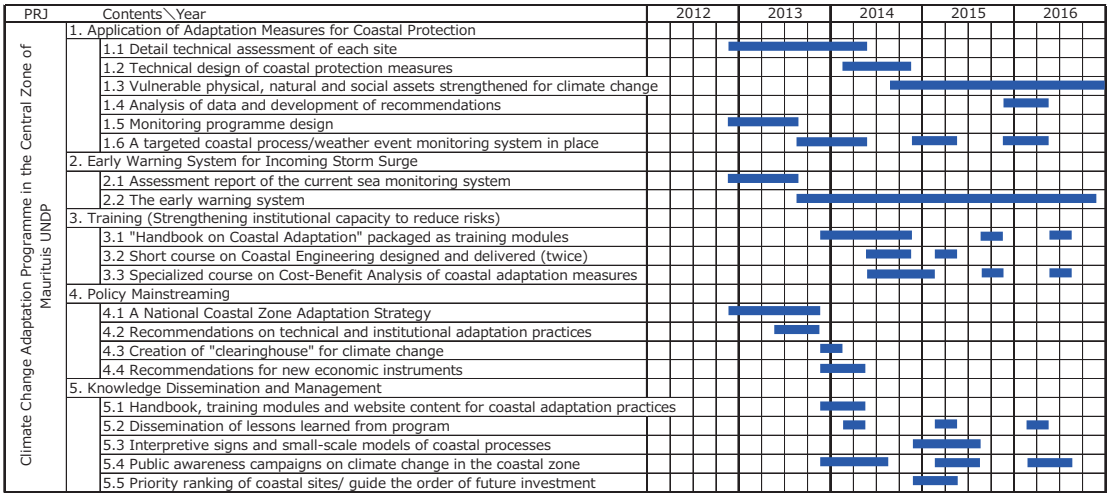


Figure 10.3.2 Major Components of AFB program

It is planned to initiate the design and execute the protection against coastal erosion at the two coasts of Mon Choisy and Riviere des Galets and the construction of a refugee centre at Quatre Soeurs, for which a total budget of 5,755,650 USD has been assigned for the component of *1.2. The evacuation platform against high tides*, which is also under consideration. Several components of the Project are similar to JICA's coastal protection and rehabilitation projects. Therefore, it is necessary to exchange information effectively as well as to accommodate the duplicated programs.

UNDP covers all up stream coordination activities, and the actual implementation will be executed by the Project Manager put in place in MOESDDBM. All issues of respective projects have been dealt with by closely exchanging all available information. The members are now working on the TOR for major activities which will be contracted out to private firms through tendering. Not only coastal areas but also for landslide portions. Also the Project

Manager of AFB participated inthe technical transfer seminar held by JET.

c. AAP (African Adaptation Program)

This Project was announced to be started before the commencement of the JICA Project. However, TOR and the implementation organization structure of the project became effective at the inception workshop which was held in August 2012. The AAP is targeted to 20 African countries for Climate Change Adaptation funded by Japan. Several components are covered by the program and it was completed in December 2012. The Program is titled Development of a Disaster Risk Reduction (hereinafter referred to as DRR) Strategic Framework and Action Plan, (December 2012, Studio Galli Ingegneria S.p.A. in association with Centro Euro-Mediterraneo per I Cambiamenti Climatici S.c.a.r.l and Desai & Associates Ltd)

Other preliminary consultancy services operated in the AAP are as follows:

- Consultancy Services for Review & Drafting of Climate Resilient Policies and Legislation
- Consultancy Services for Mainstreaming Climate Change Adaptation in the Development Process of Tourism, Fisheries and Agricultural Sectors and also for Rodrigues
- Climate Change Adaptation Planning and Design of Buildings in Mauritius

The results of the AAP were projected to the action plan called the "National Climate Change Adaptation Framework for the Republic of Mauritius" (12 December 2012). This framework is currently being conducted by the Climate Change Division (CCD) of MOESDDBM. The Climate Change Information Center was established in August 2012 under the CCD.

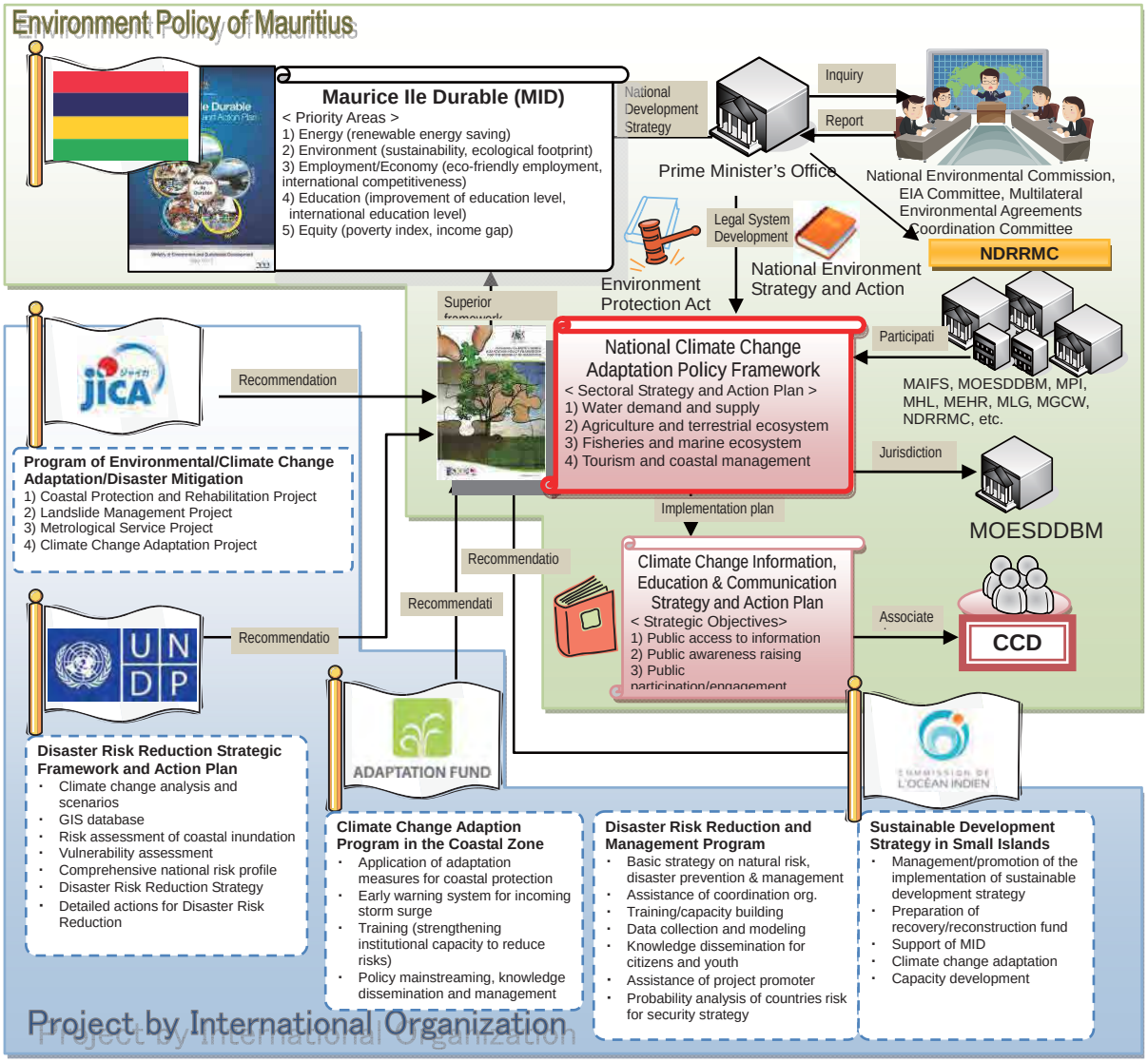
Including DRR, in total, 39 projects are planned within five categories, of which cross sectorial programmes have the highest priority. The project period is set from 2013 to 2015, and the major projects (funded projects) are as follows;

1. Preserve a healthy natural environment (45,000,000 MUR)
2. Coastal Management Plans for Inundation (45,000,000 MUR)
3. Sound Spatial Data Infrastructure (270,000,000 MUR)
4. Flood Management Plans (937,000,000 MUR)

Currently the Project of Coastal Management Plans for Inundation is active. However, only the project "Preserve a healthy natural environment" has been budgeted and others are still in the preliminary phase without budgets. The other 35 projects, including cross sectorial ones, have not started yet. The goals of these projects are still far from being achieved.

10.3.3 Summary on Environment, Climate Change Adaptation and Disaster Management by JICA

The whole image of the relation between the projects on climate change and disaster management by international development partners (such as UNDP, AF and IOC) and the Government of Mauritius is illustrated in Figure 10.3.3. The Figure presents the projects related to climate change and disaster management. The frameworks are extracted based on the results and lessons learnt from these projects.



Source: JICA Expert Team

Figure 10.3.3 Relationship between CCD and related International Organisations/Ministries

The major outcomes of this project on coastal protection and rehabilitation are summarized as follows;

1. In the framework of climate change adaptation and disaster management, cyclones, unstable rainfall patterns and inundation caused by the sea level rise may be considered as coastal management. The coastal sediment budget is found to be decreasing in recent years though it was accreted in the past. The causes seem to be the increase of cyclone intensity and the deterioration of (coral) reef environments.

2. The coastal conservation plan is formulated under the framework of the JICA Climate Change Adaptation and Disaster Management package for the Government of Mauritius. The large scale structure for coastal protection may damage the current state of the landscape and coast. In general, coastal management shall maintain the current coast, and if needed, beach nourishment may be applied.

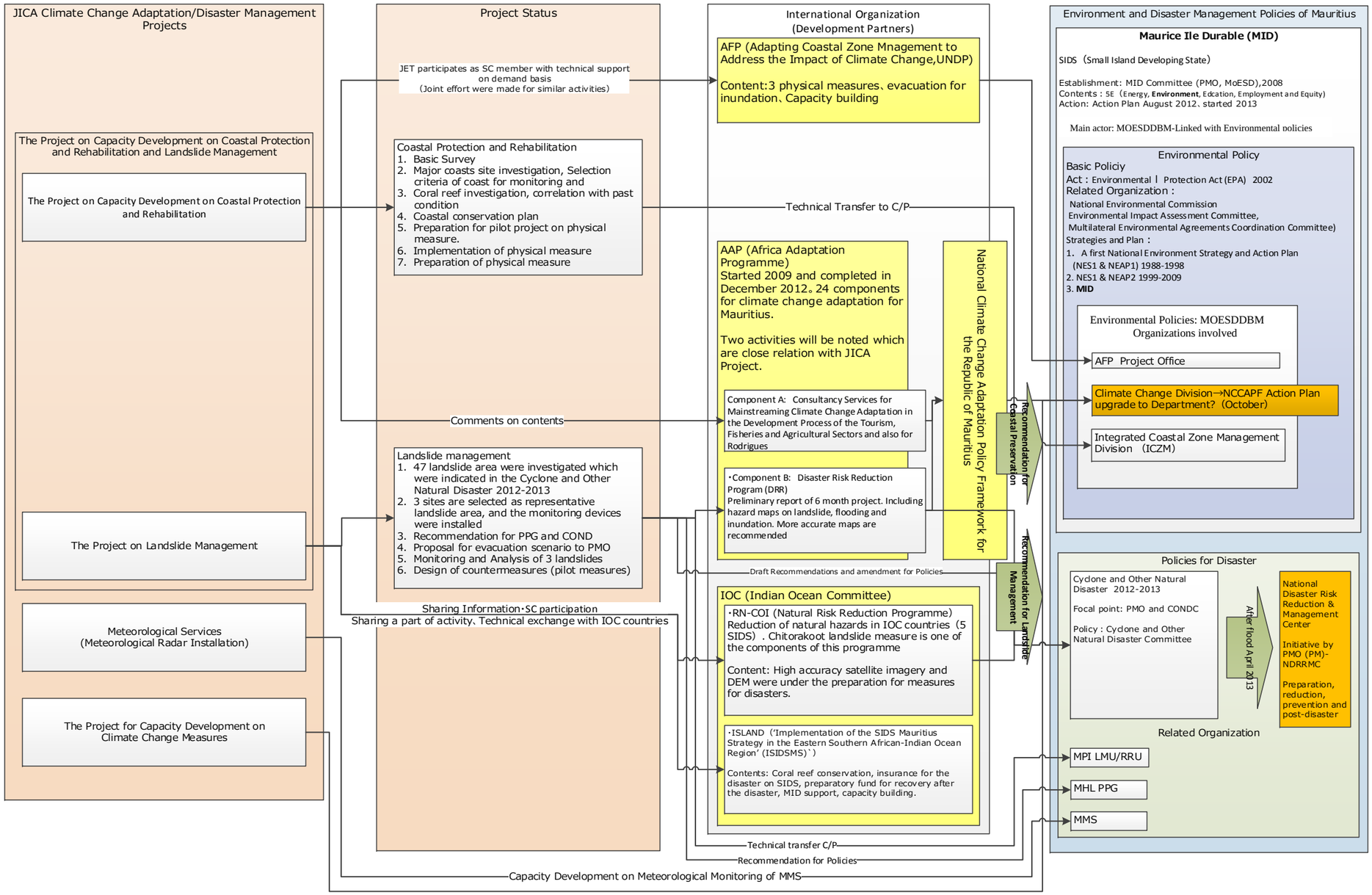
3. The coral reef is the source of beach sand and has a function of wave dissipation. The survey of corals shows that they are in a state of degradation. The causes are the increase of sea surface temperatures and eutrophication in lagoons. It is necessary to start the

mitigation measures even though the impact does not appear immediately. Regular monitoring, understanding the situation and the analysis are included in the action plan because the current information on corals, seagrasses and beach changes is limited. Together with this the plantation of corals and seagrasses is proposed based on the past experiences to rehabilitate the coral reefs.

4. Recommendations for effective coastal management were made. For the priority coasts the coastal conservation plan and management plan were formulated. The setback to reduce the risk faced by coastal areas is important for the adaptation to future changes in the climate. The existing setbacks were evaluated. Then the management of facilities in the setback zone was proposed together with the new setback limit for the cliff coast.

5. Flexible revetment of gravel was proposed to cope with the future sea level rise and wave overtopping. It is easy increase the height of such measures compared to conventional revetments and it can respond to changes. The effects were confirmed in the demonstration project. It is effective from both environmental and beach use perspectives.

These contributions are summarized in the flow chart presented in Figure 10.3.4.



Source: JICA Expert Team

Figure 10.3.4 JICA Climate Change Adaptation/Disaster Management Projects and Relation with Other International Development Partners, and the related Policies of Mauritius

Chapter 11

Conclusion and Recommendation

11. Conclusions and Recommendations

11.1 Conclusions

11.1.1 Status of Coastal Conservation

It is necessary to undertake measures to mitigate the degradation of corals and the sea level rise in the future together with the present erosion problems. This is concluded from the basic study of the beach changes, coral conditions in lagoons and the present status of conservation measures in Mauritius.

a. Coastal Change

The coastal changes were analyzed based on a series of aerial photo from six years over a 45-year period between 1967 to 2012 in order to understand the long-term beach changes. The target beaches are sandy coasts of 13 sediment cells and become 67 km in total length. The eroded beaches are 17 %, the accreted ones are 23% and the stable ones are 59%. Three sediment cells of the total sandy coasts are eroded, and the other seven sediment cells are partly eroded and accreted. The sand budget is accreted in total.

The changes in the short-term are larger than the long-term. The causes of these are cyclones, the growth of coral patches and the disappearance of seagrass. On the other hand, as for the changes in the long-term, the beaches accretion were continued until 1990 and after those beaches became stable. There is a possibility that the beaches will be eroded in the future. Therefore, if there is a change from a state of stability to erosion, then measures will be necessary.

b. Reef Environment

The coral reef has important function for the coastal conservation as it is the source of beach sand and decreases the energy of waves. Therefore, the coverage of live coral was monitored at 44 points by the spot check method. The mean coverage was 27%. The long-term changes of the coverage have been monitored by AFRC from 1998. The results show that the coverage at the fore reef decreased continuously from 50% to under 20% and at the back and shore reef it dropped from 50% to 10% or 20% by the increase of sea surface temperature in 2009.

The eutrophication of water is estimated as one of the causes of coral degradation. The condition is not understood because of the low accuracy of water analysis. The field observation shows that the coral coverage decreases with the increase of turbidity, chlorophyll *a*, nitrogen and phosphorus. Then the conservation of coral reef is necessary.

c. Coastal Conservation

The Cyclone Carol of 1960 caused beach and cliff erosion along the coastline of Mauritius and the erosion became 13 m at its maximum. Gabions of 3.5 km in length were installed after the Cyclone Hollanda in 1994.

In 2003 Baird pointed out after a detailed investigation that the sandy beaches showed a tendency of recovery after an erosion episode, and that these beaches would not recover if the system of coral reefs, lagoons and beaches were impacted by human activities. From these results it was recommended that the coral reefs and the dynamic beaches should be kept in

the natural condition and the structural measures shall be the measures of last resort. The sand mining in lagoons was banned in 2003.

After 2006, as a result of Baird's study results the coastal protection measures of removing of gabion revetments, construction of rock revetments, and sand nourishment were conducted. The implementation of these structural measures in the required coasts have almost finished. The rock revetment has problems of coastal use, environment and landscape because of its larger size, which is necessary for it to resist external forces.

The coastal zone is defined from the high water mark (HWM) to 1 km both in landward and seaward directions in Mauritius. The land from HWM to 81m inland is called Pas Geometriques and is owned by the state. It is used for commercial and private as a leasehold. The 30 m inland from HWM is the setback area where the construction of structures is generally not allowed. The setback before 2004 was 15 m and the existing buildings must be setback by 30 m when their leases come up for renewal. The structures for coastal protection need to obtain an EIA license. The systems are effective to decrease the disaster risk on the coastal zone though there are small problems.

The organizations for coastal conservation are Integrated Coastal Zone Management (ICZM) of MOESDDBM which is responsible for leading, managing and coordinating with related organizations in the coastal zone, the Ministry of Housing and Lands (MoHL) which is responsible for land management, the MoF which is responsible for the conservation of reefs environment, the Beach Authority (BA) is responsible for the management of public beaches, the Ministry of Social Security, National Solidarity and Reform Institutions (MSS) and Mauritius Oceanography Institute (MOI) which are responsible for conducting investigations and researches, the Ministry of Tourism and Lager (MoTL) which is responsible for tourism development and others. The management system for the integrated coastal zone has been developed, however, it was not observed in this survey that the related organizations were necessarily playing organically its role-sharing. Therefore, in this point of view this study conducted the technology transfer after clarifying the roles of each institution.

11.1.2 Coastal Conservation Plan

a. Strategy

The strategy of coastal conservation is proposed based on the basic study results and the related issues for three objectives which are coastal protection, coastal development and environmental conservation.

- To maintain and utilize the natural characteristics of the coast

Because the erosion along the sandy beach in Mauritius is a natural and reversible process, and the coastal structures are not necessary, it is important to maintain the sandy beaches as natural coasts. The natural sandy beaches are the resources of tourism which is one of the main industries in Mauritius, therefore these sandy beaches have to be maintained. Coral reefs, which have important functions of sand supply and wave dissipation together with the conservation of ecosystem and fisheries, should be conserved and rehabilitated properly.

- To build the abilities for natural and socio-economic changes in the future

It is necessary to strengthen the adaptive ability for the future sea level rise caused by climate change and economic development. Adaptive coastal management is going to be conducted by

the following procedures: setting the precise goals, implementation of the plans, monitoring the conditions, and evaluation of the results. It has to be conducted in order to accumulate and apply the information and past experience, and to develop measures and structures based on natural characteristics.

- To integrate coastal management with the collaboration of stakeholders

The coastal zone has to be managed in an integrated way for coastal protection, nature conservation and coastal use. MOESDDBM will manage the coastal zone by making decisions with the cooperation of related organizations. Each governmental organization plays their role in this integrated management system and strive make this process inclusive of local residents.

b. Coastal Conservation Plan

The coastal conservation and maintenance plans for the 14 priority coasts are formulated from the problems of the coasts, the classification of these coast characteristics and alternative measures.

In the coastal conservation plan, the principle is to keep the natural conditions through the setback and/or sand nourishment because the eroded coasts are limited from the baseline survey and the sandy beach is an important resource for tourism. The reef environment is also deteriorated. So conservation of the reef is included.

Sand nourishment is taken as a measure for coasts which are eroded as a whole. This is applicable for Mon Choisy. In this case the eroded volume is estimated at roughly $500m^3$/year which is feasible to implement without interfering with the beach use. Also, a combination of groynes is possible as was done at Pte. aux Cannoniers.

Sand recycling, coral farming or planting of seagrass will be applied depending on the causes and beach characteristics for the partly eroded and stable or accreted coast in total. If the erosion is partly caused by the disappearance of coral, seagrass and mangrove, sand recycling can be applied from the accreted area to the eroded area in the short term and rehabilitation of the coral, seagrass and/or mangroves will become a long term measure. This applies to the Bras d'Eau, Flic en Flac and Pte. d'Esny coasts. At Ile aux Cerfs, the problems are channel clogging and erosion at adjacent beaches caused by the topographic characteristics. The measures are sand dredging from the channel and sand recycling to the eroded beach. At Le Morne, the beach has eroded at one side and accreted at the other side by the jetty for anchorage. In this case, sand bypassing will be applied.

If the coastal changes are caused by cyclones or the degradation of coral or seagrass, it is necessary to apply the setback. From the existing information, the present setback of 30 m is reasonable. However, monitoring of changes to topographical features is required to make any necessary adjustments. In the project, the setback at cliff coast was studied at Albion as an example. The plans includes improvement or removing of vertical revetments to gentle revetments. The removal of facilities in the setback area is also proposed.

Coasts formed by silt or cobble with wide reefs are characterized by low-lying ground in the coastal area. These low-lying areas are considered to be at risk of wave run-up in the future due to high waves and/or sea level rise. As one of the measures, flexible revetment was

proposed. It imitates the local topography and material. The applicability is demonstrated by the demonstration project at Grand Sable.

Coral, which is the source of sand and which acts to dissipate wave energy, is deteriorated by the increase of sea surface temperatures. In order to recover losses, coral farming is proposed by the improvement of water quality and the regulation of activities in lagoons.

During the formulation of coastal conservation plans, technical committees and meeting by working groups were held in order to develop the capacity of related organizations. The basic information for the plan is limited so improvements can be made by evaluation from the demonstration projects and continuous monitoring.

c. Coastal Maintenance Plan

For the maintenance of the coast, reprofiling beach scarp which is easily formed by cyclones is recommended for the earlier recovering and the security of the public. In the setback area, the improvement of the vertical revetment to decrease scouring and the impact to the adjacent beach is recommended. In addition, monitoring and management of illegal construction as well as removing sand from the beach during beach cleaning is recommended.

d. Reef Environment Conservation Plan

From the time series analysis, the coral patch and seagrass bed in lagoons are clearly related to the coastal changes of erosion and accretion. The coral condition in Mauritius changed after 2000 from “good” to “failure” according to the comprehensive evaluation. The causes are estimated to be eutrophication, sediment inflow, fishing and marine sports in lagoons, anthropogenic causes together with the biological factors (crown-of-thorns starfish, etc.), coral bleaching and rises in sea surface temperatures.

To solve these problems, an action plan is recommended. It includes monitoring the reef environment by aerial photo and sea truth and water quality, analysing monitoring results, regulating human activities in a lagoon, controlling water quality in a lagoon, planting seagrass and coral farming. These activities will contribute to the rehabilitation of the reef environment and to the stability of beach.

e. Coastal Management Organization

For the planning of coastal management system, organization, information, education and communication, the ICZM frame work was already proposed by Landell Mills (2009) and has been approved by the Mauritius government. Implementation should be the focus point as a lack of action is the problem. Issues relating to implementation are the capacity development of responsible officials through the daily work, the exchange of information between related organizations, and the creation of measures based on the characteristics of Mauritius.

11.1.3 Demonstration Projects

a. Physical Demonstration Project

As a physical measure, flexible revetment made of sand and gravel was proposed when taking into account the natural characteristics of the site, the coastal use, the environment and land scape, and the ease to cope with future changes such as sea level rises. In the project, the evaluation of the revetment and the capacity development were considered.

Grand Sable at the southeast was selected as the demonstration site of physical measures. Here the coast is low and the coastal road will easily be impacted by wave run-up and future sea level rise. The revetment plan is 400m long with the height at 2 m and the width at 10 m with the slope at 1:5. A part of 240m portion constructed from October to December 2013. For the capacity development, planning, designing and construction management were carried out with the counterparts. For reaching an agreement and future maintenance, by the local people, meetings and events were held.

The monitoring results after one year show that the gravel and sand mix is almost stable. The sand is partly transported alongshore to the north area without construction but it is not a serious issue. The beach has various uses including boat landings, functioning as a playground for children, and fishing. It is clean compared to the pre-construction state. The smell and water quality has improved. The local people monitor and clean the beach voluntarily. The results can be applied to the other coasts.

b. Non-physical Demonstration Project

For the non-physical measures, the project was aimed at building consensus for the plan among stakeholders which include local residents. Pte. d'Esny at the southeast coast was selected as the site. Bungalows and houses are located along the coast as well as some hotels. Revetments and groynes were constructed for the prevention of coastal erosion in the past. The coast is accreted as a whole but partly eroded and the impacts of structures are expected.

Problems include the lease contract, the setback, the effects and impacts of existing structures, the mechanism of erosion and the conflict between individuals and overall conservation plans. The project tried to build a consensus of stakeholders.

The project direction and its proposed measures include rearrangement of existing structures and sand nourishment based on the erosion conditions and consultations with stakeholders. Several meetings with residence were held which proposed alternatives that took into account the opinions of the lessees. However it is difficult to get everyone to agree on the same thing.

The main problem of consensus building for this plan is removing existing structures and showing unequivocally that there will be necessary no impacts caused by the removal. It is necessary to show the similar examples by monitoring and accumulation of data and to obtain the residents understanding'.

11.1.4 Capacity Development

The Project was conducted to improve the technical capacity and to obtain engineering knowledge required in the practice. On-the-job-trainings were carried out through site surveys, beach monitoring, data analysis, task analysis, planning and the implementation of demonstration projects. Related guidelines were also formulated. Seminars, workshops, training in Japan, and technology exchange were carried out in combination. These are considered to be suitable for the technical level and the conditions in Mauritius. The capacity development is a long continuous process and these activities are believed to give opportunities to start it. Each person is expected to develop the capacity on his own initiative.

The technical guidelines proposed are for the natural and designing conditions of coastal conservation works, designing and planning of coastal structures, the monitoring of beach and coral conditions, water quality analysis, coral farming and EIA for coastal protection.

Improvement of those guidelines are recommended based on the own experiences in Mauritius.

The workshops were opened for the coastal conservation plan with related organization and residents to discuss its contents and to confirm the plan at the site. Seminars were held to inform the outline of the Project at the beginning and to disseminate the results at the end of the Project. The counterparts attended a seminar in Seychelles where a similar project was conducted. They reported the activity in Mauritius by discussions with the related people. These activities will contribute to enhance the engineering capacity in Mauritius.

11.2 Recommendations

In the past there were many recommendations to the coastal erosion and integrated coastal erosion management. It is better to concentrate on the important points with the limited human resources and financial conditions. In the execution of the coastal conservation plan, it is recommended that the actions should be carried out based on the proposed strategy by focusing on the following items.

11.2.1 Coastal Zone Management

It is recommended to emphasize on the coastal management in addition to structures in coastal conservation measures. The problems in the future are mainly caused by the change of environmental conditions and the plan is not effective because it is difficult to predict the future changes. The adaptive management procedures should be applied with monitoring for the improvement of the plan.

The past structural measures such as gabions and rock revetments cause problems and the construction works of these have been already completed at the target coasts. Then the management of coastal zone becomes important.

Setback plays an important role for the management of coastal erosion. The construction of new facilities is not permitted in the setback zone. However, some existing buildings are currently permitted within this setback zone, and this situation needs to be remediated. The 30 m of setback is reasonable at present. In future it is proposed to revise the value of the setback based on the monitoring results of beach changes caused by cyclones and sea level rise at certain intervals.

The beach is stable from a long-term perspective at present. However, it was greatly eroded by cyclones such as Carol in the past. That kind of erosion can be managed by the setback but causes problems of the beach usage. Beach reprofiling should be applied to advance the recovery of the beach after such events. During the project technical training was conducted and one organization (LEU) has been developed. LEU is expected to respond in emergency situations such as when cyclones cause beach changes.

Wave overtopping by long waves has become a clear coastal disaster on the low-elevated coasts where coastal road and fishing villages are located at the back of wide reef. Those areas will be easily affected by the sea level rise by the future climate change. The measures considered are the raising of the coastal road and the construction of revetments. It is necessary to consider not only the coastal protection but also the regional development and environmental conservation. For the specific plan, a topographic survey of coastal land is necessary and proposed with contour intervals of 1 m or 2 m because there are no accurate topographic data in Mauritius. The measures have to be discussed and implemented with

stakeholders which also include local residents such as the case of the consultation for the flexible revetment proposed in the demonstration project.

11.2.2 Monitoring

In particular the monitoring and the development of the results are recommended as a priority for the coastal conservation. The monitoring of beach profile and reef environment is indispensable for the planning of measures and management. The proposed monitoring methods for reef environment in this Project are feasible and practical. In future the application of satellite data and remote sensing techniques can be applied because of its rapid progress.

The monitoring methods of the water quality in the sea are not enough to evaluate its impacts on corals because of the unsuitable index and insufficient accuracy. Also there is no water quality standard for the conservation of corals. Here the measurement of Chlorophyll *a* and turbidity is proposed as indexes to understand easily the eutrophication in a lagoon. The regulation of lagoon water quality with the continuous monitoring are recommended after the establishment of the water quality standard for coral conservation based on the monitoring results.

In the past the monitoring data were stored as GIS data but not fully utilized. It is recommended that as a data center MOESDDBM has to distribute the data widely, to keep the accuracy and to show how to use.

11.2.3 Eco-engineering

The transplant technology for coral and seagrass has to be developed in the reef environment because these play an important role for the production and stabilization of beach sediment. It is proposed to study the reproduction and conservation of coral and seagrass in foreign countries and to consider its suitability for application in Mauritius as an initiative to protect the reef environment.

The development of nature friendly facilities is recommended such as the flexible revetment in the demonstration project as one of the measures in considering the environment and coastal use. From the observation at the actual beach and the improvement through pilot projects, nature friendly measures based on the specific conditions in Mauritius can be considered.

The sediment transport and beach changes are complex and not fully understood in the coral reef. The development of new erosion control measures for the coral reef coast is proposed with the observation of the phenomena by the use of donated wave and current gauges. Most of the beaches are stable in Mauritius. The eroded beach will be stabilized by analyzing and simulating the stable beach.

11.2.4 Stakeholders Involvement

The goal is to cooperate with stakeholders. It is recommended to obtain the participation of stakeholders to the implementation of coastal conservation measures not only by the government agencies but also the local people.

The coral and seagrass will contribute to stabilize the sediment in front of beaches. The hotel owners tend to be proactive in conserving coral and seagrass if they are informed of the

relevant facts.

In the planning and designing of coastal facilities, consultants have an important role for the proper solution. The development of technology for coastal facilities by the Engineers Association should be encouraged by the government. Furthermore, it is recommended that the relevant documents for understanding the specific coastal conservation and geomorphological conditions in Mauritius should be distributed to foreign consultants who are working in Mauritius.